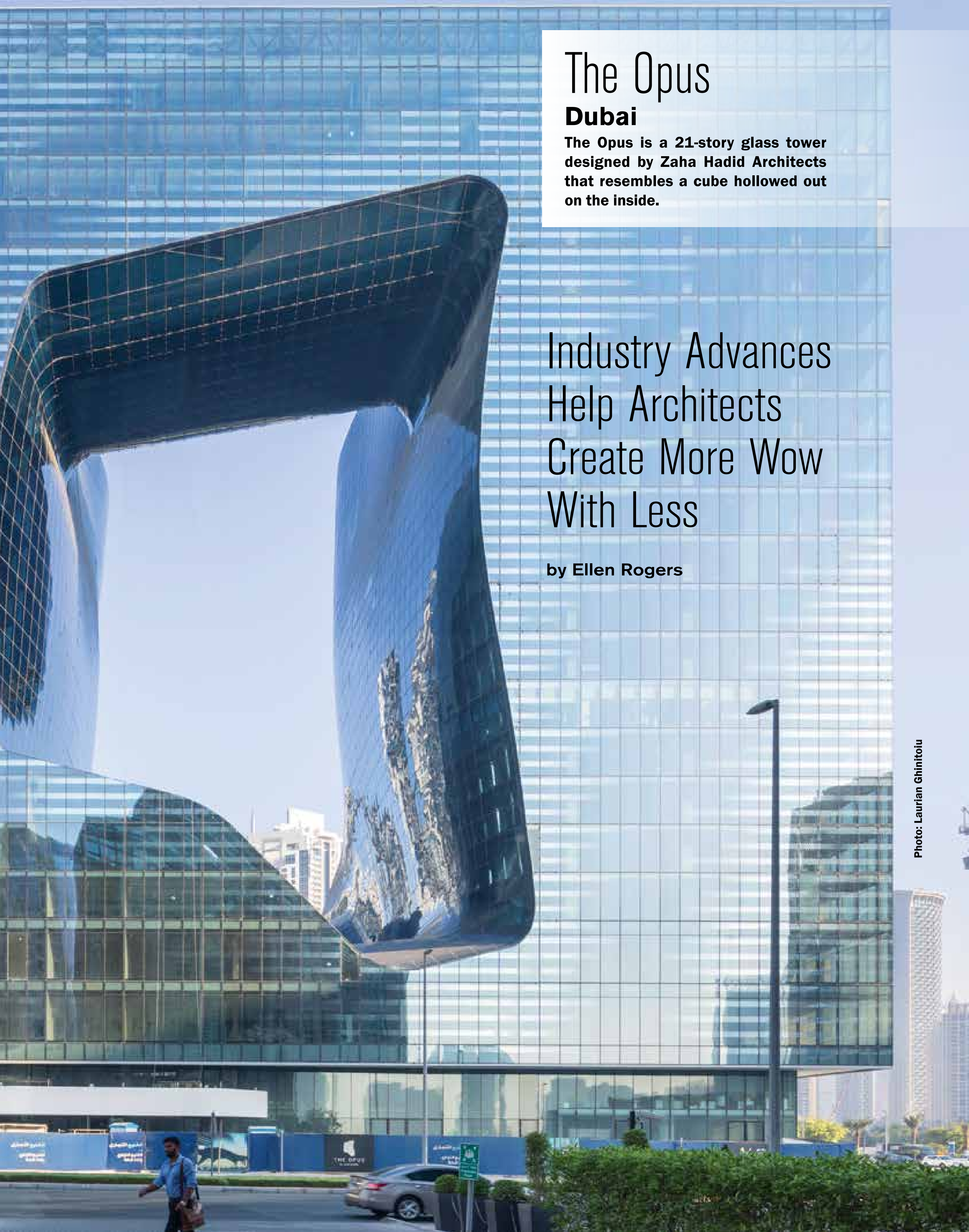
BEHIND THE FAÇADE

If there was a buzzword circulating within the architectural glazing industry, it might be complexity. Façades and building structures are becoming more intricate, designs are more involved, and architects constantly challenge glass manufacturers, fabricators, metal and even component suppliers to create the products to meet these demands. So, glass became clearer. It got bigger, thicker and even thinner, allowing architects to create more—more wow—with less. Or so it may seem.

While a structure's appearance may seem simple, it's not. Such buildings and façades are actually the result of a complex recipe of design, engineering, collaboration and the right products, installed the right way. Today's architecture is taller, bigger and shapelier than ever before, and it uses glass in ways that at once seemed impossible.

continued on page 64



The Opus

Dubai

The Opus is a 21-story glass tower designed by Zaha Hadid Architects that resembles a cube hollowed out on the inside.

Industry Advances Help Architects Create More Wow With Less

by Ellen Rogers

Photo: Laurian Ghinitoiu

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Hip to Be Square: ZHA's The Opus

The world is filled with simple, small, beautiful buildings—but these aren't the ones designed by Zaha Hadid Architects (ZHA). Instead, there's ZHA's Opus, a 21-story building nearing completion in Dubai.

Located within the Burj Khalifa district of Dubai, the Opus is designed as two separate towers that coalesce into a singular whole. The cube is carved in the center, creating a central, eight-story void, providing views to the exterior from the center of the building. Construction began in 2012 and the building envelope was completed in October 2017. The interior is still under construction, and the project is slated for completion in 2020.

The construction team included façade builder Alu Nasa in Dubai, consultants from Koltay Façades in Dubai, Pilkington Glass, and insulating glass manufacturer Shennanyi of China, which worked with Edgetech Europe for the Super Spacer flexible spacer that was needed for the project's unique shape.

Each of the 4,544 units for the dark blue-glazed void is a custom-made individual item, with the majority consisting of curved double-glazed insulating glass units (IGUs) with irregular shapes.

The lower end of the void is bordered by a freely formed glass roof over the multi-story atrium. At the upper end of the building, standing 71 meters, the towers are connected by a nearly 38-meter-long bridge, made of curved, double-glazed IGUs, double curved aluminum frames and steel. This part of the building alone weighs 1,000 tons. More than 10,000 individually curved aluminum profiles were supplied from Denmark and the Netherlands, and the glass units were produced in three factories in China.

The project includes both flat and single bend glass units, as well as hot- and cold-bent double-glazed IGUs. Shennanyi developed a technology specifically for the combined hot bending and tempering of the glass where the IGUs were heated to more than 1,000 degrees Fahrenheit, tempered following the molding process and cooled with the aid of compressed air nozzles to increase their breaking strength. The units consist of 8-mm low-E (coated on the inside), a 16-mm cavity between the panes, 6-mm clear glass, a 1.52-mm PVB color laminate and another 6 mm of clear glass. To help save costs, the number of hot-bent elements was reduced and cold-tempered, tempered insulating glass was used when possible.

At night, the void is illuminated with LED installations to connect the building with the surrounding city. LEDs can be individually controlled and were installed in each glass panel. The transparent façades of the two rectangular reinforced concrete towers are made of double-glazed insulating glass with a UV coating and printed colored layers of different sized dots.

BEHIND THE FAÇADE

continued from page 63

The Right Combination

A project's complexity could be due to a number of reasons. For example, unique geometric shapes, large sizes and even new products can add to the intricacy of the design and installation.

According to Sameer Kumar, director of enclosure design for SHoP Architects in New York, façade complexities can occur on multiple levels. Some, he says, are intentional based on the architect's design, while others are not.

"We [architects] are able to accomplish geometric complexities because we're finding the industry as a whole has become more comfortable with managing it ..." For example, machinery and equipment have evolved to allow for more complex installations, as has software.

According to Johannes von Wenserski with Edgetech Europe GmbH based in Germany, "complex buildings such as Zaha Hadid's The Opus *(see sidebar on left)* or even the Museum of the Future, which is still under construction in Dubai, could not have been realized without digital planning tools."

Tools such as the computer-aided design (CAD) software CATIA, originally developed for the aircraft construction sector, are now essential to architectural glass façades. Other common programs include Rhino, a 3D computer graphics and CAD application, along with Grasshopper, a visual programming language and environment that runs within Rhino, and Autodesk Inventor, a computer-aided design application for 3D mechanical design, simulation and visualization. Also commonly used, Revit is software for building information modeling with tools to create intelligent 3D building models that can then be used to produce construction documentation.

"There's also a more competitive environment where we're seeing more willingness to take risks," adds Kumar. "We would not be able to just conjure up a complex structure [and make it] happen … every project has to prove itself to be eligible to be built across the

continued on page 66

continued from page 64

board—it has to be buildable based on schedule, budget, etc. and everyone takes on a reasonable amount of risk. The credit for being able to do more complex work belongs to the industry collectively."

SHoP Architects has worked on a number of unique projects, including Manhattan's 111 West 57th Street residential tower, currently under construction, with completion expected in 2020. The tower stands 1,428 feet and is one of the tallest buildings in the city. Elicc Group is the contract glazier, and the façade incorporates glass from SYP in China and terracotta to create a staggered, wavy aesthetic. Kumar says that as façades become more complex, it can impact their supply chain.

"We work in a very global supply chain in the façade industry and as we go through the design phases we are talking regularly to a wide variety of suppliers, especially in the glass industry … and we are constantly evaluating the possible supply chain potential based on, say, the geographic location or the project procurement strategy and trying to engage with suppliers early on so that mutual benefits can be discovered and incorporated," he says.

Maic Pannwitz, vice president of sedak Inc., attributes much of the evolution in façades to advances in architectural glass and structural components.

"In the past when you had a façade, curtainwall, window wall, etc., you had a frame, you put the glass in and it worked. People were happy," he says. "But then [architects] said 'if you remove the columns in the middle of the glass, that would be great.' So, the glass panels got wider. But for structural support, you still had to have a steel bar/structure." That transitioned to the use of glass fins as the structural support.

"Now, because of the structural capabilities of certain laminated glass interlayer materials, we are able to provide panels up to 56 feet high for applications without any vertical support to carry the windloads," he says.

Looks Good, Does it Work?

The ever-growing focus on energy performance is another consideration. That means architects' desire for large spans of clear glass, for example, must now be combined with energy-efficient features, including insulating glass units (IGUs) and high-performance coatings.

According to Pannwitz, it can be challenging to meet the demand for a highly transparent façade while still achieving a good solar heat gain coefficient and low U-value. This is because there needs to be a balance in the type of coating and the desired visible light transmittance.

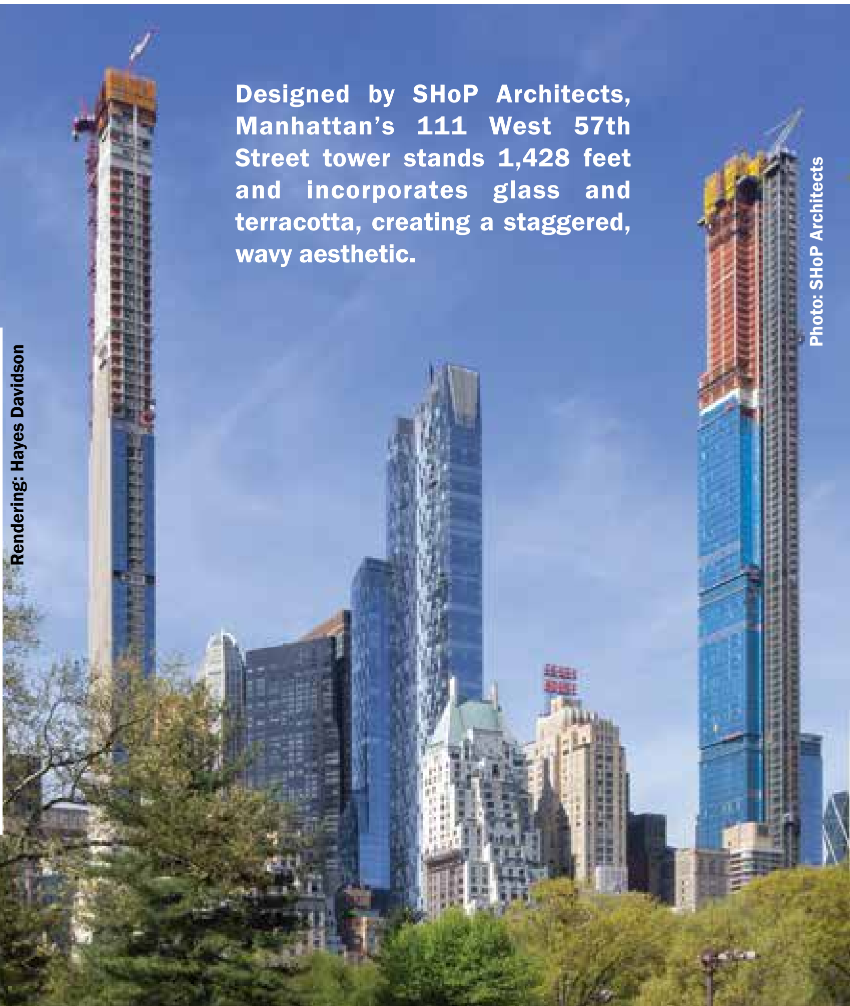
"So now we have a combination of a non-fin façade and IGUs that are carrying the load," he says.

Walter Crim III, a project manager with Portland, Ore.-based Benson Industries, is also seeing an increasing focus on energy performance.

"We've put more emphasis on thermal concerns for the curtainwall and

continued on page 68

Manhattan's 111 West 57th Street Tower
New York



Designed by SHoP Architects, Manhattan's 111 West 57th Street tower stands 1,428 feet and incorporates glass and terracotta, creating a staggered, wavy aesthetic.

Photo: SHoP Architects

Rendering: Hayes Davidson

continued from page 66

The Edith Green-Wendell Wyatt Federal Building

Portland, Ore.

The Edith Green-Wendell Wyatt Federal Building in Portland, Ore., features reed-like shading devices that span the 18-story west façade and an integrated shade/light reflector on the south and east faces that are optimized for the building's off-axis orientation. Benson Industries was responsible for the glass, metal extrusions and the installation.

Photo: Michael Ackerman

continued on page 70

continued from page 68

creating more energy efficient façades," he says. "Architects love glass and we're a glass contractor, so to give them the glass they want to use, while still meeting energy requirements, we're doing more work on thermal performance and shadow box systems."

He continues, "A decade ago we may have only modeled two major areas of the building for National Fenestration Rating Council certification. Now we may create 10 to 20 thermal analyses to get a better picture of how the vision, different types of spandrel and framing will perform," he says. "We provide these separate whole unit U-values to the architect and contractor so they have an idea of where the building envelope stands thermally. They then have a custom kit of parts that they can use to modify the aspects of the building to suit their needs and budget."

Photo: sedak GmbH & Co. KG

In response to increasing requests for transparency in façades, sedak has developed a glass spacer for insulating glass units.

Give 'Em What They Want

Sometimes creating what architects envision isn't as easy as it looks. That's when early collaboration with other members of the design and construction team—including suppliers—is essential.

"When you see renderings of buildings, they look beautiful but have no real structural support," says Pannwitz. "The façade contractor has to find a way to achieve the aesthetic as close as possible to [what the architect has drawn]."

Considerations determine what type of glass can be used in a particular project. The more information a façade contractor has upfront, the better they can work with the architect to meet the desired aesthetic.

"Sometimes we have to tell them they just can't get a certain size," says Crim. "That's especially so when they're asking for a special feature, such as a bird-friendly frit or coating," he says. "You can't just add more features and details to the glass throughout the process. Our role becomes giving them as much information as possible, but explaining there are limitations."

He continues, "Collaboration early on means we can influence the design to achieve the architects' goals and the contractors and owners understand where the cost is going. As the architect makes adjustments to what the building will look like we can provide input on whether it's do-able at all, or if it's do-able, but expensive. We know we can't simplify it so much that the building is no longer interesting, but we can make suggestions to improve efficiencies and costs."

Endless Options

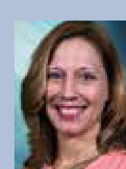
The architectural glazing industry is dynamic. It's constantly changing, driven by architects' desires to create extraordinary structures. As architects search for answers to questions related to glass strength, size, transparency and performance, the glass industry finds itself continually challenged to meet these demands.

"I see the use of glass becoming a structural element more and more, such as the Steve Jobs Theatre in Cupertino, Calif., where the roof is supported by the glass panels," says Pannwitz. "Then there's the desire for transparency, which is why we created the isopure—a glass spacer in between the lites in the vertical part of the IGU," he says. "We are getting requests from architects to present this to clients so they can see how it looks."

Kumar says his firm has one key focus in mind, and it definitely involves glass.

"Our interest—on almost every project—is we're constantly seeking to break out of the flatness of façades. The majority of the materials we use today start out as flat sheets and we put in a lot of effort to break out of that and create visual interest. We find ourselves pursuing architectural languages that do not result in flat, unarticulated surfaces, but are inherently three dimensional or, through some operational mechanism, break out of plane. This creates greater potential for introducing more materials into the mix to allow the building to transform with time of day, with the seasons, etc. We're finding architectural languages that are richer than what simple applications of flat glass affords us." ■

the author



Ellen Rogers is the editor of USGlass magazine. Follow her on Twitter @ USGlass and like USGlass on Facebook to receive updates.