ab ArchitectureBoston

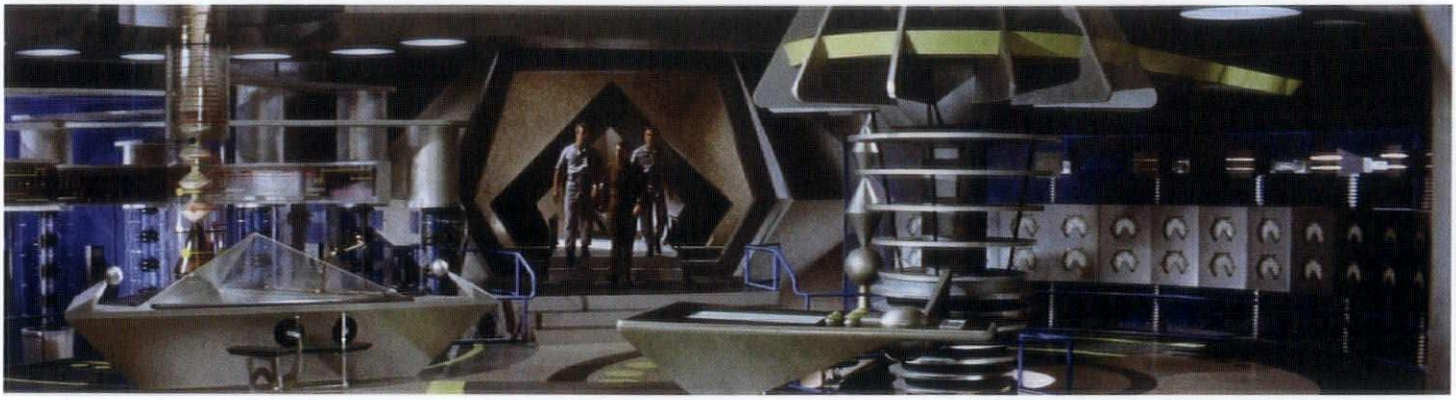
SCIENCE

Practical Science

Performance Anxiety

If Walls Could Talk

L 2011 / VOL. 14: NO. 3 / US $6.95



Science

ABOVE
From *Forbidden Planet*, 1956, MGM. Photo: Matt Paprocki, DoBlu.com.

COVER
Pattern Recognition, Helmick + Schechter, 2007. Installed at the Phoenix Police Forensic Crime Laboratory in Phoenix, Arizona. Photo: Clements/Howcroft.

Features

Departments

Science Fiction

The '70s can be blamed for many sins, not least of which was the conviction that architecture must adopt the language of some other discipline in order to establish its legitimacy. Thus began an unfortunate compulsion to see architecture in terms of metaphors. Semiotics, linguistics, and innumerable branches of philosophy have all had their turn at puffing up the profession's claim to gravitas, while mostly baffling the few members of the public who bothered to pay attention.

The next contender is already evident: science. A few trial runs with the vocabulary of biology, ecology, and geology were the first clue; another is the generational tic among those educated in the 1990s who dub their firms "experimental" or "speculative" practices. Now it seems that no one designs anymore—projects have been recast as "research" and "investigations."

Let's stop this nonsense before it does something dangerous. The growing interest in science-as-metaphor produces not science but something science-ish—at a time when we need the real thing.

Anyone who really wants to understand the state of the profession should spend a few hours at continuing-education workshops where practitioners gather, often hungry for technical information. Small-firm practitioners—who represent the majority of the profession—may be the most ravenous: Without access to big-firm infrastructures of technical staff and consultants, they make decisions on a daily basis about rapidly changing codes, energy concerns, sustainability, and new materials—always with the threat of liability. Attendees in after-session conversations shake their heads at reports of yet another failed miracle product, share rumors about green buildings that don't measure up to their claims, and bemoan the legal cones of silence that descend over building and product failures, preventing anyone from learning from mistakes. Constrained by limited time and resources, they want answers—"just tell me what to do"—but they also want the confidence and knowledge to judge for themselves.

Architecture needs to embrace serious science. This is not a call for nerds and hipsters doing the kumbaya thing. Architects need to understand the science of building. But the profession also needs to address one of its most serious failings: its inability to develop a culture of true research and shared knowledge. And in this, architecture can learn from science.

Of course, the scientific ideal of objective rationality does not always match reality: The finest minds in science have always been subject to political and religious affronts, and the field has had its share of fraudulent and slipshod work despite mechanisms meant to ensure quality. Nor is the transmission of knowledge always seamless: As Dr. Jerry Avorn, a professor at Harvard Medical School, recently wrote in *The Boston Globe*, medicine suffers from an increasing inability to connect new information and research to the practicing doctors who need it.

But architecture is peculiarly hobbled by the fetters of tradition, legal hamstringing, and lack of funding. Someone needs to generate research, and someone needs to disseminate it.

Who is that someone? Everyone. The AIA could take a leadership role, expanding its research-grants program, revising its contract-documents series to include provisions for research, developing a research-based wiki, and sponsoring a clearinghouse that would serve as a sort of legal DMZ for discussion of construction failures; perhaps most significantly, it could sponsor follow-up performance evaluations of the buildings it has recognized with COTE/Top Ten Green Projects awards.

The growing interest in science-as-metaphor produces not science but something science-ish.

Consortia of academics and industry leaders could sponsor, vet, and publish research online; the National Academy of Environmental Design, established in 2009, is already a promising model. Architecture firms, as a few already have, could integrate research and development within their practices. Perhaps some nonprofit could follow the model of San Francisco's Public Architecture to provoke a cultural shift within the profession itself.

It's not a radical notion. Scientists and architects are equally drawn to the question posed by the astronomer Johannes Kepler four centuries ago: "Why are things as they are and not otherwise?" Challenging assumptions and imagining alternatives can lead to good research and good architecture. ■

Elizabeth S. Padjen FAIA
Editor

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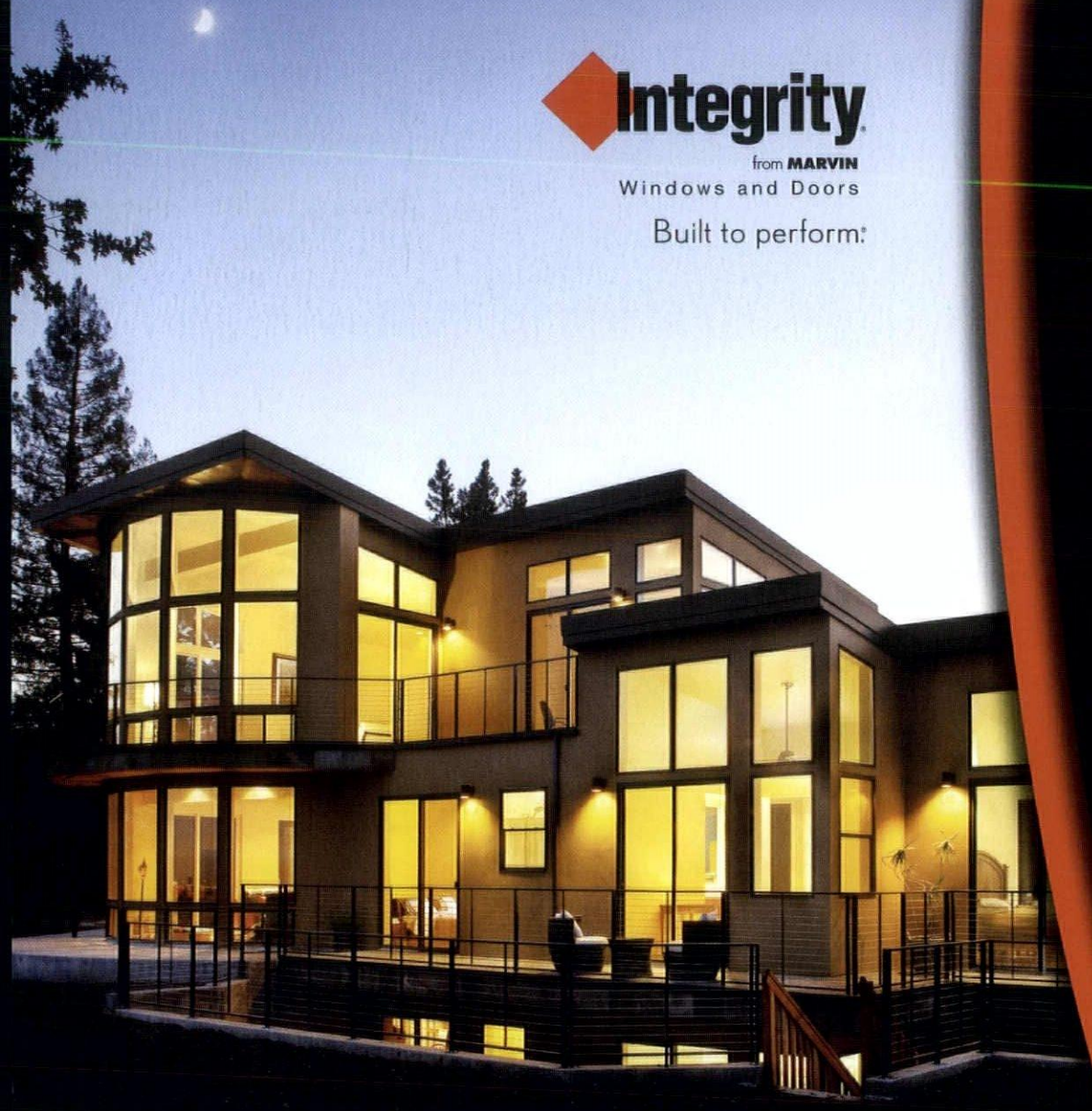

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Harvard University Statistics Department
photo: Eric Roth

On "Government" (Summer 2011)

Michael Liu's article, "The Shadow Government," was a welcome addition to the discussion of how best to transform the building industry toward sustainability. The ever-changing world of green building requires continued discussion, re-evaluation, and evolution, from the foundations of the LEED green building rating systems that help us engage an entire industry to the AP+ credentials of the implementers.

In fact, the stakeholders participating in the discussion are what have made LEED successful. The painstaking, volunteer-driven, consensus-based process for rating-system development depends on community involvement. The verification and certification infrastructure behind this rating system certainly has a cost to maintain; however, the US Green Building Council (USGBC) is committed to reducing the cost of certification and increasing the number of certifications through initiatives like the Volume Program and LEED Automation.

Like LEED, the Accredited Professional credential was developed as a tool for market transformation. After some experience implementing a rating system in the real world, the presence of professional silos preventing the uptake of green principles became apparent. Architects, engineers, developers, code officials, and contractors had all begun to speak the same language, but they certainly weren't fluent. Someone who could fill in the gaps and communicate across industry silos was required, hence the development of the LEED AP. Since that time, the industry has demanded greater levels of expertise in addition to familiarity with principles, and the credentialing system has grown. Like the pursuit of LEED certification itself, the use of LEED APs by project teams is completely voluntary.

As the industry evolves, the basic principles of green building design will become basic principles of all building design, requiring an evolution of not only the rating system but also the education and credentialing system. The evolution will continue until the mission is completed and every building is truly sustainable. Silly titles aside, we welcome constructive contributions to this vital discussion.

LANE BURT
Director, Technical Policy
US Green Building Council
Washington, DC

Congratulations to Michael Liu for exposing the sham called LEED ["The Shadow Government"]. If I have my facts right, it was started by a marketing director, a lawyer, and a used-car salesman (that may be hyperbole), but there is no doubt that it has grown into a feel-good, huge, money-making organization devoid, as Liu points out, of any serious supervision about claims or structure. True, the USGBC has raised awareness, but at what cost to the actual understanding of sustainability? What was not said is that the AIA should have been out in front of this issue rather than allowing sustainability to become just another commercial enterprise. Real sustainability is affordable for everyone, but LEED isn't.

JEREMIAH ECK FAIA
Eck | MacNeely Architects
Boston

My congratulations to Michael Liu for suggesting the emperor has no clothes ["The Shadow Government"]. In my view, USGBC and LEED are a direct threat to our profession—and to our children's survival.

Those of us at May's AIA convention heard Thomas Friedman make that point starkly in his keynote address: Right now, we are all having a Green Party, when what is required is a Green Revolution. At parties, it's about everyone having a good time; in revolutions, it's about change or die. We can build all the LEED-certified buildings we want, but by itself that will do little to solve the problems—not only because 98 percent of the building stock is already here but also because it is the settlement pattern and corresponding lifestyles that require correction. This is only one of the reasons why LEED and the USGBC are actually an impediment to real solutions: Their focus is dangerously misplaced, while providing participants with a feel-good gold star for their foreheads. What worked in third grade seems a poor model for grownups to follow.

Real solutions to a "hot, flat, and crowded" world lie at a scale well beyond the parts of the building, or even the building itself. It is clear that solutions lie at the community, city, regional, and national scales: it's about walkable cities, work/live in the same places, mass transit, higher densities. Finding those solutions likely points to firms that are integrated across disciplines, because solutions are going to be systems-level solutions.

If architects are to remain viable as independent professionals, that is the path that is required to stay ahead of the curve. Without this understanding, architects will simply become a small design cog in a large systems wheel. The bigger vision will be lost, and the course steered will fall to the likes of the USGBC and their unfortunate self-serving bureaucracy. I'd like to see architects at the helm on this one, as we have already given away too many parts of our profession.

In closing, I urge *ArchitectureBoston* to adopt a formal policy to stop printing the LEED letters after architects' names. As licensed professionals, placing LEED after one's name is a tacit admission that you once did not know how to score points, but now you do. Why is that a credential worthy of our profession?

SERGIO MODIGLIANI AIA
Sergio Modigliani Architects
Brookline, Massachusetts

Although ArchitectureBoston's "Government Issue" was both timely and thoughtful, I read with consternation Chris Walsh's characterization of Massachusetts' affordable-housing zoning law, Chapter 40B. To begin, Walsh fails to mention that in the November 2010 election there was a referendum question on 40B, and Massachusetts voters decided to continue the program.

Although it is true that 51 communities have exceeded their 10 percent threshold, which Walsh asserts as evidence of the program's failure, it is also true that, at present, 117 municipalities only need to produce or preserve fewer than 100 units to reach the 10 percent threshold. Walsh alleges that the 40B program eats up open space. This does not reflect the reality of Massachusetts land use in which large-lot zoning is probably the most important determinant of housing development, and particularly so when coupled with Title V and the Wetland Protection Act, neither of which is suspended in determining site acceptability. In fact, increasing housing density under 40B is actually more land efficient. Further, the expiration date of low-income use requirements referred to applies to subsidy or financing programs and does not apply to Chapter 40B developments that are held in perpetuity through zoning.

Citing the Columbia Point development as a failed large urban housing project neglects its complicated history as Boston's largest public housing development, the lurches and retreats of federal housing policy, the geographic isolation of the development, its history as a dump, and its miraculous conversion in 1984 into the mixed-income Harbor Point development.

Walsh's critique may make for good sound bites on the campaign trail, but the inaccuracies of his examples and general lack of understanding of the history and context of affordable housing sadly misrepresent reality, to the detriment of your readers and those they may influence.

DIANE GEORGOPULOS FAIA
Cambridge, Massachusetts
Ms. Georgopulos has worked for 25 years as an architect for MassHousing, the state's affordable housing finance agency.

I opened ArchitectureBoston's "Government Issue" with great anticipation but found little within to be upbeat about. From the editor's opening observation that 69 percent of respondents in a recent student survey believe that community service is honorable while almost no architects serve in elected office, it seems obvious that there is a world of difference between advocating for good design in the public realm and actually serving in public office, unfortunately exemplified by the recent conviction of yet another Massachusetts State House leader.

At a time when popular opinion is running against "big government," our failure to maintain bridges, build a successful public education system, invest in smart growth, or even provide adequate healthcare to all is a failure of political leadership, not government, be it big or small. In a society driven by sound bites and devoid of critical thinking, it is easy to conflate government with politics. But contrary to what we hear, government at all levels is filled with many smart, talented, and even idealistic people who want to be challenged to do the right thing, as James Kostaras notes in "What I Learned."

If, as Vernon Woodworth tells us in "Notes From the Suggestion Box," technology will soon allow us to model performance and regulatory metrics of all sorts, we need political leadership with a compelling vision for this future. And with political vision should come a commitment to honest and timely assessment of government programs.

Idealistic? Yes. Unrealistic? No. But as long as we keep seeing the "problem" as government and fail to demand political vision and leadership, and as long as the electorate is titillated by elk-shooting, combed-over candidates, and not challenging government to be all that it can be, there is no purpose for architects to seek public office.

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We want to hear from you. Letters may be e-mailed to epadjen@architects.org or sent to *ArchitectureBoston*, 52 Broad Street, Boston, MA 02109. Letters may be edited for clarity and length, and must include your name, address, and daytime telephone number. Length should not exceed 300 words.

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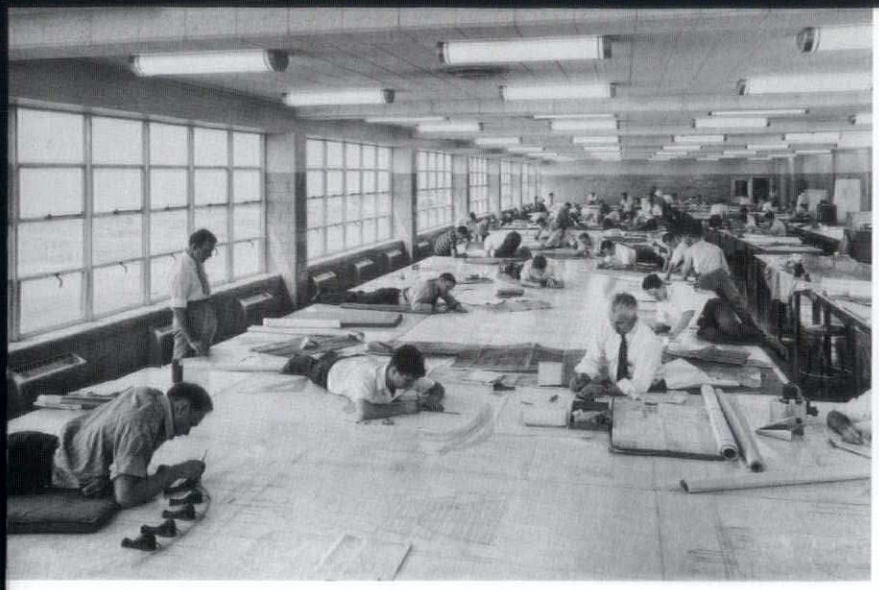


Jonathan Powers is a PhD candidate in the history and theory of architecture at McGill University.

ABOVE
View of the drafting room, Ford Motor bomber factory, Willow Run, Michigan, 1942. Photo: Hedrich Blessing. © Chicago History Museum.

Architecture in Uniform: Designing and Building for the Second World War

Canadian Centre for Architecture
Montreal
April 13–September 18, 2011

If World War II was remarkable for its blurring of the boundary between civil and military, it must come as little surprise that architecture enjoyed enormous prestige during that era. From the celebrated career of Archimedes, the ancient Greek mathematician and engineer, to the European architectural treatises that have for centuries divided their subject into military and civil, architecture has long been recognized as addressing both concerns. The exhibition *Architecture in Uniform* documents the astonishing variety of ways in which architects and their professional skills were conscripted to serve the world's first fully industrial war and the industrial peace that followed.

The visitor enters the exhibition by passing between wall-sized photos of Hiroshima and Guernica after their respective bombings and then immediately confronts a ceiling-high silo with a broad slit running down its side. Within the silo hangs one line of portrait photos, placed at eye height and ordered alphabetically, of a representative selection of war-era architects and designers: the known and the unknown, the grizzled as well as the green, the militant alongside the artistic.

Eschewing the tired distinction between Axis and Allies, the exhibition never loses sight of architecture's paradoxical power to ravage cities or of war's human dimension. From Norman Bel Geddes' marvelous scale models of naval engagements to Hugh Casson's ingenious ideas for camouflaging buildings to Hans Stosberg's banal economic development plan for Auschwitz, the exhibition portrays architecture as both inspiring and terrifying. Ultimately, the exhibition's moral even-handedness, intelligent thematic structure, and elegant physical design ensure the impression of architecture as a discipline that demands respect not only for its strategic significance but also for its pervasive ethical gravity.

James McCown is a Boston-based journalist and photographer specializing in architecture, design, and real estate.

RIGHT
Late-19th-century dressmakers' patterns, from *Authentic Victorian Fashion Patterns, A Complete Lady's Wardrobe*, Kristina Harris, editor, Dover Publications, 1999.

Tailoring Form

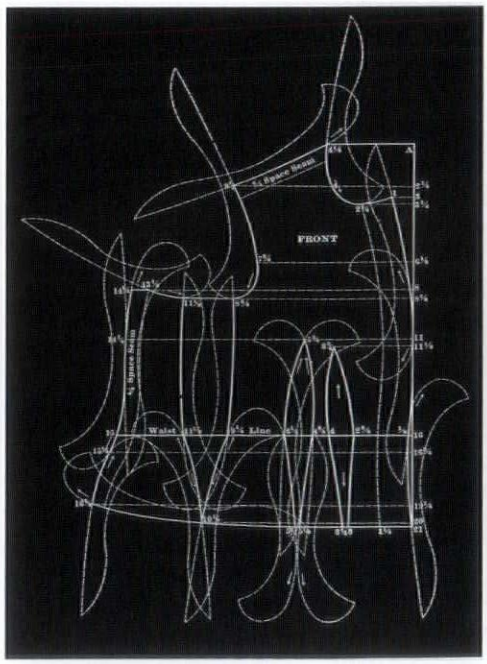
pinkcomma gallery
Boston
April 8–May 15, 2011

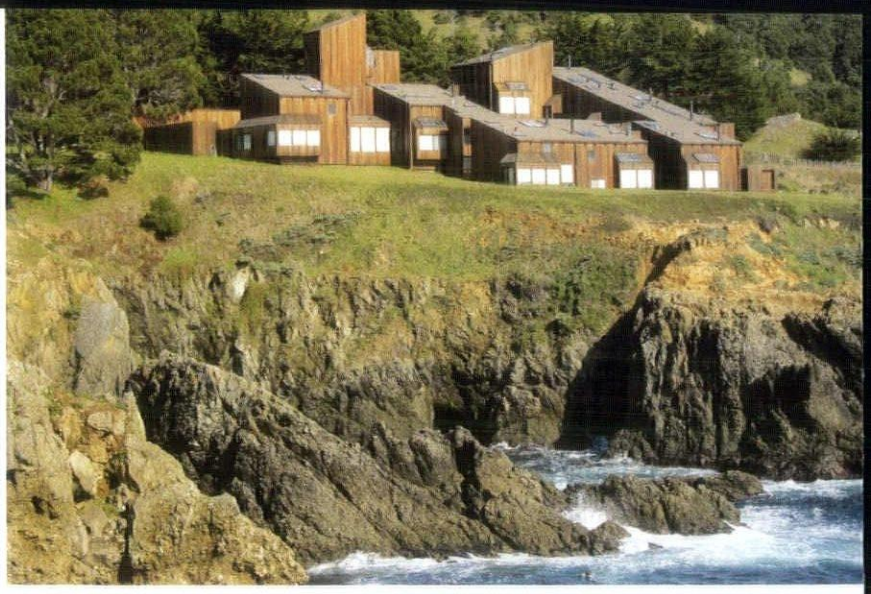
What do a Renaissance cathedral and a 1950s finned car have in common? They were both produced using templates, which *Webster* defines as a "gauge, pattern, or mold used as a guide to the form of a piece being made."

Tailoring Form, a small but superb exhibition, includes a wide range of templates, increasingly scarce artifacts in an age of digital design and production.

Filippo Brunelleschi used full-size wood templates to produce the massive stone ribs of the dome of the Florence cathedral. General Motors designers spent weeks using curved rulers and clay to shape the swooping surfaces of the Firebird III concept car. Other exhibition items explore how airplane, boat, and even dress design are all beholden to the template. The curators, Natalie Fizer and Glen Forley of New York, insist the template be celebrated in and of itself.

Bravo, Fizer, Forley, and pinkcomma. *Tailoring Form* is really a homage to the ingenuity, patience, and sweat that was design in the precomputer age.





Seen

The Sea Ranch
Sonoma County, California

Carl Solander AIA is the founder of Reverse Architecture in Somerville, Massachusetts, and teaches at Wentworth Institute of Technology.

ABOVE
Sea Ranch. Architects: MLTW and Joseph Esherick, with Lawrence Halprin. Photo: Jim Alinder.

For the author's photos of the Sea Ranch, visit www.architectureboston.com

We arrived awestruck, ill, and exhausted. My wife and I had driven 100 miles north from San Francisco, our infant daughter asleep while our stomachs roiled with the dramatic hairpin turns of Route 1. Finally, we could stop and take it in: the Sea Ranch.

I had learned about this place mostly through hints and references, maybe an errant slide slipped into a lecture on vernacular influences in Modernism. Sea Ranch was not a hot topic of study for my generation, what with the rise of the computer and its formal exuberances. But perhaps you have to first delve into the fantastic and immaterial to fully appreciate something so direct and tangible.

A brief impression: houses of weathered redwood and cedar, spread across the landscape in a more spacious version of a cul-de-sac suburb, displaying every imaginable variation of the shed roof, all interconnected by the automobile, evidence of which is camouflaged within the undulations of the bluffs.

Somehow, I could barely find the time to seek out all the individual architectural gems; I was too overwhelmed by the whirling grasses and the crashing surf. The great achievement of Sea Ranch is its concealment of architectural vicissitudes within nature. The suburb recedes as one walks, and the surreal quality of a human landscape superimposed onto a natural one takes hold. The joy of Sea Ranch is to wander along this edge, looking in one direction into the infinity that is the Pacific and in the other at weathered walls, gray receding into waves of green. We stood on this path with other visitors, clutching my daughter as we watched seals on the beach below. Her sudden calm within the blustering wind struck me as fitting.

Received

Back to School

Louis I. Kahn: Conversations with Students
By Louis Kahn
Princeton Architectural Press, 1998
The delight in this slim volume is its straightforward simplicity: the unadulterated words of a poetic teacher. This is one title in a nine-book series that includes Mies van der Rohe, Ian McHarg, and Peter Smithson.

The Study of Architectural Design: With Special Reference to the Program of the Beaux-Arts Institute of Design
By John F. Harbeson AIA
Pencil Points Library, 1926
(Reissued by W. W. Norton & Company, 2008)
Frustrated with answering the same questions over and over from his students, Harbeson created this guide to the Beaux-Arts educational system—the dominant idea of American architectural training through the 1940s. Follow the illustrated assignments and indulge your inner classicist.

Citizen Architect: Samuel Mockbee and the Spirit of the Rural Studio
Directed by Sam Wainwright Douglas
DVD (60 minutes), Big Beard Films, 2010
This film revisits the familiar but still inspirational tale of Auburn University's design/build program in impoverished Alabama—this time with new interview footage of the late architect/teacher Sam Mockbee FAIA, the program's charismatic founder; conversations with clients; and commentary by Peter Eisenman, Cameron Sinclair, Michael Rotondi, and others. The legacy continues.

Inventing American Modernism: Joseph Hudnut, Walter Gropius, and the Bauhaus Legacy at Harvard
By Jill Pearlman
University of Virginia Press, 2007
Pearlman presents Hudnut as an unsung hero—a pioneer of American architectural education, a public intellectual, and an awful self-promoter. Hudnut hired Gropius. Gropius soon became a rival, and the rest, as they say, is history.

101 Things I Learned in Architecture School
By Matthew Frederick
The MIT Press, 2007
Frederick's witty and clear reflections mix with succinct philosophy. His knack for distilling wisdom now extends to a series of professions: film, culinary arts, fashion, business, and others; browse them at 101thingsilearned.com.

Back to the Future

2940 Chain Bridge Road, Washington, DC

Ann Hershfang
HON. AIA, HON. BSA
is cofounder of WalkBoston. She served on the boards of Massport and the Massachusetts Turnpike Authority, and as undersecretary of transportation for the Commonwealth of Massachusetts.

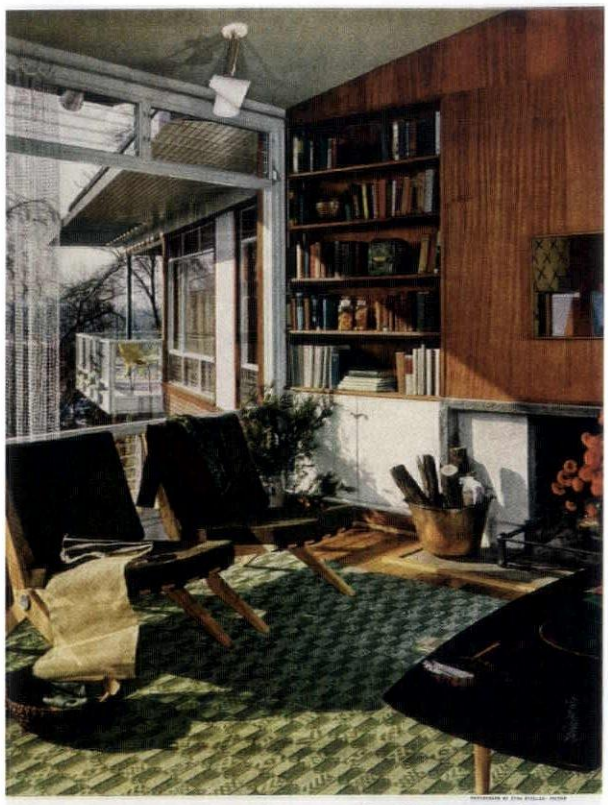
The house at 2940 Chain Bridge Road was commissioned by Hershfang's parents and featured twice in *House Beautiful* in 1951 for its climate-control features and for its kitchen design. For PDFs of the original stories, including drawings, see: www.architectureboston.com.

Image: Reprinted with permission of *House Beautiful*, © 1951. Photograph by Ezra Stoller © Esto.

My parents' house was quite "green"—so green, in fact, that it was a case study in *House Beautiful's* "Climate Control Project" and featured in the April 1951 issue. Designed by Chloethiel Woodard Smith FAIA, it had radiant heat and a porch overhang to keep out summer sun and admit winter sun. All the rooms had louvered windows at the bottom on one side and at the top on the opposite side to encourage cross ventilation. An air space between the ceilings and roof, a large hall fan to exhaust hot air, and sprinklers that cooled the roof when it got too hot kept us in reasonable comfort during the DC summers.

From every room, you could look out through glorious plate glass into woods (not an easy feat on a 0.7-acre lot). The house was on one floor, which was very useful as my mother aged. Like other Modern houses of the period, its bedrooms were compact, its closets even more so—not a bit elaborate but splendid.

The house is still there, on its fourth owner since us. I go back every now and then. Each successive owner has made changes. The third one joined our three bedrooms into one; the current owners have added an additional story and an outside swimming pool, an excellent use for a difficult yard. The house still has its plate glass, openness, view, and beauty. With its idiosyncratic style, it has always been slow to sell but always adored by its owners. The current ones are no exception.



Glass wall expands visual dimensions of living room, provides sun in winter, year-round view

Focus

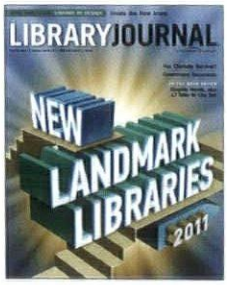
Sensing Place: Photography as Inquiry

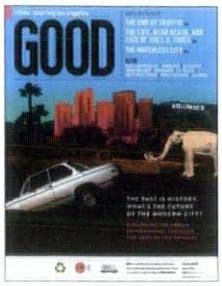
Since 2000, MIT professor and landscape architect Anne Whiston Spirn FASLA has taught "Sensing Place: Photography as Inquiry," a course that explores seeing as a way of knowing and photography as a way of thinking. Students keep journals and develop portfolios of images that investigate a single place in the Boston area throughout the semester.

For a selection of student photographs: www.architectureboston.com

For the course website: architecture.mit.edu/class/landphoto

LEFT
Charles River/Storrow Drive, 2009, by Ethan Lacy.





Covering the Issues

Gretchen Schneider AIA, LEED AP is the principal of Schneider Studio in Boston.

Read all about it... *Library Journal* presents its top 20 "New Landmark Libraries" (May 15, 2011). In this cover story and related print and online commentary, the editors showcase relatively unknown-yet-exemplary small libraries across the US, with the hope of inspiring other communities. Current design trends include sustainability, flexibility, transparency, and collaborative spaces, which together help these libraries become more effective community centers. Even though technology is rapidly transforming the book, the need for free access to information—especially for children, elders, and immigrant populations—is as powerful today as it was when the Boston Public Library launched the institution in 1852.

The end of the world as we know it... Pulitzer Prize–winning author Junot Díaz tackles "Apocalypse: What Disasters Reveal," in a ***Boston Review*** cover story (May/June 2011). The Haiti earthquake killed an estimated 220,000 people, left iconic historic and cultural buildings in ruins, destroyed the electrical grid, and left 10 percent of the population homeless. Díaz notes that the Greek root of the word apocalypse means "uncover and unveil," arguing that the calamitous effects of the earthquake—as well as the recent Asian tsunamis and Hurricane Katrina—were caused by human actions, not nature. From issues of deforestation and poor infrastructure to depleted coral reefs and global inequality, Díaz reminds us that Mother Nature is not subject to moral judgment.

Dollar signs... Today, 3.5 million people live in cities; by 2050, that number will nearly double, with the most explosive growth happening not only in Brazil, China, and India but also in smaller nations including Vietnam, Colombia, and Chile. Peter Loscher, head of Siemens (makers of urban infrastructure such as computer-operated trains, electrical transformers, and water-treatment systems), sees enormous market potential. In "Urban Outfitter" (***Forbes***, May 9, 2011), writer Daniel Fisher describes Loscher's vision, explaining that "even shantytowns need electricity and clean water." Siemens is designing special equipment that functions in high humidity, with solar power, and at a lower price point, as it's partnering with explosively growing cities to improve carbon emissions and energy efficiency. Good design is great business?

Preservation gets pummeled... Rem Koolhaas's recent exhibition and lecture at the New Museum on the state of historic preservation has prompted a torrent of commentary. Architectural critic (and *ArchitectureBoston* editorial-board member) Sarah Williams Goldhagen provides important context in "Death by Nostalgia" (***The New York Times***, June 10, 2011), explaining how preservation has become a means for planning, design review, and development (yes, and actually preserving valuable old buildings, too), where projects are often evaluated in terms of economic dealmaking rather than historic importance. Writing for ***ARTINFO*** (posted May 16, 2011), Ben Davis suggests that the "solution is not a better theory of preservation, but a more humane model of economic progress." Meanwhile, ***The New Yorker***'s Paul Goldberger (posted May 10, 2011) argues that the real issue is not the limits that preservation imposes but the marketing of architectural celebrity. Time will tell?

LA story... Sometimes ***GOOD*** is great. The Spring 2011 edition of this five-year-old quarterly explores "critical issues facing global cities," with Los Angeles as its focus. Touching on schools, urban ecology, riots, homelessness, houses of worship, water, density, and the politics of mixed use, its wide range of contributors include architects and designers to writers who shaped LA's image, from novelist Joan Didion to urban thinker Mike Davis. Directly and indirectly, the built environment pervades all. Chock-full of hip infographics and photography, the print magazine is only the first step; be sure to check out *GOOD*'s robust website and event schedule, too.

The 80 Percent Challenge

MassINC
Boston
May 19, 2011

Peer pressure: it's not just for high school anymore.

In 2008, Massachusetts passed the Global Warming Solutions Act (GWSA), putting the Commonwealth on the leading edge of US climate-change policy with an ambitious goal: reduce greenhouse gas emissions by 80 percent by the year 2050. That target will require significant cultural shifts. Realizing this, independent think tank MassINC conducted a statewide survey to gauge public response to climate change and then convened an expert panel and a public forum to discuss the results.

For the most part, the findings confirmed information many attendees had probably seen elsewhere, such as the fact that most people simply don't rate climate change as a "high priority" issue (only 32 percent in this study). Jobs and the economy, healthcare, and education all dominate their concerns. But one finding did jump out: Even among those people whom the study defined as "convinced" (people who believe that climate change is both the result of human activity and a serious threat), only one-third of those aged 18 to 29 are taking personal action to conserve energy; thus the cohort widely considered to be most concerned by climate change is doing the least. The panel offered the explanation that, no matter one's age, environmental behavior, like behavior in general, is strongly influenced by the actions of peers, known as "normative messages."

Panelist David Cash, the undersecretary for policy in the Massachusetts Executive Office of Energy and Environmental Affairs, provided an illustration. In communities where one household installs PV (photovoltaic) panels within view of neighbors, it is often just a matter of time before panels start to pop up throughout the neighborhood. Similarly, as an audience member observed, residents of city blocks tend to recycle either almost entirely in unison or not at all. Whether these examples provide evidence of environmental peer pressure is debatable, but normative messages have proven to be successful as part of other cultural-shift campaigns, such as anti-smoking initiatives.

Ultimately, meeting the GWSA's ambitious targets will require tougher regulations at a policy level. But if this research is any indication, individual action can influence the action of others, and collective action in turn builds support for policy. It is through the creation of this "culture of climate protection" that real change is possible.

Keller Roughton AIA, LEED AP is an architect at Gensler in Boston and a member of the BSA Committee on the Environment.

For more information: www.massinc.org/Research/The-80-percent-challenge.aspx

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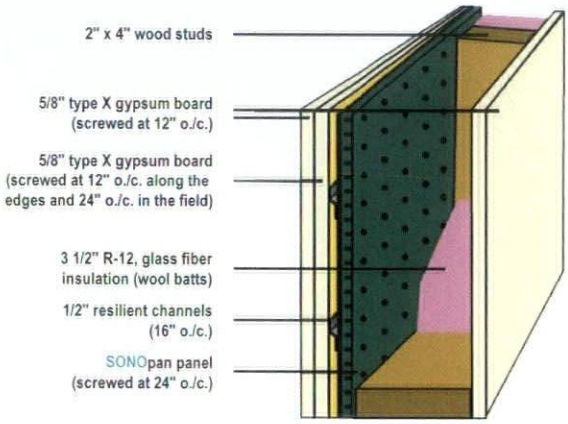

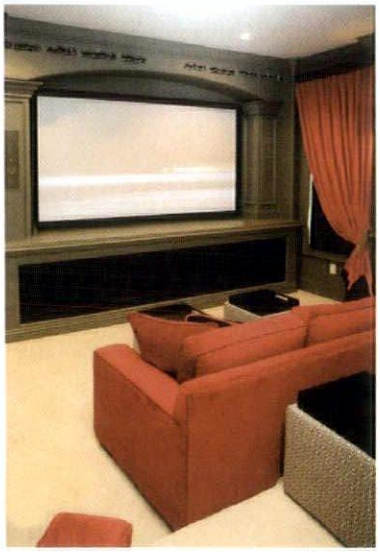

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Practical Science

Increasingly complex building systems, interest in sustainable materials and technologies, and demand for improved energy efficiency—most architects would agree that the need for hard data and real innovation has never been greater. Some firms have embraced what would have been unimaginable a few decades ago: the integration of practice and science-based research. Their success suggests that they may have also found a path toward more artful design.

SOM/CASE

Nicholas Holt AIA

The Center for Architecture, Science, and Ecology (CASE) is a unique scientific research partnership that was formed by Skidmore, Owings & Merrill (SOM) and Rensselaer Polytechnic Institute's School of Architecture in 2008. CASE's ambitions are manifold. Perhaps the most important is to produce desperately needed, game-changing technologies that will enable the aggressive net-zero goals that are being adopted in the US and worldwide. A second priority is to use the synergistic, academic-professional partnership to confront the ways in which new architectural technologies are developed and brought to market.

Applied research as it is currently practiced in the building industry is often slow and inefficient, and results in building systems that do not meet their potential when confronted with the practical realities of practice. The architecture profession has in large part not taken advantage of its power and responsibility to truly innovate. RPI and SOM hope the CASE model presents industry and universities with a way to change that.

SOM views CASE as a complementary practice, not a separate institution, and CASE's headquarters are located within SOM's Wall Street office in New York City. CASE is led by a tight group of academics and professionals: Professor Anna Dyson of RPI's School of Architecture is the director and Associate Professor Jason Vollen is the assistant director, with Kenneth A. Lewis, a managing director at SOM, and me, technical director at SOM, acting as CASE principals. Currently more than 24 PhD, master's, and undergraduate students actively do research and attend classes led by five professors and other guest scholars. Members of SOM's staff collaborate with CASE investigators daily.

CASE researchers work primarily in the area of technology transfer. They mine discoveries and developments in fields unrelated to architecture, such as optics, aerodynamics, and the biological sciences, and develop them into full-scale building systems. Currently under development are sustainable building systems, such as a modular daylighting system that includes helioptic concentrators that improve the efficiency of photovoltaics; high-performance eco-ceramic masonry walls; electropolymeric dynamic shading systems for buildings; and an active-photoremediation wall system using plants to purify air, reducing the need for outside air.

SOM's real-world experience brings considerable influence to bear on the development of CASE's research, particularly in making conceptual ideas scalable, manufacturable and, ultimately, commercially viable. These technologies must be proven to be maintainable, aesthetically compatible where applicable, and usable in real construction. They must be shown to perform at a level whose impact is great enough to make their costs justifiable. Prototypes must withstand mockup testing and the rigorous standards of health and life-safety codes.

The firm's involvement allows CASE's investigators to focus on in-depth research while leveraging SOM's expertise to challenge ideas and adapt solutions to real-life projects. The collaborative environment works. CASE investigators have successfully developed comprehensive testing prototypes and submitted their work at the proof-of-concept stage to the rigorous scrutiny of peer review, and their papers have been published in academic journals. SOM's involvement has also been helpful in securing federal and state grants.

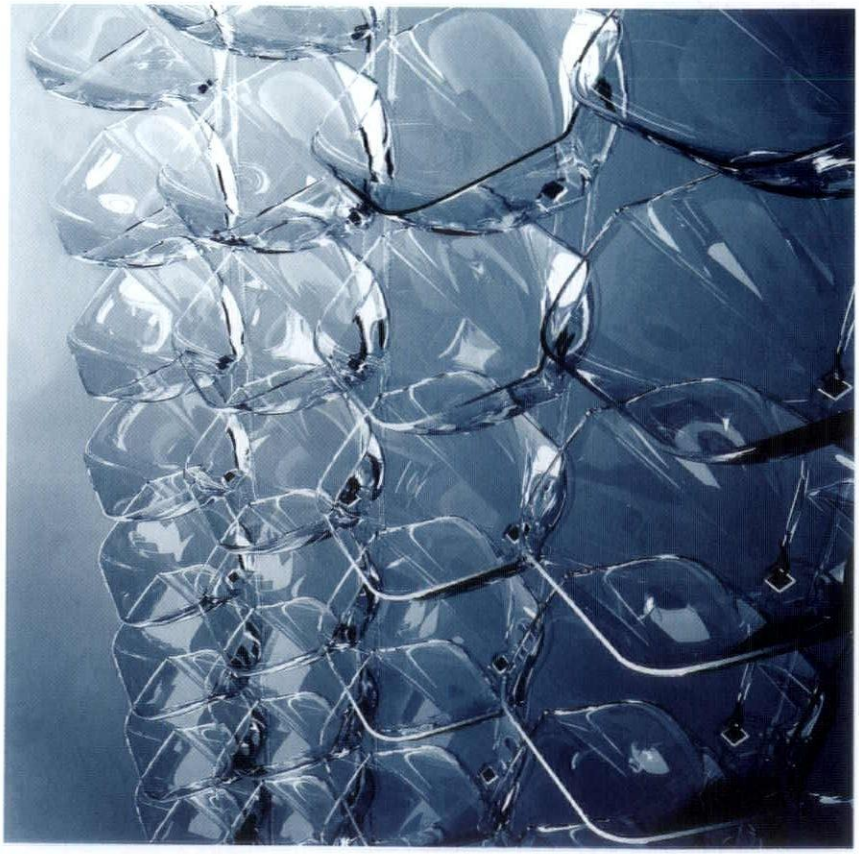
The benefits of the CASE collaboration include the satisfaction of attending to the urgent business of creating a sustainable world, and in playing a crucial role in the development of systems that are imaginative, ambitious, and potentially game-changing. In turn, the advanced high-performance buildings SOM is working on provide teaching moments for some of the most imaginative minds working in building-systems research today. What is priceless, however, is the dialogue resulting from the exchange of ideas between academics and professionals that enriches all who participate in it.

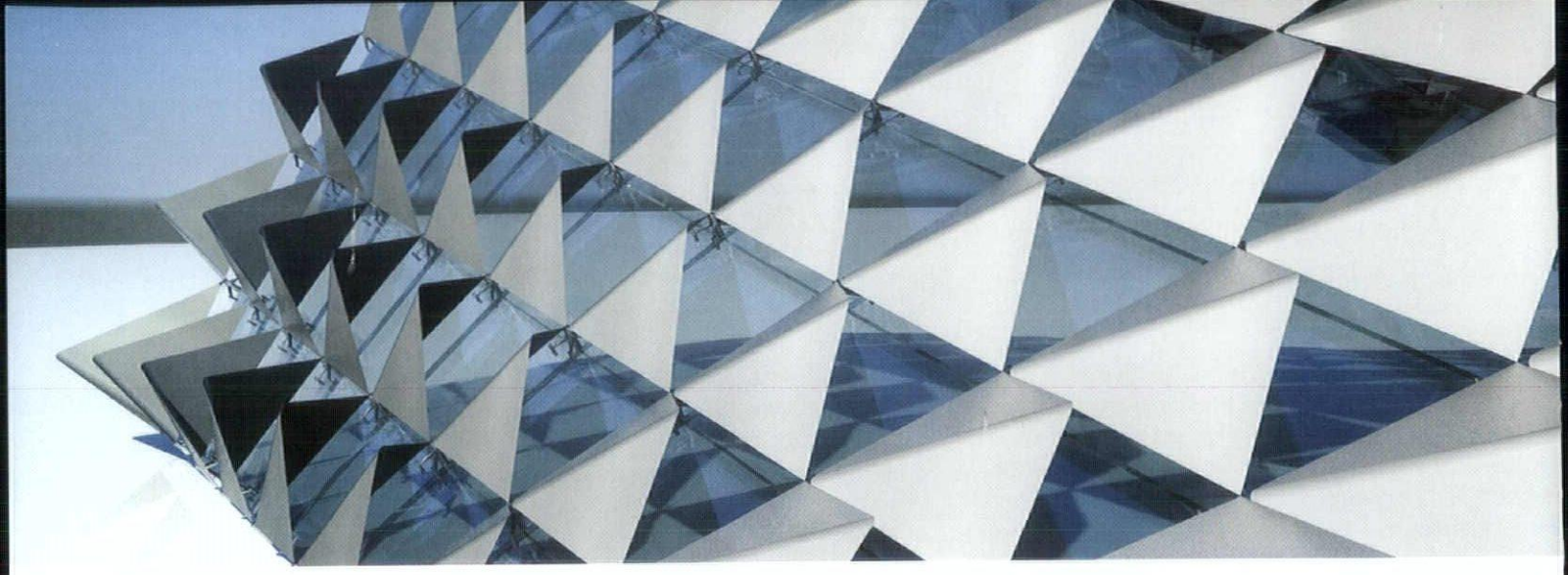
Nicholas Holt AIA, LEED AP is the technical director of SOM in New York City.

BELOW
Detail, IC Solar Façade, daylighting system with integrated photo-voltaic cells. Licensed by HeliOptix. © CASE/Rensselaer.

FOR MORE INFORMATION
www.som.com/content.cfm/case_center_for_architecture_science_ecology

LEFT
Notes on thermal dynamics and solar heating from "Building Technology Laboratory," Fall 2004, a course taught by MIT professor Leslie Norford, available at ocw.mit.edu/courses/architecture. Illustration by Amanda Sim, Stoltze Design.





Yanel de Angel
AIA, LEED AP is a project architect at Perkins+Will in Boston, where she was the recipient of a 2010 Innovation Incubator grant. Her work has also been published in *Perkins+Will Research Journal*.

ABOVE
Detail, solar-responsive shading elements designed with a custom plug-in for Revit developed by Perkins+Will that allows import of analytic data and parametric control of model geometry. For more information: *Perkins+Will Research Journal*, Volume 03.01.

For more information, including links to the *Research Journal*, the Perkins+Will Precautionary List (of suspected harmful building materials), and the 2030 Calculator (measuring project compliance with the 2030 Challenge): www.perkinswill.com/purpose/innovation.html

For information on the Innovation Incubator: vimeo.com/22455359

PERKINS+WILL

Yanel de Angel AIA

In 2009, Perkins+Will made a commitment to support additional research initiatives within its practice as a means of solving our clients' increasingly complex challenges and advancing the profession. Although these initiatives grew out of the firm's cultural focus on the convergence of design, technology, and research, our experience indicates that these initiatives have in turn fostered an environment that is even more open to innovation and collaboration.

With more than 1,200 employees in 23 offices, Perkins+Will has organized these initiatives under the oversight of its Research Group, which includes full-time researchers whose investigations include biomimicry and ecological systems; strategies for operational efficiency; building technology and performance; design process benchmarking; policy research; carbon and energy analysis; and organizational behavior.

Currently, two initiatives within the firm focus on developing and disseminating a new generation of science-based research. The first is the *Perkins+Will Research Journal*, a biannual publication available online and in hard copy that documents some of the firm's investigations, representing a range of research from behavioral studies to building science. All research articles go through a rigorous internal and external peer-review process prior to publication. Examples include articles on design strategies for double-skin façades and their impact on energy performance; energy modeling; design considerations for pools in cold climates; the effect of heat flow and moisture on exterior enclosures; and a comparative analysis of the environmental and economic performance of flooring materials. The value and significance of this publication is that practice-oriented research is documented and shared both within our global practice and with the larger design community.

The second initiative, the Innovation Incubator, is a funding program that supports small, focused research projects proposed by staff members with micro-grants of money and time. Launched in March 2010 with the goals of providing the opportunity for invention and creating a culture of innovation within the firm, these micro-grants provide incentive for proactive idea exploration, technical development, and design collaboration. After project completion, each participant is expected to provide a tangible product that explains the aim, procedures, and outcome of the project. Participants make detailed formal presentations of their work to their home-office colleagues, and their work is disseminated across the firm through summaries published on the firm's intranet.

In its first year, 12 projects were selected from 90 applications, representing seven offices and 20 participants. Projects included research on acoustics, energy analysis, air pollution mitigation, and energy consumption in food production, as well as an array of projects related to planning, practice, and user-based design. The program allows and encourages a range of formats: technical white papers; events and installations; project prototypes; and process refinements. Already, several projects have found second lives: Some have influenced the firm's business policy, some inspired conferences, and others are candidates for extended internal research.

As the experience of Perkins+Will has demonstrated, practice-oriented research has a logical and comfortable role in the firm environment that is based on parallels between research and architecture. As the editors of the *Perkins+Will Research Journal* wrote in the second issue, "Architectural design requires immense amounts of information for inspiration, creation, and construction of buildings. Although uniform sets of systems, materials, and construction processes are considered during this process, every design is an answer to a set of unique questions and circumstances. Therefore, research becomes an integral part of the design and construction of buildings and environments, where inquiry into existing knowledge, study, and adaptation to particular circumstances leads to the development of new knowledge."

PAYETTE

James H. Collins, Jr. FAIA

Payette's practice has always been focused on challenging not only the status quo but also our own well-established thoughts and beliefs. We embraced the pursuit of innovation and invention within the context of a traditional design process but acknowledged the lack of appropriate tools beyond our instincts. Although we could often justify (or post-justify) the directions we took with calculations or measurements taken from the final design and construction, we were rarely able to pursue rapid iterations of design modifications in a controlled setting.

Over the past 10 years, however, the development of new software tools made specifically for design analysis, coupled with a surge of interest from academia, has enabled us to bring true rigor to this fundamental part of our work. With architecture schools throughout the country emphasizing technology, sustainability, and process, we have been able to bring new architects into the firm who leverage this technology and contribute to the design process at its earliest stages.

Of course, Payette is not unique in pursuing this agenda. Firms across the country have embraced science in myriad ways. Some have focused their practices on making each project an academic research endeavor. Others have formed elite "skunk works" teams within their organizations to pursue cutting-edge technologies, often with institutional partners. Payette has taken an approach that lives between these two extremes, incorporating tools as they come online but keeping specific client and project needs at the forefront. The focus is on the practical application of design research.

To turn this concept into reality, Payette recently established a "Research and Innovation Initiative." This effort is led by representatives from each area of the firm, who make research tools—such as modeling software, prototyping equipment, and an in-house Wiki—available to all design teams, leaving the teams to determine how to implement these resources. As part of this initiative, a building scientist joined the firm to provide expertise in the physics, engineering, and analysis of building performance.

Some examples of specific decisions that were a result of this approach may be useful. In Pakistan, we were able to develop a modern version of the traditional wind catcher, using earth ducts to provide natural ventilation and cooling throughout a new college campus. For a small community college in upstate New York, we were able to analyze multiple façade technologies to determine the cost benefit of double-wall construction under varying thermal conditions. For a small cheese production facility in suburban Boston, we were able to investigate multiple options for the development of a zero-net-energy installation specific to the needs of this farm.

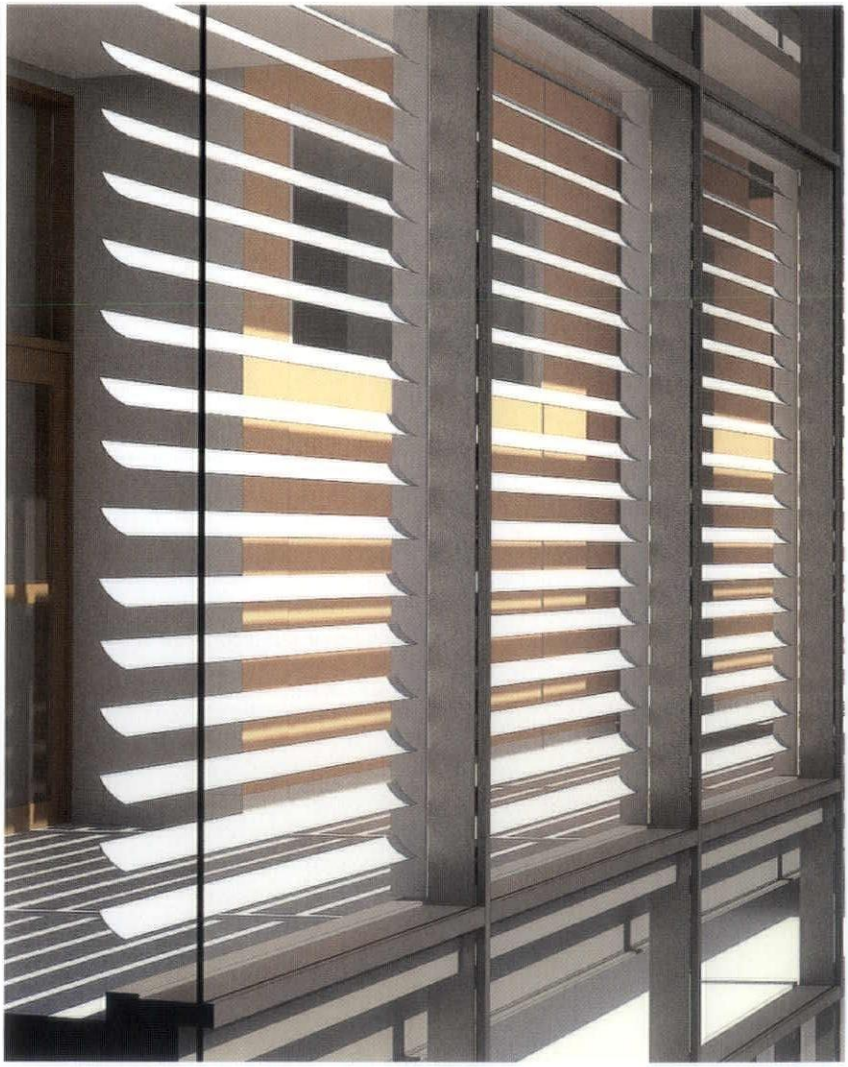
The defining trait of these projects is that the results have relevance far beyond the immediate needs of the projects; this allows us to justify the additional overhead expense of the exploration. These investigations inform the entire practice and should streamline and influence future decisions. Ideally, significant research and results can be taken beyond our walls to the greater professional community through our online presence, conferences, and publications.

Ultimately, we see this as a question of leverage. We are not trying to live on the bleeding edge, inventing new technologies or materials, but we want to use all of the resources at our disposal to attack every problem we confront. Our approach to research is about strategic investigation that helps to rationalize our process, bring rigor to the work and, more than anything, develop the intuitive sense that drives all formative design work.

James H. Collins, Jr. FAIA, LEED AP is the president of Payette in Boston.

BELOW
Detail, thermal buffer zone with automated blinds, developed for Brahan Science Center, Hudson Valley Community College, Troy, New York. © Payette.

FOR MORE INFORMATION
www.payette.com



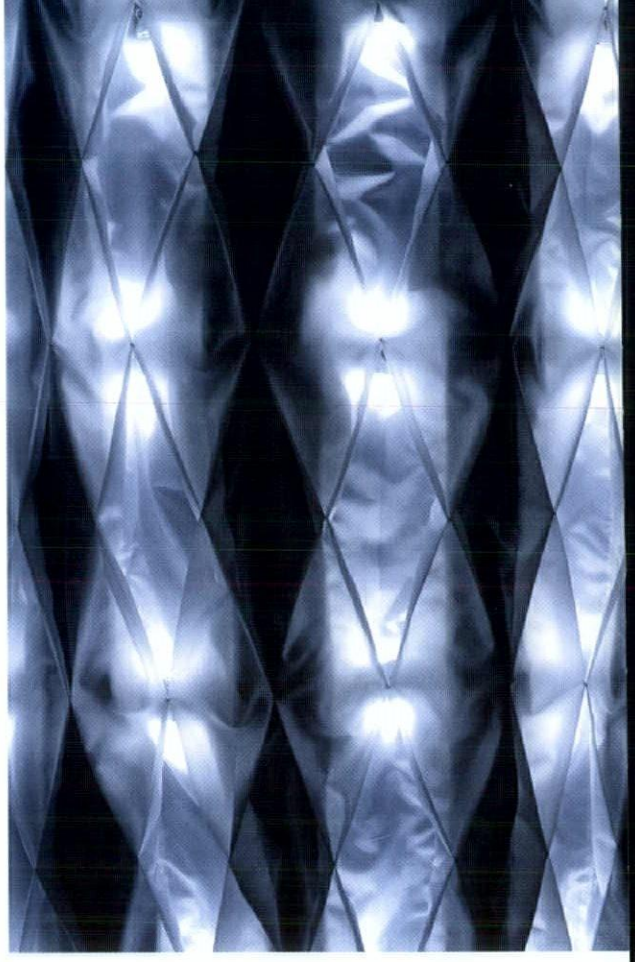
J. Frano Violich FAIA is a principal of KVA and its subsidiary, MATx, in Boston.

RIGHT
Detail, Smart Curtain (prototype), a moveable, soft partition with integrated solid-state technologies (including LED, USB, photovoltaics) for IBA Soft House, Hamburg, Germany. Photo courtesy KVA/MATx.

FOR MORE INFORMATION
www.kvarch.net

KVA

J. Frano Violich FAIA



We practice at a time when the stakes could never be higher for architecture to respond to the challenges of our time: health, mobility, economy, and the environment. Yet the compartmental roles institutionalized by practice have reduced the design process to a limited number of repeatable steps that favor design service over design inquiry. Architectural exploration takes place primarily within academic settings or with a handful of specialized consultants, a fact that further distances the architect from the direct hands-on investigations required to address these global challenges.

In architecture schools in the late '70s and early '80s, research was limited to social or environmental factors driven primarily by program. This was followed by a tendency to explore history and the urban fabric as a design research tool. What I found missing as I entered the profession was an understanding of how systems worked, especially infrastructural systems and their implications for urbanism and architecture. Further, at a more detailed level, there was no opportunity to investigate architecture through its material properties. This was the root of Kennedy & Violich Architecture's beginnings and the subsequent establishment of the firm's material research division, MATx.

One of the greatest challenges for the profession is to establish a place within the discipline that integrates research with the design process and the workplace. As digital drafting tools evolve, so, too, do fabrication tools, and they are becoming increasingly synergistic within the design process. Details of an exterior building envelope that have been generated through an algorithmic script to respond to climatic exposure can be 3D-printed or routed to test design characteristics from the assembly of parts to its overall look and proportion, all of which can be done without even leaving the workstation. Almost half of KVA's office in a converted bottling plant is dedicated to research and fabrication, including spaces for optoelectronics, digital prototyping, and analog equipment, such as table and band saws, drill presses, soldering guns, and sewing machines. The intersection of digital and hands-on fabrication is a foundation of KVA's research process. It is not always a pretty sight to come into the shop and see the latest swatches of high-performance textiles, flexible CIGS photovoltaic panels, electroluminescent panels, digital circuitry, lithium-ion batteries, milled lumber, plywood, and recycled plastic strewn about the workbench and even sometimes the floor. However, research is by nature a messy business. It raises many more questions than answers and, in this sense, is less noun than verb. *How* research is conducted is important, yet equally critical is *where* it is done, because spaces dedicated to research offer the room for an expanded range of projects to occur, from industrial design to temporary installations and architecture, promoting an office culture where "making" exists side by side with "drawing."

The work now coming out of KVA/MATx has never been more diverse: a law school at the University of Pennsylvania; a prototypical urban solar rocking chair and charging station; sustainable housing in Hamburg; portable power and light for communities in the Amazon; a ferry terminal in New York City; and the planning of 5½ miles of the Upper Mississippi in Minneapolis as an urban ecological landscape. Yet the work has become more focused, primarily due to a commitment to practice that applies speculation and inquiry to contemporary conditions that affect our quality of daily life. Maybe it's time to step out of the office and plug in to the shop.

Seeding Knowledge

The BSA Research Grants in Architecture

by Carol Burns FAIA

RESEARCH, BROADLY DEFINED, is systemic inquiry directed toward the creation of knowledge. Research adds to a profession's body of knowledge.

Why, then, has the architecture profession failed to embrace formal research as part of its culture?

Although architects in practice regularly engage in investigations in which they gather, evaluate, interpret, and analyze information, these efforts are rarely considered "research." Formal research is framed by protocols, including statements regarding hypothesis; methodology; and the formulation of claims, evidence, and generalized conclusions. In sharing or disseminating research, the peer-review process upholds the accepted standards of a discipline and prevents publication of irrelevant findings, unwarranted claims, unacceptable interpretations, and personal views.

As a field, architecture is not effectively using and creating knowledge. Peer-reviewed research is rarely incorporated into work in professional practice. Research protocols rarely frame professional efforts, and results are rarely documented for sharing. As a consequence, architects rediscover or repeat what is already known and fail to focus on the development of new knowledge. The tradition of research has not been adequately recognized and honored, and the vital role of research has been undervalued as well as underfunded.

Recognizing the importance of research, the Boston Society of Architects (BSA) established a program in 2004 to provide funding to individuals and teams to conduct research in architecture. The BSA Research Grants in Architecture program supports original research in any area of architecture by anyone with a clear methodology and the potential to contribute to knowledge. With a focus on practice-based and practice-oriented research, the program has funded 55 projects in areas including: materials and technology (about one-half of all projects funded); social, economic, political, and cultural dimensions of architecture; aspects of physical design; and historical topics. Many projects cross two or more of these categories, speaking to the interdisciplinary nature of architecture.

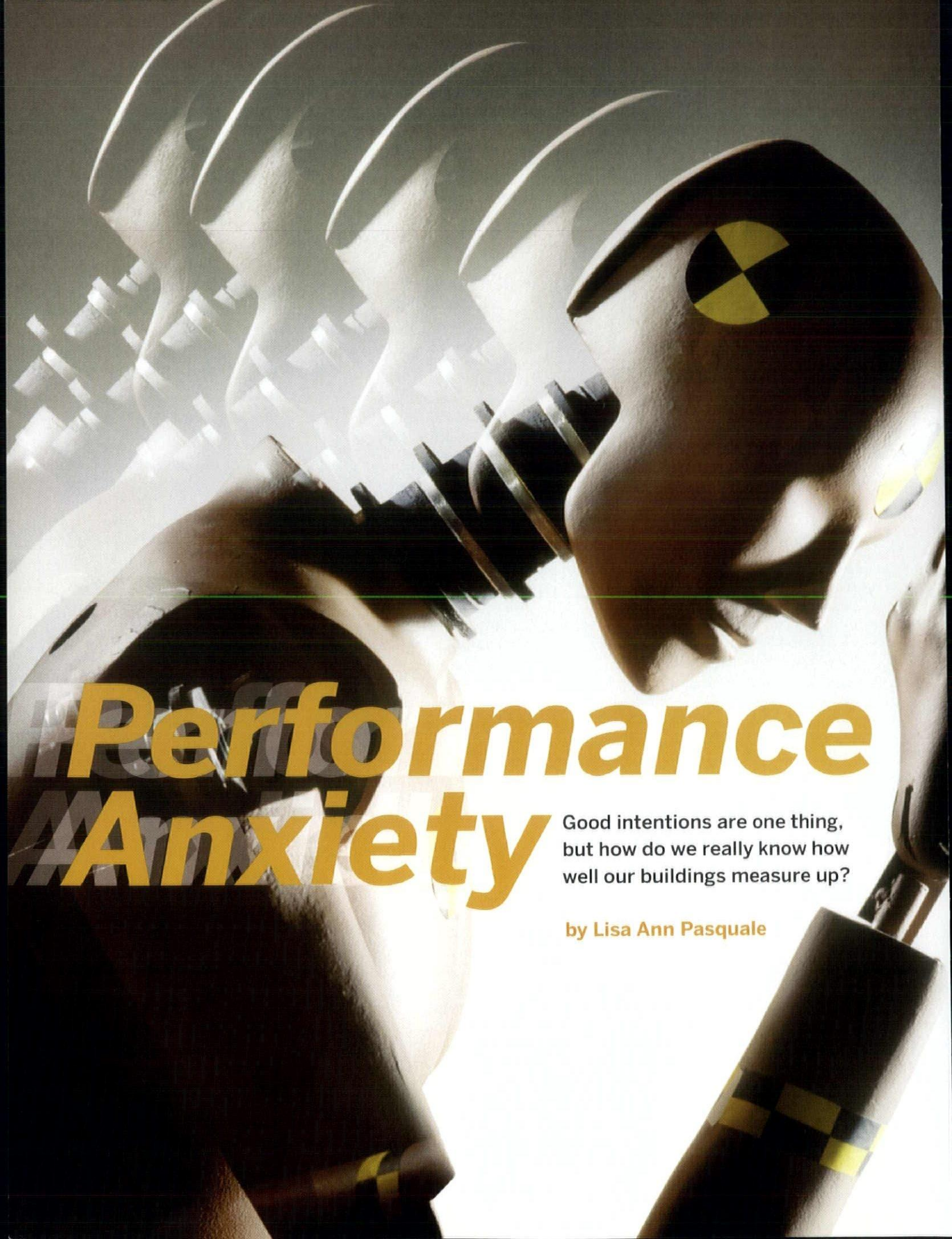
The BSA program is distinguished in many ways. Grant amounts and recipients have varied widely depending on the scale and need of the project, from $2,000 awarded to students to $10,000 awarded to support studio-based projects and $40,000 awarded for more significant research projects that can bring together professionals, industry representatives, and academicians. No other program offers grants of this size targeted to support substantial work by interdisciplinary teams. After seven years, the BSA Research Grants in Architecture program now occupies a unique niche in architecture as a "long-lived" program.

What has the program accomplished? The completed projects have been shared as lectures, publications, and books. In direct response to this initiative, the AIA has created new research programs, including the Upjohn Award. The BSA has contributed to the creation of a culture of research within the profession. Where should it go? In my view, architecture is a "generalist" profession that demands knowledge across a wide spectrum, and practitioners should be able to search for and obtain useful "evidence-based" knowledge at their desks. Presently, the BSA takes the first step by posting on its website all abstracts and reports of completed projects. Alliances with other web-based publications are being explored to support peer review and enhance accessibility.

The field of architecture is constantly evolving, and research has never been more important to our profession than now. As Thomas Fisher states in the pioneering chapter on research in the *Architectural Graphic Standards* 2007 edition, "For architecture to flourish as a profession, we must have a reliable and researchable base of knowledge shared among ourselves and proven in ensuring people's health, safety, and welfare." ■

Carol Burns FAIA is a principal of Taylor & Burns Architects in Boston. A cofounder of the BSA Research Grants in Architecture program, she has taught at Yale, Harvard, MIT, Wentworth Institute of Technology, and other schools; served as the director of the Harvard Institute of Affordable Housing; and has been co-editor of several volumes including *Site Matters* (Routledge, 2005). She currently serves as the chair of the Boston Art Commission and designator for the Henderson Foundation.

For information on the BSA Research Grants in Architecture program, summary reports of past projects, and interviews with recipients: www.architects.org/grants.



Performance Anxiety

Good intentions are one thing, but how do we really know how well our buildings measure up?

by Lisa Ann Pasquale

Science is what you know. Philosophy is what you don't know.
—*Bertrand Russell (1872–1970) English philosopher, mathematician*

The days of architects justifying design decisions with interpretations of esoteric philosophy are all but numbered. Wright rearranged clients' furniture, Le Corbusier's roofs leaked, and Mies van der Rohe's Farnsworth house is the epitome of dysfunctional Modernism. Contemporary clients, however, are less accommodating (and more litigious) and rarely consider hubris a desirable quality in the person paid to design the roofs over their heads.

Architecture is a unique form of commercial production in that every building is a prototype—our crash-test dummies are, generally, the previous client. Each building has a unique combination of form, use, construction, systems, site, and project team, each with an impact on performance, energy, environment, cost, and quality. Assurances to clients ride on a plethora of assumptions. The only way to establish if the assumptions are valid is to revisit buildings after occupation, and systematically and objectively monitor, measure, and evaluate their performance. Similarly, the only way to substantively move the practice of architecture forward is to establish practice methodologies based on solid, scientific evidence rather than intuition and anecdote.

The idea is not new. First developed in the 1970s, post-occupancy evaluations (POEs) took a "real world" scientific approach to assessing the performance of buildings and, by extension, the built environment. Incorporating a host of comparative methods, these were typically conducted about two years after occupancy of new buildings and addressed how well the buildings met user needs, their environmental performance and, in some instances, their operating and projected lifecycle cost.

Traditionally, POEs were associated with recently built projects, especially those with ambitious energy and environmental targets or unique technologies. Thus, they generally did not address the energy impact of the existing building stock and had little influence on retrofit and renovation efforts. But perhaps the greatest failing of the approach was its lag time: project teams received feedback years after the initial design work. Designers often felt that their thinking and methodologies had self-evolved enough in the intervening years that the feedback was no longer relevant, making it difficult to change design practices. To ensure that critical lessons took root, feedback needed to be integrated more effectively into the project process, and evaluators needed to assess and report on buildings that designers felt still represented the pinnacle of their technical prowess.

Building Performance Evaluation (BPE) has evolved out of decades of efforts to address these issues. BPE refers to a broader application of POE and scientific assessment techniques; unlike POE, it extends into the construction phase and can be easily applied to existing structures and renovations. In construction phases, these techniques are used as an advanced means of quality control. Triple air-pressure tests, for example, verify airtightness at key stages of completion to ensure that detailing and construction methods are meeting the intended technical standards. Periodic quality checks also ensure that construction crews develop their own skills and processes to more effectively monitor their own work. They also maintain a dialogue about quality between the design and construction teams so that specifications and details can be improved with input from builders. This is a clear advantage to teams who consistently work together.

The process has uncovered problems with "rules of thumb" and regulations, sometimes sending designers unexpectedly back to revisit the fundamental principles of good design. A recent co-heating and thermography survey of masonry townhouses built to 2006 regulation standards in the UK showed massive heat losses through the roofs above party walls. Previous regulations assumed that heat loss from dwellings through party walls was zero. However, the study consistently showed that poor detailing and construction resulted in thermal bridges, a lack of cavity closures, and air gaps, which drove convection currents in the cavities. These were acting as thermosyphons, drawing heat from the adjacent units into the cavities and then to the outdoors through the cavity roof and walls, accounting for up to 30 percent of the building's total heat loss. Findings like these have the potential to change industrywide practices, influencing both regulations and strategic investment.

Every building is a prototype—our crash-test dummies are the previous client.

Lisa Ann Pasquale is an environmental specialist in London, where she works as a building performance evaluator for Oxford Brookes University and as sustainable design development manager for Architype Ltd. She received her BArch from Rensselaer Polytechnic Institute and an MSc in sustainable environmental design from the Architectural Association.

OPPOSITE
Photo: Steve Hathaway

BPE can also serve to test theoretical assumptions and calculations. For example, field tests that measure the heat flux and thermal conductivity through walls have shown variations ranging from roughly 5 percent to 20 percent of theoretical values, with certain constructions and fabrication techniques consistently more reliable than others. This empirical knowledge of inherent variations is applied in Scandinavia, where designers adjust the theoretical thermal conductivity values of construction assemblies twice in design calculations to give more realistic predictions of completed performance. They factor in one variable to account for uncertainties in the properties and dimensions of building materials and the resulting inconsistencies in craftsmanship, and another to adjust for the effect the assembly complexity has on its performance. This prevents them from assuming that an overly complex construction that is difficult to implement on site is more thermally effective than it's likely to be.

Although construction-phase monitoring can improve quality, and scientific assessments can evaluate technical assumptions, they are still not enough to ensure that performance expectations are met. In 2009, the Usable Buildings Trust and Building Services Research and Information Association (BSRIA), both based in the UK, launched the "Soft Landings" framework to respond to the need for immediate feedback and increased user support as well as to provide the opportunity for more extensive assessments. Studies had found that buildings weren't used as designers envisaged, often because of misunderstood design intentions, poorly executed design features, and inadequate user training, sometimes with drastic effects on energy use and performance. Soft Landings is intended to increase the intensity of designer engagement both before and after initial occupancy. A residency period during the first weeks of occupation gives the design team a structured time period in which to carry out quality assessments that must be done while the building is operational, to support and advise the client and users, and to learn from working in their own building. The process is akin to "sea trials" in naval architecture, where a boat's design and robustness is tested in real-life scenarios as part of the commissioning process. In practical terms, Soft Landings aids in risk management by using BPE methods to anticipate problems.

But perhaps the greatest value of Soft Landings is its potential to boost the quality and rigor of the research that is key to ensuring relevant lessons are extracted and that the root causes of problems are addressed appropriately in future projects. The whys are always

more important than the whats. For example, data collected on a new primary school as part of a two-year joint BPE research project between Architype Ltd. and Oxford Brookes University showed a spike in gas use over the summer break. The detailed nature of the data-collection methods allowed researchers to identify exactly the weeks in which the boilers were burning, which led them to the cause: When the boilers were serviced just before the summer break, the mechanic overrode the automatic controls to check his work but never re-engaged them when he left, leaving the boilers running all summer. The findings led to specific recommendations to the client for improved management and modifications to the designer's own client-handoff process (a more formal, extended process in the UK than it is in the US), to reduce the likelihood of similar problems on future projects.

The temptation is to sanitize findings such as this and to give a figure for the buildings' potential performance without operational slip-ups—a temptation that should be resisted. The X-factor effect of the occupants' presence is as important as the quality of the building's design and construction. Designers must accept that their buildings are rarely used as they anticipate, however frustrating that may be. The haze of unrealistic expectations will dissipate with comprehensive knowledge of how buildings are used and also lead to more robust assumptions in design phases, better expectation management, more realistic predictions of performance, and reasonable expectations of occupants. The all-too-human tendency to overpromise and underdeliver is not one that the profession will survive in a competitive environment. But firms that see opportunity in these techniques can develop more comprehensive services for clients who understand the difference between assuring and ensuring performance.

Although BPE is a science, it's not an exact science. Sometimes spurious data is recorded (such as when schoolchildren make a game of breathing on a CO_2 sensor to make the count on the digital readout go up and down), and sometimes the answers from scientific analysis are ambiguous, with no clear resolution. Not all problems have simple solutions; scientific answers can be more baffling than the questions. However, every question has a means of investigation, and although the complexity of buildings in operation can be overwhelming, ignorance should not be the accepted default. The scientific evaluation of building performance is the only way for our industry to move forward and meet the expectations of the societies we serve. ■

FOR MORE INFORMATION

Soft Landings
www.bsria.co.uk/services/design/soft-landings

Usable Buildings
www.usablebuildings.co.uk

Low Carbon Building Group, Oxford Brookes University
www.brookes.ac.uk/schools/be/oisd/lowcarbonbuilding

Architype Ltd.
www.architype.co.uk

Things *WE DON'T KNOW* WE DON'T KNOW

We all rely on shortcuts: rules of thumb, accepted convention, common knowledge.

WHAT IF THEY'RE WRONG?

BY KIEL MOE AIA

"WE MUST HAVE A BODY." —*Gilles Deleuze*

"WE DO NOT EVEN KNOW WHAT A BODY CAN DO." —*Baruch Spinoza*

Architects must have buildings, but we do not even know what buildings can do. Like the at-once utter familiarity and utter strangeness of our own bodies, we know little of how buildings actually perform and behave. This is perhaps best illustrated by too many recent LEED Platinum–certified buildings that are documented to perform worse than baseline code buildings.

The recent renewed focus on building science and building performance in the discipline and practice of architecture is therefore very welcome (especially after a period defined by the theatrics of quarreling styles). In the context of increasing demand for diminishing resources, this turn in attention promises fundamental transformations for architecture in the coming decades. Given the paucity of knowledge about the actual performance of buildings, it may seem that the value of embracing building-science research would be the introduction of more certitude into design practice. But the greater value, and greater need, is the introduction of *doubt*. Currently, there may be no more efficacious way to increase both the rigor and the vigor of the profession.

The more one learns about building science, the more one begins to question central assumptions—assumptions that are as widely taught as they are pervasively practiced. The logics of air conditioning, multilayered wall assemblies, and R-values, for example, become more dubious the more one thinks deeply and systemically about bodies, building performance, and global resources. Study of the assumptions at the beginnings of air-conditioning science reveals compelling insights and oversights: Willis Havilland Carrier brilliantly ignored the role of radiant heat transfer in his calculations (even though that is the body's primary mode of heat transfer) because he was solving a problem for hygroscopic machines and, later, designing a new industry; he was not designing for the comfort of humans or the performance of buildings. Likewise, the flawed concept of R-values also ignores multiple forms of heat transfer such as the important but neglected role of thermal diffusivity for more massive materials or the role of convective flows in insulating materials such as batt insulation, which undermines their capacity to resist heat flow. In short, the more an architect thinks about the relationship between our physiology and the science of heat transfer, to consider only one example, the more apparent the fact that many platitudes of contemporary construction are based not on sound science but instead on a broad network of sometimes unwarranted suppositions and habits. If the discipline of architecture is to become more deliberate, more effective, and therefore more respected, architects will need to develop a habit of questioning assumptions: They cannot acquiesce to conventions and customs any more than they can capitulate to the rhetorical escalations of "new" techniques and technologies.

Exposing the flaws

Questioning assumptions is key to any effort to advance the integration of building science with building design. Too often, cutting-edge, if not glib, techniques are seen as driving revolutions in architecture—a worn-out trope borrowed from early Modernism, when new materials and technologies promised new architectures. However, as German philosopher Peter Sloterdijk has suggested, history has not been a process of revolutionary modernization. Instead, as Sloterdijk has written, it has been about a process of "explication," which he defines as "the revealing inclusion of latencies and background data in manifest operations." In other words, real progress is most often made by reconsidering what we think we know and re-examining the layers of presumed fact, supposed truth, and accepted practice. Any substantive, meaningful shifts in the practice of architecture in the coming decades will likely emerge from a similar process: the overt explication of prior practices.

Kiel Moe AIA is assistant professor of architectural technologies at the Harvard Graduate School of Design. A 2010 Fellow of the American Academy in Rome, he is the author of *Integrated Design in Contemporary Architecture* (2008) and *Thermally Active Surfaces in Architecture* (2010), both from Princeton Architectural Press.

OPPOSITE
Detail, the Babbage Difference Engine No. 2, designed in 1821 by Charles Babbage (1791–1871), first built, 2002. The "father of the computer" designed this mechanical calculator in response to his frustration with errors in the printed numerical tables used by scientists, engineers, navigators, and businesspeople, who unwittingly introduced and compounded errors resulting from hand calculation and typesetting. Collection, Museum of Computer History, Mountain View, California. Photo: Johan Mathe

What might such shifts look like? I can offer a couple of suggestive examples from my own recent work. Based on research that questions the assumptions and practices of 20th-century architecture, my work has focused on three topics that suggest three new modes for building design. First is the role of thermally active surfaces in architecture as an alternative to air conditioning; this paradigm finally activates the corpus of the body and the building in the same thermodynamic space. Second is an examination of lower-technology, higher-performance design rather than the planned obsolescence of higher-technology, lower-performance approaches of recent decades; this is a mongrel paradigm of durability, adaptability, and resilience that leverages the intelligence of both archaic and contemporary techniques. The third is based on an overt recognition of Einstein's observation that matter is but captured energy. Energy and material systems have been taught, designed, and engineered as disparate entities—a thoroughly false division that chronically handicaps architects. An alternative, integrated paradigm conflates energy and matter, thereby drawing attention to new hybrid approaches to building materials and systems.

"THERE ARE THINGS WE DON'T KNOW WE DON'T KNOW." —*Donald Rumsfeld*

Knowing what we don't know

Even now, as we are beginning to better understand building performance and behaviors, buildings are becoming increasingly obscure. For example, we know slightly more, perhaps, about the performance of certain building assemblies, but the geography and ecology of the materials that constitute those assemblies are largely as indeterminate as ever. This is a disconcerting split in knowledge.

Moreover, the reliability of new research is not guaranteed. New knowledge about building performance is often based on energy modeling and simulation, which give the appearance of accuracy and objectivity. But nearly all numerical models of reality are as incomplete as they are inaccurate. Further, they typically serve to answer only small questions in architecture. Numerical models are equally remarkable for what they tell us and what they conceal about building performance. (This is especially true for weak simulation programs such as Ecotect that are attractive

because of their easy, graphic interface.) Numerical models do not verify the actual performance of a building or building assembly; instead, they verify performance measured against the assumptions embedded in the parameters of the model itself. What current digital models ignore is as important as what they analyze; their output cannot be any better than their inputs. The words of philosopher George Grant apply to the current interest in building simulation: "We can hold in our minds the enormous benefits of a technological society, but we cannot so easily hold the ways it may have deprived us, because technique is ourselves."

Admittedly, recognizing the failings of this technological and computational determinism can lead to despair: How can we make any progress in the face of so many unknowns? The answer lies in a perhaps unexpected realm: judgment. Judgment itself is a profoundly sophisticated and integrating algorithm, a robust method of modeling and simulation. In a period of increased interest in science and technology in design, judgment prevents us from descending into pure technique, from becoming pure technique ourselves. As such, science and technology in architecture should always remain a subset of judgment. Despite the availability of increasingly sophisticated simulation techniques, the most refined processor and algorithm in architecture remains the integrating capacity of the mind, and the most subtle thermodynamic and physiological processor remains the body. This is what can make architecture so rich, and maintaining this hierarchy is necessary if we are to integrate design with life rather than subjugate life to mere technique.

The most consequential aspects of any science experiment are, first, the examination of the assumptions that condition the experiment and, second, the evaluation of the results of the experiment—in short, the application of explication and judgment. The practice of architecture—that which will determine the future of the profession—must always be in this sense an experimental practice, one that applies extensive explication and robust judgment to the integration of science and design. Only then we will begin to know those things we don't know we don't know. ■

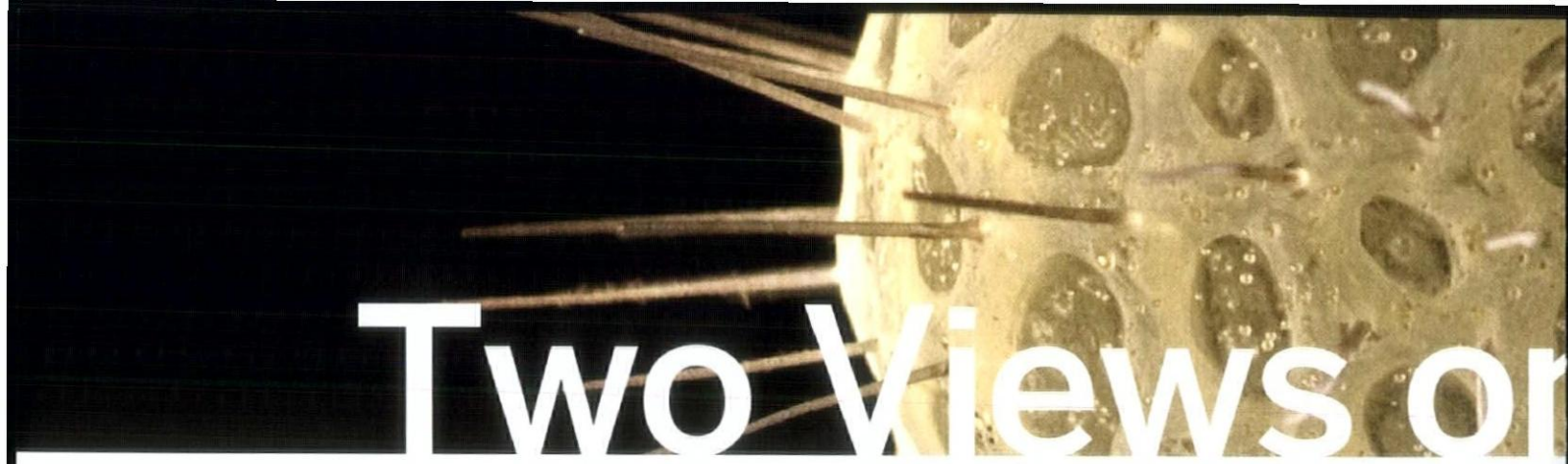
FOR MORE READING

"Good-bye, Willis Carrier" by D. Michelle Addington in *Proceedings of the 85th ACSA Annual Meeting and Technology Conference.*

"Energy Performance of LEED for New Construction Buildings: Final Report" by Cathy Turner and Mark Frankel in *New Buildings Institute*, March 4, 2008.

"Thermal Metrics for High Performance Enclosure Walls: The Limitations of R-Value" by John Straube in *Research Report 0901*, Building Science Press (2007).

Thermally Active Surfaces in Architecture by Kiel Moe AIA, Princeton Architectural Press (2010).



Two Views o

Forget beakers and Bunsen burners. Architects can learn from the way scientists *think*.

Tyrone Yang AIA, PhD

Tyrone Yang AIA, PhD received a doctorate in perceptual psychology before pursuing a career in architecture. He has taught seminars at Wentworth Institute of Technology on human factors and architecture, and currently works as a researcher with the Living Labs and Changing Places groups at MIT.

If architects behaved more like scientists, perhaps architects would systematically observe and measure how buildings are performing. Experiments and studies would adjudicate disagreeing ideas. Articles would be written about buildings not just when they are shiny and new, but years later, when they have been used and tested by people. But architects are not scientists. Their primary goals differ (creating unique, memorable places versus discovering general laws about the world), as do the demands of their professions. Nevertheless, some of the practices from the field of science could be useful in architecture.

For instance, the scientific method could address architectural questions. Good scientific hypotheses make predictions. Data are collected to evaluate these hypotheses, which, if consistent with the data, are promoted to theories and sometimes laws that help organize our broader understanding of a topic. Schooled in this method, practitioners, not just researchers, would know how to evaluate questions and assumptions, such as whether student performance in schools might improve with better daylighting or whether thermal comfort is higher in naturally ventilated or in mechanically conditioned buildings. Architects could rigorously investigate the causal mechanisms that explain phenomena that they observe in practice; the answers to such questions could influence health, comfort, and energy use in buildings. Where controlled experiments are not possible in the real world, scientific thinking could still guide critical reasoning: When the USGBC posts the claim on its website that people are healthier and more productive in green buildings—which may indeed be true—architects would note that cause and effect is often complicated in such correlational studies.

Architects could also learn from the methodologies that science has developed to manage knowledge. Architects typically employ a *personalization* model of knowledge management, in which knowledge resides in various experts, such as the consultants on a project team. Science has a more established system for *codification* of knowledge, organizing it into journals, verifying new findings through formal peer review, incorporating previous studies by accepted citation methods, and producing review articles on a regular basis to synthesize knowledge in a particular area. Applied to architecture, such a system could replace the informal amalgamation of reports, client feedback, and anecdotal evidence that substitutes for a knowledge base in most firms. Better codification would aggregate information from a variety of firms and projects and advance architectural knowledge in a broader manner.

Although these practices have already been implemented by building-science researchers, they are not typically integrated with routine architectural design practice. Compared with other areas of science, research in architecture faces particular challenges, such as client privacy, liability, and a lack of funding for even the most basic investigations, such as building performance evaluations.

In the future, enabling science to benefit architectural design may require a multipronged effort. Most important, clients, the public, and the government need to understand the value of creating better-performing buildings and the utility of science as a means of achieving this goal. Funding—from the industry, government, and clients—would create better cross-talk between practice and academic research. We might see new collaborations with specialist consultants—not only engineers but also building scientists and human-factors researchers. Perhaps new technologies like those for ubiquitous sensing, now under development at the MIT Media Lab, could automate data collection or create more responsive buildings. The way to advance the profession is to advance its knowledge, and that will come only with a change in the profession's intellectual ecosystem. ■

Nevin M. Summers AIA

Scientists are discoverers, driven by curiosity. Their discipline is not a belief system but a knowledge system that uses reason, observation, and empirical finding to separate causation from correlation and to unify and explain otherwise disparate, unfathomable phenomena. Science thrives on unexplained facts that challenge the validity of current theories that are shown to be incomplete by their lack of universality.

Perhaps the best way to understand how scientists differ from architects is to look at the ways they create, disseminate, and use knowledge.

Much like the most collaborative of architectural practices, science is a community effort. Although there's intense competition to discover and publish first, the intellectual enterprise thrives on collegiality and shared knowledge. Academic labs are run as knowledge studios supervised by professors.

Unlike architects, however, these professors are also part of a larger economic ecosystem: They are encouraged by federal grants to found startups under "tech transfer" policies that maximize commercial value to society but minimize conflict-of-interest. (The entrepreneurial biotechnology industry originated this way.) Although a scientific discovery per se cannot be patented, a method, machine, or composition of matter that employs such a discovery in a novel, unobvious, and useful way can; this is the work of engineers, who apply scientific principles to make the products demanded by society. Science is thus the driver of the modern economy and is therefore closely aligned with the national agenda, benefiting greatly from federal funding.

Where scientists strive for simplicity and universality, architects pursue fitness within the context of place, purpose, and culture; the unique, the custom, and the individual predominate. Architects are integrators charged with achieving a synthesis of many disparate factors; their work is much more complex and multifactorial.

Neither science nor architecture, however, is immune from the simple fact that, left alone, any discipline will develop a proprietary culture that seeks to restrict the flow of knowledge for private gain. Research on problems that adversely affect all players consequently goes unattended, despite the fact that knowledge is built as a shared enterprise "standing on the shoulders of giants," as Vitruvius and Newton both noted.

Knowledge is a wasting asset. Like money, it diminishes in value over time unless it is invested and its growth is allowed to compound exponentially. An unfortunate systemwide inefficiency of private (Western) capitalism is that competing firms, which must keep their work secret to preserve patentability, create a massive wasteful duplication of effort. In industry, even failed scientific experiments are sequestered for fear others may use that knowledge for benefit; the architectural analogue is sealed settlement agreements regarding building failures. Entire industries can stagnate from a hyperproprietary culture, as in the case of pharmaceuticals today, where innovation has stalled despite vast sums of aggregate (but uncoordinated) spending on research and development.

Darwin showed that competition is necessary to allocate resources and to propagate the fittest, most adaptive individuals. But competition alone is insufficient. There must also be cooperation to satisfy the evolutionary tendency toward increasing complexity. Without collaboration among disciplines, we will not develop the knowledge we need to become better stewards of the global environment—the greatest issue facing society today. Environmental challenges such as climate change do not respect professional boundaries; they mock them. ■

Nevin M. Summers AIA is president of Novation in Cambridge, Massachusetts, a life-sciences consulting firm, and former director of corporate development for the Biomedical Enterprise Program in the Harvard-MIT Division of Health Sciences and Technology. He holds degrees in molecular biology, architecture, and management of technology.

ABOVE
Detail, glass model of a radiolarian (a marine protozoan) created in the late 19th century by Leopold and Rudolf Blaschka. Collection, Smithsonian Museum of Natural History. Photo: Victoria Pickering

beautiful photograph is not a pretty picture.

Photographs and text by David Arnold

On a rainy April morning in 2005, I was driving home with a newly purchased Bradford Washburn photograph propped against the passenger window.

It was an aerial picture of a glacier, one of thousands taken by the former president of the Museum of Science (who died in 2007). Sneaking peeks at the photograph, I wondered: If the hullabaloo about planet warming is true, has this scene changed?

The question resulted in an exhibition of historic and contemporary photographs of glaciers, now touring the country, and a new project in the works using a similar methodology: I am shooting corals, using benchmarks from other photographers to create comparisons by replicating the camera angles and conditions in the earlier pictures.

The news is not good. The ice world is melting fast. And about 40 percent of the planet's reefs are in decay: Coral death is complicated, but human fingerprints are all over it. Humans are to blame, and humans are the solution. Says who? Says 98 percent of the peer-reviewed climate research and every significant national science academy. Our dependence on fossil fuels with their byproduct of carbon dioxide is thickening a heat-trapping invisible quilt around the earth.

Frankly, science has never been my strong suit. I took "Physics for Poets" to fulfill my college requirement. But looking through a lens at the pace of change today has forced me to ask questions and judge motives of the deniers because, although I have not become a scientist, I have become more science literate.

The research put through the acid bath of peer reviews says that if we don't smarten up fast, a dangerously warmer planet ensues. We don't want this, particularly on our watch. The consequences are unfathomable—not to mention the guilt.

So the skittish among us start concocting narratives to address the very understandable anxiety. Those narratives offer hope, albeit spurious: We hope that the science is faked; climatologists are in it for the money; Gore is just a griping presidential loser; we are in a natural warming cycle; we are in a natural cooling cycle; we can legislate against the laws of physics and chemistry; the problem is not coal and oil but water vapor and cow farts; we can throw sulfuric pixie dust into the atmosphere and all will be well. Adding more science may only increase the anxiety and the need to cling to narratives.

The rub is that science is a discipline. It thrives on transparent peer-chewed data. Evidence, not opinion, makes good science.

The good news is that, just as these photographs speak to unsettling change, they speak to nature's plasticity. We have the technology to reverse our course. The science says that if we get off a fossil-fuel diet, the monster will retreat. It's physics for poets.

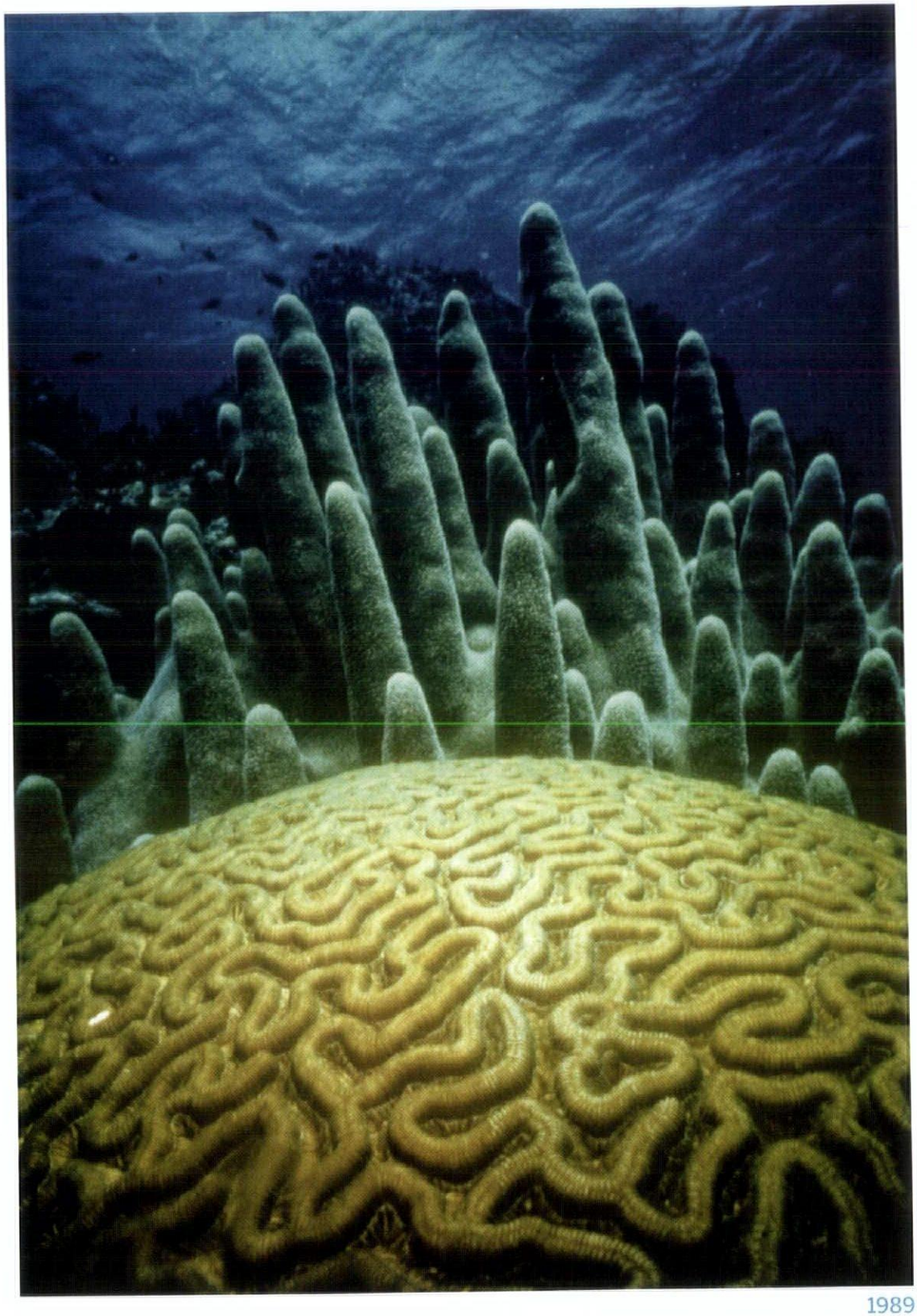
David Arnold is a freelance photographer and journalist who was a staff reporter at *The Boston Globe* for 25 years. For more information on his project, Double Exposure: Photographing Environmental Change, visit: www.doublexposure.net.

Top right: Guyot Glacier, 1938. © Bradford Washburn, courtesy archives, University of Alaska. **Bottom right:** Guyot Glacier, 2006. © David Arnold.

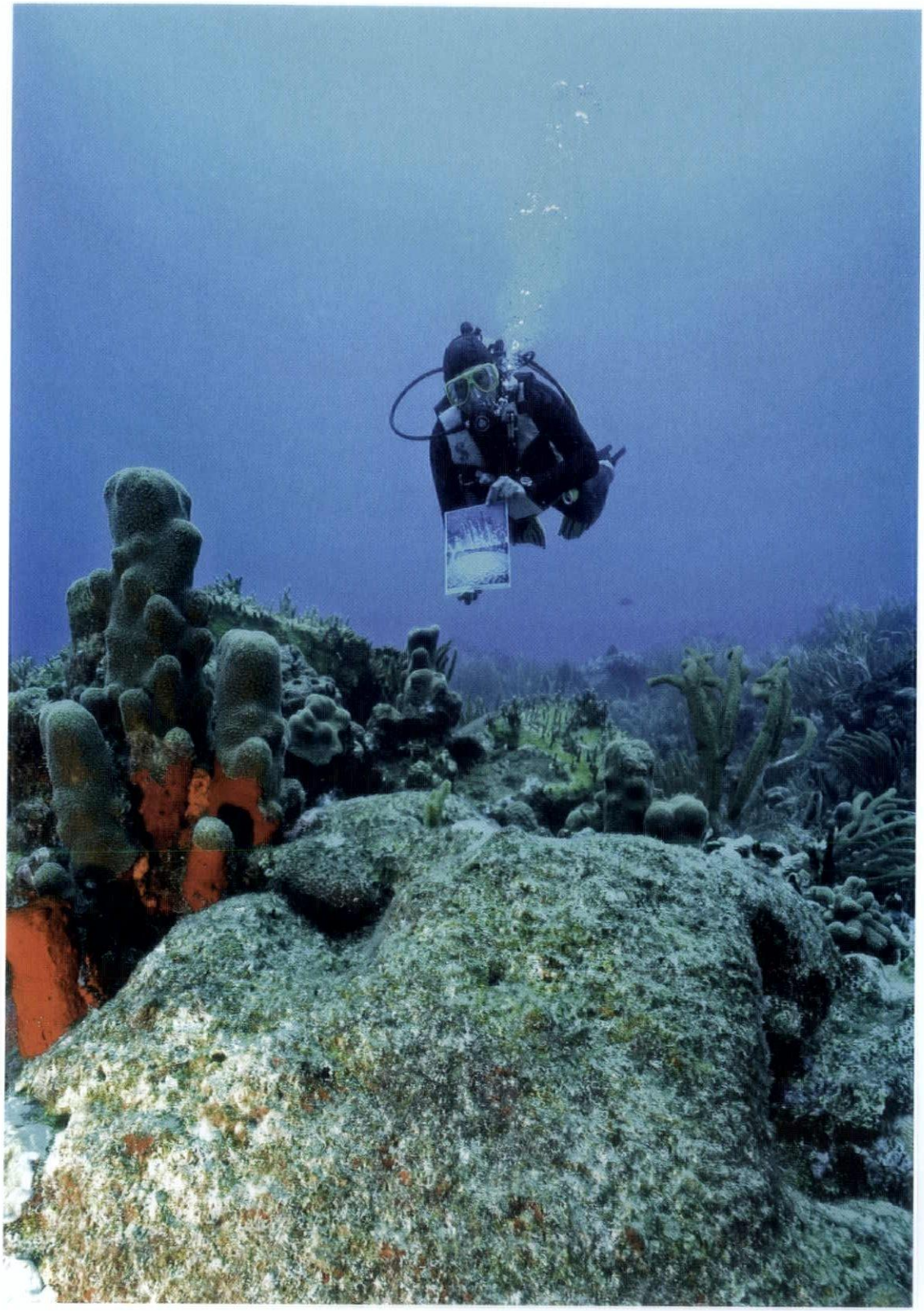
The glacier, located in southeast Alaska, has receded 12 miles up the bay. (The white in the foreground of the image is fog.) Enough fresh water has melted from the Guyot during the past 70 years to supply all of New York City's water needs for 47 years. The state of Connecticut would fit in this scene with room to spare.

1938

2006



1989

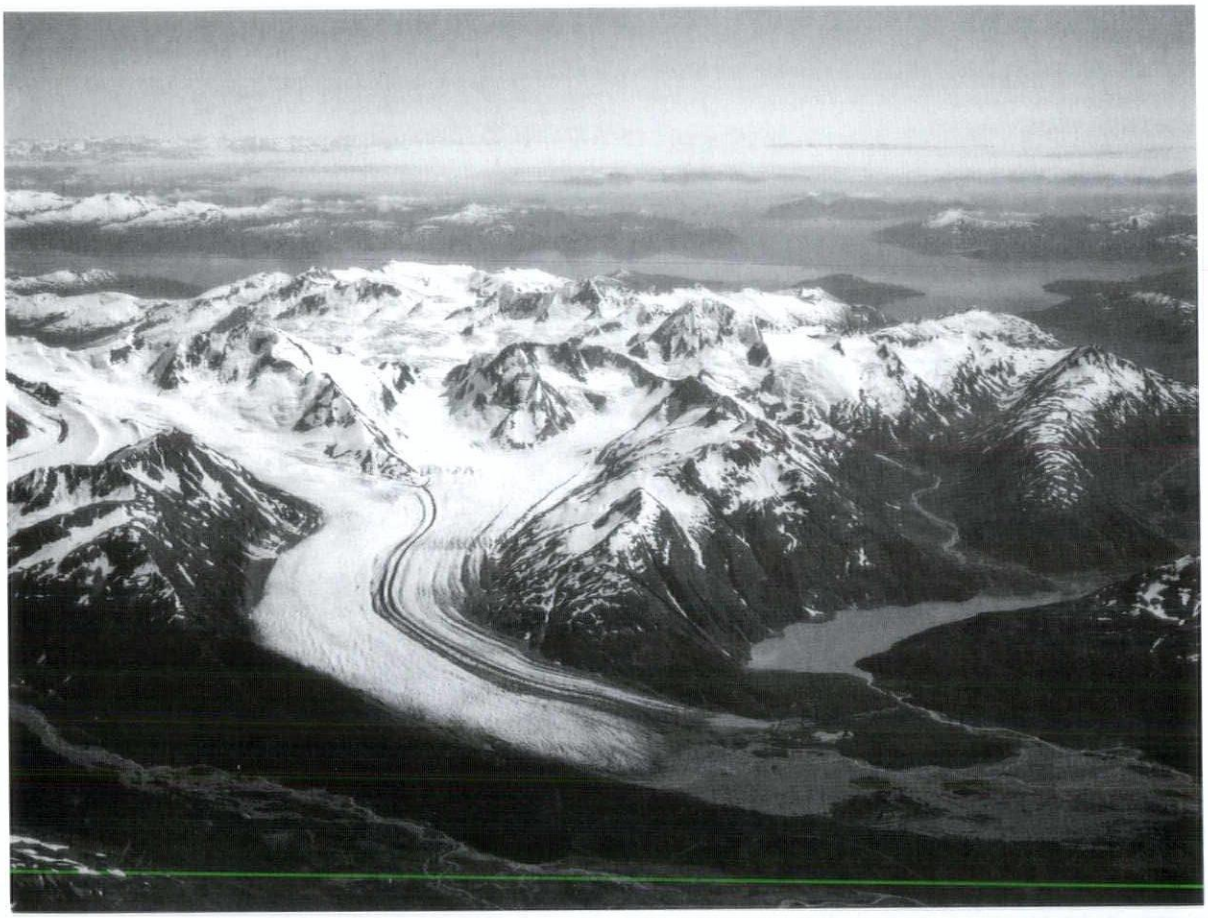


2011

Opposite: Brain Coral, Rhone Reef, British Virgin Islands, 1989. © Armando Jenik.
Left: Brain Coral, Rhone Reef, British Virgin Islands, 2011. © David Arnold.

Major change can be a challenge to accept. Sue Thompson, the professional diver holding the 1989 photograph of this site, has logged more than 8,000 dives (equivalent to almost one entire year underwater) in the British Virgin Islands. "I would not have believed this was the same place," she said, "had I not seen it slowly happen over time."

1938

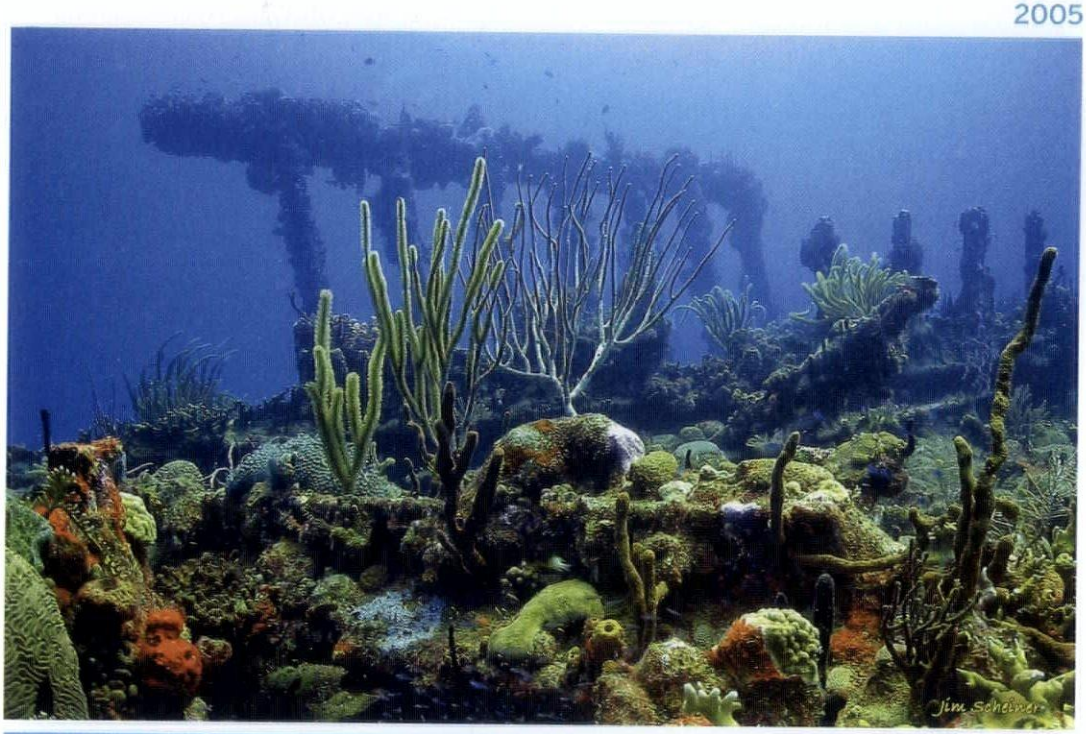


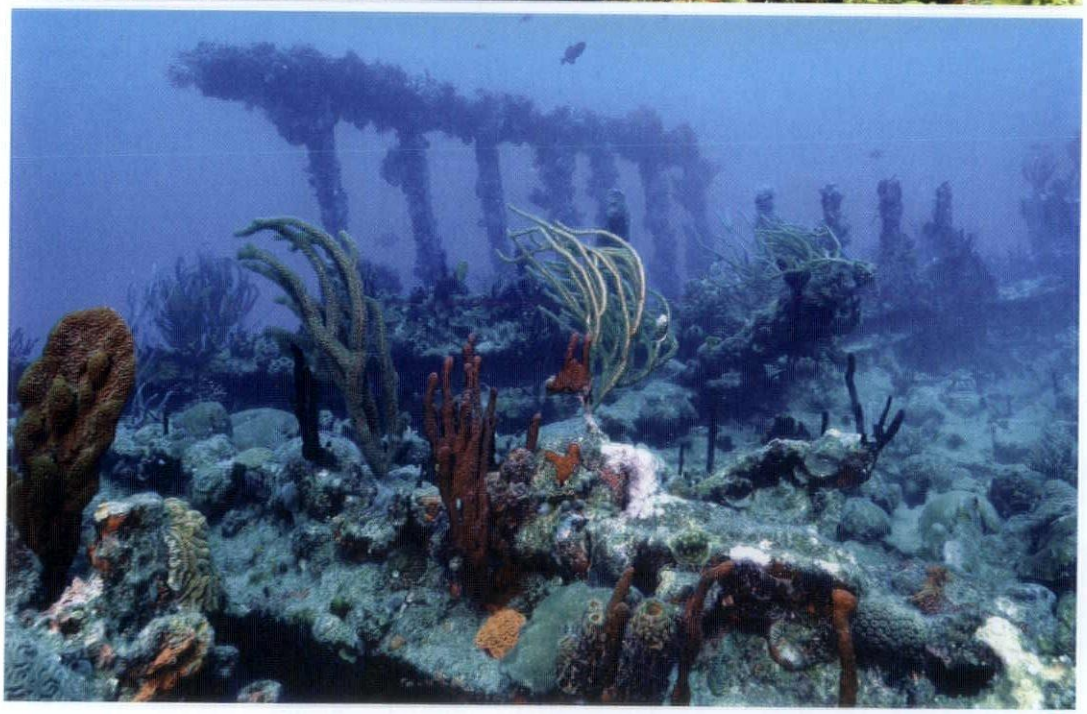
2006

Top: Twentymile Glacier, 1938. © Bradford Washburn, courtesy archives, University of Alaska. **Bottom:** Twentymile Glacier, 2006. © David Arnold.

Located in the Chugach Mountains south of Anchorage, Alaska, the glacier was photographed from an altitude of 15,000 feet in late summer in both 1938 and 2006. After 68 years, the glacier has receded, and snow cover has dramatically decreased.

2005

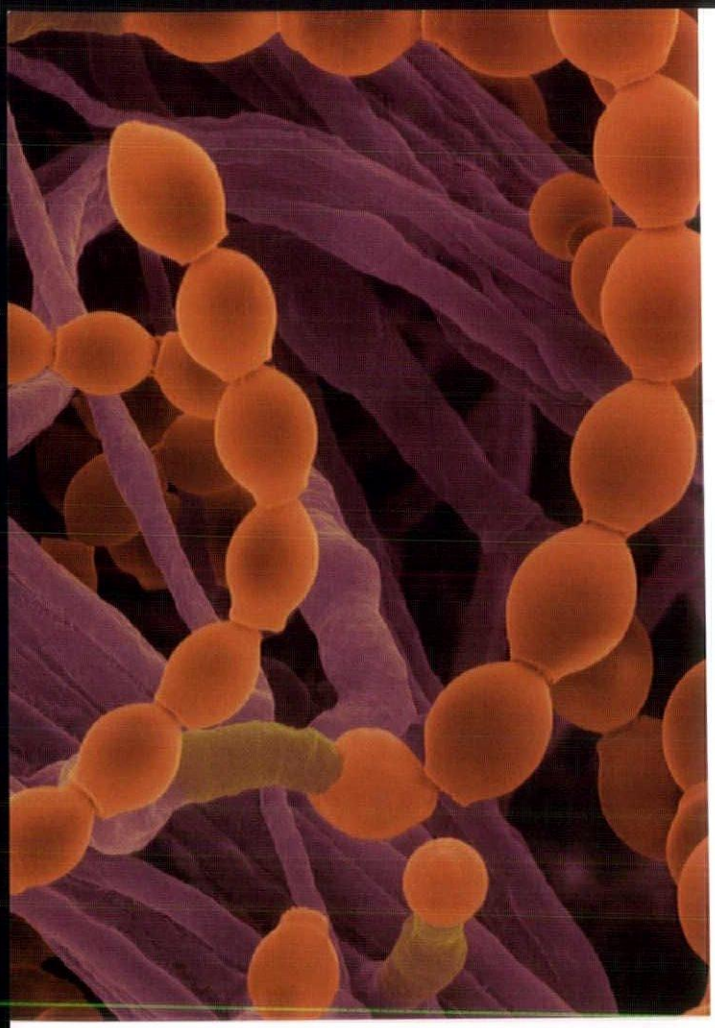


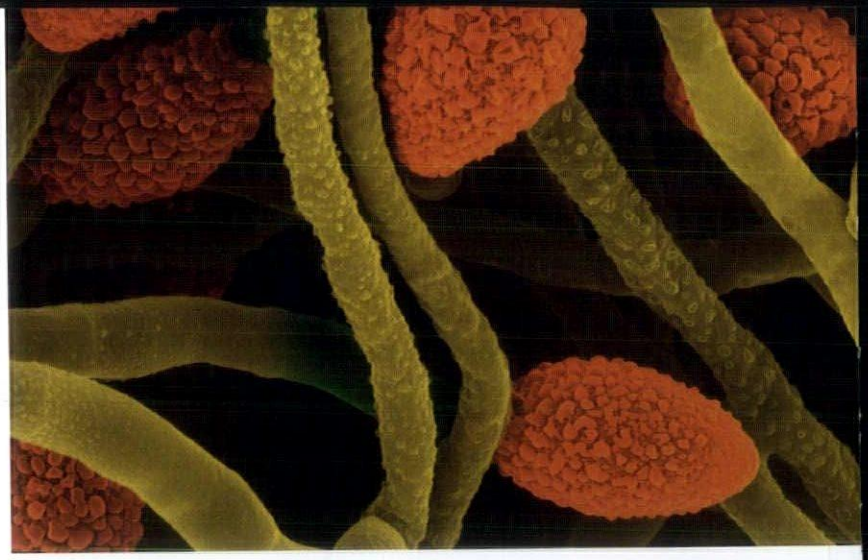


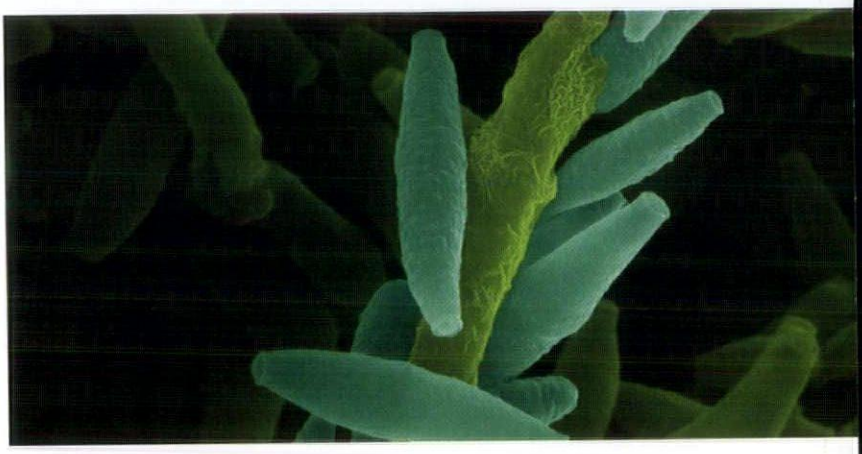
2011

Top: Wreck of the Rhone, British Virgin Islands, 2005. © Jim Scheiner.
Bottom: Wreck of the Rhone, British Virgin Islands, 2011. © David Arnold.

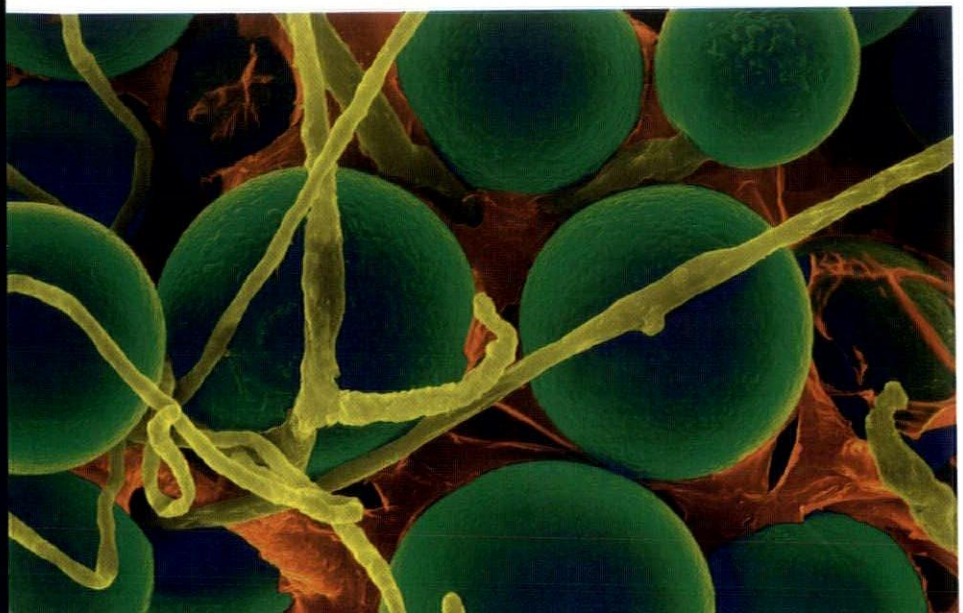
During the summer of 2005, much of the Caribbean warmed, killing the colorful algae that lives on corals and supplies them with vital nutrients. Deprived of algae, the corals turn white and often die. Some remains of white, or "bleached," coral can still be seen in the bottom picture. Severe bleaching episodes worldwide are far more common today.

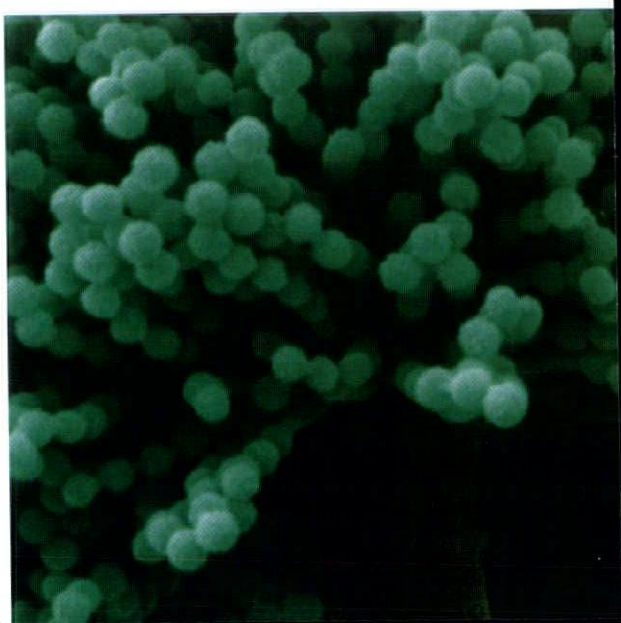






If Walls Could Talk:
The Science of Building





Jason Forney: In the days when the architect was the master builder, science was an integral part of building design; but in the latter half of the 20th century, architects lost that connection. Through writing, teaching, consulting, design, and an extensive website, your firm, Building Science Corporation, is largely responsible for reacquainting a new wave of architects, builders, and clients with science. Why have you committed yourselves to that endeavor, and why do you think people are listening now?

Betsy Pettit: I was concerned that the architecture profession was giving up a lot of its work to other types of consultants. Architecture is really a combination of art and science, and we architects need to understand how things work in order to come up with an aesthetic that is meaningful for sustainable, energy-efficient, durable projects.

Jason Forney: You define building science as "the study of the interaction between the various materials, products, and systems used in building construction, the occupants of these buildings, and the environments in which they are located." A lot of people would assume that's a definition of architecture—or that it used to be. So what happened?

If walls could talk, there would be a whole lot of moaning, groaning, and general kvetching.

Betsy Pettit FAIA *and Joseph Lstiburek PhD, P.Eng talk with Jason Forney* AIA

Joseph Lstiburek: I think the problem started when architects came to view themselves more as artists and lost their familiarity with all aspects of construction. I'm appalled in some cases at how architects practice. How can you possibly be an architect and not know the technical side, the physics side, of construction? There should be no place for firms such as ours. If architects do their job, there is no need for another consultant to do the stuff that architects used to do as part of their day-to-day practice because they knew how buildings worked and they knew their materials. Now architecture is mostly art. I love art, but you don't leave your artwork outside in the rain.

Jason Forney: There is a stereotype that beautiful buildings leak, and efficient, technically well-conceived buildings are ugly. But there's no reason that needs to be true.

Joseph Lstiburek: You can't possibly have good architecture without beauty. As an engineer, I approach the problem a little differently. I say the only way buildings are going to last a long time is if people take care of them. The only way that people are going to take care of buildings is if they want to take care of them. And people don't take care of ugly things; ugliness is not sustainable.

Jason Forney: Sustainability has, in fact, drawn a lot of attention back to building-science issues. What are the overlaps between building science and green building?

Betsy Pettit: A building that's sustainable is one that is durable, that people can live or work in comfortably, that doesn't require a lot of intervention to achieve good indoor air quality. And, serendipitously, the things that provide durability, comfort, and good indoor air quality happen to be the things that promote better energy efficiency. That is really where green building and sustainable building should be going. The science helps us get there.

Joseph Lstiburek: I view green as a passing fad. I'll be happy when it's over with and we can get back to following the rules of physics and doing architecture in the truest sense: beautiful buildings that stand the test of time, that are structurally sound and therefore safe, that don't make people sick, that are comfortable and durable. Why do you need a special label certifying that you did what you were supposed to do? Why do architects need to join a special club with an arbitrary and capricious checklist and a secret handshake? I'd be insulted if somebody told me that I had to follow this checklist. That's why I became a professional. Are we not professionals anymore?

Jason Forney: We're seeing significant revisions to building codes in response to concerns about sustainability and energy consumption. Do you think codes can drive change?

Joseph Lstiburek: Codes have long ceased to be a means of preventing disasters. They've become instruments of social change and government policy. I don't have a problem with social change and government policy; I have a real issue with building codes as the vehicle for achieving that.

Betsy Pettit FAIA is a principal of Building Science Corporation (BSC) in Somerville, Massachusetts.

Joseph Lstiburek PhD, P.Eng is the founding principal of BSC and an ASHRAE Fellow. He is the author of several books, including the *Builder's Guide* series.

Jason Forney AIA, LEED AP is a senior associate at Bruner/Cott & Associates in Cambridge, Massachusetts.

OPPOSITE
Common molds found in residential construction. Photo series by Dennis Kunkel, 2004–2008. © Dennis Kunkel Microscopy, Inc. For an online slideshow: www.architectureboston.com

Jason Forney: Can you give a specific example?

Joseph Lstiburek: The thermal-resistance requirements for the building enclosure—we're now being told what glazing ratios to use. So homeowners who want lots of windows for views and daylight and transparency are forced to build a very different sort of structure, because someone has decided that limiting windows is the prescribed route to lower energy consumption. The codes are consensus documents, but consensus from whom? They are subject to unbelievable lobbying—the process is subject to tremendous political interference. I think people would be appalled at what codes have turned into if they knew how bad the process is. Having said that, I don't have an alternative.

Jason Forney: What would your code look like if you were in charge?

Joseph Lstiburek: My code would be one sentence: Don't do stupid things. But the entrenched reality is that codes are political documents. It took me 15 years to get the vapor-barrier provisions changed because of all the politics. Politics in a vapor-barrier discussion? Well, sure: If the code requires a vapor barrier, then you have created a market for a certain set of products that must be used. If the code doesn't require it, then the market expands to a different set of products. Somebody makes money, somebody loses money.

> Houses in general haven't saved energy, because the houses have gotten bigger. So we have all of these wonderful improvements in technology and efficiency, but we've managed to find some way to squander every one of them.
>
> *—Joseph Lstiburek PhD, P.Eng*

Betsy Pettit: And we haven't even mentioned the legal aspects of buildings that had polyethylene vapor barriers. We live in a litigious society. If Building Science Corporation says not only that you do not need poly vapor barriers but also that they can create problems, have we cleared the way for a whole new category of lawsuits? And what does that mean for the profession's ability to expand its body of knowledge? We should be able to live and learn and evolve. Some experiments are failures, but they help us to learn more about the way things work.

So we have to be very careful about the experiments we make. And frankly, it makes doing research in architecture very difficult. Who pays for it and how? We've been lucky to be part of the Building America program, a research program established by the US Department of Energy to promote more energy-efficient housing. Unlike almost every other industry in the country, the building industry, generally speaking, does not invest in research.

Jason Forney: What sort of directive did you receive from Building America?

Joseph Lstiburek: In the early days of the program, the government said, in effect, that things aren't working and we're not sure why; go and figure something out. It was as general as that. We said, let's focus on the failures, which are very expensive, and try to solve them in an energy-efficient way. In other words, try to get a two-for-one. And if the mechanism of solving the problem doesn't in itself save energy, maybe we can at least save money that we can deploy somewhere else in the project to promote efficiency.

Jason Forney: That's an interesting way to think about a project—in terms of redistributing savings to rearrange the budget.

Joseph Lstiburek: Only an architect can connect the dots in that way. This is important. Think for a moment about the perspective of typical homebuilders. How do they figure out how large a heating or cooling system a house needs? They ask a mechanical contractor to size the system. Mechanical contractors have absolutely no incentive to make the system smaller. They make money based on the number of tons of installed cooling capacity. So there's no reason for a mechanical contractor to say, "You know, if you use better windows and maybe make them a little smaller and move them from here to there, I can save you two tons. So maybe you spend $2,000 more on windows to save $3,000, but you're still $1,000 ahead."

Incentives get even more skewed when you talk about construction at the scale of the production homebuilders. One of the legends in the homebuilding industry is Bill Pulte; his company is one of the largest homebuilders in the US. He explained it to me pretty clearly: the science and physics of building is a complete distraction. In fact, constructing a house is completely incidental to their real business, which is pushing the property and financing package. It's all about impressing Wall Street.

The only solution lies with architects. But now we have a gazillion consultants because the architecture profession today doesn't have enough generalist

knowledge to ride herd on everybody. Architects need to be more in control. They need to know enough so they can push back when a mechanical engineer or a structural engineer gives them colossally stupid advice. That probably sounds surprising, coming from an engineer. But I want architects to have more knowledge and more power. They don't have to know everything, but they need to be good general practitioners.

Jason Forney: Some residential architects are headed in that direction, optimizing energy performance with the Passive House standard and the net-zero-energy concept.

Joseph Lstiburek: If you want to have an R50 slab insulation, I think that's fabulous. If you want to have an air-tightness requirement of .6 air changes per hour at 50 pascals, knock yourself out. But when you run around saying anything less than R50 and .6 is dumb, I get irritated. There is a difference between private standards and labeling, which can be helpful, and mandates. I believe that certain decisions and tradeoffs should be left to the client and the architect. Of course there should be an energy code, but its requirements should make sense. The code shouldn't push beyond technology's ability to respond, which is what's happening now. We don't yet have the industrywide delivery mechanism to achieve some of these targets on a large scale.

Jason Forney: Do you think there'll be a point in time when that changes? When either the cheap oil era has really ended, or energy costs increase so dramatically that changes are forced on us?

Joseph Lstiburek: In fact, on a square-foot basis, houses in the United States and Canada have improved dramatically in the last 30 years. But houses in general haven't saved energy, because the houses have gotten bigger. So we have all of these wonderful improvements in technology and efficiency, but we've managed to find some way to squander every one of them. We now have efficient heating, cooling, windows, and enclosures, and I suspect house sizes have maxed out. So how come we're still using so much energy? Well, have you ever looked at what we put into a house? The televisions, the computers—all of the consumer stuff that's plugged in and never turned off. Betsy just worked on a house where the miscellaneous electrical loads are larger than either the hot-water load or the space-heating load.

Betsy Pettit: It was a house with three boys, who are all into gaming and technology. But at some larger level, these are moral questions that people need to struggle with individually. It's not the job of the architect to impose the answers. But we can build holistically and efficiently, and help people make smart tradeoffs.

> We should be able to live and learn and evolve. Some experiments are failures, but they help us to learn more about the way things work.
>
> *—Betsy Pettit FAIA*

Jason Forney: In the introduction to your *Builder's Guide* series, you talk about the loss of knowledge and the reliance on following convention, when people don't understand why or how the methods that they're using work. Sometimes the science exists, yet it's still ignored. That's a lot of inertia to overcome.

Joseph Lstiburek: We don't teach fundamentals in school anymore, so people seem to be incapable of sorting through the nonsense.

Jason Forney: Betsy, a lot of your recent work involves transforming homes through deep energy retrofits. But there are millions of existing homes. It's a huge challenge just to know how to begin to evaluate them.

Betsy Pettit: And we don't have the total answer. It's much easier to figure out a way to build new buildings after learning from the forensics why things fail. But the problem of existing buildings is that each one is a research project in itself; none of them are the same. We are working with National Grid and the Commonwealth of Massachusetts on the Deep Energy Retrofit pilot program; they really want these retrofits to be affordable, and they want to be able to implement them by component. Right now, we're not comfortable with not understanding the whole house. We believe that a plan needs to be made for the whole building before we can think about ways to implement it incrementally.

So we have a demonstration project with whole houses. We're hoping that we'll learn from that process how to do it less expensively and how to make a kit of parts that will give homeowners some options: Here's how to waterproof and insulate your basement. Here's what you can do to your attic. Here are ways you can change your windows. These techniques can be applied to larger buildings, too,

FOR MORE INFORMATION

Building Science Corporation: www.buildingscience.com

National Grid Deep Energy Retrofit program: www.powerofaction.com/der

Building America: www1.eere.energy.gov/buildings/building_america

Insulating Masonry Buildings: www.buildingscience.com/documents/insights/bsi-047-thick-as-brick?topic=doctypes/insights

Builder's Guide to Cold Climates, by Joseph Lstiburek, Building Science Press, 2006. Available from www.buildingsciencepress.com; other climate zones available in the series.

although those projects tend to have consultant teams. Houses are the bigger problem.

Jason Forney: Historic buildings present another set of challenges. How far should we be pushing changes in appearance to historic buildings for the sake of increased efficiency?

Betsy Pettit: One of the most controversial issues in historic structures is windows. Old window technology is terrible compared with new windows. The argument is over aesthetics; I don't believe that the difference is huge but, obviously, some people do.

Joseph Lstiburek: It's a political, moral, and philosophical judgment. I can put windows back into a building that are exactly what I took out, without improving them. Or I can install windows that are significantly technologically superior that look very similar. I understand the arguments for the old windows, and I know the new ones aren't the same. But what are we trying to accomplish here? Especially when taxpayers' money is involved through tax credits. I think it's appalling that taxpayers' money is being used to subsidize energy inefficiency.

Betsy Pettit: And sometimes decisions are made on the basis of outdated or incorrect information. Our office is in the Somerville Historic District, so we needed permission to change the windows. We knew they would be wood; we wanted low-E glass, which was not allowed because early low-E had a purple tint. That's not an issue anymore. I had to bring in sample sashes to convince them, and we ultimately got permission.

Jason Forney: Another controversy in this region is insulating masonry buildings. Why are so many architects afraid to add insulation to the inside of masonry walls?

Betsy Pettit: We've told people that you could potentially change the way the brick sheds moisture, and you could ruin your brick. So there should be some fear about that. But we've got mill buildings all over New England. Probably every architect in the region has at some point turned a mill building into housing of some sort. Why in the world would we think that it's not OK to insulate the brick wall?

Joseph Lstiburek: It's irrational hysteria. Yes, there is some level of risk in insulating a masonry building on

the interior, but it's been overblown. If you control the way rainwater is handled by the surface of the building from the outside, the risk is trivial. I just did a project in Vermont, a 100-year-old masonry building. You could see the problems from the parking lot: a stain under every window and at the parapet, which meant those were the areas with water issues. I told the owners to rebuild the parapet, and then pull out the windows, pan-flash them and give them drip edges, and then put them back—because they needed the historic tax credit. So regardless of the thermal performance of the window, they could resolve the water management problem and safely insulate the interior.

What I loved about that project was the architect, who was grinning because the clients had paid to bring in the outside expert to tell them exactly what he had already been saying. This is an architect with a world of experience, and he knew what he was talking about: You keep the water out, you keep it from collecting where roofs and walls come together, and you can insulate as much as you want. Once you handle the water, everything else is secondary.

Jason Forney: Your last 30 years have been, in effect, one big research project. What are your conclusions at this point?

Betsy Pettit: Buildings are complex structures. Things happen that you can't anticipate. So I never brag about projects while they're only on paper; I like to wait until they've been built for at least a few years. What we don't do enough as architects is go back to our buildings. Of course, we don't get any money to do that, generally speaking, so it's tough. Nobody would pay for pure building-science research if we didn't have public funding. We are thankful to have the government as a client who will pay us to do the research that architects and engineers are benefiting from. We're doing our best to make that information available through our website and teaching.

Joseph Lstiburek: Thirty years ago, I thought I was a really clever guy who knew everything; now I'm an older guy who is convinced that he knows significantly less than what he thought he knew. I've discovered that ignorance truly was bliss. With the lens of experience, I know that a lot of issues are not as black and white as people like to think they are. There's a lot of gray. But I do know this: You can't substitute the judgment of the architect or the engineer with a computer simulation program and a checklist. ■

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Books

Field Notes on Science & Nature
Edited by Michael R. Canfield
Harvard University Press, 2011

The practice of taking systematic and detailed field notes enabled the rise of scientific disciplines including paleontology, evolutionary biology, and ecology. The 19th-century journals of Lewis and Clark, Darwin, and Thoreau are still read for their scientific insights and literary grace. Today, because the scientist may never get the chance to revisit a particular spot in the Sierra Nevada or Papua New Guinea, field notes are still required to document research. And in our era of environmental crisis, they provide a baseline for measuring change over time.

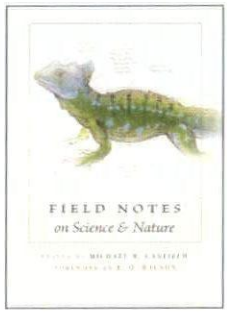
Field Notes on Science & Nature contains 12 essays by leading scientists celebrating the enduring role of the field notebook—an essential tool for all scientists who work outside the laboratory. Each essay provides a window into a different scientist's mind by describing his or her note-taking methods and the experiences that shaped those methods. We read about Kenn Kaufman's childhood bird lists, Karen Kramer's mapping of Mayan villages, and Roger Kitching's harrowing trial of carrying a researcher with a broken leg down a mountain river in Borneo.

One fascinating chapter, "Letters to the Future," by John Perrine and James Patton, describes the fieldwork of early-20th-century teams led by the pioneering ecologist Joseph Grinnell. Their notes were so detailed that scientists today can restudy the same places to show how human activities have affected California ecosystems over the past century.

Field notebooks are also seedbeds of speculation, where new lines of research and theory can germinate. Bernd Heinrich describes how his studies of animal behavior often arise from some oddity he has seen and scribbled down. "When I am in the field collecting information, I am on the outlook for the nascent, the new, and the unexpected that may spring out of the familiar."

Many scientists rely on drawings to record information and express ideas. *Field Notes* contains splendid reproductions of entire notebook pages, where sketches and diagrams alternate with text. Jonathan Kingdon, an authority on African wildlife who also trained as an artist, sees an affinity between science and art: "Learning to discriminate between what is significant and what is irrelevant ... is an essential part of field studies, and just such discrimination is integral to the art of drawing."

The contributors to *Field Notes* are mostly staunch defenders of the paper notebook. But the references to photography, computer databases, and GPS mapping make one wonder about the future of field notes in the digital age. Like the architect's sketchbook, the field notebook may endure or vanish or more likely transform itself in unimaginable ways. But the need to look closely and think about what one sees will remain central to science, as it will to design.

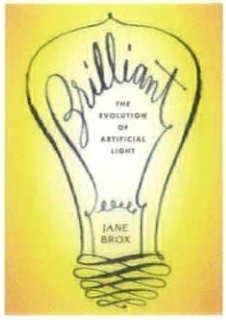


Jay Wickersham FAIA practices environmental and construction law and teaches at the Harvard Graduate School of Design.

Brilliant: The Evolution of Artificial Light
by Jane Brox
Houghton Mifflin Harcourt, 2010

When the sun is out of view, we surround ourselves with small-scale replacements—curving forms that emit light and heat. Before centralized energy distribution, our sun substitutes also conveyed the passage of time. Flames danced through each passing second, and the fuel source (tallow or beeswax, kerosene or whale oil) steadily retreated over the course of hours. The development of gaslight in the 1800s converted artificial light into a constant and separated it from responsibility, making possible a new concept: "nightlife." We build now with the expectation that there will be light whenever it is wanted, wherever we wish it.

In her absorbing book *Brilliant: The Evolution of Artificial Light*, Jane Brox narrates luminary progress starting with the light of a sandstone bowl containing a bit of moss tucked into animal fat in the hands of the earliest interior designers, the creators of elaborate cave paintings; the history extends to the OLEDs around the next corner. To describe that which describes everything without itself possessing a physical form, Brox interweaves compelling observations, sensory descriptions, and statistical data in an approach well suited to a story that parallels the blossoming of empirical science. From Baudelaire, we gain a writer's perspective of what it was like to be a pedestrian at the dawn of nightlife: "A kaleidoscope equipped with consciousness." In Thomas Edison's lab notebooks, we glimpse the rigor



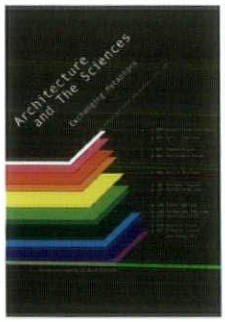
Amelia Thrall ASSOC. AIA, LEED AP is a designer and educator living in Cambridge, Massachusetts.

applied to the refinement of the incandescent bulb.

Houses were wired for electricity first for light, after which irons and washing machines soon followed. Personal accounts from farmwives reveal the liberation of womankind that accompanied the harnessing of electricity. "I'll tell you—of the things of my life that I will never forget, I will never forget how much my back hurt on washdays." Our ever-growing reliance on energy has placed us on a dangerous trajectory, but a return to washboard scrubbing and candlemaking is unthinkable.

Perhaps what is needed is a reassociation of light and time. At my grandparents' house in Vermont, a small red light was installed on a switchplate in the 1970s; when the light is off, demand is low and a reduced rate is charged. My grandmother, who grew up mindful of all consumption during the Depression and World War II, moderates her use of electricity according to the time of day because she has a visual reminder of the energy source.

Brox wonders "whether we are hampered more by brilliance than our ancestors ever were by the dark." It is an important question, especially for designers. Can we achieve a sense of tranquility in a world awash in artificial light? It is not just the visibility of the Milky Way that we are missing but the opportunity to reflect on the Milky Way, or the mesmerizing movement of a small flame.



Crystal Tobin Chandler AIA is an architect at Sean O'Kane AIA Architect, PC in Ridgefield, Connecticut. She received her BS in building sciences from Rensselaer Polytechnic Institute.

Architecture and the Sciences: Exchanging Metaphors
Antoine Picon, Alessandra Ponte, editors
Princeton Architectural Press, 2003

The notion of scientific metaphor in design frequently conjures images of a material expression of a familiar object in nature, such as Herzog & de Meuron's "Bird's Nest" stadium for the 2008 Beijing Olympics or Frank Lloyd Wright's treelike columns in the Johnson Wax building. The use of biological interpretations like these to shape built form can provide a symbolic significance in design. Alternatively, science can more deeply influence the methods and even the purpose of architectural endeavors. In *Architecture and the Sciences: Exchanging Metaphors*, a collection of 11 essays by historians and scholars, editors Antoine Picon and Alessandra Ponte present the relationship between science and design in terms of the quantifiable, analytical, and innovative methods used to advance each field.

The first theme addressed is the influence that natural science has had on the composition of structural form and the relationship between site and architecture. Perhaps the best-known historical example is Vitruvius's writings on spatial order governed by nature and the importance of site, discussed here by Denis Cosgrove. Vitruvius, as did subsequently the astronomer Ptolemy in his study of the cosmos, attempted to create a framework to define space through empirical measures to rationalize form. A later essay by Ponte depicts the influence of scientific advances on form and site, describing geometric craters created from nuclear testing. In this essay, nuclear development highlights both the destructive and creative capabilities of science. The physical destruction at the testing site, undeniably horrific, is also perceived by some as art—as an altered landscape form—while possibly offering a positive effect by prompting the analysis of structures that could survive a nuclear blast.

Natural sciences such as anatomy and biology also played a role in the development of architectural documentation, as the 19th-century architect Viollet-le-Duc attempted to objectify the architecture of the Middle Ages through a novel scientific approach: studying buildings as a bodily dissection. Anatomical explorations of exploded skull drawings, as well as other cranial studies, influenced architectural drawing and the art of perspective as a way to understand and define architecture. In the 20th century, anatomical and biological metaphors were replaced by metaphors from the physical sciences as, for example, crystalline structures and geometric patterns were reflected in the designs of architect Buckminster Fuller.

In the 21st century, it is digital technology that is the scientific tool most linked with design; the three-dimensional capability of the computer drawing package may serve, much like its 19th-century anatomical and biological precursors, to provide entirely new approaches to the study of buildings. But the ability to layer site data with programmatic representations, such as architect Greg Lynn's "animate design" process, allows even more: the ability to investigate multiple options and to understand the implications of design decisions. As the interconnections of architecture and science continue, we can expect to witness an accelerating evolution in methodologies for research-based design.

Site Work

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Inspired by science and fueled by technology, these Massachusetts-based architecture students-turned-entrepreneurs make wicked cool housewares and jewelry. Natural phenomena such as coral formations and cellular division influence both the process and the product. Download the code and start making your own.

The Boston ArtScience Prize
www.artscienceprize.com

Each year, more than 100 Boston high school students work after school to develop ideas that address a global problem—such as "The Future of Water"—using both analytical and aesthetic methods. Their goal? A share of the $100,000 ArtScience Prize established by Harvard scientist David Edwards, who believes successful innovation needs both art and science. Winners also participate in an "Ideas Translation Workshop" in Paris. Bonne chance!

A Day Made of Glass
www.corning.com/news_center/features/A_Day_Made_of_Glass.aspx

In this corporate-video-gone-viral, glass giant Corning offers its vision of what the not-too-distant future might look like. It's a compelling demonstration of the application of research and science to building materials, design and, well, life.

Occupant Indoor Environmental Quality Survey
www.cbe.berkeley.edu/research/survey.htm

The Center for the Built Environment at the University of California at Berkeley has developed a set of tools to help evaluate occupied buildings. Download surveys, and see for yourself how this feedback might improve your design or help your clients better manage their facilities. It may sound dull, but how often have you wanted to change the temperature at your own workplace? Exactly.

National Institute of Building Sciences
www.nibs.org

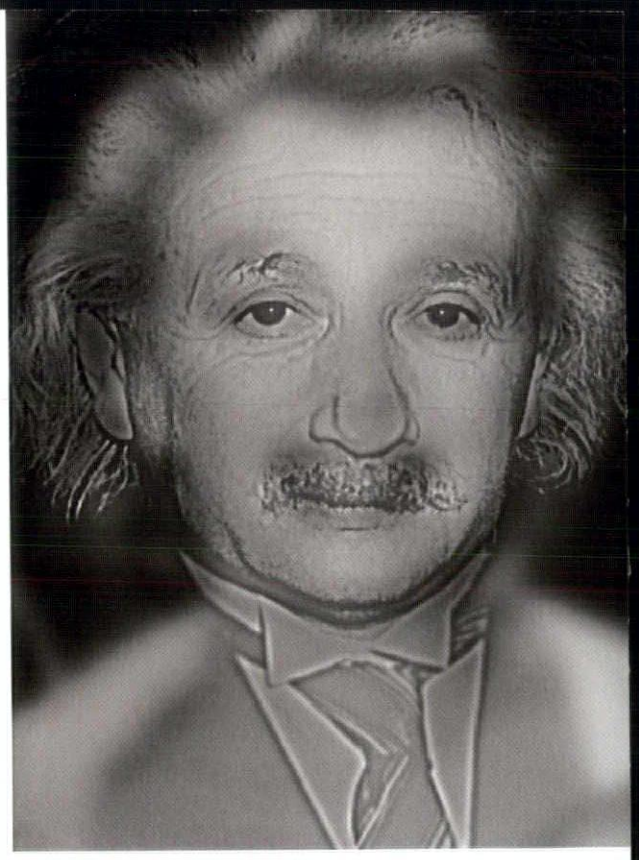
Established by Congress, the institute's mission is "to serve the Nation by supporting advances in building science and technology to improve the built environment." Essentially a constellation of specialized groups, the institute oversees programs including the Building Enclosure Councils, the Whole Building Design guide, building performance, and hazard mitigation. And that's just the beginning.

C.P. Snow's The Two Cultures
www.youtube.com/watch?v=BYEvSwViGRY

The first of a five-part lecture series at the University of Maryland, Baltimore County discusses the enduring split between science and the humanities, and the legacy of C.P. Snow's famous 1959 lecture at Cambridge, "The Two Cultures." ■

The MIT Museum

Mark Slater has been active in the global technology and finance scene for more than two decades and now works at a Web startup in Cambridge, Massachusetts. He writes commentaries on urban life.



RIGHT
Marilyn Einstein from the "Hybrid Illusions" series by Aude Oliva, 2007. Oliva, the head of the Computational Visual Cognition Laboratory at MIT, developed this hybrid photograph (best viewed at two distances) from superimposed images of Marilyn Monroe and Albert Einstein as part of her research on visual perception and interpretation.

Context is all, and the MIT Museum, well, looks like it belongs at MIT. The core of MIT's campus, which despite recent additions, looks like a not-completely-unfortunate collision between a cargo train of Quonset huts and a hyperactive concrete factory, often feels like an aggressive celebration of the triumph of utility over form.

The museum itself, set in a collection of low-rises in the commercial ghetto between campus and Central Square, is a bunker with cramped, sideways approaches: It lies askew to the main axis of the area and hides itself away, size and shape receding behind the façade. Saying that this adds to a budding sense of excitement would be hyperbole of the worst sort: Approaching the museum has all the majesty of walking up to a poorly situated convenience store.

My visit is informed by my own context: My college physics work was notable only for the brutality I routinely and inadvertently inflicted on equations as I tried to wring answers out of them; my stint as an actual graduate student at MIT was at the business school, which the rest of the MIT student body charitably viewed at best as an alien intrusion and at worst as a home for the lesser equipped. Chip on my shoulder? No, but my baggage cart is full.

Once inside the building, you're enveloped by a cool minimalism reminiscent of a Philippe Starck hotel lobby, but at least here there's no doubt that it's an authentic statement. Unfortunately, despite the hint of a hotel lobby, there's no matching bar.

Ascend the stairs to the main gallery on the second floor, and your footsteps trigger musical notes at each tread. Yes, a sense of humor pervades the space. But are they just making light of overly serious endeavors or showing off their mastery? Humor, even when illuminating, is domination of the audience or the object. Perhaps it's a part of the self-consciousness that pervades the place, this earnest effort to connect you to the essential humanity behind the science.

A collection of small, mechanical devices deconstruct elements of nature while simultaneously exulting in their own artificial life: One is endlessly self-nourishing, lifting and pouring oil over itself, like a small Sisyphus, but with purpose; another mimics miniature flying birds constructed from small pieces of paper and metal, moving in a more stately fashion than nature itself.

Other exhibits highlight major advances in technology and scientific thought: Wiener's cybernetics, Land's Polaroid camera, Shannon's information theory, and so on. Virtually all are organized around a defining individual, with photographs of the scientists mounted with the reverence of icons: "You may know the science, but remember them."

Elsewhere, a collection of holograms, mostly of scientists, fills a room. Monuments to essential human connections, they stand as eerie memento mori. The most arresting is that of the late Keith Haring, looking out at you looking in, an artist captured by scientists, his momentary inspection in turn presented for your lingering one. Homage to an artist or assertion of primacy, it's hard to be sure. The perceptual gamesmanship returns to a lighter note with a hybrid photograph in which Albert Einstein morphs into Marilyn Monroe. The scientist as jokester? Yes, but also an assertion that the beauty of discovery should rival beauty itself.

Lastly, a classic of MIT's campus life, the remains of a piano pushed (a different one every year) off the fifth-story roof of a campus building, with high-speed photographs and charts illustrating the literal descent of the piano in front of thousands of spectators—and, hence, the metaphorical descent of man. Just kidding! It's mocking gravity and entropy at the same time it delights in the shared understanding of these concepts more than the concepts themselves.

You can't get at the real joke unless you peer across that divide to the community itself, which is defined by the fact that its members understand and even play with these concepts. It's not just the science—it's the scientists. ■

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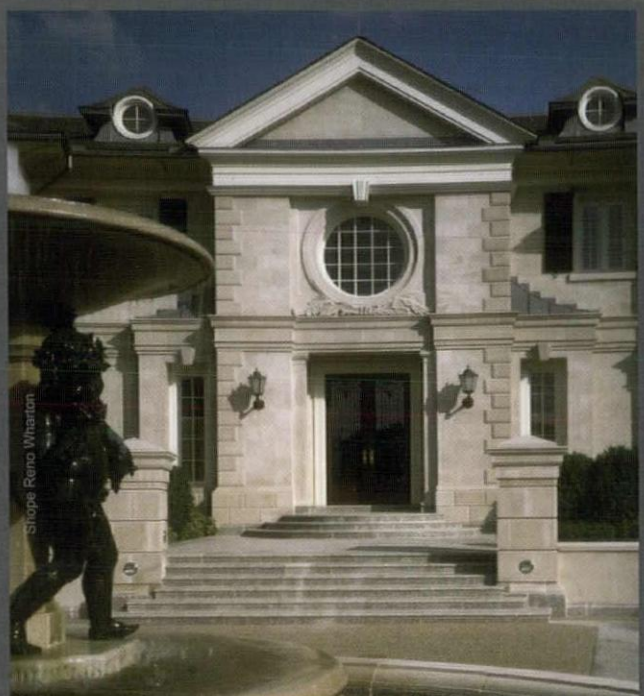
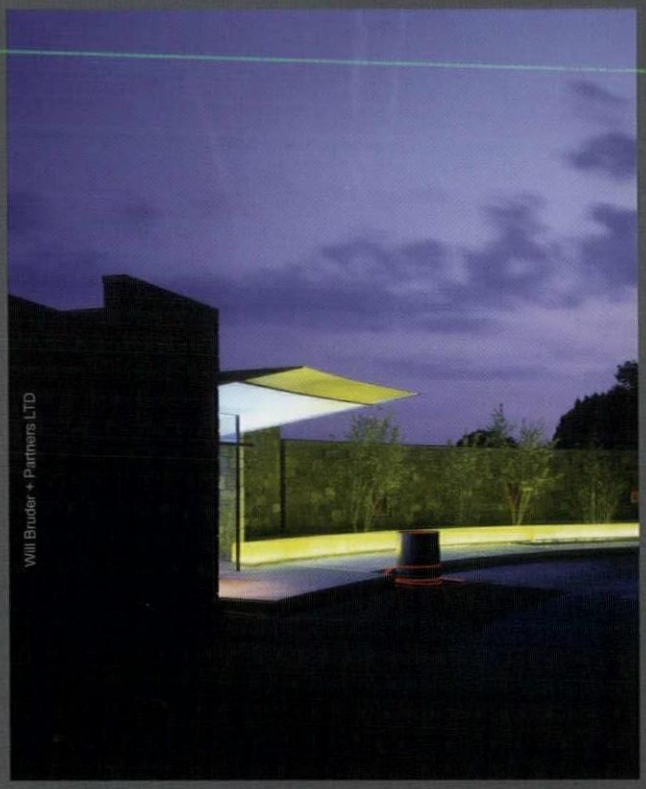


Winner of *Boston Magazine*'s 2011, 2010 Best of Boston Home™ Award: Best Modern Contractor
Winner of *Boston Magazine*'s 2009, 2008 Best of Boston Home™ Award: Best Builder



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