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PIONEERING DESIGN
FACADE TECTONICS

When the Envelope Matters

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ARCHITECTURE, ENGINEERING AND CONSTRUCTION OF THE BUILDING ENVELOPE

BY KAREN M. KENSEK, LEED AP BD+C, ASSOC. AIA & DOUGLAS NOBLE, PH.D, FAIA

Photo by Douglas Noble

The facade has become one of the most talked about elements of architecture as the various collaborators in research, design and delivery devote more time, energy and money investigating the next generation of building skins.

Certainly envelope research is not entirely new, and not confined to a narrow definition of architecture. Bob Harris of the USC School of Architecture has argued that the building facade was a wall defining both an interior and an exterior urban room. Ralph Knowles has been making the case for daylight and energy access through the concept of the solar envelope for half a century. There have been countless books, articles and research projects on the building envelope throughout the centuries.

There is, however, a renewed sense of enthusiasm and optimism that the building envelope can do much more. Recent investigations are not limited to new products and processes, or the integrative aspects of the envelope with the occupants, mechanical and lighting systems, but also include sustainability, urban impacts, and much more.

The depth and breadth of scientific research in architecture has been held back until fairly recently by limited funding, some professional skepticism, and outdated academic models. While the hard sciences and many humanities fields have supported deep research through doctoral programs in universities for centuries, it was only in recent years that architecture has begun to develop a similar community of scholars. Medicine, engineering and other university majors have collaborated with their respective professions for some time. Doctoral education in architecture is a more recent phenomenon, but we are starting to see substantial results of the establishment of scientific research on the built environment.

The authors of the facades articles in this journal came together in mutual support of the new Ph.D. program at USC. Although doctoral education in architecture started 50 years ago in the USC School of Architecture, it was only recently that the "facade tectonics" research group was formed. Konrad Wachsman started the first doctoral program at USC, linking it to his facades research with the General Panel Corporation. In 2008, Dean Qingyun Ma restarted the dormant Ph.D. program at USC, infusing new life into building science research, and creating a research community.

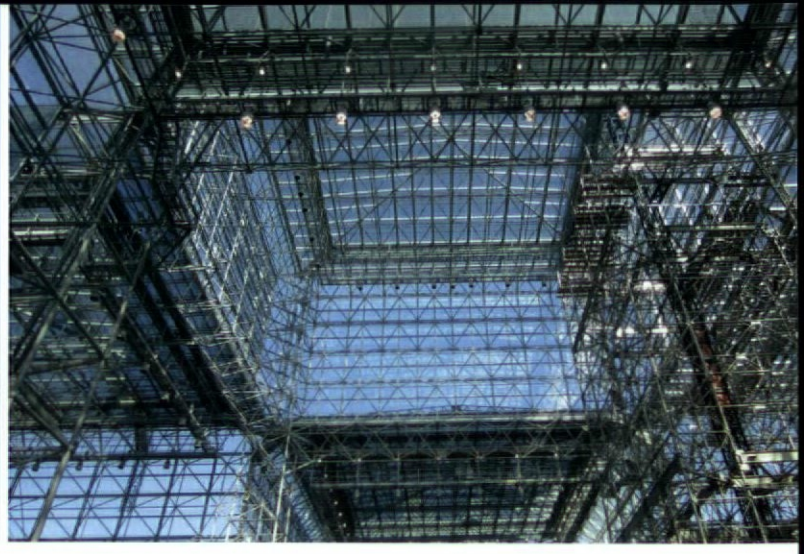
Students, faculty and professional experts are coming together through these kinds of research communities. While there are too many to list, examples include the team of Valmont, Christoff, and Mange collaborating to explore approaches to combating facade acoustical problems such as "flanking sound" (sound that transmits through the facade), Martinez and Patterson examining the energy and sustainability impacts of facade retrofit (including, for example, surprising observations about our inability to recycle facade glass due to the coatings and manufacturing processes), and Schiler and Suk are seeking to determine new ways for analyzing and predicting visual glare.

Interest in facades has spawned more than a dozen facades conference groups, including Facade Tectonics, FacadesPlus, the Building Enclosure Sustainability Symposium (BESS) at Cal Poly, and many more throughout the world. A significant number of books and conference proceedings have also come out recently. The Facade Tectonics Conference generates the "Facade Tectonics Journal," and a facades conference at Columbia University resulted in the well-regarded book, "Engineered Transparency."

Facade consulting groups have formed and grown as stand-alone firms and as expertise units within well-established consultants such as Arup, Buro Happold, and others. Larger AEC firms have created facade research groups as internal research groups much in same way that firms did when they created committees for computer integration in the 1980's. Professional organizations such as the American Institute of Architects (AIA) and the National Institute of Building Sciences (NIBS) have formed specialy committees like the Building Enclosure Council (BEC) and the Building Enclosure Technology and Environment Council (BETEC). Facade assessment has become an accepted professional category.

The watchwords for the next generation of facades are integration, innovation, collaboration and sustainability. Facades are becoming increasing integrated into building management systems so that mechanical systems, lighting and human comfort are being addressed through the cooperation and communication. Innovations in materials and processes will potentially be both very high-tech (electrochromics and smart-nano-materials), and very low-tech (plywood and turnbuckles for parametric formwork). Formerly mundane materials like precast concrete are being transformed with powerful skins such as on the Perot Museum (Morphosis) and the Glass-Fiber Reinforced Concrete on the Broad Museum (Diller Scofidio + Renfro). Facade design and delivery processes will be increasingly collaborative, with professional interaction occuring earlier and earlier. New research will help improve the energy profile of facade through the traditional metrics, but also including embodied energy and the eventual demolition and recycling of the facade materials. ■

For more coverage on Facade Tectonics, including a complete list of participants, visit www.formmag.net.



REFURBISH OR REPLACE?

THE JACOB K. JAVITS CONVENTION CENTER RENOVATION AND EXPANSION

BY ROBERT GOLDA, ASSOCIATE IN CHARGE WITH HEINTGES & ASSOCIATES, FAÇADE CONSULTANTS FOR THE JACOB K. JAVITS CONVENTION CENTER

The Jacob K. Javits Convention Center, first opened in 1986, has undergone its first major renovation in its 25-year history, under the direction of the architectural joint venture of FXFOWLE/Epstein.

The Convention Center was originally designed by IM Pei & Partners in conjunction with Weidlinger Associates and consists of four main spaces: the Crystal Palace, Concourse, Galleria, River Pavilion, as well as the expo halls to the north and south of the Galleria volume resulting in a cladding area of approximately 450,000 square feet. The main exposed structural system of the building is a steel space frame on a 10' x 10' module and is one of the largest of its kind. The insulated glass included an early PPG coating as well as a reflective opacifier film applied to the monolithic spandrel glazing at the Expo Halls and Galleria facades.

The decision to replace the existing facade systems was a result of a focused study, which included extensive onsite testing and analysis of the existing cladding and skylight system. In the end, it was determined that while technically feasible, the benefits of replacing the existing facade and skylights with newly engineered systems significantly outweighed any effort to bring the existing wall and skylights up to current codes and performance standards.

The renovation program for the facade and skylight systems included the removal of the existing insulating glass and framing and replacing it with new high-performance insulated glass, optimizing transparency. Additionally, the spandrel areas of the building were reverted from utilizing the existing reflective glass to include new stainless steel panels with a variety of finishes and textures to reflect the programmatic function of the building within. The new skylights reverted back to the original IM Pei & Partners design which included a central pyramid skylight as well as a perimeter shallow sloped skylight over each of the cube volumes.

Given the enormity of the glazing areas, a key element of the FXFOWLE/Epstein design was to select the appropriate glass make-up to meet not only the performance criteria but also the aesthetic aspirations for the project. A variety of domestic and international glazing suppliers and manufacturers were considered for the project with the critical aspect of the glass selection being that the new glass would have to meet or exceed the performance of the existing glass make-up as required by local code. While this was not an issue when comparing U-value, the driving factor became matching the low SHGC of 0.26 of the existing glass while still achieving maximum transparency and visible light transmittance.

After an extensive mock-up process, the decision was made to go with Viracon's VNE-63 triple silver high performance low-e coating, in conjunction with a custom color and pattern ceramic frit. One key item to note is that the inner lite glass substrate switches from a clear substrate to Guardian's Crystal Gray substrate at the River Pavilion and Galleria areas to reduce the visible light transmittance due to the programmatic functions of these spaces. For user comfort and programmatic reasons, the visible light has been reduced in other glazed areas of the building by utilizing a tinted glass substrate within the glass make-up. The new glazing includes a custom color ceramic frit which achieves the desired aesthetic of the design team, meets bird safe guidelines and enhances glass performance. The use of much lighter colors for the curtain wall framing and building space frame structure, in conjunction with the new glazing, have had a transformative effect on the overall appearance and experience of the building from the interior and exterior.

The increase of visible light through the new glazing also speaks to the original design aesthetic of the original IM Pei & Partners design, who at the time were only able to meet their building mechanical requirements with available technologies at the time, resulting in a dark colored and highly reflective coating being utilized. ■

TOP LEFT: View of facade replacement in progress. TOP RIGHT: View of building interior. Photos courtesy of Heintges & Associates

Skidmore, Owings & Merrill

Craig W. Hartman, FAIA, Design Partner
San Francisco, CA
Website: www.som.com

Craig Hardman, Design Partner at SOM, sees high-performance towers as the essential modules of cities, fusing commercial and cultural aspects with the possibility of optimal environmental sustainability. Furthermore, he lauds them for their "surgically-precise placement of density where infrastructure and urban amenities can be leveraged for the highest social and environmental good".

SOM's list of sustainable innovations is extensive. Would you name a few?

We emphasize a collaborative interrelationship between all design disciplines. The Burj Khalifa (2010), designed to sway with a gentle 11-second period by Bill Baker, SOM's Partner of Structural Engineering in Chicago, is inherently safer. We have developed patented steel structural systems, which, in earthquakes, deform, dissipate energy, and return to their original position, as well as the Sustainable Form Inclusion System that inserts pre-engineered bundles of post-consumer, non-recyclable inert material into concrete slabs to achieve long spans with reduced concrete weight and reinforcing steel. Through the Center for Architecture Science and Ecology (CASE) research collaboration between SOM and Rensselaer Polytechnic Institute, we have developed a Phytoremediation Wall System that uses plants to organically purify air and reduce energy consumption.

You emphasize public interaction at street-level as critical to urban integration.

350 Mission (2015) is a new kind of post-9/11 American office tower, combining access to mass mobility, open space, and human amenities. A 40-foot-tall video wall, to which the public can connect with personal mobile technology, wraps the building's core [situated] within a 50-foot-high first level public space where folding glass walls completely open the interior to the street. An amphitheater stair and seating connect the grade level to a mezzanine terrace supported by curated food venues. Towers are no longer inert objects, but rather organic, breathing extensions of their urban environments.

How high can they extend?

The current physical limits to tower height are not structural. According to Bill Baker, the Burj Khalifa at a half-mile could as easily be designed to be a mile high given current structural system ideas that are being studied. The real question is purpose. Beyond the display of economic and political power along with technical prowess, extreme height does nothing for the human condition. The better use of intellectual and economic resources in this century is to focus on making cities of delight with broadly shared social and environmental equity.


350 Mission


Pearl River Tower

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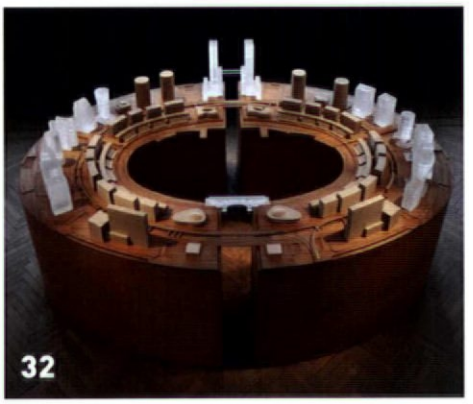

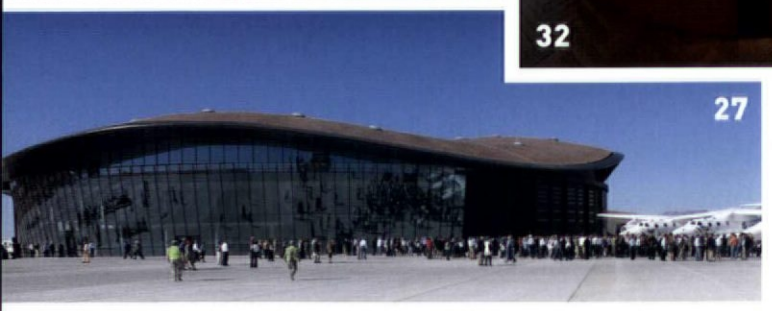

DEPARTMENTS

FEATURES

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CEO/Publisher	Ann Gray, FAIA FRICS
Editor in Chief	Alexi Drosu alexi@formmag.net
Advertising Sales	Jerri Levi jerri@formmag.net 818.726.1765
Art Direction + Design	studiofuse.biz
Office Manager/ Production Coordinator	Sheila Mendes-Coleman sheila@formmag.net
Digital Editor	Lisa Bingham Dewart lisa@formmag.net
Contributing Writers	Michael Webb Lisa Bingham Dewart Andrea Cohen Gehring
Printing	Navigator Cross-media
Reprints	Peter Shamray Navigator Cross-media 626.222.5646 peter@navcm.com

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512 E. Wilson Avenue, Suite 213, Glendale, California 91206
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COVER: Cover photo courtesy of Nigel Young, Foster + Partners.

Studio Daniel Libeskind

Yama Karim, Principal
New York, NY
Website: www.daniel-libeskind.com

Yama Karim, Principal at Studio Daniel Libeskind, quotes Daniel as saying that "our interest is never to become experts in anything." With this in mind, we delve into the rich undergrowth of an ever-changing challenge.

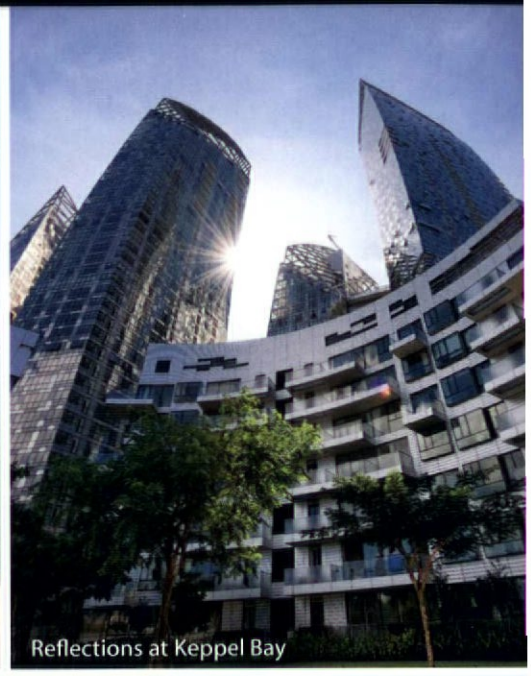
You've stated that a high-rise is a "very tight sweater" in which you look for "that little bit of room to create something dynamic." How do you succeed?
The common strain in all our projects is always trying to figure out how to create a sense of place, create and give identity, address the individual within the masses. The skyscraper is a particularly challenging typology because it's driven more by technology and repetition, so there's less freedom to create variety or overly sculpted structures. In Archipelago 21, orientation of each floor in the Dancing Towers is slightly different than the one above or below, like a pinwheel with the floor plates rotating around the core…a real challenge to make the structures sound and the cores line up while using movement to vary [exposure and views]. The same with our Singapore towers that are bent in a curve while the practical aspects have to shift in a very systematic way to make the planning work.

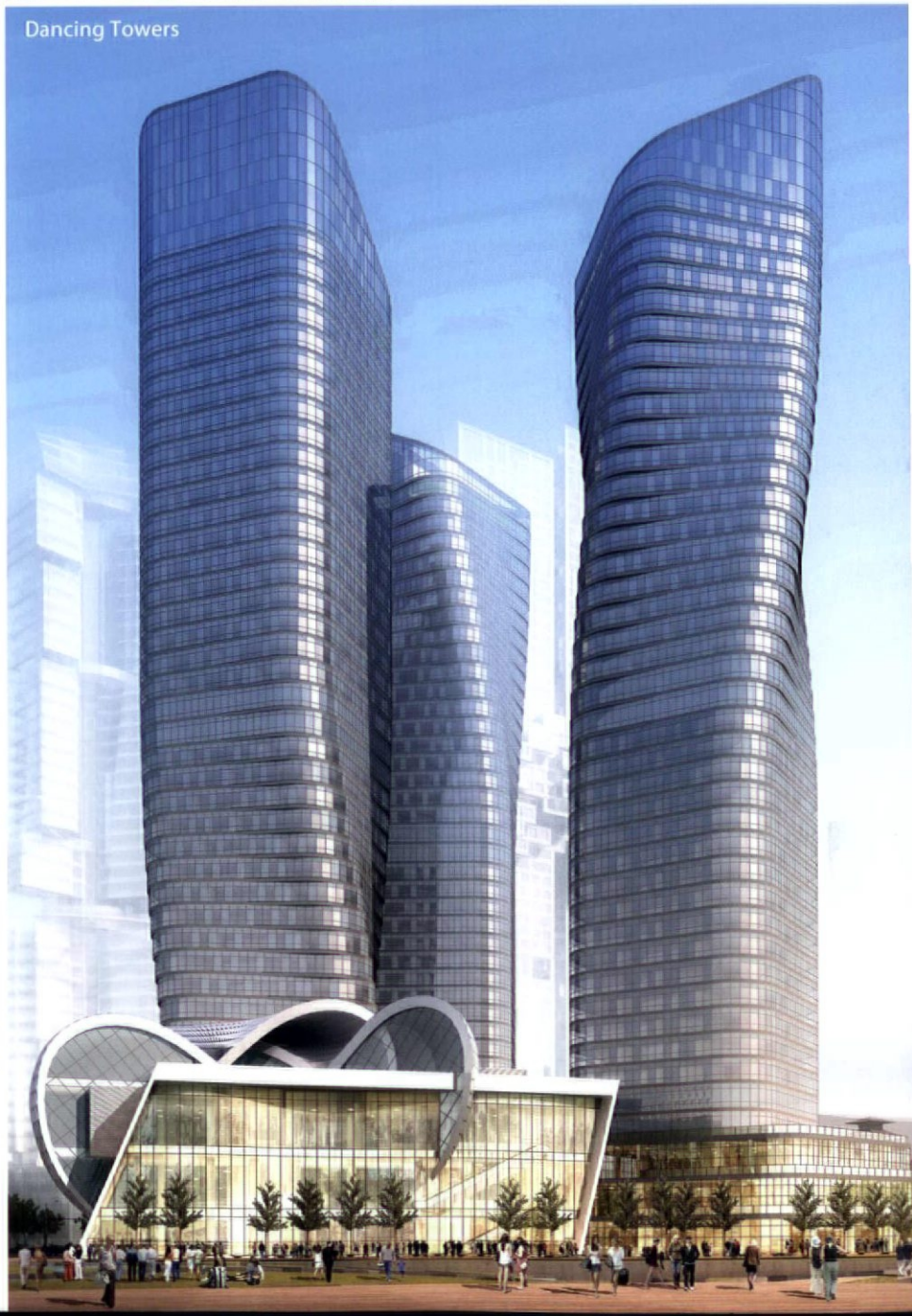
Does bringing open spaces up into the sky support differentiation and individualization within a relatively rigid framework?
Bridge courtyards, sky terraces, and gardens in Singapore offer private and public spaces. The New York Tower's [asymmetrically carved out] garden spaces end up creating a penthouse typology throughout the building, bringing the outer space in, within a dense urban setting… completely engineered, absolutely resolved and totally feasible. Bringing 30 columns through the building underneath, four main penetrations in the basement below, which branch out and in as they go upwards, like a pulse.

How do you reconcile the upward necessities of vertical building with the urban existence below?
Height has always been an infatuation, like landing on the moon. Ego, a political statement, a sign of wealth and prosperity, but also the humanistic endeavor to see how high one can go. Size is also driven by physics, infrastructure requirements, and programming. One reason our Master Plan for Ground Zero was selected is that it could be phased. Daniel was very keen on making the master plan feel complete for the pedestrian experience, with or without all the towers, [so we first] created a street wall with retail and public spaces that could be part of the urban fabric [right away].

Renderings courtesy of Studio Daniel Libeskind
Image courtesy of Keppel Bay Pte LTD.


One Madison


Reflections at Keppel Bay


Dancing Towers

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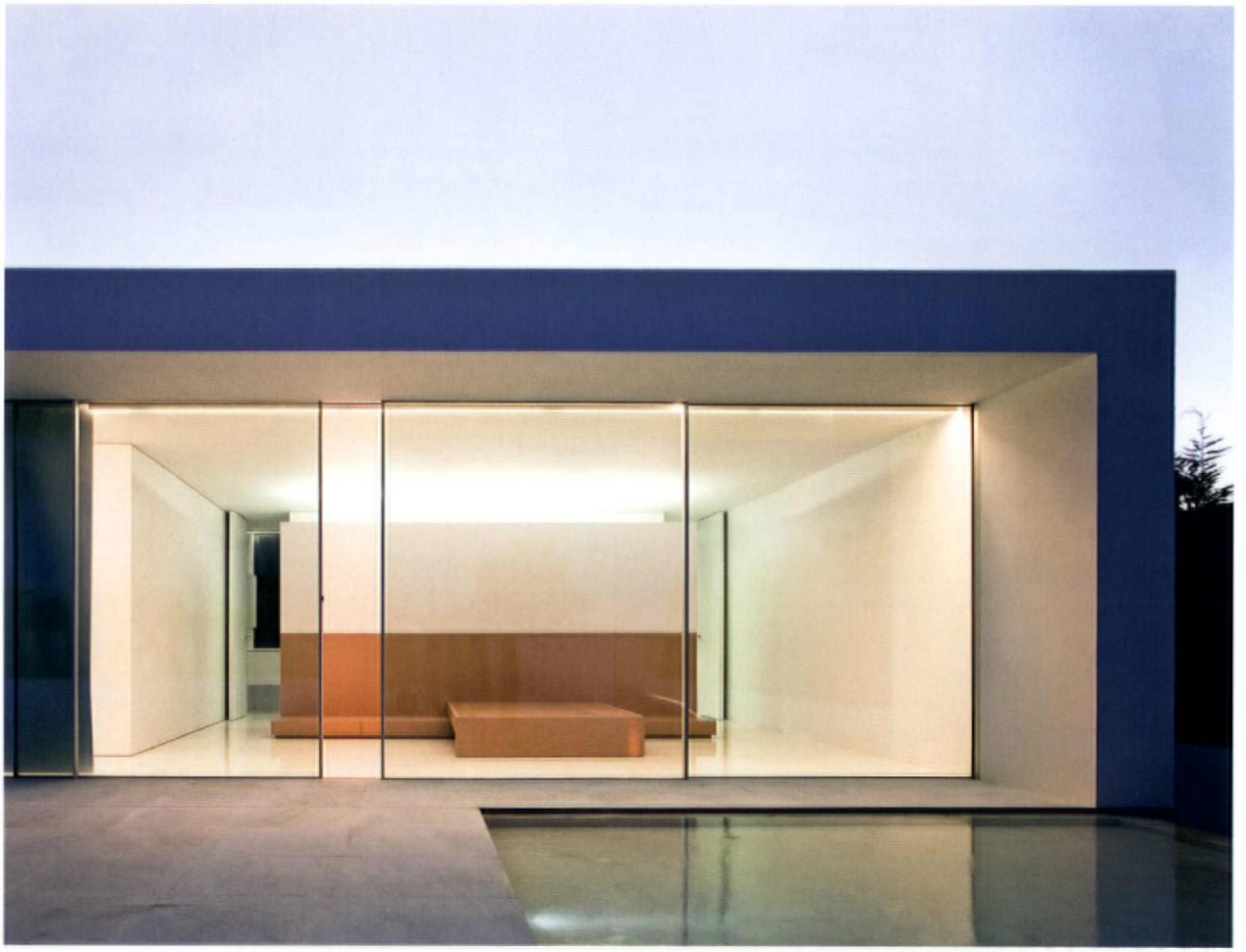

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Gensler

Olivier Sommerhalder, Design Director
Los Angeles, CA
Website: www.gensler.com

As Design Director with Gensler's L.A. office and Lead Designer of L. A.'s Metropolis project, which will redefine, not only the skyline, but the urban fabric itself, Olivier Sommerhalder describes the potent interweaving of multiple aspects and trends in the architectural crucibles we call skyscrapers.

You define beautiful buildings as the integration of motion, culture, and technology. What is a successful example?

The rising, twirling Dragon's tail shaping the Shanghai Tower has positive effects on how the wind interacts with the structure…[The buffering] outer sky lobbies around the seven different stacked programs inside, give an ephemeral, veiled quality to the serpentine outer atriums, increasing a very nice ecological aspect which is very hard to achieve.

What are some innovations in sustainability?

To build a super efficient exterior wall in Pittsburgh's PNC tower [due for completion in 2015], a double-skinned wall that can breathe… we created a very large solar chimney [like historic North African structures] that essentially cuts back on mechanical power. We wanted the feel in the workspaces of actual air coming from the outside when you open the windows. People feel better. From a technological standpoint, it has not been done on this scale and it's quite amazing. [Also] in the PNC tower, going beyond a focus on primary energy efficiency, the interior thermal skin that people operate is all made out of Pennsylvania White Oak. A renewable material, supporting healthy forestry, almost carbon neutral, with an ecological human aspect.

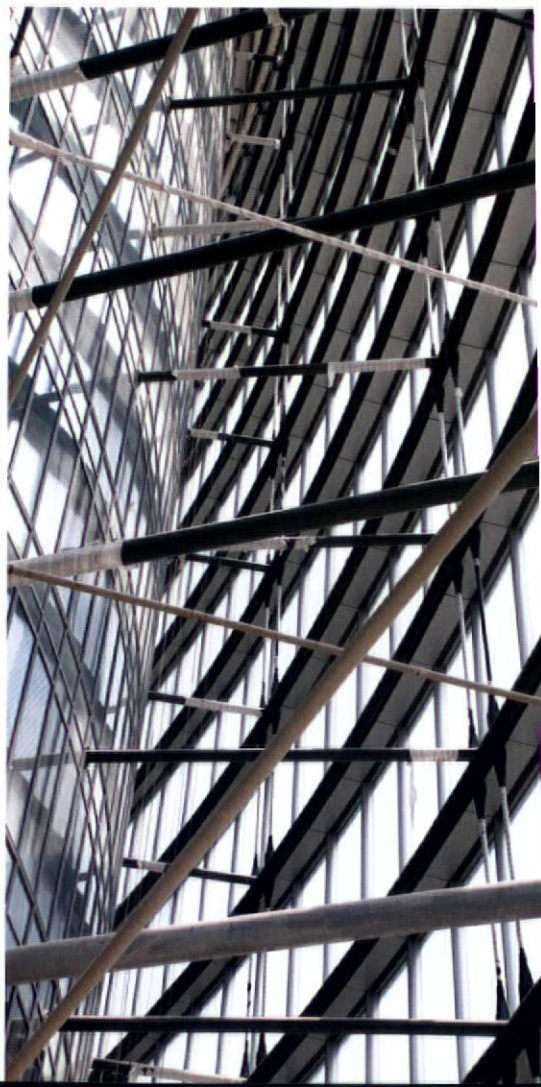
You say that a building incorporates not just the object itself but everything that goes into or out of it. What is the broader impact of high-rises?

The investigation of new technologies to reaching beyond allows us to go higher. If you want to go higher you also drive the research for those technologies, benefitting others through a trickle-down effect. Breaking new ground in multi-program towers benefits many other sectors…it builds communities, supports neighborhoods. The horizontal infrastructure is the supply chain…the taller you go, the more of a challenge.

Images and renderings courtesy of Gensler

Metropolis


Shanghai Tower



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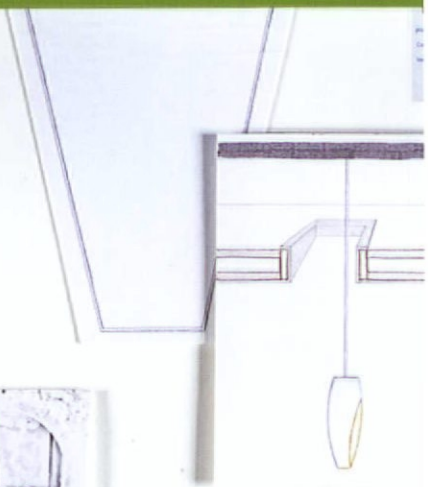

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Kohn Pedersen Fox Associates

David Malott, Principal, KPF, and Trustee, Council on Tall Buildings and Urban Habitat
New York, NY
Website: www.kpf.com

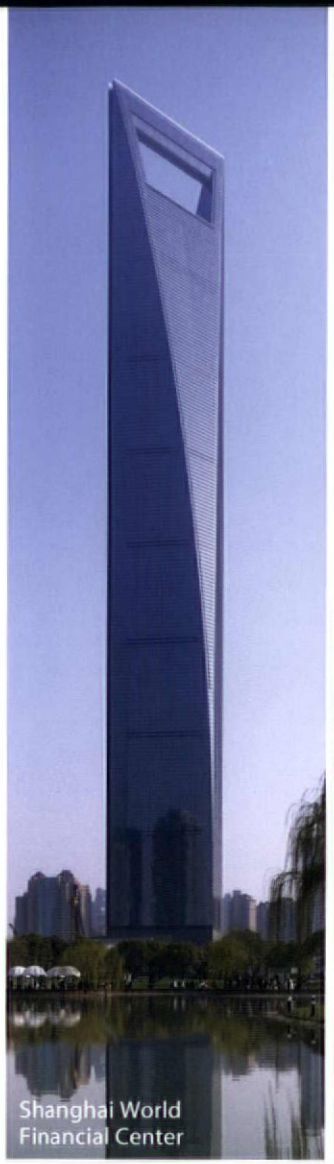
Addressing the trend of migration into cities, David Malott, KPF Principal, well experienced in Far East projects, describes height as "an affirmation of renewed interest to participate in the urban experience". Height seeks to resolve the conundrum of providing and sustaining an optimal human environment within a dense urban context.

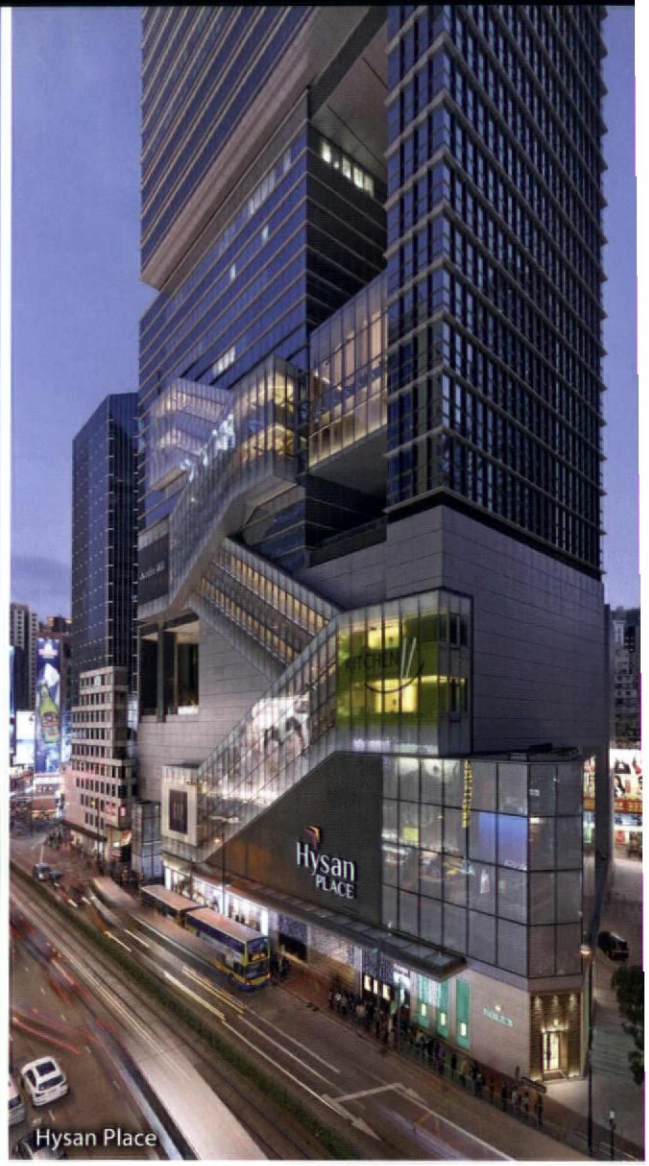
What are some challenges of building in the sky?
The loss on September 11 compelled us to design tall buildings with greater resiliency to limit 'progressive collapse' of a structure. The Shanghai World Financial Center, for example, was designed with a concrete and steel mega-structure capable of re-distributing force around a damaged area in the tower. 'Refuge floors' separating the tower into vertical compartments allow phased evacuation. Shuttle elevators, normally used by visitors to the observation deck were modified to serve as 'lifeboats' in a catastrophic event.

How do you test materials to ensure they perform well in soaring vertical structures?
With the aid of the computer tools such as finite element analysis and thermal modeling, engineers are able to predict results with greater accuracy. Still, it is crucial that the construction industry relies on physical tests for major building materials. Building construction relies on the skill and integrity of the contractor and each worker involved. A computer simulation simply cannot predict everything.

The Shanghai World Financial Center symbolizes the heavens and the earth through its bisected square geometry. What role does nature play in KPF's approach?
While increased urban density has many advantages, it also leads to greater pressures [which] we are looking to relieve [by opening] up our buildings once again. KPF has tested this concept in a few highly innovative projects, notably Hysan Place in Hong Kong, and Oriental Financial Center in Shanghai, [where] the heart of the project is occupied not with concrete, but with an outdoor space inviting the user to participate in the joyful experience of the tall building. The building plays the role of shelter, but without confinement, allowing nature and humanity to move freely.

TOP LEFT: Photo by Tim Giffith
TOP RIGHT: Photo by Grischa Ruschendorf
RIGHT: Courtesy of Kohn Pedersen Fox


Shanghai World Financial Center



Hysan Place


Ping An Finance Center

Verde II

Shizheng Tower

Leopalace 21

Johnson Fain

Scott Johnson, FAIA, Design Partner
Los Angeles, CA
Website: www.johnsonfain.com

As Founder and Design Partner at Johnson Fain, Scott Johnson is focused on an integrative approach to a holistic end. This integration stretches not just to disciplines and technologies, but to the anticipation of an architectural future concerned with sustainability and a better way of city life.

Does technology drive the architecture or vice versa?
Technology is opening up the design process to a vast store of data and design team iteration. It re-contextualizes the architect's role, perhaps still the conductor, but making choices from a wider array of inputs, infusing the project with more content. The pursuit of the tallest buildings will continue, a place with a vista, a place of privilege and protection. I believe this drive exists within us and we are now beginning to come full circle with our desires matching our needs: densifying our cities to achieve a better live-work balance, building more sustainable neighborhoods, paying for the municipal infrastructure bills.

Do these parameters vary geographically?
Technology is somewhat globally available, part of an ongoing international conversation in the community of skyscraper architects, [but] the important program elements that define a successful skyscraper in various cultures is quite different. An aspirational culture that wants a super-tall tower as a symbol of state pride may be very different from a mixed-use tower, which creates vertical neighborhoods in traditionally high-rise cultures such as those in Asia. In the US, I believe there will be an increase in mixed-use towers in an attempt to develop vertical neighborhoods in more sustainable cities… low-rise and mid-rise areas will achieve higher densities while the centers of cities and areas around public transportation will become more vertical.

You've stated that "sustainability and energy management are among the areas in which tall buildings can excel." How so?
[Among other things, the walls of our] LEED Platinum tower for JMB Urban in Century City Center are designed in response to different solar exposures. The westerly wall, which attracts the greatest solar heat gain, is a double glass wall with a vertical plenum naturally ventilating the wall. The southerly wall has horizontal sunshades while the east and north are yet again different. We have designed a 2-acre green roof atop the parking structure, which will dissipate heat and collect gray water for irrigation throughout the project. At the ground level plaza, a Metro Purple Line station will tie the building to the public transit system.

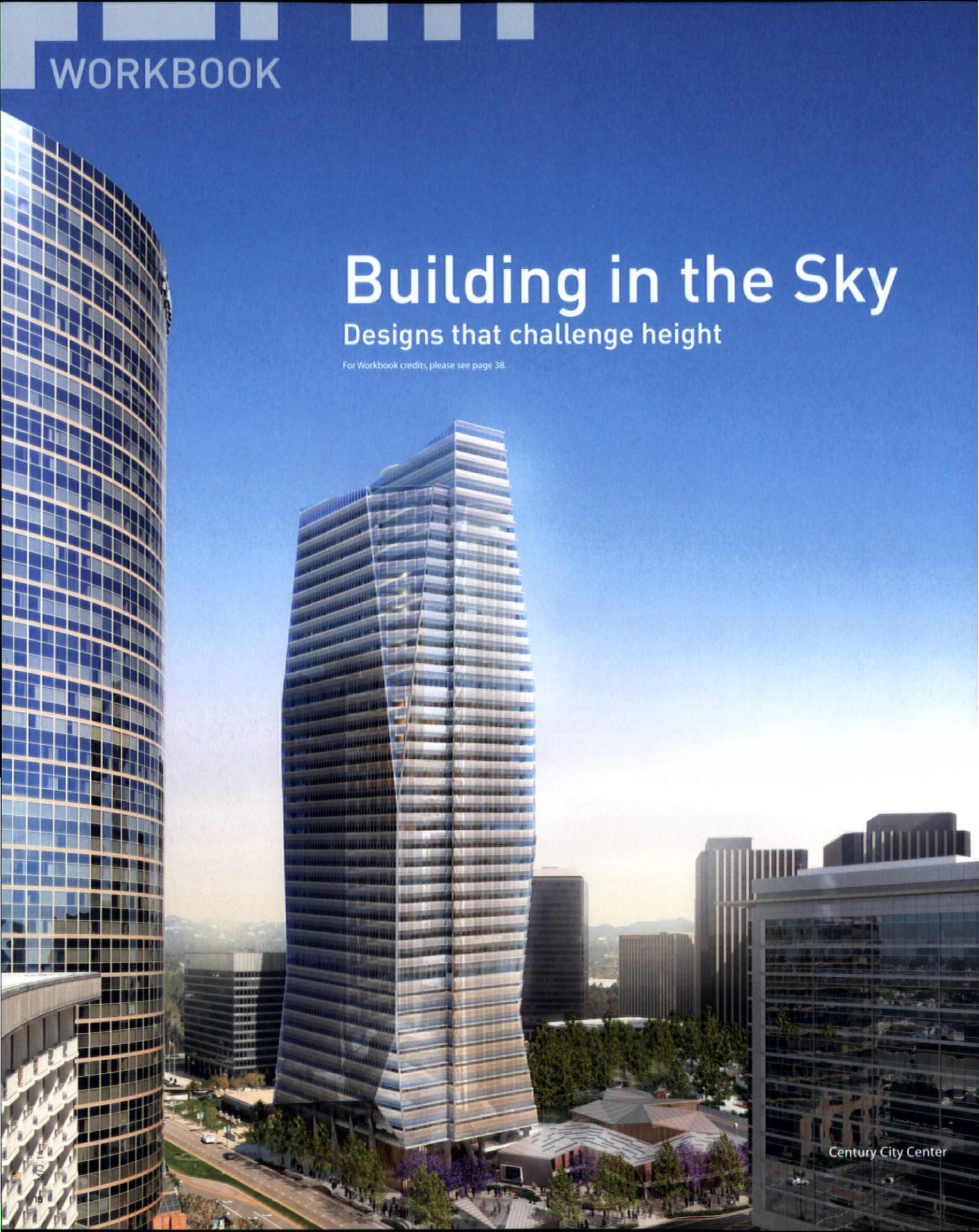
Images and renderings courtesy of Johnson Fain.

WORKBOOK

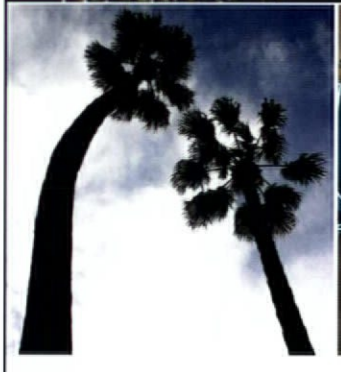
Building in the Sky

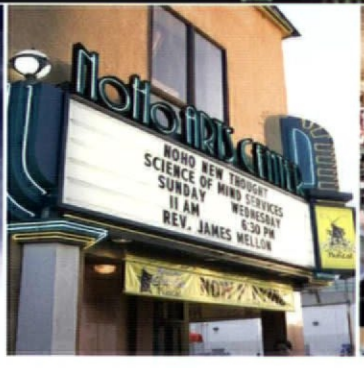
Designs that challenge height

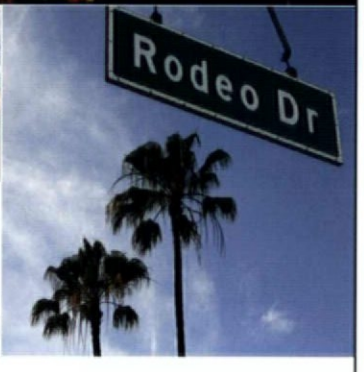
For Workbook credits, please see page 38.



SUMMIT *of the* AMERICAS







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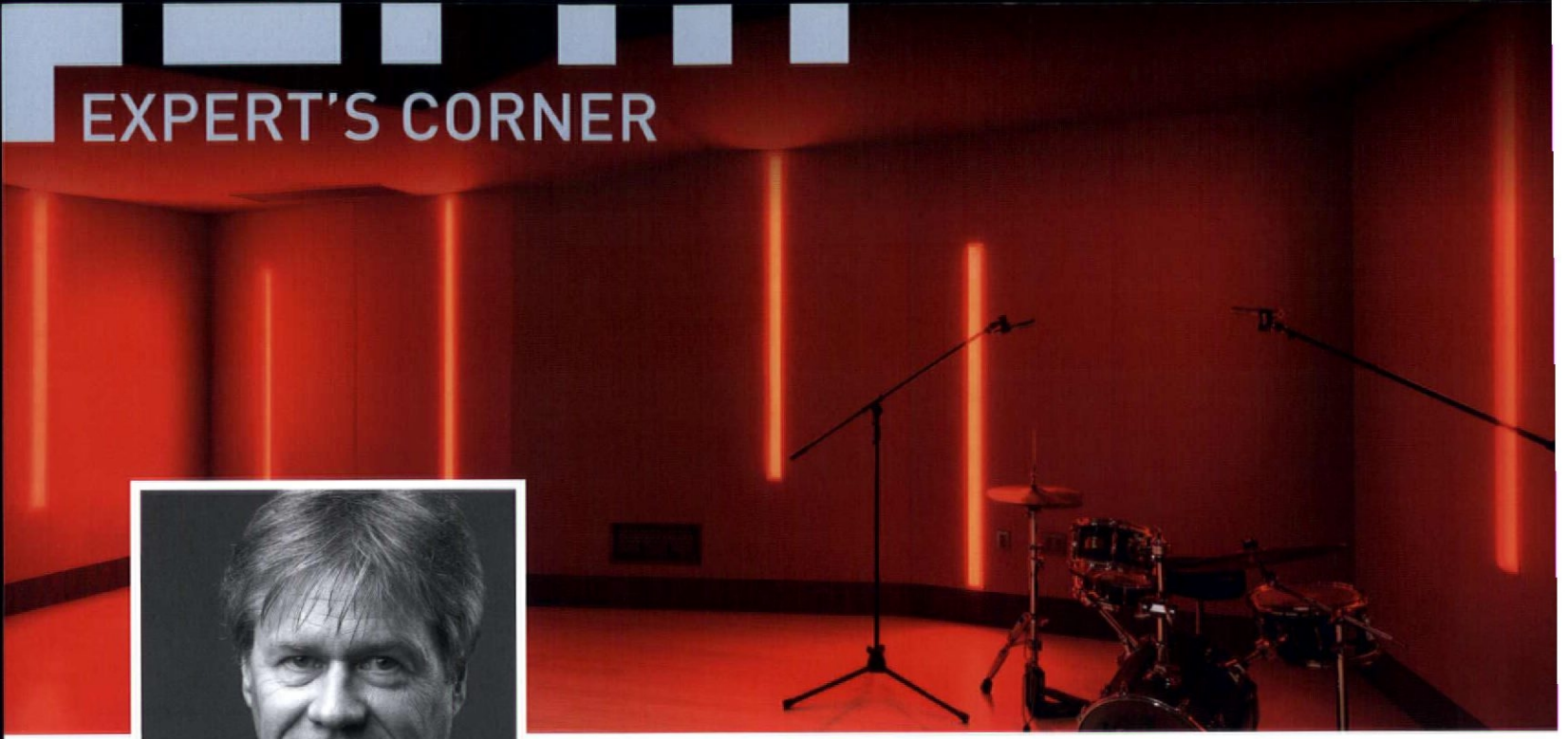


Peter Grueneisen, FAIA

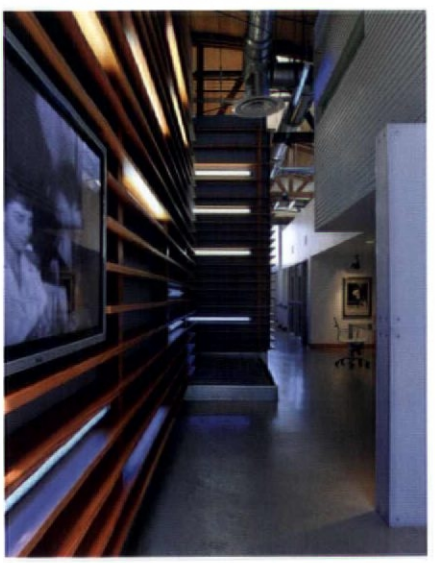
Principal and Founder of nonzero/architecture

Grueneisen believes it's important to take a comprehensive approach towards architecture, one that integrates the project with art and technology, but is grounded in functionality and sustainability. Perhaps this is one reason why so many musicians and film composers are keen to work with the firm. "The creation of stimulating structures and spaces is a primary aspiration, while economic realities, social dynamics and limited natural resources demand a thoughtful and conscious approach to design and construction," he adds.

What are some of your current projects?
We're finishing up a building complex called Remote Control Productions; it's a group of film composers [that work with] Hans Zimmer. When we started, they owned quite a few buildings—eclectic light industrial buildings—some were converted into studios others into office space. It's a whole campus. The latest building was ground up, 16 smaller studios and two larger suites. In the new building, the studios are dark, no windows, floating rooms in the building. But when you come out, all the hallways on the upper floors have large skylights. There is also a balcony with cantilevers. You have screens that can move to regulate the shade; it's very connected to the environment.

How do you begin your design process when working with musicians or artists?
We do research on the work that they do, not just on a technical level, but also their views on design and environment. On the one hand, the space has to be relatively neutral so different people can [work]. It must be conducive to creative work. On the technical side, they have to be isolated from sound and light. So there is a balance between creating public spaces that are connected and the private spaces that allows them to be creative.

Tell me about new technology that you are incorporating.
On the studio side, technology has become easier; everything is shrinking. We're experimenting with LED lighting. Color can create different moods for a musician. Changing the color of the whole space gives them a range of ambiance, rather than creating a room that never changes. Climate, lighting, louvered shades are being integrated into one system. Lutron for lighting; Crestron as an overarching system. The goal is always to make it easy and simple. We also use computerized fabrication to [design] exterior screens, basically a combination of privacy shade and sun shading, that are [mounted] outside on the glass. They are inspired by an image that is important to the client and we distort it into the pattern.



As an architect you appreciate quality design. Do you admire any products?
What we are looking for is something that is well designed, functional, economical, and sustainable. For example, we always used Macs because we thought [the computer] was more intuitive and an elegant way of working. Tesla is another example that relates to how we try to work. Maybe it's a problem that's been around for a 100 years, but something comes along that changes how we work. Doing things the way they are always done is easy. Finding new ways to address old problems is hard.

Any new innovations in soundproofing?
Some of the drywall companies are making boards that dampen sound from the outside. We've been able to use the materials and cut down on labor costs and space. For sound absorbing or interior acoustics, we have been using a lot of cotton panels made from recycled denim, Ultratouch by Bonded Logic. It's healthier for the environment. A lot of the acoustic elements are about diffusion. With new design methods using computerized manufacturing, we've been trying to put together new diffuser methods.

Flames of Desire

A cozy campfire can spark spirited conversations during breezy, summer evenings. But, you don't need all the smoke with so many clean burning options—streamlined coffee tables, moveable fireplaces, a ribbon of fire or a modern cube.

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FUSE LIGHTING

Los Angeles-based lighting designer Kevin Kolanowski recently introduced the London Sconce in two sizes (5" x 10" and 8" x 10"). The handmade fixtures have a jewel-like quality, the shade comes in five options and nine metal base finishes. Prices available upon request. **Fuselighting.com**

MCLAUGHLIN COLLECTION

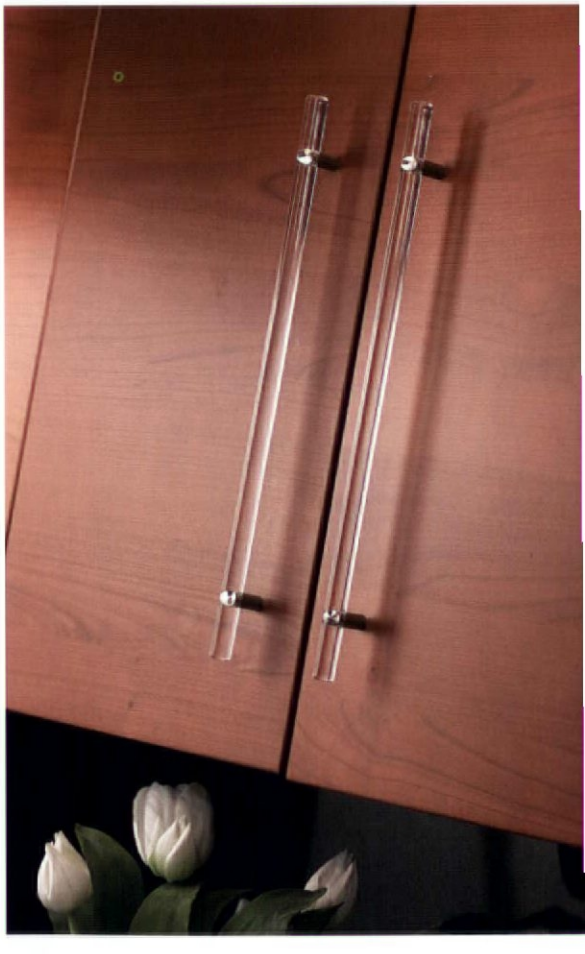
Inspired by the Art Deco period, the three-shelf bar cart ($9,000) reflects a more streamlined and contemporary interpretation. Constructed of clear cell cast Lucite and manufactured by local craftsmen, the product is 100 percent recyclable. **Mclaughlincollection.com**

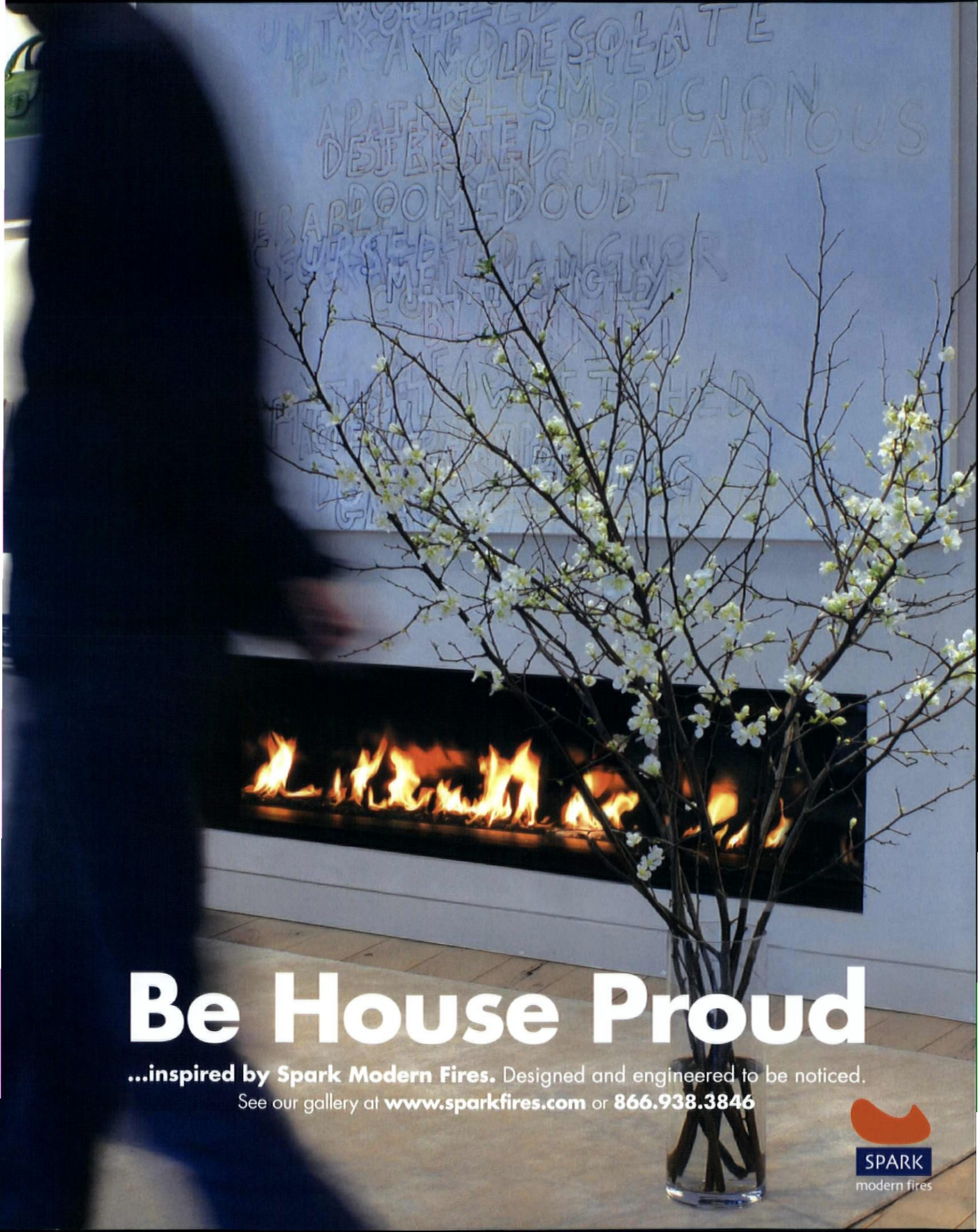
CALMA-E-GESSO

This Italian company has managed to do the impossible—bring gorgeous sophistication to the game of ping-pong. Designed by Adriano Design, the Lungolinea crystal table ($30,000) can accommodate the most competitive of players. **calmaegesso.com**

ATLAS HOMEWARES

Made of translucent polycarbonate, the Optimism collection provides an affordable and chic hardware solution. Available in 6- and 12-inch rail pulls, square and round knobs. Prices range between $16 and $31. **Atlashomewares.com**

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Does Height Really Matter?

Tall: adjective. Of great or more than average height, especially relative to width.

BY ANDREA COHEN GEHRING, FAIA, LEED AP

Like the prow of a big ship, the Flatiron Building in Manhattan appears to be in perfect motion as it commands the intersection of Fifth Avenue, Broadway and E. 22nd Street. One of my favorite tall buildings of all time, it's not so tall anymore, standing at a mere 21 stories. When it was built in 1902, however, it was one of the tallest buildings in New York due to its innovative "steel frame". Designed by Daniel Burnham, it has become one of the world's most iconic skyscrapers and achieved National Historic Landmark status in 1989.

The Flatiron's unique classical facade and contextual triangular floor plan is only six and a half feet wide at the vertex. So acute is the angle, that it has been known to create strong wind currents in its vicinity. But it's that sharp point that makes it a glorious experience to see. The building's impact goes far beyond its footprint as it inspired the neighborhood around it to be known as the Flatiron District. Although controversial at the time of its construction, it remains one of the world's most iconic skyscrapers.

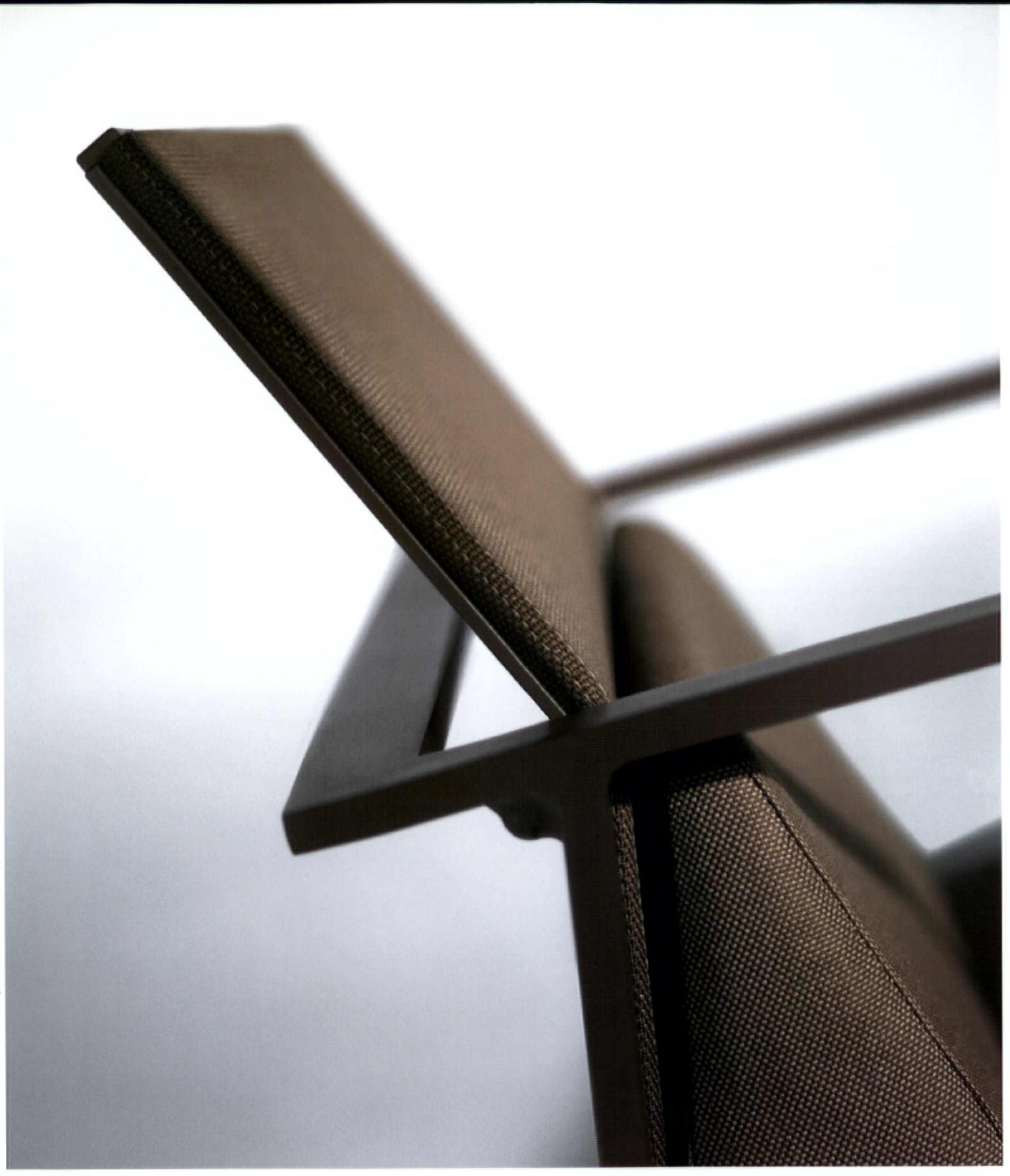
This month's issue of FORM addresses the challenges of building in the sky as it showcases tall building projects. It is an exciting proposition to design the next "tallest building in the world". But, looking back, is height the most important thing about a building? It's certainly newsworthy, but then what? I think "tallness" is a factor that has a certain shelf life, until technology and market forces allow the next architect to push that edge beyond known boundaries.

A skyscraper that seeks to be worthy of consideration for the next National Historic Landmark must do much more than break the latest "tall building" record. It needs to be memorable and create a positive impact to its site, which continues to evolve through time. It needs to address context and scale, and be bold in its concept, which may at times be controversial, by exceeding those boundaries. The dynamic shape and exquisite proportions of the Flatiron Building continue to move me, no matter how many times I visit that building. And, its height never crosses my mind.

Originally called the Fuller Building, the Flat Iron's signature shape quickly took over as a moniker.

Courtesy of iStockphoto.

Andrea Cohen Gehring is a Design Leader at DLR Group and this year's AIA/LA Chapter President.



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EDITOR'S NOTE

Imagination knows no bounds. And, as Michael Webb points out in the feature *Space: A New Frontier for Architecture*, writers have been fantasizing about galactic civilizations long before we had the scientific knowledge and engineering skill to travel and live in outer space. But, it sounds like technology and fantasy are finally intersecting.

Eric Roth

Perhaps in the near future, we'll be able to take a Virgin Galactic flight to the moon and stay overnight in one of Norman Foster's lunar habitations (p.27) that have been built using 3D printing technology. Building in the sky, however, is also a terrestrial pursuit. Our Workbook projects (p. 16) share the challenges of building skyscrapers that break all boundaries of height, while AIA/LA President Andrea Cohen Gehring (p.8) questions whether building tall has a short shelf life. Her thoughtful essay looks at how a skyscraper can stand the test of time. Similarly, Arata Isozaki (p. 32) ponders time, space and existence in an interview with the leaders of the Global Arts Foundation. Isozaki believes that every 25 years or so, we see a shift in design paradigm, and perhaps, today, we are on the brink of a transformation.

Alexi Drosu
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