A CINEMATIC MINDSET

NELSON AERIAL PRODUCTIONS WINS SECOND ANNUAL ENGINEERING DRONE VIDEO OF THE YEAR

Matt Cummings
A Global Journey with Milestones

Lisa Nisenson
An Emerging World
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I MIGHT BE AN ENGINEER, but I love a good story about marketing and business. And that’s exactly what I found in Jordan Nelson, the entrepreneurial founder of Nelson Aerial Productions, Inc., winner of C+S Engineer’s second annual Engineering Drone Video of the Year.

The 30-year-old upstart and his compelling video compilation – it features footage from 10 building implosions captured over the course of four years – beat out 60 other entrants. Not bad for a guy who is a self-taught, one-man show with a degree in geography.

In my role as President and CEO of Zweig Group, I talk a lot about elevating the AEC industry, imagining what’s next, hustling for results, and figuring out problems. Nelson embodies all of this. When he was still in his 20s, he found his passion, committed himself to excellence, and made his services viable in the market. Along the way, he solved plenty of problems, envisioned his future, and certainly put in the long, hard hours. He’s now enjoying the rewards he deserves, which include an important recognition from his hometown Boone Chamber of Commerce in North Carolina.

If you know his story, like I do, then you’ll agree it’s pretty amazing. But before I go further, I’ll share a few details about the drone contest itself. From last year to this year, submissions doubled, web traffic tripled, and the quality of the content was elevated. Around 18,000 people voted live for the three finalists this spring at the AUVSI XPONENTIAL Conference in Chicago, with Nelson winning the crown over CATEC and Civiltech Engineering Inc.

Now, back to Nelson. A graduate of Appalachian State University, his background is in science, not videography. But that’s where he’s making his name. He got his start using a GoPro camera to record his snowboarding adventures in the Smoky Mountains. But he soon gravitated to drones and aerial footage, sharing his videos of Boone and the surrounding area on social media.

A contractor was familiar with these videos, which had become quite popular, and when it came time to film the implosion of an old dorm on the App State campus, he gave Nelson a call. The rest is history. Nelson would go onto film a dozen more implosions, effectively building an entirely new business line to go with what he was already doing, video of architecture and golf courses. He has a fleet of drones, and records in either Cinema DNG or Apple ProRes at up to 5.2k resolution. He uses the good stuff.

So, was a little luck involved in Nelson’s transformation from snowboarding guru to an industry-recognized entrepreneur with a dozen implosion videos under his belt? Probably. But the story is more about Nelson’s initiative and drive, his attention to detail, and his ability to make, and own, a decision.

In an interview with C+S, Nelson said he wants to broaden his suite of offerings to include inspections. In an age of growing interest in the holistic lifecycle of buildings and infrastructure, this sounds like a great idea. He even said he’d like to figure out a way to marry his love of video production with his degree of knowledge of geography. Knowing Nelson, he’ll figure out a way to get it done.

The fun thing about all this is that Nelson had never been to Chicago before. Outside of the AUVSI conference, he took time to enjoy the city – deep-dish pizza, a hot dog heaping with “the works,” and one of the world’s great skylines. He made a few new connections but also met with friends he’d only known through social media. Sounds like he had a great road trip, and we were honored to be part of it.

Read Nelson’s story. Share it with your friends and colleagues. He’s elevating the industry, and that’s something that should be celebrated.

CHAD CLINEHENS, P.E., is Zweig Group’s president and CEO. Contact him at cclinehens@zweiggroup.com.
SLICING THROUGH A WIDE RED RIVER, our small boat approaches the muddy clay shore. A green crocodile startles and deep dives. At the sun-drenched landing spot, girls clad in royal blue blankets wave at us. As our party lands on the shore, they run toward us and stare with intense, magical gazes. Their eyes are pure deep black, and all their eyelashes have been removed. As we step onto the grass, they poke our skin and reach out to touch us and pull on our hair. They are as curious about us as we are about them. I notice the girls all have elongated earlobes, in which large plates are implanted. Women have large clay plates, as round and large as six inches, placed below their bottom lips. An incision is cut below their bottom lip when girls are young and ever-larger-sized plates are inserted as ornamentation – a sign of beauty for this remote African tribe.

I am in Ethiopia, close to the South Sudanese border. Here in the Omo Valley, eight different indigenous tribes have lived for millennia, totaling about 200,000 people. This is where humankind originated. A two-million-year-old fossil of a humanoid was found here. We are visiting a tribe known as the Mursi. There are about 5,000 of them living in the jungle, grouped into small family bands. Their lifestyle is nomadic, but they rely on the Omo River to flood annually to irrigate their riverside crops – mostly sorghum, a type of grain. They have very little contact with the outside world. Our boat is the only motor-powered boat on the entire Omo tributary. Their language and customs are unique, and they are the only Mursi people in the world.

Our chief guide is Lale, who hails from a nearby tribe called Kara, an indigenous tribe of the Omo Valley. He is a 40-something, tall, muscular man with a determined face. His quick smile keeps things cheerful. He is one of very few in the region with a college education. Highly articulate and strategic, he has a warm personality and speaks several languages, including fluent English. Being a guide, he is conversant on current world affairs and he even cracks a few Trump jokes.

Lale translates as the Mursi chief, Weletula, talks.

“The annual flooding of the Oma River has been stopped for three years now,” he said. “Some old are starved and dead, and young families are scattered to the forest for food. I don’t know where they are now. I am losing our people and tradition. A large dam built upstream stopped all the annual flood water.”

He is talking about a massive hydro-electric dam, Gibe III, a $1.6 billion, 1,870 megawatt, 240-meter-high concrete structure that doubled Ethiopia’s power output for its expanding agricultural business. This is the third largest dam in Africa. This great engineering achievement will help the country progress. But at the same time, marginalized indigenous communities are starving. And their culture and traditions, dating back thousands of years, are being lost.

The next day, Lale takes us to his Kara homeland downstream. It is a tribe of 3,000 people with a distinct language. Only one in the world. It is famous for its colorful body painting, elaborate clay-formed hairstyles, and trading skills. Kara is a farming tribe that also relies solely on the annual Oma River flooding. He leads us to their ceremony house, a one-story wooden construction about half the size of a football field. It is indeed a magnificent structure with a heavy timber roof and columns, and has a sacred feel.

Lale asks us to leave our Land Cruiser because it is forbidden to drive on the grounds here. As we approach the sacred structure, I see five ancient men sitting on small carved wooden chairs. They look very formidable with paint and tattoos covering their bodies, which are skinny but muscular. Lale explains that they are the Elders who lead his tribe. Elders are chosen, not by their blood, but by their abilities and wisdom. All ideas from anyone are considered and debated. Their political system is very democratic and advanced.
“Our people and traditions are dying,” Lale says. “For three years, Gibe Dam is built, no more flood. This means no more harvest. Without it, our tradition forbids a ceremony for young boys becoming men, the Bull Jumping Ceremony. This is the ancient custom – brave boys run and jump over several bulls and are recognized as men. Then they can be married. We haven’t got any marriages for three years now. It is tradition. It must happen.”

One of the ancient elders adds, “We are starving as our ancestral land is. Our young people are leaving for jobs in the sugarcane plantations to feed their families and get married. Our 1,000-year tradition is disappearing from us in front of our eyes.”

Lale signals us to come down to the river. An array of new solar panels sits on the bank connected to a floating pumping system on the river. “We worked on politics for a while to release water for just two weeks during flood season in vain,” he said. “Politics takes time. Technology is the only way out to save our people now. One solar-powered pump system can feed 25 acres of land, which can yield crops to feed 200 people. For our village of 800 people, we need three more like this.

“It cost $100,000 per a pump, reservoir and irrigation system. I even made a trip to London to raise money. We raised $60,000 so far and now you see the result of it. I am working to raise the rest before this summer’s flood season to complete this for the first 25 acres. But I need to work on the next three irrigation systems to save our people.”
I respect that he has come up with such an ingenious but simple engineering solution rather than hitting the wall on politics or blaming circumstances. He is already acting on the solution. It is the best practice of leadership at work. Now the Elders and his people are following his lead.

The Great Gibe dams, a cascade dam system that empowers cultivation of large, modern plantations, may help Ethiopian prosperity. But there are forgotten victims created by this great engineering achievement. A simple engineering solution can save a millennium of tradition, language and culture. This is not about Kara, Mursi or Lale. This is about us. This is about how we as humans can keep our diversity and culture.

We can do this one village at a time. The first one will need four solar-powered pumps at $400,000. You can save the Omo Valley civilization and its last indigenous tribes. Please contribute any amount to Miyamoto Global Disaster Relief at www.miyamotorelief.org/donate. It is a U.S. nonprofit organization. We will make sure that donations go to constructing solar pumps and water systems for Lale and his tribe. You may affect a small chapter of human history.

H. KIT MIYAMOTO, PH.D., S.E., is the CEO and a structural engineer for Miyamoto International (http://miyamotointernational.com), a California seismic safety commissioner, and president of the technical nonprofit Miyamoto Global Disaster Relief. He specializes in high-performance earthquake engineering and disaster mitigation, response, and reconstruction.
NOT QUITE THE ULTIMATE, YET. The locals in central Florida are grumbling. The $2.3-billion, 21-mile highway project through the heart of Orlando, known as the I-4 Ultimate, is experiencing some serious PR problems. At least four deaths, 160 reported injuries, a grinding construction schedule, route changes, orange-coned bottlenecks, seven-figure change orders, and fines have Orlando residents fuming.

The misgivings led one TV station to make this the lead of one of their stories: “Two things are all but certain in Central Florida: Humid summer days and construction on I-4.” But local news outlets aren’t the only ones taking notice. The project, and all the problems associated with it, made The Wall Street Journal in late May. And not one byline on the story, but two.

Highway construction is never painless, but what makes the I-4 Ultimate stand out are the players involved, the money being spent, the environmental ambitions, and the delivery model being used. The I-4 Ultimate is the biggest public-private partnership in Florida history and one of the largest road projects in the country. According to the Florida Department of Transportation, a consortium was formed to “…design, build, finance, and operate the project through a 40-year P3 concession agreement ….” In other words, toll roads. Equity members, according to FDOT, include Skanska Infrastructure Development and John Laing Investments Limited, two of the leading brands in the business. You don’t entrust a $2.3-billion project to just anyone.

While we’re sure the road will be finished, one day, no one knows if the project, which began in 2015, will be done by the announced completion year of 2021. And if things do go terribly wrong from here until then, those stuck in the traffic and paying the tolls – at least a few of the really vocal ones – will blame it on the public-private partnership and the “fat cats” in Tallahassee. P-3s haven’t completely caught on in the United States yet, so if the I-4 Ultimate tanks for some reason, or if it’s been perceived to have tanked, that could shape the way the greater public – and the state legislators they vote into office – thinks about the delivery method. In an era of crumbling infrastructure and shrinking federal dollars, P-3s are seen by many, but certainly not all, as a way to leverage private dollars for the public good. What happens in Orlando, good or bad, will probably influence the conversation moving forward. Should be an interesting next few years in central Florida.

WINDOW WASHERS. We’re sure you saw the crazy footage of the window washers being blown about as they attempted to do their job at the top of the 50-story Devon Tower in downtown Oklahoma City. The clip even made it to CNN which, considering the network’s obsession with presidential politics, is news in and of itself. The window washers were eventually rescued, but not before they presumably watched their lives flash before their eyes.

The whole episode got us to thinking. What’s life like washing the windows of the architectural and engineering marvels of the modern world? With office towers growing taller and taller, and increasingly being sheathed in glass, the business of washing the windows, it would seem, would be trending upward. According to an article in the San Francisco Chronicle, that is indeed the case. But in that same story, a window-washing contractor says his employees make as little as $17 an hour. At a fast-food restaurant or a cinema, that’s good money, but for spending each day working dozens or even hundreds of feet in the air, that ain’t much.

And consider the stakes. A brief review of US Department of Labor statistics tells a grim reality for those unfortunate window washers who make a mistake, or who are the victims of failed equipment. This from the last few years of OSHA accident reports: Employee cleaning windows falls and is killed; Window washer falls from 10-story building and is killed; Window washer is killed in fall from fourth floor ledge; Window washer falls and dies from injuries.

You get the picture. So, the next time you see a gleaming office tower or gaze out at the silhouette of a skyline, just remember that there’s an army of folks out there who keep these buildings clean, and that they do so under hazardous conditions and for meager wages.

WHEELS OF JUSTICE. Sometimes it’s slowly, but they always seem to turn. The New Jersey engineer who was popped for bilking the state out of about $4.6 million in bridge contracts finally surrendered his engineering license to state authorities this spring.

That, of course, after the guy was handed a suspended sentence, three years of probation, and paid $250,000 in restitution back in 2017 for falsifying bid documents to make his firm seem more qualified than it really was. During his five-year campaign of scams, from 2011 to 2016, the engineer represented an employee as a degreed professional with plenty of experience, when in fact the employee was nothing more than a high-school graduate who had never worked on a bridge before. He won four contracts and got away with it, but on his fifth try, investigators nabbed him.

The engineer, Chetan Shah, is barred from entering into any public contracts for five years.

If you know of an interesting or off-kilter story taking place in the AEC industry, please contact C+S at rmassey@zweiggroup.com.
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"I WENT WITH PLAN B SINCE IT SAVED SO MUCH ON DESIGN COSTS"
He’s already done plenty of meet-and-greets and traveled many thousands of miles. That Matt Cummings, P.E., would journey across the world and connect with some of the AEC industry’s most talented people was a foregone conclusion when, in April, he was named president and CEO of T.Y. Lin International (TYLI) Group.

Indeed, the United States, Asia, the Middle East, and Europe comprise the grand stage from which Cummings will spearhead his most ambitious project yet – creating an affiliation of global infrastructure companies, all of them under TYLI’s parent company, the Dar Group, that can compete with the world’s largest firms for the world’s largest projects.

Simple enough, right? Recruited out of mega-firm AECOM, where over the course of more than 26 years he shaped both his technical and management expertise, Cummings said he’s invigorated by the entrepreneurial spirit baked into the DNA of a smaller, privately-owned company.

Plus, Cummings said he’s honored to have his hand on the reins of a firm like TYLI. Founded in 1954 by Chinese engineering prodigy Tung-Yen Lin, the firm does half its business in China and Southeast Asia, but is headquartered in California with offices throughout the Americas and Asia. The firm, old and prestigious, has a sterling brand, particularly in the field of bridge building.

“That made a big difference for me,” Cummings said, referring to the firm’s global reputation for exceptional work.

He likes to build collaborative teams, a must in the AEC world. Just as important, however, is the process of managing integration, something Cummings saw a lot of during his years at AECOM, and something he will have to do, and on a global scale involving thousands of people, in the years ahead.

Emerging as the top candidate in a wide-ranging executive search, Cummings, a bridge builder himself, seems to be a natural fit for TYLI. In the press release announcing his hire, Cummings voiced his enthusiasm for the new opportunity.

“T.Y. Lin International has established itself as the go-to firm for solutions to the most difficult engineering challenges,” he said. “We are globally recognized for setting the standards for excellence, innovation, and incomparable technical solutions. I look forward to building on our momentum and furthering the firm’s legacy of delivering remarkable infrastructure projects.”

He succeeds former President and CEO Alvaro J. Piedrahita, P.E., who transitioned to a new role as Chairman of the Board of Directors of TYLI Group.

Cummings, who holds a bachelor’s in civil engineering from Lehigh University and completed the Wharton Management Program at The Wharton School, now finds himself at the top. But with more than 30 years in the business, he had to work for what he’s got. His recipe for
success is pretty simple: “It takes perseverance, some good fortune, and a lot of diplomacy along the way. You don’t give up.”

A Q&A with Matt Cummings

C+S: After more than 26 years at AECOM, you were named President and CEO of T.Y. Lin International Group. What opportunity did you see at TYLI that you did not see at AECOM?

TYLI has a storied brand and reputation in the marketplace. It’s a great opportunity that Dar Group represents, to tie the infrastructure pillar companies in an affiliated way and as a collaborative partnership. The companies include T.Y. Lin International, Landrum & Brown, Ross & Baruzzini, Integral Group, and GPO Group. TYLI is a smaller, private entity with real entrepreneurial spirit. This is a challenging opportunity to strike out in a slightly different way in the same industry.

C+S: You worked for one of the giants of the industry for a quarter of a century. Still, TYLI is a big firm, an old firm, and a prestigious firm that has plenty of signature projects in its portfolio, like the elevated bridges in Taiwan, the Hoover Dam Bypass Bridge, and the Eastern Span of the San Francisco-Oakland Bay Bridge. What’s it like being the president and CEO of a firm with the brand value of TYLI?

It’s really a privilege to work for TYLI and to build on the great brand. T.Y. Lin, the person, is an inspiration as an original innovator in bridge design. It’s a happy coincidence to land at TYLI as I am a former bridge engineer. I have a lot of respect for the professionals that build these beautiful structures.

C+S: The press release announcing your position says you plan to “leverage the strength of and unite the various global infrastructure affiliates” beneath parent company the Dar Group. The parent company employs nearly 19,000 people in 296 offices in 59 countries and has annual revenue of about $2.4 billion. Tying all this together would seem like a Herculean task. What kinds of resources, and over what kind of timeframe, must you deploy to make this happen?

This is going to be an evolution. It won’t have a hard beginning with a hard end. It’ll be a journey with milestones along the way, measured more in years rather than months. It will be a thoughtful journey. We have great staff and leadership at TYLI and at the other firms. They will all contribute to making the strategy successful.

C+S: As you assess the various companies in the process of bringing them together, what are a few of the key things you will be looking for – what do you need to find to make this endeavor successful?

It all starts with people. Being new to the enterprise, I’m getting to know all the people and their leadership and capabilities, both within TYLI and our affiliate companies. To date, I have visited locations within the U.S. I’ll be visiting our Asia locations, and then Jordan, to discuss strategy with Dar leadership, followed by a trip to Europe to meet with affiliates there. It’ll be important to not only form a collaboration, but to also ensure the success and health of each entity. I’ll also keep an eye on the health, prosperity and growth of TYLI, and the other firms, looking at the broader strategy of collaboration. The collaborative concept has been formulating over the years. We’re coming together to thoughtfully bring all the people and companies along using a well aligned strategy. I’m a connector at heart and feel strongly about forming teams and supporting collaboration among people.

C+S: As you seek to bring the various pieces of the Dar Group together, what is expected to be the biggest challenge to overcome?

Any kind of change and overcoming the inertia of the way things have been done, is always a challenge. We must work hard to overcome it, but it’s not insurmountable. With thoughtful communication, transparency, and laying out a strong, clear strategy and approach, we’ll succeed.
C+S: What is the timeline on the formation of this new group?

This is an exciting time with high potential, but nothing will happen overnight. There will be no radical shifts in the TYLI brand. We’re engaged in a thoughtful process aimed at close collaboration among companies to be able to deliver large, complex projects around the world. Collaboration among firms under the Dar Group’s Infrastructure pillar, and across pillars, will allow us to compete with the largest firms for the largest global projects.

C+S: When you have brought the companies together for an expanded, global presence, what would be the goal of the new entity?

To deliver our specialized expertise across a broader global platform. To provide opportunities for our people to excel.

C+S: Dar Group’s mission is to create sustainable communities worldwide. What does that mean to you and how do you go about realizing the mission?

Along with all our people here, I take great pride in designing the beautiful structures and infrastructure in their communities. We live where the projects are built, and there’s a great source of pride in delivering on needed infrastructure that the communities and all our people value.

C+S: You are, and have been, a global player. When you were at The Wharton School, did you see this type of future ahead of you?

This opportunity combines the experience I’ve cultivated over my career of 30 years, my training that includes Wharton, my engineering background, and my entrepreneurial spirit. This is the perfect opportunity for me. At the foundation, I’m an engineer. I’m passionate about building a better world and building the infrastructure that our society and communities need.

Wharton certainly pointed me in a good direction, but I didn’t envision everything playing out the way it has. As a mid-career engineer at the time, Wharton helped round-out my business, strategy, and leadership skills. It gave me the exposure I needed to realize you can do important things and change your path from technical to business leadership, and that’s been a valuable lesson.

RICHARD MASSEY is managing editor of Zweig Group publications. He can be reached at rmassey@zweiggroup.com.
FOR LARGE ENGINEERING FIRMS, keeping up with changes in state licensing requirements can be a challenge. To help your firm maintain compliance, we’ve gathered these highlights of recent changes in the regulatory landscape.

Alabama
The Alabama board recently clarified that providing proposed pricing for engineering work prior to being properly selected based on qualifications violates state law. The fee may be negotiated after a selection is made, and at that point, the client may make another selection if the price is unsatisfactory. Providing pricing in advance may lead to disciplinary action by the board.

Alaska
The Alaska board updated regulations to stipulate that an engineer in responsible charge of a discipline may grant other engineers who are registered in that discipline the authority to seal drawings on behalf of the firm. This does not relieve the engineer in responsible charge from responsibility for the work.

Regulations were also updated to clarify that while the state requires a licensee in every office, firms do not need a licensee in each office for every engineering discipline. Engineers may be in responsible charge of work done within their discipline through other offices so long as the company has at least one engineer who is regularly employed and licensed in that discipline. The board defined regularly employed as working at least 20 hours per week.

The board also updated requirements to add structural engineering registration by comity, among other changes. The changes took effect in March 2019.

Connecticut
In 2018, Connecticut tightened ownership requirements for engineering firms. Professional corporations and limited liability companies must be at least 66.67 percent owned and controlled by Connecticut-licensed engineers or land surveyors. This is part of a larger, ongoing trend of increasing ownership requirements for engineering firms.

District of Columbia
The D.C. board recently implemented continuing professional competency (CPC) requirements of 20 hours per renewal cycle for P.E.s and 12 hours for land surveyors.

The District has yet to release an application for the design firm license introduced in 2017. The license, when implemented, will encompass architecture, interior design, and landscape architecture.

Kansas
In February 2019, the board approved a new application for P.E. licensure by reciprocity for Model Law Engineers (MLEs). Applicants may submit an official National Council of Examiners for Engineering and Surveying record to the board showing their MLE designation for expedited processing.

Hawaii
The Hawaii board recently clarified that for licensing purposes, experience must be supervised by a licensed professional in the same jurisdiction. If work is done in Hawaii, the licensed supervisor needs to be licensed in Hawaii.

Maine
Maine’s licensing board voted in January to permit engineering graduates working under the supervision of a licensed P.E. to use the title “engineer” so long as they have graduated from an approved degree program, such as an accredited engineering or engineering technology program, and are working under the supervision of a licensed professional engineer.

Minnesota
Effective May 13, 2019, Minnesota enacted new rules to allow applicants for the Architect Registration examination and the Fundamentals of Engineering examination to apply directly to their respective national councils to take the examination.

Nebraska
Nebraska recently eliminated the requirement for firms to secure a separate certificate of authorization for every branch office location. Nebraska still requires a resident engineer in responsible charge for each branch office.

Oklahoma
Oklahoma is now requiring foreign qualification in order to obtain firm licensing. This requirement has become nearly universal for engineering firms.

Oregon
In Oregon, licensed professional firms, including engineering firms, will likely need separate name approval in order to obtain a license.

South Dakota
In September 2018, the South Dakota board ruled that the Structural Engineering I exam alone would no longer be accepted as a Principles and Practice of Engineering (P.E.) exam. Applicants must pass the Structural Engineering I and II exams to qualify for licensure.
Texas
The Lone Star State has introduced an online firm registration system to make it easier to submit your license application.

Vermont
In April 2019, the Vermont board issued guidance on the distinction between civil and structural engineering qualifications, noting that applicants for civil licensure sometimes provide a record of experience that is substantially structural. The state requires applicants for licensure to demonstrate progressive experience in the appropriate specialty discipline. The board also affirmed that experience toward an advanced degree may not also be used to satisfy real-world experience requirements.

West Virginia
In October 2018, the West Virginia board published updated regulations stipulating that firms with the word “engineer” or “engineering” in their names, or firms planning to offer engineering services in West Virginia, must obtain a certificate of authorization from the engineering board before registering with the secretary of state.

Grow With Confidence
For engineering firms, the license review process is measured in months rather than days in many states, so it’s important to ensure that your applications are positioned for approval the first time around. By staying on top of the nuances from state to state, you can safeguard your firm’s compliance and move forward with confidence in pursuit of the next opportunity.

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As the global effects of climate change become more and more apparent, the impacts of extreme climate and weather events are increasingly taking their toll on infrastructure systems within the United States. The Department of Energy’s Argonne National Laboratory is using their leading-edge climate modeling and infrastructure science capabilities to provide actionable information to companies, agencies, cities, and utilities to help safeguard their infrastructure in the face of these challenges for decades to come.

While global climate modeling data is readily available, Argonne is using its unique combination of supercomputing capabilities and climate modeling and infrastructure science expertise to use that data and turn it into higher resolution, local scale climate impact models.

“Argonne takes this a step further,” explained Tom Wall, Senior Infrastructure and Preparedness Analyst and leader of Argonne’s Climate Impact Data and Decision Support effort. “Our team at Argonne takes these raw climate variables and turns them into climate impact data tailored to the specific needs of a particular company or agency.”

The first element to the development of this climate impact data is to “downscale” the global models that display data on a scale of 100-150 km blocks. As Atmospheric and Earth Scientist Jiali Wang describes it, “There are two ways to take low-resolution global and regional climate models and localize them to a neighborhood level: statistical downscaling and dynamic downscaling.”

Statistical downscaling is used to form statistical relationships between global/regional climate models and local observations to “back-cast” historical climate trends of a particular area in order to infer projections about that area’s future climate.

While this method of downscaling does not require much relative computing power, and is therefore widely available, it has significant shortcomings. “It functions on the assumption that these statistical relationships will remain constant over time,” Wang elaborated. “But this isn’t the case. In the face of climate change, we are seeing these relationships and distributions change over time.”

At Argonne, the climate modeling team uses dynamic downscaling to produce high-resolution climate models on a scale of 12 km blocks. Dynamic downscaling refers to using atmospheric physics- and chemistry-based models to dynamically extrapolate future regional climate, in order to produce high-resolution, “neighborhood” scale projections.

This is a massive amount of data, however, and it is processed to create hourly climate projections for the next several decades. One year of these hourly projections would take more than 4,000 hours of computation time on a standard computer. Argonne’s supercomputing capabilities allow the climate modeling team to process this data on a large scale at incredible rates, finishing more than 50 million total core hours of computing in mere months. “We are using these capabilities to explore further downscaling to 4 km blocks to improve the model’s performance, reduce bias, and boost our overall confidence in future projections,” Wang explained.

Argonne researchers achieved this using a combination of modeling systems such as the Weather Research and Forecasting (WRF) model and the WRF-Hydrological (WRF-Hydro®) system for modeling regional climate at the 12 km scale and inland flooding due to precipitation down to even the 200 m scale. In conjunction with the Advanced Circulation Model (ADCIRC) for modeling coastal flooding due to storm surge down to the 50 m scale, the research team at Argonne achieved this detailed, high-resolution “neighborhood” modeling.

Argonne recently collaborated with AT&T, using these climate resiliency science capabilities to analyze and address issues with AT&T’s network infrastructure in the Southeastern United States, a region that has been hit with some of the largest hurricanes and other extreme weather events in recent history.

According to a CNBC article, such natural disasters have cost AT&T $847 million since 2016. As part of this collaboration, AT&T paid Argonne $375,000 to create a Climate Change Analysis Tool to model the impacts of coastal and inland flooding, as well as wind for the coming 30 years in Florida, Georgia, North Carolina, and South Carolina.

Moved by strong concern for repeated losses from similar natural disasters in the Southeast, AT&T worked with Argonne to identify this region as the target for developing the climate impact model. Throughout this process, Argonne helped determine what data would be useful for AT&T in terms of safeguarding their infrastructure.
“We needed to provide more than just information on precipitation values,” explained Eugene Yan, Principal Scientist in Earth Science. “We had to bridge the gap between these complex models and these industries by showing how climate change would directly impact their network infrastructure.”

The team used the dynamically downscaled climate models to illustrate the impact of extreme climate change in the future. In order to do this, the team used generalized extreme value distributions to identify what “extreme” weather might look like in the coming decades and with what frequency it might occur.

This information directly informed an analysis of Intensity Duration Frequency (IDF) curves for coastal and inland flooding in this region, a fundamental tool used when planning infrastructure. “As a critical piece for civil and structural engineers to incorporate into their designs,” Yan explained, “IDF curves offer information on probability and potential danger of flooding due to hurricanes and heavy rainfall.”

Using the Climate Change Analysis Tool, Argonne researchers were able to improve the analysis of IDF curves in this region to more accurately inform engineering decisions. The Argonne team used non-stationary, time dependent parameters in conjunction with historical data to create what Yan called the “next generation IDF curves.” Yan further explained that these impact models are novel in that they not only predict what future extreme climate events will look like, but also quantify the uncertainty around these predictions that is inherent when combining climate projections from numerous global models.

Not only would the impacts of flooding on buildings and infrastructure vary dramatically from block to block, but so too would the impacts of wind levels. This modeling for future extreme wind levels can greatly inform wind loading needs for buildings in the future.

Argonne is currently working with AT&T and other parties to expand the Climate Change Analysis Tool to encompass the impacts of forest fires and other extreme climate effects and weather events.

“This work goes beyond the physical structures themselves and potential economic losses,” Wall elaborated. “At the core of any engineering work is a commitment to public safety.” Communication services, utilities infrastructure, physical infrastructure, are all critical to safety and relief efforts during natural disasters and weather emergencies. “The Climate Change Analysis Tool is crucial for preparing and safeguarding this infrastructure and these services in the decades to come.” Organizations interested in learning how they might tap into Argonne’s expertise, facilities, and tools to unlock technical challenges and seize opportunities—including tools to help safeguard their infrastructure from climate events—should contact partners@anl.gov.

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**CASE STUDY**

**NPW Contracting, Inc. Streamlines Scheduling and Enhances Field and Office Communications Using Assignar’s Cloud-Based SaaS Platform**

**Colorado-based thermal/moisture protection, restoration and structural repair contractor, modernizes daily operations, maximizes productivity, and facilitates compliance**

**Customer**

Based in Denver, NPW Contracting Inc., is a full-service thermal/moisture protection, restoration, and structural repair contractor that offers many services to commercial clients.

**Challenge**

NPW Contracting Inc., owners Helen Madden-Weiss and Joshua Weiss wanted to improve daily operations, increase production and take on additional projects. Along with their team, they began talking with Assignar about the potential benefits of using a cloud-based SaaS platform.
Solution
Assignar’s field operations software platform for sub- and self-perform contractors.

Key Results:
• Savings of 220-man hours and $7700 per year (per 10 people) – as NPW Contracting crews become more proficient with the app, these savings will likely increase
• Reduction of paper waste, and human error on tracking and forms
• Reduction in time spent scheduling (and often rescheduling) workers for specific jobs and projects

Collaborating on some of Colorado’s most visible projects
Helen Madden-Weiss and Joshua Weiss, owners of NPW Contracting, have been in the full-service thermal/moisture protection, restoration, and structural repair business for 30 years. Based in Denver, NPW Contracting Inc., employs 16 crew members full time – in total, the team boasts over 100 years of cumulative experience.

The family-owned, self-performing contractor specializes in accommodating large-scale projects and has worked on numerous high-profile projects in the Rocky Mountain region – including work on the Denver Union Station, Eagle P3, and FasTracks commuter rail projects, and the recently opened Gaylord Rockies Hotel and Convention Center.

For NPW Contracting’s traditional process for assigning workers to specific jobs, Courtney Lively would spend approximately 10 hours a week manually matching up various team members, jobs and equipment on a well-worn standard whiteboard. Once complete, she would then send individual emails and texts to employees to let them know their schedule. When jobs changed, or situations would arise, as happens in the world of construction, Courtney was required to “go back to the drawing board,” shifting workers and jobs around, reorganizing the schedule and, once again, updating every team member about the changes.

In addition, field workers were required to stop by the office first to make sure they had the latest schedule, and to gather relevant paperwork specific to certain jobs.

“Our previous scheduling process was insane,” said NPW administrative assistant Rachel Weiss. “We only had a whiteboard that showed the
guys’ names on it, and the dates for the current week and the next week.”

According to Ms. Weiss NPW, took time to carefully research a variety of potential solutions to their challenges. The most compelling criteria for choosing Assignar was efficiency, ease-of-use and cost-savings. In addition, Ms. Weiss noted that it was essential for their team to find a complete, integrated platform versus using several single-point solutions they would have to piece together.

**Gradual Implementation Leads to Easier Company-Wide Adoption**

After speaking with the team at Assignar about a solution to streamline their daily operations processes, NPW, determined there were many advantages to trying out the cloud-based, collaborative software.

“Basically, our project manager insisted that we needed a solution to our scheduling challenges,” Ms. Weiss said. “At that point in time, communication between the field and our office was proving to be a consistent challenge to our overall business and operations.”

To get the process started with adopting Assignar’s solution, NPW Contracting Inc., gradually implemented the technology across the company.

“We began using some of the software’s capabilities with a test group of about five workers, which included a foreman and a few technicians,” Ms. Weiss said. “After working closely with this group for a short amount of time, rolling out the solution to the rest of the team was easy.”

Assignar’s software helps construction teams meet project deadlines by efficiently scheduling and allocating available and compliant resources to multiple projects simultaneously. When crews have been dispatched, the powerful platform is a real-time connection to the office providing instant access to digital forms and timesheets.

According to Ms. Weiss, the learning curve for training was relatively easy. The contractor hosted an initial in-house training led by Assignar representatives.

“Assignar made the whole training process easy and seamless,” she noted.

**Eliminating paperwork, maximizing efficiencies**

Since adopting Assignar, NPW’s 16-person crew has transformed into a more efficient, effective and productive team. The company has saved an estimated 220 man-hours and $7,700 per year (per 10 people). And, because employees now spend less time in the office checking schedules and filling out paperwork by hand, the company’s team members can work more proficiently and take on more jobs.

According to Ms. Madden-Weiss, “Another significant advantage of using Assignar is the responsiveness of the Assignar team. For instance, we were made aware that Assignar’s developers were working to solve the needs and fill the requests of their clients, one of which was a Spanish language setting. It is evident that Assignar also values diversity and inclusion with an app for both English and Spanish language settings.”

NPW also has replaced its daily paper forms with Assignar’s digital forms, including its Daily Vehicle Inspection Reports and Daily Work Reports. In addition, NPW believes that Assignar’s technology has had a positive impact on enhancing the complete depth and scope of their projects.

“Team members can take pictures with their smartphones of specific project aspects in the field … and it’s much easier for them to store and share those images in one, easy-to-access place,” said Madden-Weiss. “It also helps prevent our office from getting flooded with images via email.”

While NPW Contracting Inc., has been enjoying the benefits of Assignar’s powerful, yet easy-to-use technology, the contractor is now starting to explore its operations management capabilities even further, with hopes to soon utilize even more features.

“There are a lot of capabilities that Assignar’s software brings to the table that we definitely plan to explore in the future,” Ms. Weiss said. “In the meantime, we are pleased that we have found something that works perfectly - and fits perfectly – into our daily routines.”
When an electric utility in the Southeastern United States sought to protect an above-ground natural gas pipeline against corrosion, the goal was to cost effectively do so while minimizing downtime and environmental impact.

Yet in the power and petrochemical industries, protecting above-ground pipeline from corrosion can be a challenge, particularly when the pipeline carries a cooled compressed gas that draws moisture out of a hot or humid external environment. This causes in use pipeline to continuously drip water, or “sweat,” making adhering a protective coating to the exterior of the pipeline virtually impossible without shutting down the line.

Traditional organic coatings also typically require days or even weeks of facility downtime depending on the project, due to complex surface preparation and application as well as curing times needed between coats. This can be tremendously expensive in terms of lost production as well as shut-down and start-up costs.

Utilizing such coatings near people or sensitive areas can also be problematic because they typically involve dangerous Volatile Organic Compounds (VOCs) and Hazardous Air Pollutants (HAPs), as well as clean up using harmful turpentine or mineral spirits.

So, when the electric utility chose an anti-corrosive coating for about 3,500 feet of power plant pipeline in a facility, it was very particular about its selection.

The 30-inch diameter pipeline connects down to smaller diameter pipe that feeds natural gas boilers at the power plant. The boilers provide steam to two 858 MW steam turbines.

Because the power plant is located near a freshwater preserve teeming with wildlife, the electric utility was very attentive to its environmental stewardship.

Accordingly, the electric utility turned to EonCoat, a spray applied inorganic coating from the Raleigh, North Carolina-based company of the same name, for use on the pipeline. EonCoat represents a new category of tough, Chemically Bonded Phosphate Ceramics (CBPCs) that can stop corrosion even when applied on in use, wet, “sweaty” pipeline. This eliminates the need to shut down the pipeline for maintenance while also eliminating dangerous VOCs and HAPs.

In Use Pipeline Corrosion Protection
Unlike traditional coatings, the CBPC coating is designed to apply over wet pipe because it is water based, ceramic, and initially porous before setting. This allows any excess water to vent out of the coating during the application process.

In contrast to traditional polymer coatings that sit on top of the substrate, the corrosion resistant CBPC coating bonds through a chemical reaction with the substrate. An alloy layer is formed. This makes it impossible for corrosion promoters like oxygen and humidity to get behind the coating the way they can with ordinary paints.

Although traditional polymer coatings mechanically bond to substrates that have been extensively prepared, if gouged, moisture and oxygen will migrate under the coating’s film from all sides of the gouge.

By contrast, the same damage to the ceramic coated substrate will not spread corrosion on the pipeline because the carbon steel’s surface is turned into an alloy of stable oxides. Once the steel’s surface is stable (the way noble metals like gold and silver are stable) it will no longer react with the environment and cannot corrode.

Visible in scanning electron microscope photography, EonCoat does not leave a gap between the steel and the coating because the bond is chemical rather than mechanical. Since there is no gap, even if moisture was to get through to the steel due to a gouge, there is nowhere for the moisture to travel. This effectively stops atmospheric corrosion of power and petrochemical industry pipeline and steel assets.

The corrosion barrier is covered by a ceramic shell that further resists corrosion, water, fire, abrasion, impact, chemicals, and temperatures up to 450 °C. Beyond this, the ceramic shell serves a unique role that helps to end the costly maintenance cycle of replacing typical barrier type coatings every few years.
“In power and petrochemical assets such as compressed gas pipelines, if the ceramic shell and alloy layer are ever breached, the ceramic shell acts as a reservoir of phosphate to continually realloy the steel,” explains Merrick Alpert, President of EonCoat. “This ‘self heals’ the breach, depending on its size, and stops the corrosion if necessary. This capability, along with the coating’s other properties, enables effective corrosion protection for the life of the asset with a single application.”

**Easy Application, Environmental Benefits**

In the electric utility pipeline project, water jetting the pipeline’s exterior was sufficient to clean and prepare the surface for coating, since only a NACE 3 / SSPC-SP 6 / WJ-1 commercial blast cleaning is needed.

The CBPC coating was successfully applied to the exterior of the “sweating” in use natural gas pipeline outside the facility when atmospheric temperature was 87 °F with 58 percent humidity.

Such CBPC coatings consist of two non-hazardous components that do not interact until applied by a standard industrial plural spray system like those commonly used to apply polyurethane foam or polyurea coatings.

While EonCoat is normally spray applied at a thickness of 20 mils before a topcoat is applied, in this case the CBPC coating was deliberately applied at 25 mils and no topcoat was used to deter mold growth on the pipeline’s exterior. The high pH of the inorganic coating tends to retard mold growth when used without a topcoat, even in a hot, humid environment.

Because of the ceramic coating’s multiple layers of corrosion protection, and the ability to “self heal” breaches, the power plant is on track to see long term protection of its pipeline, effectively eliminating the traditional cycle of blasting and recoating during costly shutdowns.

The electric utility also met its environmental goals with this approach. The CBPC coating is inorganic and non-toxic, so there are no VOCs, no HAPs and no odor. The coating is also non-flammable. This enhances safety not only for plant personnel but also for the wildlife of the nearby freshwater preserve.

With atmospheric corrosion a perennial problem for owners or operators of any pipeline that carries compressed gas, whether for natural gas fired power plants or midstream oil and gas companies, the utilization of CBPC coatings that can control corrosion for decades will only help the bottom line and protect the environment.

Del Williams is a technical writer based in Torrance, California.
A tendency to leverage technologies and a stronger focus on sustainability are two of the trends that are defining the construction industry post-recession. The rise of prefab is the offspring of these trends. Photo: TATA Nest-In

Prefabricated construction technologies have gained traction globally over the last few years, and it isn’t hard to see why. Prefab construction, also referred to as off-site construction, allows various components of a building to be manufactured in a factory and transported to a construction site. The components are assembled there piece by piece. This off-site construction technique can help finish a building project on schedule, stay in budget and minimize the needs of skilled labour. These manufactured homes are energy-efficient – an attribute that makes it more attractive for the millennial home-buyers, who are arguably more focused on sustainability than the previous generation. Hence, we are to see a lot more prefabricated homes in the future. And here are some factors that have made architects and civil engineers pin so much hope on prefab:

Speed of Construction
Off-site construction methods can reduce delivery time by almost 50 percent. Factory-based construction also helps minimize delays due to climatic factors, and construction site mismanagement. The urban population is exploding all over the world. Fulfilling the housing needs of such an enormous population is not a mean feat and the city-planners must think of some methods that not only can minimize the construction time, but also building material wastage. Only the prefab construction system can provide homes to the maximum number of people in the minimum of time.

The Quality of Construction
With prefab, you can rest assured of the quality of raw materials because all the components are manufactured under controlled conditions. Moreover, the production process undergoes strict quality control guidelines, which are incorporated at every stage of the construction. The sub-assemblies are built to perfection and uniformity.

Customization
With the incorporation of customizable features and energy-efficient technologies, prefab homes can be a better construction choice than conventional buildings both in terms of aesthetics and functionalities. People often tend to associate the term prefab with cheap building solutions. This mindset can be attributed to the fact that prefabricated houses have often been used to address post-calamity housing needs. This does not hold true anymore. Thanks to the introduction of fresh and flexible architectural designs, home-buyers can incorporate features according to their likings. In fact, several prefab vendors project their offering as a chic housing solution for stylish home-buyers.

Energy-Efficiency
Prefab homes are extremely energy-efficient and help to save on electricity. High-quality insulation, the use of energy-efficient doors, windows, and roofs are just a few features that make prefab homes energy-efficient.

Low-Maintenance
Factory-manufactured homes are generally low on maintenance. As opposed to brick-and-mortar structures, you need not spend a lot of money on their maintenance.

Free of Structural Defects
In prefab constructions, the wall panels are made in the factory environment. Besides helping avoid structural deviations, factory production also helps to do away with a number of quality issues such as water leaking and cracking of walls, among others.

Flexible Design
One can modify a modular home anytime. Components can easily be dismantled and re-assembled, as per the homeowner’s needs.

Cost-Effective
Prefab structures help you bypass several construction expenses, including labour cost, costs relating to material loss, and water consumption, making it cost effective in the long run.

Big brands like TATA Steel have ventured into this field to capitalize on the enormous potentials of this new-age construction method. Branded as Nestudio, these steel based housing units are becoming quite popular all over India.
Rajesh Nath, Director of the Indian Office of The German Engineering Federation (VDMA), has succinctly summarized the benefits of prefab housing:

“Precast construction saves time and minimizes the risk of project delay. Further, the precast work can be carried on simultaneously with other works on site such as earthwork and surveying. One of the largest conveniences with constructing and assembling homes with prefabricated components is the ability to reduce the number of on-site labor hours. For construction companies this is crucial because every extra hour you remain on the worksite your liability, overhead costs, and workers compensation increases.”

As the above discussion attests, it will hardly be an exaggeration to conclude that the future of construction does rest in prefab. Speaking of the Indian context, at present, India’s construction industry is undergoing a number of problems – shortage of skilled labor, long gaps between project inception and execution, increasing prices of raw materials, and pollution caused by a lot of construction wastes. Prefab construction can free the construction industry from all these problems. India needs 50 million homes by the year 2022. More than 90 smart cities are in the pipeline. Only modular prefab homes can meet this need.

Nilesh Gupta is a realtor and real estate investor with 14-plus years of experience in innovative construction solutions, and has a special interest in next-gen building technology and smart city projects in India.

**MEGAPROJECTS AND CONSTRUCTION TECH**

**MEGAPROJECTS WERE AROUND** long before modern mobile construction tech, but it’s hard to imagine how project managers dealt with the complexity.

Monuments like the Eiffel Tower, Sears Tower or even the World Trade Center were all completed without the coordination that modern construction tech provides. So, how much easier — and more profitable — could those projects have been with access to modern management tools? One expert says we’re only beginning to see the impact modern tech can have on megaprojects.

Kyle Slager grew up around the construction industry, working on his father’s construction sites before he founded Raken, a company providing field management software. Raken’s technology has been used to coordinate several high-profile megaprojects.

Project management has to deal with the inherent complexity of a construction project, which exists no matter the size of the project.

“Construction projects are chaotic,” Slager said. “Simply put, there’s just a lot going on, and everybody who is hired to build something
is also responsible for documenting what they're building. Without technology, they're working in their silos, and silos are where small problems become big problems.”

Those problems only scale up. In today's economy, megaprojects can often cost $1 billion or more.

“The general contractor managing the project (for a megaproject) could have thousands of subcontractors on the jobsite, all of which have multiple equipment and material deliveries every single day,” Slager said. “In some of these projects you could be a mile away from somebody who needs to know that you received an equipment delivery today because that affects their timing. Something as simple as having a couple hours of rain could push back a concrete pour which can delay the entire project – this can cost hundreds of thousands to millions of dollars.”

Because of this complexity, Oxford project management expert Bent Flyvbjerg estimated that nine out of 10 megaprojects go over budget. Slager said the budget factor is one of the reasons why megaprojects of the past could have benefitted from construction tech.

“Technology provides greater visibility, which leads to greater forecasting and predictability,” he said. “Historically, you couldn't access data that's available today, making time and budget much harder to predict. With increased predictability, construction companies are more profitable. These profits are then reinvested in technologies which further increase efficiencies and are starting to really push the industry forward.”

Paradigm Shift
Increased adoption of project management technology is helping take the mystery out of megaprojects, though. In an industry previously resistant to technology, the shift towards tech solutions is a big change. Slowly, static pen-and-paper documentation and even spreadsheets are being replaced with new, dynamic tech.

“The construction industry was one of the only industries in the world that looked at technology as an expense rather than an investment,” Slager said.

The reason is the risky nature of the business itself. When you don't know if your next project will be profitable, and with market fluctuations having a huge impact, it's hard to justify taking a risk on learning a new technology. But project management solutions and many other tech advances coming into the construction industry are taking the guesswork out of projects.

“I think the industry is getting smarter and smarter,” he said. “Now, that data can be turned into project intelligence.”

Under the old model of pen-and-paper documentation, lessons learned from a project were often lost. With project management platforms, those data points are collected and accessible to inform later projects.

“Over time, you're going to see that construction companies are going to be able to become more and more accurate regarding costs when they bid for a project,” Slager said. “Owners, developers and general contractors are going to get smarter and smarter about what the expectations should be from those bids.

“I think there were a few decades when companies questioned whether tech could really move the needle, but the conversation has completely changed. Enough have experienced savings that are impossible to ignore, and we're seeing a major paradigm shift.”

Game-Changers
Construction technology is a developing field, and Slager said he sees several advancements coming in the future that will help make megaprojects easier to manage and more profitable. But, to be successful, any new technology must address real-world challenges in the industry.

For example, before launching the software in 2014, Raken's founders met with more than 100 general contractors with experience on megaprojects. Slager said most of them identified daily reporting workflow as their biggest pain point, citing taking an hour or more each day to document everything that occurred on the jobsite.

With that much time involved in documentation, the contractors said sometimes it gets forgotten, put off or not done at all, opening their companies to costly litigation.

“They can get sued up to 10 years after the conclusion of a project,” Slager said. “On any project, something can go wrong. At the end of the day, they hire a team of lawyers to go through filing cabinets to find the report for that day, which might be incomplete or not there.”

Raken addressed this pain point with a mobile solution that would make daily reporting a one-click task, then followed with a live-streaming dashboard for office staff. The first Raken pilot project showed $1 million in time savings alone.

“The value proposition became really clear,” said Slager. “That’s happening in different technologies in all different phases of construction execution. New technologies are completely changing the game.”

While most construction technologies are still in the early adoption phase, Slager said they have the potential to make all projects, but especially megaprojects, more profitable and easier to manage. However, he encouraged general contractors to get recommendations first.

“In speaking to our industry, there are just so many examples out there of companies being more successful and projects being more profitable by utilizing technology,” he said. “I would challenge them to reach out to the companies that have had successful outcomes and find a technology that suits the needs of their business. I think they will find that in the near term and even more so, the long term, they are going to significantly benefit from making that investment.”

Those benefits, like the chaos of any construction site, only scale up. And the next innovation may be right around the corner.

SHANNON BRYANT is a writer with more than 15 years of journalism experience covering business, construction and local government. She is a content marketing writer for Ripley PR, the Maryville, Tenn. agency representing Raken.
For many years, exposed heavy timber framing elements have been permitted in U.S. buildings due to their inherent fire-resistance properties. The predictability of wood’s char rate has been well-established for decades and has long been recognized in building codes and standards.

Today, one of the exciting trends in building design is the growing use of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction. Like heavy timber, mass timber products have inherent fire resistance that allows them to be left exposed and still achieve a fire-resistance rating. Because of their strength and dimensional stability, these products also offer an alternative to steel, concrete, and masonry for many applications, but have a much lighter carbon footprint. It is this combination of exposed structure and strength that developers and designers across the country are leveraging to create innovative designs with a warm yet modern aesthetic, often for projects that go beyond traditional norms.

This excerpt is from a paper written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It focuses on how to meet fire-resistance requirements in the International Building Code (IBC), including calculation and testing-based methods. Unless otherwise noted, refers to the 2018 IBC.

Mass Timber & Construction Type
Before demonstrating fire-resistance ratings of exposed mass timber elements, it’s important to understand under what circumstances the code currently allows the use of mass timber in commercial and multi-family construction.

A building’s assigned construction type is the main indicator of where and when all wood systems can be used. IBC Section 602 defines five main options (Type I through V) with all but Type IV having subcategories A and B. Types III and V permit the use of wood framing throughout much of the structure and both are used extensively for modern mass timber buildings.

Type III (IBC 602.3) – Timber elements can be used in floors, roofs and interior walls. Fire-retardant-treated wood (FRTW) framing is permitted in exterior walls with a fire-resistance rating of 2 hours or less.

Type V (IBC 602.5) – Timber elements can be used throughout the structure, including floors, roofs and both interior and exterior walls.

Type IV (IBC 602.4) – Commonly referred to as ‘Heavy Timber’ construction, this option has been in the building code for over a hundred years in one form or another, but its use has increased along with renewed interest in exposed wood buildings. This construction type is unique in that fire-resistive behavior is based in part on the inherent and long-demonstrated fire resistance of large solid wood framing. Structural wood components are permitted in floors, roofs and interior walls when they meet minimum cross-section sizes. Per IBC Sections 602.4.1 and 602.4.2, exterior walls required to have a fire-resistance rating of 2 hours or less are also permitted to use FRTW framing, or CLT when covered with FRTW sheathing or noncombustible materials. In general, heavy timber components used in Type IV construction (called Type IV-HT in the 2021 IBC) can be exposed.

Heavy Timber Requirements
The fire-resistance of heavy timber construction is based on the inherent size of large timber elements. In a fire, large members tend to retain their load-carrying ability longer than members with small cross-sections; this is because a char layer forms on the surface while the interior remains undamaged and structurally sound. IBC Section 2304.11 (IBC 2015 Section 602.4) provides minimum heavy timber sizes for columns, floor framing and decking, roof framing and decking, and walls.
These minimum nominal sizes are applicable to solid sawn wood members. However, in consideration of engineered wood products, IBC Table 2304.11 (IBC 2015 Table 602.4) provides equivalent glulam and SCL sizes that qualify as heavy timber.

### TABLE 1: Heavy Timber Minimum Member Sizes

<table>
<thead>
<tr>
<th>Application</th>
<th>Minimum Nominal Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor decking</td>
<td>3&quot; decking planks w/ 15/32&quot; WSP; or 4&quot; boards on edge (NLT) w/ 15/32&quot; WSP; or 4&quot; CLT</td>
</tr>
<tr>
<td>Roof decking</td>
<td>2&quot; decking planks; or 3&quot; boards on edge (NLT); or 3&quot; CLT</td>
</tr>
</tbody>
</table>

Source: IBC Section 2304.11 *WSP = Wood Structural Panel

### Fire-Resistance Rating Requirements

For most building elements other than heavy timber, passive fire-resistive requirements are in the form of a required fire-resistance rating (FRR). The IBC defines FRR as the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703.

#### FRR based on Construction Type

The construction type of a building determines many of the minimum required fire-resistance ratings for different building components, as shown in IBC Table 601.

A couple features of this table are relevant to mass timber.

### Other FRR Requirements

In addition to requirements related to construction type, there are other requirements for fire-resistance ratings in the IBC. For multi-unit residential buildings, walls and floors between dwelling or sleeping units are required to have a fire-resistance rating of 1/2 hour in Type II-B, III-B and V-B construction when sprinklered throughout with an NFPA 13 system, and 1 hour for all other construction types (IBC 420, 708 and 711). Multiple separated occupancies (IBC 508.4), incidental uses (IBC 509), and special provisions (IBC 510) also require fire-resistance ratings of select components and assemblies.

### Selecting a Construction Type

Selection of construction type for mass timber projects is one of the more significant design considerations. While it’s common to choose...
construction type based on structural material—i.e., to assume that steel and concrete structures should be Type II, light-frame wood should be Type V, and exposed heavy timber should be Type IV—this approach can lead to additional costs. While Type IV construction can be used for exposed mass timber projects, a full understanding of the allowable use of materials in all five construction types, as well as the unique allowances and limitations associated with each, will help to inform the most efficient design.

To optimize a building design from a construction type perspective, it is best to start with Type V-B construction, and work up toward higher construction types. This avoids unnecessary defaults or assumptions—and unnecessary costs. The fact that certain materials are being used doesn't mean there is only one option for construction type. Similarly, a mix of occupancy groups doesn't dictate that certain materials, construction types or building configurations are required. For example, a mass timber building may have isolated steel, concrete or masonry structural elements, but this doesn't mean that Type I or II construction is necessary, nor does it mean that some or all of the building can't be framed with mass timber. Likewise, a building with mass timber elements has options other than Type IV construction. Note IBC Section 602.1.1:

602.1.1 Minimum requirements. A building or portion thereof shall not be required to conform to the details of a type of construction higher than that type which meets the minimum requirements based on occupancy even though certain features of such a building actually conform to a higher type of construction.

This section permits the use of elements commonly used in a higher construction type without requiring that the entire building meet all of the provisions of that construction type. For example, if a building’s size permitted the use of Type V-B construction, it could still be completely framed with noncombustible materials while being classified as V-B. Similarly, a Type III or V building could be framed with a combination of combustible and noncombustible materials.

As noted, from a cost efficiency perspective, it is usually best to start a building analysis with Type V-B construction as this provides the most flexibility in terms of allowable use of materials throughout the building while minimizing requirements for fire resistance-rated assemblies and structural elements. However, Type V-B is also the most restrictive in terms of allowable building size. All three of these factors—allowable building size, allowable use of structural materials, and required fire-resistance levels—are interconnected.

Construction type, which is a direct function of the types of materials used in a building (and vice versa) looks at limiting the size of the building based on fire and life safety risks. In other words, how much of a building’s contents and structure are combustible has an impact on presumed risk, which in turn affects the code’s allowances for building size. Fire-resistant measures required of the building’s structure dictate the length of passive fire endurance (i.e., 1 hour, 2 hours).

If Type V-B construction doesn’t allow as large a building as desired, the next step is to check Type V-A. The main differences between V-B and V-A are fire-resistance rating requirements and allowable building size. If Type V-A doesn’t allow the desired size, Type III-B is the next choice, with Type III-A following. Type IV construction has similar allowable building size limits as Type III-A; however, there are nuances to the selection of one or the other.

Read the full-length paper for a discussion of these nuances as well as methods of demonstrating fire-resistance ratings of mass timber; fire performance of glued-laminated timber (glulam), nail-laminated timber (NLT), tongue and groove decking, structural composite lumber, and cross-laminated timber (CLT); fire protection of connections; and interior finish requirements. It is available as a free download on the WoodWorks website, along with an Inventory of Fire Resistance-Tested Mass Timber Assemblies and Penetrations.

WoodWorks – Wood Products Council provides free technical support as well as education and resources related to the code-compliant design of commercial and multi-family wood buildings. A non-profit organization staffed with architects, structural engineers and construction experts, WoodWorks has the expertise to assist with all aspects of wood building design, including (but not limited to): allowable heights and areas/construction types, structural detailing of wood and hybrid systems, fire resistance and acoustical-rated assemblies, efficient and code-compliant lateral system design, alternate means of code compliance, and energy-efficient detailing. For assistance with a project, visit www.woodworks.org/project-assistance or email help@woodworks.org.
PIPE FLOW DESIGN

THE MANNING FORMULA AND THE COLEBROOK-WHITE EQUATION

By Stephen Webster

Introduction
The hydraulic capacity of drainage pipes is a complex theoretical problem because in real drains the flow is turbulent. The different layers of water flow are constantly mixing with each other creating small eddies within the flow which reduces the hydraulic capacity in complex and unpredictable ways. For this reason the formulas used by drainage design engineers are a mix of empirical and theoretical formulas.

There are two main methods in use today for estimating the capacity of drainage pipes for design purposes. These are most commonly known as the Manning Formula and the Colebrook-White Equation. Each formula has a different theoretical basis and different empirical corrections.

Manning Formula
In the US and many other parts of the world the Manning Formula is most commonly used for drainage pipe design. It is also included as a possible method in the European codes of practice. The Manning Formula is an entirely empirically derived formula used to calculate the average velocity and the flow of any open channel including a circular pipe not running under pressure. The Manning Formula as used for drainage pipe design is often expressed as shown below.

\[ V = \frac{1}{n} \cdot R^{2/3} \cdot \sqrt{S} \]

\( V \) = Average Water Velocity (can be multiplied by flow area to calculate the flow capacity)
\( n \) = Manning Coefficient. This is an empirical roughness correction coefficient which is used to calibrate the formula to allow for the different energy losses caused by different pipe materials.
\( R \) = Hydraulic Radius. This is the area of flow divided by the length of the water-pipe interface. For circular pipes flowing full this can be taken as the pipe diameter divided by 4.
\( S \) = Hydraulic Gradient. This is simply the slope of the pipe (in m/m).

In the past one of the advantages of the Manning Formula was its simplicity. Nomographs and tabulated solutions were very useful before the proliferation of scientific calculators, particularly when designs needed to be altered onsite.

The disadvantage of the Manning formula is its lack of accuracy. The empirical formula was originally derived from a very limited dataset and does not have a strong theoretical basis. While the formula can be used to produce a good estimate of the hydraulic capacity of a circular drainage pipe for conditions similar to the original dataset, it loses accuracy the further conditions deviate from this. Generally the Manning Formula produces good results for surface water drains less than 300mm and for slimed foul drainage pipes less than around 750mm diameter. For larger diameter pipes the accuracy of the Manning Formula deteriorates and has been shown to overestimate the capacity of surface water drains in some cases.

Colebrook-White Equation
The Colebrook-White Equation was developed in 1939 through experiments with commercial drainage pipes with artificially roughened internal surfaces. The results were combined with the von Karman-Prandtl and Darcy-Weisbach formula to produce the design equation. Initially the equation was considered too complex for practical use but subsequent publication of design charts and tabulated values allowed the more accurate equation to be used in some standard design conditions. Nowadays programmable calculators and simple excel

\[ Q = -2\sqrt{2gDS} \times \log \left( \frac{kS}{3.7D} + \frac{2.5lv}{D\sqrt{2gDS}} \right) \]

The Colebrook White Formula in Circular Pipe. Photo: Stephen Webster
Spreadsheet programs can be used to complete the calculations allowing designers to use the more accurate equation in all conditions.

\[ v = -2 \cdot \sqrt{(2 \cdot g \cdot D \cdot g \cdot S \cdot \log10 \left( \frac{ks}{3.71 \cdot D} + \frac{2.51 \cdot vk}{D \cdot \sqrt{2 \cdot g \cdot D \cdot S}} \right)} \]

g = Gravitational Constant. Can be taken as 9.81m/s².
D = Internal Pipe Diameter
S = Hydraulic Gradient. As in the Manning Formula this is the slope of the pipe (in m/m).
vk = Kinematic Viscosity of the water. This can be taken as 1.139mm²/s for water at around 15°C.
ks = Equivalent Sand Roughness Coefficient. This coefficient describes the internal roughness of the pipe. The value of this coefficient must be derived from hydraulic tests of the pipe materials. European standards state that values of 0.6mm and 1.5mm are used for surface water and foul water drains respectively. These conservative values include allowances for some grit in surface waters and sliming of foul water drains.

Flow in Partially Full Pipes

In most design standards it is accepted practice to calculate the maximum hydraulic capacity of drainage pipes when they are flowing just full. In actuality the maximum capacity of circular drainage pipes does not occur when they are running full but when the water level is at around 94 percent of the maximum height. This is because friction at the pipe-water interface slows down the water and reduces the flow. So after the 94 percent mark the ratio of flow area to length of pipe-water interface reduces the hydraulic capacity. The difference between the capacity of a circular drainage pipe flowing full and the true maximum flow capacity is around 8 percent.

The main reason this is allowed in drainage design standards is because calculating the true maximum pipe capacity is a more complex calculation and before programmable calculators were widely used it was felt that the simpler more conservative calculation would be sufficient. Nowadays any drainage design software or even a simple drainage design spreadsheet can instantly calculate the true hydraulic capacity of drainage pipes. Where these programs are used it is often justifiable to allow for the true capacity rather than a conservative estimate used only for reasons of simplicity rather than to allow for a specific practical variability.

Conclusion

In some cases the designer is not allowed to choose the hydraulic design methodology as it is dictated by the specification or national standards. However in most cases the designer should consider which method is more suitable to the design conditions. In some cases the two formulas are roughly equivalent, but in many cases the Colebrook-White Equation will deliver more accurate results where they are required. Similarly the designer should consider the partially full pipe condition as the full pipe condition specified in most national standards can be quite conservative, both in terms of the flow capacity and the minimum water velocity. The slightly more complex calculations can lead to significant savings where the hydraulic performance of the drainage pipes is critical.

Stephen Webster is a Chartered Civil Engineer based in the UK who runs a civil design consultancy and blog dealing with civil and structural engineering design. He can be reached at stephen@civilweb-spreadsheets.com.
TERRAFIRMA EARTH TECHNOLOGIES TACKLES COMPLEX DEWATERING AT REVÉ, BOULDER’S HIGHLY ANTICIPATED MIXED-USE COMMUNITY

By David Giles

TERRAFIRMA EARTH TECHNOLOGIES has completed the installation of temporary dewatering and groundwater treatment systems for Revé, Boulder’s highly anticipated mixed-use development. The Revé project is located at 30th and Pearl St., across from the new Google complex. It has been four years in the making, and projected occupancy is winter 2021. This is Southern Land Company’s first development in the Boulder market.

The Revé Community will offer multiple lifestyle choices including micro, studio, efficiency, one, two, and three bedroom, town home, and live/work residences. The plan contains 244 residences, 24,500 square feet of retail space, 108,700 square feet of office space, and ample green space and bike paths.

With the dewatering system up and running, the excavation of both the north and south parcels has successfully reached its target subgrade of 26 feet below ground surface, despite having to perform the work throughout Boulder’s winter months. The estimated eight-month-long maintenance and operation phase of the dewatering continues and is expected to be complete by Summer 2019.

Winter temperatures required constant monitoring of the deepwells. TerraFirma provided a technician who monitored the wells 24/7, either remotely with camera images every 15 minutes, or on site for the winter months, to be certain the low nighttime temperatures didn’t freeze the pipes and disable the pumps.

According to Southern Land Project Manager Jonathan Harel, “TerraFirma crews were very responsive to any situation that came up. Whenever a situation emerged, they were always willing to put in the time to resolve it, even late in the night.”

Crews kept concrete blankets over the main that connected the wells and added heat trace to be sure nothing froze.

Why So Deep?

As available lands become scarcer, underground parking has become more and more appealing, especially in growing urban areas like Boulder. Additionally, city planners’ and developers’ desires to maintain views and not block sunlight further the advantages of underground parking over above ground parking. For these reasons, Southern Land Company chose to build two levels of subterranean parking beneath the entire development.

Digging deeper, however, can be a difficult and costly task if not properly planned out. One of the most important considerations, especially...
for excavations extending below the groundwater table, is effective control and lowering of the groundwater prior to excavation. This process is known in the construction industry as “dewatering.”

For site dewatering, Southern Land turned to TerraFirma Earth Technologies, a Houston-based dewatering company with offices in Denver.

The high water table, located just 10 feet below ground surface, along with complex geological conditions at the Revé site, created special challenges for TerraFirma, with important cost considerations for the developer.

“The site of Revé is situated over 2 to 11 feet of man-placed fill, underlain by water bearing, naturally occurring sand, gravel, cobbles, and even some boulders,” said TerraFirma Superintendent Bairn Leonard. “Making dewatering even more of a challenge, bedrock was encountered between 12 to 28 feet below ground surface. With a planned excavation extending to approximately 26 feet below ground surface, well below the top of bedrock, this meant lowering the water table to the top of the confining layer. Committed to having the two parking levels below ground, we proposed multiple possible dewatering methods for the developer to deliberate over. These were supported by the geotechnical engineering report conducted by Terracon, and the Groundwater Characterization Study by Ayres Associates.”

Deepwell Dewatering Wells Chosen Over Other Means of Temporary Dewatering

With the excavation extending well beyond the limits of a traditional vacuum wellpoint dewatering system, and the anticipated flow rates exceeding that of an ejector-well dewatering system, TerraFirma chose to rely on closely spaced, large diameter deepwell dewatering wells as the primary means of controlling the groundwater. The deepwell dewatering wells were installed from ground surface, just outside the excavation’s h-pile and wood lagging support system. With the perim-
was contaminated.

“To deal with the contaminated groundwater, we teamed up with United Rentals Fluid Solutions Group,” Leonard said. “Their extensive experience in the Boulder area and knowledge of its groundwater chemistry, as well as their working relationship with the various regulatory agencies involved, has proven invaluable.”

Following the approval of the Remedial Discharging Permit Surface Water Permit from the Colorado Department of Public Health and Environment (CDPHE), United Rentals Fluid SolutionsCorp, in close conjunction with TerraFirma, developed a Remedial Activities Management Plan to reduce the pollutants of concern to below the limits set forth in the permit issued by the CDPHE.

James Weeks, Filtration Productline Manager for United Rentals Fluid SolutionsCorp said, “The variety of hydrogeologic and environmental conditions in the Denver area and associated Rocky Mountain Front Range offer a number of groundwater treatment challenges to meet strict Colorado surface water discharge requirements. We take pride in the ability to provide tailored, cost-effective, groundwater treatment options that are individually designed to meet discharge permit requirements on a site-by-site basis.”

The groundwater treatment plan included the introduction of sodium hypochlorite into the dewatering influent water to oxidize the metals Iron (Fe), and Manganese (Mg). Caustic acid was also dripped into the tanks as a means of controlling pH, and further promoting the oxidation of the metals. These reactions took place in two, 21,000-gallon flocculation tanks. From the flocculation tank, the water was pumped through two 12-unit bag filtration pods to capture the flocculated metals. Granular activated carbon was added to the treatment train to remove any volatile compounds encountered, as well as for the removal of any residual chlorine in the treated water.

Mr. Leonard added, “This process has proven effective and cost efficient in achieving the desired results. The system was designed for flows up to 500 gallons per minute. Once the site was dewatered, the system was resized for lower flow rates, significantly reducing the area required to accommodate the equipment on the already very congested site – a benefit to this near zero-lot line project – returning pure, drinkable water to the Left-Hand Ditch.”

Tony Brace, General Superintendent of Colorado, Southern Land, said, “This project, like many others, was different in the field than it was on paper. For example, the discharge manifold was modified in the field as it was being laid. TerraFirma had the flexibility to work with the other trades, giving access to the people that needed it, which kept the project on time.

“TerraFirma is one of the best dewatering subcontractors we’ve ever worked with. They have a ‘get it done’ attitude that produced the results we were looking for, no matter what obstacles we ran into. When field modifications had to be made, their boots-on-the-ground team, led by Superintendent Bairn Leonard, came through without reservation.”

DAVID GILES is President of TerraFirma Earth Technologies. Mr. Giles has a B.S. in Geology from Iowa State University and 33 years of experience in developing and implementing design-build solutions for construction dewatering and groundwater control using deep wells, wellpoints and ejector systems. TerraFirma is a Houston-based dewatering firm with offices in Denver. David Giles may be emailed at dgiles@tfearth.com.
**THE GERALD DESMOND BRIDGE REPLACEMENT PROJECT** in Long Beach, California, once built, will be the second-tallest cable-stayed bridge in the U.S. with the highest vertical clearance of any cable-stayed bridge in the country. Positioning the pier decks called for patience and precision; crane and heavy lift rigging specialist Bigge Crane and Rigging Co. used Enerpac’s strand jack technology to lift the decks into position over a 10-hour period.

Built in the late 1960s, the Gerald Desmond Bridge is in urgent need of replacement. It stretches over the entrance to the Inner Harbor of the Port of Long Beach, the second-busiest container port in the U.S., after the neighboring Port of Los Angeles, and generates approximately $100 billion in trade. When the bridge was constructed, cargo ships were one-sixth the size they are today. Although the Port of Long Beach’s Outer Harbor docks are “big ship ready” and already handling the world’s largest cargo vessels, the existing bridge prevents these cargo ships from reaching the Inner Harbor.

Started in 2013, The Gerald Desmond Bridge Replacement Project is a “design-build” project, combining project design and construction into one contract rather than the conventional three-stage process: design, bid, build. By being more efficient, design-build projects have the potential to be built faster, and at a lower cost, than traditional construction projects. The Bridge Replacement Project is a joint effort of Caltrans and the Port of Long Beach, with funding contributions from the U.S. Department of Transportation and the Los Angeles County Metropolitan Transportation Authority (Metro). Construction of the bridge is managed by SFI JV, a joint venture organization comprising Shimmick Construction Inc., Spanish company FCC Construction, and Italian company Impregilo S.p.A.

When completed later this year, the Gerald Desmond Bridge Replacement Project will span the Port of Long Beach’s Back Channel with a deck rising 205 ft above the water; high enough to accommodate the newest generation of container ships. With three lanes in each direction plus safety lanes, it will be wider and better able to serve the current 68,000 vehicle trips that travel over the current bridge each day. It will also include a dedicated bicycle path and pedestrian walkway.

The Gerald Desmond Bridge Replacement will be built with a cable-stayed design based on two 515 ft steel-reinforced concrete towers, that transition from an octagonal base to a diamond shape at the top. Forty steel wire cables will be used to connect each tower to the bridge deck in a fan-like pattern. The longest cable will be 573 ft. The main span and back spans will be 2,000 ft long and 205 ft above the water. The total length of the bridge from west to east will be 8,800 ft, includ-
Bigge Crane and Rigging lifted the 1.35-million-pound pier tables for each of the two towers into place. Bigge used Enerpac strand jacks to lift the pier tables.

Photo: Port of Long Beach

Combinations, so the potential for large-scale synchronous lifting is quite scalable. The flexibility of the strand jack system allows Bigge to use this equipment on many other projects across multiple industries.

Enerpac HSL 50006 strand jacks, each with 48 steel strands, were used to lift the steel framework pier table positioned around the base of the tower onto the four-column falsework. Synchronized control of the strand jack allows all four jacks to lift simultaneously, ensuring the structure remains balanced and does not tip. Each incremental lift was 18 inches, with the entire lift of the pier table taking 10 hours. Bigge synchronized the lift through a strand jack computer.

“The lift was straightforward. However, maneuvering the pier table into its final resting position on the falsework was a delicate operation — the final alignment was coordinated with the strand jack and visual feedback by engineers on the piers,” John Levintini noted.

Mike Beres has been with Enerpac for 19 years and is currently the Business Director for Enerpac Heavy Lifting Technology in the Americas. He is responsible for helping to matching up unique lifting products such as strand jacks, gantries and jack-ups to a Client’s unique problem creating opportunities to “lift really big things.”

Lisa Nisenson consumes a lot of media about smart infrastructure and innovative parking solutions. She travels a lot, talks to plenty of people and, most importantly, listens to what they say. At home in front of a city council or in a room full of West Coast tech junkies at a conference in Portland, Nisenson is positioning herself to do at least two things — solve a problem and even predict the future.

She’ll have plenty of chances to do both. Nisenson, after decades in the field as a consultant, researcher, activist, entrepreneur, and planner, was recently named VP for New Mobility & Connected Communities at WGI, a firm with huge aspirations for the future.

In the press release announcing her hire, WGI had this to say: “Lisa’s experience spans work in the private, non-profit, and public sectors, including federal and local government agencies. At the United States Environmental Protection Agency, she developed pioneering policy for sustainable community design, including guides and regulatory support for low-impact development and redevelopment. She brings a practical approach to helping clients through new planning methods, interactive public engagement, zoning-code reform, and best practices that deliver multiple benefits.”

An Emerging World

WGI Names Lisa Nisenson as VP for New Mobility & Connected Communities

By Richard Massey

Lisa Nisenson Consumes a Lot of Media about smart infrastructure and innovative parking solutions. She travels a lot, talks to plenty of people and, most importantly, listens to what they say. At home in front of a city council or in a room full of West Coast tech junkies at a conference in Portland, Nisenson is positioning herself to do at least two things — solve a problem and even predict the future.

WGI
“WGI clients are aware of both the potential, and challenges, associated with technology related disruption and change. Lisa helps demystify trends, engaging clients to develop both long-range scenarios and near-term roadmaps. This helps cities of all sizes incorporate new technology into existing planning efforts while anticipating potential and probable changes in transportation and land use.”

Nisenson’s hire comes on the heels of other major, forward-looking developments for WGI, all of it pursuant to the firm’s 2025 vision for 1,000 associates and $200 million in revenue.

In January, it acquired Austin, Texas-based multidiscipline firm Big Red Dog, and in 2017, acquired Michigan-based Carl Walker, Inc., which specializes in sustainable parking structures. Last year, the firm named Greg Sauter as its president. While Sauter checked all the traditional boxes for a top hire, he also brought something novel to the table. Sauter was the founder of Smart City Works, an accelerator for early-stage companies focused on civil infrastructure, a nice dovetail with Nisenson’s background.

Nisenson joins WGI as the world of urban planning and mobility, and public expectations about both, are being revolutionized by technology and innovation. Amazon’s purchase of old malls and their subsequent conversion into fulfillment centers is one of the big headlines, and it points in the direction of last-mile delivery, autonomous vehicles, and the ongoing transformation of grocery getting – all of which will change the urban landscape.

“It’s a whole new world,” Nisenson said.

There’s a fever pitch out there right now, as communities large and small are consumed by the Fear of Missing Out on the latest tech and trends, and fumbling the competitive advantage that allows them to recruit the workforce of the future.

Tech companies are cashing in, or attempting to cash in, by pitching their services to cities. But city leaders must be prudent and not fall into the trap of adopting technology for the sake of adopting technology. In that case, a community could be left holding the bag on something that is quickly left behind by the marketplace.
“You can’t adopt the tech because you think it’s cool,” Nisenson said. “You have to solve a problem.”

The smart-city grid here in the US is still in its infancy, and a lot of problems must be solved before the curbsides and sidewalks of the future are figured out. A big issue right now is one of speed. How do you mesh together various modes of transportation – pedestrian, bike, electric bike, scooter, and even moped – without creating chaos in the right-of-way? Nisenson might need to read the crystal ball, something she’s more than willing to do.

“You’ve got to get the infrastructure right,” she said.

A Conversation with Lisa Nisenson

C+S: You were recently named the VP for New Mobility & Connected Communities at WGI. What are your goals in this role?

Lisa Nisenson: The scope of innovation in the types of smart city and smart transportation is enormous, from smart streetlights that collect and distribute data to connected cars and even scooters. Less covered are the secondary impacts of all this technology on our built environment and infrastructure. As a full-service engineering and design firm, this means technology impacts every facet of what we do. My goal is to make sure we are prepared and ready to provide solutions to our clients that meet their existing needs as well as adapt to a changing future.

C+S: In the press announcing your new position, WGI talks about place-making, shared-use mobility, smart cities, and autonomous vehicles. The firm is adding expertise in this field as part of its strategic plan. What does the firm see on the horizon?

LN: Yes – we have a lot of talent in-house – and see the need to constantly evaluate trends and what it means for designing communities and infrastructure.

Because it’s difficult to tell exactly how technology will evolve, we look at two things. One are “tried and true” practices that stand the test of time. For example, we are working on a Complete Street in West Palm Beach that will support walking, biking, access to transit, and vehicles. The lesson here is not so much about technology, but about creating a street that supports not only mobility, but a sense of place. This in turn adds economic vitality.

Second, adaptable infrastructure will be critical, such as our garage design called FlexPark.TM. Parking right now is being impacted by technology, notably transportation network companies (TNC) like Uber and Lyft. This is particularly true for entertainment districts, since ridehailing customers note the ability to avoid drunk driving as the top reason for using a TNC. Many experts see further shifts in parking, which means garage owners may seek to repurpose parking spaces for other activities.

Some of the emerging issues we are watching are things like the rise of e-commerce. If retailers want to get you anything you want within a couple of hours, imagine what that means for warehousing and the constant stream of deliveries on sidewalks, in streets, and overhead with drones. We are also mindful of the need for resilient infrastructure as trends play out with more frequent, dangerous storms. This affects all aspects of design, from buildings to infrastructure to land use and economic development.

C+S: WGI is a dynamic growth firm. How does the culture of a place like WGI feed into your own entrepreneurial approach?

LN: The most important part of taking an entrepreneurial approach is first and foremost listening to customers to see what their main problems are – or what they see looming. Nothing matters if you don’t address the right problem.

Second, I like to boil down my approach as getting out in front of the future. When I convene stakeholders, whether internal or in a design charrette, I always like to use a first workshop to explore technology and how it’s likely to evolve. This helps form a common understanding of the types of technology, likely impacts, and how we can manage impacts. For example, autonomous cars get a lot of press for the potential for both positive and negative impacts. Whether AVs cause more congestion or relieve congestion will depend on a range of decisions on pricing, where they can park, and whether they are owned or shared.

C+S: In your new role, you will be working with all of WGI’s service lines. What’s the key to communicating with such a large, diverse group of colleagues?

LN: That’s really the next step. When I joined in March, the first couple of weeks I went out to talk to clients, and then formed a small internal group. Your question really addressed the next couple of months, which will require a lot of internal lunch-and-learns and office visits.

Lisa Nisenson, of WGI, says the smart-city grid here in the US is still in its infancy, and a lot of problems must be solved before the curbsides and sidewalks of the future are figured out. Photo: W Creative Services, a division of WGI
C+S: You are a national thought leader in your field. If you were talking to a group of young engineers, what would you tell them about forging a national profile?

LN: Find a way to take one of these emerging topics – whether it’s parking, autonomous shuttle policy, or the future of funding transportation infrastructure, and join professional working groups.

C+S: Civic engagement is a big focus for you. In terms of project delivery, what’s the difference between good, and poor, public engagement?

LN: I got my start in urban design as a civic activist in Arlington, Virginia, so I’ve been in several stakeholder roles. In my case, our neighborhood taught itself urban planning to make the case for a better project. By better, we had to think about how the project worked on several fronts (not just those of one neighborhood).

Ideally, the best engagement is ongoing and explores different facets of community life. Lately, stakeholder engagement is having to also pull in a lot of emerging (and sometimes worrisome) trends like climate change and technology. I’ve found, in this world of social media and relentless news cycles, local and personal is the way to go. Walking tours are my favorite way to study our communities closely for things that work, don’t work, or serve as a conversation springboard for talking about the future.

C+S: You worked for the EPA for 17 years. How did this experience shape your career?

LN: I got my start professionally working on pesticide regulation! I then changed over to the Sustainable Communities group after my experience in my own neighborhood working on sustainable, transit-oriented development. So it was less EPA shaping my career than me shaping EPA.

C+S: Your background includes a lot of experience working with governments at the local, state and federal levels. What’s the secret to delivering successful projects owned by publicly-funded stakeholders?

LN: Most of my work that was for public projects relates to street and roadway design. I’ve noticed a growing shift in rethinking the public’s investment in rights-of-way. For cities, streets often represent their largest real estate holding, yet it’s thought of for moving cars and stormwater. All too often, it does neither of these well (congestion with cars and polluted runoff and flooding). The other problem is our deficit in infrastructure repairs locally and for interstates.

I’ve noticed cities reviewing street design as a way to unlock local value. So, a street can be converted to a festival area or closed for markets. Right now, there is a move toward curbless streets that can easily be re-programmed for public spaces or the extension of private spaces for new sources of revenue. Though controversial, cities are reallocating parking spaces for pick-up and drop-off zones for ride services like Uber and Lyft, as well as moveable parklets and bike parking.

Working with the public, the message is about getting more value from every taxpayer dollar on public rights-of-way.

C+S: You have a biology degree, yet you are working for a large multi-discipline consulting firm. What perspective do you bring to the table that perhaps engineers do not?

LN: WGI has a talented, multi-disciplinary team – we even have the WGI Creative Services office with design professionals. This gives us access to videographers, graphic designers, and other visual storytellers. This gives us the chance to break from professional-speak to stories people can understand.

As a biologist, I am heartened by the increasing use of the word “ecosystem” to describe systems – even parking and streets. This recognizes that cities, like habitats, are interlinked systems and not siloed engineering topics.

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The congestion had reached a level where we needed a solution quickly,” said John Cordary, TxDOT Fort Worth District’s deputy district engineer.

Part-time shoulder use is a common practice in some European countries and is gaining in popularity in the United States. According to the Federal Highway Administration (FHWA), there are currently more than 30 shoulder-use installations in 14 states, but many part-time shoulder use facilities utilize the right side outside shoulder.

“This is only the second time we are implementing a peak-period use shoulder lane in Texas,” said Cordary. “We knew a more permanent solution like adding capacity or reconstructing corridors would take us many years to advance through the project development process. Widening inside shoulder lanes and using them during peak hours provides an interim operational solution that we can not only implement relatively quickly, but also cost-effectively.”

Alternative Analysis
To implement this operational solution, in January 2017, TxDOT selected Lockwood, Andrews & Newnam, Inc. (LAN), a national planning, engineering and program management firm, as the lead design engineer. Maldonado-Burkett was on the project team to implement the project’s Intelligent Transportation Systems (ITS).

The existing lane consists of two,12-foot lanes; 4-foot inside shoulders; and 10-foot outside shoulders in each direction. The scope of the project includes widening inside shoulders for north and southbound SH 121, as well as widening overpass bridges at Harwood Road, Cummings Drive, Cheek-Sparger Road and FM 157. Other project features include ITS and active traffic management strategies such as closed-circuit cameras for incident detection, overhead dynamic message signs, additional lighting, emergency pull-off locations, and rapid-response tow trucks to remove stalled vehicles.

To determine the optimal solution, LAN evaluated various alternatives for widening the section. After reviewing the alternatives, TxDOT chose additional widening for a 10-foot inside shoulder for the north-bound lanes to enhance safety for the traveling public and facilitate enforcement. The north-bound lanes have a continuous concrete traffic barrier so the added 10-foot shoulder will provide a safe place for law enforcement. All bridges will be widened to the maximum width to the inside so TxDOT will not have to widen again on the inside, maintaining the structural integrity of the bridges. Following TxDOT’s decision, in September 2018, the project was let and Austin Bridge & Road, Inc. was awarded the contract for $17.4 million.

Lessons Learned
In 2015, TxDOT implemented a similar solution on a three-mile stretch of State Highway 161 in Irving. This project also used the existing highway shoulder to provide one additional travel lane in each direction during selected travel times. This project was the first of its kind in Texas, and the solution significantly alleviated the congestion in that corridor. However, there were also some challenges after this
implementation. TxDOT applied two important lessons learned from that project in the SH 121 project.

The first was the enforcement mechanism. After the SH 161 project was implemented, some commuters started driving on the shoulder lanes at all hours. This meant that if a police officer pulled someone over and stopped the car on that lane, it would affect the rest of the commuters on that lane. Consequently, enforcement became an issue. To deal with this concern, TxDOT and the project team chose to add the extra 10 feet of pavement to the north-bound lanes. In effect, the north-bound lanes would have a 22-foot shoulder during non-peak periods and a 10-foot shoulder during peak periods. This ensured that police officers would be able to use that extra shoulder space when not in operation, and for other emergency situations.

The second important takeaway from the previous project was dynamic operations. On the SH 161 project, the shoulder lanes were open during peak periods only from 6-10 a.m. and 2-7 p.m. on weekdays. For the SH 121 project, TxDOT has decided to open and close the shoulder lanes not only during the peak hours, but also at other times of the day as needed, based on real-time traffic conditions. This would allow TxDOT to reduce congestion in the case of an emergency or during major special events that generate off-peak traffic. Through state-of-the-art ITS equipment, a traffic management center will monitor conditions on the corridor and open the shoulder for use as congestion arises or in anticipation of increased traffic. Dynamic signs will actively inform motorists when the shoulder is open for use.

**Stakeholder Communication**

Communication has been critical to the project’s smooth progress to date. The project involves many public and private stakeholders, including TxDOT’s Fort Worth and Dallas District, North Central Texas Council of Governments (NCTCOG), FHWA, Bedford and Euless Police Departments along with various safety and emergency response stakeholder groups, such as local tow-truck agencies.

“We had numerous meetings with various stakeholders about the SH 161 project implementation and the lessons we learned,” said Cordary. “We met with them to explain what we are implementing at SH 121, how it would work, heard their concerns and have thought about how we would solve them.”

The construction of the project began in January 2019 and is expected to be completed in 2020. The project is expected to accommodate the existing and future traffic volumes for the next 10-15 years and improve the safety conditions of the road.

“This project shows how innovation can be used to solve a transportation challenge in a cost-effective manner,” said Cordary. “At TxDOT, we are always looking for different types of strategies to quickly implement solutions. This is another tool in the tool box that transportation departments can use to mitigate congestion.”

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As Historic Floods Swamp the Midwest, Oklahoma Counts On TriAx Geogrids for Constructability and Longevity

In many parts of the South and Midwest, road construction projects use chemical stabilization to deal with weak, wet soils and create an acceptable subgrade. Chemical stabilization is often cost-effective compared to the conventional approach of excavating and replacing poor quality soil, but it has some drawbacks which can affect installation and performance, especially in wet weather. For several communities in Oklahoma, Tensar’s TriAx Geogrids have provided a cost-effective alternative which improves road performance while also reducing construction time.

Communities across the South and Midwest have experienced extreme weather over the past few months, with historic rains resulting in devastating floods. In addition to the immediate dangers and damage that floods bring, construction and maintenance of transportation infrastructure can be affected dramatically. Saturated conditions can cause both delays in construction schedules and structural issues which shorten the life of existing roads.

In Oklahoma, transportation departments in two communities chose Tensar’s TriAx Geogrids over chemical stabilization to address poor subgrade conditions. Chemical stabilization is often used in these areas to prepare subgrades for road construction. Since chemical treatment requires good weather for both application and curing, all the recent precipitation could create havoc with construction schedules. An additional concern in areas where roads can be inundated during floods is the fact that pavement structures are weakened significantly when they are saturated with water. As the flood waters recede, significant damage can be done by traffic which uses the road before the aggregate base and subgrade have dried out. Because chemical treatment reduces the drainability of both aggregate and soil, the potential for permanent road damage is higher unless more severe traffic restrictions are imposed.

Tensar’s TriAx Geogrids solve this problem because they stabilize weak subgrades differently, by interlocking with aggregate to create a stiff, stable layer on which to build. TriAx Geogrids can be installed in just about any weather conditions, and they actually help preserve the ability of the pavement structure to drain, by preventing the loss of granular material into the subgrade and the pumping of fines into the aggregate layer. The triangular geometry of the geogrid creates high stiffness in the aggregate layer and retains that stiffness over time, making for roads that last longer.

In a project for the City of Claremore, Oklahoma, the city’s engineering department decided slightly higher upfront costs of using Tensar’s TriAx Geogrid were worth the long-term improvements in road performance, including reduced maintenance and extended service life. Over the years to come, using TriAx Geogrid for this project will save Claremore taxpayers money, allowing the city to address other needs that would have gone unmet.

A project in Oklahoma City saw TriAx Geogrid reduce overall construction time in addition to increasing pavement life. Switching to Tensar’s TX7 Geogrid shaved off several days of construction time which would have been spent waiting for chemical stabilization treatment to cure. Instead, the contractor was able to place the aggregate and test for compaction in the same day, which meant less time waiting around to install pavement, and less inconvenience for motorists. For a high-traffic intersection in Oklahoma’s most populous city, this was precious time saved without compromising on design life.

Tensar’s TriAx Geogrids may not be able to completely protect roads against extreme weather and flood damage, but for these Oklahoma communities, civil engineers can take pride in high-quality roads that last for decades, and citizens can trust elected officials to spend taxpayer money wisely.

About Tensar International
Headquartered in Atlanta, Tensar International is a full-service provider of specialty products and engineering services that offer innovative and cost-effective alternatives to traditional construction methods. Tensar solutions are based on advanced soil stabilization and reinforcement technologies and incorporate unique, engineered applications for commercial, industrial, municipal, residential and transportation infrastructure site development. The company specializes in solutions for common site development challenges, including grade changes requiring retaining walls and poor soil conditions affecting the cost of roadways, parking lots and building structures. Patented, polymeric Tensar® Geogrids and Tensar’s Geopier® foundation reinforcement piers are the primary components of the company’s systems, offering reliable strength and durability. Contracted services include site evaluation, conceptual engineering, design, value engineering and installation advice. For more information, visit tensarcorp.com.
It all started with a phone call back in 2014. An old dorm was being imploded on the campus of Appalachian State University in Boone, North Carolina. The project manager wanted a drone video of the event, so he called Jordan Nelson, a local who was known for the entertaining videos he’d been posting on social media. Nelson, owner and founder of Nelson Aerial Productions, took the job. Good decision. The contractor on the project, D.H. Griffin, had plenty of more work in terms of demolitions, so Nelson became part of the package, shooting a total of 11 implosions with the wrecking company.

That body of work, compiled over the course of four years, went into “The Big Boom.” The video earned Nelson Aerial Productions the C+S Engineering Drone Video of Year award during live voting this spring at the AUVSI XPONENTIAL conference in Chicago. Footage from 10 separate projects – shot primarily with a DJI Inspire 2 drone carrying an X5S camera – included demolition of the Georgia Dome, coal plants, and office buildings. The compilation, from eight projects filmed for D.H. Griffin and two for Pettigrew Inc., took 12 hours of intense editing, and effectively chronicled an entirely new business line for Nelson.

Earning the lion’s share of the more than 18,000 votes cast at AUVSI, “The Big Boom” represents a groundbreaking triumph for Nelson, who has spent countless hours in the field and in front of the computer honing his craft. Now, the world knows what he’s been up to the last few years.

“This is a huge honor,” Nelson said. “All the hard work paid off knowing people saw it and appreciate the creativity and effort. Every video I create, I want it to be better than the last one.”

Video runner-ups were “Contact Inspection Drone for Civil Engineering Structures” by CATEC, and “Longmeadow Parkway” by Civiltech Engineering, Inc. “Aerial Buzz,” a division of Spiracle Media, won last year’s inaugural event.

Nelson, 30, did not go to college for what he does for a living. Self-taught with the help of YouTube, online tutorials, and old-fashioned trial and error, he graduated from Appalachian State with a degree in Geography, and only jumped into serious video production after college.

So, the story begins on the ski slopes around Boone. Using GoPro cameras, Nelson captured his snowboarding adventures and posted them to social media. He took a keen interest in how the cameras were mounted, and when he saw one attached to a drone, Nelson was hooked. Moving beyond snowboarding, he ventured into aerial shots in and around Boone, situated in the scenic Blue Ridge Mountains. And it was those videos, not so much the snowboarding pieces, that captured the public’s imagination – and caught the eye of the project manager on the dorm demolition.

“He just decided to call me up,” Nelson said. “That phone call started all of it.”

Fast-forward to today, and Nelson is enjoying the payoff, both in contracts and in notoriety. The Boone Chamber of Commerce honored his big AUVSI win with a major press release.

Not content to sit still, Nelson plans on expanding his production team, and cracking into yet another business unit, inspections. Nelson also documents natural disasters, such as hurricanes Matthew and Florence in 2016 and 2018, respectively, the 2015 flood in Columbia, South Carolina, and the 2017 flood in Boone, which garnered a plump one million views on Facebook.

Nelson records in either Cinema DNG or Apple ProRes at up to 5.2K resolution. His current fleet of drones is composed of an Inspire 2, Mavic 2 Pro, Phantom 4 Pro, Inspire 1, Mavic Pro, and a Mavic 2 Enterprise Dual which is used primarily for search and rescue operations. To ensure that his work is always at hand, he relies on a network of storage systems or, as Nelson likes to say, “back-up for the back-ups” anchored by multiple 12-terabyte drives.

While there are plenty of technical aspects to Nelson’s profession, there’s certainly room for art, and it’s something he always strives for. Of his videos, he had this to say: “They might not remember what they saw, but they’ll remember what they felt.”

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“AUVSI was filled with hundreds of people all looking forward to the next 10 to 20 years, and that was the exciting part. It was a giant think tank. The drone industry is filled with such great promise that when you put that many people in a room together it’s hard not to get excited. When I saw the opportunity for the C+S Engineering Drone Video of the Year, I knew I had to be a part of it.”

Miguel Ángel Trujillo Soto, CATEC
Video: Contact Inspection Drone for Civil Engineering Structures

“We are thrilled to have had the opportunity to participate in the C+S Engineering Drone Video of the Year. Our experience from this contest has been very positive, so we are enthusiastic about participating again next year. As we are a technological center with multiple innovative drone technologies, we will need to carefully select what we are going to present next year because our objective will be to win the first prize.”
With survey projects, there’s complex, there’s very complex, and then there’s the Cedar River Flood Control System (CRFCS) project in Cedar Rapids, Iowa. Launched in 2015, the 20-year, $750 million construction project is building a combination of permanent flood walls, removable walls, levees and gates along seven miles of the river’s banks.

As a survey consultant for the CRFCS, engineering company Foth Infrastructure Environment has been providing survey data for the project when needed. In 2017 it was tasked with an assignment that seemed innocent enough: survey one site to acquire railroad pier features for hydraulic modeling and analysis and perform an as-built, topographic survey at another site for flood wall design and clearance verification. Upon further inspection, however, the challenges to meet that assignment went beyond complex: Site One was only accessible by boat and involved an active railroad bridge and for Site Two, they would only have four hours to capture one mile of as-built data.

“For the setting, time constraints and required precision of the data, we had to have extremely efficient and reliable technology that could give us long-range data capture without sacrificing accuracy,” says Jody Budde, a professional land surveyor with Foth, based in Cedar Rapids. “Conventional survey techniques would challenge us to meet those specs and timelines and would put our crews’ safety at risk.”

Armed with a tactical fieldwork plan, GNSS and advanced scanning, imaging and high-speed scanning technology, a small crew not only captured all the infrastructure elements needed, they delivered more data than was initially requested and debunked a previous assumption about the true low point of a bridge arch, saving the city from a costly oversight.

Tackling Complexity
Planning for the CRFCS began while the last drops of water were receding from the “Flood of 2008,” the most devastating flood in the region’s history. In June of that year, the Cedar River crested at 31 feet, surpassing the previous record set in 1993 by 11 ft. The flood waters deluged 10 square miles – 14 percent of the city – displaced 10,000 residents and swamped Cedar Rapids, Iowa’s second-largest city, with $6 billion in damages. In 2015, the city adopted the CRFCS master plan and started redeveloping the riverfront and building the flood protection elements in earnest.

Along with the levees, and permanent and removable flood walls, the CRFCS will add up to eight pump stations, replace one bridge, create a basin to store excess rain water and construct an amphitheater designed to be a storage basin during high water events. Taken together, the entire flood-protection system is designed to withstand the 2008 flood-volume levels. To date, seven phases of the long-term plan have been completed and four projects, including the first permanent flood protection control on the west side of the River, are underway.

Critical to designing the new flood structures was understanding the Cedar River bank topography and the existing infrastructure along the bank and in the water to accurately model hydraulic flows and determine volume tolerances through specific sections of the River. When Foth was tasked with acquiring this information, it became clear early on that they would need to move beyond conventional total station and
scanning technology to deliver the precise detail both on spec and on time.

“In preparing for surveying both sites, we studied the areas of interest and the project specifications and we scanned one of the bridge arches with our existing equipment as a test,” says Budde. “Although we acquired the data, it required extra steps to create an accurate, georeferenced point cloud. We needed several trips to the site to establish control and targets and scan the bridge arch. Those additional set ups would add time we didn’t have, and range limitations of the scanning technology wouldn’t allow us to shoot across the river.”

Based on the exercise, Foth determined they needed a single instrument that could integrate total station measurements with high-speed, georeferenced 3D scans. After evaluating available technology, they acquired a Trimble SX10 scanning total station. The SX10 combines surveying, imaging and scanning (up to 26,600 points per second with a range of 600m).

“The SX10 was not only going to give us the range we would need, it would allow us to eliminate the need for additional field work because it automatically integrates the project coordinate system and georeferences the points,” says Ben Sullivan, a lead geospatial specialist at Foth. “That would save us significant time both in the field and in processing the data in the office. It also offers a true survey workflow that our crews are already familiar with so we’d need little training – and it would provide a safer working environment.”

Banking on the technology
Based on the CRFCS project schedule, Foth began with Site One, a 1.4-mile-long rugged stretch of river bank about 6 miles north of downtown, where an operational railroad bridge crosses the river and several abandoned, 100-year-old bridge piers dot the water. Foth’s specific assignment was to capture railroad track locations and define the shape and size of the existing and inactive bridge piers to within 0.05 of a foot. That data would be used in a hydraulic model to understand the effects of water flow with those objects in the river.

In the fall of 2017 a two-person crew launched their motorboat carrying a Trimble R10 GNSS rover, the SX10, a Trimble Yuma 2 tablet computer and a Trimble TSC3 data controller. Their first task was to find safe, suitable spots on land to set project control, locations that would also provide good vantage points for scanning. Criss-crossing the 500-ft-wide river, they navigated to nine locations to establish control using the R10.

With survey control completed, they switched to the SX10 and followed the same navigational path. Using the same control points, the team set up the robotic scanner and captured the scene, from the railroad bridge piers all the way downstream to the old pier remnants, collecting features along the river and across the river at distances of nearly 1,000 ft. To gain even more detail and perspective on the scanning objects, the crew performed resections between the control points to acquire several separate 3D measurements of the same feature, enabling them to better show the varied bridge piers’ characteristics. In total, it took them two days to scan the tracks and 12 piers, collect 11.8 million 3D points and take color photos with the built-in camera for coloring the point cloud.

“We were asked to define the size of the piers on one plane,” says Sullivan. “But the old piers had vertical size discrepancies between four and six feet and varied shapes. Accurately measuring those variations with a total station would have been difficult. Scanning was able to quickly and accurately capture the unique detail of each pier and in color, allowing the engineers to better evaluate and incorporate those structures into their model for a more precise analysis.”

Back in the office, they used the drag-and-drop nature of Trimble Business Center (TBC) software to take the data from the TSC3 and Yuma and seamlessly integrate the GNSS and scanning data into one project. In a few hours, they created and delivered a 3D point cloud for the engineering design firm to immediately integrate into its own hydraulic analysis software.

“Originally, the data deliverable request was for a standard CSV text file,” says Budde. “But we knew a point cloud would give them more data depth and much better feature definition for further analysis. After they realized how beneficial the point cloud information would be, they asked for the 3D data going forward, starting with Site Two.”

Racing the Clock
Foth returned to the Cedar River in Spring 2018 to tackle Site Two. This particular 1-mile stretch of riverbank will have a permanent flood wall so Foth needed to collect a topographic survey and as-built data of ground-level and submerged infrastructure and three bridges to inform the design of the wall construction.

Collecting that information, however, required the city to close an upstream dam for the first time in its history. That opened a flood of unknowns, and led the city to err on the side of caution and only allowing the dam to be closed for four hours.

Because of the uncertainties, Foth dispatched two, two-person crews who set ten control points with the R10 and started scanning with the SX10 while the water level was lowering. To accommodate the notably

A shot of the 12th Ave Bridge from the SX10 internal camera with its equivalent point cloud view. This particular bridge had a 1.5-in clearance tolerance to the bottom of the bridge requiring a team to capture a 3D point every 0.125 to 0.25 inches. Photo: Foth
high-accuracy vertical precision required – one specific bridge had a 1.5-in clearance tolerance to the bottom of the bridge – the crews also used a Trimble DiNi digital level at each control point to ensure height elevations would be within the project’s 0.01 of a foot specification.

In parallel with the control crew, the scanning crew used project control to capture 3D points of the infrastructure. Using four separate locations on the east side of the river, they scanned the entire length of the west bank AOI, collecting features up to 800 ft away including bridges and bridge arches, existing flood structures, utilities and submerged features like underground pipe networks as the riverbank became more exposed. They also performed resections between control points to gain better perspective on specific objects such as the bridge structures. For the 12th Avenue Bridge, the structure with the tight 1.5-in clearance design, the Foth team captured additional scans of its underside to capture a 3D point every 0.125 to 0.25 inches. By the time the dam was reopened, the crews had finished the job and collected 27.6 million points.

“Without the speed and scanning range of the SX10, we would not have been able to do this job,” says Ben Sullivan, a lead geospatial specialist with Foth. “Conventional survey technology would’ve required up to three times more man-hours and we would’ve collected only about 20 percent of the data detail we captured with the scanner.” Had Foth used a dedicated scanner, they would have incurred significant additional time setting targets intervisible from the multiple setups.

Similar to Site One, they used the TBC software to integrate the diverse data streams from the R10, DiNi level and the SX10 to process and validate the optical, leveling and GNSS data into one georeferenced project. In processing the point cloud and using the TBC plane-definition and cross-section tools, the Foth team discovered an unexpected data discrepancy for the 12th Avenue Bridge. Historical data indicated that the lowest arch points were the lowest clearance point. The 3D scanning data clearly showed a support pipe under the bridge deck that was lower than the bridge arches, revealing the pipe as the true low point for vertical clearance.

“The wall structure would be constructed using pre-cast concrete panels fabricated off-site,” says Budde. “If they’d designed and built the panels on the original assumption, they would’ve had a costly mistake.”

Instead, the engineering design firm has a precise 3D point cloud to integrate into its own modeling software, providing the information they need to create the most effective permanent flood wall for that part of the west bank.

With many more phases of the CRFCS to complete, it’s a good bet that Foth will face its share of complexity in the future. Based on the results of its SX10’s scanning debut, they are confident they have the right tools to succeed.
Building a successful client relationship is just like building any relationship. It takes work. It’s really no different than building relationships with your spouse, significant other, children, or best friend. Healthy, productive relationships require attention and intentional behavior.

It’s a common misconception that building client relationships only takes place on the golf course or at a bar. Not true. In fact, there are a number of actions you can take to build successful relationships and never leave your desk. Industry statistics place the cost to win a new client around five times more than what it does to keep an existing one. While developing new business is certainly critical, keeping the business – and clients – you have is equally (and arguably more) important. By employing these five strategies, you can build a culture where every member of your team – from your full-time business developers to project managers to administrative staff – contributes to client relationships and, ultimately, building your business.

Communicate
1. **Listen.** Active listening is the most important thing you can do to connect with a client (or your coworker, or your spouse). Train yourself – and your team members – to remove distractions, engage, and truly listen to your client every single time you have an interaction. And if you can’t, call them back. Don’t risk missing important details from a conversation, or even subtle nuances your client may impart, because you aren’t focused on what they’re saying. Active listening gives you information to confirm what you are doing right and also what might need fixing. And, who doesn’t want to be heard? Listen to what your client is telling you and repeat back to them what you heard. This practice (of parroting) will ensure your client knows you’ve heard them and proves you are listening.

2. **Check in for no reason.** Seriously. Call your clients just to check in. You certainly want to be respectful of their time, so make the call short. But, a friendly call to say “Hi” and ask how they are doing isn’t going to be offensive. Surprise and delight your client by calling with no agenda or motive, but as a friendly and sincere gesture.

3. **Gather intel.** In the process of interacting with your clients, ask questions. Take a few extra minutes to learn more about their needs and pain points. Ask if they have any future projects that would be an excellent fit for your firm. Share the intel with your market leaders and marketers to help position your firm in the future.

4. **Send notecards.** We receive 30,000 commercial messages a day. Stand out by sending your client a notecard. Make it simple: “I appreciate you as a client” or “Thank you for your business” or “It was so great to meet you.” We are all pleasantly surprised when we go to our mailbox, and there is something other than junk. Your hand-written card might just brighten your client’s day.

Connect
1. **Use LinkedIn.** LinkedIn is an excellent resource for getting to know your clients and finding common interests. Connect and follow your clients. And
then share and comment (when appropriate) on their postings.
2. **Say their name.** People love the sound of their name. Dale Carnegie famously said, “A person’s name is to him or her the sweetest and most important sound in any language.” Use your client’s name as an important way to create a connection.
3. **Send items/intel of value.** Work to know your clients. And when you do, take time to send them things or information that they can use, like a restaurant recommendation if they’re a foodie, a travel tip for their upcoming vacation, a business journal clipping mentioning them or their project, a bit on intelligence in the marketplace, or even a recent article you read about the importance of client relationships. Clients like, and hire, firms who know and stay connected with them.
4. **Guide your clients through your services.** Consistently offer to proactively talk through your project process or when you send any deliverable or report. Provide a forum for interaction and questions. This practice will improve your client’s experience and provide you a wealth of knowledge to understand and meet their needs. And, if they decline your offer, you’ve still demonstrated your willingness to connect.
5. **Debrief.** Whether you win or lose a project, debrief every time. Ask for direct, honest feedback when not selected for a project and be clear you’ll use this information to better position your firm in the future. And when you win, it’s even more important to know why you were selected and what differentiated you from the competition (so you can repeat that in the future).

**Care**
1. **Be client-centric.** Engage. Ask questions. Know your clients personal and professional goals. Treat them as you would a friend and in all things be genuine. Strong client relationships lead to more work and a better working relationship.
2. **Always respond.** Clients want to be heard. They want to feel important. To ensure you’re doing this, be responsive every time. Even if you don’t have an answer, respond that you’ll get back to your client ASAP with a solution.
3. **Don’t take your clients for granted.** We tend to take our closest relationships for granted. Do you assume your best clients will keep hiring you? I promise you, there is a long line of your competitors that are working to take your client away from you and are likely showering them with attention. If you’re not tending the relationship, at some point your client may give your competition a shot.
4. **Show your passion.** We all like to work with people who are passionate about what they do. Your clients are no different. They want to know the person they’re entrusting with their project is just as excited about a successful outcome as they are.
5. **Seek client feedback.** Don’t wait until the project is over to seek input. Ask if you and your team are meeting your client’s needs and how you can improve throughout the life of a project. Develop a process for client feedback and put it to work.

**Educate**
1. **Educate yourself.** Understand your firm’s history, mission, vision, values, and strategic goals so you can speak to clients about your firm with confidence. Understand your clients so you can understand their needs and frustrations. Know your markets so you can have informed conversations with your clients. Share what you learn with your colleagues, leaders, and marketing team to position your firm to win.
2. **Educate your clients.** You learn something every time you complete a project. Share that knowledge with your clients. Position yourself as an expert to build trust and confidence.

**Prioritize**
1. Make client relationship building (business development) a priority. Bookend your day by scheduling five (5) minutes of business development activity before you start your day, before you check your email, and before you leave the office. Use Outlook as a tool to help you remember to follow through and employ the many strategies above.

Remember, the most successful client relationships are intentional and require persistence, time, and effort to be effective. If you want to maximize your return, employ everyone in your firm and teach them to focus on client relationships. At Zweig Group, we believe business development is everyone’s business. It can be at your firm, too!

Co-Author by Jen Newman, CPSM, Managing Director, and Doug Parker, FSMPS, CPSM, Managing Principal & CMO, Zweig Group.

As Managing Director at Zweig Group, Jen Newman, CPSM utilizes her 20 + years of AEC specific experience to help firms grow their people and profits while ELEVATING THE INDUSTRY.

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Insulating Concrete Forms for Multifamily Residential Construction

By Lionel Lemay, PE, SE, LEED AP and Tien Peng, Assoc AIA, LEED AP+, PMP

Credit: 1 LU/HSW
Course Number: ZG062019CS

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Course Overview:
This article provides guidance for architects and engineers on how to design and build high performance reinforced concrete multifamily residential buildings using Insulating Concrete Forms (ICFs). Combining the strength and durability of reinforced concrete with rigid insulation, ICFs provide ideal solutions for apartments, condos, hotels, dormitories and assisted living facilities. With increased attention to occupant safety and comfort, design professionals can take advantage of concrete’s inherent fire resistance and noise reduction qualities. This article addresses how the thermal properties of ICFs offer building owners significant energy savings over the long term. The article also provides guidance on how to minimize the cost of ICF concrete construction to take full advantage of these benefits.
Learning Objectives:

1. Understand the basic design criteria and construction elements of Insulating Concrete Forms (ICFs) for multifamily residential projects
2. Demonstrate the economic benefits of building multifamily projects with ICFs
3. Recognize the energy performance characteristics of ICF for multifamily construction
4. Understand the contribution concrete makes to a building’s resilience to fire, flood, wind and earthquakes

Introduction

Insulating Concrete Forms, or ICFs for short, combine two well-established building products, reinforced concrete for strength and durability, and expanded polystyrene (EPS) insulation for energy efficiency. ICF walls are made up of two layers of rigid insulation held together with ties to form ICF form units with a cavity in the center. The ICF form units are stacked in the shape of the wall, reinforcing steel is added into the form cavity and then concrete is placed into the form. The result is a reinforced concrete wall with a layer of insulation on each side. What makes ICFs different than traditional concrete construction is that the forms remain in place after the concrete is cured to provide thermal insulation. The combination of reinforced concrete and insulation provides an ideal load bearing wall, thermal envelope, fire barrier and sound barrier.

In addition to ICF walls there are also ICF concrete floor and roof systems. The concept is similar in that the ICF form is made with rigid insulation to function as a one-sided form at the bottom surface. The forms are installed to span between concrete walls, reinforcing steel is placed and then concrete is placed over the forms. The result is a reinforced concrete floor or roof with rigid insulation on the bottom.

ICF wall systems have been used for building applications ranging from single story buildings to 20+ story high-rise buildings and everything in between. There are examples of ICF buildings all over the U.S. and Canada including single-family residential, multifamily residential, hotels, dormitories, assisted living facilities, offices, healthcare facilities, manufacturing and warehouse buildings. Schools built with ICF are popular due to low- or net-zero energy use. Theaters are also trending towards ICF construction for superior sound attenuation. For this article we'll focus on multifamily occupancies including apartments, condos, hotels, dormitories and assisted living facilities.

What makes ICFs so attractive for multifamily construction is that they are cost competitive with wood frame, steel frame and masonry construction. A building owner gets a building that is more disaster resilient and energy efficient at or nearly the same cost. Fire safety is a key element of multifamily construction since occupants sleep in these buildings and are often challenged to evacuate during a fire. Concrete walls and floors provide the fire resistance needed to not only allow occupants to evacuate, but contain the fire within a single unit, imposing less risk to fire fighters and property.

ICF Wall Systems

Typically, ICF wall units are comprised of large molded EPS blocks, similar to Lego® blocks with a cavity for concrete in the center. Blocks are manufactured in an EPS manufacturing facility. The blocks range in size from 48 to 96 inches long and 12 to 24 inches high depending on the manufacturer. The most common configuration of an ICF unit is made up of two layers of 2-3/8- to 2-5/8-inch-thick EPS spaced 4, 6, 8, 10 or 12 inches apart depending on design requirements. The most common cavity is 6 inches or 8 inches for most low to mid-rise buildings,
but for taller buildings, taller walls, or exceptionally large loadings, thicker walls are necessary. For simplicity, ICFs are generally called out by the width of cavity, hence an ICF with a 6-inch cavity is called a 6-inch ICF and an ICF with an 8-inch cavity is called an 8-inch ICF and so forth.

The blocks are designed to have interlocking teeth that hold the forms together much like Legos®. Most manufacturers not only supply straight blocks but have corner blocks, angled blocks, t-blocks and some even have curved blocks. Most even provide special blocks with brick ledges. Most companies supply blocks that are fully assembled and ready for installation, but some ship blocks that are folded into a flat configuration and then unfolded for installation. One manufacturer ships blocks and ties separately that are assembled on site. Many have special window and door bucks along with other accessories such as bracing, clamps and scaffolding to make the construction process more efficient.

There are some ICF forming systems that are made of other insulating materials and with slightly different configurations and shapes, but flat-wall ICF systems dominate the marketplace. This can be attributed to the fact that flat-wall ICF form units are designed to create standard reinforced concrete structural elements, using well-documented design criteria, such as ACI-318.

There are at least a dozen companies that manufacture flat-wall ICF systems that can deliver their product throughout the U.S. and Canada and many are members of the Insulating Concrete Form Manufacturers Association (ICFMA). For more information visit www.icf-ma.org.

EPS insulation used for ICFs is governed by ASTM C 578, Type II closed cell foam with an R-value of 4 per inch. Polystyrene beads are first expanded with steam forming high density beads, which are injected into a mold to form the desired shape. Once removed from the molds and cured, EPS is a stable and durable material ideal for construction. No chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) or formaldehydes are used in the manufacturing process and there is no off-gassing. EPS is moisture resistant, non-absorbent and resistant to mold and rot. EPS contains a flame retardant and the smoke from burning is non-toxic. In addition, EPS is recyclable at its end of life.

The plastic ties that hold the two wythes of the block together are generally made with polypropylene plastic, but it does depend on the manufacturer. They are designed to withstand the liquid concrete pressure during construction. Most manufacturers
design their ties to secure horizontal and vertical reinforcing bars into notches in the ties to minimize the need to use tie wire. Although different manufacturers provide a wide range of spacing for ties, the most common spacing is 6 or 8 inches. The ties have no thermal bridging, they do not degrade or rot over time, and all ties have furring strips embedded in the EPS for screw-on attachment of exterior or interior finishes.

Concrete being pumped into an ICF wall. Photo: Quad-Lock

Reinforcing steel used in ICF walls is the same used for any other type of concrete structure. Typically, smaller diameter bars are used such as #4, #5 or #6, but thicker bars can be used for higher loading, concentrated loads and pilasters. In most cases, reinforcing steel is placed in one layer in the center of the wall at wide a spacing as permitted by code, especially for above-grade walls built using 6- or 8-inch ICFs. For 10-inch and larger ICFs, one can consider using 2 layers of reinforcing on each face. The objective is to minimize congestion and facilitate concrete placement. In some cases, steel fibers have been used in place of reinforcing steel in ICF walls, but most common applications use both horizontal and vertical steel reinforcement.

Concrete is typically placed in ICF walls using a boom-type concrete pump, though line-pumps or even conveyor belt equipment can be used. Specified compressive strength used in ICF walls can be whatever is required to resist structural loading, but most common are a 3000 psi or 4000 psi concrete pump mix. The recommended maximum aggregate size should be ½-inch aggregate for 4- and 6-inch cavity forms and ¾-inch aggregate for 8-inch and larger cavity forms. The required concrete slump is 6 inches but could be up to 8 inches or more to accommodate pumping using high-range plasticizers and mid-range water reducing admixtures to achieve necessary flowability.

Concrete is typically placed one level at a time. In other words, ICF blocks are stacked in the shape of the wall for a single story. Reinforcing steel is installed as the forms are stacked. Bracing, scaffolding, window and door bucks are installed. Once the ICF wall is plumbed and straight, concrete can be placed in 4-foot lifts. For a wall that is 12 feet tall, concrete would be placed in 3 different lifts by placing 4 feet of concrete at one time for the entire length of wall. By the time pump reaches the starting point, the concrete is usually stiff enough to place the second lift and so on.

As construction continues, electrical and plumbing lines can be embedded into the interior layer of foam by cutting channels with a hot-knife or other tool. Interior or exterior finishes can be applied directly to the surface by screwing into the plastic furring strips. Gypsum wall board on the interior, and stucco, brick or siding on the exterior are common finishes ideally suited to ICF construction but nearly any finish can be applied.

**Click Here to Finish This Continuing Education Piece and to Take the Quiz**

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**TIEN PENG, ASSOC AIA, LEED AP+, PMP** is Vice President, Sustainability, Codes and Standards, National Ready Mixed Concrete Association
1. What materials make up an insulating concrete form wall?
   a) Structural insulated panels
   b) Expanded polystyrene
   c) Reinforced concrete
   d) Fiberglass insulation
   e) Both B and C

2. A typical 6-inch insulating concrete form wall easily achieves an STC rating of _____.
   a) 55
   b) 75
   c) 150
   d) 300

3. For multifamily construction, ICFs are cost competitive with
   a) Wood frame
   b) Steel frame
   c) Masonry
   d) All the above.

4. EPS used for ICFs is typically ASTM C 578, Type II closed cell foam with an R-value of:
   a) 4 per inch
   b) 2 per inch
   c) 1 per inch
   d) 10 per inch

5. Concrete used for ICF walls typically has specified compressive strength of:
   a) 1,000 or 2,000 psi
   b) 2,500 psi
   c) 3,000 or 4,000 psi
   d) 5,000 psi

6. ICF floors and roofs can span up to about ________, depending on the depth of each joist.
   a) 10 feet
   b) 16 feet
   c) 20 feet
   d) 30 feet

7. Which systems offer the advantage of having space for mechanical and electrical within the floor cavity?
   a) Precast hollow-core plank
   b) Concrete on metal deck combined with steel joists or cold formed joists
   c) ICF floor and roof systems

8. Maximum aggregate size for 6-inch ICF walls should be:
   a) ¼”
   b) ½”
   c) ¾”
   d) 1”

9. Which of the following performance benefits do ICFs have?
   a) Noise attenuation
   b) Fire resistance
   c) Energy efficiency
   d) Strength
   e) Durability
   f) All of the above

10. ICFs are considered by the IECC and ASHRAE 90.1 as mass walls with continuous insulation and typical whole wall ICF assemblies have an R-value between ________ depending on the exterior and interior finish materials.
    a) R-11 and R-19
    b) R-20 and R-23
    c) R-24 and R-26

11. Which hazard kills more Americans each year:
    a) Earthquakes
    b) Tornadoes
    c) Floods
    d) Fires
    e) Hurricanes

12. A 6-inch ICF wall will typically achieve a fire rating of:
    a) 1 hour
    b) 2 hours
    c) 3 hours
    d) 5 hours

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A CLEAR VIEW
FINANCIAL DATA SHOWS THAT FIRMS ARE PROFITABLE,
PUBLIC-SECTOR WORK IS HEALTHY
By Will Swearingen

ZWEIG GROUP’S 2019 FINANCIAL PERFORMANCE SURVEY of AEC Firms gives firm leaders a clear view of industry trends and financial metrics that can help them effectively manage their resources. A great way to improve profitability is to have a strong understanding of financial metrics and accounting activities. This report isn’t only for executive-level leaders, either. AEC professionals at all levels of the organization can benefit from understanding what metrics are tracked and how their performance helps improve overall firm performance.

Many of the metrics tracked by Zweig Group over the years have ticked back. Pre-tax, pre-bonus profit on net service revenue bounced from 12.7 percent last year back up to nearly 14 percent. This is certainly a positive indicator as year-over-year growth metrics for gross revenue and full-time staff equivalents also moved back up. Firms operating predominantly in the public sector enjoyed strong growth coming off a relatively flat 2017-2018. Firms operating predominantly in the public sector grew revenue by 11 percent, compared to 6 percent for firms in the private sector, and grew their staff count by 4 percent where private sector firms were relatively flat.

Net service revenue per full-time equivalent (NSR/FTE) again reached a 10-year high. It is encouraging to see the year-over-year growth in NSR/FTE (2.2 percent) outpace inflation (1.8 percent) this year, after not doing so in 2018. NSR/FTE was $144,434 last year and this year that number reached $147,790. Over the last five years, the growth of NSR/FTE for AEC firms was around 15.3 percent, nearly seven points above the average US inflation of 8.6 percent for that time frame.

Analyzing staffing ratios, very high-profit firms have nearly seven (6.9) technical professionals to each administrative staff. When comparing this to their revenue factor (2.18), the same trend is seen based on firm profitability. Zweig Group believes that the revenue factor is the strongest measure of a firm’s overall performance (calculated: NSR/total labor or chargeability x net multiplier). Low-profit firms have a staffing ratio of 3.8 and a revenue factor of just 1.76. The same trend is not found when comparing staffing ratios to chargeability or utilization, indicating that the fee charged and total labor utilized are more important than just looking at hours charged to projects.

The report also analyzes operating costs, looking at group insurance, vacation, and PTO as well as payroll and labor expenses. One area with an interesting divergence was group insurance as a percentage of total costs. The publication shows this figure decreasing over the last two years where data in Zweig Group’s 2019 Policies, Procedures and Benefits Survey of AEC Firms clearly shows insurance costs going up. So, what gives? As part of total costs, vacation and PTO costs are included, which have jumped from 5.7 percent to 6.3 percent of total costs. As firms look to satisfy the flexible work environment that the market demands, their costs structure is also changing.

Zweig Group’s 2019 Financial Performance Survey of AEC Firms and its accompanying Benchmarking Tool show how firms performed on nearly 100 indicators. Each measure is described in detail, so you can better understand the implications of being excessively high or low on any one measure. Firms can use this to target internal initiatives, investment opportunities and improvement efforts to match their best performing peers or simply determine if their metrics are moving in the right direction.

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