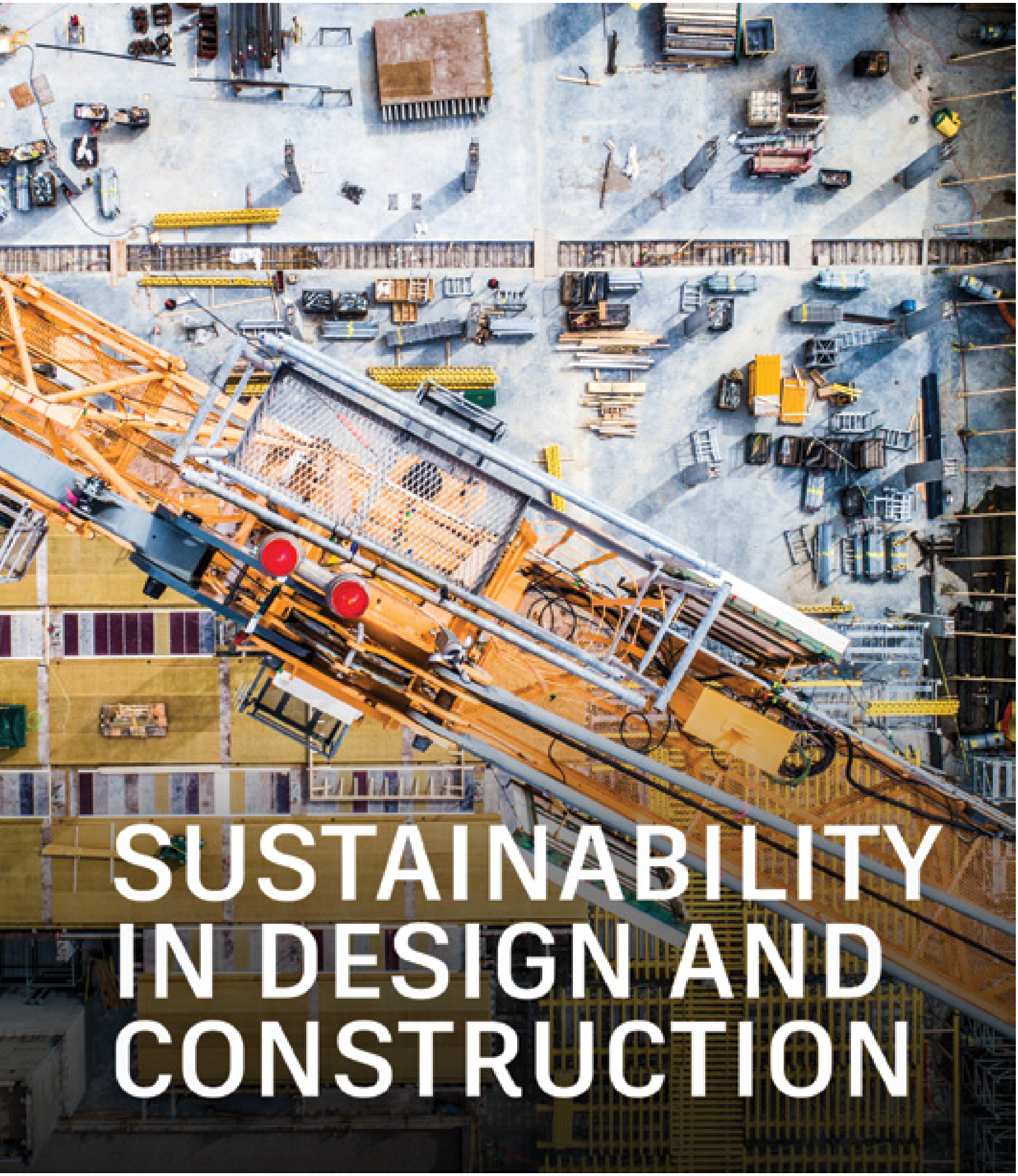

SUSTAINABILITY IN DESIGN AND CONSTRUCTION

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INSIDE

EDITOR'S NOTE

- Kylee Swenson,
Redshift Editor in Chief

Allow me to introduce you to Autodesk's online publication **Redshift**. Why Redshift? Well, in **space terminology**, astronomers use the word redshift to measure how far away an object is traveling. When an object moves away from the Earth, it appears redshifted; the wavelength of its light is stretched into lower frequencies, which makes it look red.

What's fascinating (and kinda scary) is the reality that the universe is continuously **expanding**, which means that light from most galaxies appears redshifted. As the universe expands, so does the Redshift editorial team's aim to move with it. Here on Earth, the global population is growing and urbanizing. With a predicted 10 billion people on the planet by 2050 (70 percent living in major cities), there's an increasing demand for more. Meanwhile, that demand is met with the reality of less—fewer natural resources, less skilled labor, and the mounting pressures of climate change.

Redshift is exploring what the architecture, infrastructure, construction, and manufacturing industries are doing to mitigate and solve some of the world's biggest challenges. By using innovative technologies such as machine learning, generative design, prefabrication, reality capture, robotics, IoT, and VR/AR, the very nature of design is shifting.

By exploring the future of making—how products, buildings, and cities will be built tomorrow and even 100 years from now—Redshift supports Autodesk's mission to help people imagine, design, and make a better world.

*Redshift is supported by **Autodesk**, creator of software tools with the power to make anything.*

With plans to house luxury residences, businesses, retailers, and a five-star hotel, China's 103-storey Tianjin Chow Tai Fook Financial Center will be a city within a skyscraper. Courtesy China Construction Eighth Engineering Division.

Making a Sustainable City Within a Skyscraper Through BIM and Prefab Construction

By Elizabeth Rosselle

Today's average city dweller has mastered the art of multitasking, and as the world's most developed cities are looking skyward—creating supertall, multiuse buildings that cater to modern life—skyscrapers are becoming great multitaskers themselves. They enhance a city's skyline, bring connected utilities to urban areas and residents, and use minimal landmass. If done well, sustainable skyscrapers use minimal resources, too.

But how do you construct a sustainable building space that can support businesses, retail, luxury apartments, and a five-star hotel? Can a building be sustainable and opulent? Located in the Binhai New District of metropolitan Tianjin (China's fourth-largest city), Tianjin Chow Tai Fook Financial Center is, essentially, a city within a skyscraper.

The building is China Construction Eighth Engineering Division Corp., Ltd. (CCEED)'s biggest project to date, standing 530 meters tall, 103 stories high, and featuring a distinctive curved tower facade. An industry leader in sustainability, CCEED conserved resources and minimized waste by using BIM technology and ff-site prefab construction.

With the skyscraper project, CCEED aims to win two of China's top construction and engineering awards, the Luban Prize and the Zhan Tianyou Prize, and to achieve LEED Gold Certification standards on three sides of sustainability: design, construction, and maintenance/operation of the building—concerns that affect the entire project lifecycle. The project has already won first place in the construction category of Autodesk's 2017 AEC Excellence Awards and is estimated to be completed by fall 2019.

Building Across Borders

To coordinate the building design with the dizzying system requirements of a mixed-use "city within a skyscraper," CCEED's BIM design team of more than 100 people created a centralized model stored on a private cloud server. The model called for nearly 1,000 BIM models and 184,504 components, so creating a singular platform enabled a much more efficient construction process with the global team of stakeholders.

"The construction for Tianjin Chow Tai Fook Financial Center is a very international project because designers came from the United States, Britain, Hong Kong, and other origins," says CCEED Project Manager Su Yawu, who started his career in skyscraper construction back in 2000.

"Before, we used a traditional construction approach by joining Excel files and the project files with other components for the project planning," Su says. But with a project on this scale, BIM ensures the far-flung teams can coordinate with local construction companies, read and understand the model easily, and share data in real time with fewer errors.

Sustainable Prefab Construction

The project mandated no design changes, storage, or reworking on the construction site, so sticking to the plan required precise coordination with the off-site factory. To meet LEED Gold certification, the CCEED design team's challenges included outfitting a five-star hotel's luxury interior with 2,000 types of materials

With a project on this scale, BIM ensures the far-flung teams can coordinate with local construction companies, read and understand the model easily, and share data in real time with fewer errors.

within a sustainable structure. Using BIM, the team was able to use prefab construction to manufacture components precisely according to drawings, thus preventing material waste and eliminating the need to cut materials on-site.

To improve tracking, the team used scannable Quick Response (QR) codes, which contain equipment details, maintenance records, and material certificates. Each model component is tracked with a QR code; 2,950 codes track major equipment and prefab processing components, all automated and managed in the cloud."With a QR code, teams can connect their management information with the project's geometry information," Su says. "They can then align the information, allowing them to more easily put edits into the BIM platform."

Imagining Spaces With VR

Sophisticated tools and technology, created using information derived from the BIM model, have been put to work throughout the project. Wiring robots were used to locate pipe support positions and improve installation precision, while virtual reality (VR) was used to train 3,000 of the team's workers to understand potential risks and learn how to avoid them. VR simulations included falling from great heights and being hit by large objects, driving home the importance of construction safety.

CCEED also used VR to test design elements, such as decoration templates for the hotel and apartment complex. This let designers and owners virtually walk through the finished space, experiencing various materials and design schemes.

Staying in Sync

Project building information—from fabrication to installation—is integrated and kept up to date. On the ground, the construction crew can use 3D scanning to compare the live jobsite with the BIM model and then modify the model if necessary to align with the physical site's Geographic Information System (GIS) tracking. To make these adjustments, drones capture daily images of the site.

For the building's curtain wall, Revit's expansion plug-in, Dynamo, helped automate geometric elements of the design process by importing its 3D coordinates—speeding up the process and improving accuracy. "We used the design to raise the position data and then generated the curtain-wall-panel geometry automatically," Su says. "Then we exported this information into Revit and used it as a parameter of assembly to generate the BIM model for the facade."

A Closer Look at Complex Systems

The BIM process that guided the design and construction teams will continue to be used to operate and maintain the building. "After the tower has been completed, the team will give the construction BIM model to the owner of the project,"

The tower's huge curved structural columns were manufactured off-site and assembled at the construction site. Courtesy China Construction Eighth Engineering Division.

Project manager Su Yawu reviews a laser scan captured on-site. Courtesy China Construction Eighth Engineering Division.

Su says. To make that possible, CCEED used LOD (Level of Development) 400, which defines the amount of detail available in the BIM model. LOD 400 is more than sufficient for most elements, but for some complex systems—such as mechanical, electrical, and piping—LOD 500 was used to include operational parameters.

"Part of the model needs to be in LOD 500 so that the owner can use the information in the operation and maintenance process," Su says. In LOD 500, the model is field-verified and contains information clients can use once construction has been completed—especially useful for the varied businesses within the tower.

Designing so many types of spaces, the team unsurprisingly faced many construction challenges—but having one overarching platform has, so far, allowed adjustments to go smoothly. For example, one basement floor is where "many mechanical, electrical, and pumping systems come together," Su says. "There are over 100 different types of mechanical systems all on one floor, so the team had to lengthen the construction time."

The Future of Skyscraper Construction

Su believes that in future skyscraper construction projects, all stakeholders—including construction workers and subcontractors—will need to work with integrated BIM models. "This approach to building will change the way people build buildings and skyscrapers in China and around the world," Su says.

For the intended end users, projects like Tianjin Chow Tai Fook Financial Center imagine a new way of living and multitasking. There's still plenty of room for growth—especially on the vertical plane—and it doesn't have to happen at the expense of the environment. Careful planning and new technology allow companies like CCEED to embrace a streamlined approach, developing supertall structures that cater to the smart folks who dwell and mingle within.

The first building to go up is called the "Technopolis" and will house the company's many laboratories. Courtesy Schneider Electric.

BIM Helps Schneider Electric Slash Its Energy Bill in Grenoble, France

By Maxime Thomas

The Dauphiné region in southeastern France has a storied history, from its time under Roman rule to its transformation in the early 20th century into one of the country's most important industrial valleys. In the heart of the French Alps—now home to wine making, silk farming, and Michelin-starred restaurants—a company now called Schneider Electric was founded by two brothers in 1836, entered armaments and electric production in 1891, and is now a global presence in more than 100 countries.

"There is a real gap between the BIM used in the design stage and the BIM used in operations," says Bertrand Lack, director of strategy and innovation for the building division at Schneider Electric.

Schneider, which employs about 5,000 people Dauphiné, is taking on a new challenge: surpassing the targets of the 2012 French Thermal Regulation by 20 to 40 percent in the construction of its two new flagship buildings in Grenoble. The buildings—one just under 120,000 square feet and the other at nearly 280,000 square feet—have to accommodate more than 2,000 employees and will require €120 million in investments to construct.

"This means we have to be innovative when it comes to setting a new standard for the group," says Olivier Cottet, Schneider's marketing and channels director of energy analytics. The two new buildings are in the running for LEED Platinum status, the top level of certification for sustainable development. Schneider Electric's goal is to exceed the target of 100 points (110 is the highest rating)—a score that's so far unsurpassed.

For efficient construction of the buildings, a key factor will be connecting the building information model (BIM) created using Autodesk Revit and building-automation software (also known as a "building management system," or BMS) used to control technology such as lighting and alarms.

"We see a great advantage in connecting the database of static data of the building [BIM] and the dynamic database, including all operating systems [automation]," Cottet says. The connection between these two databases requires a specific structure of the two data sets, especially on the BIM side, and unleashing its full potential requires adjustments of the BIM model after the construction work has been completed.

"In fact, there is a real gap between the BIM used in the design stage and the BIM used in operations," says Bertrand Lack, director of strategy and innovation for the building division at Schneider Electric. "Between these two lies the construction phase—and it's during this phase, when the workers are on site, that they make do with what they have on hand."

Making any adjustments on site won't be reflected in the blueprints or in the digital model. These adjustments that take the "as-designed" BIM model to

GreenOValley, two exemplary buildings at Schneider Electric. Courtesy Schneider Electric.

an “as-built” one are critical to ensure that the BIM model reflects the physical asset as its “digital twin.”

The reality that construction and operations worlds often ignore each other is a barrier the group is working to counteract, bringing together the philosophical and technical minds of two actually very similar fields. “During our research projects on energy performance, we realized that many of the buildings’ operational difficulties stem precisely from this organizational divide between the teams,” Cottet says. “It’s a treasure chest waiting to be discovered.”

Working closely with the general contractor GA and the engineering office Artelia, Schneider Electric has tested a “contract for guaranteed results in preconstruction”—a commitment to meeting the energy-performance levels in the digital model. “Admittedly, it is quite complex. We have to take things one step at a time,” Cottet says. “The goal is to set up a digital twin of what our building will look like at the time of delivery.”

As the project has advanced, BIM has saved time for the teams, at a fixed budget. “It saves us money since it’s one of the tools that allows us to achieve our goals of reducing energy consumption,” Cottet says. “It was out of the question for our real-estate department to spend an additional €1 million under the pretext that we were going to build a high-performance building.”

Schneider Electric uses Autodesk software to create operating tools for future buildings, including monitoring interfaces that gather information on the building in real time.

As one of the buildings has already been completed, Schneider and its partners use it to understand the algorithms and features needed to reach the target of an average 45 kWh/m^2 per year. This has informed the construction of the second building, which is underway and is expected to lower the annual consumption further to 37 kWh/m2.

As a point of context, a late-2016 study by Skanska found that the average total electricity consumption of certified

From design to maintenance. Courtesy Schneider Electric.

office buildings in Europe was 142 kWh/m^2. Schneider’s building performance is even more remarkable in a city such as Grenoble, where the average temperature in January can dip below freezing.

Several thousand sensors were installed in the first building with the goal of achieving precise facility management. “Another major undertaking for us is moving from big data to smart data: Too much data can lead to information overload,” Cottet says. “We’re therefore also working on how this data is presented so that we can get the most out of it.”

Schneider Electric has also included solar technology in these structures’ designs. The larger of the two new buildings will produce more energy than it consumes in a year, thanks to more than 43,000 square feet of photovoltaic panels on the roof.

In addition, integrating the Internet of Things (IoT) will provide more flexibility of control over the buildings’ temperature, lighting, air quality, and even power usage. Thanks to the IoT architecture, equipment can be controlled based on multiple criteria. “This flexibility will allow the consumption of energy to be shifted to times when energy is cheapest, which will help to lower our bill,” Lack says.

Schneider Electric is also preparing a project with the City of Grenoble that will allow the benefits of such flexibility in electrical supply to be brought to the community. The municipality and the company responded to a call for projects together under France’s Investment for the Future (PIA 3) programs and have applied for the smart-city designation funded by the European Union.

Buildings such as Schneider’s flagship creations, created in perfect symbiosis with BIM models, could help create a new standard in efficient building operation and energy performance.

As Climate Change and Natural Disasters Intensify, It's Time to Build Back Better

By Joe Speicher

Better urban planning and resilient infrastructure can help prevent flood devastation from intensifying climate change.

Natural disasters are a part of human existence—ever since the inhabitants of Pompeii were victims of Vesuvius, *Homo sapiens* have been dying unnecessarily due to the extremes of Mother Nature. Yet today, extreme weather events are even more calamitous, increasing in both frequency and cost. In 2017 alone, the United States experienced 15 natural disasters that each caused more than $1 billion in damages.

It's known that deviations in temperature and rainfall due to rising greenhouse gases result in more intense climate change and natural disasters. The International Monetary Fund noted in its 2017 World Economic Outlook report that "the frequency of disasters caused by heat waves, tropical cyclones, and wildfires will increase considerably" in countries of all economic stripes throughout this century.

The global society expends a great deal of resources responding to these disasters through the Red Cross, Federal Emergency Management Agency (FEMA), and United Nations' bodies responsible for disaster response. And while people have the capabilities to anticipate, mitigate, and prevent a significant portion of the devastation caused by natural disasters, they typically do not.

That's because public institutions are organized to deal with disasters after the fact, doling out support and relief as needed instead of allocating more resources to prevention and mitigation. The psychology behind this is easy to understand: Spending resources on individuals in immediate need is preferable to spending money to avoid a problem. This manifests in all kinds of human systems, such as health care, where treatment is inherently the focus. Prevention is invisible—the absence of death and destruction is the only measure of success.

Now is the time to "build back better"—to commit to sustainable-design practices that will rebuild the world's infrastructure with climate resilience at the forefront.

But given the increasing scale of the problem and the potential of new technologies that provide predictive power, this is no longer acceptable. Now is the time to "build back better"—to commit to sustainable-design practices that will rebuild the world's infrastructure with climate resilience at the forefront.

Natural-disaster preparation must accomplish three essential things:

1. Update regulations, such as zoning laws and building codes, and enforce them better.
2. Leverage newly available tools to simulate the effects of rising sea levels and higher wind speeds, with

The Salesforce Tower is now San Francisco's tallest building but also one of the safest from earthquake damage due to performance-based design and computer simulation.

more robust stress testing of the built environment.

3. Incorporate long-term thinking into urban planning to ensure that the policies and public works projects of today account for the impacts of tomorrow.

Beyond Building Codes

There are some encouraging examples of people voluntarily enhancing building codes to promote greater resilience. In the San Francisco Bay Area, a multitude of earthquake-related strategies can serve as examples for how to prepare for other types of disasters. Many new buildings in earthquake-plagued San Francisco exhibit the preventative, build-back-better philosophy by going beyond the base-level building codes for earthquake safety.

The Resilience-Based Earthquake Design Initiative (REDi) Rating System, developed by ARUP, establishes design and planning criteria to minimize structural damage, repair costs, and repair time. With its REDi Gold Rating, the 56-story commercial and residential tower at 181 Fremont St. in San Francisco is the most earthquake-resilient tall building on the West Coast. It should withstand the “maximum credible earthquake” for the area—a magnitude 8.0 event—with expected repair costs 10 times lower than a standard-code building and expected downtime of only a few weeks (as opposed to years).

Improving upon existing building codes is a global need. Autodesk Foundation supports organizations such as Build Change, which works with people in emerging nations to build houses and schools that can withstand earthquakes and typhoons. As founder Dr. Elizabeth Hausler says, “It’s not the earthquake that kills people; it’s a poorly built building.” Build Change works with governments to develop building standards and trains contractors in better rebuilding practices.

Simulation Tests

San Francisco’s tallest building—the 1,070-foot Salesforce Tower, which opened early this year—is among the safest buildings to be in during an earthquake up to magnitude 8.0, despite its location in a soil liquefaction area. It benefited not only from going beyond the existing building code, but also from strenuous simulation tests. Magnusson Klemencic Associates worked with the city and a peer-review panel on a process called performance-based design, which used computer simulations to test the tower’s design against 22 earthquakes modeled on the worst tremors in the Bay Area’s recorded history. Performance-based design allows architects to optimize buildings for their specific sites; save time and money by using fewer materials; and most important, anticipate disasters.

When the new eastern span of the San Francisco–Oakland Bay Bridge opened in 2013, it marked the completion of the largest public works project in California history. Engineering firm T.Y. Lin International designed it with seismic innovations like “accordion-style” expansion joints that move in various directions during an earthquake. Complex computer simulations used throughout showed how the bridge would stay intact, “dancing to the rhythm of the earthquake.”

Other urban planners and builders must have those same types of physical and digital tools at their disposal to

Computer simulations showed how “accordion-style” expansion joints and other seismic innovations would absorb earthquake shocks on the new eastern span of the Bay Bridge.

As founder Dr. Elizabeth Hausler says, “It’s not the earthquake that kills people; it’s a poorly built building.”

make decisions that will help the greatest number of people. The United Nations High Commission for Refugees (UNHCR), the UN body responsible for housing and supporting 35 million refugees worldwide, is beginning to put that idea to the test in the Bangladesh refugee camp of Rohingya Muslims who have fled Myanmar. UNHCR’s computer modeling determined that more than 100,000 refugees would be vulnerable to floods and landslides this monsoon season. In conjunction with other international relief groups, the UNHCR then ran much more low-tech simulation exercises to prepare relief practitioners to deal with flood impacts and move families to safer, planned settlements.

Think of the Future, Act in the Now

Although it may not seem like it, the Army Corps of Engineers actually prepared for flooding around Houston by conducting simulations prior to Hurricane Harvey. However, ballooning housing needs in the greater Houston area led policymakers to ignore the Army Corps’ work and build housing in a manner that endangered lives and property. These actions significantly increased the devastation caused by the hurricane.

Nevertheless, the long-term thinking necessary to address this problem has started to catch on in certain high-risk areas of this country. For example, in the wake of last year’s Hurricane Irma, Miami-Dade County completed a $1.2 billion plan for flood-management infrastructure, such as water pumps, sewer improvements, and street protections.

However, the plan is not entirely funded yet. Due to short election cycles, the public sector can be incredibly risk-averse to prevention spending. Philanthropic organizations and corporate foundations often have more risk tolerance built in, with the freedom to act on new thinking and innovative designs. They need to step in and carry the torch for better rebuilding policies, partnering with governments when possible.

One such partnership had excellent results: After Hurricane Sandy, the Department of Housing and Urban Development (HUD) and the Rockefeller Foundation launched Rebuild by Design, a design competition for natural-disaster resilience projects. The competition has funded seven infrastructure projects in New York, New Jersey, and Connecticut for preventing floodwater and wave erosion damage, to begin construction from late 2018 to early 2020.

Modeled on Rebuild by Design, the San Francisco Bay Area Resilient by Design challenge selected 10 design teams that are currently bringing together local residents, public officials, and experts to develop resiliencies to sea-level rise, severe storms, flooding, and earthquakes in 10 locations around the Bay.

Rather than waiting for natural disasters, these cooperative efforts focus on damage prevention and present models for others around the world to follow. Preemptive natural-disaster interventions can be the catalyst for massive mind-set changes, moving away from ignoring the future and toward preparing for it.

Sustainability and community inform Bangkok's WHIZDOM 101 housing concept, which integrates work, home, and a common "third place". Courtesy MQDC.

"The Great Good Place" Uses Sustainable Innovation to Connect Bangkok Residents

By Elizabeth Rosselle

Bangkok, Thailand, is a vibrant metropolis. This colorful capital city, one of the most visited in the world, offers amazing food and culture, tourist-friendly floating markets, golden palaces, great shopping, and booming nightlife. But—as is true of life in other big cities—its residents also deal with issues of social isolation, lack of access to green spaces, and other urban woes.

Magnolia Quality Development Corporation, Ltd. (MQDC), a Thailand-based real-estate developer, recognizes that potential home buyers might want more than just a building complex and created an integrated 17-acre campus called WHIZDOM 101. The venture is called The Great Good Place, after sociologist Ray Oldenburg's 1989 book, which posits that to live well, a balance between home life, the workplace, and sociable "third places" to build community is crucial. WHIZDOM 101 is a sustainable smart city within a large metropolis designed to help residents lead more efficient, healthier, and more fulfilling lives through innovation and technology.

"Before we start a project, we normally take a year or two to study what would benefit the people around the project," says MQDC's President Khun Suttha Ruengchaipaiboon, a civil engineer with more than 26 years' experience in real-estate projects in the United States and Asia. "People—we call them that 'new generation'—we interview them, and we find out about things like what they enjoy doing during their free time."

The Third Place

A 2017 Autodesk AEC Excellence Award winner for sustainable design, the WHIZDOM 101 project is geared toward younger city-dwelling professionals and emphasizes values of health, the environment, and social responsibility. The campus, set to open in mid-2018, will contain a jogging track, bike track, library, and green space, along with a street lined with businesses and restaurants. It offers an improved outdoor microclimate through strategic use of trees and plants and an indoor controlled microclimate, managed through both passive systems and intelligent active systems.

The smart systems control room conditions, lighting quality, carbon-dioxide levels, and real-time energy consumption in a single platform. Residents can use an app to manage their home cooling and heating, food delivery, utility payments—even to figure out where there's parking available before driving around and wasting fuel.

To fill the need for a third place, the design emphasizes outdoor spaces to relax with friends, go shopping, and enjoy nature. Designed with more than just humans in mind, MQDC's green space will host an entire healthy ecosystem to draw in more birds and animals.

"'Smart city' has a lot of meanings," Ruengchaipaiboon says. "But for us, it's a smart city for the community—for the people. We call it a 'smart community.'" One ingenious way that WHIZDOM 101 brings together smart technology and community is through Pavegen energy- and data-collecting floor tiles at the entrance to its campus. The tiles convert kinetic energy from human footsteps into low-voltage electricity which can be stored and used to power LED lighting, wayfinding solutions, and mobile-device chargers. "When [visitors] come into our project, they are creating alternative energy with us," he explains.

"Sustainovation" as a Core Value

According to Ruengchaipaiboon, one of MQDC's core values is to make every project sustainable using innovative technology. It calls this approach "sustainovation," for sustainable innovation. "As developers, we're well aware that we can create a positive or negative impact on this world," Ruengchaipaiboon says. "So we ensure that each project has minimal impact on the environment, society, and people at large."

To reduce that net environmental impact, the firm uses fewer construction materials while opting for eco-friendly building materials and methods. The WHIZDOM 101 condominium tower, for example, is strategically positioned to allow for better natural airflow and light and less heat from the sun, increasing energy efficiency. Ruengchaipaiboon says that "if we can position the tower to draw in the natural light and wind, people will use less energy, including less air conditioning."

Green Building Information Modeling (BIM)

To attain LEED Gold–certification standards, MQDC implements energy-saving and eco-friendly measures.

One of MQDC's core values is to make every project sustainable using innovative energy. It calls this approach "sustainovation."

"We have to reduce the energy by 30 percent," Ruengchaipaiboon says. "We also must target to reduce water usage by 40 percent. We do this by collecting and reusing water on-site, and we have the goal to reduce CO_2 emissions by 15,000 tons per year, which is about 30 percent, comparable to a project about one-tenth the size of ours."

MQDC balances environmental concerns with a people-centered design approach that promotes residents' health and well-being. For example, the condominiums feature a ventilation system called ERV, or energy recovery ventilation. ERV works while you sleep, drawing carbon dioxide out of the room and replacing it with fresh air from outside. "You get better oxygen while you're sleeping, and you're rested when you wake up as a result," Ruengchaipaiboon says.

MQDC has made serious investments in technologies that modernize design and construction and has been working with local designers, engineers, consultants, constructors, and suppliers to reengineer those traditional processes.

Case in point: At the start of the project six years ago, those stakeholders weren't equipped for BIM and were concerned that adopting the process would add more time and cost. "I'd been using BIM for the past 20 years before coming here to MQDC," Ruengchaipaiboon says. "I said, okay, we're not going to use BIM 100 percent on day one. We asked the team to participate in a few projects using BIM to get started. My goal was that they would see the benefits very quickly, and it turned out to be true."

The team introduced BIM technology gradually, starting with architects and structural engineers using Revit to develop and coordinate the designs. This success extended to working with the contractor and supplier during preconstruction, which helped reduce change orders and material cost.

"In the construction industry, construction sites around the world generate about 15 to 30 percent waste material," Ruengchaipaiboon says. "By using the BIM process in our development, we can reduce waste material by up to 15 percent, so that saves a lot of energy, saves a lot of material." Each step in the construction process has been photographed and implemented into a BIM 360 model, so all pipes, electric, walls, and every position of every part are accounted for. At the close of the project, the BIM as-built model will be handed over to the property managers, so instead of a 2D drawing, they'll have a 3D model to maintain the site.

Future Smart Communities

Looking ahead, MQDC is researching a project that will cater to multiple generations. Ruengchaipaiboon says creating mixed-use communities to improve the quality of life is a growing trend for MQDC. These smart communities could give people more opportunities to spend time outdoors, interacting with nature and their peers. Social interaction is key to a city's vibrancy, and sustainovation is setting the stage for more great, good places across Thailand.

An interior view of the Circl pavilion, built with disassembly in mind, at ABN Amro's headquarters in Amsterdam. Courtesy BAM.

With Circular Design for Material Reuse, What Goes Around Comes Around

By Angus W. Stocking, L.S.

"The Cold Equations," a famous Golden Age science-fiction story, featured a rocket ship on an emergency mission to a faraway planet. Per the cold equations of time traveled and oxygen available, a young stowaway had to be jettisoned—abandoned in cold, empty space—for the mission to succeed. The story influenced a whole generation of engineers who admired its relentless logic and, perhaps most of all, the way it showed that engineers must often make practical decisions upon which lives depend.v

Flash-forward about 50 years: Many see planet Earth, itself, as a spaceship, one with limited resources that are subject to cold equations—a spaceship that needs to be managed properly if everyone aboard is to survive. Civil engineers in particular are influenced by this view, as they are designing the infrastructure and cities that use the majority of Earth's available resources.

"The construction and operation of the built environment consumes 60 percent of all materials in the UK," according to "Circular Business Models for the Built Environment," a report by design and engineering firm Arup and European construction group Royal BAM.

"It's not just the UK, of course," says the report's coauthor, BAM's Group Director of Sustainability Nitesh Magdani. "Globally, cities consume 75 percent of global primary energy and are responsible for 70 percent of global carbon-dioxide emissions. Just in Europe, it would take between two and three planets' worth of resources to sustain the current lifestyle. There are many good companies working on circular business models for things like soda bottles and other consumables, but none of that will matter much if designers and contractors don't start making more efficient buildings."

The application of circular business models (CBMs)—those that consider the entire lifecycle of a product or, in this case, building—is key to realizing the circular economy. According to the Ellen MacArthur Foundation the circular economy is "restorative and regenerative by design," and it "aims to redefine products and services to design waste out while minimizing negative impacts." Achieving the circular economy requires reinventing current material-recovery systems while committing to renewable energy sources. For construction, as Magdani's report states, CBMs in design, use, and recovery are paramount.

Circular design is simple in concept but fiendishly difficult to apply to buildings. "We need so much data," Magdani says. "There is so much to learn about capturing data and creating value in building materials after numerous years of initial use. As a whole, the construction sector is not really capturing this information

"There is so much to learn about capturing data and creating value in building materials after numerous years of initial use. As a whole, the construction sector is not really capturing this information during building lifecycles, and that's a problem—material without information is waste."

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Fortunately, there is considerable motivation to begin capturing this data and to build in a way that extends the use and value of construction materials. In addition to sustainability benefits, the potential economic gains are staggering: According to the report, capturing efficiencies and values in building materials and design could add 4 percent to the world economy in the next 10 years.

"We know that certain materials are going to become scarce and therefore more expensive," Magdani says. "If we want to survive as businesses, we need to start thinking of materials as assets that remain valuable, as buildings, systems, components or as a material again, after its initial use."

As part of his work, Magdani is exploring the application of CBMs to buildings in many different ways. BAM is active in engineering, facilities management,

"If we want to survive as businesses, we need to start thinking of materials as assets that remain valuable, as buildings, systems, components or as a material again, after its initial use." - Magdani

Circl Pavilion at ABN Amro in Amsterdam. Courtesy BAM.

and public-private partnerships—which makes it perfectly suited to test the realities of circular-design ideas. It's as if the built world is BAM's laboratory.

"Buildings are hard to experiment on because they last so long," Magdani says. "To speed that up, we teamed with Arup, Frener & Reifer, and The Built Environment Trust to design and build a Circular House in London—a building that we would intentionally deconstruct after a short time to see if we could successfully reuse materials and components. Our brief to manufacturers was that we wanted to 'borrow' materials and that we would give them back. And we have begun that journey: We've disassembled the building successfully and will be reusing materials and components in other projects to test the concept before giving them back to manufacturers—we've learned a lot."

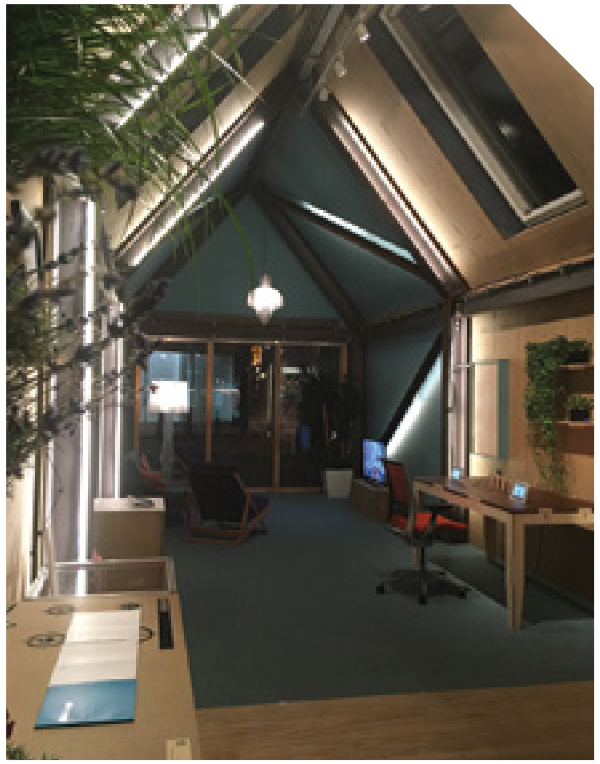
Another circular building that BAM cocreated, a pavilion called Circl at ABN Amro's headquarters in Amsterdam, was designed specifically for easy disassembly, relying heavily on demountable components and reused or reusable materials.

Changes in ownership, however, can be a barrier to collecting reliable building data. "I've designed many buildings that I think are sustainable, but there's just no guarantee that they won't end up in a landfill," Magdani says. "Part of the problem is that designers don't know who will own the building, or asset, 50 or 100 years down the line. It's frustrating."

One solution is for building designers and contractors to become the operators of new facilities, on behalf of owners. "That way, the Building Information Model used for construction is also used for operations, and all the asset information remains current and is with the building when it's time to disassemble," Magdani says. "This will realize value for asset owners rather than the industry thinking about their assets as a liability."

But there's also value in the most basic building materials and fixtures—if

The Circular House, built with "borrowed" materials to be returned after disassembly. Courtesy BAM.



A peek inside the Circular House, which has now been disassembled. Courtesy BAM.

the market exists. "One project we're working on is for an engineering company that wants office space for just the next 10 years, for which they would pay fixed rent as tenants," Magdani says. "Our design response was to repurpose an existing warehouse, and we were able to source secondhand materials like rafters, cubicles, ductwork, et cetera. It worked, but we had to convince investors that their investment will still have sufficient value at the end of 10 years, if it gets disassembled. For that, a marketplace will help."

To that end, BAM is developing an online marketplace that makes supply and resale of building systems, products, and materials more practical. Magdani also believes that demolition contractors need to redefine their roles when it comes to materials. "Really, they're urban miners," he says. "When they disassemble buildings, they are recovering valuable resources that can be put back into buildings and cities—it's a tremendous opportunity."

Applying circular business models in construction will certainly be disruptive, but doing so has the potential to provoke positive change in an entire economic sector. And if Earth is indeed a spaceship with limited resources, embracing the circular economy might be the best way to keep all its passengers alive and comfortable.

How Positive-Energy Building Can Create Tiny Houses With a Big, Green Impact

By Susan Kuchinskas

In October 2018, the world received a dire warning: In just 12 years, without a drastic reduction in carbon-dioxide emissions, global warming will reach an unsustainable level. According to the Intergovernmental Panel on Climate Change report, global energy production from renewable sources needs to jump to 50–60 percent to avoid rising sea levels, floods, droughts, and famine.

The prefabricated Solace house can travel in a single cargo container and takes about three days to assemble with a crew of three people. Courtesy Solace House.

Reaching that level of renewable energy is an immense task. Almost half of the energy generated in the European Union (EU) comes from fossil fuels; in the United States, that number is 63 percent. In the EU, general household usage accounts for a 25.4 percent of all energy use, with 64.7 percent of that used for heating homes. In the United States, the average annual electricity consumption for a residential utility customer is 10,766 kilowatt hours (kWh).

Polish startup Solace House aims to flip the household-energy equation through positive-energy building: Instead of houses that suck up energy for heating and lighting, it builds homes designed to generate more energy than its inhabitants use.

Live Large in a Small House

"In 2018, buildings are built in a way that is completely wasteful for society," says Solace House cofounder Bartłomiej Głowacki. "It's harder to govern designers, builders, and society in a sustainable way because what's governing them is the cash. The higher the cash, the higher the influence you can have on the planet."

Solace House strives to provide cheap, high-quality homes that are emission free, carbon neutral, and energy positive. The three-year-old company unveiled its first product—a complete home in Warsaw, Poland—in September.

Głowacki and cofounder Piotr Pokorski met three years ago. Pokorski, an architect, had experience developing modular, energy-efficient houses since 2010 and received a patent on his design for a passive solar home.

Głowacki, a former management associate for Citi, was working on an MBA in art and communications and had long been interested in sustainability. His team won a global student competition helping to design a solar-powered water-purification unit. He also helped design Bug Hub, a solar-powered microfarm kiosk for raising and processing insects for food and income in sub-Saharan Africa.

To realize Pokorski's home-design vision, they spent the first year of their collaboration testing the market to see if these design ideas would sell. The feedback exceeded expectations, with more than 1,000 inquiries in one month.

> The design maximizes solar-energy production while minimizing heat loss or gain through the exterior walls. The roof is covered with solar panels.

Tiny Price, Big Impact

A Solace House is small indeed—just 35 square meters (377 square feet) with a total living space of 45 square meters (385 square feet), thanks to a loft. Home sizes vary widely in Europe and North America; according to the UK's Office of National Statistics, the average size of homes sold was 63 square meters (678 square feet) in Eastern European countries such as Lithuania and Latvia, 90 square meters (969 square feet) in the UK, 106 square meters (1,141 square feet) in Portugal, and a whopping 245 square meters (2,637 square feet) in the United States.

Each prefabricated Solace House fits into a single shipping container for transport and can be assembled on site in three days by a crew of three. Głowacki says they simplified the construction process to require the least amount of installation work—such as

For a typical European climate, the Solace House's array of 24 solar panels can produce slightly more energy in a year than the homeowners will use. Courtesy Solace House.

A nontoxic polyurethane foam insulates the Solace House interior. Courtesy Solace House.

The shape of the house maximizes energy collection—a design decision that intentionally emphasizes building performance rather than the designers' ideal aesthetics

connecting solar panels to the utility company's meter and connecting to the sewer system—while still making it a suitable all-season house.

The design maximizes solar-energy production while minimizing heat loss or gain through the exterior walls. The roof is covered with solar panels. In a typical European climate, Solace House expects the solar installation to produce 6,500 kWh per year—inhabitants are expected to use around 6,000 kWh, a net gain of 500.

Poland's net metering system keeps track of the solar energy that homeowners produce during the day and gives back 0.8 kWh for every 1 kWh of surplus when the home needs it during the night or in the darker winter months. The idea is to store surplus energy over the course of a year with Poland's net metering system and get back enough to fuel the house year-round after the grid takes its 20 percent tax.

The shape of the house maximizes energy collection—a design decision that intentionally emphasizes building performance rather than the designers' ideal aesthetics. "It's the highest volume with the lowest possible wall surface, while the rooftop angle of 32 degrees provides the most exposure to the sun," Głowacki says.

Smart, Safe Materials

Pokorski's design, created in Autodesk AutoCAD, combines highly effective thermal insulation, a heating and ventilation system that recaptures heat, and a new type of modular construction that eliminates framing. The lack of framing lowers the cost and also reduces thermal bridging, the transfer of heat through an insulated wall via a conductive material.

Instead, Solace is constructed of MFP Living Boards, a type of water-resistant chipboard (unlike regular chipboard, this one doesn't emit formaldehyde), supplied by Pfleiderer. The second element of the building's construction is nontoxic polyurethane foam from Lallafom USA to provide maximum insulation without harmful compounds. Two walls and the roof of the building are covered with Blachprofil 2, a modular steel sheeting that's highly recyclable. The other exterior walls are sheathed with Siberian larch, harvested responsibly by Polish wood supplier DLH.

The company says 80 percent of the materials used can be recycled. And then there's the tiny price: $40,060.50 for the whole package, sans interior paint and flooring.

The Warsaw house includes a smart energy system created by telecom Orange Polska. Multiple sensors give inhabitants greater control of energy consumption. Although not included in the basic package, the components of the HVAC system can also be enabled with smart controls. "The management of energy and electricity doesn't require any additional devices," Głowacki says. "The crucial scenario is the heat inside the house connected to the air exchange and the solar panels."

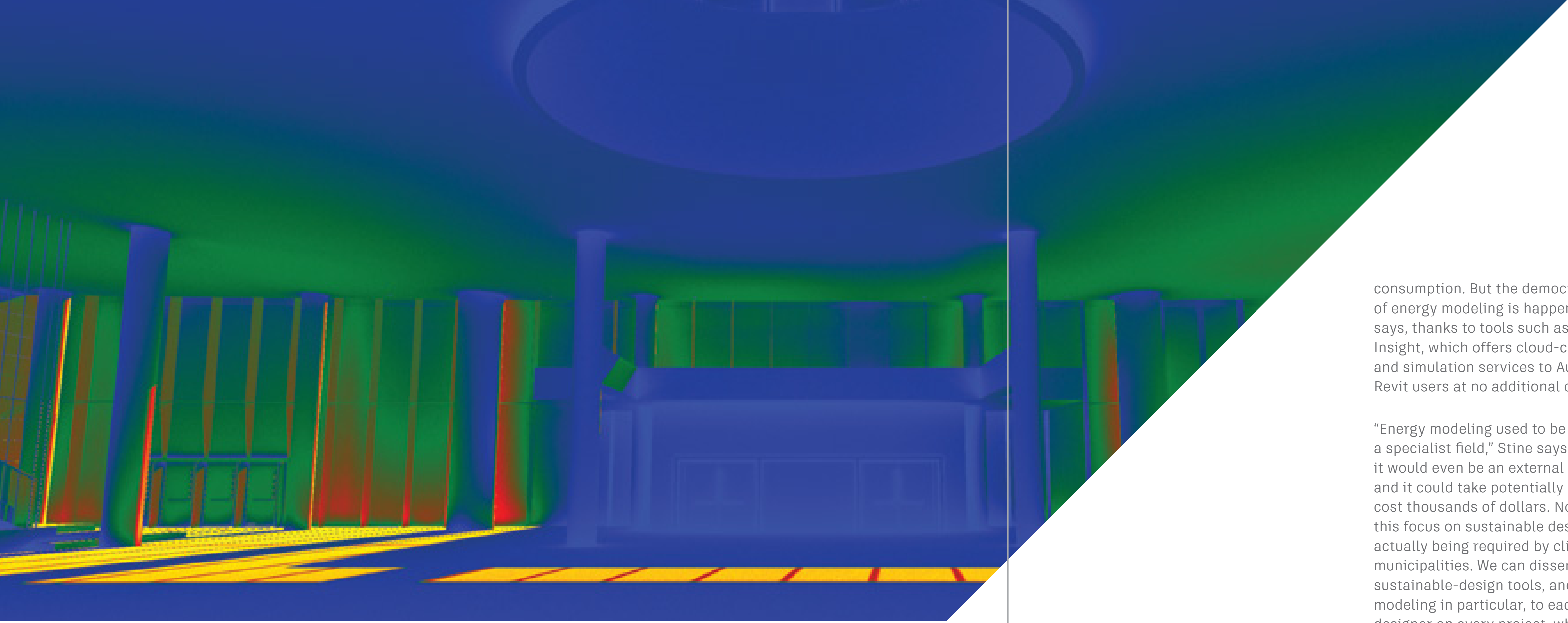
Scaling Up

So far, Solace has been mostly financed by its cofounders and with some small grants from the European Commission—notably 50,000 euros from the Horizon 2020 SME (Small and Medium Enterprises) Phase 1 Grant; 20,000 euros from European climate innovation initiative EIT Climate-KIC; and 50,000 euros from a variety of smaller grants and competitions. Several of the materials vendors also contributed to the construction of the demonstration home.

The company is seeking a grant of 2.5 million euros from the European Commission that would fund factory processes for producing 15 houses a month. If the grant doesn't come through, Solace will proceed house by house, using the down payment from each buyer to build a single home using manual processes.

Głowacki sees a primary market in young, eco-conscious people contemplating their first home purchase. Beyond that, he'd like the Solace House to turn its owners into sustainability evangelists. "They can tell their families and friends how proud they are that they are sustainable," he says. "And they will start the movement."

Solace House cofounder Bart Głowacki (far left), architect Pawel Krynski, communications officer Natalia Struzik, and cofounder Piotr Pokorski. Courtesy Solace House.



Energy analysis can be used to review daylighting and glare, as in this lobby design. Courtesy Corgan.

4 Ways Energy-Analysis Tools Work for Architecture Firms—and the Planet

By Kimberly Holland

It's no longer enough to build walls with recycled wood pulp or roof buildings with energy-absorbing tiles and call your work "green." Companies want energy efficiency from top to bottom, roof to slab, folding environmental considerations into the entire process. Designers and architects are being called to lead the way—and using energy-analysis tools helps you get there.

To reap the potential rewards, firms have to know where to start. Energy-modeling tools determine how much energy a building requires per year, based on its size, orientation, and materials. Dan Stine, AIA, CSI, CDT, and BIM administrator with LHB in Duluth, Minnesota, encourages firms of all sizes to develop training for energy-analysis skills.

Adopting and properly using the latest tools has a measurable learning curve—even for associates fresh out of school—to produce the high-quality modeling needed to project a building's energy consumption. But the democratization of energy modeling is happening, Stine says, thanks to tools such as Autodesk Insight, which offers cloud-computing and simulation services to Autodesk Revit users at no additional cost.

"Energy modeling used to be primarily a specialist field," Stine says. "Often, it would even be an external company, and it could take potentially weeks and cost thousands of dollars. Now, with this focus on sustainable design, it's actually being required by clients and municipalities. We can disseminate sustainable-design tools, and energy modeling in particular, to each individual designer on every project, which is really cool."

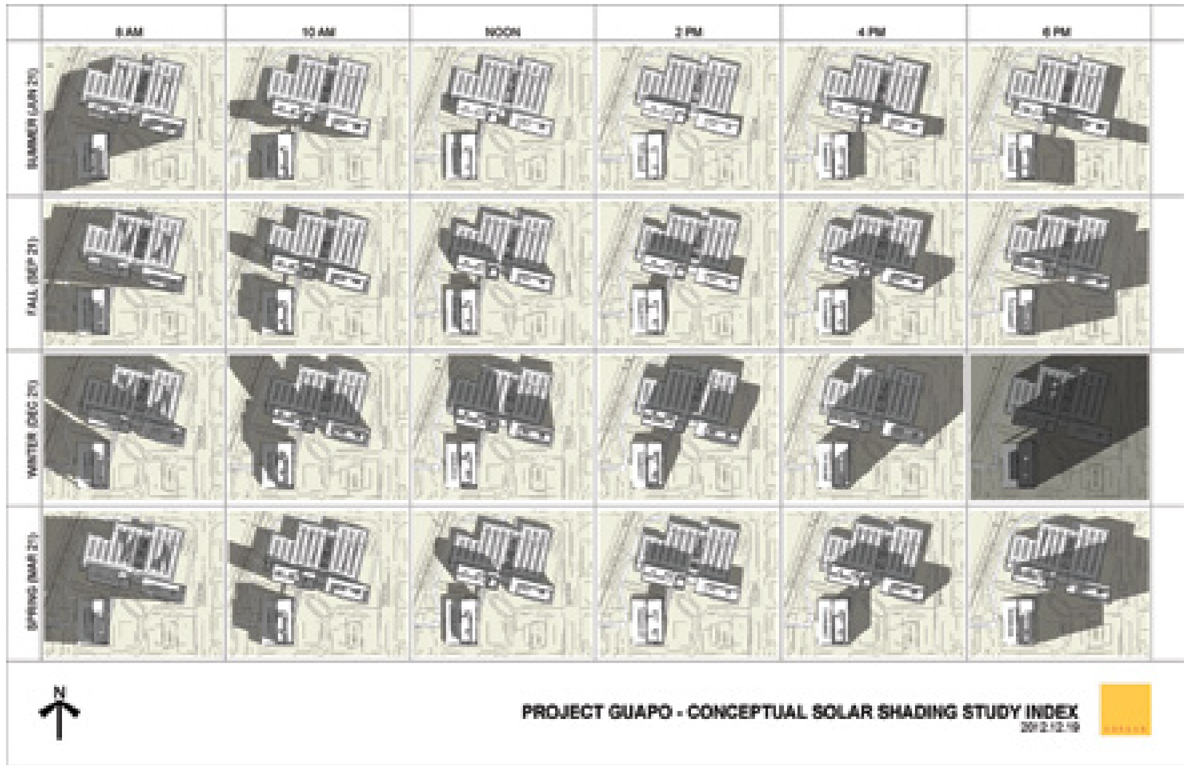
Read on to discover four reasons why you should adapt energy-analysis tools and keep your firm ahead of rapidly evolving energy demands.

1. Energy Analysis Makes Your Firm More Earth Conscious

Decades ago, it was difficult to really understand the impact that buildings have on the environment, says Justin Dowhower, AIA, LEED AP, WELL AP, and an associate with Corgan in Dallas. But today, clients and owners want to better understand everything that goes into a building and what it will cost in the long run. That requires more research up-front with everything from environmental impacts to energy consumption and generation.

"When we start to go through design development and we're doing pricing, we can go back and say: 'Yes, these are actually required. It's not just a pretty thing we threw on the building,'" Dowhower says. "If you want to value-engineer it or take it out, we can show you the data of all the impacts it's going to have on building performance."

A corporate headquarters design. Courtesy LHB.



This thumbnail study looks at changes in sun and shadow angles on a site throughout the year. Courtesy Corgan.

"As designers, it's easy to simply copy-and-paste what we've done on a previous project because it saves time and we know it worked before," Dowhower says. "But now more than ever, we're realizing that every design decision we make requires thorough research. We need to push the building industry—manufacturers in particular—to help with disclosing the environmental and health impacts of materials and products that we put in our buildings." Stine uses carpet sourcing as an example. When considering lifecycle analysis (LCA), where the carpet comes from greatly impacts the building's initial energy costs—from the extraction of raw materials to production to transport from the manufacturer to the construction site.

"In Mississippi, they might make a lot of carpet," Stine says. "To ship that to northern Minnesota has an embodied cost of putting that carpet on a truck and bringing it here. LCA tools can track all of this information associated to all the different elements in a model and know where to look for better options. Our goal is to reduce the global-warming potential as much as possible, which is better for the environment."

2. Smarter Design Makes Happier Clients

"The ideal result of sharing energy-analysis results early on between the designer and the client is that meaningful changes are still able to be made that will not affect the project schedule or require previous work effort to be undone," Stine says.

Energy modeling creates outputs that enable side-by-side comparison of materials, a visual benefit that helps improve client communications. This, Stine says, has helped firms make more informed design decisions and helped clients better understand their cost and energy implications.

"Energy modeling is no longer just steady-state energy modeling," Stine says. "Insight has taken a wide range of inputs for glass and for the roof and possible positions and analyzes all of those possibilities. There are literally thousands of options. Once you get into the cloud, you play with these settings, and the end result also changes—in real time—the energy use index. If you wanted to try more glass on the north side of the building or more roof insulation, you can see it change in real time instead of having to run a variety of calculations and inputting them back into your model."

3. Performance Analysis Creates Efficient Buildings

Energy modeling—or performance analysis, as Dowhower calls it—isn't just looking at which way the windows face, where the carpet comes from, or how the paint is made. It also analyzes how the building will be used and how it can save companies money.

"Every three years, a new energy code comes out, increasing the minimum energy-performance standards," Dowhower says. "We're seeing that LEED is pretty commonplace now, and that's above and beyond the code minimum requirements. If the client is also going to be a tenant, such as a corporate office project, they care about their long-term energy and utility costs, so they want to see energy savings over time."

Performance analysis can also be explored using occupant evaluations. Stine's firm did this kind of study with its own Minneapolis workspace before creating a renovated, LEED CI Platinum–certified space in a historic building. The design team collected valuable information from the occupants—their coworkers—to learn how the space worked for them and applied this research to their new workspace. After the project was complete, LHB did a post-occupancy evaluation (POE) to see how well the design goals and intentions matched up with the reality. The team not only shared the results of the POE with the entire company to assist in future projects but also presented the findings at conferences such as Greenbuild to help move the industry forward.

4. Energy Analysis Can Help You Justify Design Decisions

Price is always a sticking point, but one of the benefits of energy analysis is demonstrating the value of your choices. For example, Dowhower says, recent work on a mostly glass building provided the opportunity to create almost a dozen sun-control options for his project. From that, he was able to find the optimized solution and present it to the client.

"When we start to go through design development and we're doing pricing, we can go back and say: 'Yes, these are actually required. It's not just a pretty thing we threw on the building,'" Dowhower says. "If you want to value-engineer it or take it out, we can show you the data of all the impacts it's going to have on building performance."

Dowhower says companies and firms of all sizes can benefit from bringing energy analysis into their everyday processes. "Firms that have figured out how to integrate performance analysis into their existing workflows have the most success," Dowhower says. "Services that firms try to add as something 'extra' or 'enhanced' are usually rejected by clients who don't want to pay for something that should already be included. Successful firms are making it part of the design process. They're not calling it anything different. It's just a best practice and good design."

Successful firms are making it part of the design process. They're not calling it anything different. It's just a best practice and good design.

7 Tactics for Meeting the Architecture 2030 Challenge and Beyond

By Heather Head

As the impacts of global climate change escalate, forward-thinking architecture firms have committed to being part of the solution.

Increasingly, these firms are signing on to the 2030 Challenge and American Institute of Architects' supporting initiative, AIA 2030 Commitment, which provide a framework to reduce fossil-fuel dependence and make all buildings, developments, and major renovations carbon neutral by 2030.

The 2030 Challenge has been adopted by 80 percent of the top 10 and 65 percent of the top 20 architecture, engineering, and planning firms in the United States, as well as many state and local government agencies. Among these are Eskew+Dumez+Ripple (EDR), a New Orleans–based architecture and planning firm; HOK, a global design, architecture, engineering, and planning firm; and CTA Architects Engineers, an integrated design, engineering, and architecture firm with offices throughout the Western United States and Canada.

Here, five professionals from EDR, HOK, and CTA share seven key tactics they've employed to move toward the 2030 target—and a sustainable future for the planet.

1. Innovate Across the Portfolio
All three architecture firms stress the importance of raising the bar for energy efficiency across a company's entire

Miller Park Café Pavilion in Chattanooga, Tennessee. Courtesy EDR.

Innovate ABQ building in Albuquerque, New Mexico. Courtesy Dekker/Perich/Sabatini.

portfolio of projects. That approach underpins every effort they make toward achieving the 2030 Challenge.

"We don't want to just target the projects that have high sustainability goals," says Jacob Dunn, an architect at EDR. "We are really interested in raising the entire bar for the middle of the distribution of projects."

2. Set Energy-Use Targets Early

"We talk about the 2030 Commitment during the marketing phase and set targets and benchmarks during conceptual design," says Anica Landreneau, director of sustainable design with HOK.

Ashleigh Powell, a sustainability director at CTA, adds that establishing Energy Use Intensity (EUI) targets at the beginning of a project creates a different way of thinking for designers and sets them up for success.

And Landreneau's team gets buy-in from clients. "We find that when the client is part of that discussion, everyone works toward that target," she says. "People forget that it wasn't mandatory or contractually obligated. They just keep working toward it."

"It's not just a matter of establishing targets, but getting that information to mean something to the designers themselves." - Ashleigh Powell

3. Model Early and Often

According to Richard Dykstra, a BPA specialist at CTA, modeling can help internal teams communicate better. "We start early on with all the teams–architecture, engineering, construction, and the owners–to figure out what the goal is," he says. "Then we play around with different models to figure out what has an impact on that goal and what doesn't. We use that to inform the design early on. Then we bring everyone together regularly, running simulations and architectural design side by side."

There can also be financial benefits to early modeling for first cost (the sum of initial expenditures on a building project). "If you don't do the model early enough, you lose the opportunity to find trade-offs where you can come in with a high-performance design that is first-cost neutral or even [yields] first-cost savings," Landreneau says.

4. Balance First Cost Against Operational Cost

But how do firms approach clients who aren't interested in sustainability?

Going after the easy fixes first is one tactic CTA uses, and along with early modeling, it can help find first-cost savings in unexpected places. "We're working on a small school that is not interested in energy conservation," Dykstra says. "They just want a school that works. We're doing everything we can to make responsible choices for them, but with a lower budget, we're obviously not going to get a super-high-performance building. We do what we can to fix some of the low-hanging fruit for them and make a highly functional, high-performing building."

There are always trade-offs, and some of them can pay off in the long run. "Another main challenge is communicating cost-benefit relationships," Dunn says. "Looking at lifecycle cost analysis and being able to communicate all the differences in the different types of operational energies and design impacts of each decision, and how that affects the bottom line down the road."

5. Make Energy Modeling Accessible and Visual

Tim Johnson, an engineer with CTA, explains how making the models visual helps to engage architects and other stakeholders in the process. "In the past, all the energy work was limited to mechanical engineers, because that's where the turnkey parts of the energy models usually are," he says."It's important to make this process more accessible to everybody to do the analysis, without hindering creativity."

All three firms cited this approach as critical to their success. "You've really got to have your firm partners involved in terms of advocating to clients," Dunn says. "It's my firm belief that architects should be running performance simulations so they can do this."

Additionally, EDR has weekly meetings with project managers and other stakeholders and trains the staff in running simulations and calculations so that the sustainability planning has become a part of every level of the organization.

"It's not just a matter of establishing targets," Powell adds. "But getting that information to mean something to the designers themselves."

6. Integrate Environmental Performance Into the Design Process

"When you start simulating, it's critical to have the right tools–that way, it's easy for architects to learn simulation analysis," Dunn says.

One such tool is Autodesk's Insight, which is integrated directly into Revit and FormIt and allows architects to run multiple energy-modeling scenarios in a fraction of the time it used to take. "These tools weren't available even a few years ago, but so much development happened that incorporating them into design is now within reach," Dunn says.

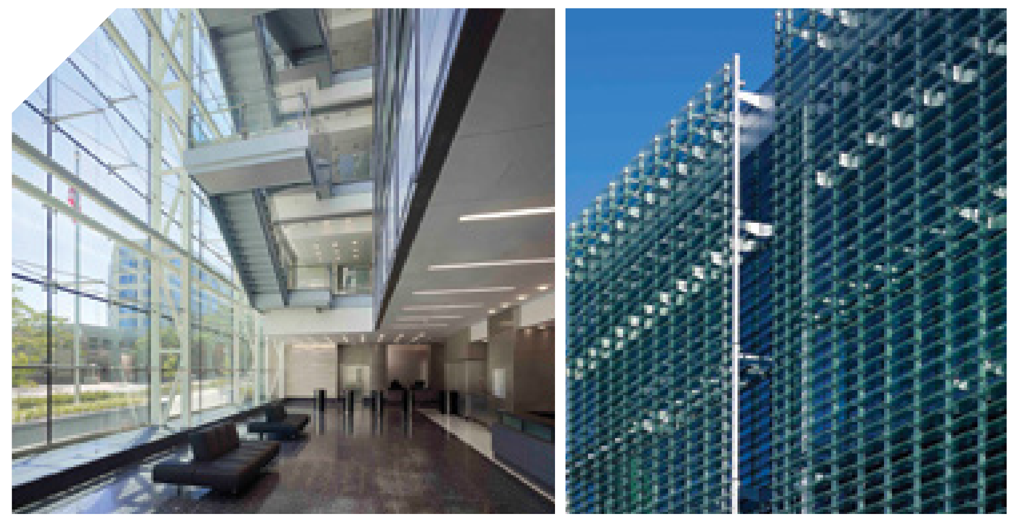
"Insight lets just about anybody into the energy-modeling world without having to know complex HVAC systems," Johnson adds. "In Insight, we can run 100 simulations at once and see where the thresholds are and where it is and is not going to be cost-effective to make changes."

7. Integrate Sustainability Into Hiring Practices

By recruiting and hiring people who are passionate about sustainability, firms secure their ability to reach their sustainability goals over the long term. New talent also brings ideas and innovation to the table essential to meeting the 2030 Challenge.

"There's a wide spread of university programs and students who care about these issues and others who don't," Dunn says."You have to be intentional about the type of people you seek out." He adds that it's also important to assign someone on your team to research and design programs for sustainability so that it becomes a part of the fabric of the organization.

Global climate change is poised to become one of the industry's most pressing concerns. Firms committed to the 2030 Challenge can lead the way by getting more designers involved in energy discussions throughout the design process and by using these seven tactics to significantly reduce the carbon footprint across their projects.



DC Consolidated Forensic Laboratory in Washington, D.C. Left image courtesy HOK. Right image courtesy Alan Karchmer/HOK.

3 Top Trends Show Green-Building Technology on the Rise

By Susan Kuchinskas

A featured company in the World Green Building Trends 2018 report, NBBJ designed The Spheres for Amazon's downtown Seattle office complex. Courtesy Amazon.

The Johnson Controls Asia-Pacific headquarters in Shanghai, China, is one of the most sustainable corporate complexes in Asia. In the summer of 2017, the campus opened as the first building in China to earn three green certifications: LEED NC Platinum, the World Bank's EDGE, and China's own Green Building Design Label.

Although just one example, the Johnson Controls building is indicative of a larger move toward green building worldwide. According to the World Green Building Trends 2018 report, three emerging trends in green-building technology are advancing the sustainability revolution in architecture: energy-analysis tools used at every stage, the promise of generative design, and the use of data from design through the building's entire lifecycle.

Dodge Data & Analytics, publisher of the report, surveyed more than 2,000 architecture, engineering, and construction professionals and found global growth in green-building projects: 47 percent of industry professionals expect more than 60 percent of their projects to be "green" by 2021.

NBBJ, one of the architecture firms surveyed for the report, takes green building quite literally for its project The Spheres (Amazon's new Seattle office complex)—its interconnected steel-and-glass domes form a conservatory for more than 40,000 plants from the world's cloud forests. However, the report defines "green" projects as including, at a minimum, efficient use of resources; waste and pollution reduction; high indoor-air quality; and as much renewable energy, nontoxic and sustainable materials, occupant quality of life, and environmental adaptation as possible.

Many incentives now entice architecture and construction firms to create buildings that meet those requirements. Owners are seeing a 10 percent or greater increase in asset value for new green buildings compared to traditional ones—as well as decreased operating costs and a shorter payback period. Survey respondents were also much less concerned with the higher cost of green building, with only 49 percent of them citing it as a factor, compared to 76 percent in 2012.

Here is a closer look at the World Green Building Trends 2018 report's three emerging green-building technology trends.

"I want us to have a good feedback loop when we're doing things that we tend to do quickly and early."
- Margaret Montgomery

1. Using Energy Analysis Early and Often

The most important trend identified by survey respondents was the availability of early-analysis tools for use with building information models to analyze building performance.

Analysis of potential energy use and daylighting is crucial for green building at every stage of the design process. For example, providing natural light to as much of the building as possible reduces the use of electricity for lighting—except in hot weather, when it can increase the heat load.

Architects and engineers can make those calculations using Building Information Modeling (BIM) and energy-analysis tools such as the Insight tool within Autodesk Revit. The integration of design programs such as Autodesk AutoCAD with BIM lets architects and engineers use an iterative process to find optimal solutions. In-house architects can begin to model energy consumption early in the design process,

without waiting until the design is turned over to consultants.

Margaret Montgomery, principal and sustainable-design leader at NBBJ, said in the report: "When our designers start at day one, they probably don't have the other disciplines sitting there with them as they are initiating their first design doodles, but I want the software to be able to support them [at that stage]. … I want us to have a good feedback loop when we're doing things that we tend to do quickly and early."

In the report, Brandon Garrett, associate and architect at Dekker/Perich/Sabatini (D/P/S), said that integrating these tools lets energy analysis "become part of the dialogue throughout the design process."

Understanding a project's energy needs is also useful in client discussions, allowing the design team to demonstrate impacts of key design decisions such as building placement and mapping–sometimes on the fly during a client meeting.

Aaron Ketner, energy specialist at D/P/S, noted that when his team can demonstrate the impact of basic design decisions on the spot at a meeting, it impresses clients, who tend to think that a firm will have to figure out those impacts off site and come back to them at a later date.

2. Heeding the Promise of Generative Design

Generative design has been called BIM 2.0. With generative-design software, designers or engineers can input design goals along with parameters such as materials, manufacturing methods, and cost constraints. This removes a lot of the guesswork inherent to the process of proposing a building design first and then analyzing its potential performance. The software can generate a variety of building designs or come up with the optimal orientation, glazing, and window treatments based on preset energy-performance parameters.

"There are inherent things in terms of beauty and delight that a computer is not going to be as effective at simulating," - Ellen Mitchell Kozack

In the World Green Building Trends 2018 report, Garrett predicted that such tools will become more and more automated into a designer's workflow: "A dashboard sitting there as you work, and as you are designing and making decisions, performance moves up or down. So it is no longer a second thought process to run the analysis, but, rather, you get live feedback as you design."

Generative-design software is already being used to design machine and building parts. For example, LMN Architects used generative-design scripts to create an acoustic reflector for a majestic new music hall at the University of Iowa School of Music Voxman Music Building.

Software will not likely create complete architectural designs, as Ellen Mitchell Kozack, principal and director of sustainability at HKS, said in the report. "There are inherent things in terms of beauty and delight that a computer is not going to be as effective at simulating," she said, "but [the technical tasks of understanding how a structure performs] can be solved by a computer very easily."

3. Using Data at Every Stage

The survey results of the World Green Building Trends 2018 report show that today's smart buildings expand the reach of the Internet of Things (IoT). Their many sensors measure factors such as occupancy, air quality, and temperature. Currently, the data generated from these sensors is often siloed in building-automation software, also known as building-management systems (BMS).

In the past, building owners seldom shared BMS data with architects; however, an emerging trend is changing that by tying building automation systems into BIM tools. This lets architecture and construction professionals understand the actual performance of a building, as well as consider potential performance throughout the planning, design, construction, and management processes.

For example, some BMS can count the people in any space in real time. This can let building systems proactively turn on ventilation to prevent carbon-dioxide buildup. Feeding this information back to architects could help them understand how users actually circulate through spaces, inspiring design strategies for improved routing or to encourage the use of stairs.

Sensor data could also make buildings more predictive than reactive. For example, climate-control systems could use the weather forecast to precool or preheat the building at off-peak times.

According to Kozack, this flood of building data is starting to fundamentally impact design. "As we move toward IoT, people will rely more and more on data to inform decisions," she said. "I think once that comes, there's no going back."

As an example, Schneider Electric in Grenoble, France, is leveraging IoT data in the design of two corporate buildings that aim to exceed the LEED Platinum standard. Designers are using energy analytics and BMS data from one completed building to lower the energy consumption of the second building by an additional 8 percent.

Right now, buildings contribute significantly to climate change, producing about 28 percent of global energy-related carbon-dioxide emissions. The three trends outlined here show the promise of technology to produce more sustainable buildings. These technologies not only result in highly energy-efficient structures but also automate processes that grant architecture, engineering, and construction professionals more brainpower for creativity.

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