ARCHITECT

SF Housing Crisis
Sound Photos
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False Idols

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The Journal of the American Institute of Architects

Holl in Houston

The New Glassell School of Art

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A Contents

Volume 107, number 8. August 2018.
On the cover: Glassell School of Art at the Museum of Fine Arts, Houston by Steven Holl Architects. Photo by Richard Barnes

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HIVE dares to challenge the best and the brightest individuals and organizations to research, validate, showcase, and model actionable solutions as a template for small, medium-sized, and large jurisdictions throughout America resulting in social impact, a cohesive purpose, and new opportunity areas to **Reignite the Dream: Affordability for Purpose and Profit.**

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Steven Johnson,
Author, *Wonderland* and *How We Got to Now*

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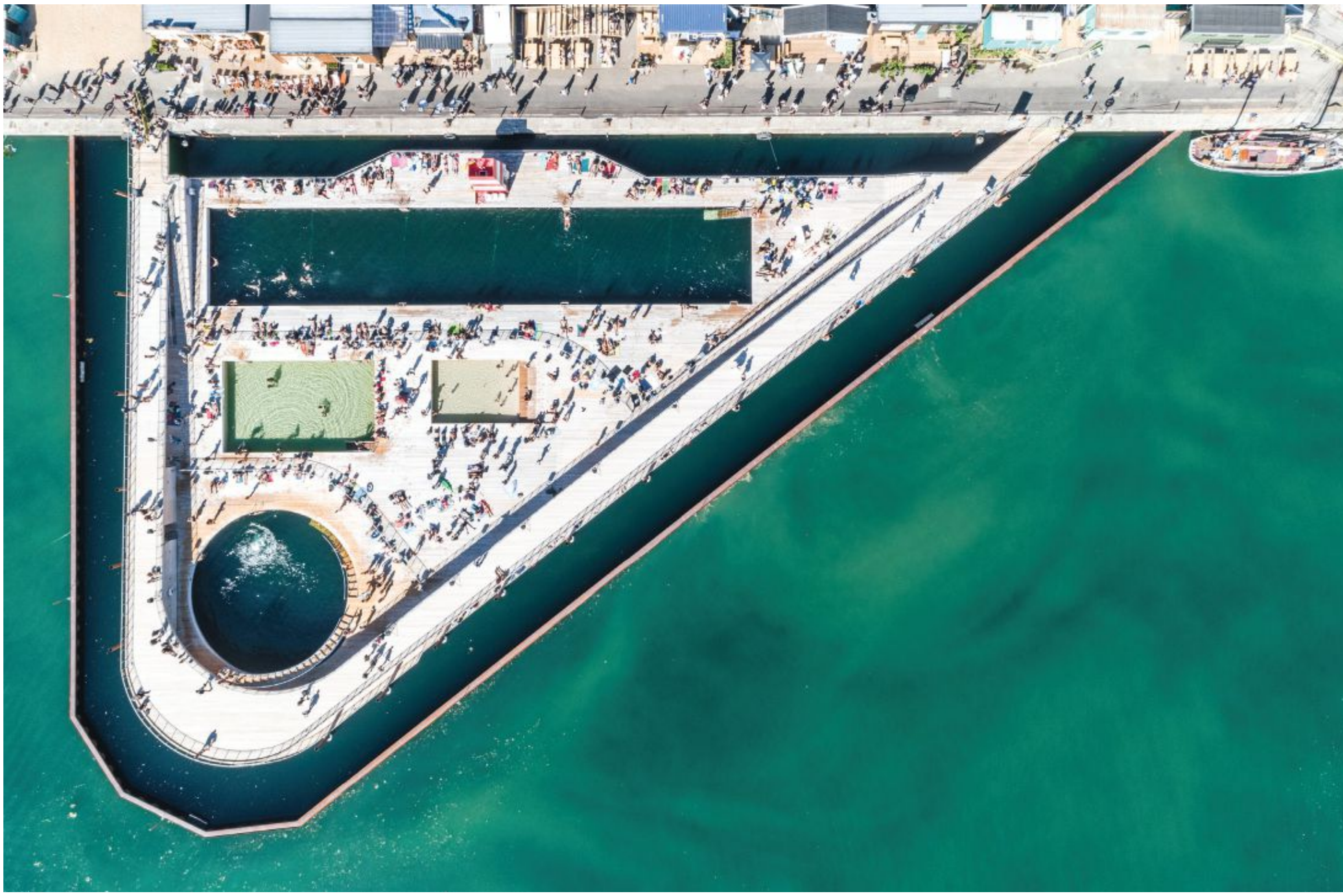
Utopian Brutalism

Covering projects ranging from Niko Kralj's Rex Chair to Uglješa Bogunović and Slobodan Janjić's Avala TV Tower, a new Museum of Modern Art exhibition highlights design in Yugoslavia. Open through Jan. 13, "Toward a Concrete Utopia: Architecture in Yugoslavia, 1948–1980" includes roughly 400 photographs, models, films, and drawings. The show features archival material from museums and personal collections as well as a modern-day perspective, like this 2016 shot of the Avala TV Tower (shown)—which was rebuilt in 2010 "to much public enthusiasm," says guest curator Vladimir Kulić, after the original was destroyed by NATO in 1999. —SARA JOHNSON

VALENTIN JECK

> *See more images from the "Toward a Concrete Utopia" at bit.ly/ConcreteUtopia.*



RASMUS HJORTSHØJ

Summer in the City

A new harbor bath in Denmark's second-most populous city isn't the Bjarke Ingels Group's first in its home country. In 2003, BIG completed the Copenhagen Harbor Bath for the most populous city, a project the International Olympic Committee recognized with a 2007 Best Public Recreational Facility honorable mention. Opened in early July, the Aarhus Harbor Bath (shown) features three pools of various depths for swimming and diving, as well as an additional 50-meter-long pool. Summer bathers can also view the under-construction AARhus, a mixed-use multifamily project BIG designed with fellow Danish firm Gehl Architects. —SARA JOHNSON

> *Visit ARCHITECT's Project Gallery for more images of the Aarhus Harbor Bath: bit.ly/AarhusBath.*

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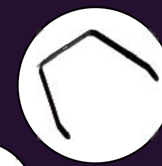

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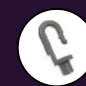

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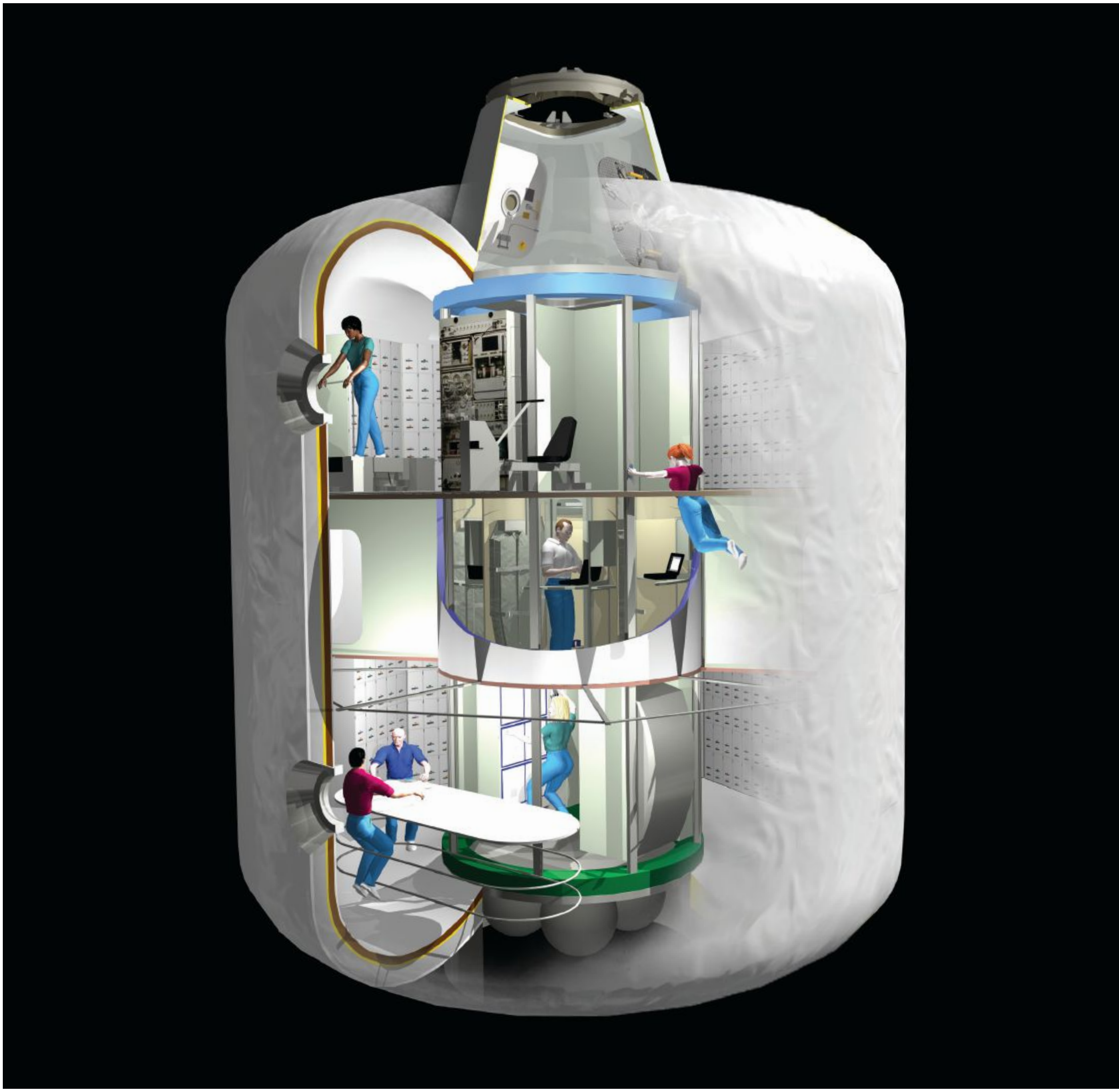


COURTESY NASA

A Champion of Space Housing

An architect by training, Constance Adams, who died last month at 53, gained fame for her contributions to NASA's TransHab (Transit Habitat). The four-level, inflatable module for astronaut living areas (shown) was designed to attach to the International Space Station, but the project never received the funding needed to deploy into space. During her time with NASA, Adams also worked on the BIO-Plex prototype for Mars, and in the late '90s she founded innovation consulting firm Synthesis International. In 2005, she was named a National Geographic Emerging Explorer for her work in "space architecture." —KATHARINE KEANE

> *Read more about Constance Adams' life and work at bit.ly/AdamsObit.*

NIC LEHOUX

Under the Arch

St. Louis has debuted a new attraction at its famous landmark: On July 3, the museum at Eero Saarinen's steel-and-concrete Gateway Arch reopened following an expansion and renovation by Cooper Robertson and James Carpenter Design Associates, both New York firms, with local firm Trivers Associates. The Museum at the Gateway Arch added roughly 45,000 square feet to the subterranean space formerly occupied by the Museum of Westward Expansion, and features a new glass entrance facing downtown. The $380 million CityArchRiver project also added new parkland over a highway, adding to Dan Kiley's landscape. —SARA JOHNSON

> *Visit ARCHITECT's Project Gallery for more information and images of the Gateway Arch Museum and Visitor Center: bit.ly/GatewayArchMuseum.*

Best Practices: Drone Imagery and Design Workflows

TEXT BY ZACH MORTICE

The use of drones to survey project sites is becoming more common among builders and engineers. For architects, unmanned aerial vehicles (UAVs) offer a distinct vantage point from which they can study and document sites for research and marketing opportunities. Below, practitioners and operators discuss strategies for incorporating UAVs into design workflows.

Embrace the Benefits

Drones are useful for architects throughout the design and construction process, from preliminary site analysis, to tracking construction accuracy and progress, and to documenting a completed project.

Russell Thomman, an associate project manager at Stantec's Austin, Texas, office, says his team uses drones for virtual site visits when it's too expensive, impractical, or unsafe for an entire team to travel.

But drone technology can also inform design choices. For a local mixed-use condo project, Thomman and his team took 360-degree photos every 50 feet before ground was broken at the site. Though initial plans called for positioning the building to the west, the team realized through the drone imagery that the building would essentially face a parking garage and the back of a hotel. They opted to reorient the project toward the east to overlook an expansive greenbelt. "It completely shifted the mindset of the entire design team," Thomman says.

Know the Rules

While it is possible to outsource drone photography to specialists with the appropriate licensing and equipment, tech-savvy firms can opt to try it in-house. However, understanding of the latest aviation laws is vital. In August 2016, the Federal Aviation Administration (FAA) released Part 107, which offers the most detailed set of regulations governing the commercial use of small unmanned aircraft to date.

Part 107, in conjunction with other regulations, dictates that commercial drone pilots must always keep their drone in their line of sight, flying no higher than 400 feet and no faster than 100 mph. In general, flying within 5 miles of an airport is discouraged and drones must yield to crewed aircraft. The FAA B4UFLY app offers UAV rules for a given area.

Most importantly, commercial drone pilots must pass a two-step testing and registration process. The FAA's $150 remote pilot certification test, offered at hundreds of locations nationwide, covers aircraft classifications, emergency procedures, and more.

But before investing money and time in purchasing and operating a high-end drone, Thomman recommends starting with a cheaper consumer drone—"something with a camera that you can fly in the park that you're not going to be too upset if you crash."

Beware the Limitations

The technology enabling drones to turn imagery into data is still advancing, but the imagery that UAVs capture has already charmed the greater public, making it particularly useful in project promotion. "Clients are still wowed by it," says Shann Rushing, AIA, a principal at Clark Nexsen in Raleigh, N.C., who also edits and packages the firm's drone imagery for project pitches. "It's not expected yet, unlike 3D renderings."

But just because clients are fascinated by this means of visualization doesn't mean it should become the centerpiece of project photography. Drone imagery of architecture is most evocative when it grounds a location in its context.

> "Superman fly-throughs don't really communicate how we, as humans, experience space."
>
> —Adam Goss, founder, Spirit of Space

Last year, Milwaukee-based architectural filmmaking company Spirit of Space incorporated two clips of drone video footage into a six-minute video of a conceptual residence by Steven Holl Architects in New York. These snippets impart a sense of sylvan isolation and the scale of surrounding landscape, but don't try to explain the space of the house itself. "Superman fly-throughs don't really communicate how we, as humans, experience space," says Spirit of Space founder Adam Goss. "For us, it's another tool in the tool belt."

> *To learn more about drone imagery and its applications in architecture, visit bit.ly/ARDrones.*

Detail: Patch22 Exterior Trusses

TEXT BY TIMOTHY A. SCHULER

A physical building model whose floors had yet to be glued down was the design genesis for the twisting floor plates of Patch22, a seven-story, mixed-use timber structure in Amsterdam by local firm Frantzen et al Architecten. The 58,000-square-foot, net-zero energy building was also developed by firm principal Tom Frantzen and his business partner, Claus Ossouren.

Despite appearances, Patch22's primary structure comprises a skeleton of timber columns and beams that join at right angles. The "twist" from floor to floor is achieved by sequentially extending the building's transverse floor beams—measuring 1.5 feet wide, 2.6 feet deep, and approximately 30 feet long—

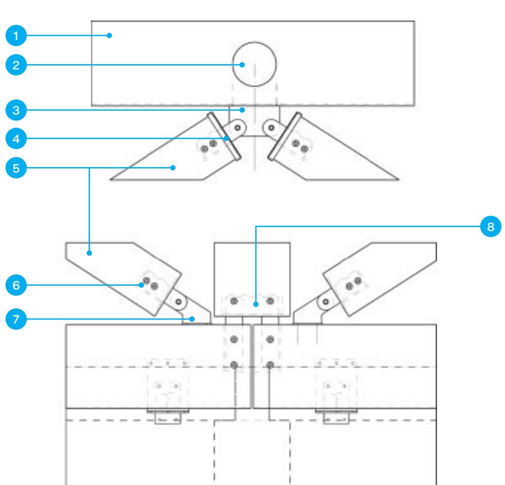
a foot further than its neighboring beam. The reverse happens on the building's opposite face, creating a parallelogram in plan.

Structurally, the balconies are stiffened by an exoskeleton of redwood trusses that tie into the floor beams via steel knife plates and a series of slim bolts ranging from 12 millimeters to 20 millimeters in diameter.

Moisture was among the biggest challenges when building with exposed wood, Frantzen says. "[T]he Netherlands are almost never totally dry," he says. "We have an ideal climate for microorganisms so if you get water inside your structure, the structure will start to rot immediately." Steel caps completely cover the ends of the diagonal web members where they connect to the top chord. Where they connect to the bottom chord, the steel plate is surface mounted to the lower chord, rather than embedded.

Moisture also dictated the coloring of the building. For Patch22's more solid east and west elevations, the architects specified fire-treated Douglas fir that had been pre-weathered. "If you didn't pre-gray the façade, it wouldn't gray evenly," Frantzen says. "You would get black lines."

Construction of Patch22 began in December 2014 and was completed in March 2016. As testament to its success, Frantzen and Ossouren are now constructing a second hybrid timber structure adjacent to Patch22.



1. 20" × 8" glulam chord
2. Ø10" hole
3. Steel knife plate with two M16 bolts
4. Steel end cap
5. 12" × 8" glulam web member
6. Steel knife plate with two M12 bolts
7. Steel shoe with M16 bolt and eight M10 × 120mm screws
8. Steel knife plate with six M12 bolts

LUUK KRAMER

> *To read more about Patch22's sustainable and adaptable design, visit bit.ly/ARPatch22.*

At MOTO, a panelized light frame wood wall system allowed each level to be framed in about a week and the entire project in less than a month. Photo: Ryan Gobuty

WOOD: REINVENTING MULTIFAMILY STYLE AND CONSTRUCTABILITY

Who says multifamily building design has to be predictable? MOTO Apartments is a masterclass in Type V podium ingenuity delivered on a tight budget, right down to the pre-built wall panels, horizontal massing, and cedar soffits.

You can't blame passing motorists and pedestrians for wondering about that cool-looking building on the corner of 8th Avenue and Sherman in Denver's trendy Capitol Hill neighborhood.

What's with the striking original art? The industrial-chic metal cladding? Or the offset floor-by-floor horizontal stacking? This six-story, 82,000 SF structure could be a hip, buzzy boutique hotel.

Tenants at MOTO Apartments can only smile.

The mixed-use development includes a four-story, 64-unit wood-framed apartment community over a two-level concrete podium housing an above-ground parking garage and two ground-floor retail spaces. In many respects, MOTO Apartments (short for "middle of town") is a classic Type V podium structure built to the developer's density and budget requirements.

Contextual, Neighborhood-Friendly Design

However, in aesthetic respects, it's anything but Podium Design 101. MOTO represents architectural ingenuity that honors context and 'of a place' design. "From a design standpoint it was an exciting challenge for us to take a familiar typology and do something new, interesting, and contextual with it," says Nick Seglie, AIA, LEED AP, senior designer at Gensler, the firm that designed MOTO.

The exterior opts for a horizontal aesthetic, unexpected for Type V buildings. The cantilevered, stacked floors play with mass, creating a dynamic offset look that suits the fashionable neighborhood. A passerby looking up discovers warm cedar soffits, a natural

MOTO's cantilevered, stacked floors play with mass, creating a dynamic offset look that suits the fashionable neighborhood. Photo: Ryan Gobuty

Warm cedar soffits are a natural counterpoint to the raw concrete base and industrial vibe of MOTO's metal panel cladding. Photo: Ronnie Leone

counterpoint to the raw concrete base and industrial vibe of the metal panel cladding.

One Month to Frame

The spirit of innovation carried over to construction, too. The project contractor recommended pre-built wall panels and BCI flooring and ceiling joists as a way to accelerate construction, reduce material waste, and eliminate rain-day downtime. The architect and developer quickly agreed to the proposal.

"Speed is really the most surprising feature of a pre-built strategy," Seglie says. "It took about one week to frame-up each floor. The entire building was framed in less than a month." Wall panels and BCI joists arrived at the job site on a just-in-time basis, perfect for a tight urban site.

Meets Code

"Permitting from the City of Denver code officials went well, Seglie said. "It was a smooth process. We received good collaboration from the City."

The interior sprinkler system complied with the NFPA 13 standard. "We even sprinklered all the balconies because of the cedar soffits. The tongue-and-groove soffits were treated with a Firestop sealant that also doubled as a clear sealer." Fire doors and smoke curtains at the elevator lobbies are interior features.

Winning Decision

Overall, wood played an instrumental role far beyond the structural elements and soffits. Wood was specified for the trellis and pool deck railings. The pine slab doors were made from trees killed by the Mountain Pine Beetle and reclaimed veneer pine. "Wood has lots of benefits. It's easy to work with. It's fast. Wood is often less expensive. We use it as a finish material as much as possible for its warmth," Seglie explains.

The developer is delighted by MOTO Apartments on several fronts. First, it was delivered on time and budget. Second, the continuing financial success of the property ratifies the developer's decision to go bold with aesthetic.

Seglie says, "That's the story of this project. I think many people get single-minded about this typology. With a little forethought, you can do a lot more with it than people expect."

Developer: Elevation Development Group
Architect: Gensler
Structural Engineer: Monroe & Newell Engineers, Inc.
General Contractor: PCL Construction
Timber Supplier: Foxworth Galbraith Lumber Company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Next Progressives: I-Kanda Architects

EDITED BY KATHARINE KEANE

Location:
Boston

Year founded:
2012

Firm leadership:
Isamu Kanda, AIA, and Marley Kanda

Education:
Isamu: B.S., Cornell University; M.Arch., Harvard Graduate School of Design (GSD) *Marley:* B.Arch., Barnard College; M.Arch., Harvard GSD

Firm size:
Three to four

How founders met:
In the streets of Cambridge, Mass.

Mission:
Our firm creates buildings and spaces that are modern, yet enduring—they are equal parts purpose and sculpture. We approach each project as a new array of needs and desires from which to conceive uniquely enhanced environments.


Isamu Kanda and Marley Kanda

Favorite project:
Cabin on a Rock is a 900-square-foot structure perched on a granite outcropping in the White Mountains of New Hampshire. Initially conceived as a rugged weekend getaway for two, the family of two grew to become a family of three, then four. The needs of our clients required maximizing the footprint while responding to the strictly limited availability of space on which to build.

The faceted geometry of the cabin reflects this evolution—a form that is elemental yet appears to be in constant transformation depending on the vantage point. This project was quite literally shaped by its surroundings and its occupants.

Second favorite project:
A seven-year-long, floor-by-floor, gut-renovation of an 1855 brick townhouse. We were the clients, architects, builders (until we wisely hired a general contractor), and occupants. This was one of our more exhausting and rewarding projects to date. It taught us endurance, phasing (in construction as well as in ideas), and the organic nature of the creative process with design as a mediator.

First commission:
In the last year of grad school, we were commissioned to convert an 1850s horse barn into a 5,000-square-foot loft-style residence. We lifted the entire timber frame structure on cribbing, poured a new basement, and clad the entire 40-foot by 100-foot volume in structural insulated panels. On the interior, we had a surprising degree of free reign, both structurally and programmatically. The dense grid of 8x8 posts and beams allowed us to weave floating volumes throughout to define habitable spaces—including four bedrooms and four-and-a-half baths—while preserving the original scale and openness.

The worst criticism you've ever received:
"I'm not sure why we need your services."

Special item in your studio space:
A Razor scooter. Our studio is in a large, converted industrial building. Wheels get us around quicker, and also keep the ideas flowing.

Design tool of choice:
Hands

Design aggravation:
Bad line weights, both drawn and constructed.

Vice:
Salami and Swedish Fish

Superstitions:
Ghosts—but more remnants and traces of the past, not so much haunting spirits.

> *To learn more about I-Kanda, visit bit.ly/ARIKanda.*

Next Progressives: I-Kanda Architects

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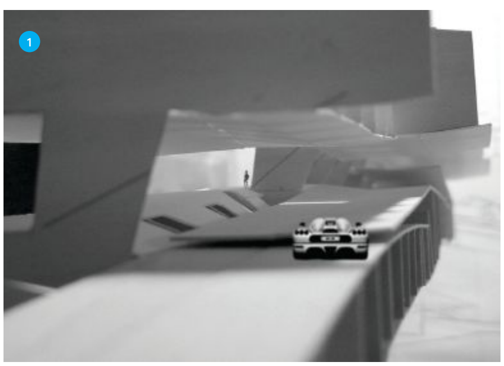

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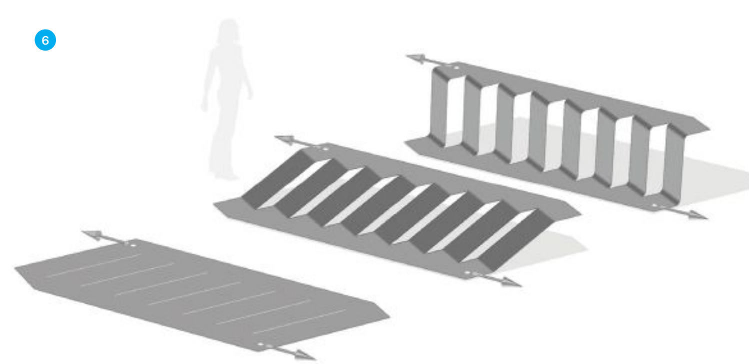
1, 5, 6: COURTESY I-KANDA; 2, 3, 4: MATT DELPHENICH



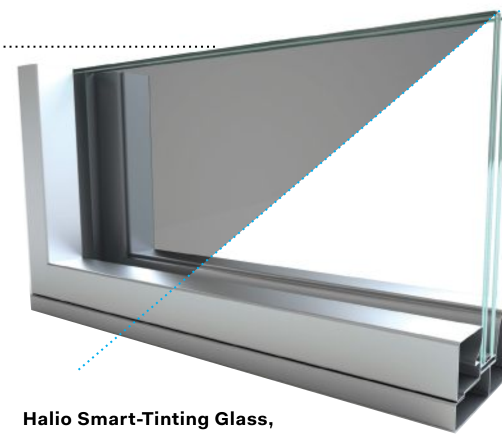
1. This proposal for a 54-unit housing complex in Boston features continuous ramps that elevate parking and living spaces above street-level pedestrian areas. 2. Cabin on a Rock, a 2017 Boston Society of Architects Small Firms Design Honor Award winner, perches on nine hand-poured, concrete footings. Many of the structural timber elements were precut to minimize site disturbance and construction time. 3. I-Kanda reoriented the kitchen of this 1915 Brookline, Mass., residence around an original chimney, which is now anchored by an "eroded, carved out" island to accommodate seating, according to the duo. 4. I-Kanda wove habitable volumes around the exposed wooden frame of a mid-19th-century horse barn in Sterling, Mass., to facilitate loft-like living in a historical structure. 5. The Housing for Regrowth affordable housing prototype is designed for refugees returning to Mosul, Iraq. The structure incorporates vernacular and modular elements to create repeating leaf-like apertures, some of which lead to private courtyards. 6. Conceptualized in collaboration with Washington, D.C.–based designer and fabricator Tomer Ben-Gal, Stretch Stairs is a research project that creates a warped set of stairs by pulling a slotted and perforated sheet of metal on diagonal ends.

Products: Glass

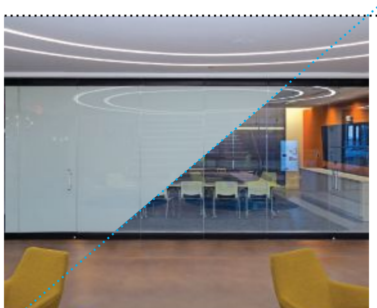
TEXT BY AYDA AYOUBI

Acuity Low-Iron Glass, Vitro Architectural Glass
Suitable for vision and spandrel glass applications, Acuity offers clarity and color accuracy without a green cast. Available with Vitro's Solarban high-performance, low-E coatings. *vitroglazings.com*

Honeycomb, Nathan Allan Glass Studios
Composed of 15" hexagonal cells in a 2.5" relief, Honeycomb is hand-cast for indoor and outdoor applications. Available in clear or low-iron glass, in annealed or laminated safety panels. *nathanallan.com*

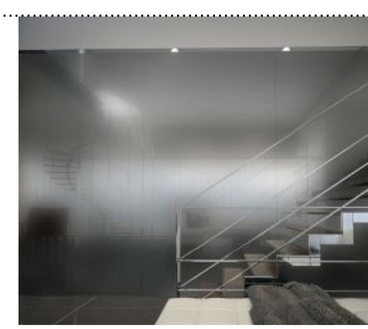


Halio Smart-Tinting Glass, Kinestral Technologies
A joint venture between Kinestral and AGC, Halio begins darkening within 15 seconds and reaches its ultimate tint in under three minutes, upon which its visual light transmission is 2%. *kinestral.com*



WhiteOut, NanaWall Systems
This frameless, dynamic glass wall system has a switchable privacy feature that transforms the panels from transparent to opaque at the touch of a button. Suitable for use in commercial spaces, such as offices. *nanawall.com*

Gallery Glass, Ann Sacks
Handcrafted in Italy, Gallery Glass is a laminated glass tile suitable for indoor and some outdoor applications. The 0.25"-thick tiles come in 24" squares and 12"-by-24" rectangles, and in seven colors. Resists freeze-thaw cycles. *annsacks.com*



SatinTech Mirror, Bendheim
For use in high-traffic spaces, SatinTech's laminated anti-glare architectural surface provides diffused reflections. The 0.75"-thick panel is available in sizes up to 60" by 120". Offered in shades of gray and a range of earth tones. *bendheim.com*

> *To read more, visit bit.ly/ARGlassProducts.*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Opinion: To End Abuse, Start with the Lone Wolf Myth

TEXT BY ESTHER SPERBER, AIA

I had always envisioned Richard Meier to be like his signature white buildings: dignified and stately. And then came the March 13 *New York Times* story detailing allegations of his sexual harassment and abuse of five women.

The #MeToo movement has exposed a widespread pattern of sexual misconduct by powerful men in the arts. Are these so-called "creative geniuses" simply taking advantage of their power and success, or is there a correlation between creativity and abuse?

The romantic image of the creative genius has long captivated Western culture. As a young adult, I was seduced by Howard Roark, the protagonist in Ayn Rand's *The Fountainhead* (Bobbs-Merrill Co., 1943) who is unwilling to compromise on the purity of his vision. Roark's readiness to destroy in the name of art was unmissable—he blows up a building when it fails to adhere to his design—but I completely missed his tendency to abuse.

In fact, it wasn't until two years ago, while I was writing an opinion piece about rape and consent, that I realized that Roark—portrayed as the paragon of the great artist—violently raped the woman he later married.

Western history has been told as stories of great white men who work alone and excel on their own merit. As a result, we have come to associate creativity with the image of these obsessive, solitary, brilliant people. Now, with the global economy shifting toward technology and innovation, the allure of the "creative man" has only increased; for example, the 2010 IBM Global CEO Study of 1,500-plus executives found creativity to be the most desired quality for leadership.

The problem with the myth of the creative genius is that it is a myth, an aggregate of cultural beliefs and biases that restricts our understanding of how innovation actually happens. In *Group Genius* (Basic Books, 2017), author Keith Sawyer argues that innovation more often comes from collaboration rather than from an individual. This is patently true in architecture, where buildings are realized only through teams of designers, engineers, contractors, and clients. Yet, until recently, many prestigious architectural awards only recognized individuals.

Creativity and masculinity have also been conflated for too long. Christine Battersby shows in *Gender and Genius: Towards a Feminist Aesthetics* (Indiana University Press, 1990) that the title "genius" in the arts and sciences was reserved for men for more than two centuries. Unfortunately, not much has changed. A 2015 Duke University study found that both men and women predominantly identify creativity as a male trait. When asked to evaluate architectural designs, men and women ranked projects that they thought were designed by a man as more creative.

But gender bias is not the most dangerous consequence of the lone-wolf image: It is the unspoken permission to abuse that should worry us. For the privilege of working alongside this aggressive and uncompromising genius, we are asked to tolerate his erratic, harsh, and selfish behavior. (In an intriguing twist, author Claire Dederer suggests that the monstrous man becomes a great artist in order to justify his bad behavior.) The genius thus wields power, feeding a vicious cycle in which male aggression is seen as proof of genius, which then opens the door to more abuse. Recent headlines suggest that when companies believe their success depends on that one male maverick, they are tempted to ignore or even facilitate his abuse.

To fight sexual abuse and abusers, we must first let go of this simplistic and fictitious image of the lone wolf. We need to open our eyes to the multiplicity of creative practices and celebrate the complex, nuanced, and more accurate understanding of how innovation happens. Only then will we stop overlooking contributions by all team members—and particularly those by women and minorities—and start developing new paradigms of creativity that leave no room for abuse.

Esther Sperber, AIA, is the founder of Studio ST Architects, in New York.

Architectural Lighting: 2018 Lightfair Innovation Awards

TEXT BY ELIZABETH DONOFF

In May, Lightfair International recognized outstanding product developments during its 29th LFI Innovation Awards ceremony, which kicked off the annual, eponymous trade show held this year in Chicago. A jury of lighting design professionals reviewed 238 entries across 14 categories. Along with naming the winners for each category, the jury selected four products that "exemplified the best in innovative design and thinking" and thus received the competition's highest honors.

MOST INNOVATIVE PRODUCT OF THE YEAR

NU4RD Vector, Alphabet by Ledra Brands · This dimmable 4" recessed downlight features LensVector dynamic beam-shaping technology and a liquid crystal lens optic that can adjust from 10 degrees to 55 degrees via Bluetooth. It offers app-based commissioning controls, scene setting, system grouping, and smart color-tuning. Offered with a color rendering index (CRI) between 83 and 98. *NU4RD Vector also won the Recessed Downlights, Wallwashers, and Multiples category. alphabetlighting.com*

DESIGN EXCELLENCE AWARD

Juno FlexConnect, Juno/Acuity Brands Lighting · Featuring MicrOptix technology and miniature silicone optics in 15-degree, 20-degree by 45-degree, and asymmetric light distributions, this linear-lighting system can be formed to follow curved channels and surfaces, field cut, and reconnected in 6" increments. Rated for indoor damp-location luminaires and indoor/outdoor IP67-rated luminaires. *Juno FlexConnect also won the Dynamic Color, Theatrical, Cove, Strips, and Tape category. juno.acuitybrands.com*

TECHNICAL INNOVATION AWARD

SolarSync Photosensor (GLS-LCCT), Crestron Electronics · Integrating a luminous intensity and correlated color temperature meter, SolarSync can match an indoor lighting system to the color and intensity of natural light. Typical power consumption is 70mW. A white acrylic, diffused dome tops the photosensor's IP67-rated housing, which measures 2.77" tall with a 2.69" diameter. *SolarSync also won the Controls: Components, Sensors, Interfaces, and Software category. crestron.com*

JUDGES' CITATION AWARD

Ores LiFi, LumEfficient · This fixed LED downlight also functions as a light-fidelity (Li-Fi) access point. Each downlight can serve up to eight Li-Fi USB keys and includes a high-power LED in neutral white (4000K) with a CRI of 80. Ores LiFi's pin-block molded housing is made of anodized aluminum and shielded by a perforated steel plate. With a faceted aluminum reflector and optical compartment sealed with tempered glass. Power-over-Ethernet (PoE) compatible. *lumefficient.com*

Architectural Lighting: 2018 Lightfair Innovation Awards

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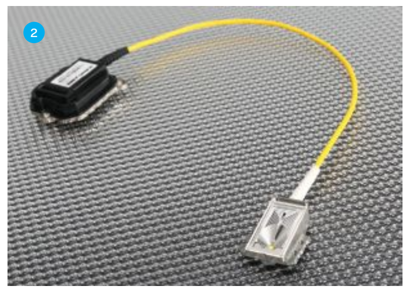

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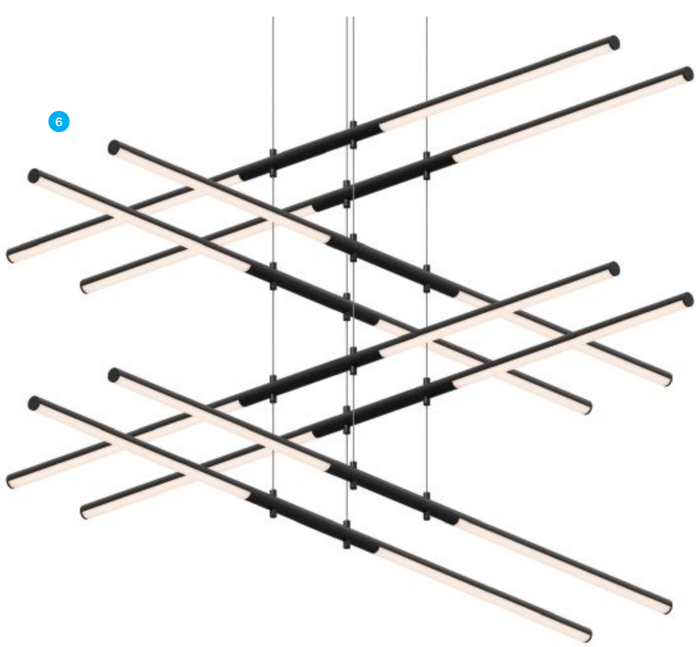


1. INDUSTRIAL, VANDAL, EMERGENCY, AND EXIT

ELM2LF Emergency Light, Lithonia/Acuity Brands Lighting · Providing at least 90 minutes of illumination in AC power failure scenarios, this wall-mounted luminaire is 5VA flame-rated in accordance with UL 94, impact-resistant, and corrosion-proof. *lithonia.com*

2. LED/OLED, CHIPS, AND MODULES

LaserLight Fiber Module, SLD Laser · This white-laser light module—the first to remotely deliver more than 1,000 megacandelas per square meter, according to its manufacturer—has an output of 400 lumens at 5600K and a CRI of 70. *sldlaser.com*

3. PARKING, ROADWAY, AND AREA LUMINAIRES

Gardco PureForm, Philips · This family of outdoor LED site and area luminaires can be specified with either comfort optics or precision optics, and offers a range of mounting heights, lumen outputs, and control options. *lightingproducts.philips.com*

4. LAMPS: CONVENTIONAL, RETROFIT, AND REPLACEMENT

HID LED 25W Lamp, Green Creative · Designed to replace 70W to 100W high-intensity discharge lamps, this 25W lamp delivers 128 to 136 lumens per watt and has a rated lifetime of 50,000 hours, according to the manufacturer. *gc-lighting.com*

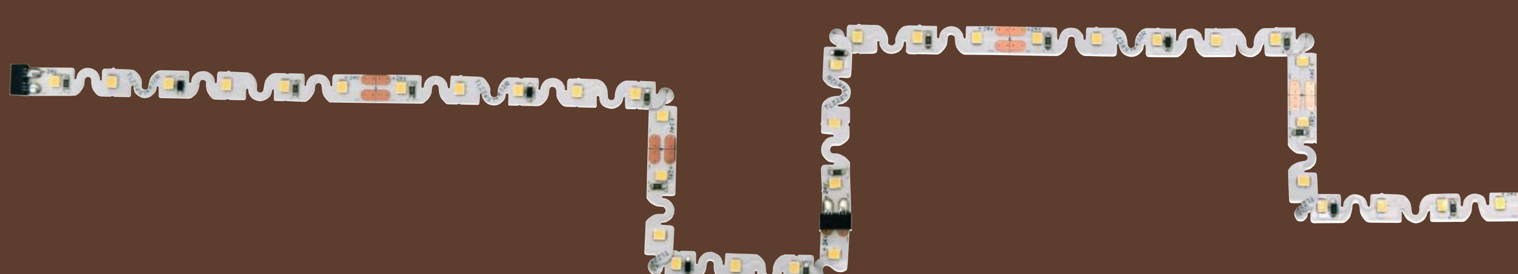
5. NON-LUMINOUS PRODUCTS: RESEARCH, PUBLICATIONS, SOFTWARE, AND SPECIALTY HARDWARE

Hekla, LEDiL · These low-profile 44mm-diameter connectors can transform one socket into a solderless connector. A twist-and-lock mechanism allows for quick lens attachment. *ledil.com*

6. INDOOR DECORATIVE

Tik-Tak, Sonneman · This suspended luminaire groups LED rods in pairs, specifiable in up to six tiers, to create dynamic and sculptural lighting configurations. Each 47.5"-long rod can be positioned as an uplight or a downlight. *sonnemanawayoflight.com*

Zig-Zag Tapelight



- Laterally bendable zig-zag design provides flexibility in applications requiring bends and arcs
- 24VDC for longer run capability
- Available in 20' reels consisting of connected, individual 12" segments; can also be purchased in individual 12" segments
- Quick and easy installation using ConTech connector system and accessories
- 5 year warranty when installed using aluminum channel

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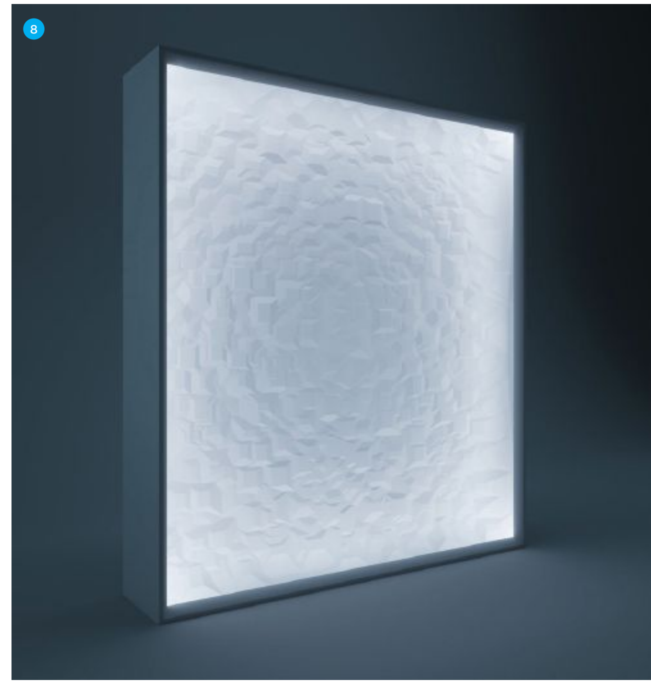
Architectural Lighting: 2018 Lightfair Innovation Awards

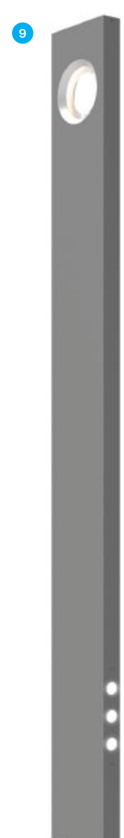


7. BALLASTS, TRANSFORMERS, DRIVERS, SYSTEMS, AND KITS

PoE-CP12-V1A, Iota Engineering/Acuity Brands Lighting · This LED battery pack (driver) converts a standard PoE luminaire into an emergency luminaire, enabling an additional 90 minutes of operation in a power-failure scenario. *iotaengineering.com*

8. COMMERCIAL INDOOR: TROFFERS, SUSPENDED, AND SURFACE MOUNTED

Chisel, Mark Architectural Lighting/Acuity Brands Lighting · This family of indirect recessed LED luminaires offers five sizes—1' × 2', 2' × 2', 2' × 4', 1' × 4' and 6" × 4'—and tunable white illumination options as well as directional gradients. *marklighting.acuitybrands.com*



9. SPORTS, STEP, LANDSCAPE, POOL, AND FOUNTAIN LUMINAIRES

Portal, Hess America · This 8'- or 10'-tall architectural column, for exterior and interior public spaces, features an anodized aluminum bezel around the ringed light source aperture for a design accent. Available in 3000K or 4000K with a CRI of 80-plus. *hessamerica.com*

10. CONTROL AND DISTRIBUTION SYSTEMS, CONNECTIVITY, AND ANALYTICS

Raccess, Legrand · This first offering from Wattstopper's Connected Services suite of services provides remote diagnostics and technical support for digital lighting management and architectural dimming lighting control systems. *legrand.us/wattstopper*

11. TRACK, DISPLAY, UNDERCABINET, AND SHELF

Supersystem II, Zumtobel · This slim-profile LED spotlight track system uses a 1"-wide H- or U-shape track to provide general, accent, direct, indirect, and wallwashing lighting options, and with LED modules in 2700K, 3000K, and 4000K. *zumtobel.us*

Residential: Process Architecture

TEXT BY CHARLES LINN, FAIA

"Regardless of someone's disability, mental health issue, or income, they should have access to a sense of volume and natural light," says Fielding Featherston, AIA, principal and founder of Orlando, Fla.–based Process Architecture, which designed a transitional housing prototype for a local healthcare provider intended for replication across the area.

With more than 50 facilities and 1,400 staff serving over 35,000 clients annually, the nonprofit Aspire Health Partners is one of Florida's largest providers of behavioral health services. Because transitional housing is often crucial to getting people back on their feet, Aspire both rehabs residential properties it buys and builds new houses. So far, the company has built four of Process Architecture's prototypes in Orlando.

Funding for the houses came in part from U.S. Department of Housing and Urban Development (HUD) Community Development Block Grants, as well as HUD Housing Opportunities for Persons With AIDS (HOPWA) grants. According to Todd Dixon, Aspire's director of development and community relations, the prototype houses serve high-risk HIV/AIDS clients and LGBT homeless youth.

Aspire's holdings in the houses' surrounding neighborhood include a campus that covers an entire block and 14 other parcels, some with houses on them and some where more houses may be built in the future. "We looked

Each house is clad in stucco over concrete masonry unit walls, with an Azek deck-board rainscreen.

Project Credits
Project: Aspire House, Orlando, Fla.
Client: Aspire Health Partners
Architect/Interior Designer: Process Architecture, Orlando, Fla. · Fielding Featherston, AIA, architect (owner and principal architect)
Mechanical Engineer: MechaniCals
Structural Engineer: William F. Stuhrke
Civil Engineer/Landscape Architect: B&S Engineering
General Contractor: R.C. Stevens Construction
Size: 1,260 air-conditioned square feet (1,611 gross square feet)
Cost: $186,000 (average cost of four constructed)

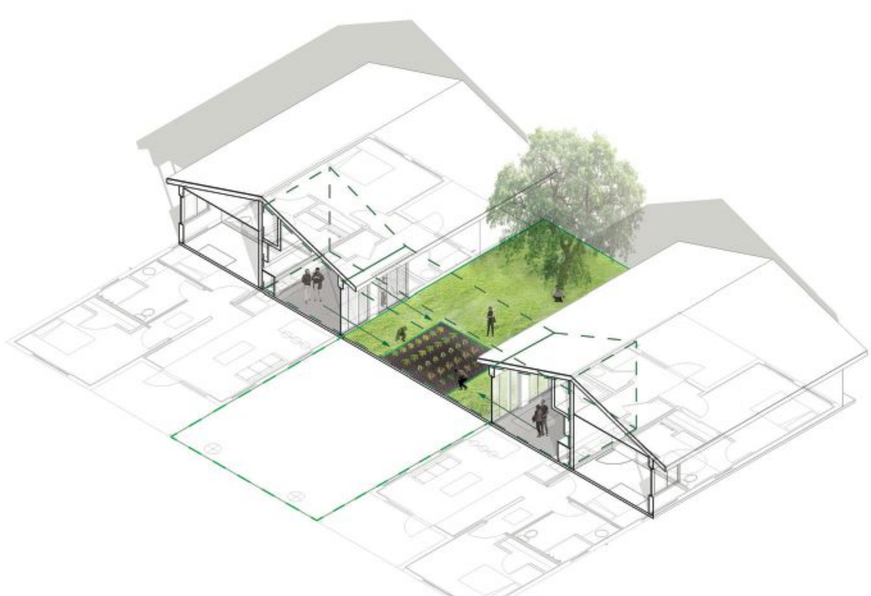
CHAD BAUMER

> *See more images of the Aspire House at bit.ly/AspireHouse.*

Residential:
Process Architecture

Floor Plan

Proposed Site Plan for Neighboring Houses



at the bungalows they [Aspire] had built, which had a lot of compartmentalized space, like dining rooms that nobody used," Featherston says. "We said, 'Let's simplify this and do something inspired by the simple, vernacular Florida shotgun home, but do it in a modern way.'"

Featherston designed daylight-filled healing spaces with vaulted ceilings and clerestories. Plan-wise, the 1,260-square-foot houses are split lengthwise down the middle into shared and private spaces. In a typical shotgun fashion, the living, kitchen, and dining areas are continuous and open, bookended front and back by porches. Three bedrooms and two baths, one of which is ADA-compliant, are grouped on the private side.

"Rather than think of this as a living room and kitchen, we refer to it as community space that extends outside," Featherston says. In the future, he says that two of the houses could be mirrored in plan, with the potential for additional doors off the kitchens leading to a shared garden between the two houses.

With design and construction costs that averaged $186,000, the houses are bare-bones and low maintenance: The exterior features stucco over concrete block, topped by asphalt roof shingles; inside, floor tile and wall base, both vinyl, are found throughout. High-performance windows and air conditioning provide comfort during the hot Florida summers.

And the design was intended to blend in with its surroundings. "Our goal is to make these houses look as much as possible like the neighborhood," Dixon says. "We didn't want there to be a difference between what you were receiving in terms of our support and what you would get if you were paying for it with your own money."

This house prototype could also have applications beyond Aspire. "Since we have copyrighted the design, we have had numerous requests to sell the house plans or to engage with new clients," Featherston says.

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Residential:
Process Architecture

1. Armstrong vinyl composition tile runs throughout the house, shown here in the combined kitchen and living areas. 2. Ample windows bring daylight into the compact space.

CHAD BAUMER

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VARIABLE REFRIGERANT FLOW (VRF) TECHNOLOGY IN HOSPITALITY DESIGN

Presented by:

MITSUBISHI ELECTRIC
COOLING & HEATING

Bicycle Hotel & Casino, Bell Gardens, CA. A VRF system delivered quiet, efficient comfort to all areas of this high-end hotel.

LEARNING OBJECTIVES

At the end of this course you should be able to:

1. Identify the unique challenges hospitality designers face when specifying HVAC systems.
2. Examine the technology behind VRF systems.
3. Analyze the performance and design benefits of VRF systems that can help solve industry challenges.
4. Evaluate two hospitality case studies where VRF systems were used to maximize occupant comfort and design flexibility.

CONTINUING EDUCATION

AIA CREDIT: 1 LU/HSW
AIA COURSE NUMBER: AR082018-1

Use the learning objectives above to focus your study as you read this article. To earn credit and obtain a certificate of completion, visit http://go.hw.net/AR082018-1 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.

HOSPITALITY AND HVAC CHALLENGES[1]

Hospitality is all about experience. Ambiance, atmosphere, and comfort contribute to guests' overall first impressions. If these qualities fall short, it is all too common to receive negative feedback and unwanted online attention. If, however, the experience is enjoyable, it often results in positive word of mouth, promotions, and return visits. A challenge to creating an experience, though, is that it involves both tangible and intangible qualities: sight, sound, and overall feel.

When it comes to hospitality construction and remodels, architects face several challenges in incorporating HVAC systems that bolster occupant comfort on all levels. The first is space. HVAC systems have traditionally been large, with outdoor units requiring ample square footage on rooftops or grounds. Indoor units and ductwork consume interior space in ceilings and plenums, and large mechanical rooms are often needed to house HVAC equipment, detracting from useable space.

In a business focused on usable square footage, this is problematic. An HVAC system should maximize an area's functionality, enabling architects to create more spaces for their clients, such as additional guest rooms and amenities. More useable space ultimately equates to more income-generating space and can lead to return visits and longer stays. Other major challenges are having to take acoustics into consideration as well as having to design around ductwork. Noisy outdoor and indoor units can contribute to a restless atmosphere devoid of comfort or ambiance.

It is also crucial for guests and staff to have personalized comfort. From guest rooms to lobbies to event and fitness areas, unique comfort demands exist in the hospitality industry. Variable Refrigerant Flow (VRF) heating and cooling systems, however, have the flexible efficiency to keep guests and staff continually comfortable. Systems can also be operated by staff or guests within each space, including the independent control of zones within a space. Zone control is highly accurate and stabilized by indoor units and controllers that sense temperature, humidity, lighting, and occupancy.

Sean McClellan, Chief Engineer for an inn and spa in Oregon states, "I never want to work with any other system ever again. Each guest has individual comfort controls in their room, which makes them happy, and for me, a snap to work with." McClellan reiterates that individual control over areas and zones minimizes complaints and maximizes comfort.

Hospitality companies are continuously exploring ways to exceed guest expectations without causing rooms and amenities to feel overly-programmed or cluttered with technology. For example, bathrooms can be upgraded to increase size and introduce technologies. The ductless ceiling cassettes of VRF systems take up less space than traditional HVAC technologies and are well-suited for making guest rooms and their newly smart bathrooms appear larger.

While modern, technologically savvy spaces add to a hotel's appeal, the hospitality's primary focus is always on the guests' quality of sleep. Whisper-quiet VRF indoor units offer a great advantage when it comes to creating luxurious spaces for a good night's rest or controlling the sounds transmitted within amenities.

VRF TECHNOLOGY[2]

The technology behind VRF systems helps to meet the variety of unique challenges faced by the hospitality industry. In addition to comfort, control, and quiet operation, VRF systems also offer energy efficiency and design and installation flexibility.

CASE STUDY—BICYCLE HOTEL AND CASINO

Photo courtesy of Mitsubishi Electric Cooling & Heating.

Bell Gardens, California

Since 1984, the Bicycle Casino has been a gaming destination in Los Angeles. With the addition of a new, 118,000-square-foot hotel, the Bicycle is now a high-end, boutique resort destination not just for patrons of the casino, but for anyone looking for a comfortable place to gather professionally or recreationally. The project team wanted a quiet and reliable HVAC system with a contemporary look to contribute to overall feel. The selected system would also have to meet the varying needs of the hotel's many guest rooms and amenities. The solution was Variable Refrigerant Flow (VRF).

The casino component of Bicycle is a dynamic gaming facility, attracting televised poker tournaments and their audiences regularly. For Doug Lee, architect at Lee and Sakahara Architects in Irvine, California, that meant creating a hotel concept and actual construction process that would not interrupt the use of the facility. It was also necessary to consider patrons' enjoyment. Lee stated, "To do that, [Bicycle] needed an HVAC system that was compatible with the iconic contemporary design concept and that offered minimal disturbance during operating hours."

Since those operating hours never end—the casino and hotel are open 24 hours a day—the selected HVAC system would have to work continuously and quietly. Lee said, "We recommended VRF from the very beginning. The hotel is right next to I-710, which is already loud. We needed a quiet system. And we were already using VRF on a hotel by Disneyland®, so we knew how quiet it could be."

John Ramirez, vice president of construction at R.D. Olson Construction, Inc. in Irvine, California, explained another challenge of the project: "It's a really large facility. The hotel is seven stories and has 100 rooms. The rooms are all large and luxurious. The hotel also includes a full spa, a restaurant, a bar, a brewhouse, a multi-purpose room, gaming areas, a coffee shop, a gift shop, [and] meeting rooms and offices, which include control rooms and management spaces." With such varying uses and spaces, "the challenge was to make sure every space was comfortable. VRF offered that."

Corey Hampton, commercial estimator for Thermal-Cool, Inc. based in Riverside, California, estimated the cost of the job and served as the project manager. He stated, "Three VRF manufacturers bid on the project: [the one we ultimately specified] fit the function of the building the best, which was about reducing the number of branch controllers. Having fewer branch controllers means having fewer ceiling access panels, which architects just don't like the appearance of, so [the system we chose] was better for the design."

Going with this manufacturer also meant working with a two-pipe system versus a three-pipe system. "When you have just two pipes, you save a lot of the cost on copper and at least 20 percent on labor. Minimizing labor is huge," said Hampton. Hampton also preferred the VRF system because of product quality and project support. He said, "This is our fourth time using this VRF system and so far it's been great. We've yet to have one service call—and service calls can be a real nightmare for a contractor! And then, with the hotel, we had project support the entire time. We really called on the manufacturer, and we got answers right away. They were even on-site for start-up. It's the best customer service I've dealt with."

The system's advanced controls are another plus; they offer smooth and effective daily operation. Ramirez said, "The management system allows an engineering staff to ensure the system is functioning as it's supposed to. You can put the management system in a central location, so everything can be overseen from one spot. A lot of ground is lost without a system like that."

Lee addressed the importance of a quick installation: "Initially, the management wanted the project completed in 10 to 12 months, so it was an aggressive timeline. We wanted a system that would help facilitate and speed up that construction." VRF's small footprint and flexibility offered just that: "We had the system installed in 50 days." Hampton explained that installation was made easier—and cheaper—because of the ability to go ductless:

"With ductless cassettes, the hotel saw a savings of about $350 per unit. That's by saving on things like labor for the installation, the ductwork itself, and diffusers." With 183 ductless units installed, the hotel saved more than $64,000. Ceiling cassettes also enabled the guest room entryways to be three to four inches taller, making the rooms feel bigger.

> "This is a higher-end boutique hotel and casino, so they wanted something more than just PTACs. We wanted the Cadillac of VRF systems. It was no question this was the right recommendation."
>
> –John Ramirez, vice president of construction, R.D. Olson Construction

The results have been reliable comfort and recognition. Built to be air- and water-tight, the hotel was certified by CALGreen and SoCal Edison, certifications that Ramirez described as "stringent."

The project team recognized the importance of VRF in earning these certifications but has been even more impressed by how the technology ensures a positive experience for hotel guests. Hampton said, "We've done so many big hotels. What I've learned is that, in hotels, you can really hear the air conditioning. With PTACs you just can't sleep. But VRF is super quiet. You can't hear it. For a hotel, that's a real advantage." Lee added, "I've been at this for 35 years now and I've never had such an interesting project. When you have management who says, 'We want the very best, so give us what you've got,' it's like having an open canvas to work with. They were receptive to new ideas like VRF, and they gave us a lot of latitude to design. The result has been great. Here's what says it best: The comments from visitors and word-of-mouth have all been positive."

VRF delivers quiet, personalized comfort for guests, contributing to a good night's sleep and an overall better experience.

In terms of energy efficiency, INVERTER-driven technology uses the minimum amount of energy needed to maintain set point conditions while adjusting to partial-load conditions which occur more often than not. Sensors monitor occupancy levels, and VRF systems with water-source condensing units can take advantage of the existing water loop system to provide more efficient cooling and heating. VRF systems can also simultaneously cool and heat by recovering heat energy that would normally be rejected into the condensing water loop.

Modular system design reduces or eliminates the need for mechanical rooms and bulky equipment on rooftops. The compact indoor and outdoor units are also ideal for tighter, smaller spaces, especially when compared to large trunks of ductwork. Wall-mounted and floor-mounted units require no ceiling space at all, leaving more room for higher ceilings or larger windows.

Precision.[3]

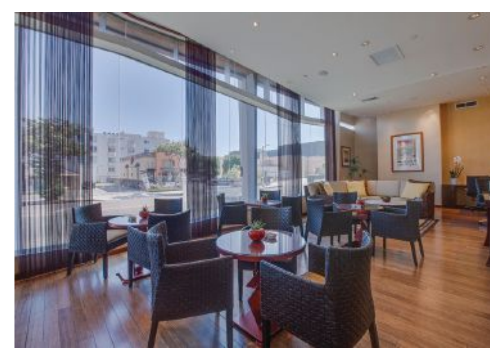
VRF systems offer design flexibility and space and energy efficiency. They also provide precise comfort control to buildings with multiple floors and areas by moving refrigerant to the zone to be heated or cooled. Not only is the refrigerant delivered directly to the area where it is needed, but the return air is measured at the indoor units, not a remote thermostat. This helps keep closer to set point temperature. INVERTER-compressor technology varies speed to match the cooling or heating demand, using minimal energy to meet space conditioning requirements while reducing energy consumption.

Many VRF units feature a two-pipe system that allows for simultaneous cooling and heating throughout a building without the need for a third refrigerant pipe. Two-pipe systems are easier and less costly to design and install. Two-pipe systems reduce the cost of the piping and decrease the number of connections needed to be made during the installation process. If the system is heat recovery, it will transfer heat from one zone to another zone within the building, rather than rejecting it outside the building.

VRF makes the most of square footage and utilizes new technology, which result in cost-efficiency. Compared to traditional HVAC systems, which according to the US Energy Information Administration can account for as much as 40% of a building's energy costs, a VRF system offers greater savings and efficiency across its lifespan.[4]

Zoning ability.

VRF systems separate a building's interior into user-defined zones, each of which can be operated independently; one room can be cooled while another is simultaneously heated. Outdoor units' compressors vary motor rotation speed, allowing systems to meet each zone's conditioning requirement while reducing overall power consumption. The system's total capacity is distributed to each indoor unit via the branch circuit controller, and the branch circuit controller works in unison with the VRF outdoor unit to provide simultaneous cooling and heating. The result is a facility where each zone can be customized.



VRF in dining areas keeps both guests and staff comfortable, without interrupting the carefully-crafted ambiance.

Design options.[5]

VRF has also been well-received because of the variety of unit styles that let architects design according to their vision without the traditional constraints of an HVAC or mechanical system. Compact equipment and lack of long run ductwork make VRF systems easier to design around. The result for the end user includes precise temperature control, elimination of hot and cold spots, reduced utility bills, quiet operation, and more space.

Ceiling cassette units offer high performance and are an excellent choice for hotel applications where ceiling space is available. Alternatively, perimeter areas can be more effectively used for indoor unit placement by specifying floor-standing models that are available as exposed or concealed indoor units. At less than nine inches deep, these units are easy to install in peripheral spaces, yet offer highly efficient cooling and heating performance. Their low operating sound and compact size make them ideal for hotel rooms. All VRF indoor units have relevant applications in hospitality, offering cost efficiency, space maximization, and design flexibility.

DOAS Technology.[6]

Part of the growing technology of VRF systems includes a Dedicated Outdoor Air System, or DOAS. DOAS technology is a split-system solution for acclimatizing outside air for commercial buildings and reducing sound in VRF applications.

A DOAS consists of a VRF outdoor unit and an air handler. The system is designed to handle 100 percent outside air with energy recovery models. It offers an energy-efficiency improvement of up to 20 percent over a traditional dedicated outside air system. Some models are pre-engineered to provide semi-custom flexibility. Heating options include modulating gas heat, electric, and hot water coils.

A DOAS not only offers improved efficiencies, but building owners can also save on operating costs. Units can better match the conditions of the targeted temperature and outside air, which results in significant energy reduction during mild and moderate months of the year. Other benefits include the following:

- Equipment location: allows for a distributed load on the roof by separating the condenser from the dedicated outside air unit by up to 50 feet.
- Humidity control: a single refrigeration circuit provides directly proportional reheat to the entire cooling load, allowing for room-neutral conditions and humidity control.
- Cooling capacity: 5 to 20 tons.
- Optional accessories: smoke detectors and condenser hail guards.

Overall, a DOAS is a stand-alone system that introduces pre-conditioned outdoor air separate from the building's HVAC system. A DOAS is multi-functional and offers reheat capabilities, as well as adjustable return air temperature. By separating the HVAC and ventilation systems via a DOAS, the capacity of an HVAC system can be reduced, which in turn reduces overall energy usage.

This article continues on http://go.hw.net/AR082018-1. Go online to read the rest of the article and complete the corresponding quiz for credit.

QUIZ

1. VRF systems offer
   a. control — b. quiet operation
   c. energy efficiency — d. design and installation flexibility
   e. All of the above

2. Traditional HVAC systems account for as much as 40% of a building's energy costs.
   a. True — b. False

3. Which of the following benefits are associated with Dedicated Outdoor Air Systems (DOAS)? Choose as many as apply.
   a. Allows a distributed load on roof by separating the condenser from the unit
   b. Has a cooling capacity of 5 to 20 ton.
   c. Always has a smoke detector and hail guard
   d. A single refrigeration unit provides proportional reheat to the entire cooling load

4. VRF systems can integrate into existing building controls.
   a. True — b. False

5. Once installed, VRF systems cannot be reconfigured.
   a. True — b. False

6. VRF systems add to energy efficiency. ____________ is delivered directly to the space being conditioned rather than moving conditioned air or water across a building.
   a. Refrigerant — b. Fire
   c. Smoke — d. Heat

7. Zone control in VRF systems is stabilized by indoor units and controllers that sense
   a. temperature — b. occupancy
   c. lighting — d. humidity
   e. All of the above

8. The Bicycle Hotel and Casino opted to use a _______-pipe VRF system, thereby saving on cost and labor.
   a. Two — b. Four
   c. Six — d. Nine

9. VRF provided the Élan Hotel with the following values: low noise, high energy efficiency, a reduced impact on the environment, minimal maintenance, and flexibility.
   a. True — b. False

10. VRF systems offer design flexibility for any application, including new builds and historic renovations. _______ percent of US commercial building stock was built before 1980.
    a. 30 — b. 40
    c. 50 — d. 60

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Mitsubishi Electric Cooling & Heating is an industry-leading manufacturer of innovative Zoned Comfort Solutions™ and Variable Refrigerant Flow (VRF) air-conditioning and heating technology that delivers comfort and efficiency to buildings of all shapes, sizes and applications.

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PHOTOGRAPHY: TODD WINTERS

Whose Architecture?

Strengthening communities, both inside and outside the firm.

Chyanne Husar, AIA, set a goal for herself in college: "I want to have an international firm by the time I'm 30." She was 31 when she attempted to establish a branch of her firm, HUS Architecture, in China. Now, however, she focuses her firm's efforts on Chicago and serves as the 2018 chair of AIA's Small Firm Exchange (SFx), all while working on building stronger communities inside the office and within the city she calls home.

As told to Steve Cimino

As a small firm, it can't be just about you; it's all about the little community you're creating. It's become a cliché to say that—everyone wants community—but it is really important. Adding one person to such a tight-knit group completely changes the dynamic, and we want to be sensitive and do our best to avoid gossip, balance team dynamics, and find ways to be inclusive by running our firm transparently. I've been able to use a small firm to follow my passions, but we need the passions of others as well. My firm is named HUS Architecture, pronounced "whose." It was originally just a play on my last name but has grown to mean "Whose is it, and how can you make it your own?"

A new employee recently asked, "So how many days off do I get?" and I realized we had yet to develop an official policy. That's where the Small Firm Exchange is so valuable. As architects we're trained to interpret client needs and translate that into built space, but as a small firm we need to deal with internal operational questions that are difficult to handle. It helps to know how similar firms tackle similar issues, and the answers aren't readily available on Google. Within the SFx, we aim to collect and curate the information that matters to architects like us. We're currently developing a sample business plan, figuring out how to grow future firm leaders, and using our collective power to advocate better healthcare solutions for small firms. Many of us try to use our own struggles and solutions to help others navigate the process more easily.

My experience with the SFx has helped me contribute to my clients' missions as well. HUS Architecture owes our start to subcontracts through the Chicago Housing Authority and Chicago's Public Building Commission. We've been able to grow our sustainability and affordable-housing expertise by serving as the glue that helps bigger firms provide consistent service. As we grow, we in turn will be helping the next generation of firms and leaders find a foothold in the industry; the SFx has given us the tools to do this effectively. By supporting each other—through guidance, mentorship, and fellowship—we all do better. Our practices do better, our psyches are better, and, hopefully, our communities ultimately benefit as well. AIA

AIANow

By Steve Cimino
Art Direction by Jelena Schulz

Postmodernism, Post-Criticism

The oft-maligned architectural style has developed an ardent following.

Postmodernism is having a moment again—or multiple moments simultaneously (in true Po-Mo spirit). Why? Whether you loved the Whites or the Grays, all that was new (but made to look old, or timeless, or Classical) is old now, and the historic preservation moment has finally caught up to Postmodernism. Two of the biggest fights in the country ask us to consider what "contributing structure" really means.

A prime example is **550 Madison Avenue** in New York City. Designed by Philip Johnson, FAIA, and opened in 1984, the former headquarters of AT&T and Sony proved undeniably unique and thoroughly influential. Never as defamed as other postmodern buildings, it's being renovated by Snøhetta with an eye toward opening up its lower floors to become more street-friendly.

When it comes to postmodern controversy, there's no more distinct target than the **James R. Thompson Center** in Chicago, designed by Helmut Jahn, FAIA. Also completed in 1984, this provocative government building has become a rallying symbol for Windy City preservationists and was recently championed by the documentary film *Starship Chicago* (2017) amidst swirling rumors of demolition.

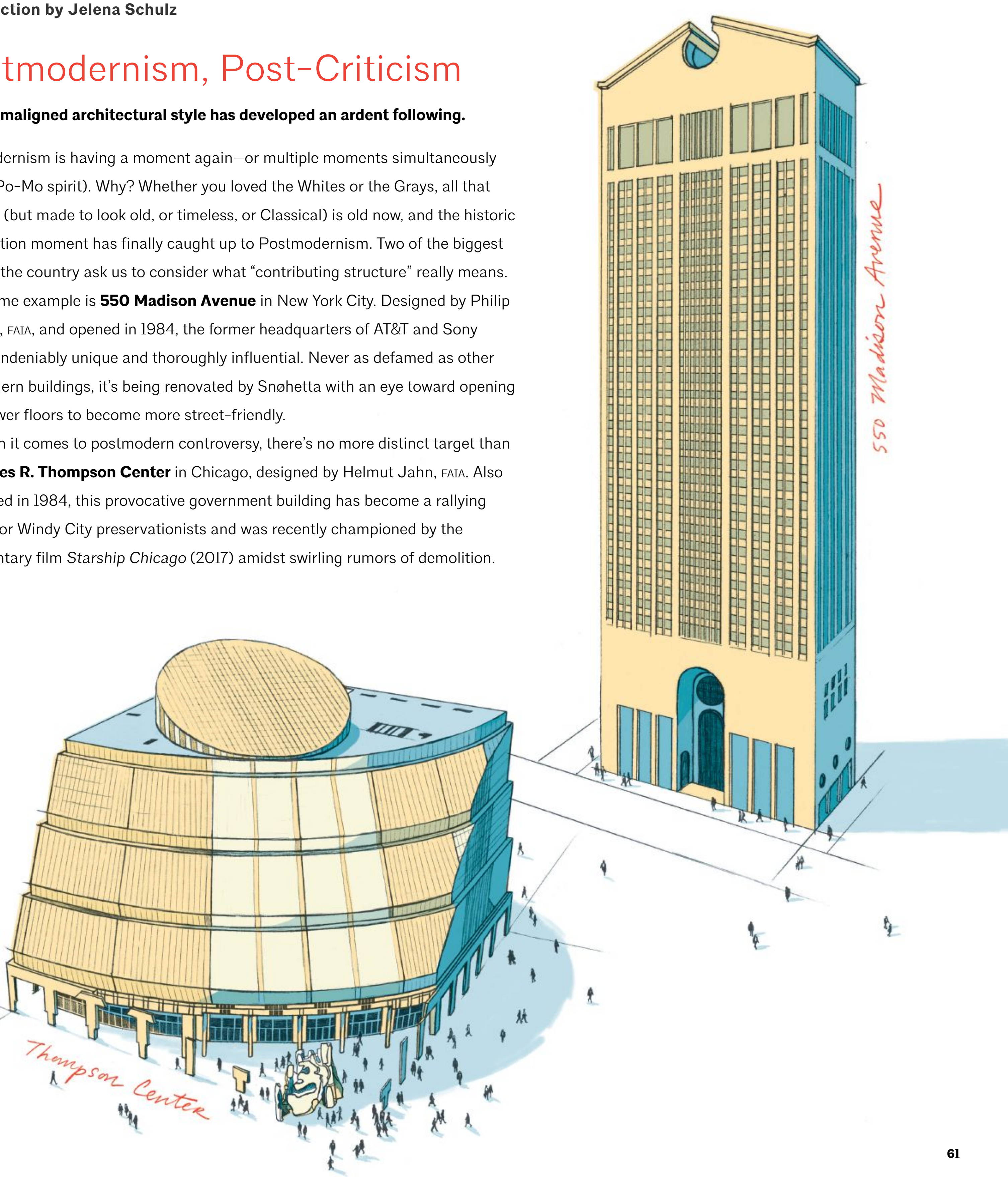

ILLUSTRATION: LAUREN NASSEF

AIAFeature

Fast, (not) Cheap, and Out of Control

Is infill the solution to San Francisco's housing affordability crisis?

By Katherine Flynn

PHOTOGRAPHY: MARKUS SPIERING / EYE EM FOR GETTY

San Francisco is adding more jobs faster than it is adding housing by a factor of eight. Median house prices have risen $205,000 in the last seven months. Rents are up 43 percent over the last decade. Where will it end?

San Francisco's affordable housing crisis peaked between 2007 and 2014, a period of huge demand and low supply. During that time, Bay Area municipalities issued building permits for only half the number of housing units needed to accommodate its rapidly growing workforce. Currently there is one available unit of housing for every 10 available jobs in the nine-county San Francisco Bay Area. But area activists, advocates, and architects hope to change that ratio through new infill strategies, one existing land parcel at a time.

The "Missing Middle"

Demand for housing is only going to continue to trend upward. No one—including current residents, employers, urbanists, and housing advocates—is questioning the fact that the area needs more housing, both market-rate and subsidized affordable units. Higher-density housing types—i.e., multifamily apartments—that blend in with single-family standalone homes such as the iconic Painted Ladies adjacent to Mission Dolores Park are seen as the "missing middle" that could relieve some of the pressure. However, since more than a third of the city of San Francisco is zoned for single-family use, filling in those gaps is currently impossible in many places. Homeowners are often wary of new construction, and they can be vocal about their concerns through California's extensive and circuitous permit-review process, which is so arduous that sometimes buildings are already outdated by the time construction is finished.

"People who are opposed to [new] development can show up to the meetings, and know how to play the political and legal system, so they can—if not kill a project—at least draw it out until the economic cycle is not as favorable, and then the project becomes economically infeasible," says Matt Taecker, AIA, principal of Berkeley-based Taecker Planning & Design and a recent chair of AIA East Bay's Regional and Urban Design (RUD) Committee.

"Dense urban infill," the urban planning term for the rededication of land in an urban environment for new usage, is one solution that advocates are increasingly pushing as the most logical solution to the Bay Area's housing woes. Prohibitive zoning, however, in addition to high construction costs, make new projects a challenging prospect. According to the Bay Area Council Economic Institute, the city is currently realizing only 57 percent of the full potential for infill housing development of its urban core. Urban designers and pro-development housing advocates have their fingers crossed for sweeping policy changes that will shift the way that developers can interact with existing space in the city.

Increasing Density Around Transit

In January, a bill to establish statewide standards for height, density, and required parking for new residential projects close to public transportation was introduced in the California State Legislature. Although Senate Bill 827 was rejected in April—with several lawmakers arguing that the provisions for affordable housing weren't strong enough—pro-development housing advocates saw it as an important first step toward instituting policy changes that would shift the way new development responds to a housing shortage that is now both acute and chronic.

One of these advocates is Laura Foote Clark, executive director of San Francisco YIMBY [Yes In My Backyard] Action.

"Something that was completely unimaginable a year ago is now part of the discourse," Clark says, noting that when her organization got its start several years ago, many people were telling them to tone down their message. "It's where we have to go next. We all know that it doesn't make sense to have single-family-only zoning next to a

AIAFeature
CONTINUED

BART [Bay Area Rapid Transit] station."

Housing advocates and policymakers are also concerned about whether government-subsidized affordable housing will be able to keep pace with the number of new market-rate units becoming available. As of May 2017, new rental projects in the city must include 18 percent on-site affordable units. According to Taecker and others, high construction costs, in tandem with a lack of available funding, are delaying the start of affordable-housing projects in San Francisco's Mission District and elsewhere.

Lawmakers across the state are looking at ways to move affordable projects through the entitlements process faster than standard market-rate buildings. An approved project opposite Candlestick Park will dedicate the majority of its units to housing families earning up to 60 percent of the area's median income, with the building's remaining 35 units designated for formerly homeless households and individuals.

Going forward, new projects like the Central SoMa Plan, which was approved in May by the San Francisco Planning Department, will seek to address the adverse effects of the housing squeeze. The plan aspires to create a neighborhood that can accommodate up to 33,000 new jobs and 8,300 new units of housing—33 percent of them affordable—by 2040. However, critics of the plan say that it isn't doing enough to address the critical imbalance between employment and housing, an imbalance that's fueling long commutes and unsustainable housing situations for teachers and other middle-income earners who face difficult choices when it comes to their housing situations.

"We're struggling to hold on to teachers," Clark says. "We had a member who lives in the South Bay [and] who is a teacher. He lives in his car, which he parks in a church parking lot and then drives to work every day."

"You don't build a city just once," she adds. "This idea of zoning—that you freeze in amber your idea of a city—I think is a fundamentally flawed idea."

While groups like YIMBY advocate for increased market-rate housing stock under the assumption that a sheer increase in the number of units will naturally create a saner and more equitable housing market, not everyone is convinced.

"I think the supply will never catch up with the demand," says Brendan Dunnigan, AIA, a principal and director of HKS Architects' residential portfolio, who typically works on projects in the Bay Area that are 250 units and above. "The numbers that I've heard have just been staggering in terms of how far behind we are in meeting that demand."

> "We had a member who lives in the South Bay [and] who is a teacher. He lives in his car, which he parks in a church parking lot and then drives to work each day."
> —Laura Foote Clark

Solutions Within the Existing Framework

While the slow-moving gears of state and municipal government try to find the best long-term solutions to the problem of too many people and not enough places to put them, architects and designers are exploring a variety of viable stopgap measures.

Additional dwelling units, or ADUs , also known as in-law flats, are one area where Taecker, of AIA East Bay's RUD Committee, sees potential for success in adding more housing while avoiding many of the most prohibitive zoning regulations.

"One of the fastest ways to deliver more projects to market, and one of the ways that have the least in the way of political obstacles, are the idea of a 'granny flat' in back," Taecker says. To that end, RUD is sponsoring an ongoing Grant for Housing Innovation research program, the first round of which focused on making the permitting process around building additional accessory dwelling units more accessible to homeowners.

In the longer-term, many planners and urbanists see moving away from car-centric infrastructure in major metropolitan areas as the only solution for moving forward in a sustainable way. Major urban centers like San Francisco are already the ideal that urbanists dreamed of when they conceptualized eliminating sprawl and bringing urban residents back to a more centralized, communal way of life. Concentrated economic activity; density that leads to interaction, which makes us all more tolerant citizens; opportunities for *dérive*, or drift theory, to play out in which our lives are enriched by aimless wandering through the city and serendipity—essentially all of the tropes of modern urbanism, real and fantastical, exist in San Francisco. New generations find that appealing, says Taecker.

"Millennials really appreciate urban environments—most don't want to live in the suburbs, and they want to live saner lives that are not constantly tied to their cars. From an environmental standpoint, it's ideal. It's what, in the 1990s, we hoped for."

The process behind realizing that ideal, however, has raised a tangle of new problems. AIA

AIAPractice

Making the Invisible Visible

The Miller Hull Partnership's West Campus Utility Plant at the University of Washington proves that function can be a formal design expression.

How can architects and planners elevate the perception of infrastructure as an art form? How can we begin to think of buildings that house infrastructure as assets, instead of eyesores?

Scott Wolf, FAIA, and Anton Dekom, AIA, have answers. Both practice at Seattle-based Miller Hull Partnership and have worked on several recent high-profile infrastructure projects in the region. The West Campus Utility Plant at the University of Washington, which won a 2017 AIA Seattle Award and the AIA Washington Council Civic Design Award, was envisioned as a campus gateway. The design addresses the building's critical systems by exposing them to public view, not concealing them as merely functional elements of a system. Tall storefront glazing showcases equipment and intertwined runs of piping and conduit, providing a window into the systems that support the campus. Form certainly follows function here, but functional also becomes a formal design vocabulary in and of itself. "[We wanted] to focus on how we could integrate it into the urban fabric and have it not be an eyesore, but actually be something that people seek out," Dekom says.

Neither Wolf nor Dekom went into the field of architecture planning to focus on infrastructure, but both believe that infrastructure isn't just a niche focus, but a fruitful future for design.

What did architects take away from your session at the 2018 AIA Conference on Architecture in June?

Wolf: In our assessment, this sector of work—what we call "sustainable infrastructure"—is an area that hasn't gotten a lot of love from the architectural community, certainly in the past 50, 70 years. It tends to be an engineering-dominated niche, if you will. And while the engineering teams are very good at making these facilities operate efficiently, there hasn't been much focus on the community integration and aesthetic components of the project. I think that's changing.

If our cities are growing, it becomes harder and harder to get these facilities out of sight, out of mind. What we're trying to do is demonstrate that there's a real opportunity to look at these projects as community assets, instead of community blights.

Dekom: We're trying to have people appreciate these infrastructure projects for the impact they can have on their communities. I think there's a perception that infrastructure is something that's kind of hidden away in the background of our lives, and we take it for granted a little bit. We're really trying to flip the paradigm by bringing infrastructure to the forefront and highlighting the kind of asset that it can be for a community. There's a phrase that we used a lot: "Making the invisible visible."

How did both of you decide to focus your careers on infrastructure design?

Wolf: I didn't go into architecture with this in mind. [I was] involved in a project for the LOTT Clean Water Alliance back in the mid-2000s. They're a wastewater treatment institution in the Olympia area. They were very instrumental in driving ideas of using reclaimed water and purple pipe and the right water for the right use, though that project was really more of an administration building and lab for the plant itself.

Through discussions with them, I became really intrigued with this idea of water conservation and water use, both on the supply side and the wastewater treatment side. I saw a lot of opportunity there, and an opportunity to see these [projects] as real community amenities. In the past 10–12 years, I have participated in a lot of these types of projects. Anton worked with me on one for Metro Vancouver, British Columbia, that was a wastewater treatment facility right in the middle of an established community.

There are opportunities where, frankly, what we can bring to the table from the architectural side is something that these projects and owners don't necessarily think is possible because they haven't seen that opportunity. For us, we think we can bring a lot of value at relatively minimal cost in that a lot of the cost is loaded into the engineering portions of these projects. For what we would consider very little effort, we're able to bring a high degree of value to owners and to communities.

Dekom: I definitely didn't become an architect thinking that I would be working on infrastructure. It wasn't until I got involved with the Lions Gate [Secondary Wastewater Treatment Plant in Vancouver] that I realized how much of an industry that there was for this. That was an example of an owner who wanted a year-and-a-half process that really just looked at coming up with a design and engaging with the community. I was pretty impressed by the amount of thoughtfulness that goes into these infrastructure projects, and I think that project led to my being involved with the utility plant at the University of Washington as well as other wastewater treatment plant projects. AIA

Katherine Flynn

PHOTOGRAPHY: LARA SWIMMER

AIA Future

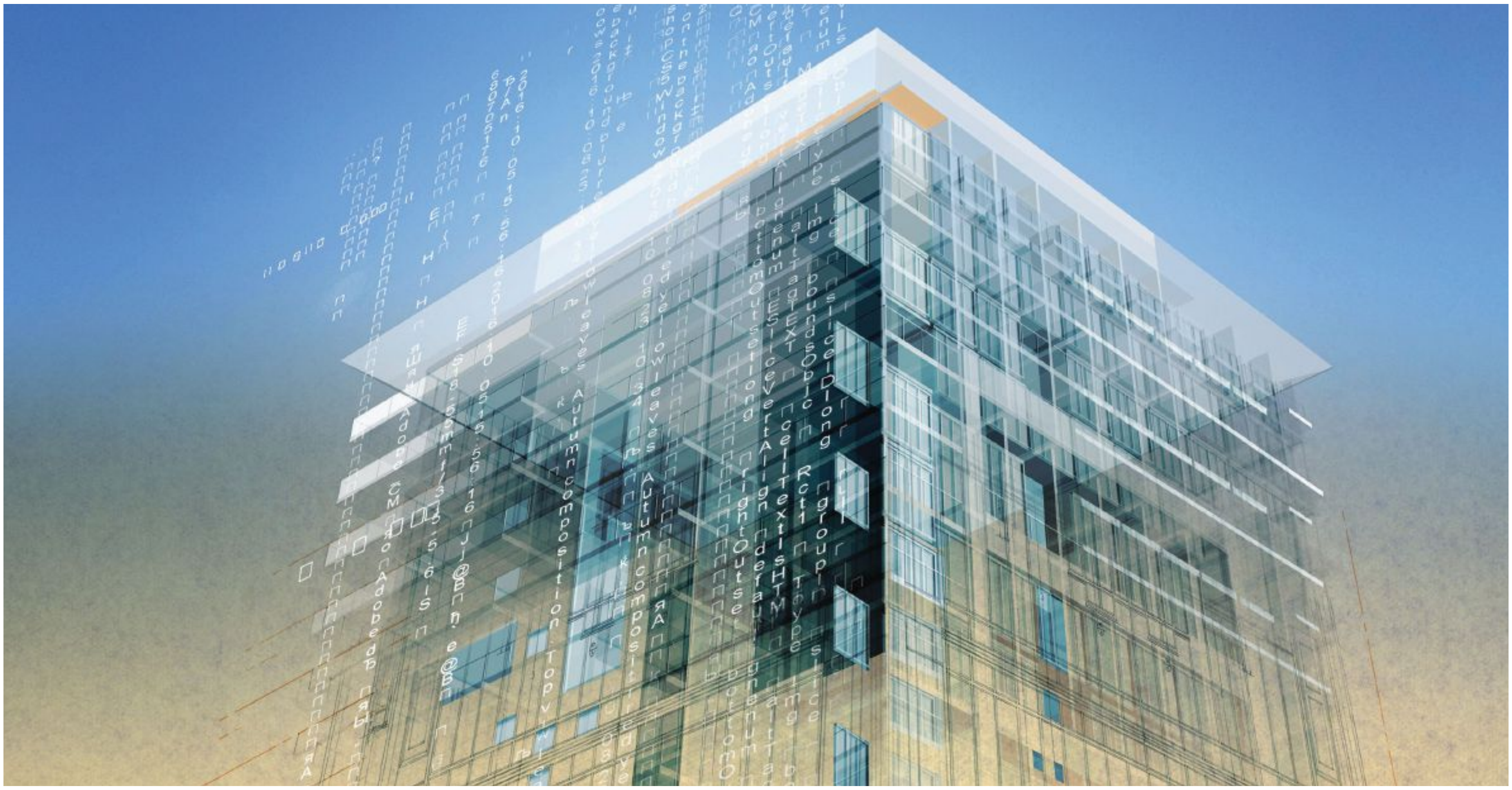

ILLUSTRATION: VIKTOR KOEN

Digging into BIM Data

As building information modeling software has evolved, firms are looking beyond the visualization elements to the data within.

Once cutting-edge technology, building information modeling (BIM) software like Autodesk's Revit, Bentley's GenerativeComponents, and Nemetschek's Vectorworks is now standard fare in architecture firms. How standard? According to AIA's biannual report "The Business of Architecture 2016," 96 percent of large firms, 72 percent of midsized firms, and 28 percent of small firms utilize one or more BIM software programs. (The 2018 edition of this report will be released this month.)

Just as BIM has gained purchase in the past decade, it has also grown in its value to firms—particularly in the data it offers.

"When I started down this path 10 years ago, BIM was mostly 3D and graphical," says Natasha Luthra, virtual design and construction director of emerging technologies at Jacobs and 2018 chair of AIA's Technology in Architectural Practice (TAP) Advisory Group. "Now it's about the intelligent data associated with the design. If there was a product that wasn't 3D but was highly intelligent and data-focused, we'd lean toward that."

Luthra became invested in the technology side of architecture when a small firm in Chicago made learning Revit a prerequisite to getting hired. She's risen among the ranks in that specialty ever since, putting aside her training as an architect to bridge the gap between designers and technologists.

"It has been my belief that you need someone who understands architecture to help other architects through the tech side of things," she says. "Otherwise it's impossible to get the maximum amount of use out of the tools at our disposal."

Those tools have certainly grown in recent years, with virtual and augmented reality being hailed as the next big thing, and artificial intelligence on the tip of everyone's tongue. But beyond all the fancy buzzwords, there has been BIM. With software from Autodesk and Bentley becoming ubiquitous in firms, there are now reams of data on every project developed and delivered. Traditionally, those data have benefited contractors, saving them time in the field. But now firms are scraping data from their models and combing through them to figure out how it can enrich their practices.

"Saying you should use BIM is not a thing anymore," says Ryan Johnson, AIA, an associate at Clark Nexsen and a member of the TAP Advisory Group. "We're well over that hump. We shouldn't be talking about why we should use BIM; we should be discussing how we can benefit more from it."

Those discussions aren't just internal. Though more data can help streamline processes and give firms insight into energy efficiency and other calculable metrics, it can also be used to strengthen bonds with long-term clients. These days, if a client has a problem or a concern, the solution can often be found within the numbers.

"I don't think 'better design' is what you use BIM for," Luthra says. "You need to talk to your clients and find out what they're looking for, then go back to the data and find out what's there. The advantage of doing that, especially with small firms, is having a relationship with the client that lasts longer than the time it takes to design the building. You want to be a partner for the entire life cycle of the building. That's the real value of BIM."

Asking and Answering

Ken Sanders, FAIA, agrees. As managing principal at Gensler, he's involved in numerous aspects of the business, including the firm's incubator labs for new ideas and co-leading the team responsible for design resilience.

AIAFuture

But technology has always been a passion of his, and he grasps how data can help answer questions that more firms—and some clients—are starting to ask.

"What's of increased interest to us is, 'Are people using, say, workplace designs as we thought they would?'" he says. "And as sensors become less expensive, how can we configure them to watch and learn how spaces are actually being used by their occupants? This can apply to a retail or hospitality project as well; we want to find out how customers and guests engaged with the environment around them, beyond anecdotal storytelling about what somebody saw or what a perceived problem might be."

Gensler worked on roughly 10,000 projects in 2017, which means no one person can know all the details of each design. Even more so, Sanders recognizes that, though training and instincts can take an architect quite far, data can reveal hidden truths that would otherwise go unnoticed.

"Sometimes the data confirm what you already believe," he says, "and sometimes you discover something unexpected. Either way, we want to use that information to help our clients and us make better design decisions. When you work on a project, you're not done after it gets built and everyone moves in. Especially at Gensler—where so much of our work is repeat business for large-scale clients—we can start to leverage what we're learning every time we deliver a project and make use of that knowledge on the next one."

Prepare for the Inevitable

"The machines are coming," Luthra says. "We've seen this in so many other industries. Cars and airplanes are being built without a lot of hand-holding or design input. We need to get to a point where people are more important than an algorithm."

A huge step toward that point is mining, organizing, and making use of data provided by BIM software. Not all clients recognize its worth, especially non-developers—"No one ever asks us to send over an Excel file with the data we're using," Johnson notes—but it's also not the client's job to be that savvy. It's the job of the architect.

"The client contracts us to come up with the best design we can," Luthra says. "And, as architects, what do we want to be? Do we want to make the pretty pictures and leave? Or do we want to be the master builders, the master executors? That's where BIM can take us." AIA

Steve Cimino

AIAPerspective

What's in a Number?

The National Council of Architectural Registration Boards (NCARB) released the 2018 edition of *NCARB by the Numbers* at its annual business meeting in late June. Many in the architectural profession, and in the broader architecture, engineering, and construction (AEC) industry, consider *NCARB by the Numbers* the definitive annual statistical and demographic assessment of the profession. There is a lot to be learned in this report. Here are my top takeaways from the 2018 publication (which represents data collected in 2017).

The architectural profession is growing, mostly. In 2017, the profession reached a record high: 113,554 licensed architects in the U.S., up 3 percent over 2016. The Institute also hit all-time highs in total membership (91,078) and licensed architect members (62,755, which represents 55 percent of all licensed architects).

NCARB reports 40,789 licensure candidates in 2017, down 2 percent from 2016, including those who are reporting hours under the Architectural Experience Program (AXP) and testing, or both. However, the greatest number of candidates completed their core licensure requirements in 2017: 5,216, up 11 percent over 2016. Students entering accredited architecture degree programs dropped in 2017: 6,982 newly enrolled students, down 6 percent from 2016. However, overall enrollment remained about the same: 24,109 students, down less than 1 percent below 2016. Growing, mostly.

It still takes too long to become a licensed architect: on average 5.8 years of school, 4.7 years logging required supervised professional experience (AXP), and two years to take and pass the Architect Registration Examination (ARE)—a total of 12.7 years. (I took longer.) On the other hand, the 2018 spring semester saw the first five students complete the Integrated Path to Architectural Licensure (IPAL) program, having reported all required supervised professional experience and passed the ARE upon graduation, a hopeful step. Still, too long.

Gender, racial, and ethnic diversity in the profession is not changing rapidly enough. *NCARB by the Numbers* focuses on people entering the profession. For women the numbers in 2017 are about the same as 2016, with women representing 43 percent of new record holders but only 35 percent of those completing their licensure requirements. (Employers take note: On average, women complete their path to licensure 1.1 years faster than men.) For racial and ethnic minorities, some numbers moved up in 2017, with 45 percent of new record holders identifying as non-white, up 3 percent. However the drop-off from completing experience requirements (30 percent identify as non-white) to completing examinations is precipitous, falling by half.

The AIA's member numbers are similar. Of those who reported their gender, women constitute 21 percent of licensed architect members and 41 percent of associate members. Of those who reported their racial or ethnic identify, 14 percent of licensed architect members and 33 percent of associate members identified themselves as non-white.

Over the past 20 years, the number of women in the profession has doubled. A hopeful sign? The same can be said for some ethnic and racial minorities—but not for African-Americans and Native Americans, whose numbers remain shockingly low. Across all categories of AIA membership, as reported at the end of the last calendar year, there were a total of only 1,730 African-American and 190 Native American members of the AIA.

I'll leave it right there and let the numbers do the talking. AIA

Carl Elefante, FAIA, 2018 AIA President

PHOTOGRAPHY: GABRIELA MARKS


FLXible Neon
Super Slim Flexible LED wih Spot-free Output
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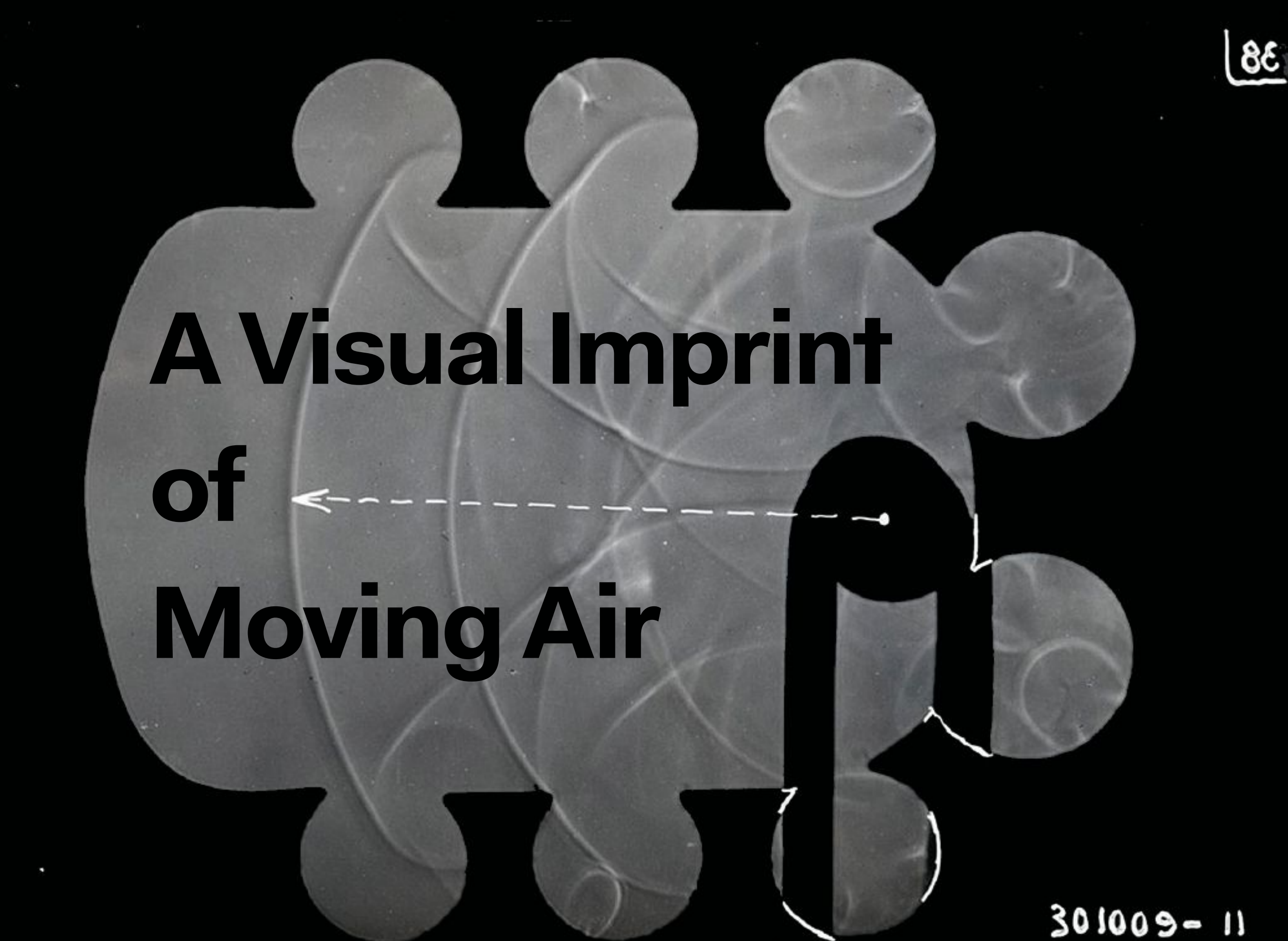

A Visual Imprint of Moving Air

Methods, Models, and Media in Architectural Sound Photography, ca. 1930

BY SABINE VON FISCHER

Zurich-based architect and scholar Sabine von Fischer writes at the intersection of architecture and science. The essay reprinted here, on the experimental pursuit of architectural sound photography, first appeared in the *Journal of the Society of Architectural Historians* (Vol. 76, No. 3, September 2017; pages 326-348; ©2017 by the Society of Architectural Historians; published by the University of California Press Journals). It won the 2018 Founders' Award, which the society gives annually for an article in the journal by an emerging scholar that exhibits excellence of scholarship and presentation.

The recent turn toward studies of the environment as part of architectural history puts in question the discipline's emphasis on the visual and challenges us to include phenomena that are physical but not necessarily recognizable by the eye.[1] Environmental histories expand the scale and media of subjects commonly thought of as "architectural."[2] For example, architectural sound photography from the 1920s and 1930s is a remarkable and overlooked reference for the noise maps and climate registers circulated currently. In this article, I examine the photography of sound in architectural models, placing it at the intersection of the history of architecture, modern architectural acoustics, and media for visualizing physical phenomena. I will show how this photographic method links the sensory and the scientific in architectural reasoning. The models and apparatuses used to study the acoustics of spaces expose the material stakes involved in simulating architecture. While mathematical calculations of architectural acoustics, such as the reverberation formula, are still in use, visual representations of sound created with photography were soon declared obsolete. Today, the study of photography of sound propagation from the archives allows us to understand the role of the senses both in the conception and perception of scientific experiments and in architectural reasoning.

During the final months of my doctoral research, I discovered a crimson loose-leaf binder containing more than a hundred photographic prints, dated from 1930 through 1933, mounted onto fifty-six sheets of mostly brown paper.[3] The binder had lain forgotten in the basement archive at the acoustics department of Empa, the Swiss Federal Laboratories for Materials Science and Technology, near Zurich, as part of the meager archive of Franz Max Osswald (1879–1944). Osswald was Switzerland's first expert in architectural acoustics and founder of the first applied acoustics laboratory at ETH, the Swiss Federal Institute of Technology, in Zurich. The photographs in the album depict sound waves propagating, reflecting, and diffracting in sectional models of various geometries. I was looking at shadowgraphs of moving air, superposed pressure wave fronts imprinted on the photographic paper as gray lines and tones, all shimmering streaks capturing a moment of sound passing through space [FIGURE 1]. The physical transfer of acoustic energy to scientific imagery as an expert's representation of sound, and the translation of the gray shadows back into what we can hear but not see, challenges our understanding of physics and the environment. Sound no longer appears ineffable but is transcribed in graphic representation. I realized that such images are crucial for communicating environmental phenomena such as the movement of air, temperature, and sound. Architectural sound photography, as this essay will show, was as much about dispelling the mysteries surrounding sonic phenomena as it was about implanting architectural design in the impenetrable registers of the science of physics.

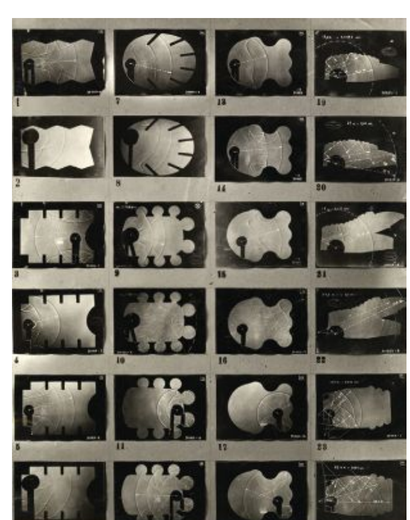

FIGURE 1

FIGURE 1
Franz Max Osswald, contact print of sound photographs in architectural models, from Osswald's applied acoustics laboratory at ETH Zurich, 1930–33 (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986437).*

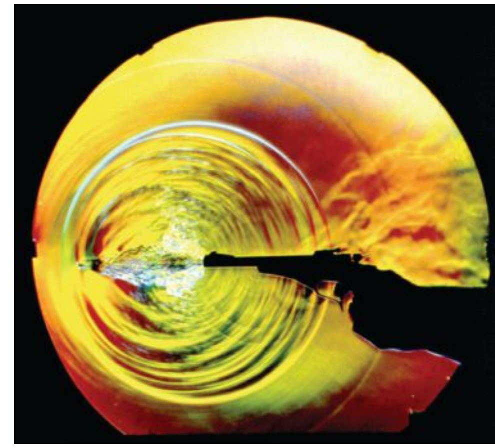

FIGURE 2

FIGURE 2
Shock wave visualization from a bullet fired from a pistol as a reenactment of a schlieren technique experiment from the late nineteenth century (photo by Gary S. Settles).

Visual representations have accompanied the acoustic sciences since the Vitruvian analogy of the sound wave with the water wave in antiquity, when the visible movement in water was employed to explain the invisible movement in air. In the seventeenth century, Athanasius Kircher illustrated sound as straight lines reflecting off of walls and buildings. Shadowgraph techniques also go back to the seventeenth century, as part of the larger field of scientific observation using microscopes, telescopes, and glass lenses: the air flow of warm air rising from a candle, or a hand, caught the attention of scientists. Architectural sound photography was developed from direct shadowgraphy without instruments (e.g., the hot air of a candle represented in a drawing) and the schlieren technique, which involved a shock wave from a gunshot and prismatic effects from lenses [FIGURE 2].[4] Both the wave and the line characterize the movement of sound and remained models for understanding sound in parallel; the photographic method explained in this essay was the first technique that held the promise of capturing the performance of sound in space in a comprehensive, objectified way, taking into account both wave and line characteristics. In architectural applications, often in studies of theaters and auditoriums, shadowgraphy and the schlieren technique aimed at capturing the spatial propagation of sound. They coexisted with other forms of visual representation through spectrography, phonophotography, melography, and oscillography, which captured specific parameters of sound, such as loudness and frequency.[5] The names of some of these techniques allude to photography, although the visualizations were produced mechanically or electrically. The products of Osswald's experiments in the early 1930s at his Institut für Angewandte Akustik (Institute of Applied Acoustics) at ETH indeed deserve to be called "sound photographs." Osswald in his schlieren imaging captured shadows of inhomogeneity in air, caused by sound waves traveling in space, on photo plates photochemically. He took blurry photographs inside sectional models, at a scale that fit into the experimenter's hand, and exposed them onto photographic paper that fit into the photo album.

Studying representations of sound brings forward the architectural consequences of media transfers and model scaling, as well as the ambiguities of expert reading and lay interpretation. The process of photographing sound raises a number of interesting questions about the relation between the visual and the auditory: The tyranny of the eye over the ear is a prevailing assumption in the hierarchy of the senses, but in these photographs the visual clearly serves the aural. While for Osswald the appeal of the schlieren technique may have lain in its (arguably unrealized) promise of objectivity, I will argue that its appeal was as an interface that incorporated the human sensorium in modern science. This may be the reason Osswald continued to pursue this method well after 1930, when others had abandoned it for its lack of precision and failure to represent all three dimensions of space accurately. In the 1930s, electroacoustic testing superseded photography and became indispensable in the automation and standardization of modern acoustic measurement. At Osswald's institute at ETH Zurich, electroacoustic testing coexisted with photographic methods, never replacing them completely.

The acoustic sciences and their applications are subject to not one but multiple epistemic traditions—physics, psychophysiology, anthropology, engineering, aesthetics, and others. Osswald's relentless pursuit of sound photography is a case study in the role of images in the construction of scientific authority in architectural design. I believe Osswald's sound photographs give insight into epistemic changes in the modern era, analogous to the "medical gaze" that Michel Foucault links to changes not only in medicine but also in society at large.[6] They also relate to what Lorraine Daston and Peter Galison have written about the ways the "scientific self" has disciplined the "scientific gaze" in pursuit of objectivity.[7] The history of photography is more than a history of constructing objectivity through a lens. It deals with vague imagery from close up, shown so memorably in Michelangelo Antonioni's 1966 movie Blow-Up and also described as the "dark side of photography" in "black boxes and dark rooms" in studies of so-called ghost and thought photography, in which shadows of the dead were seen as emerging from the photochemical process.[8] While the intentions of shadowgraphy and schlieren photography were far from such metaphysics, sound and ghost photography share the ambiguity produced by the photochemical process.

The term *soundscape* has been criticized because of its assumed origin in the realm of the visual, a perspective opposed especially by anthropologist Tim Ingold, who recuperates *scape* for a discourse related to topography and materiality.[9] What physicists and engineers photographed in the images studied here belongs to the materiality of sound: the acoustic energy visualized in architectural sound photography had been acknowledged for decades before these images visualized the phenomena. Architectural sound photography could thus be interpreted as an afterimage of acoustic reasoning, in the sense of a confirmation of knowledge gained previously. I argue that, while architectural sound photography claimed to represent "mechanical

FIGURE 3
Arthur L. Foley and Wilmer H. Souder, experiments with schlieren photography in enclosed geometries, 1912 (Arthur L. Foley and Wilmer H. Souder, "A New Method of Photographing Sound Waves," *Physical Review* 35, no. 5 [1912], plate V).

FIGURE 4
Apparatus for architectural sound photography, 1912 (Arthur L. Foley and Wilmer H. Souder, "A New Method of Photographing Sound Waves," *Physical Review* 35, no. 5 [1912], 374).

objectivity," it simultaneously and implicitly included and activated the human sensorium.

The story of the production of photographs of the temporal, ephemeral phenomenon of sound brings together objective method and the experience of learning through the senses. The schlieren technique and its architectural applications rendered visual what could be heard, engaging the visual sense. The mechanical process qualified the technique as affirmation, proof, and a means of quantifying acoustic phenomena. The acousticians discussed in this essay, especially Osswald, used photography in their search for a multisensory approach, in anticipation of future sciences that would link the physics and the psychophysiology of sound.

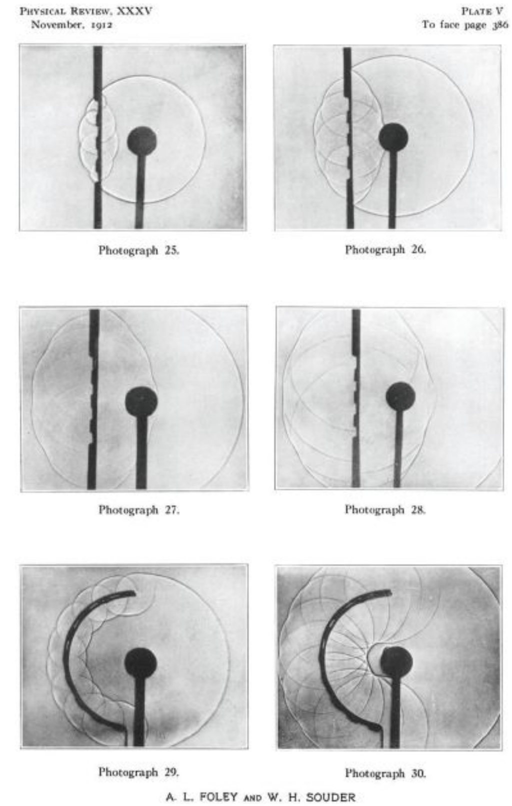

FIGURE 3

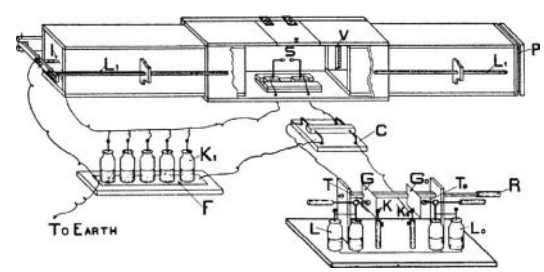

FIGURE 4

Wallace C. Sabine's Search for Sound Localization

In his relentless experimentation with architectural applications of sound photography, Osswald appropriated the methods of the American physicist Wallace C. Sabine (1868–1919). Osswald began his career as an acoustic consultant in 1922, the same year his role model's posthumous *Collected Papers on Acoustics* was published—a coincidence established retroactively by the disciple himself.[10] Osswald corresponded for many years with Wallace Sabine's successor at Riverbank Laboratories in Geneva, Illinois, Wallace's distant cousin Paul E. Sabine (1879–1958).[11] A photograph dated 1925 and stamped by the Riverbank Laboratories, included among Osswald's papers in the crimson binder, may well have inspired Osswald's photographic experiments in Zurich.

Wallace Sabine's reverberation theory—first published in the article "Architectural Acoustics" in the *American Architect and Building News* in 1898—is widely considered the catalyst for modern architectural acoustics.[12] Osswald was among the following generation who relied on Sabine's methods almost exclusively. In 1913, Sabine had illustrated his essay "Theatre Acoustics" in the journal *American Architect* with architectural sound photography, describing the origins of his technique as "what may be called the Toeppler-Boys-Foley method of photographing air disturbances."[13] What Sabine refers to is the optical rendering of inhomogeneity in transparent media. It was physicist August Toepler (1836–1912) who, between 1859 and 1864, while earning his PhD at the Agricultural College of Pappelsdorf, invented, named, and refined what is now commonly referred to as the schlieren technique.[14] The German word *Schlieren*, which means striation, streak, or smear, was previously used to describe inhomogeneities in glass. Toepler observed pressure wave fronts and drew what he saw in ink; his drawings were so fine that many mistook the images for photographs.[15] Toepler's wife had his tombstone inscribed with the words "He was the first to see sound."[16] While Toepler did not see sound as such, he observed a variation of density in air caused by candles, electric sparks, and shock waves from gunshots and made drawings of what he had seen (photographic techniques of sufficient speed for his schlieren imaging were not yet available). In 1887, Ernst Mach (1838–1916), who entered the physics of sound with a background in physiology, together with Peter Salcher of the Naval Academy in Fiume, developed Toepler's method further so that the fluid dynamics of projectiles traveling through air at ultrasonic speeds, and ultimately the wave characteristics of sound, could be captured photographically. Both Toepler's and Mach's schlieren imaging was visual and thus qualitative, rather than numerical or theoretical, as physicist Gary S. Settles notes; it was Toepler's "excellent physical 'feel' for his subject" that triggered the experiments later integrated into the canon of objective scientific methods that can be expressed quantitatively.[17]

In 1912, physicist Arthur L. Foley and his junior teaching fellow Wilmer H. Souder adapted Toepler's method to confined shapes, though not yet architectural models [FIGURE 3].


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They published a paper that included a drawing and a detailed description of the apparatus they used.[18] In the paper, they describe the challenges of obtaining a source of light sufficient to create a photographic image and the difficulty of controlling the interval between the first spark to set off a sonic pressure wave and the second spark to expose the photographic plate. The line drawing of the apparatus illustrates the mechanisms for timing the gap between the electric spark causing the sound wave and the light spark (L) that then exposes the photographic plate: "When the interval between the two sparks is properly timed the sound wave at S casts its shadow on the photographic dry plate P" [FIGURE 4].[19] Foley and Souder dispensed with the lenses previously used by Toepler, which enabled them to produce images inside confined spaces such as circles and ellipses. The experimenters photographed the sound wave as it reflected back from straight and bent surfaces, some of them perforated, using what they themselves referred to as the "point source shadow method."[20]

Photographic experiments with sound waves in confined objects enabled the visualization of refraction (breaking) and diffraction (bending). This technique complemented the geometric modeling of sound as rays, which Adolf Loos had explained as "straight lines from the sound source to the ceiling, assuming the sound would bounce off at the same angle, like a billiard ball from the cushion, and continue on its way."[21] Loos's judgment that this method was "nonsense" is certainly wrong.[22] However, it is correct that it is not true for all spatial conditions, especially as sound waves have the capacity to bend around obstacles. Geometrical ray constructions rely on the analogy with optics, rendering only the directionality of sound. Although modeling sound propagation as rays provides useful approximations for outdoor areas and large spaces, scientists looked for further ways of modeling sound. Especially in auditorium and theater design in the nineteenth century, the conflicting requirements of lighting and sound design were increasingly recognized, as the straight lines representing light worked for illumination but not for acoustics.[23]

In the early twentieth century, sound was a contested public issue. The building industry launched new products for sound insulation and absorption, newspapers debated noise abatement, and citizens sought increased silence and privacy. In churches and auditoriums, audience sizes increased, and with them the distance sound had to travel; sound reflectors, both those already created by the enclosing walls, floor, and ceiling and additional reflectors, were studied in depth. At this time, then, both drawings and photographs were useful and welcome tools for communicating the emerging field of architectural acoustics. While concepts and goals could be spelled out loudly, scientific explanations for sound lacked words and notations. Further models, other than mere line drawings, were needed to show the diffraction of sound waves.

The analogy of sound waves with water waves had been used since the time of Vitruvius, who described the expanding waves caused by a stone thrown into water. In 1787, the German physicist and musician Ernst Florens Friedrich Chladni (1756–1827) created the famous Chladni figures, patterns of sand resulting on metal or glass plates from vibrations at specific frequencies. Media historian Jonathan Sterne considers Chladni's technique "the founding moment of modern acoustics, and it embodies this connection between objectification, visualization, and the reversal of the general and the specific in theories of sound."[24] If we include Chladni's sound visualization in modern science, it predates what is considered the modern era of architectural acoustics.

According to Emily Thompson's influential history of architectural acoustics, the modern soundscape evolved in the nineteenth century, culminating with Wallace Sabine's reverberation formula, which gave architects unprecedented control over the acoustic performance of auditorium spaces.[25] At the beginning of the twentieth century, Sabine expanded the parameters of architectural design using a range of methods. His formula for reverberation time was the most influential; it is still used with little mathematical adjustment. In papers published from 1898 onward, Sabine explains how the geometry, volume, and material of a space determine its capacity to absorb or reflect sound. The formula $k = 0.171 \cdot V$ calculates the overall average of sound's energy in a space.[26] It describes quantitatively what we define in words as sound qualities such as "dead" or "dry" (with no or short reverberation) or full and echoing (with long reverberation). What Sabine's formula cannot explain is the local distribution of the sound's energy, which is crucial in auditoriums, where speech and music from the stage should be heard at all seats.

Sabine's subsequent 1913 paper on theater acoustics was extensively illustrated with schlieren technique sound photographs, as appropriated from Foley and Souder. The schlieren method promised a simulation of the differing intensities of sound—such as focal points and dead corners—across a space. Sabine announced that the "details of the adaptation of the method to the present investigation will be explained in another paper."[27] So far, however, this second paper has not been found, and Sabine makes no further mention of sound photography in his writings. Despite his disinterest in further photographic experiments, his 1913 paper is worth a closer investigation. It begins with a quote from Vitruvius's *Ten Books on Architecture*: "All this being arranged, we must see with even greater care that a position has been taken where the voice falls softly and is not so reflected as to produce a confused effect on the ear."[28] This emphasis on the "position taken" by the audience underlines the pertinence of describing the spatial geometry of sound distribution, of which Sabine's reverberation method had left out. The time and the intensity of sound were not the only things at stake in speech intelligibility and musical listening experience—the locality of the sound was also important. The excerpt from


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FIGURE 5
Wallace C. Sabine, contours of sound intensity, 1913 (Wallace C. Sabine, "Theatre Acoustics," *American Architect* 104, no. 1984 [31 Dec. 1913], 261).

FIGURE 6
Wallace C. Sabine, experiments with schlieren photography in a model of the New Theatre, New York, long section, 1913 (Wallace C. Sabine, "Theatre Acoustics," *American Architect* 104, no. 1984 [31 Dec. 1913], 269).

FIGURE 7
Wallace C. Sabine, experiments with schlieren photography in a model of the New Theatre, New York, cross section, 1913 (Wallace C. Sabine, "Theatre Acoustics," *American Architect* 104, no. 1984 [31 Dec. 1913], 271).

Vitruvius's treatise goes on to describe natural obstructions to the projection of the voice: those that reflect sound into the succeeding sound (creating dissonant sound), those that spread sound in all directions and reflect it into an indistinct field of sound (creating circumsonant sound), and those that reflect the voice, "producing an echo and making the case terminations double" (resonant sound). The last of Vitruvius's categories describes acoustic conditions "in which the voice is supported and strengthened, and so reaches the ear in words which are clear and distinct" (consonant sound).[29] In an effort to distinguish modern physics from practices based on traditional knowledge, Sabine updates Vitruvius's terminology with his own: "But to adapt it to modern nomenclature, we must substitute for the word dissonance, interference; for the word circumsonance, reverberation; for the word resonance, echo. For consonance, we have unfortunately no single term, but the conception is one which is fundamental."[30] Sabine's revision of acoustic method departed from ideas of proportion or universal harmony. It did so through a new terminology, complemented by new modes of representation. If reverberation measurements in milliseconds were a decisive step toward a mathematically precise description of sound in space, schlieren photography was a step toward mechanical objectivity in visual terms.[31]

The first illustration in Sabine's 1913 essay is a photograph of a small model of the Greek Theatre at the University of California, Berkeley (architect John Galen Howard), opened in 1903 and designed according to Mariano Fortuny's brand-new "Kuppel-Horizont" system. Sabine illustrates the problematic sound focalization in domed ceilings that were designed to reflect light by tracing the contours of sound intensity, showing that the sound's energy is concentrated in the focal area of the dome and not reflected to the audience in any way analogous to the way light is reflected, as the designers had assumed [FIGURE 5]. The graphic representation of contours of sound intensity served as proof for Sabine: the theater was designed for light projection effects, not for sound.

Sabine complemented the plans and interior views of the Little Theatre in New York (designed by the firm Ingalls & Hoffman and opened in 1912; now Helen Hayes Theatre) with a reverberation diagram. He illustrated his subsequent examples by means of photographs, including fifteen taken inside models of the longitudinal and cross sections of New York's New Theatre (designed by the firm Carrère and Hastings and opened in 1909) [FIGURES 6 AND 7] and seven photographs taken during his experiments for Boston's Scollay Square Theatre (architect Clarence H. Blackall, 1912). For the latter, Sabine compared the longitudinal sections of the initial sketch (with a dome ceiling over the stage) to the built project with a flat plane over the stage.

After Sabine's premature death in 1919, the 1913 essay was included in his *Collected Papers on Acoustics*, published in 1922.[32] This collection of his revised papers led to the dissemination of modern acoustic theory and laid the ground for the formation of architectural acoustics as a discipline of its own on both sides of the Atlantic. In the

FIG. 5. INTERFERENCE SYSTEM FOR TENOR C IN THE KUPPEL-HORIZONT, HAVING A THIRTY-SIX FOOT PROSCENIUM OPENING. THE INTENSITY OF SOUND IS REPRESENTED BY CONTOUR LINES, THE MAXIMUM VARIATION BEING FORTY-SEVEN FOLD.

FIGURE 5

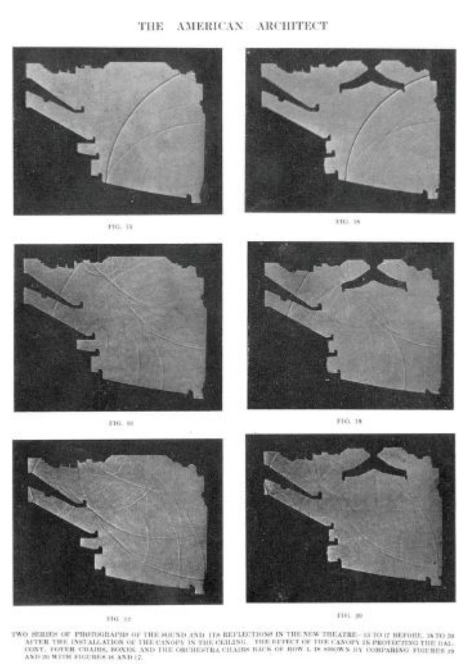

FIGURE 6

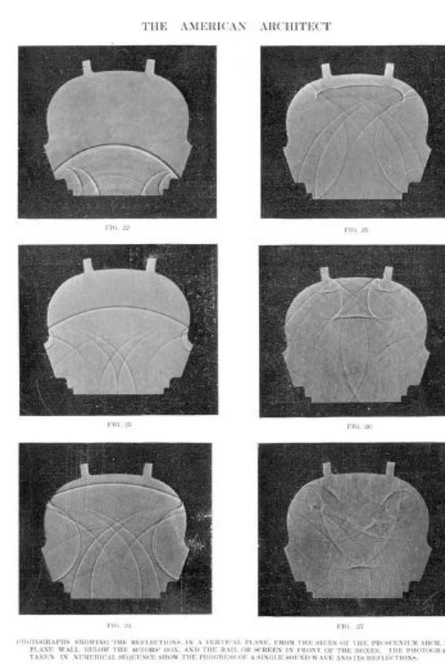

FIGURE 7

NOVA MODULAR SUSPENSION SYSTEM

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FIGURE 8
Eugen Michel, geometrical construction of sound propagation in the Gewandhaussaal, Leipzig, 1921 (Eugen Michel, *Hörsamkeit grosser Räume* [Braunschweig: Vieweg, 1921], 32).

comprehensive 1922 edition, a photograph of the open-air amphitheater in Orange, France—presented as the epitome of theater acoustics—was added as a full-page title image before the 1913 essay, even though it is hardly discussed in this paper on modern, enclosed theaters. Indeed, Sabine heaps scorn on the accounts of those who visit the Greek and Roman ruins and praise their acoustics. He claims that such praise is based on mystification and mocks the prejudiced ear, when the visitor in the ruins "makes a trial wherever opportunity permits ... always with gratifying results and the satisfaction of having confirmed a well known fact. ... The difficulty with such casual evidence is that it is gathered under wholly abnormal conditions," in "scant reminders of the original structure" (which had more reflecting enclosures than the present ruins) and in "absence of a large audience" (and their absorbing bodies and clothes).[33]

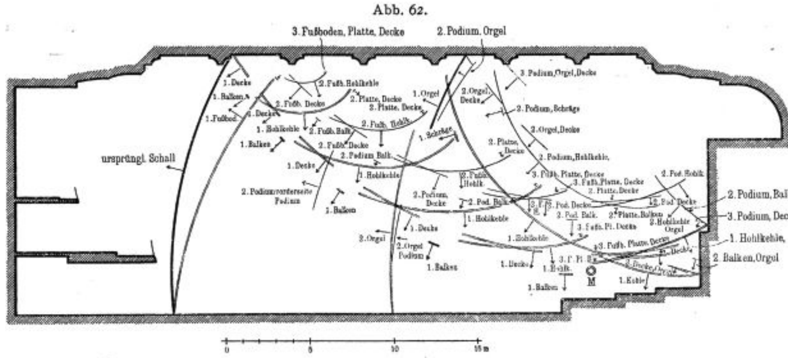
Sabine illustrates his article with sound photographs of contemporary enclosed theaters, establishing his reasoning as based in mechanically derived, objectified fact. The nuances of light and shadow inside scale models of modern theaters must have appeared mysterious to many of the article's readers, and yet it was exactly the "mystery of acoustics" that Sabine meant to expel from the discourse on sound. Despite the extensive use of photographic illustrations in his 1913 paper, Sabine never published such images, or referred to the technique, again. This seems to support Emily Thompson's contention that Sabine found the photographic method unrewarding and so did not pursue it further. Thompson restricts her discussion of his photographic experiments to a few lines, saying merely that "limitations of the available sources and detectors impelled Sabine to reconsider the utility of techniques for visually representing sound."[34]

Thompson links Sabine's interest in visual technique to eighteenth- and nineteenth-century practices, regarding it as an anachronistic move accounted for by his frustration with the fact that sound could be measured only relative to the hearing threshold of the human ear. However, the rich illustrations in Thompson's 2002 benchmark account on modern architectural acoustics demonstrate a consensus on the capacity of images to communicate scientific objects and phenomena. In his 1913 discussion, Sabine observes that images do not expose the "factors in determining the acoustical quality of the theatre, but the photograph affords excellent opportunity for showing the manner in which reflections are formed."[35] It is in "showing" more than in "knowing" that the founder of modern acoustics appreciates the photographic method.

Despite Sabine's abandonment of the technique, the fascination with sound photography among acoustic scientists persisted for another two decades, and beyond: At the beginning of the 1920s, German engineer Eugen Michel experimented extensively with acoustical water wave photography in ripple tanks. Michel preferred photographing ripples of water in a basin to animating the air in a schlieren technique apparatus, because it required little equipment and involved a less complicated technological transfer. The schlieren technique asks for electrical equipment and, due to the necessary intensity of light, a rather small sectional model set vertically into the photographic apparatus. Water wave photography was easier: one simply put a model, of practically any scale as long as it fit into the basin, horizontally into water and photographed the surface of animated water, or the reflections thereof on a screen.[36] Water and air are both fluid media. In the ripple tank, the propagation of sound in air was simulated in water; the ease of handling, in Michel's assumption, compensated for their differing physical properties.

In 1927, scientists Alfred H. Davis and George W. C. Kaye of the National Physical Laboratory in Teddington (on the outskirts of London) published a comprehensive overview of the different methods for studying sound, three of which they described in detail: the geometrical method, the sound-pulse method, and the ripple-tank method.[37] The techniques are not listed in chronological order of their emergence; rather, they are ordered according to their assumed efficiency in capturing the performance of sound. Over three pages, Davis and Kaye introduce the method of geometrically constructing line drawings as a "first approximation."[38] In this section they quote from Michel's 1921 benchmark publication and reproduce several of the meticulous drawings preceding his photographic ripple-tank experiments [FIGURE 8]. They remark, however, that "the diagram gives no indication of the relative intensities of the

Abb. 62.



Gewandhaussaal in Leipzig. Längsschnitt. Rückwurf mit Schallhalbmesser von 25 m.

FIGURE 8


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FIGURE 9
Alfred H. Davis and George W. C. Kaye, kinematographic visualization of sound propagation in a ripple tank, 1927 (Alfred H. Davis and George W. C. Kaye, *The Acoustics of Buildings* [London: G. Bell and Sons, 1927], plate XII).

FIGURE 10
Franz Max Osswald, portrait on the occasion of his graduation from ETH Zurich, 1905 (photo by Johannes Meiner; Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000271413).*

various portions of the wave-front."[39] Next is a description of the electrical "pulse" or "spark method" of architectural ultrasound photography as derived from the schlieren technique. Davis and Kaye then discuss the ripple-tank method in four pages of text and four pages of plates that culminate in a kinematographic series of fifty-five images [FIGURE 9]. They reinforce the importance of studying not only single moments but also sequences of sound propagation. The limitations of schlieren sound photography are more severe than simply the two-dimensionality of the model sections. These photographs lack not only the third dimension of space—a problem Sabine addressed by always studying both long and cross sections of theater spaces—but also the fourth dimension of time, a necessary consideration in the study of sound that the kinematographic image recordings were able to capture.

Thanks to its practicality and simplicity, and despite the fact that acousticians acknowledged the blurry pictures and lack of precision, water wave photography outlived the laborious schlieren applications in architectural acoustics.[40] Experiments are documented into the post–World War II period and beyond, as I have discussed elsewhere.[41]

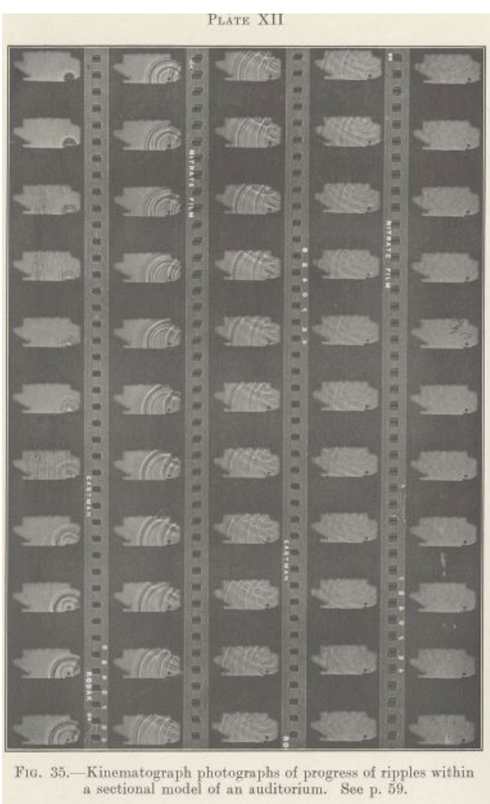
PLATE XII
FIG. 35.—Kinematograph photographs of progress of ripples within a sectional model of an auditorium. See p. 59.
[To face page 59

FIGURE 9

FIGURE 10

Franz Max Osswald's Sound Photography as Scientific Practice

In 1924, Franz Max Osswald began installing his research at ETH Zurich, Switzerland's first polytechnic university. ETH was his alma mater; he graduated with a degree in mechanical engineering in 1905 [FIGURE 10].[42] In 1929, he received his *venia legendi*—permission to teach at university level—and was given two spaces in which to set up his own laboratory: a larger one to be used as a reverberation chamber and a smaller one for his apparatuses.[43] In the smaller space, from 1930 through 1933, he produced hundreds of sound photographs. The remaining prints of Osswald's sound photography experiments are kept in the crimson loose-leaf binder that I discovered among the materials from the antecessors of contemporary acoustics. The binder is part of a system patented in 1909 by a British manufacturer; inside it, Osswald's 124 remaining photographs are mounted on fifty-six sheets of blue and brown paper.[44] I mention the folder's origin because it indicates Osswald's international orientation. He was a pioneer in his field and corresponded with other experts in Europe, as well as with Paul E. Sabine at the Riverbank Laboratories in the United States.

The photographs in the binder show the propagation of sound wave fronts in architectural models by illuminating the changes in the density of air, sometimes at a specific moment, sometimes in a sequence milliseconds apart, tracing how the waves expand and reflect inside the model space. It is likely that Osswald developed his plates in the ETH photography facility, founded in 1886 and located in the natural sciences building from 1916 onward. From 1926 to 1947, ETH's Photographisches Institut (Institute of Photography) was headed by Ernst Rüst. While there is no indication that Osswald relied on Rüst's expertise, their careers show interesting parallels. They both failed to position their small institutes in the debates over the "split" between pure and applied science of the time.[45]

In a class he taught on architectural acoustics, Osswald explained his "ultrasound photography apparatus" (another name for schlieren photography), constructed according to Foley and Souder's publication [SEE FIGURE 4], to the students in great detail, as is documented in a diagram included in the transcript of a lecture he gave during the winter semester of 1932–33 [FIGURE 11]. In the apparatus, milliseconds after the sound spark from the shotgun [8 IN FIGURE 11, TRIGGERED BY 3 AND 4], a light spark [9 IN FIGURE 11, TRIGGERED BY 5] was ignited, the timing of which required extremely advanced electrical controls [1 AND 2 IN FIGURE 11]. The shadow of the air's inhomogeneity caused by the sound spark was then projected onto a photographic plate [7 IN FIGURE 11].[46] Osswald was taken by the technique to the extent that he built a second, improved version of the device in which, he claimed, the timing of the sparks was much more precise [FIGURES 12 AND 13].

FIGURE 11
Franz Max Osswald, diagram of an “ultrasound photography apparatus” from the transcript of his lecture on architectural acoustics, winter semester 1932–33 (University Archives, ETH Zurich).

FIGURE 12
Apparatus room at Franz Max Osswald’s applied acoustics laboratory at ETH Zurich, 1930 (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986421).*

FIGURE 13
Franz Max Osswald, revised and improved apparatus for ultrasound photography, 1933, published in 1936; SEE NOTE 48. (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986422).*

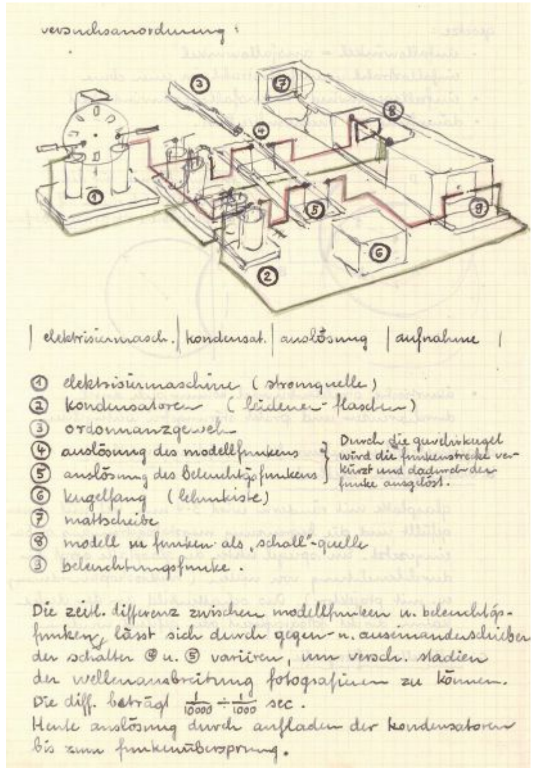

FIGURE 11

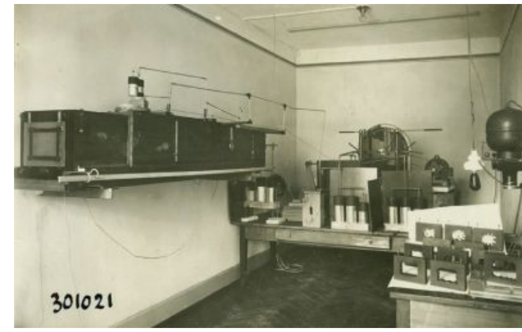

FIGURE 12

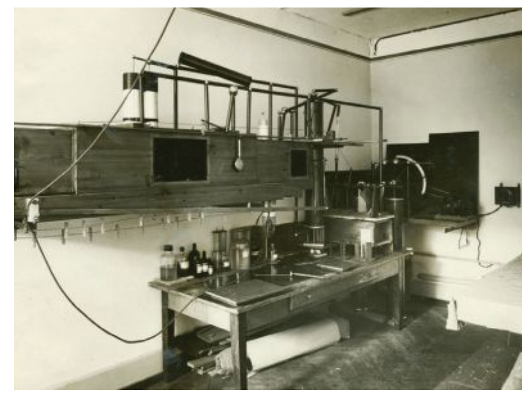

FIGURE 13

Precision, here, is a relative term. The schlieren technique in aircraft and rocketry research of the late 1930s, as in the German wind tunnels in Peenemünde, was part of costly wartime techniques.[47] Experiments of the same origin in the Institute of Applied Acoustics at ETH in Zurich, in contrast, operated with practically Osswald alone, at times with a part-time assistant and with little interest and funding from the university, addressing architectural questions in auditorium design.

The first of Osswald’s schlieren apparatuses is shown in a print dated 21 October 1930 [FIGURE 12]. The second Osswald photographed on 11 July 1933 and published in 1936 [FIGURE 13].[48] Both versions appear in photos on the initial sheets in the loose-leaf album. The photograph of the first version also shows eleven small sectional models with different wall and ceiling geometries in the lower right-hand corner [SEE FIGURE 12]. These were cut from hard rubber and inserted in the middle of the long apparatus. Osswald’s second version of the apparatus controlled the time gap between the two sparks and thus the accuracy of the simulation, with a range from 0.00005 to 0.0005 seconds, which corresponds to sound traveling the distance of 2.5 to 25 centimeters in a model at scale 1:400, or 10 to 100 meters in real space.

The scale ratio of 1:400, which Osswald seems to have used as a standard for this method, was most likely determined by the intensity of light he could generate for the photographic exposure. The scale given by Davis and Kaye in Britain is roughly the same: 1 inch = 32 feet, which translates to 1:394 in the metric system.[49] A scale of 1:400 is actually very small compared to other architectural working models showing interiors, often built during the design process to enable evaluation of the volume and proportion of spaces; an auditorium model at that scale would, in most cases, fit into the palm of the experimenter’s hand.

Osswald indicated the scale of the models on two of the photos in the crimson binder, both considerably larger than 1:400. A photograph dated 8 December 1930 of an unidentified study model marked “Luzern” has the note “1:254.” The scale of the model of Gottfried Semper’s Stadthaus Winterthur auditorium (discussed below), photographed on 4 July 1933, is noted as “1:183.” The issue of scaling is especially pertinent in relation to today’s practice of measuring sound in concert hall models at a scale ratio of 1:10. In Osswald’s technique for sound photography, enlarging the model to 1:10 would have rendered the procedure impossible. The principal problem being the intensity of the light spark, greater distances to the photographic plate weakened the photographic imprint. Because of this, in 1936 Osswald recommended photographing sound propagation at distances of a maximum of 15 centimeters within the model, which corresponds to approximately 60 meters in the actual space. The scale of the model was thus chosen at a critical distance for auditorium acoustics. Osswald concluded that “ultrasound air wave photography is a precise and revealing means to recognize the reflecting effect of enclosures, which may then need to be shaped differently, or dampened,” that is, redesigned in a different form, or clad with absorbing material.[50]


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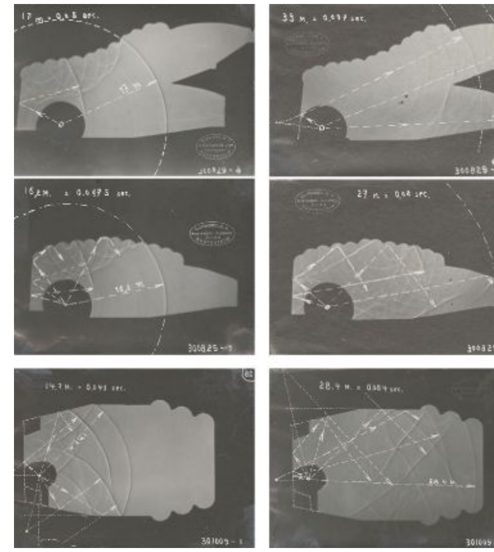

FIGURE 14

FIGURE 14
Franz Max Osswald, sound tests in the model of an auditorium with variable volume, published in 1930; SEE NOTE 54 (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986428; http://doi.org/10.3932/ethz-a-000986429; http://doi.org/10.3932/ethz-a-000986430; http://doi.org/10.3932/ethz-a-000986431; http://doi.org/10.3932/ethz-a-000986432; http://doi.org/10.3932/ethz-a-000986434).*

All of these measurements are based on the premise that a sound within the hearing range, when scaled down to an inaudible frequency, can simulate an audible phenomenon. In Osswald's 1930s experiments, different densities of air resulting from a sonic impulse become perceptible as an image on paper. His method, however, neglects the material properties of the air inside the apparatus and of the spatial enclosures, which were rendered in a section cut out of hard rubber. The experiment pretends to take place in a vacuum of abstract geometry without atmosphere, even though it was well known at the time that temperature and humidity change the propagation of sound. Aside from the problem of the model's reduced scale and its standardized material, there is also the issue of scaling in the photographic process itself, where further social, technical, aesthetic, and affective scales come into play.[51] While Osswald's apparatus was larger than many photographic devices of the period, the models he used for testing sound performance were miniaturized.

Geometric Studies of Auditorium Design

Like other experts at the time, Osswald focused much of his attention, in both teaching and research, on modern auditorium design. One of the highly controversial designs of this period was the large assembly hall at the League of Nations headquarters in Geneva, Switzerland, which was projected to have a capacity of 2,700—a size unheard-of in auditorium design at the time. After the jury had ruled on the 377 entries in the design competition for the auditorium in 1927, Osswald published his expert opinion of the large assembly hall both in Switzerland and in the United States, stating his doubt that loudspeakers could resolve the problem of amplification in very large auditoriums: "as experience has shown," they would "amplify at the same time the disturbing reverberation, thus failing to alleviate the difficulty."[52] His work was quoted by the leading proponents of modernism, such as Peter Meyer and Sigfried Giedion.[53] Auditorium design posed a pressing problem both for speech and for music in the 1920s. Audiences had grown larger, but loudspeaker technologies were not yet able to reproduce sound in interior spaces to a quality that was comfortable to listen to, or was even intelligible.

When Osswald first immersed himself in the technique of architectural sound photography, he built a model of the type of auditorium that he thought could best enable sound to travel to all positions in the audience. Thanks to a large gallery, sound would be reflected up to the very last row without becoming too reverberant. Photographs that Osswald took on 29 August (in a model of the vertical section) and on 9 October 1930 (in a model of the horizontal section) were published in *Schweizerische Bauzeitung* on 1 November 1930 [FIGURE 14].[54] They show two variations of the room: one with an open gallery and one with the gallery closed off. The variable internal volume of the space was key and allowed the users to accommodate differing requirements for speech and music. To reduce the volume when a shorter reverberation time was required, Osswald proposed, the gallery should be closed off. Thus, without the gallery extension, the space would serve more intimate performances and lectures. When enlarged from 6,100 cubic meters to its full capacity of 8,750 cubic meters, the space would be suited to orchestral music, with more seating and a longer reverberation time.[55]

The contemporary approach to controlling reverberation time was to rely on the many new absorbing materials promoted by industry. By contrast, Osswald continued to work on manipulating the volume parameter of the reverberation formula and paid little attention to the use of materials for sound control. After its publication in *Schweizerische Bauzeitung*, Osswald's idea of the variable volume was appraised in the 1932 American handbook *Acoustics and Architecture*, one of the most comprehensive works on architectural acoustics at the time. Its author, Paul E. Sabine, repudiated Osswald's reasoning:

> *Osswald of Zurich has suggested a scheme whereby the volume term of the reverberation equation may be reduced by lowering movable partitions which would cut off a part of a large room when used by smaller audiences and for lighter forms of music. … In connection with Osswald's scheme, one must remember that in shutting off a recessed space, we reduce both volume and absorbing power and that such a procedure might raise instead of lower the reverberation time.*[56]

Without specification of the walls' and partitions' materials or thickness, it is impossible to judge which of the acoustic experts was right, since they relied on different parameters. Nevertheless, this contemptuous mention in an international publication may have become an obstacle to Osswald's further career, which had advanced significantly after he voiced his

FIGURE 15
Franz Max Osswald, acoustic studies for wall shapes in film theaters, 1930, published in 1936; SEE NOTE 48. (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986436).*

FIGURE 16
Franz Max Osswald, sound test in a horizontal model of Gottfried Semper's Stadthaus Winterthur auditorium, 1933 (Franz Max Osswald, "Raumakustik in geometrischer Betrachtung," 1930, published in 1936; SEE NOTE 48. Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000098644).*

FIGURE 17
Franz Max Osswald, sound test in a model of the Ear of Dionysius, a Sicilian cave that is surrounded by a myth of perfect sound conductivity, 1930 (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986441).*

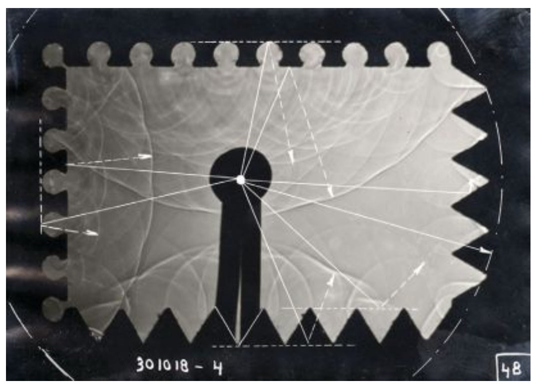

FIGURE 15

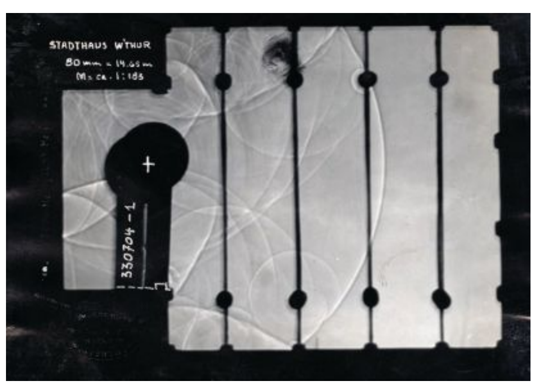

FIGURE 16

FIGURE 17

expert opinion on the 1927 League of Nations competition. Throughout the 1930s, and until his death in 1944, he continued to work in his laboratory, but he received less acclaim and attention than he had in the late 1920s.

In the fall of 1936, Osswald submitted his architectural sound photography to the *Zeitschrift für technische Physik*. The short article was accepted and published as three pages of text, exceptionally richly illustrated with glossy plates containing eleven samples of sound wave photography and photographs of the built theater spaces on which the models were based. The photographic experiments showed sound propagation and reflections not only in familiar types of modern auditorium geometry but also in extravagantly shaped models with folded, curved, and undulating walls. These models feature geometries that were unlikely to represent actual spaces; rather, Osswald probably created them to study certain wall angles or the curvature of a room's enclosure. These unusual sections were presented in the context of existing and alternative shapes for film theaters [FIGURE 15].[57] In this most extensive publication of his photographic reasoning, Osswald included many of his 1930s experiments and a few of the photos taken for the doctoral thesis of Hans Frei, Osswald's only doctoral student, in 1933.[58]

Osswald's profound fascination with photographing sound was untimely, and he received scant reward for his time-consuming method of firing a rifle and illuminating moving air in a small two-dimensional model. His most direct critic was his student, Hans Frei. With funding by the wood construction industry, Osswald produced his improved apparatus and a second large series of photographs. Many were published in Frei's doctoral thesis on electroacoustic investigations in reverberation chambers, for which Osswald acted as coadviser. The primary adviser, the ambitious physicist Franz Tank, seems to have had little sympathy with the objective of a visual exploration of acoustic phenomena. The dissertation's criticism of the photographic experiments was crushing. Frei's critique cited the method's neglect of absorption, phase shifts, and its two-dimensional reduction, rejecting it as reductive, vague, accidental, and not suited to modeling a "theoretically precise image of the situation in real space."[59] Rather than valuing its aesthetic or communicative value, Frei seems to have judged Osswald's photographic technique as a comprehensive theoretical model, by which standard it was unable to deliver.

Fluting, folding, triple pocket moldings, cannelures, cavities, and waveforms were built into the walls of Osswald's sectional models of round, elliptical, rectangular, and potato-shaped spaces. While these imaginary spaces were certainly of no use in proving the "objectivity" of the method, the treatment of the walls was a practical concern in the context of sound film. Film theaters in the 1920s were designed for silent film, usually accompanied by music from a single live instrument. With changes in film technology and the advent of sound film, many

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theater spaces had to be remodeled to distribute sound more evenly through the audience and to be less reverberant. Of the three plates published by Osswald in 1936, two showed former silent film theaters that had been adapted to accommodate talking movies. The third was Gottfried Semper's Winterthur city hall of 1869, which had undergone several acoustic corrections before and after Osswald's consultancy [FIGURE 16]. Osswald even photographically examined model sections of the Ear of Dionysius, a space that is supposed to have perfect sound conductivity [FIGURE 17]. This ear-shaped Sicilian cave had long been a mecca for acousticians; that it still holds such interest is an indication of the "hard" natural science of acoustics' long tradition of engaging with psychophysiological and sociocultural mysteries of sound in space and in the ear.

While Osswald called for architectural designs that could distribute sound by spatial form and for methods of measurements that included the ear, the discipline of architectural acoustics, which he had helped to establish, had shifted interest to electroacoustics. Members of this next generation focused their attention on electrical methods for amplifying as well as for measuring sound. Osswald remained undeterred, devising other apparatuses intended to improve the practice of sound measurements and to correct the drawbacks of early loudspeaker technologies. For example, a huge spiral through which reverberation could be produced and added to the amplified sound from loudspeakers—another speculative proposal—speaks more of Osswald's sensitivity to spatial sound than of physical expertise [FIGURE 18].[60]

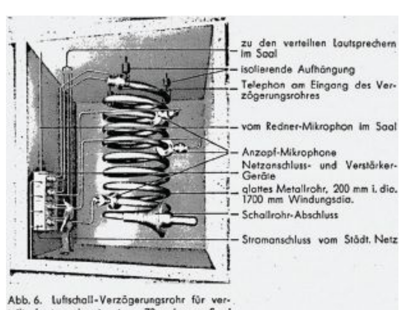

FIGURE 18

FIGURE 18
Franz Max Osswald, *Luftschall-Verzögerungsrohr*, a pipe for delaying airborne sound, proposed to enable spatially adequate loudspeaker transmission in large auditoriums, 1937 (Franz Max Osswald, "Zur akustischen Gestaltung von Grossräumen," *Schweizerische Bauzeitung* [4 Sept. 1937], 69).

In a book published in 1939, the German acoustician Joseph Benedict Engl reproduced Osswald's two photographic sound tests for Semper's auditorium [FIGURE 16]. Engl acknowledged the explanatory value of the visualizations and remarked that "not everything can be expected of this method."[61] Despite continuing criticism of the method by scientists, its explanatory value may be the reason that images of sound persisted throughout the twentieth century. Architectural acousticians in various countries and contexts embraced sound wave photography both for its promise of scientific objectivity (by means of the mechanical apparatus) and for its inclusion of the visual sense. The modern technique of photography, even though it did not satisfy physicists' theoretical desires, did enable scientists to communicate the experience of hearing in modern terms.

In his paper on theater auditorium design, Wallace C. Sabine discussed the "inadequacy of the discussion of the subject of architectural acoustics by the construction of straight lines" and directed readers' attention to the areas of the photographs that exposed "waves reflected from the screens in front of the boxes, of the balcony, and of the gallery." He concluded, "The method of rays, although a fairly correct approximation with large areas, is misleading under most conditions," especially when it came to theaters.[62] Sabine thus hoped that the knowledge gained from a photograph could exceed the geometric ray method and praised the method for incorporating the effects of diffraction into the acoustical rendering. Osswald's extensive practice with sound photography, however, exposes an enthusiasm that cannot be found in Sabine's skeptical description: "The system of reflected waves in the succeeding photograph in the series is so complicated that it is difficult to identify the several reflections by verbal description. The photograph is therefore reproduced a second time, marked and annotated with an extensive caption."[63] Osswald's annotations seem less reluctant, often superposing lines of white to explain the direction in which the sound waves propagated through the sectional models and reflected from the walls [SEE FIGURES 14, 15, 19, AND 20]. That both Sabine and Osswald needed such elaborate annotation hints at their struggles to interpret in words the vagueness of the visual imprint of sound from moving air.

When, in the 1930s, Osswald traced his own photographs with white ink, indicating the directions in which the sound waves propagated, the superposed, simplified lines were intended to highlight the evidence provided by the photographs and to communicate his findings to lay audiences; yet at the same time, the hand-drawn lines subverted the objectivity granted by his schlieren apparatus. Though Osswald's lines were meant to clarify the trajectories of sound, in fact they obscure more than they reveal. They trace what the experimenter himself expected, and what he saw. While helping lay viewers of Osswald's photographs understand where the blurry wave fronts might be moving, the hand-drawn lines also acted as markers of where the photographs failed, and as an affirmation of Osswald's expertise.

Sound photography proved effective for communicating expert knowledge to lay audiences. In the case of acoustic sciences, the lay audience includes many, from engineers to designers and architects. While providing a valuable tool for communicating findings to this audience, photographic images also assisted the experts in reiterating the processes they investigated and reevaluating their results. To the

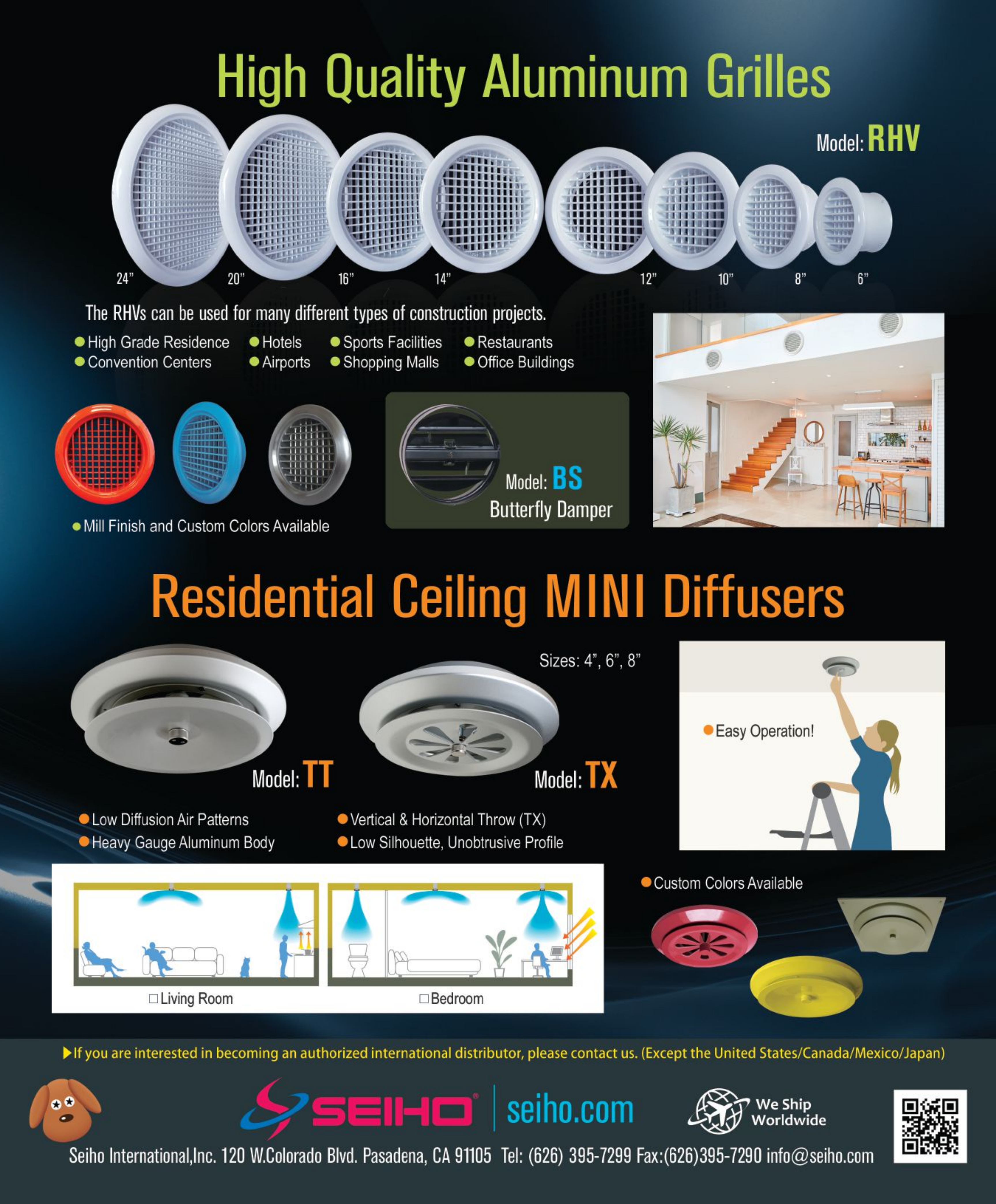

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FIGURE 19
Lothar Cremer's comparison of the geometric construction of sound reflection and Franz Max Osswald's experiments with schlieren technique, 1949 (Lothar Cremer, *Geometrische Raumakustik* [Zurich: Hirzel, 1949], 147).

architect who sought the advice of the acoustician, the image was explanation and proof. And the confidence of the audience reassured the experts of their own expertise.

Despite their limited scientific usefulness, the sound photographs resurfaced. Lothar Cremer used Osswald's photography in his seminal *Geometrische Raumakustik* of 1949. Cremer juxtaposed an example of Osswald's photographic tests with a simple drawing constructed geometrically, although he concluded that the photographic technique offered no additional information [FIGURE 19].[64] In Cremer's book, as in Frei's thesis, the photographs were published without arrows to indicate the directions of the sound waves; the audience was considered expert enough to understand the photographs without explanation. Possibly, Cremer and Frei thought Osswald's markings were a simplification, a "pandering" to nonexpert readers with no relevance for contemporary science. The hand-drawn lines did not survive within the new practice—and paradigm—of pattern recognition, which ultimately required expert understanding. Certainly, Osswald's markings hardly fulfill Daston and Galison's criteria for the third period of objectivity, when "trained judgment" allows information to be highlighted or reduced by an expert but not to be added or superimposed from preexisting knowledge.[65] The geometrical lines that Osswald superposed onto the blurry shadows of sound waves in the photographs—which I have classified as belonging to Daston and Galison's second periodization, "mechanical objectivity"—were conceived in the logic of "truth-to-nature," the first of Daston and Galison's three periodizations, when preconception was not opposed to scientific knowledge. Different concepts of modern objectivity collided in the applied acoustics laboratory at ETH Zurich.

Osswald's hand-drawn lines counteract the intended modern objectivity—granted by the mechanical process of his photographic technique—with a modernity that is subjective and, in the words of Hilde Heynen, "refers to the typical features of modern times and to the way that these are experienced by the individual."[66] These lines assert the relevance of Osswald's untimely image making by exposing the simultaneity of scientific and aesthetic intentions; they oscillate between intuition and simplification. The modern assumption that photography could capture a more comprehensive range of physical phenomena than could mathematical formulas collided and merged with the tradition of engineers thinking with pictures.

As historian of science Hans-Jörg Rheinberger describes it, scientific findings require "a kind of attention with a sharp sense for subtle tones, thus an attention which seems to

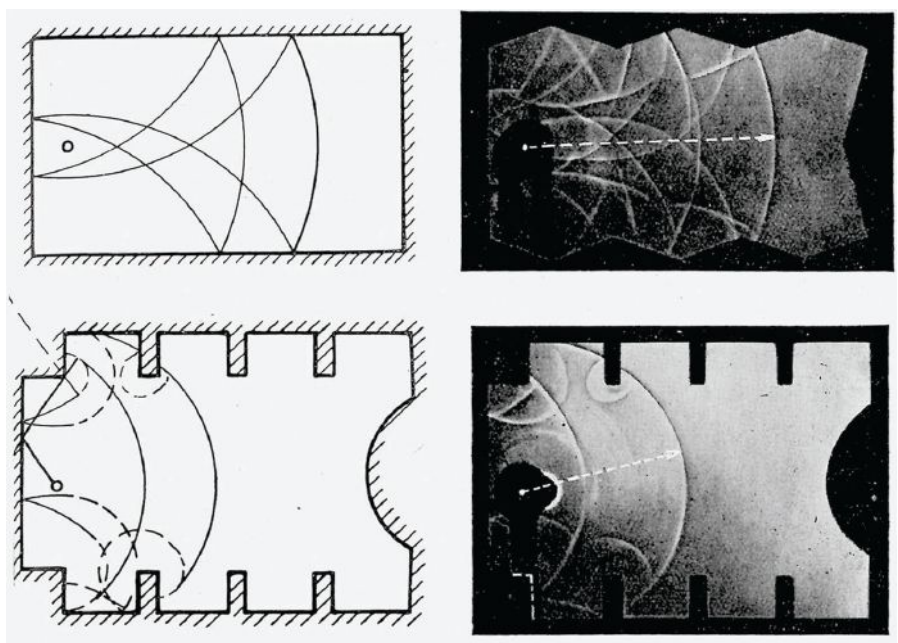

Abb. 64. Schlierenaufnahme an Modellen mit grobgegliederten Seitenwänden im Vergleich mit geometrischen Konstruktionen der Wellenfront
(Aufnahmen von Osswald, siehe Fußnote)

FIGURE 19


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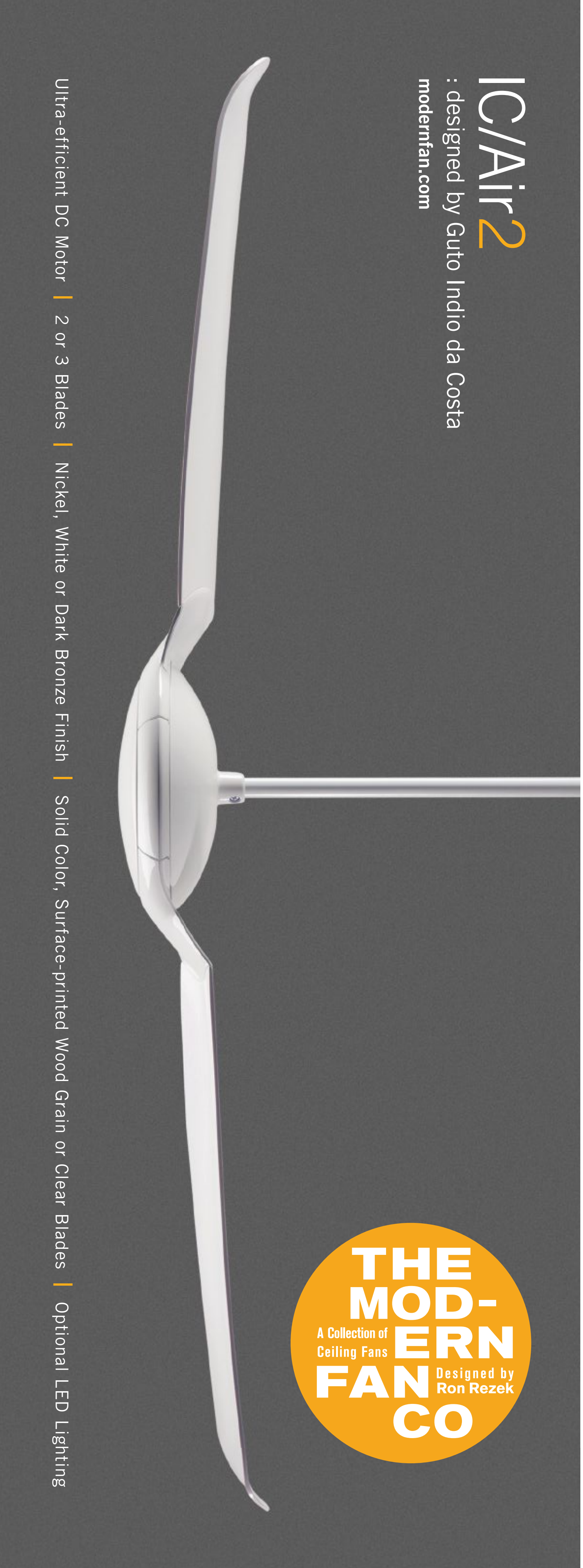
hover above" and does not steer the viewer rigidly toward a predefined result.[67] The kind of attention that comes with Osswald's tracing over areas of subtle grays with blurry contours gets in the way of his ambition to create an "objective" image of the phenomena of sound; intuition then is inseparable from the kind of subjectivity that science calls prejudice. Osswald traced the lines of his own forecast onto the grayish print, as many scientists in the medical sciences and in applied acoustics had done before him and would do after him. Perhaps the motivation for the laborious schlieren technique was more than the production of evidence. One of the questions explored in this article relates to visual reasoning in acoustics, when engineers combined scientific photography with the experience of hearing.

In 1961, Willi Furrer (1906–85), Osswald's successor at ETH Zurich, claimed that the insights offered by sound photography were "relatively limited" and had "no relationship to the efforts necessary," therefore the technique was not used after 1930 (the year of Osswald's most extensive photography experiments).[68] While the first edition of Furrer's book *Raum- und Bauakustik, Lärmabwehr*, published in 1956, does not refer to the technique at all, in the 1961 edition he uses Osswald's reproductions of British sound photography from the National Physical Laboratory in his discussion of modeling sound. Despite Furrer's disparagement of the method, it is most likely because of him that the crimson binder survives; the album was one of the few objects left by Osswald that Furrer might have thought worth keeping. French architectural acoustics, too, remained fascinated with sound photography in the postwar period: a 1952 handbook dedicated seven out of twelve pages of illustrations to sequences of water wave photography, one page to photographs of light reflections in a model, and none to the tedious method of ultrasound photography with the schlieren method.[69]

Osswald's eager and relentless experimenting was at once ahead of and behind its time, both pioneering and too late. This was the moment when architectural acoustics gained momentum and formed a discipline, and when specialists across the globe appropriated its techniques.[70] But by the mid-1930s, when electroacoustics entered the scene, most of Wallace C. Sabine's cohort had already left the field. Such shifts in scientific attention accompanied the realization that the information conveyed in architectural sound photography was not sufficient. Sound propagation, like many other phenomena, could be more precisely rendered by electroacoustic techniques than by the photographing of air movements. Nevertheless, the images kept appearing in journals. Lay audiences and experts alike were fascinated by the elucidation of acoustic phenomena, so little understood and so hard to explain.

Unlike many of his contemporaries, Osswald never suspended his belief in the role of the senses in his experiments, abandoning neither the visual—illuminated



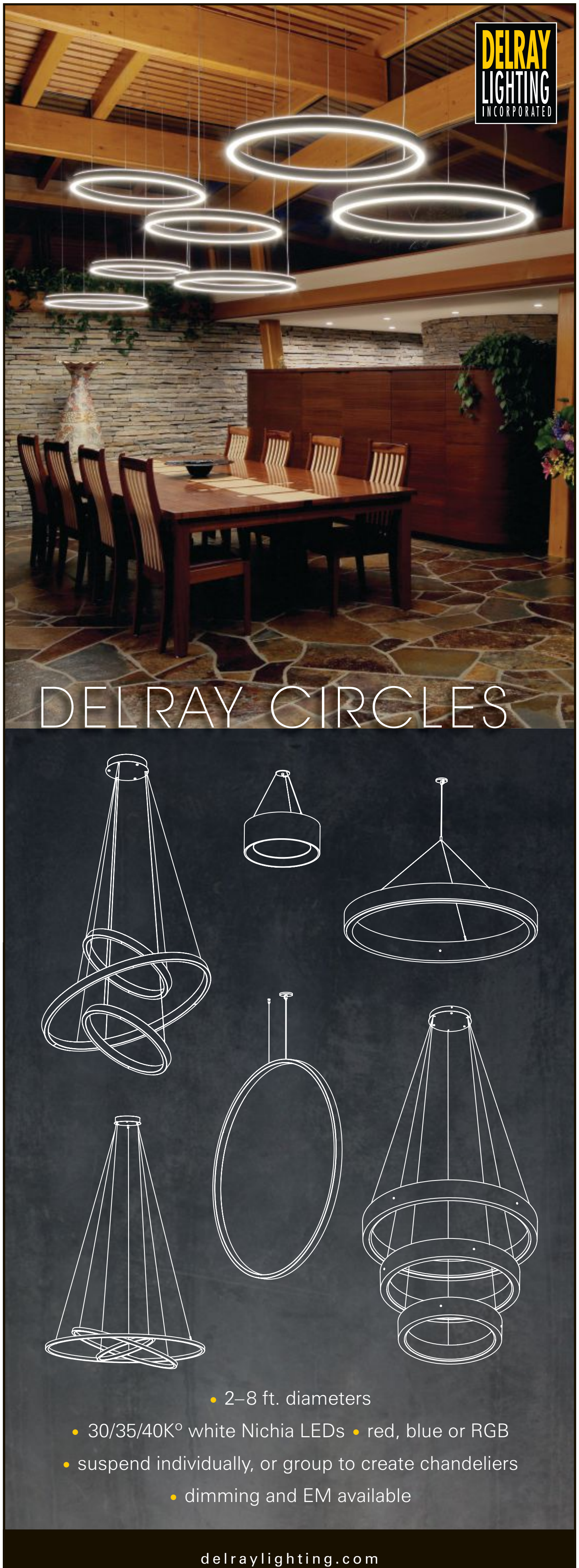
by the photographs he produced—nor the auditory sense. When he devised a tapping machine with variable loudness as part of a new "method for measuring impact sound" in 1936, he did so by including hearing as a means in scientific measurement. Doing so, he reversed the point of reference in the scientific experiment, declaring the sound to be the variable parameter against the constant of the physiological threshold of hearing: "It is necessary only that the 'threshold' of the detecting instrument be constant. Nature has provided a wonderful threshold instrument, the human ear," he noted as he explained his apparatus in the *Journal of the Acoustical Society of America*.[71] Osswald's claim must have sounded absurd to other scientists in the 1930s, when automated acoustic measuring had finally obliterated the unsatisfactory subjective judgment of sound levels by the ear. Nevertheless, Osswald's paper propagating the human hearing threshold as an instrument of standardization was accepted for publication in the *Journal of the Acoustical Society of America* in 1936. The human ear, as a "wonderful threshold instrument," seemed to be a viable part of acoustic measurement methods.

Eyes, Ears, Experts, and Oracles: Conclusion

Osswald's success as researcher and consultant in architectural acoustics coincided with the proliferation and institutionalization of architectural acoustics. Recognition of his work was propelled by his expert judgment of contemporary auditorium designs during the 1920s and peaked in 1929—the founding year of the Acoustical Society of America and the year of Osswald's promotion at ETH.[72] His efforts in photographing sound in architectural models during the 1930s, when electroacoustics and loudspeaker amplification were increasingly applied to architectural designs, were rather untimely. Studying these photographs now, when the rivalry between ocular-centric and sonic positions is superseded by more comprehensive, multisensory interests, however, seems timely.

In the endeavor to capture, measure, describe, and control sound, what emerges in the study of photographic practices in architectural acoustics is a strange ambivalence regarding sensory perception. Inserting visual techniques into the study of sound raises many issues, such as that of "technologically inflected vision," when manipulation becomes a condition for objectivity.[73] In regard to Osswald's photographs, we can no longer be sure whether the scientist's hand acts as an extension of or imposes his intention on the machine he has created.

Architectural sound photography, like almost all photography in the natural sciences of the epoch, did not speak for itself; it required explanation. For example, British physicists Davis and Kaye instructed readers to interpret the image series of sound traveling with their attention "directed to the progress of only one of the waves of the train" of the many reflections photographed in the ripple tank.[74] As shown here



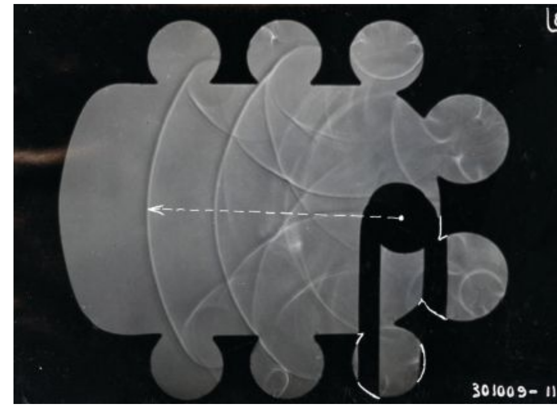


FIGURE 20

in examples from Osswald [FIGURE 20; SEE FIGURES 14, 15, 19, AND 20], many sound photographs are marked with lines to guide the eye of the observer, indicating the directions in which these singled-out "waves of the train" propagated. As Jennifer Tucker emphasizes, the veracity of photographs was often suffused by claims of subjective intervention: the production of images of invisible phenomena required exceptional skill and knowledge, thus exposing the authority of the expert to contestation.[75]

The photographs captured blurry, and to an extent accidental, nuances of the light and dark of inhomogeneous air caused by the movement of sound pressure. These patterns complemented scientific inquiry in that they included some of the intricacies of sensory perception that the natural sciences otherwise exclude. If nonintervention lies at the heart of photography, the manual interventions on the photographs interfered with the goal of mechanical objectivity as defined by Daston and Galison. The relation of sound photography to the "unprejudiced, unthinking, blind sight" of mechanical objectivity raises questions of method, model, and media; of the relationship of visual and auditory cultures; and of the authority of the expert.[76] Hand-drawn lines and arrows, as Athanasius Kircher had etched three centuries earlier, seem anachronistic but remind us how verisimilitude as well as intuition persisted in the age of mechanical objectivity, and beyond. I argue that such hand-drawn interventions also show how the visual representation of sound raises the question of media and visibility per se. The photographs relate to an epistemology of modern architecture both in the setting of the experiments,

FIGURE 20
Franz Max Osswald, acoustic studies for wall shapes in film theaters, 1930, published in 1936; SEE NOTE 47. (Image Archive, ETH Library Zurich, *http://doi.org/10.3932/ethz-a-000986433*).

in the laboratory, and in the technique of representation, schlieren photography, borrowed from the natural sciences. They remind us that the amplification of sound once depended largely on the geometry of a room, together with its materials and size, as expressed in the reverberation formula, when spatial form and not electroacoustic amplification shaped the sounds of the environment.

The youngest generation of sound-mapping systems has appropriated a name pertaining to photography: market leaders such as Norsonic (Norway), Brüel & Kjær (Denmark), and CAE Systems (Germany) currently promote "acoustic cameras." These register sound levels at different frequencies using microphone arrays of varying sizes. The "noise maps" thus produced are superimposed onto photographs of the sites where the sound intensities were measured, expecting remedy for the auditory while communicating by visual media.

Osswald's practice around 1930 seems to lie at a crossroads of modern science. He was persistent in observing the blurry shadows cast by sound waves but eager to mark the images with his hand-drawn lines, simultaneously rigid in copying Sabine's methods and blinded by the visual magic of the patterns emerging. In the expert culture in architectural acoustics of the 1930s, architectural sound photography restated the geometry and the volume of physical space, thus spatial form, as the decisive parameter for architectural acoustics and enforced this concept—against the increasing application of electronic amplification—by means of a representational technique borrowed from the natural sciences. Yet at the same time, the aesthetic appeal of the photographs plunged them into the realm of sensory magic. It seems that Osswald consulted his apparatus like an oracle, to bring out an image that explained more than a mathematical formula could. Yet we might suspect that, through his self-constructed oracle, Osswald sought only to confirm what he already knew.

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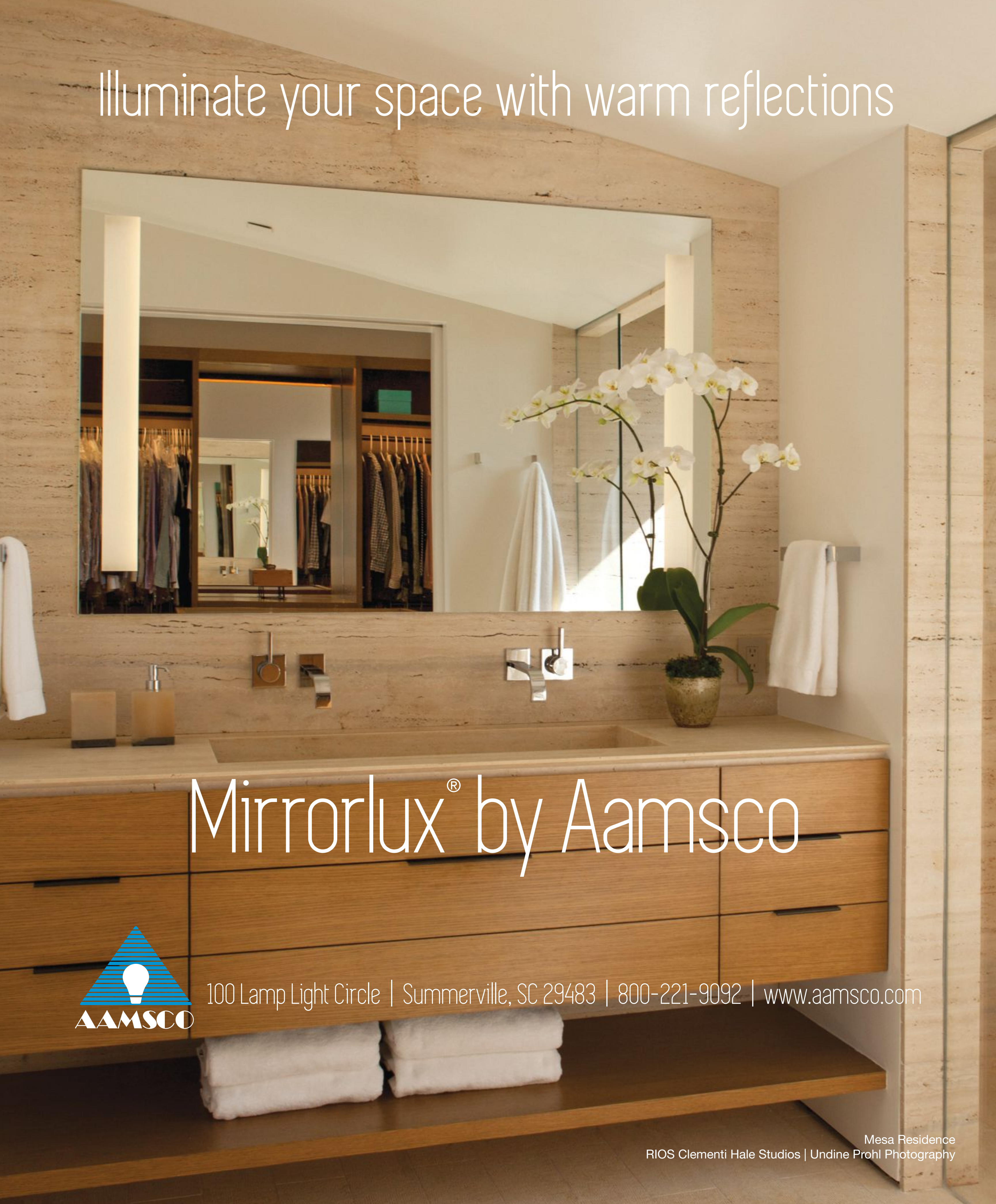
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Notes

1. This essay was written on the occasion of my postdoctoral stay at the Max Planck Institute for the History of Science, Berlin, in 2015. Thanks to Viktoria Tkaczyk and her research group Epistemes of Modern Acoustics for their responses to an early draft, and for the invitation to serve as visiting scholar in 2016–17. I am grateful to the *JSAH* editorial team and the anonymous reviewers for their encouraging and helpful comments on earlier versions of this article. Dear colleagues have inseminated the essay with their comments: Carlotta Daro, Brenda Edgar, and many others, and I owe a debt to the expert reasoning of physicists Robert Hofmann and Gary S. Settles. Initially, the research for my Swiss National Science Foundation–funded doctoral thesis "Hellhörige Häuser: Akustik als Funktion der Architektur" (2013), supervised by Prof. Laurent Stalder, Prof. David Gugerli, and Ing. Kurt Eggenschwiler of ETH Zurich, gave me the opportunity to study Franz Max Osswald's previously unstudied contribution to architectural acoustics. I am especially indebted to Kurt Eggenschwiler, head of acoustics at Empa Duebendorf, for opening the basement of his department to my research. Further thanks to the Max Planck Institute's library and ETH Library Zurich for help with digitizing and archiving the photographic materials.

2. See "Field Notes: Architecture and the Environment—A Questionnaire," ed. Sophie Hochhaeusl and Torsten Lange, *Architectural Histories 5* (2017). This position paper with statements by fifteen scholars reflects methods and themes of "environmental histories of architecture." Daniel Barber has also recognized this as an expanding subdiscipline; see Daniel Barber, "Introduction," in "Architectural History in the Anthropocene," ed. Daniel Barber, special issue, *Journal of Architecture* 21 (2016), 1165–70.

3. The 124 photographs from the crimson binder have, in the meantime, been archived at the Image Archive of ETH Library Zurich; they are available online there and in the Max Planck Institute's database Sound & Science: Digital Histories, created by the Epistemes of Modern Acoustics research group.

4. Gary S. Settles, *Schlieren and Shadowgraph Techniques: Visualizing Phenomena in Transparent Media* (Berlin: Springer 2001), 8. A brief explanation of schlieren imaging is available at Gary Settles, "High-Speed Imaging of Shock Waves, Explosions and Gunshots," *American Scientist*, Jan./Feb. 2006, *http://www.americanscientist.org/issues/feature/high-speed-imaging-of-shock-waves-explosions-and-gunshots/1 (accessed 21 Apr. 2017).*

5. Susanne Holl, "Strahl und Welle: Bilder des Schalls um 1800," in *Über Schall: Ernst Machs und Peter Salchers Geschossfotografien*, ed. Christoph Hoffmann and Peter Berz (Göttingen: Wallstein, 2001), 171–98; Douglas Kahn, "Concerning the Line: Music, Noise, and Photography," in *From Energy to Information: Representation in Science and Technology, Art, and Literature*, ed. Bruce Clarke and Linda Dalrymple Henderson (Stanford, Calif.: Stanford University Press, 2002), 178–94; Patrick Feaster, *Pictures of Sound: One Thousand Years of Educed Audio: 980–1980* (Atlanta, Ga.: Dust-to-Digital, 2012).

6. Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception*, trans. A. M. Sheridan (1963; repr., New York: Pantheon, 1973).

7. Lorraine Daston and Peter Galison, Objectivity (New York: Zone Books, 2010), 16. See also Lorraine Daston and Peter Galison, "The Image of Objectivity," *Representations*, no. 40 (Fall 1992), 81–128; Lorraine Daston, "Wordless Objectivity" (Preprint 1), Max Planck Institute, Berlin, 1994.

8. Peter Geimer, "Noise or Nature? Photography of the Invisible around 1900," in *Shifting Boundaries of the Real: Making the Invisible Visible*, ed. Helga Nowotny and Martina Weiss (Zurich: vdf Hochschulverlag, 2000), 121. See also Tom Gunning, "Invisible Worlds, Visible Media," in *Brought to Light: Photography of the Invisible*, ed. Corey Keller (New Haven, Conn.: Yale Architectural Press, 2008), 51–63; Anthony Enns, "Vibratory Photography," in *Vibratory Modernism*, ed. Anthony Enns and Shelley Trower (Basingstoke: Palgrave Macmillan, 2013), 177–97.

9. In parallel to the critique of the term *landscape, soundscape* has been criticized and recuperated as derived not from "looking at" (Greek: *skopein*) but from land formation (Old English: *sceppan* or *skyppan*); see Tim Ingold, "Four Objections to the Concept of Soundscape," in *Being Alive: Essays on Movement, Knowledge and Description* (London: Routledge 2011). The term has also been exposed as inherently related to sound reproduction; see Jonathan Sterne, "The Stereophonic Spaces of Soundscape," in *Living Stereo*, ed. Kyle Devine, Tom Everett, and Paul Théberge (New York: Bloomsbury, 2015), 65–84. Further, it has been criticized for its vagueness and ubiquity; see Ari Y. Kelman, "Rethinking the Soundscape: A Critical Genealogy of a Key Term in Sound Studies," *Senses and Society* 5, no. 2 (2010), 212–34. This ubiquity and similarity to *landscape* make *soundscape* useful, too. "Like a landscape," Emily Thompson argues, "a soundscape is simultaneously a physical environment and a way of perceiving that environment; it is both a world and a culture constructed to make sense of that world." Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900–1933* (Cambridge, Mass.: MIT Press, 2002), 1. Buckminster Fuller's 1964 conference talk "The Music of the New Life," published first in 1966 in a journal (and discovered there by my colleague Olga Touloumi, with whom I am engaged in a lasting discussion on this

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matter) and later in Fuller's best-selling paperback *Utopia or Oblivion*, has three uses of the word *soundscape* within only two paragraphs, as in a firework of words. See R. Buckminster Fuller, "The Music of the New Life: Thoughts on Creativity, Sensorial Reality, and Comprehensiveness, Part I," *Music Educators Journal* 52, no. 5 (1966), 52; R. Buckminster Fuller, *Utopia or Oblivion: The Prospects for Humanity* (New York: Bantam Books, 1969), 43. Utopia was out there, broadcast by radio and loudspeaker systems, in a media frenzy that could possibly lead to oblivion (which probably was Fuller's take on immersion). The "paranoiac state" to which Marshall McLuhan referred in a 1974 letter to R. Murray Schafer was a state of confusion in which a term like *soundscape* held a promise of totality; see Marshall McLuhan to R. Murray Schafer, 16 Dec. 1974, in *Letters of Marshall McLuhan*, ed. Matie Molinaro, Corinne McLuhan, and William Toye (Toronto: Oxford University Press, 1987), 508. The overview inherent in the term is continuous with modernist trajectories of technological control and electronic stratification. See Sabine von Fischer, "Soundsphere: Electronic Dispositives in Acoustic Space," in *Staging Space: The Architecture of Performance in the 21st Century*, ed. Jeffrey Huang, Anton Rey, and Sabine von Fischer (Zurich: Park Books, forthcoming), 78–84.

10. This was a coincidence that Osswald emphasized, even altering his professional résumé to match the dates. Franz Max Osswald to the board of ETH, 12 Jan. 1934, item 14 of the board meeting of 3 Feb. 1934, SR3:1934/232.14, University Archives, ETH Zurich.

11. For a comprehensive history of the different generations of Sabines at Riverbank, see John W. Kopec, *The Sabines at Riverbank: Their Role in the Science of Architectural Acoustics*, ed. Acoustical Society of America (Woodbury, N.J.: Peninsula, 1997).

12. Wallace C. Sabine, "Architectural Acoustics," *American Architect and Building News* 62, no. 1196 (1898), 71–73. In 1900, a seven-part article series ("Architectural Acoustics I" through "Architectural Acoustics VII," from 7 April to 16 June), also in *American Architect and Building News*, expanded on the 1898 publication. See also note 26 below.

13. Wallace C. Sabine, "Theatre Acoustics," *American Architect* 104, no. 1984 (31 Dec. 1913), 268. Sabine erroneously spells August Toepler's name with two *p*s.

14. Settles, *Schlieren and Shadowgraph Techniques*, 8.

15. Peter Krehl and Stephan Engemann, "August Toepler: 'Er sah als erster den Schall,'" in Hoffmann and Berz, *Über Schall*, 200, 204.

16. "Er sah als erster den Schall" (my translation; all translations are my own unless otherwise noted). See ibid., 223. In an earlier English publication of Krehl and Engemann's essay on Toepler, *Schall* was translated as "shock waves." Peter Krehl and Stephan Engemann, "August Toepler—The First Who Visualized Shock Waves," *Shock Waves* 5 (1995), 1–18. Toepler's investigation of gunshots at a young age, in which he did not consider frequency, is often referred to as a study of "shock waves." The epitaph undoubtedly alludes to the broader phenomenon of sound.

17. Settles, *Schlieren and Shadowgraph Techniques*, 10.

18. Arthur L. Foley and Wilmer H. Souder, "A New Method of Photographing Sound Waves," *Physical Review* 35, no. 5 (1912), 373–86 (followed by five plate pages). A later, shorter publication on the technique made it familiar in the architectural community: Arthur L. Foley, "Sound Wave Photography in the Study of Architectural Acoustics," *American Architect–Architectural Review* 122, no. 2406 (1922), 415–18.

19. Foley and Souder, "A New Method," 374.

20. Ibid., 382.

21. Adolf Loos, "Das Mysterium der Akustik," *Der Merker: Österreichische Zeitschrift für Musik und Theater* (Jan. 1912), 9–10. A revised version of this work was published in Adolf Loos, *Trotzdem: Gesammelte Schriften 1900–1930*, ed. Adolf Opel (1931; repr., Vienna: Prachner, 1997), 116–17. An English translation titled "The Mystery of Acoustics" appears in Adolf Loos, *Adolf Loos: On Architecture*, trans. Michael Mitchell (Riverside, Calif.: Ariadne Press, 2002), 108–9. On this text, see Sabine von Fischer, "From Seat Cushions to Formulae: Understanding Spatial Acoustics in Physics and Architecture," in *Germany in the Loud Twentieth Century: An Introduction*, ed. Florence Feiereisen and Alexandra Merley Hill (New York: Oxford University Press, 2011), 63–77.

22. Loos, "Das Mysterium der Akustik."

23. Viktoria Tkaczyk, "Listening in Circles: Spoken Drama and the Architects of Sound, 1750–1850," *Annals of Science* 71, no. 1 (2014), 299–334.

24. Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction* (Durham, N.C.:

Duke University Press, 2003), 43–44.

25. Thompson, *The Soundscape of Modernity.*

26. "Being equal to about .171V in the present experiments, but dependent on the initial intensity of the sound." Wallace C. Sabine, "Architectural Acoustics III," *American Architect and Building News* 68, no. 1271 (5 May 1900), 35–37. *V* stands for volume in cubic meters, and the constant (*k*) is composed of reverberation time *(T)* and total absorption in square meters (*A*). In later calculations, the constant of 0.171 was slightly lowered to 0.163, which is still used in the contemporary formula for reverberation time: $T = 0.163 \cdot V/A$.

27. Sabine, "Theatre Acoustics" (1913), 268.

28. Vitruvius, *De architectura*, bk. 5, chap. 8, "De locis consonantibus ad theatra eligendis," quoted in Sabine, "Theatre Acoustics" (1913), 257.

29. Ibid., 258.

30. Ibid.

31. Absolute accuracy was not achieved during these measurements, however, which still involved the experimenter's hearing threshold; rather, accuracy was achieved through mathematical calculation: "Each determination being the mean of about twenty observations under conditions such that the audible duration of the residual sound was 4 seconds, the average deviation of the single observations from the mean was .11 seconds, and the maximum deviation was .31. The computed 'probable error' of a single determination was about .02 seconds; as a matter of fact, the average deviation of ten determinations from the mean of the ten was .03 seconds, and the maximum deviation was .05." Wallace C. Sabine, "Architectural Acoustics II," *American Architect and Building News* 68, no. 1269 (21 Apr. 1900), 19.

32. Wallace C. Sabine, "Theatre Acoustics," in *Collected Papers on Acoustics by Wallace Clement Sabine*, ed. Theodore Lyman (Cambridge, Mass.: Harvard University Press, 1922), 163–97.

33. Sabine, "Theatre Acoustics" (1913), 274–76.

34. Thompson, *The Soundscape of Modernity*, 64.

35. Sabine, "Theatre Acoustics" (1913), 268–70.

36. Eugen Michel, *Hörsamkeit grosser Räume* (Braunschweig: Vieweg, 1921).

37. Alfred H. Davis and George W. C. Kaye, *The Acoustics of Buildings* (London: G. Bell and Sons, 1927), 46.

38. Ibid., 47.

39. Ibid., 48.

40. Eugen Michel, *Akustik und Schallschutz im Hochbau* (Berlin: De Gruyter, 1938), 50.

41. Anselm Lauber, *Wasserwellenversuche*, report no. 22.160 (Bern: Generaldirektion P.T.T., Forschungs- und Versuchsanstalt, 1951). For discussion, see Sabine von Fischer, "Refractions Reflected in a Ripple Tank, Reconsidered (1951)" (paper presented at the Fourth International Meeting of the European Architectural History Network, Dublin, 2–4 June 2016).

42. The work and career of Franz Max Osswald form a key narrative in Sabine von Fischer, *Das akustische Argument* (Zurich: gta Verlag, forthcoming).

43. Osswald asked for the two rooms numbered 39A and 35/36A. Habilitations—Gesuch Osswald an den Schweizerischen Schulrat, 2, SR3:1928/170, University Archives, ETH Zurich.

44. U.S. Patent US931819 A, granted 24 Aug. 1909, for "Walker's Loose Leaf" to the manufacturer John Walker Jr., London, England. Walker sold paper refills specifically to fit Osswald's binder (Refill Size No. 1299), but instead Osswald filled it with custom-cut brown craft paper and thin, pale-blue cardboard.

45. In her thesis, Lea Haller investigates the history of the ETH Photographisches Institut within the larger framework of the separation between basic and applied science. Lea Haller, "Reine und angewandte Forschung: Zur Praxis einer Grenzziehung. Eidgenössische Technische Hochschule Zürich, 1918–1952" (MA thesis, Universität Zürich, 2006).

46. Franz Max Osswald, "Akustik in der Architektur" (lecture presented during the winter semester 1932–33), Hs 1412:20 (bequest of Rolf Meyer-von Gonzenbach), University Archives, ETH Zurich.

47. Settles, *Schlieren and Shadowgraph Techniques*, 19.

48. Franz Max Osswald, "Raumakustik in geometrischer Betrachtung," *Zeitschrift für technische Physik* 17, no. 12 (1936), 562–63. Figures 15 and 20 in this essay are published on plate XI, Figure 16 on XIII.

49. Davis and Kaye, *The Acoustics of Buildings*, 52.

50. "Ultraschall-Luftwellenphotographie ist ein genaues und anschauliches Mittel zur Erkennung reflektorisch einflussreicher Begrenzungsteile, die nötigenfalls anders zu formen oder zu dämpfen sind." Osswald, "Raumakustik in geometrischer Betrachtung," 563.

51. See Andy Fisher, "Photographic Scale," in *On the Verge of Photography: Imaging beyond Representation*, ed. Daniel Rubinstein, Johnny

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Golding, and Andy Fisher (Birmingham, England: ARTicle Press, 2013), 151–57; this essay was also published in *Philosophy of Photography* 3, no. 2 (2012), 310–29.

52. Franz M. Osswald, "The Acoustics of the Large Assembly Hall of the League of Nations, at Geneva, Switzerland," *American Architect* 84, no. 2559 (20 Dec. 1928), 838.

53. On the debates concerning the League of Nations auditorium, see Sabine von Fischer, "Debating Volume: Architectural vs. Electrical Amplification in the League of Nations, 1926–28," in "Sound Modernities," ed. Sabine von Fischer and Olga Touloumi, special issue, *Journal of Architecture* (forthcoming).

54. Franz Max Osswald, "Akustischer Konzert- und Vortragsaal mit veränderlichem Volumen," *Schweizerische Bauzeitung* 96, no. 18 (1930), 224–25.

55. Ibid., 225.

56. Paul E. Sabine, *Acoustics and Architecture* (New York:McGraw-Hill, 1932), 163.

57. Osswald, "Raumakustik in geometrischer Betrachtung," plates XI, XII, XIII.

58. Hans Frei, "Elektroakustische Untersuchungen in Hallräumen" (Electroacoustic experiments in reverberation chambers; PhDdiss.,ETHZurich, 1935).

59. Ibid., 79.

60. With the theoretical suggestion of the *Luftschall-Verzögerungsrohr* (pipe for delaying airborne sound) Osswald (naively) asserted that resonances could be somehow eliminated in the context of large auditoriums, especially churches, where the amplified sound reached the audience before, instead of after, the direct sound, thus creating misorientation and sound perceived as a monstrosity. Franz Max Osswald, "Zur akustischen Gestaltung von Grossräumen," in Schweizerischer Ingenieur- und Architektenverein Centennial special issue, *Schweizerische Bauzeitung* (4 Sept. 1937), 69. For a general reference on the history of the reproduction of reverberation, see Axel Volmar, "Auditiver Raum aus der Dose," in *Klangmaschinen zwischen Experiment und Medientechnik*, ed. Daniel Gethmann (Bielefeld: Transcript-Verlag, 2010), 153–74.

61. Joseph Benedict Engl, *Raum- und Bauakustik* (Leipzig: Akademische Verlagsgesellschaft, 1939), 224.

62. Sabine, "Theatre Acoustics" (1913), 270, 272.

63. Ibid., 270.

64. Lothar Cremer, *Geometrische Raumakustik* (Zurich: Hirzel, 1949), 147.

65. Daston and Galison, *Objectivity*, 46, 371.

66. Hilde Heynen, *Architecture and Modernity: A Critique* (Cambridge, Mass.: MIT Press, 1999), 10.

67. Hans-Jörg Rheinberger, "Über Serendipität—Forschen und Finden," in *Imagination: Suchen und Finden*, ed. Gottfried Boehm, Emmanuel Alloa, Orlando Budelacci, and Gerald Wildgruber (Paderborn: Wilhelm Fink, 2014), 235. The focus on serendipity in science is attributed to Royston M. Roberts, *Serendipity: Accidental Discoveries in Science* (New York: JohnWiley, 1989).

68. Willi Furrer, *Raum- und Bauakustik, Lärmabwehr*, 2nd ed. (Basel: Birkhäuser, 1961), 112.

69. Auguste Constant Raes, *Acoustique architecturale* (Paris: Eyrolles Editeur, 1952), plates I–XII.

70. "Architectural Acoustics" was the title of a journal article in 1898 and then of a series of articles in the *American Architect and Building News of 1900*, all by Wallace C. Sabine. It was not until three decades later, when the Acoustical Society of America and its journal were founded, that the field asserted a wider presence as an academic discipline.

71. Franz Max Osswald, "Method for Measuring Sound Isolation, in Particular of Impact Sound," *Journal of the Acoustical Society of America* 7 (Apr. 1936), 261. This article and its unpublished German manuscript are discussed in von Fischer, *Das akustische Argument*; and in Sabine von Fischer, "Tapping Machines: Listening to Difference, 1928–1956," in *Architecture / Machine*, eds. Moritz Gleich and Laurent Stalder (Zürich, gta Verlag, 2017), in print.

72. See von Fischer, *Das akustische Argument*.

73. Corey Keller, "Sight Unseen: Picturing the Invisible," in Keller, *Brought to Light*, 35.

74. Davis and Kaye, *The Acoustics of Buildings*, 58.

75. Jennifer Tucker, "The Social Photographic Eye," in Keller, *Brought to Light*, 44. Tucker foregrounds the history of visualization as a history of material culture. See also Jennifer Tucker, "The Historian, the Picture, and the Archive," *Isis* 97, no. 1 (2006), 111–20.

76. Daston and Galison, *Objectivity*, 16.

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Pavilions

Three warm-weather structures that provide shelter from the summer sun.

1 Basecamp Delta Glen Jean, W.Va. Digsau

TEXT BY IAN VOLNER
PHOTOS BY HALKIN MASON PHOTOGRAPHY

Every four years, as many as 50,000 adolescents descend on Glen Jean, W.Va., to participate in the National Scout jamboree. “It’s an unbelievable mass,” says Mark Sanderson, AIA, a principal at Philadelphia-based firm Disgau and the lead architect on a project that caters to that swarm of youngsters—Basecamp Delta at the Summit Bechtel Reserve, a complex of public spaces and structures that serve one section of the sprawling campgrounds.

The project comprises three main components: a headquarters building with meeting spaces and camper amenities; a flag plaza for ceremonial events; and an open-air pavilion for large assemblies, performances, and general lounging. The underlying design language “is really rooted in traditional camp structures,” Sanderson says, with the headquarters taking the form of an oblong barn-like volume topped by a gable roof and clad in weathered wood. What grabs the visitor are the window and door frames, outlined in eye-popping orange—“a wayfinding element for the entire site,” says Sanderson, and one that distinguishes Delta from the five other color-coded sites sprinkled throughout the former strip mine. Besides adding a visual identity, the orange also punctuates the rustic vernacular with a stirring bit of modernity, particularly in the pavilion, a more abstract form whose zigzagging ceiling under a flat roofline is a veiled reference to the mountain range visible from the raked hillside seating.

Off-the-shelf fixtures and a simple and frankly expressed roof truss in the headquarters complement Digsau’s modern-yet-timeless formal solution. The combination of old and new seems especially appropriate for the Boy Scouts, an organization that has been looking to find a way forward in a society whose ideas about gender and gender-exclusive organizations have been rapidly changing. The design of Basecamp Delta, says Sanderson, is intended “to remind us of our best selves from the past, while at the same time looking forward toward the future.”

Floor Plan

1. Pavilion
2. Flag plaza
3. Breezeway
4. Reception
5. Classroom
6. Office
7. Conference
8. Storage

Previous Spread: View of Basecamp Delta from northeast, with pavilion at left, flag plaza at center, and headquarters at right

Above: Pavilion in use, looking northeast

Above: In the headquarters building, slatted wood doors on steel frames open the reception area to the plaza

Opposite: Reception hall with worktables, with classrooms and offices beyond

Project Credits
Project: Basecamp Delta at Summit Bechtel Reserve, Glen Jean, W.Va.
Client: Boy Scouts of America
Architect/Interiors: Digsau, Philadelphia · Mark Sanderson, AIA (principal-in-charge); Jesse Mainwaring, AIA (project manager); Jamie Unkefer, AIA, Jeff Goldstein, AIA, Michael Goldberg, AIA, Kristy Kimball, Harris Ford, AIA, Rebecca Braun, Molly Baum (project team)
M/E/P Engineer: Alderson Engineering
Structural Engineer: CVM Professional
Site & Civil Engineer: Mead & Hunt
General Contractor/Construction Manager: Swope Construction
Landscape Architect: Andropogon Associates
Size: 14,000 gross square feet (pavilion and headquarters)
Cost: Withheld

2 Mary F. Rounsavall Pavilion
Crestwood, Ky.
De Leon & Primmer Architecture Workshop

TEXT BY KATIE GERFEN
PHOTO COURTESY DE LEON & PRIMMER ARCHITECTURE WORKSHOP

The largest structure in the Yew Dell Botanical Gardens in Crestwood, Ky., isn't a greenhouse, a conservatory, or even a storage barn for mulch. It is the Mary F. Rounsavall Pavilion, a new 6,000-square-foot events space designed by Louisville-based De Leon & Primmer Architecture Workshop (DPAW). The pavilion sits on a flat site where temporary shelters were set up to host everything from weddings to plant sales, but "I think they were tired of putting up and taking down tents," laughs Roberto C. de Leon Jr., FAIA.

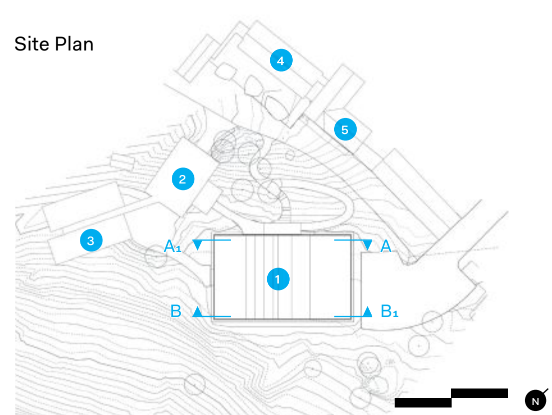
In spite of a culture where bigger is often better, de Leon and his partner M. Ross Primmer, AIA, were careful to make sure that the new structure did not overwhelm the other buildings on site. The pavilion announces itself to the main plaza with a pleated roofline with peaks that reach as high as 18 feet, 8 inches—just shy of 8 feet above the structure's lower roof edges. But those pleats smooth out as they extend so that the other three sides of the 60-by-100-foot roof look "like a flat line in the landscape," de Leon says.

Slender steel-tube columns—6 inches wide at the front of the pavilion and 4 inches wide elsewhere—support a roof that is actually two stacked planes, with the lower one inset, that conceal a wood truss system. "We wanted it to seem like two zero-edge planes," Primmer says. The ceiling is lined with a running-bond herringbone pattern of stained 2-by-8-foot plywood sheets—a lighter stain inside better reflects light for evening events. Deployable screens make the open-air structure more, if not fully, weatherproof, and a gravel apron around the perimeter helps mitigate runoff.

The pavilion marks DPAW's sixth project with the botanical gardens since 2005, including renovating a historic barn and adding a small pavilion for events; a master plan analysis; a welcome center; an entry gate; and a greenhouse and horticulture center. For this, the largest of them all, "we wanted a light, whimsical thing that hovers over the site," Primmer says, "and that has its own visual interest—even when it's not in use."

Pavilion from northwest, showing double-roof structure

Site Plan



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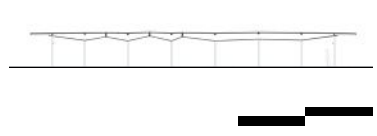
Section B–B_1



1. Mary F. Rounsavall Pavilion
2. Events barn
3. Events pavilion
4. Greenhouse
5. Horticulture center

Project Credits
Project: Mary F. Rounsavall Pavilion, Crestwood, Ky.
Client: Yew Dell Botanical Gardens
Design Architect: De Leon & Primmer Architecture Workshop, Louisville, Ky. · Roberto C. de Leon, Jr., FAIA, M. Ross Primmer, AIA (partners, principals-in-charge); David Mayo, Michael Gastineau, ASSOC. AIA (project managers)
Structural Engineer: Bender & Associates
Electrical Engineer: Shrout Tate Wilson
Contractor: Kiel Thomson Co.
Landscape Architect: Environs Inc.; Jones Landscape Architecture
Size: 6,000 square feet (plus 0.5 acre of site development)
Cost: $643,100 (including site development)

3 Hide & Seek New York Dream the Combine

TEXT BY SARA JOHNSON
PHOTOS BY PABLO ENRIQUEZ

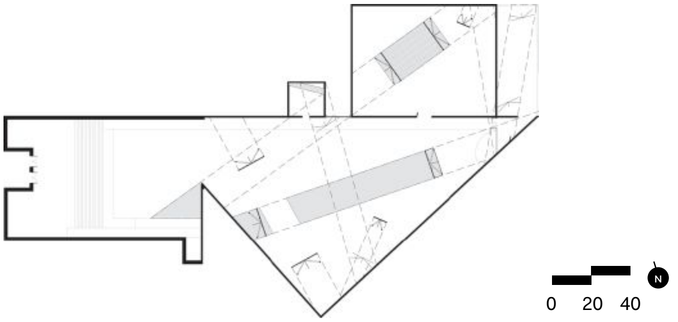
"The museum can throw a hell of a party without architecture," says Tom Carruthers, half of the Minneapolis-based partnership Dream the Combine, standing in the courtyard of MoMA PS1, the Queens outpost of New York City's Museum of Modern Art. So with the design for Hide & Seek—the duo's winning design for the annual Young Architects Program (YAP) summer pavilion that shelters and shades attendees of MoMA PS1's weekly Warm Up concert series—"we're after this visceral experience in the body," says partner Jennifer Newsom, AIA.

Carruthers and Newsom, in collaboration with Clayton Binkley of Arup, mounted 34 mirrored glass sheets, grouped into 14 gimbaled panels, onto a framework of steel trusses set in and above MoMA PS1's trio of connected, concrete-walled courtyards, dividing the outdoor space into smaller, human-scaled sections. The mirrors move, in response to wind or human touch, reflecting changing views. But they also bring more of the party inside: A mirror mounted at the northwest corner reflects the line that forms at the door and snakes around the museum on Saturday nights. Angling the mirrors just so was "like playing pool but with mirrors and eyeballs," Carruthers says.

A raised "runway" occupies one of the steel frames in the largest courtyard, while a polyester rope hammock occupies one of the two smaller spaces. A mesh canopy stretches over many of the steel frames, shading party guests from the summer sun. Fulfilling the brief's requirement for a water element to cool visitors, the top two trusses contain a misting system, and LED fixtures illuminate the mist at night, creating "a kind of literal watercolor," Carruthers says.

As the name suggests, YAP, now in its 19th official year, has become an incubator for young design talent. The duo founded Dream the Combine in 2013, and Newsom is the first black architect to win YAP. When asked how this commission has impacted their studio, Newsom says: "People know who we are."

Floor Plan



Polyester rope hammock, bookended
by gimbaled mirrors

Runway in largest courtyard, covered by mesh canopy

Project Credits

Project: Hide & Seek, MoMA PS1, New York
Client: The Museum of Modern Art (MoMA) and MoMA PS1
Architect: Dream the Combine, Minneapolis · Jennifer Newsom, AIA, and Tom Carruthers (principals and lead architectural design); Max Ouellette-Howitz, Tom Vogel, Nero He, Emmy Tong, Mikki Heckman
Structural Engineer/Lighting Design: Arup
General Contractor: Jacobsson Carruthers
Fabrication/Installation: Murphy Rigging & Erecting; LnJ Tech Services; Liskelly Construction; Checkpoint Welding & Fabrication
Size: 18,000 square feet
Cost: Withheld

Glassell School of Art
Houston
Steven Holl Architects

A new school building for the Museum of Fine Arts, Houston brings together students of all ages in studios filled with daylight.

TEXT BY MARK LAMSTER

PHOTOS BY RICHARD BARNES

If there's one thing that the new Glassell School of Art has in common with its predecessor, it's that it glows in the dark. The L-shaped building, a branch of the Museum of Fine Arts in Houston, is the work of New York–based Steven Holl Architects (SHA), and its dramatic exterior is defined by trapezoidal precast concrete panels and equally large panes of translucent insulated glass. At night, those large windows turn the building into an immense lantern, suggesting the artistic life within.

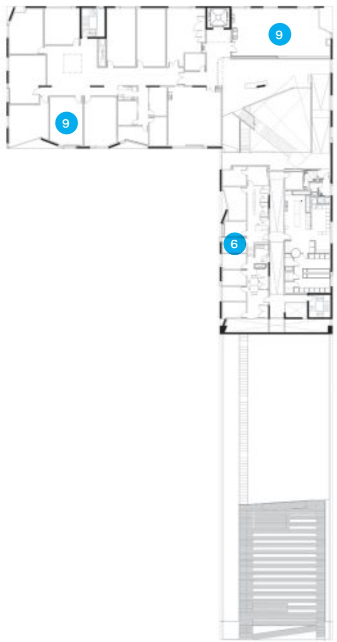
That translucency recalls the beloved old Glassell building that SHA's new structure replaced: a 1978 tour-de-force of reflective glass block designed by local architect Eugene Aubry, FAIA EMERITUS. The demolition of that building occasioned considerable upset among Houston preservation advocates. "It is hard to accept," said Stephen Fox, a lecturer in architecture at Rice University and the de facto dean of Texas architectural historians. "For the museum to sacrifice its own architectural heritage bespeaks an institutional tendency, prevalent in Houston, to discount existing architecture and sweep it away."

But administrators for the museum argue, with some justification, that the old building had passed its useful life and was no longer adequate to the school's needs. "There were really charming things about the old Glassell, but it was a hodgepodge of spaces for the programs we run," says Joseph Havel, a sculptor who is the Glassell's director.

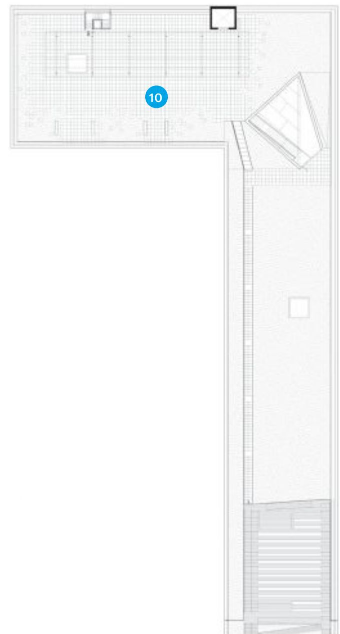
The new building marks a considerable expansion for the school, a center for artistic education for students ranging from age three to adults as well as emerging artists. Overall square footage more than doubles from 39,000 to 93,000 square feet. The additional space means that for the first time the Glassell Junior School (serving ages 3 to 18) will be housed in the same facility as its Studio School (for adults) and its advanced Core Residency Program (for emerging artists). With the new facility, total student population is projected to grow from 7,000 to 8,500.

For the architects, the benefits of removing the old Glassell extended beyond the opportunity to make a new building; it gave them the chance to integrate the school into an expanding campus that will include a

Third-Floor Plan



Roof Plan



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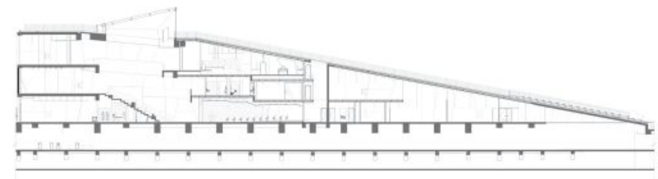

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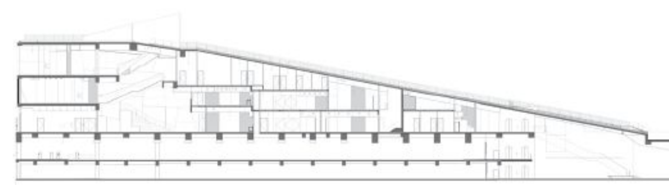


Ground-Floor Plan

Second-Floor Plan

Previous Spread: West façade, with view of plaza from across street

Opposite: Aerial view from west at night, showing roof terrace

1. Entry
2. Forum
3. Sculpture yard
4. Auditorium
5. Studio
6. Office
7. Gallery
8. Rooftop amphitheater
9. Core studio
10. Roof terrace

Central atrium with grand staircase leading to exhibition and studio spaces above

new museum building by Holl, the Nancy and Rich Kinder building for modern and contemporary art, on an adjacent site. “What unlocked the possibility of a new campus was the removal of the old Glassell,” says Chris McVoy, a senior partner at SHA and the partner-in-charge of the project.

It was that broad vision that attracted the museum to Steven Holl, FAIA, in 2012, when he won the project in a competition. The brief for that contest called for a seven-story garage to be set behind a new Glassell building. Holl countered by placing the bulk of the new school where the garage was to go, and by slipping parking for 285 cars underground, beneath a landscaped plaza.

That open space sits in the elbow of Holl’s L-shaped building, flanked by the main three-story block and by a wing that angles down like a ski slope. “The space shaped by the building is as important as the building itself,” McVoy says.

That space should have more energy than it does, but a sparse formal landscape plan by New York–based Deborah Nevins & Associates does little to take advantage of it. The decision to take up much of the court with a fountain is particularly perplexing, as it eats up what could be a useful exhibition and gathering space for the school’s students.

More problematic is the plaza’s openness to Isamu Noguchi’s adjacent Cullen Sculpture Garden of 1986. The old Glassell building fronted this quiet oasis, and its presence is still indicated by a pair of low parapet walls salvaged from it. But the removal of the building, and lack of any further landscape screening, have pried open Noguchi’s garden, compromising its intimacy. The blurring of boundaries is exacerbated by the placement of two sculptures, a new 30-foot-tall Anish Kapoor mirrored lozenge, and a repurposed Eduardo Chillida granite composition, “Song of Strength,” which sits directly in front of the school.

Holl’s new building treats Noguchi’s garden with a great deal more reverence. It was the angled concrete planes of Noguchi’s garden walls that inspired the geometries of Holl’s sloping wing and trapezoidal panels, which mirror and play off Noguchi’s design.

Those precast concrete panels are not just façade elements: they are load bearing. Each one is unique—there are 178 in all—and each is a foot thick. Most are 16 feet tall. “It has a real toughness to it,” McVoy says. “It’s one of the most tectonic buildings that we’ve made. For an art school that’s pretty interesting.”

That system was designed in collaboration with New York–based structural engineer Guy Nordenson & Associates. Within, cast-in-place concrete rib beams support precast concrete floor planks, each 4 feet wide.

The product of this system is a series of dynamic interior spaces that are limpid, open, and milky-white. The principal entry, at the joint of the two wings, funnels into a skylit atrium with a (now *de rigueur*) grand stairwell that does multiple duty as informal gathering space and amphitheater seating.

On one side of the lobby is a gallery and café space; on the other, a 75-seat auditorium dressed in warm wood and green fabric, the only space in the building that is not either white or light gray. At the top of the stairs, on the second level, is the school’s principal gallery space, a rectangular room illuminated by the broad trapezoidal windows, which can be closed off to create a darkened space for video works and other installations that are allergic to light.

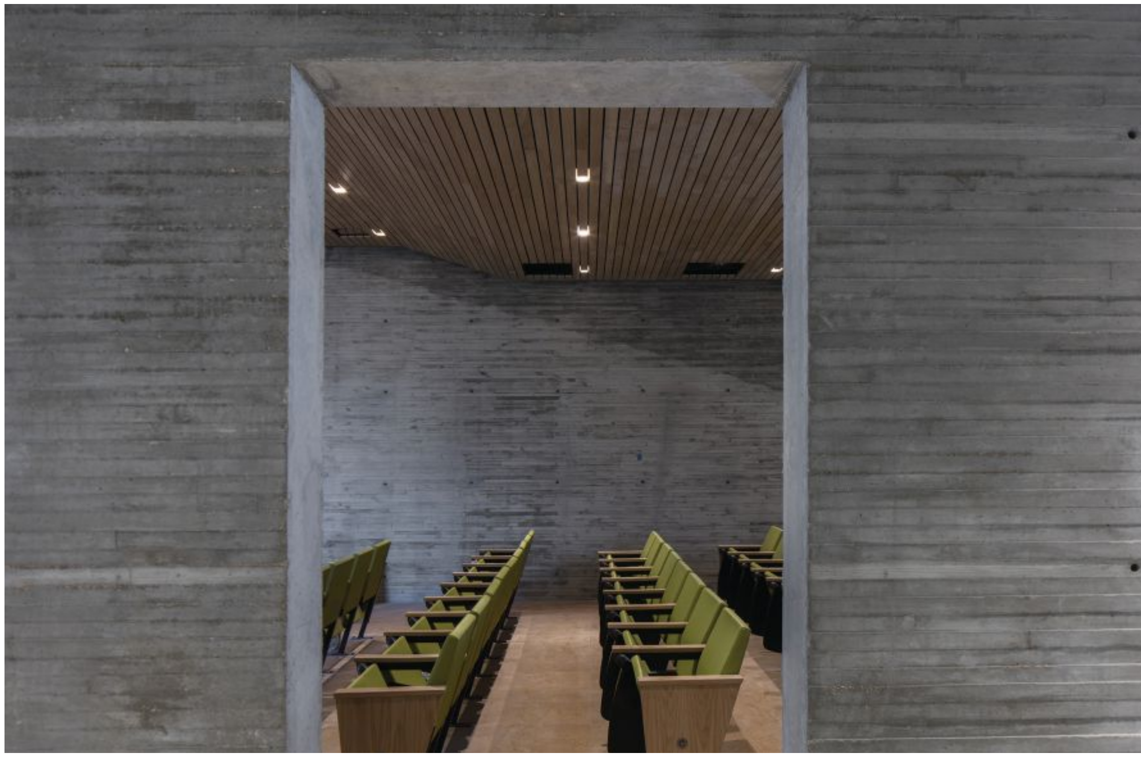
The building’s almost relentless whiteness makes it a metaphorical blank slate from which students can conjure their own visions. Its heart are the studios themselves, 24 in all and of varying size, each filled with clean bright light. That light streams in from the broad trapezoidal glass panes, which are supplemented by 3-foot-square operable windows notched into the concrete panels. From the exterior, these small cutout windows give the concrete panels almost human form, like abstracted Easter Island heads.

Of these studios, the choicest are the five extra-large workspaces on the third-floor dedicated to the Core Residency program. These are sequestered around their own skylit central gathering space, and have a private entry, so that the fellows can come and go as they please at all hours.

Members of the public, too, are welcome to make use of the building at their own discretion. At the base of the sloping wing is an amphitheater of ipe wood benches that can be used for performances or just to sit and contemplate. A path up the angled green roof leads to a terraced pavilion with views across Houston.

But the most dramatic space of the entire composition might just be beneath that amphitheater, under the wedge where the sloping plane hits the ground. This isn’t wasted space, as one might imagine. Instead, it is the top of a dramatic three-story atrium that will link the underground garage to Holl’s new museum building—which is currently under construction and is expected to be complete in 2020—via an umbilical tunnel.

That space, which will be animated by an Olafur Eliasson installation, is both a physical and metaphorical manifestation of the school’s relationship to the greater museum. “It feels like there’s an electrical charge coming from this building to the rest of the campus,” Havel says. “It’s like a battery that charges the museum with new ideas.”

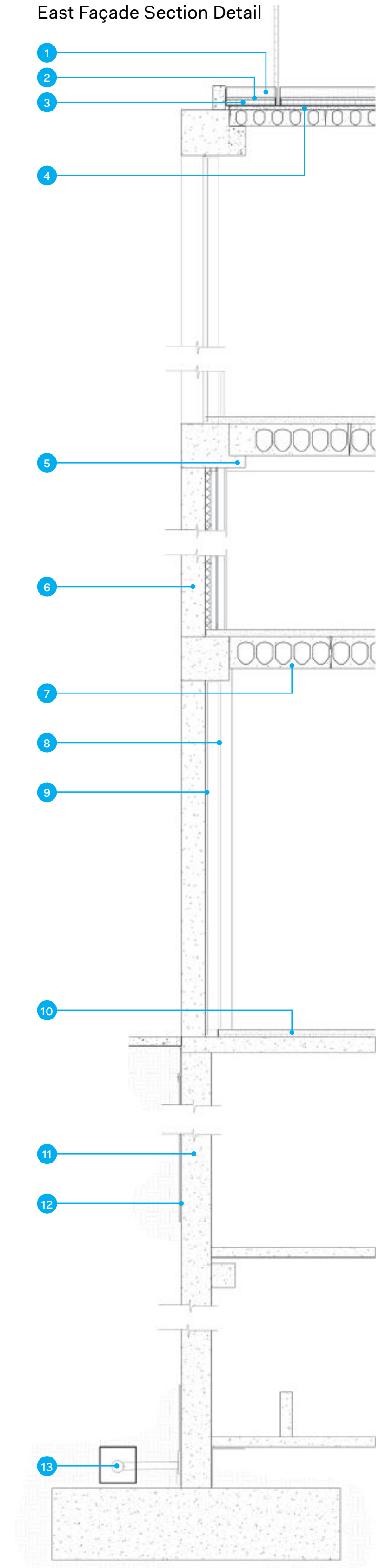


Top: First-floor auditorium with board-formed concrete walls

Above: Second-floor drawing and design studio, looking north

First-floor junior ceramics studio, looking northeast

East Façade Section Detail



1. Planting material
2. Drainage course
3. Insulation
4. Green roof system
5. Cast-in-place concrete beam
6. Precast concrete panel
7. Precast concrete plank
8. Vertical mullion
9. Glass
10. Concrete topping slab
11. 15"-wide foundation wall
12. Betonite waterproofing system
13. Foundation drain

0 2 4

Plaza and school from southwest, with view of green roof leading to rooftop terrace

Project Credits

Project: Glassell School of Art, Houston
Client: The Museum of Fine Arts, Houston
Design Architect: Steven Holl Architects, New York · Steven Holl, FAIA (design architect, principal); Chris McVoy (design architect, partner in charge); Olaf Schmidt (senior associate in charge); Rychiee Espinosa, Yiqing Zhao, AIA (project architects, Glassell School of Art); Filipe Taboada (project architect, Nancy and Rich Kinder Building); Xi Chen, Suk Lee, AIA, Maki Matsubayashi, Elise Riley, Christopher Rotman, Alfonso Simeo, Yasmin Vobis (project team)
Associate Architect: Kendall/Heaton Associates, Houston
Project Manager: Legends
Structural Engineer: Guy Nordenson & Associates; Cardno Haynes Whaley
M/E/P Engineer: Icor Associates
Climate Engineer: Transsolar
Lighting Consultant: L'Observatoire International
Cost Estimator: Venue Cost Consulting
Façade Consultant: Knippers Helbig
Size: 93,000 square feet
Cost: $90 million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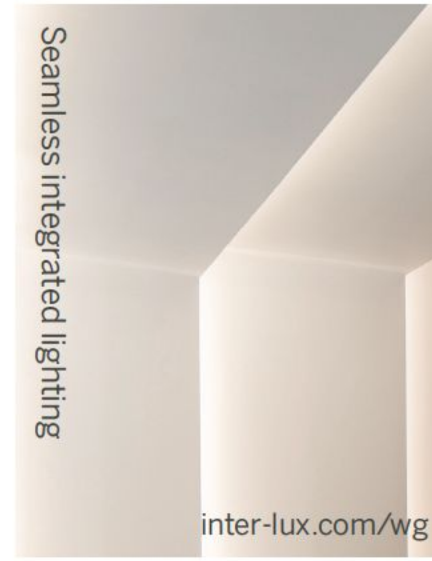
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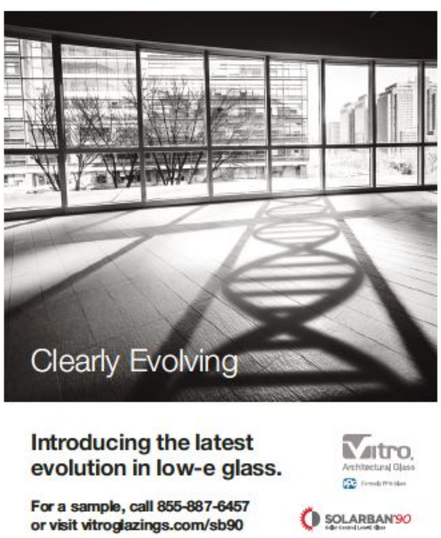
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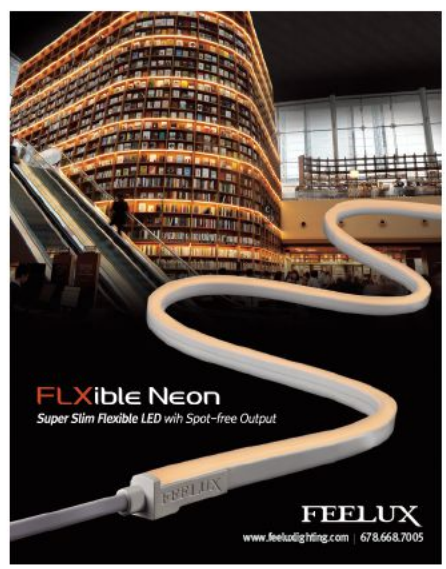
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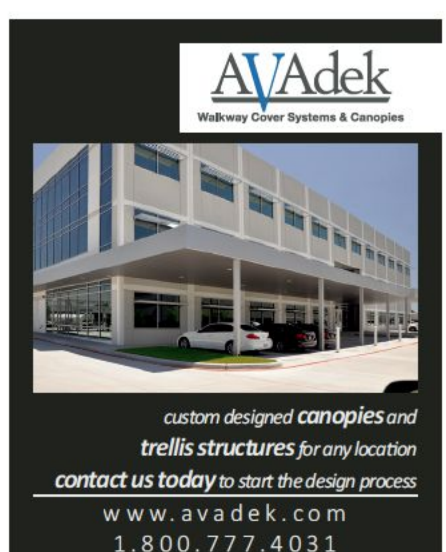
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Editorial: Design Thinking from the Fifth Century

From seventh to 12th grade, I attended a monastery school in the St. Louis suburbs founded by English Benedictines. The institution, while imperfect like any other, constitutes nonetheless a rather wonderful admixture of tradition and modernity. Successfully reconciling these opposing tendencies strikes me as rather miraculous, particularly in these fractured times. I wish more of us could find the patience to learn how.

The monks live according to the ancient *Rule of Saint Benedict*, teaching Latin and Greek to boys born in the digital age. While Benedict (c. A.D. 480–550) wrote the *Rule* as a guide for autonomous groups of religious in sixth-century Italy, even for today's secular societies it encourages habits of worth—above all humility, but also moderation, hard work, a love of learning, the responsibility of the individual to the group, a spirit of hospitality, a just distribution of necessities, and care for the sick, the young, and the elderly.

My own appreciation of the *Rule* is practically genetic: My grandfather helped found the monastery and school; my father was in the first graduating class and in his old age became an oblate, a sort of monastic affiliate. But one need not be a monk or an alumnus of the school to get it. A walk around the grounds will convey the idea in architectural terms. The spirit of the place reflects the ways of the community.

On the rolling wooded property, formerly a country estate, the original turn-of-the-century Georgian brick house and wood-frame outbuildings continue in active use, interspersed with modest midcentury modern blocks by St. Louis–based HOK. The poured-concrete church, the sole instance of willful manmade display on the 150 acres, was designed by Gyo Obata, FAIA, with Pier Luigi Nervi according to a centralized plan as old as Constantine the Great; during mass, its improbably thin parabolic vaults reverberate with liturgical plainsong dating to the 12th century.

These architectonic and social values returned to me this summer, in the south of France, where I visited Sénanque Abbey. Founded in 1148 by Cistercian monks who opposed the worldliness of such celebrated medieval abbeys as Cluny and Fleury and were determined instead to observe the *Rule* by the strictest possible interpretation, the abbey is sited in a deep Provençal valley amid fields of lavender. It's gorgeous.

As in St. Louis, the design of the Sénanque Abbey complex makes a formal and structural virtue of Benedict's simple injunctions, but according to the Romanesque architectural conventions of the time and region: individual stones laid straight, one upon the other; thick walls and vaults that retain nighttime cool under the Mediterranean sun; a single heated room, or calefactory, where the monks gathered in winter to copy old manuscripts. (Today the monks harvest and sell the lavender to make their living.)

Modern existence, at home and at work, affords far too few opportunities to exercise the qualities that Benedict proselytized. Despite, or perhaps because of this, his teachings remain supremely relevant. Take or leave the explicit references to God. The *Rule* could easily serve as the basis for an ethical, sustainable, and resilient practice of contemporary architecture, one that harnesses individual creative will to the common good, makes much of limited resources, and builds to endure. Humility can be a powerful design tool.

STEPHEN VOSS