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If there’s one thing I’ve learned in the last few years in the AEC industry, it’s this: You just never know who you’ll talk to.

One day it’s earth, the next it’s fire, and then it’s water. Engineers do it all, and when your job is to talk to them and to curate their stories for publication, you end up with an A-to-Z view of the show. And what an amazing sight to behold. From the massive infrastructure pieces underway in China and India, to the innovation of worldwide software companies like Autodesk and Bentley Systems, the evidence is overwhelming – engineering has gone global and now has the ability to go under, over, around, or through obstacles to deliver landmark projects anywhere.

Do we want to save the planet from climate change? How about bringing safe drinking water to millions? Or anticipating the effects of urbanization and digging new tunnels for the expansion of public transit? There are countless inquiries, and somewhere out there, teams of engineers are working overtime to deliver the answers. Based on an ever-evolving foundation of technology, engineers are doing their best to serve mankind across the gamut of wants and needs. And while the battle has certainly not been lost, it will never quite be won, either. Just look at the numbers. The global population is about 7.7 billion right now, but is expected to grow to as much as 11 billion-plus by century’s end. That means a lot more of everything, from roads and bridges to wastewater treatment plants, from office buildings and airports to housing and hospitals. Engineers have their work cut out for them, and they’ll be racing against the clock the entire time.

In the United States, construction starts are expected to slip by as much as 4 percent from 2019 to 2020, according to Dodge Data & Analytics. How long will this slowdown last, and what effect will it have on the engineering industry? On the business end of things, it could mark the beginning of a new wave of M&A activity and an easing of the labor market. Firm owners looking to retire might decide that the time is right to sell, while acquiring firms might finally find the deals they’ve been looking for, and the talent they need. Whichever way the slowdown unfolds, you can be sure that adjustments will be made and that opportunities will be found – at least that’s what I was told during a recent interview by a business minded CEO who founded his own firm.

In this month’s issue, you’ll read about a team of researchers that ascended Mt. Etna to gain a better understanding of the volcano and to predict its eruptions. To achieve their goals, researchers used a complex system of measurements, which included a global network of GNSS tracking stations, and existing aerial imagery. They succeeded in measuring the mountain, and did so at an elevation of more than 10,000 feet amid dust, gas, and loose rocks. Leave it to the engineers to go where others might not tread, all in the name of obtaining that extra bit of data.

Also in December, you’ll see a piece about credentialing for AEC firms. Maybe not quite as neat as going to Sicily to measure Mt. Etna, but keep in mind that if an individual, or a firm for that matter, does engineering work without the proper licenses, they could be fined, have their name made public by a state enforcement board, and lose credibility among their peers and clients. As firms look for new geographies and markets, credentialing looms as an important issue, one that cannot be ignored or treated as an afterthought.

Indeed, from the spectacular to the mundane, engineering has it all. As I ponder what’s going on around the AEC world, all I can say is this: You just never know who you’ll talk to, and it’s fun sitting on the front row.
The complexity and pace of change in the current business environment requires that the creation of value and decision making not be centralized. Many firms have some form of “innovation” in their mission or vision, yet lack the ecosystems that actually encourage innovation. I’m sure most leaders will agree that they do not have a monopoly on winning ideas. That is why creating an environment where ideas naturally and consistently emerge is vital. Doing so requires support for the exploration of new ideas and experimentation, a comfort with failure, and a commitment to working with external partners.

I’m always happy to discuss, at length, the creation of this ecosystem. But we must first tackle something much more foundational if we are to have any success. What I’m talking about is the role of morality, values, and ethics in business – things that in certain circles have become taboo or passé. Admittedly, the subject is nuanced, and the topic will not be sufficiently covered in this article. It is, however, the underpinning of everything that is successful, or not, within our organizations, even if we’d rather not admit it.

I’d like to argue that values, morals, and ethics are inseparably linked and foundational to our businesses, culture, and strategy. It is these pillars that allow us to even discuss decentralization and the creation of an innovation ecosystem. To begin, we will have to define the terms in order to ensure we are on the same intellectual footing.

• **Values** – I typically define these for our clients as the unwavering principals that are necessary to infuse your culture with purpose. They are the foundation of a person’s ability to judge between right and wrong, the deep-rooted system of beliefs with intrinsic worth but that are not universally accepted. It is a system that allows individuals to determine what should or shouldn’t be. These fundamental beliefs guide a person’s decisions. There are also various levels including individual, firm, and societal values. I strongly encourage all leaders to reflect on their own individual values, but for now, let’s focus on the firm. Of course, if the two are not in harmony, then there is a poor fit with your organization which can cause additional challenges.

• **Morals** – Morality is formed out of our values. Morals are the actual system of beliefs that emerge from a person’s core values. These are specific and context-driven rules that govern a person’s behavior. Since this system of beliefs is tailored to an individual or firm, they are subjective, and this is where we see moral relativism injected into the discussion – that each firm’s morals may be different relative to any other firm. Morality is subjective and worth inculcating and discussing in our businesses.

• **Ethics** – Finally, we have the vehicle that allows us to act out our morality. Ethics are what deliver the moral system that we’ve developed. A person, therefore, can be said to be ethical by acting in accordance to one’s morality. That is why codes of ethics are always discussed as actions such as, “perform professional services only in areas of their competence” or “conduct themselves in a fair, honorable, and respectful manner,” to borrow from the code of ethics by the American Institute of Chemical Engineers.

Careful thought and consideration are paramount when defining your firm’s values, morals, and ethics. If you accept the premise at the outset of this article – that of a decentralized system and a required innovation ecosystem – then this foundation is the first step. As technology, particularly AI, continues to develop at a brisk pace, I would even argue, particularly for larger organizations, that an ethics/values committee be established to keep you accountable and aligned in the “face” of a nameless, faceless machine learning platform.

**PHIL KEIL** is director of Strategy Consulting, Zweig Group. Contact him at pkeil@zweiggroup.com.
DECEMBER 2019

GEO-INSTITUTE TECHNICAL COMMITTEE WEB CONFERENCE
DEC. 2-6
The Geo-Institute Technical Committee will be streaming our 4th Annual Web Conference on December 2-6. Each day a diverse set of case histories will be presented by top geotechnical professionals. Each event will run 2 hours and includes opportunities to interact with presenters. This year’s topics are: Deep Foundation, Earthquake Engineering and Soil Dynamics, Embankments, Dams, and Slopes Grouting, Earth Retaining Structures, Embankments, Dams, and Slopes, Embankments, Dams, and Slopes, Computational Geotechnics, Soil Improvement, and Sustainability in Geotechnical Engineering. https://www.geoinstitute.org/index.php/events/web-conferences-2019

THE WATER ASSET MANAGEMENT CONFERENCE
DEC. 4
The conference is hosted entirely in an online format, allowing you the flexibility to log in to view single presentations or multiple, all without leaving the office. The conference will be broken into a two-part series – one in May and the other in November 2019. Each series will feature two-hour-long weekly sessions throughout the month. The best part? Registration is FREE for all attendees! CEUs are available for an additional cost. https://www.waterassetmgmt.com/

INTERNATIONAL CONFERENCE ON ELECTRICAL, ELECTRONICS & COMPUTER ENGINEERING (ICEECE)
DEC. 6-7 – GREENSBORO, NC
The International Conference on Electrical, Electronics & Computer Engineering (ICEECE) is an interdisciplinary conference that aims to encourage and promote high quality research on important theoretical, methodological and empirical issues in engineering and sciences with the aim of providing an outlet for innovative research in those fields. https://www.researchlink.org/engineering-greensboro

2019 INTERNATIONAL CONFERENCE ON POWER, ENERGY AND ELECTRICAL ENGINEERING
DEC. 19-21 – LONDON, UK
The aim as well as objective of PEEE 2019 is to present the latest research and results of scientists related to Power, Energy and Electrical Engineering topics. This conference provides opportunities for the delegates to exchange new ideas face-to-face, to establish business or research relations as well as to find global partners for future collaborations. We hope that the conference results will lead to significant contributions to the knowledge in these up-to-date scientific fields. http://www.peee.org/

JANUARY 2020

GEO-INSTITUTE TECHNICAL COMMITTEE WEB CONFERENCE
JAN. 7-10 – LAS VEGAS, NV
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BEFORE IT ALL BURNS DOWN

It seems like the wildfires in California just keep getting worse. And that they may not ever end. We were reminded of this on a recent visit to San Francisco, when we saw the haze from the Kincade Fire, which burned in Sonoma County for 13 days and scorched over 77,000 acres of land. While the fire was about 80 miles north of San Francisco, its flames could be seen from the city’s Sutro Tower. Pretty scary.

Things aren’t any better in Southern California. The Getty Fire burned for over a week in Los Angeles County and came dangerously close to the Getty Museum and the trove of art it houses. Fire knows no bounds and doesn’t care about whom, or what, it destroys.

While the Kincade and Getty fires have been contained, the long-term news is not good. California wildfires have been on the rise since the 1970s, and scientific models indicate that the trend will continue. Indeed, the rogue’s gallery of California wildfires – Woolsey, Tubbs, Blue Cut, Camp, Maria, Easy, and Mendocino Complex, among many others – looks like it’s only going to grow.

Millions of Californians live in areas known as the Wildlife-urban interface, and this is where a lot of these fires break out. Bottle rockets, cigarettes, electrical utility work, a spark from a muffler – all of it can trigger an inferno in an area where people probably aren’t supposed to live. And on top of that, climate change and the profound, global havoc it is creating.

So, what happens when all this stuff burns? Houses, appliances, furniture, piping, electronics, cars, office and industrial buildings, and everything else in between. You guessed it. Polluted water sources, toxic air laden with particulates, and land contaminated with heavy metals and chemicals. And that’s not good for anyone. Just ask the folks in Paradise, California, whose town was basically erased in 2018 by the Camp Fire. The cleanup topped $1 billion, and workers were wearing protective suits, hard hats, and respirators to protect themselves from the “Toxic Twins” of hydrogen cyanide and carbon monoxide.

For Kathleen Hetrick, a senior sustainability engineer with BuroHappold Engineering in Los Angeles, this outbreak of wildfires represents an opportunity to take a hard look at what’s going on in the construction industry. Not just where things are being built, but what they’re made of, and, in general, the entire construction supply chain. A toxic building or household material that ends up in sprawling subdivisions in California, for example, might have been made in a “Cancer Alley” chemical plant in a place like Louisiana.

Hetrick is well positioned to ask questions, too. She’s part of the BuroHappold team that worked on the Santa Monica City Services Building, which used a restrictive procurement that excluded the “Red List” materials spotlighted by the International Living Future Institute. No polyvinyl chloride and formaldehyde at the Santa Monica City Services Building, which is seeking certification under the rigorous Living Building Challenge.

Not all places have the mindset and resources of Santa Monica. Hetrick knows that just as well as anybody. Still, the questions need to be asked. Are there alternatives to the use of PFAS, a family of more than 5,000 man-made chemicals present in everything from waterproofed clothing to carpet and furniture textiles? Is there a way to build homes that aren’t in mountain lion country, or in a drought-prone area near a national forest, and that don’t contain synthetics harmful to humans and biodiversity?

The brightest minds in the world are in the engineering industry, solving problems large and small. Where there’s a will there’s a way, or at least that’s what they used to say. In an increasingly polarized political environment, science is oftentimes the casualty. It serves one side or the other, they say, so it cannot be trusted by one side or the other. But our money is on people like Hetrick. Maybe it’s time to take a good look at the entire construction supply chain, confront climate change, and figure a few things out before it all burns down.

If you know of an interesting or off-kilter story taking place in the AEC industry, please contact C+S at rmassey@zweiggroup.com.
"...the boss told me to have a good day, so I went home"
His distinguished gray beard earned him the nickname “Old Man Winter.” He wears it well. With over four decades in municipal water, Warren Green, PE, of Lockwood, Andrews & Newnam, Inc., is respected among his peers and a beacon for the new generation. In the process of building his career, Green became his own man. When a lot of folks were moving from north to south, Green went in the opposite direction, leaving Jackson, Mississippi for Chicagoland in 1988. He has an herb garden – fresh basil, cilantro, and rosemary year-round – builds 18th Century furniture, owns a trove of over 100 antique engineering texts, and can tell you about a miraculous Civil War-era bridge over Potomac Creek that seemed to be made of “cornstalks and beanpoles.” And, most importantly, he was blessed with the gift of fatherhood when he was 50, an event that changed and enhanced his life. Indeed, any which way you cut it, Green is just a bit different from the rest. But when you set aside the personal background that makes him unique, one finds an engineer’s engineer, a man whose top priority is to devise an economical solution to a problem. And he’s done plenty of that. He was part of the team that brought Lake Michigan water to surging DuPage County, Illinois, an achievement that Green counts among his finest. But it being a water utility, that accomplishment, among others, was essentially cloaked in anonymity. Those who labor over piping systems and fluid dynamics just don’t get the kind of public recognition given to the builders of skyscrapers. But Green doesn’t mind. If the job is done right by the client, he’s satisfied.

“My career has touched millions of people and they don’t even know it,” he said. “I’m okay with that.”

A Conversation with Warren Green

Civil + Structural Engineer: You graduated from college in 1978 and have 40 years of experience. Looking at the latest generation of water and wastewater engineers, what’s your advice to them?

Warren Green: Take some time and learn the history of our profession. And that means not just reading it but delving into the theory that our predecessors developed when addressing design questions. The early engineers had to “figure out” the solutions without the aid of computers or even calculators, so their mathematical calculations were elegant. We still use many of these equations today, such as the Barlow Hoop Stress equation for the design of pressure pipes. The equation was developed in the early 1800s.
C+S: *You are an acknowledged expert in “all things water.”* Tell us about your love of water and wastewater engineering, and how you’ve contributed to the communities you’ve served.

WG: I do not refer to myself as an expert in “all things water” and I have limited experience in wastewater. I lost interest in wastewater when I fell knee-deep, and headfirst, into the primary cell of a sewage lagoon while working on a research project my senior year in college! Yep, killed that career interest.

I decided to pursue the “clean water” side because most of the sanitary engineers (that’s what we were called back then) were going into wastewater due to the U.S. EPA programs of the late ‘70s, and there was less competition. The new U.S. EPA Safe Drinking Water Act was just beginning at that time. I thought it would be an interesting career to get in on at the start.

Communities receiving improved water quality, pressure, and fire protection have been the contributions of my career. Sometimes, when I am in a group, people will be discussing their communities’ water systems and they have no idea that I was part of the team that brought the improvements to them. That gives me a real thrill.

*C+S: What was your biggest project? How long did it take, what was the key challenge, and what was the local/regional impact?*

WG: My biggest project was working with the DuPage Water Commission to bring Lake Michigan drinking water to an entire county. DuPage County, just west of Chicago, was primarily a farming area back in the 1950s. The population of the county began seeing accelerated growth to a point that some of the 30 communities in the county were said to be the fastest growing in the country.

These 30-plus communities relied on ground water from an aquifer that was rapidly depleting, therefore supply was limiting growth and the water quality was somewhat marginal, primarily high hardness and iron. Many of the new residents were from communities that had access to high-quality Lake Michigan water supplied by the City of Chicago. The citizens of the county began demanding Lake Michigan water.

A massive $380 million (in 1985 dollars) project was initiated in the mid-1980s with the DuPage Water Commission formation in 1984. Engineering began in 1986 with the first construction contracts let in 1987. The projects included 162 miles of large diameter pipe (up to 96-inches), a 320-mgd pumping station, a 185-mgd pumping station, 2.4 miles of 12-foot diameter tunnel, two 30-million gallon storage reservoirs, two 6-million gallon water storage tanks, three 7.5-million gallon water storage tanks, and 64 delivery structures.

I joined the project in 1988 as the manager of construction phase services. The key challenges were maintaining project schedules with up to 20 construction projects running simultaneously and coordinating with 35 governmental entities for permits.

We finished the project one year ahead of schedule and almost 850,000 people had a new water supply. No more in-home water softeners! To this day, I remember that project with a lot of pride.

C+S: *Tell us about your love of engineering history. As we all know, Alexander the Great, Fourth Century BC, was accompanied by engineers while on campaign. How far back do you go into the history of engineering, and who, in your mind, is the father of engineering, whether it be in the ancient or modern age?*

WG: Over the course of my career, I’ve read numerous accounts of “ancient engineers” from the pyramids from the Middle East and Central America, to the khanats (rock-lined tunnels) constructed in Persia.
to bring water to the parched cities of the area. One cannot forget the water systems developed by the Romans and the engineering required to build the aqueducts.

I tend to read/study modern engineering development in the fields of fluid dynamics and structural design of piping systems, generally from the mid-1800s to the mid-1900s.

Who is the father of engineering is a difficult question. For my water supply profession, I would pick George Warren Fuller, considered by many to be the father of modern-day water supply. Early in my career, I worked as the water engineer for the City of Jackson, Mississippi, and one of our water treatment plants was originally constructed in 1914. Even though it was expanded several times over the decades, the original portion was still in use while I was there. The original plant was designed by George Warren Fuller.

C+S: You are a noted Civil War historian. What was the greatest feat of engineering during the Civil War?

WG: I generally refer to myself as a “well-read” Civil War history buff. There were many technological advances during the American Civil War, but two areas of advancement stand out to me: railroads and naval combat vessels.

Railroads were used by both sides in the war to move men, livestock, and equipment. The U.S. Army built a vast network of railroads over the four years of the war. Herman Haupt, a mathematics and engineering professor from Pennsylvania, led the Union’s railroad effort. He was responsible for the building of approximately 600-plus miles of railroad track, which included 26 miles of bridges, during the war.

One of his numerous bridges comes to mind: It is more than 400 feet long and approximately 80 feet high and crosses the Potomac Creek. During a visit to the site by President Lincoln on May 28, 1862, he observed: “That man Haupt has built a bridge four hundred feet long and one hundred feet high, across Potomac Creek, on which loaded trains are passing every hour, and upon my word, gentlemen, there is nothing in it but cornstalks and beanpoles.”

The American Civil War saw advances in naval warships that had never been seen before, such as ironclads, warships with no sails, submarines, revolving gun turrets and pressurized flushing toilets. On March 8-9, 1862, the ironclads CSS Virginia and the USS Monitor faced each other at the Battle of Hampton Roads and every other navy in the world immediately became obsolete.

The USS Monitor was designed by a Swedish born engineer named John Ericsson. The ship’s most prominent feature was the revolving turret instead of fixed gun positions but, in fact, the ship had approximately forty patented inventions. This is a remarkable achievement considering the ship was designed, built, and delivered in about 120 days!

C+S: Provide us a few details about your collection of engineering references dating back to 1862.

WG: I started collecting old engineering texts 35 years ago when a colleague gave me an old pump manual. While reading through the manual, I was impressed with the design engineering information provided to assist the engineers in the proper selection of the pumping equipment. My second acquisition was at a used bookstore when I found a book on steam engineering. This second one started my intentional search for old engineering books. Currently, I have about 100 textbooks, design manuals, equipment catalogues, and handbooks from 1955 all the way back to 1862. The majority are from 1890 to 1930.

Usually, I get one or two calls a month from clients or colleagues with questions about aged pipeline products and they ask me for data on those products to effect repair solutions.
C+S: You’ve done a lot of work in Green Bay, Wisconsin. Outside of the Packers, what makes that town special?

WG: Very simply, the quality of life and the people. My family has made lifelong friends in Green Bay. Nearly every project that I worked on in Green Bay was a joint effort between the owner, engineer, and the contractor to get the job done on time and done right.

My family enjoys Green Bay several times a year for long weekend visits, not including Packer games. One February, several years ago, my 11-year-old son was unhappy during our Friday night dinner at his favorite restaurant. When I inquired as to why, he said, “I need some Green Bay,” then my wife said, “I need some Green Bay also.” We left the next morning for Green Bay to snow tube and visit friends.

C+S: You’re from Mississippi, but a large chunk of your career has been spent in the Midwest. What took you so far from home, and how did you handle the culture shock of leaving the Deep South?

WG: I decided to leave the public sector and move to the private side. I was offered several opportunities in the south along with one offer from a firm in Chicago. The Chicago firm had the contract for the DuPage Water Commission and offered me the construction manager position. It sounded challenging, and it was a new area and a new experience. So, I accepted that job offer.

From the cultural shock point of view, I was struck by how fast everybody moved, talked, etc. It was just a different pace of life which I initially found somewhat rude. About a year or so after moving there, we went back for a visit and I could not believe how slow things were back in the South.

C+S: You have a love of 18th Century furniture. What drew you to the furniture of that era, considered one of the landmark centuries in Western History?

WG: I started woodworking at about age seven, working with my grandfather in his garage. Under his direction, I completed my first furniture project, a nightstand for my bedroom, when I was 10. In my middle teens, I started noticing that older furniture was just better made than newer pieces. Around age 17 or 18, I started wood carving, which led me to appreciate the carving on the Chippendale-style furniture with the foliage, shells, and ball-and-claw feet.

In my early twenties, I started taking classes on how to evaluate and recognize antique furniture by examining period tool marks and construction techniques. The wood on most antiques is only finished on the outside and the unfinished side still has the tool marks. Examining these tool marks helps date the piece. It was this training that challenged me on how to recreate the work of these furniture masters who produced their pieces with hand tools.

I make two types of furniture from the Georgian, Queen Anne, and Chippendale periods. One type is built with no nails or screws, with only hand cut joints and glue. I do use modern glue (in lieu of animal hide glue), modern finishes and power tools, but I carve, smooth and cut joints by hand. The second type is “modern furniture” styled after the period pieces.

C+S: Herb gardening. What do you grow and are you using it in your kitchen?

WG: My summer garden includes rosemary, cilantro, basil, sage, thyme and scallions. Indoor winter garden includes basil, cilantro, and rosemary. We use them almost every day.

C+S: As a Mississippi State football fan, which era do you prefer, Jackie Sherrill’s or Dan Mullen’s?

WG: Hard call. Sherrill brought a winning attitude to MSU. Mullen refined it. If forced to choose, I probably prefer the Mullen era. When I was attending a game during Mullen’s time, I felt an energy on campus that had never existed before.

C+S: Your nickname is “Old Man Winter.” How did that come about?

WG: Bestowed upon me by my dear friend Bob Card because I have a very white beard!

RICHARD MASSEY is managing editor of Zweig Group publications. He can be reached at massey@zweiggroup.com.
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BENTLEY SYSTEMS, INCORPORATED, the leading global provider of comprehensive software and digital twin cloud services for advancing the design, construction, and operations of infrastructure, has announced the winners of the Year in Infrastructure 2019 Awards. The annual awards program honors the extraordinary work of Bentley users advancing design, construction, and operations of infrastructure throughout the world.

Twelve independent jury panels of industry experts selected 54 finalists from 571 nominations submitted by more than 440 user organizations in more than 60 countries.

Bentley Systems acknowledged 18 Year in Infrastructure Awards winners and nine Special Recognition Awards winners at a ceremony and gala on October 24 at the conclusion of the Year in Infrastructure 2019 Conference in Singapore.

**Year in Infrastructure 2019 Special Recognition Awards winners:**

**Advancing Urban Planning through Digital Twins**
Civil Engineering and Development Department, Hong Kong SAR Government and AECOM
The Town Plaza Urban Design Study for the Establishment of the Kwu Tung North, New Development Area
Hong Kong, Special Administrative Region

**Advancing Industrial Sustainability through Digital Twins**
MCC Capital Engineering & Research Incorporation Ltd.
Henan Jiyuan Iron & Steel, 80MW High-Temperature Ultra-high-Pressure Gas Power Generation Energy-Saving Renovation Project
Jiyuan, Henan Province, China

**Digital Cities Award for Comprehensive Roadway Digital Twins**
Shenzhen Highway Engineering Consultant Co., Ltd.
Yangang East Interchange Project
Shenzhen, Guangdong Province, China

**Digital Cities Award for Comprehensive Water Digital Twins**
Águas do Porto, EM
H2PORTO Technological Platform for the Integrated Management of Porto’s Urban Water Cycle
Porto, Porto, Portugal

Advancing Infrastructure Resilience through Digital Twins
Italferr S.p.A.
The New Polcevera Viaduct
Genoa, Liguria, Italy

Advancing Construction Industrialization through Digital Twins
Heilongjiang Construction High-Tech Capital Group Co., Ltd.
Smart and Digital Application in Heilongjiang Construction Industry Modernization Demonstration Park
Harbin City, Heilongjiang Province, China

Advancing Economic Infrastructure through Digital Twins
CCCC Water Transportation Consultants Co. Ltd. (WTC)
SAPT Automatic Container Yard and Housing Project in Pakistan
Karachi, Sindh, Pakistan

Advancing Digital Workflows through Digital Twins
Mott MacDonald / Systra Designers working with Balfour Beatty / Vinci Joint Venture
High Speed Two Sectors N1 and N2 Main Works Civil Contract
Birmingham, Country North Sectors, United Kingdom

Bentley Institute Knowledge Advancement Advocate Award
Alison Watson, chief executive and founder, Class of Your Own

The winners of Year in Infrastructure 2019 Awards for going digital advancements in infrastructure are:

**4D Construction**
Mortenson, Clark – a Joint Venture
Chase Center and Warriors Mixed-use Office and Retail Development
San Francisco, California, United States

**Bridges**
PT. Wijaya Karya (Persero) Tbk.
Design and Build Harbour Road 2 Project
North Jakarta, Jakarta, Indonesia
Buildings and Campuses

Voyants Solutions
Detailed Design, Tendering and Project Management Services for Establishment of 12 IT/Hi-Tech Parks in Bangladesh

Communications and Utilities

POWERCHINA Hubei Electric Engineering Co., Ltd.
Technology Application in Miluo Western 220kV Substation Project

Digital Cities

Shanghai Investigation, Design & Research Institute Co., Changjiang Ecological Environmental Protection Group Co.
Application of Digitalization in Jiujiang Smart Water Management Platform

Geotechnical Engineering

ARUP Singapore Pte Ltd.
Tanjong Pagar Mixed Development

Manufacturing

Hatch
Sulfuric Acid Plant Project in the DRC

Mining and Offshore Engineering

Shanghai Investigation, Design & Research Institute Co., Ltd.
China Three Gorges New Energy Dalian Zhuanghe III (300MW) Offshore Wind Farm Project

Power Generation

Hunan Hydro & Power Design Institute
Hanjiang Yakou Shipping Hub Engineering Project

Project Delivery

South Carolina Department of Transportation (SCDOT)
Seamless Information Sharing and Integration Across Multiple Platforms Using ProjectWise

Rail and Transit

Italferr S.p.A
AV/AC in Southern Italy, Napoli-Bari Route

Reality Modeling

MMC Gamuda KVMRT (T) Sdn Bhd
Drone Surveying for BIM and GIS Data Capture - Malaysian Metro Megaproject

Road and Rail Asset Performance

Lebuhraya Borneo Utara Sdn Bhd
Pan Borneo Highway

Roads and Highways

Foth Infrastructure & Environment, LLC
Foth Transforms, Connects, and Revitalizes Cedar Falls, Iowa Corridor

Structural Engineering

WSP
WSP Delivers Optimized Design for Complex Basement under Iconic Admiralty Arch

Utilities and Industrial Asset Performance

EPCOR Utilities
Implementing Risk Based Asset Management for Power Distribution

Water and Wastewater Treatment Plants

Jacobs Engineering Group and Singapore’s National Water Agency, PUB
Tuas Water Reclamation Plant

Water, Wastewater, and Stormwater Networks

Balfour Beatty, Morgan Sindall, BAM Nuttall Joint Venture
Thames Tideway Tunnel

To view photo albums of the event, please visit The Year in Infrastructure 2019 Awards.
A high-rise building needed new covers installed over its hanging sheds that were high up on the side of the building. An innovative solution was devised using ALE’s specialist lightweight crane to complete the upgrades.

A large heavylift crane could not be used for the operation due to the compactness of other buildings in the area. After the client had become aware of ALE’s equipment capabilities, ALE’s engineers undertook close co-ordination with them for the project’s planning. ALE worked with the client’s individual requirements to engineer a specialist lifting solution that could overcome the project site’s limited space.

They conceived an innovative solution by constructing a lightweight crane on a moving installation that had originally been designed for a completely different purpose. This unique heavy lifting solution saved time and costs compared to the use of a traditional tower crane, while also minimising disruption to the local area.

On top of the building, ALE’s innovative Lightweight Service Crane was installed on a suspended gantry that was designed for cleaning windows. The Lightweight Service Crane is highly mobile and can be assembled by hand for lifts up to six feet in areas that are hard to reach. The lightweight crane’s modular construction enabled ALE to complete the operation swiftly as the crane could be installed quickly, with shorter mobilisation and demobilisation times.

Once the Lightweight Service Crane was in place, the gantry was moved on its rails and ALE installed each of the new covers one by one using the crane’s adjustable ballast and a vacuum grip system.

The upgraded covers will ensure the building’s hanging sheds continue to have efficient protection against the elements while providing essential storage for the building.

DAVID SHAW can be reached at d.shaw@ale-heavylift.com.
A COLLABORATION of the University of Nebraska Medical Center (UNMC) and the Nebraska Medical Center (NMC), the $284 million Fred & Pamela Buffett Cancer Center is the largest project in the university’s history and the largest public-private partnership in Nebraska’s history. The project capitalized on $50 million in state funding, $35 million from the City of Omaha, and $5 million from Douglas County, with the remainder covered by private donations.

The L-shaped building rises in two towers: a ten-story, 252,000-square-foot cancer research tower with 98 laboratories; and an eight-story, 325,000-square-foot, 108-bed hospital and inpatient tower. Researchers work in laboratories just steps away from clinicians caring for patients. The proximity means opportunities for collaboration, communication, and problem-solving abound, and that patients receive advanced treatments based on the latest research findings.

Additionally, the building accommodates a pair of fueling-capable heliports on the roof, each large enough to support a large military helicopter. The facility was also designed to be LEED-certifiable.

**Structural System Overview**

Concrete has been the structural material of choice for UNMC and NMC for years, and Fred & Pamela Buffett Cancer Center is no exception. The entire structure utilizes over 25,000 cubic yards of structural concrete as its primary structural system. Concrete was selected for a number of reasons:

- **UNMC prefers concrete due to its inherent fire resistance, and the client prefers not to have friable fireproofing.**
- **The lab spaces have restrictive vibration criteria, and the mass and stiffness of concrete makes it easier to satisfy the performance requirements.**
- **The continuity in monolithic concrete construction provides a moment frame for lateral resistance at minimal cost.**
- **The concrete structure made it easier to match the floor-to-floor heights of the adjacent existing building.**
- **It was simpler to cantilever the floors back to meet the existing structures on two sides of the building with a concrete structure.**
- **For radiation resistance, the linear accelerator vaults require massive concrete walls (up to seven feet thick) and roofs. Integrating these concrete vaults into a concrete structure was far easier than if the structure had been steel.**

**Technical Summary:**

- Ten-story cancer research building and eight-story inpatient care and surgery building.
- Strict vibration limits in the research spaces.
- "Skip-joist" and girder systems are used to resist gravity loads.
- Moment frames in both directions are used to resist lateral loads.
- Drilled piers serve as the building foundations.
- Typical concrete strength is 4,000 psi, with the columns utilizing concrete strengths from 4,000 psi to 6,000 psi.

The structural team solved hundreds of problems on this project, but this article will focus on just a few of the highlights.

**Schedule**

Like most major construction projects today, compressing the design and construction schedule dictated early design bid packages. An early foundation and concrete frame package for the cancer center was issued for construction, which meant that construction was well underway before the architectural, mechanical, and electrical designs were complete.

To meet the aggressive schedule, the design team sat as a special project team within the HDR Omaha office, which facilitated closer coordination and faster information sharing. All of the design disciplines modeled their work in Revit, so that the project could be coordinated in three dimensions. The Revit models were also regularly shared with the contractor, Kiewit Building Group (KGB), so KGB could track the progress of the design, update its construction schedules, and adjust its cost estimates. KGB also exported the Revit model into Navisworks for the sub-contractors to use for coordinating their work.

**Seismic Design**

While it is true that Nebraska is not a high seismic region, the Occupancy Category of this building, along with the ASCE 7 ground accelerations and soil classification, placed the cancer center in Seismic Design Category (SDC) C. The structural forces were manageable, but the bigger implication of being classified as SDC C is that ASCE 7 requires seismic bracing for all critical mechanical and electrical systems. Seismic equipment/system bracing had the potential to add millions of dollars to the project and would add to the complexity of above-ceiling coordination.
The seismic accelerations were only slightly above the line between SDC B and C, so Terracon Consultants were hired as the geotechnical engineer to perform a site-specific ground acceleration analysis. The results of the site-specific analysis reduced the ground accelerations, and permitted the buildings to be re-classified as SDC B. Thus, seismic bracing of the mechanical and electrical systems was no longer required by code.

Flooring
Flooring adhesives changed from an oil-based adhesive to a water-based adhesive about ten years ago to be more environmentally friendly. Although better for the environment, water-based adhesives can deteriorate if too much water vapor remains in the concrete floor slab. This problem is exacerbated on fast-track projects such as the cancer center, because there is less time for the concrete floor slab to “dry out” between when the concrete is placed and when the flooring is installed.

The Buffett Cancer Center has 90,000 square feet of concrete slabs that incorporate Aridus rapid-drying concrete. Aridus is a proprietary concrete mix design supplied by Ready Mix Concrete that optimizes the concrete mix to reduce the amount of water required for hydration. This project is the first large-scale use of Aridus concrete in Nebraska, and its use eliminated the vapor transmission concerns that lead to flooring adhesion issues and allowed for acceleration of the construction schedule.

Linear Accelerator Vaults
The cancer center includes four linear accelerator vaults, which require massive concrete to shield the spaces outside the linear accelerator vaults from the high-dose radiation used for cancer treatments inside the vault. The density and thickness of the concrete vault walls and roof are critical in providing the required radiation shielding.

The available thickness of the vault roof slabs in the cancer center was limited due to the floor-to-floor height of the building. Thinner vault walls were also desirable to provide for an improved architectural floor plan.

To provide thinner vault walls and roof, 1,900 cubic yards of higher-density concrete was used in combination with lead blocks in order to achieve the required radiation shielding. The concrete density was increased using 390 pounds per cubic yard of Rad Ban aggregate added to the concrete mix. This combination allowed for the vaults to fit within the required floor-to-floor height.

Sanctuary Space
One of the many unique spaces within the Fred & Pamela Buffett Cancer Center is a healing garden and sanctuary space, which was added to the project after construction was well underway. A donor came forward with funding for artist Dale Chihuly to create the rooftop healing garden and sanctuary space. The sanctuary is meant to be a quiet and contemplative space filled with Chihuly artwork, and its sculptural form is an integral component of the art.

The floor/roof that was to become the sanctuary and healing garden had not yet been poured when the concept was developed. Additional reinforcement could be placed in the slabs for the revised loading; however, the columns and, more importantly, the corbels supporting the framing at a building expansion joint were already poured and could not easily be strengthened. As a result, the capacity of these existing support elements limited the load that could be added.

Further complicating the addition of the sanctuary space was the organic shape of the design. The design started with hand-sketched floor plans from Chihuly that were converted into a Rhino model by HDR. Once Chihuly approved the plan in the Rhino model, the Rhino model was exported into Revit to create the geometry used for the construction documents. The plan coordinates of the columns were exported from the Rhino model and imported into Ram Advanse to generate the structural analysis model. Once the columns were imported into Ram Advanse, roof framing and loads were added to complete the analytical model.

The roof is framed with metal roof deck on wide-flange steel beams supported by three concrete columns located in the interior. HSS columns double as vertical mullions for the exterior glass walls around
the perimeter. The roof loads were more uniformly distributed onto the concrete slab below by using the mullions as load-bearing elements spaced at the width of the exterior glass panels.

Overall Results
The Fred & Pamela Buffett Cancer Center was completed on time and within budget. Perhaps more importantly, the cancer center achieved the highest designation as a Comprehensive Cancer Center from the National Cancer Institute – one of only 41 in the United States.

MICHAEL KUHSE, P.E., S.E recently retired after working more than forty years as a senior structural engineer for HDR in Omaha, Nebraska. Although he has worked on numerous project types all over the United States, Michael specialized in large-scale healthcare projects.

FUTURE-ORIENTED BUSINESS SCHOOL COMPLEX AT UNIVERSITY OF CINCINNATI SHOWCASES BuroHappold’s Innovative Design and Analysis Approaches

By C.C. Sullivan

BuroHappold Engineering, a world-class global practice creating solutions for buildings, campuses and cities, in October announced the opening of the Carl H. Lindner College of Business at the University of Cincinnati.

The much-anticipated new building – conceived by Danish firm Henning Larsen on a campus known for innovative academic and campus life environments – includes an expansive atrium, two spacious courtyards, and flexible areas for informal meetings and interdisciplinary education among students, researchers and business leaders, all reflecting the university’s project-based learning approach and enriching academic life with daylight and inspiring spaces.

The 225,000-square-foot construction project, overseen by Turner Construction Co. and designed by Henning Larsen and Cincinnati-based architect KZF Design, reflects a global vision from the Copenhagen-based architects and supported by BuroHappold’s U.S. team in the cultural and educational sectors.

Among the challenges for the $120 million complex, which broke ground in May 2017 and opens on schedule and on budget in October, are a novel cantilevered structural system to bridge existing site utilities that cross the site as well as the interior’s airy and daylight drenched four-story atrium connecting labs, study zones, and faculty office areas. The completed building is tracking to meet rigorous green-building criteria for LEED version 4.0 Gold certification.

BuroHappold has harnessed a powerful suite of analytical tools to inform the design process for daylight evaluation, dynamic thermal modeling, people flow modeling and energy modeling, says Matthew Herman, a principal in the firm’s Chicago office. A fourth tool, computational fluid dynamics, or CFD, predicted the movement of air and heat inside the complex building as well as wind impacts on its exterior.
“Together, these four tools provide institutions like the University of Cincinnati and their architects an unparalleled understanding of how to minimize energy use while ensuring the comfort and enjoyment of students and faculty over the life of the investment,” Herman said.

According to Henning Larsen, “We designed the Lindner College of Business with the ambition of creating an open and generous addition to the campus. In a field where creating personal networks is so important, we considered it essential to create an institution that values educational excellence and social wellness equally. We are enormously proud of not just the building, but also of the close collaboration with the university and design partners that made it possible.”

As design engineer for this advanced academic community, BuroHappold collaborated with the design team and consultants including PEDCO (mechanical, electrical and plumbing systems) and Woolpert (structures) to resolve a number of critical challenges:

• To allow drainage of a nearby creek bed and protect an old brick conduit, BuroHappold helped devise a structural cantilever, hidden amid the base of the new Lindner College of Business, according to the firm’s associate Andy Rastetter, P.E., and associate principal Phil Skellorn.

• Inside the new building, the large atrium creates connected spaces for informal meetings and flexible teaching and study facilities, emphasizing the university’s project-based approach to learning. To ensure the vast open interior meets both campus energy goals and safety needs for smoke evacuation, BuroHappold engineers devised a performance-based solution in conjunction with local officials to manage smoke exhaust systems.

• For the green roof and its large areas of plantings and gardens, structural engineers at BuroHappold modeled the roof slopes and access points, which are critical to ensure robust roof design and function. In addition, a unique truss system at the roof level supports lower parts of the structure, which are hung off the truss, according to BuroHappold’s structural engineer, Rastetter.

“We’ve matched the University of Cincinnati’s commendable environmental targets by delivering a low energy strategy integrated with the architectural intent,” said BuroHappold’s Herman, who oversaw the BuroHappold team. “By using radiant surfaces combined with controlled introduction of fresh air, the academic community benefits from the openness of the building atrium and light wells to draw in sunlight and air, creating a productive and engaging environment ideal for a business school.”

Among the offerings to serve some 5,000 students at the Lindner College of Business are the large courtyards and atrium, more than 240 faculty office spaces, a 150-seat, two-story lecture hall, a 250-seat auditorium, research labs, open workspaces, exam and tutoring areas, huddle and breakout rooms.

“This new work represents a major milestone for our college as we collaboratively build the future of business education here in Cincinnati,” said David Szymanski, dean of the Lindner College of Business. “Our College’s community has worked diligently to ensure this building serves as a tremendous catalyst for a continued ascension to preeminence.”

The design team’s various engineering advances have been essential to creating this “infrastructural and social gathering point” envisioned by Henning Larsen for the university’s growing West Campus. The new college also represents the continuation of an ambitious campus master plan developed over a decade ago by university leadership and Hargreaves Associates, a planner and landscape architect – a plan still advancing the institutional mission and attracting many internationally recognized architects.

“As an urban university, we have a commitment to not only educate the future workforce but to partner in ways that advance the entire community,” said Neville Pinto, president of the University of Cincinnati. “The new facility [serves as] a 21st-century hub for our students, faculty, and Greater Cincinnati business community, providing a collaborative space for education, research, and innovation to thrive.”

CHRIS SULLIVAN is founder of the marketing, content and public relations agency C.C. Sullivan, which serves clients in architecture, arts, construction, real estate, urbanism, cycling and other markets. With experience in print, broadcast, online and face-to-face media, Chris works with clients in Chicago, New York, Phoenix and Los Angeles on integrated messaging, PR, marketing, content and business development programs. Before founding C.C. Sullivan, Chris was chief editor at Architecture and BD+C magazines and previously worked for architects in New York City and Madrid, Spain.
Throughout the project, McCarthy’s team will self-perform several aspects of the job including:

- Process piping
- Process equipment installation
- Pile driving
- Concrete work
- Metal installation
- Earth work

Other marine/treatment plant projects McCarthy has completed includes the San Jacinto River Authority (SJRA) surface water facilities and the Village Creek Water Reclamation Facility – Peak Flow Basin. Additionally, McCarthy has extensive experience along the Texas coast with Port Houston including the construction of Bayport Phase I Wharf and Wharf 2, Bayport Phase I Stage 1 and Phase I Stage 2 Container Yards, Bayport Truck Gate Complex and Bayport Port Road. McCarthy is also currently working on the new Container Yard 7 as well as the rehabilitation of Wharf 3 within Barbour’s Cut Container Terminal at Port Houston as part of the latest expansion efforts, both slated for completion in 2020.
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A 33-inch sanitary interceptor pipe lay exposed in the middle of the Unnamed Tributary to the Saline Branch. Rising water from a storm carries a large log towards the exposed pipe. The log rams into the pipe; the pipe bends but does not break – yet.

Had the pipe broken, thousands of gallons per minute of raw sewage would have spilled into the tributary; thousands of gallons per minute of stream and storm water would have entered the pipe, flooding the wastewater treatment plant and causing immediate sewage back-ups at the homes connected to the pipe.

This scenario is occurring all over the United States as aging pipe infrastructure crosses streams that were once small ditches, but are now large, flashy, urban streams. The pipe infrastructure is deteriorating due to having been installed 50 to 100 years ago, while the streams they cross have increased in size and strength. The combination of these two factors can be a hazard to public health and to the environment.

In 2017, the American Society of Civil Engineers (ASCE) gave a report card on US infrastructure. We, as a country, received a D for Drinking Water Infrastructure and a D+ for Wastewater Infrastructure, which means the infrastructure is in poor to fair condition and approaching the end of its service life. Condition and capacity are of serious concern with strong risk of failure.

So, the pipes carrying our drinking water and wastewater have a strong risk of failing and many of those pipes cross streams. Years ago, when most of the drinking water and wastewater pipes were installed, pipes crossed small ditches. However, as more areas were developed and more rainfall ran off into the ditches, they grew into large streams with serious erosive capabilities.

Broken pipes often cause adverse environmental impacts, in addition to harming and inconveniencing the community. Boil orders and sewage backups into basements can cause damage and frustrate homeowners. Emergency fixes to the pipe, the stream, and the water/wastewater plant can be expensive while also leaving the public with a negative impression.

Performing stream restorations at pipe crossings protects aging infrastructure and also provides communities with urban green space and has numerous ecological benefits. A stream restoration is the manipulation of the physical, chemical, and biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. Stream restorations stabilize streambeds and banks to prevent scouring of pipes and improve the basic functions and ecology of stream systems.

In addition, people are drawn to natural spaces, particularly when they are easily accessible in urban areas. Restoring sections of stream in urban settings can provide personal wellness opportunities to the community. What once was a liability can become an asset for the community and the environment.

**Protect Infrastructure**

Water is powerful. Water can cut into banks, undercut pipes, and erode pipe and bridge footings. I have seen a 33-inch sanitary interceptor that was once buried under a stream completely exposed with the stream flowing under it. Another stream cut into its bank until a large exposed vertical streambank was 20 feet away from a home.

A stream restoration not only redirects the flow of water away from the bank but also from infrastructure. We can direct the flow of water into the center of the stream using large boulders, logs, or tree root wads placed in the streambed. The boulders or logs are placed to create structures that force water to slow down near the bank, then speed up as it cascades over the boulder into a center pool in the middle of the stream.

We can also spread the water out onto the floodplain to slow down the water and decrease the force it has on the streambanks. When streamflow is confined to a narrow, deep channel, the flow increases and the water can erode banks and infrastructure easily. When the streamflow can spread out over a floodplain, the flow is slower and banks are more protected.

In Champaign, Illinois, an electrical box was located on the outside bend of the Copper Slough. The stream had eroded the bank away,
leaving the electrical box only a few feet away from a vertical, unstable streambank. Farnsworth Group, a full-service architectural and engineering firm, protected the electrical box by restoring the stream. Boulder structures were used to direct water into the center of the stream, away from the bank with the electrical box. A small ledge, or bench, was graded into the bank to allow water to spread out and slow down during rain events. The bend in the stream channel was adjusted to be a longer, more gradual curve, adding stability in the stream. Native vegetation was planted on the banks to protect against bank erosion and to provide an ecological habitat for pollinators and small wildlife.

Because of this stream restoration, the electrical box is protected, the stream is stable, ecology in the area is flourishing, and the homeowners can reap the benefits associated with being near nature.

Copper Slough post-restoration. Photo: Jenkins / Farnsworth Group

Increase Personal Wellness
While at graduate school in Maryland, I lived in a suburb of Washington D.C. My research afforded me an opportunity to get outside, but my day-to-day routine kept me in very urban environments. I found myself making time to hike and camp, referring to it as my “woods fix.” After my “woods fix,” I felt centered, calm, and rejuvenated.

Several years later I realized that it’s not just me who needs a “woods fix.” Researchers have found that being in nature or even viewing scenes of nature reduces anger, fear, and stress. Forest bathing, a common practice in Japan, consists of simply being in the forest and has become a healing and preventive healthcare practice in Japanese medicine.

Blue Space, a specific subset of “woods fix,” is the term given to the impact of water — sea, river, lakes, and even urban water features — on health and wellbeing. The sight and sound of water can relax us by lowering cortisol (stress hormone) and raising serotonin (the “happy chemical” our nerve cells produce). Areas of water in or near nature are particularly beneficial to human health and we tend to seek them out when we can (think beach and lake vacations).

People enjoy being near nature – it improves their mood and wellbeing. Stream restorations at pipe crossing locations create an opportunity for Blue Space and nature accessibility for the community. If a stream corridor is owned by the City or Park District, a pipe crossing a stream can become a park amenity by adding a pedestrian bridge over the stream, creating a walking path near the stream, incorporating waterfalls or other water features, or building a playground or pavilion adjacent to the stream.

The City of Champaign, Illinois took advantage of the Boneyard Creek restoration project in a similar fashion. Though the main objective of the project is to provide flood storage, the restoration provides a multi-use trail along-side the channel and flood storage basin, called Second Street Basin. On any given day, you can walk past the Second Street Basin and see kids playing in the waterfall feature, runners jogging on the trails crisscrossing the Basin, and people bird-watching, picnicking or just napping on the benches along the creek.

Provide Ecological Benefits
Stream restorations are an ecologically friendly way of approaching stream instabilities to protect infrastructure. Many of the features that help create a stable stream and protect infrastructure, like access to a floodplain and boulder structures, also provide benefits to ecology. When streams flood onto their floodplains, food sources found on floodplains are washed into the channel. Organic matter like leaves, woody debris, and vegetation are introduced into the stream ecosystem. Aquatic invertebrates, like insect larvae, snails, and crawdads, consume the organic matter; fish consume invertebrates. To create and preserve a healthy circle of life in the stream, you need a constant supply of organic material, which is readily available on the floodplain.

Stream structures designed to protect the bed and banks of streams, as well as the infrastructure on the bed and banks, also provide ecological benefits to the stream system. Structures create diversity in channel flow. Slower water upstream of the structure and immediately behind (downstream) of a boulder are refuges for smaller fish. The fast-moving riffles over a structure provide dissolved oxygen to the water. Fast-moving water also washes away fine sediment particles from the gravel bottom of the channel, which is necessary for ideal fish spawning locations.

Vegetation along the banks of the stream provides shade to the stream, which regulates the temperature of the water. Vegetation also provides habitat to pollinators like bees, butterflies, and dragonflies. Did you know that dragonflies can eat 30 to over 100 mosquitoes every day? Small mammals and birds live and eat in streamside vegetation. A restored stream system can host a diverse bevy of species.

For example, one week after the Copper Slough bank restoration project in Champaign was complete, a blue heron was fishing off the boulder structure in the stream. Fish were enjoying the depth of the scour pool beneath the structure, and dragonflies, songbirds, and butterflies were bountiful in the native vegetation lining both sides of the stream.

Birders regularly come to the Boneyard Creek Second Street Basin to watch the migratory birds take refuge in the restored in-stream basin.
The Illinois Department of Natural Resources (IDNR) found a fish species called the Largescale Stoneroller in the Kickapoo Creek one year after the first phase of a stream restoration project was completed. The Largescale Stoneroller is classified as a species in greatest need of conservation by IDNR.

**Increase Property Values**

Not surprisingly, the biggest argument against stream restorations is the cost in comparison to a less-natural approach, like using riprap or concrete to stabilize infrastructure. Certainly, stream restorations are expensive, but they are also sustainable.

Stream restorations have long-lasting, positive effects. With a one-time restoration project, infrastructure is protected for the foreseeable future because the flow is manipulated away from sensitive areas. Conversely, riprap and concrete in the stream simply armor the sensitive areas. When water hits riprap or concrete, it is moving fast and creates turbulence near the bank. That turbulence can erode adjacent unprotected areas of the bank, causing increased erosion around and downstream of the hard-armored materials.

Additionally, research shows that property values increase near water features. Home lots adjacent to wet ponds in Champaign and Urbana, Illinois are worth an average of 21.9 percent more than non-adjacent lots in the same subdivision. A 2017 study by Nicholls and Crompton shows that “significant positive property price effects are associated with river, stream, and canal view and proximity.” Once a stream has been restored to protect infrastructure, adjacent property values will increase.

The most sustainable and multi-functional method to protect infrastructure at stream crossings is a restoration. Stream restorations create a stable stream that will provide long-lasting protection of the infrastructure. Restorations have the additional benefits of reestablishing the ecological function of a stream system and reconnecting people to nature, thereby improving their personal wellness. By changing our perspective, we can turn failing infrastructure into an opportunity to create an asset to the community and the environment while protecting the well-being of both.

And what about the 33-inch exposed sanitary interceptor pipe in the Unnamed Tributary to the Saline Branch? Farnsworth Group compared several options to protect the pipe and determined the most cost-effective solution was to restore the stream.

We adjusted the channel alignment to gently curve the stream away from the threatened manhole, constructed a small bench, or shelf, on the bank to give the stream space to flood, and constructed a series of structures with boulders to direct the flow of water into the center of the channel and away from the bank. We also slowed the water directly upstream of the pipe by creating a slow-moving pool, followed by a long, steep streambed where water cascades and tumbles over large rocks. The banks and floodplain are now planted with native vegetation.

The interceptor pipe is now carefully protected underneath the boulders of a stream structure. Deer, heron, turtles, and a plethora of fish have been spotted in the park setting, and raccoon tracks can be seen on the stream bank. The sound of running water muffles traffic noises nearby. I watch a dragonfly dart across the water and listen to the bees droning on the bank. The serenity of the stream relaxes and rejuvenates me as I head back to the office to start the next project.

**EMILY PONYER JENKINS, PHD, PE, CFM,** is a project engineer for Farnsworth Group (www.f-w.com) who has been designing stable and sustainable stream restorations and bank stabilizations for more than 10 years. Examples shown in this article are designs of hers and the Farnsworth Group team. Her clients have included municipalities, utility companies, local developers/builders, and private property owners.
AFTER 22 YEARS in the City of Los Angeles’ books, the Taylor Yard Bikeway and Pedestrian Bridge is underway. Earlier this year, the groundbreaking ceremony was attended by Los Angeles mayor Eric Garcetti, LA Metro CEO Phillip Washington, council members and local officials, to celebrate the progress of this project and its value to the community. Working closely with the City of Los Angeles and Studio Pali Fekete Architects, Arup is the bridge design consultant and engineer of record.

The Taylor Yard Bikeway and Pedestrian Bridge will connect the existing Elysian Valley neighborhood south of the river to the newly developed Cypress Park community to the north. It will provide a safe travel path for both pedestrians and cyclists, connecting to an existing bike path south of the river and a future bike path along North San Fernando Road.

The bridge will also connect to a future river revitalization project, the Taylor Yard G2 River Park Project. The project will be built on the 42-acre site adjacent to the river known as the G2 parcel. Currently, the G2 parcel serves as a construction staging area to assemble the bridge’s truss segments.

Once the bridge construction is complete, the G2 parcel will be transformed into a park and recreational greenspace that is sustainable, safe and inviting. Taylor Yard Bikeway and Pedestrian Bridge is one of three pedestrian crossings under construction along the Los Angeles River as part of the City’s river revitalization plan, which aims to serve local communities, connect neighborhoods, and maintain flood protection and safety.

The proposed two-span steel-truss box structure bridge spans 400 feet over the Los Angeles River and is designed to stand as a landmark with its distinctive profile and unique orange color. The structural steel frame system consists of square hollow structural sections (HSS). The vertical and horizontal HSS members are connected to form a box truss structure. Diagonal tension rods triangulate the truss to provide lateral stiffness and transmit shearing force vertically and transversally.

The design team’s selection of steel as the bridge’s structural material provides many benefits, including expanded design options, faster construction, broad architectural possibilities, and sustainable offerings. These advantages helped the design team mitigate project constraints and meet the client’s goals, architectural vision, and architectural aesthetic requirements. The high strength-to-weight ratio of the steel also helped minimize the substructure and foundation costs.

Steel truss offers a lower structural depth below deck for the span compared to a concrete bridge of similar span. This was achieved by increasing the height of the vertical truss member, which provided a longer lever arm for the top and bottom chords, reducing their axial forces and increasing the bending capacity. This helped overcome the vertical clearance constraints at the north abutment, while providing a low-profile, aesthetically pleasing section. In addition, the prefabrication of steel truss members reduced the construction time and minimized the ecological footprint and disturbance to the river’s natural habitat.

As one of the most recycled construction materials, steel also offers sustainability benefits. At the end of a steel bridge’s useful life, the steel structural members are sent back to mills or manufacturers to create new steel products.

The superstructure consists of HSS modules that are 30 feet tall, 30 feet wide and 22 feet 7 inches long. Designed to create a floating appearance, the concrete deck consists of an 18-foot-wide, 8-inch-thick reinforced-concrete deck slab that is cast on a stay-in-place corrugated steel metal decking form. The slab is supported on secondary longitudinal wide-flange beams that run the full length of the bridge. The longitudinal beams are supported on the primary transverse wide-flange beams spanning between the vertical HSS members and spaced at 22 feet 7 inches along the full length of the bridge. The stainless-steel tension rods triangulating the bridge vary in size, from 2-inch diameter to 3.5-inch diameter. They provide stability, improving the lateral stiffness and strength of the bridge’s structural system during construction and over its service life.

The bridge substructure and foundation system consist of a reinforced pier wall at mid-span. The wall is supported on four 7-foot-diameter cast-in-drilled-hole piles connected by a reinforced-concrete pile cap. At the north and south abutments, the bridge is supported on four 3.5-foot cast-in-drilled-hole piles connected by a reinforced-concrete pile cap. The steel superstructure is supported on bearings at the pier wall and at the abutments to transfer the forces from the bridge superstructure to the substructure.
The City’s vision for this landmark bridge included a high level of seismic resilience, so they requested that the structure adhere to the California Department of Transportation’s (Caltrans) seismic design criteria and performance goals. Under these criteria, the bridge is categorized as Ordinary and classified as Standard, which triggers a Safety-Evaluation Ground Motion Assessment. This assessment is based on probabilistic ground motion, and the design spectrum is based on a 5 percent in 50 years probability of exceedance, or an approximately 975-year return period.

The seismic design strategy adopted is ductile substructure and elastic superstructure. The ductile (inelastic) behavior of the bridge is limited to the bottom of the pier wall. The structural steel HSS truss members are designed to withstand the deformation imposed by the design earthquake, with sufficient strength and reasonable reserve capacity to ensure it will not collapse during an earthquake. The HSS members are supported on bearings at the north abutment, south abutment and at the center pier. The longitudinal wide-flange steel beams cantilevering north of the bridge are also supported on bearings that connect to the retaining wall. All bearings are designed to resist the lateral seismic force and displacements in an extreme event.

The hydraulic study for the Taylor Yard Bikeway and Pedestrian Bridge concluded that the proposed bridge will increase the design-flood water-surface elevation by up to one inch at the upstream bridge face. However, this increase will not reduce the top-of-bank freeboard – the distance between the high-water elevation and the bottom of the structure – beyond the minimum level recommended by codes and local authorities. This design ensures the structure will remain safe and above water in a 100-year flood event.

The design team also considered strategies to build the bridge sustainably and minimize disruption to the waterway and the ecological habitats. At an early stage in the design development, the Arup team carried out an extensive constructability study, which articulated a feasible construction sequence option, as well as Caltrans inspection and maintenance protocol for steel bridges with fracture critical members. The constructability white paper informed the City of the complexity and size of the project, which enabled them to grant additional funding. As a result of this initial sustainability-focused constructability research, the project will be built only during the dry season to reduce impact on the river habitat. That means construction can only be done six months out of the year, from April to October. To increase the speed of construction and minimize environmental impact, segments of the bridge will be built on the off-site fabrication yard adjacent to the river. The steel box truss will be built in five segments, with each segment made up of four to five bays that will be pre-assembled off-site and then lowered to the river and spliced to the next segment.

The bridge is scheduled to be completed in 2021 and is targeting Envision Platinum certification, which is awarded to sustainable and resilient infrastructure. When the bridge is completed, it will serve as a connector between two communities, as well as a key component to revitalizing the Los Angeles River.

**SURUR SHEIKH** is a senior bridge engineer based in Arup’s Los Angeles office. She has more than 16 years of local and international structural engineering design and project management experience, working on a range of projects in the built environment. She has designed and delivered infrastructure projects in the UK, UAE and USA. Her expertise includes structural analyses, detailed design of reinforced concrete, structural steel, precast and prestressed concrete, and composite construction.
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Italy’s Mount Etna is one of the world’s most famous – and most active – volcanoes. Located on the east coast of Sicily, the mountain’s location and frequent eruptions make it a popular tourist destination. Plumes of ash and gas vent from fissures in the mountainsides and lava flows reshape the steep slopes extending from the summit.

While spectacular, Mount Etna’s eruptions are also dangerous and worrisome. Eruptions have been recorded over the past 3,500 years and the mountain has been erupting continuously since September 2013. The current eruption, termed “Strombolian activity,” produces lava flows and ash emissions that affect the terrain and nearby communities. Activity in July produced ash clouds that forced the temporary closure of nearby airports. Scientists are studying the mountain to improve their ability to anticipate activity and issue warnings and alerts; the recent activity served to emphasize the value of these studies.

Etna’s ease of access and continuing activity make it an important site for scientists seeking to better understand volcanic goings-on. The mountain serves as a virtual laboratory; it’s blanketed with sensors that measure different aspects of the volcano’s behavior, some of which can be precursors to impending activity. The Italian National Institute for Geophysics and Volcanology (INGV) continuously monitors the volcano by terrestrial, remote, and satellite technologies. Understanding the spatiotemporal patterns in the monitored data facilitates predicting the behavior of the volcano and supports efforts to mitigate hazards.

The quantities monitored include surface deformations and spatiotemporal gravity changes. These changes are indicative of magma mobility and pressurization in the mountain’s internal plumbing system, which can lead either to unrest or volcanic activity. Simply put – scientists want to know what’s going on inside the mountain. They do this by measuring changes of observables on its surface.

In July 2018 researchers from Slovakia, Peter Vajda, Pavol Zahorec, and Juraj Papčo, and INGV in Catania, Filippo Greco and Massimo Cantarero, teamed up for a one-week campaign of intense observation. Their objective was to test a new approach to modelling the internal plumbing system, which can lead either to unrest or volcanic activity. Simply put – scientists want to know what’s going on inside the mountain. They do this by measuring changes of observables on its surface.

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While real-time GNSS was the team’s first choice to obtain precise positioning in the difficult and sometimes dangerous environments, Mount Etna’s terrain and lack of communications presented obstacles to accuracy and productivity. By using precise point positioning (PPP) with satellite-delivered corrections, the researchers produced accurate, reliable data with less time and effort than ground-based RTK GNSS measurements.

Tracking Magma with Gravity

Studying Mount Etna is rugged work. In addition to high altitude and steep terrain, research teams face a constant stream of spewing smoke and gases, unstable ground and explosive eruptions of ash and lava. In spite of the challenges, the Slovak and INGV team view Mount Etna as a research lab in which they can measure and analyze the movement of magma inside the mountain.

The replenishment, or movement, of magma within Mount Etna manifests itself through temporal gravity changes that can be observed on the surface of the volcano. The magma’s motion can also deform the mountain’s topography. To study these effects, scientists combine gravity data with digital elevation models (DEM) and eventually local improvements using drone-flown photogrammetry.

For Papčo, a geodesist at Slovak Technical University in Bratislava, obtaining precise gravimetry called for high-accuracy GNSS positioning. He was especially interested in obtaining accurate heights (elevation) measurement wherever gravity data was collected. But even in such a thoroughly measured site as Mount Etna, precise GNSS measurement is not straightforward.

While Mount Etna is surrounded by geodetic control points, conducting real-time GNSS observations on the mountain proved challenging. Inconsistent cellular service on the mountain made connection to Italy’s real-time GNSS network difficult and unreliable. Constraints on radio licensing ruled out conventional RTK.

To ensure reliable GNSS performance, Papčo turned to Trimble® Cen-
CenterPoint RTX correction service. CenterPoint RTX uses a global network of GNSS tracking stations and advanced data analysis to enable its subscribers to obtain precise real-time positions nearly anywhere on Earth. With GNSS correction data delivered via communications satellites, CenterPoint RTX users can operate without relying on cellular or radio datalinks.

Real-Time GNSS on an Active Volcano

Working with colleagues from INGV, Papčo conducted initial measurements on 10 existing profile points using a Trimble R10 GNSS receiver and CenterPoint RTX. He then measured multiple sites on the mountain, including a trip to the summit.

“There was a lot of dust, loose rock and gas; it was very, very terrible to breathe” Papčo said. “In many places it was quite dangerous and scary. In one location where I wanted to go, the people from INGV said, ‘No, no, don’t go there. If something happens there you will completely die.’ But in spite of the danger there were interesting aspects of sounds and odors. It was fascinating to see how it works and to experience the smell and the life of the volcano.”

Papčo used CenterPoint RTX to capture data at 17 locations where gravity data was collected. At each gravity point, he measured additional ground points to provide check data for the elevation models developed from aerial imagery. “Using RTX corrections was very exciting,” Papčo said. “On many points, especially on the higher part of the volcano, Internet signals were poor or none at all. Only by using RTX were we able to collect real-time data.”

The project teams used existing aerial imagery to identify the areas where they wanted to measure VGG. They then used RTX to navigate to the locations before collecting real-time and static data on the points. “We had a very good experience with CenterPoint RTX. It performed well in higher elevations and in difficult conditions,” Papčo said. “Without RTX, it would have been very difficult and complicated to navigate to the desired points.”

For each profile and gravity point, Papčo collected real-time positions as well as roughly 25 minutes of static observation. Some gravity points were located inside buildings or under tree canopy. To produce 3D positions on these points Papčo set intervisible points with GNSS and then used a Trimble M3 total station to measure into the structure or forest. He processed the static data using Trimble Business Center software (TBC) and compared the static results with RTX and previous measurements by INGV.

The data collected using RTX produced vertical accuracy of four to five centimeters. “From my point of view the accuracy was very good,” Papčo said.

He also imported and processed aerial imagery using the UASMaster module in TBC. The ability to process all the aerial imagery, total station measurements, and GNSS data in one software provided an added benefit; Papčo noted that point classification and making transformations into the local coordinate system went smoothly.

A Deeper Understanding

The work on Mount Etna revealed that precise information on topography and point positioning is essential to accurate VGG predictions for the purposes of volcano geodesy. Using GNSS and PPP provides the needed accuracy and is helping scientists understand how changes in topography reflect gravity changes attributable to the magma redistribution. The approach will give scientists refined tools to better anticipate and characterize volcanic behavior.

While predicting eruptions of any active volcano remains a challenging science, the work of the multinational Slovak–Italian team provides valuable contributions to understanding volcanoes and anticipating volcanic events. Thanks to their achievements and the work of INGV, the laboratory known as Mount Etna continues to reveal its secrets.

John Stenmark, LS, is a writer and consultant working in the AEC and technical industries. He has more than 20 years of experience in applying advanced technology to surveying and related disciplines.
IN THE PROFESSIONAL WORLD of successful architecture, engineering, landscape architecture, planning and construction, noncompliance isn't an option. Corporate credentials compliance responsibilities are riddled with ever-changing non-universal requirements, whether practicing as a single professional or with multiple disciplines in several states. Now if you have our attention, are you thinking, “Do we comply, who can we rely on for professional guidance to comply? Let’s learn about noncompliance issues and how to avoid serious legal consequences with steep financial penalties.

Case Study:
A principal of a multi-discipline firm registered to practice in 52 US jurisdictions recently stated, “I understand the law until it gets in the way of doing business.” A couple of leaders in this firm (not all Principals were informed of this action) decided they wanted to set up an umbrella corporation to then engage in design-build projects. Initially there was no corporate compliance review/audit of 52 US jurisdictions. Of course, the firm’s legal counsel was pleased to set up the umbrella corporation. However, the law firm only considered the business laws in the jurisdiction where the firm was originally registered to practice. Upon the threat of a seasoned administrator within the firm – “I am not going to jail for what you guys have done” – the firm’s Principal COO initiated an independent legal corporate compliance review/audit. The firm received a complete 17-page report with legal recommendations and actions to be taken.

Naïveté Still Flourishes in the 21st Century:
A professional A/E association executive recently said, “I have not had one inquiry in the last 37 1/2 years about corporate compliance issues.” To this we say, “Really!” Professional associations do not necessarily know the truth nor the whole truth of firms and their internal politics. Firms may be extra cautious about their failings in credentialing for various reasons – embarrassment because disciplinary action becomes public information, potential conflict with a client’s contractual agreement, and possibly relationship instability with supporting industry consultants.

Corporate Organizational Structure:
Corporate credentials compliance issues can simply arise because of changes in leadership, changes in ownership, elevation of an associate to principal, retirement, no transition planning due to death or even a disaster such as a fire or catastrophic weather event. Another example of a compliance issue comes from a New York engineering licensing statute.

Can a Professional Service Corporation (PC), Registered Limited Liability Partnership (RLLP), or Professional Service Limited Liability Company (PLLC) offer stock ownership to non-licensees? No. The ownership of PC’s, RLLP’s, and PLLC’s providing architecture, landscape architecture, engineering, geology, and/or land surveying services will be restricted to those who are licensed and registered in New York in the profession(s) of architecture, landscape architecture, engineering, geology, and land surveying, respectively. In order to allow non-licensees to have an ownership interest, a D.P.C. must be formed.

Jurisdiction Business Licensing Requirements:
Within the United States, Washington D.C., and three US territories, each business licensing jurisdiction has its own requirements which are not universal across the remaining 53. To confirm how complicated a jurisdiction can be, below is an example of business licensing requirements for the State of North Carolina with respect to architecture, engineering and landscape architecture.

Case Study: A Complicated Compliance Review
A firm practicing in 22 jurisdictions is considering expanding to include five new jurisdictions. The following is an example of the firm’s in-house best solution for managing corporate credentials and jurisdiction requirements.

Now, let’s learn how a detailed report with recommendations can save the firm time, money, and legal ramifications.

Compliance Affects Marketing Professional Services:
Currently, while the economy for commercial construction growth is humming along, A/E firms design, engineer, and construct in many locations across the US and internationally, too. It is not uncommon to initiate design and engineering in a new jurisdiction without full knowledge of the requirements to practice. Even more critical, mar-
Marketing professional services without following jurisdiction statute requirements can and has resulted in serious financial penalties/consequences. It is best to research and know the laws per jurisdiction prior to submitting an RFP, or forming a joint venture partnership to practice engineering, architecture, landscape architecture, interior design, etc. The business relationship may not be acceptable to the new jurisdiction with current corporate structures.

In Conclusion:
It is challenging to simplify the many complications facing corporate compliance within the professional A/E community. It is complex and detailed, and a moving target based on the actions of 54 separate US jurisdictions.

An overall legal compliance review/audit with a report and recommendations from a respected legal corporate credentials compliance services firm may be necessary to maintain “good standing” per jurisdiction.

LEXI SELVIG, President of LS Credentialing Services, provides legal corporate credentials compliance management services in addition to individual professional credentials management/maintenance services exclusively to the international A/E community. She can be reached at lexi@aecredentialing.com. Visit her company’s website at www.aecredentialing.com.
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In this article, we’ll discuss how allowing the geotechnical engineer to conduct a thorough soil investigation can save the owner money on their ground improvement. Then we’ll look at which aspects of the geotechnical soil report enable the specialty subcontractor to create the ground improvement quote with the lowest cost and highest value.

Before ground breaks on any new construction project, the site in question must be investigated to determine whether the soil has the bearing capacity to support the proposed building. Typically, this investigation is done by a third-party geotechnical engineering consultant, and the results are compiled into the geotechnical soil report.

Using a variety of field-observed and lab-tested data, the geotech will describe the site and subsurface conditions that will impact design and construction of the project. From that data, they’ll make recommendations about whether ground improvement is necessary to reach the required bearing pressure, or if deep foundations should be considered.

But with no universal standard governing how much data must be collected during the investigation and written into the final report, the geotechnical engineer and owner are left to negotiate what should be included.

How a Thorough Geotechnical Report Minimizes Risk and Saves Money

The geotechnical engineer wants the most thorough investigation possible and the owner wants to keep the cost of all geotechnical work as low as possible.

These two requirements are more aligned than they appear on the surface. There are opportunities to save significant sums of money on ground improvement design and construction by getting the clearest data at the report stage.

No matter how thorough the investigation, the geotechnical contractor has to design and install a ground improvement system – or deep foundation if ground improvement isn’t feasible – that meets the bearing pressure and settlement criteria of the building.

The subcontractor’s bid will be based on the amount of information provided. If they only have minimal strength and settlement information about the soil, the contractor will be forced to overdesign their ground improvement plan to meet these parameters. A lack of data also increases the risk of the contractor encountering soil conditions not specified in the report, resulting in change orders and a rise in cost.

The initial savings of a less thorough investigation will quickly be negated by a more conservative, and thus more expensive, aggregate pier design. Allowing the geotechnical consultant to conduct a detailed investigation of the site helps the owner achieve the goal of creating the most cost-effective ground improvement design.

The Most Valuable Aspects of a Geotechnical Report to the Specialty Subcontractor

Conducting site investigations and writing geotechnical reports are a big part of a geotechnical consultant’s job, so this won’t be a 101 description of how to write a report. Rather, it’ll explain which aspects geotechnical subcontractors find most valuable in developing the highest quality, lowest cost quote for the owner.

At absolute minimum, the geotechnical subcontractor’s ground improvement design has to meet the required bearing pressure to support the building. This requires the engineer designing the ground improvement to have a clear idea of the strength and settlement parameters of the soil throughout the site.

To design the most efficient aggregate pier system, they need as much data about the soil as possible. This means more soil borings, more soil samples taken at each boring site, more field-observed strength tests and more lab analysis done on the samples to determine the strength of the soil.

Specifically, though, the subcontractor is looking for tests and analysis that gives a good idea of soil strength. The more strength and settlement information available to the geotechnical contractor, the more they can refine their ground improvement plan, identifying which sections of a site require a more involved design and which don’t, resulting in significant cost savings.
Here are three ways to test a site’s soil strength and settlement parameters:

**Standard Penetration Tests (SPT)**
SPTs are a routine soil testing and sampling procedure conducted in the field within a soil boring. A small, hollow tube is hammered into the ground and the number of blows required to advance is measured, giving a rough idea of soil strength. The soil collected within the hollow tube can then be retrieved and used to visually identify the samples or taken to the lab to run further strength tests.

While the data collected from SPT isn’t as robust as that collected from the next two tests, SPTs are an inexpensive way to visually and physically corroborate the information collected in shear strength, consolidation and cone penetrometer testing.

**Shelby Tubes**
Shelby tubes, a cylindrical sampling container, are used to collect undisturbed samples in cohesive soils for visual and lab inspection. Samples are typically collected at five-foot elevation intervals within a boring.

While a myriad of tests can be run on a Shelby tube samples – plasticity, moisture, visual inspections – the most useful pieces of information are results from the shear strength testing and consolidation testing. Often times, you see nearly continual Shelby tube samples in a boring; however, no testing of these samples has taken place, so there is no strength information on the soil.

Consolidation tests give the settlement parameters of the soil and shear strength tests give a more accurate picture of soil strength than SPT blow counts. The data collected from these two tests gives a good idea of the column strength a subcontractor can achieve with ground improvement at different points throughout the site.

Undisturbed sampling with Shelby tubes allows for more accurate strength and consolidation testing within the lab compared to samples obtained through traditional SPT methods.

**Cone Penetrometer Testing (CPT)**
Both the Shelby tube and SPT testing are done at intervals, testing only one strata at a time within the soil boring. Cone penetrometer testing (CPT) can provide more reliable data than either, with a probe continuously measuring the soil shear strength throughout the elevation profile. It gives the best information on the actual, in-situ strength of the soil.

CPT is generally more expensive than SPT or Shelby tubes, but it provides better strength data than either. Still, SPTs and Shelby tubes are important to visually corroborate the data gathered from a CPT.

While CPT equipment isn’t widely available throughout the country, the insights gleaned from CPT tests are so valuable that it’s worth seeking out for large-scale projects. The initial cost of running the tests is quickly justified through the significant savings achieved with a more efficient ground improvement design.

**The Importance of Investing in Both Field Explorations and Lab Testing**
In addition to a thorough subsurface exploration program, laboratory testing of soils is critical to developing a safe and efficient ground improvement design. Ground improvement design relies upon accurate determination of the soil strength/stiffness and its compressibility.

Gradation and Atterberg Limits testing help the geotechnical engineer accurately classify the soils and verify visual classifications. Additionally, unconfined compression testing and various consolidation tests give insight into how the soils will react when loaded and allow for the most efficient and appropriate ground improvement design.

By investing in thorough field explorations and soil sampling as well as appropriate laboratory testing, the owner puts their design and construction teams in a position to successfully support their project.

**Terminology Matters**
The strength and settlement data gathered in the tests above help the geotechnical subcontractor design and construct the most cost-effective ground improvement plan. But a geotechnical report can’t be discussed without mentioning the importance of the foundation recommendations section.

A lot hinges on the way a geotech words their recommendation for aggregate piers. Recommending a propriety product such as Rammed Aggregate Piers® – which can only be installed by a small subset of contractors – greatly limits the pool of contractors who can bid on the ground improvement project. Additionally, construction specifications should be written to include non-proprietary terminology.

Using broader language, like “aggregate piers” or “vibro stone columns,” opens up the bid to more subcontractors and more value. When geotechs and structural engineers word their recommendations and specifications for aggregate pier ground improvement this way, it ultimately helps the geotech provide greater value to the owner.

**LYLE SIMONTON** is the Director of Business Development for Subsurface Constructors, one of the largest ground improvement contractors in the country.
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Research and Development Tax Credits
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SKANSKA USA, the contractor hired to construct the $400 million Pensacola Bay Bridge, could earn a $15 million bonus for completing the work early. Likewise, when it contracted out the development of a collapsed section of Interstate 85, the Georgia Department of Transportation offered a $3.1 million early completion bonus to the contractor.

Fast-tracking bridge projects can be very lucrative for contractors – if the work is done right. There are numerous steps along the way where work can be accelerated. One of these is when waterproofing the bridge deck.

Choose the Right Removal Method
If you’re refurbishing a bridge, removal of original coating and waterproofing can be a time-consuming process. Talk with your waterproofing manufacturer to find out about the various removal methods, such as water blasting, that could minimize manual efforts. The removal method will depend on many factors, including the chemical composition of the original coatings and the type of waterproofing membrane now being applied.

Involving the Manufacturer and Applicator in Pre-site Inspections
This is important for new construction as well as refurbishment projects. For bridges that are being refurbished, the condition of the existing paving and waterproofing membrane will influence the refurb plan. For example, the amount of surface prep needed can vary, depending on the type and condition of materials used previously. In some cases, a single pass of a blast machine won’t be enough to clean the surface. If this prep isn’t done right, it can impact the bond between the bridge waterproofing and the substrate.

It can be hard to know what situation you’re getting into without seeing these conditions firsthand, which is why pre-site visits are essential.

Prevent weather delays
As the weather gets colder, ice crystals or condensation may accumulate on the bridge deck. This can result in work being halted when it’s too cold out. Nobody wants to have a crew waiting around to apply waterproofing until the weather changes. To extend your construction season and avoid work delays, choose a liquid waterproofing system that can be applied in moist, freezing temperatures.

Use On-the-Spot QA Tools
Having the right QA methodologies give contractors the peace of mind that they’ve performed a high-quality application. It’s easy to validate the waterproofing membrane’s performance through adhesion testing that ensures the entire system is going to be fully bonded to the substrate. This way as you apply subsequent coats of waterproofing, you know you have a chemical bond between the waterproofing layers and the substrate below. Wet film-thickness testing can also be performed immediately to verify the waterproofing was applied properly. This allows applicators to instantly identify and repair any areas in need.

In addition, products like the ELIMINATOR waterproofing membrane have a color-coded system that enables applicators to confirm full spray coverage at a glance. Overcoating can be performed at any time, offering greater flexibility and high-performance adhesion at day joints.

Consider a Phased Approach
Having the flexibility to perform certain work, such as spraying on waterproofing, during overnight possession can accelerate project completion and minimize frustration for the commuters who rely on the bridge. This is a factor to consider when selecting your waterproofing membrane. For example, by broadcasting aggregate at 100 percent “to refusal” onto the membrane, the ELIMINATOR waterproofing membrane can temporarily be trafficked by vehicles within one hour of application. This gives you the flexibility to apply waterproofing at night, open the bridge to traffic in the morning and then apply asphalt paving the next night.

Confirm That the Membrane can be Applied Cold Anytime
Many waterproofing membrane manufacturers claim to have liquid membranes that are cold applied. However, some of these products must be heated up when used in the wintertime so they don’t become too thick. To avoid this extra step, and the extra cost of bringing generators to the site, it’s best to choose a product that can be applied cold anytime of the year.

LYNN CONNORS is Global Marketing Manager of Liquid Applied Waterproofing at GCP Applied Technologies. Connors has over 15 years’ experience growing emerging markets by bringing innovative solutions to market. She has held senior management positions at iRobot Corporation and Velcro USA Inc. Connors has an Executive MBA from the University of New Hampshire.
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For the largest fixed dome structure in the world, there is no home more fitting than New Orleans, Louisiana, a city known for its resilience. For over 40 years, the Mercedes-Benz Superdome has remained a beloved landmark symbolizing both athletic excellence and city pride.

The Superdome was created by law on November 8, 1966, and opened its doors on August 3, 1975. After suffering significant damage during Hurricane Katrina in August 2005, the Superdome reopened on September 25, 2006, with a Saints victory over the Atlanta Falcons.

Although the Superdome had reopened, the process of fully restoring it had only begun.

The rebuilding process was no small feat. Having gained international recognition during the hurricane’s aftermath as a last-resort shelter for 30,000 New Orleanians, the Superdome captured the world’s attention as it was being reconstructed. The hurricane-force winds had torn holes in the Superdome’s roof, sending water pouring inside. Once the stadium was declared structurally sound a few weeks later, the work of cleaning, drying, and restoring the structure to its former glory began.

Restoring such a massive structure as quickly as possible to help get New Orleans back on its feet seemed daunting, but the team of architects and engineers at Trahan Architects evaluated the damage, developed a set of performance-based criteria for the renovation of the exterior of the Superdome, and got to work.

Designing the Supersized Superdome

The exterior of such a premier venue for major entertainment and sporting events – including seven Super Bowls – had to exude excellence and prestige. The criteria included developing a cladding system that would allow for easier replacement and finishing the exterior with a color that replicated the original finish and looked like the New Orleans Saints gold. The team wanted the beauty of the embossed aluminum to show through while also retaining its color for years to come.

LORIN’S COIL ANODIZED ALUMINUM OUTFITS THE SUPERDOME: RESTORING A NEW ORLEANS LANDMARK FOR GENERATIONS TO COME

By Ed Dahlquist

FOR THE LARGEST FIXED DOME STRUCTURE in the world, there is no home more fitting than New Orleans, Louisiana, a city known for its resilience. For over 40 years, the Mercedes-Benz Superdome has remained a beloved landmark symbolizing both athletic excellence and city pride.

Anodized aluminum from Lorin Industries, Inc. provides the finishing touch on the Mercedes-Benz Superdome. Photo: Lorin
The material would also have to be formable into the panels and strong enough to pass upgraded wind testing, a precaution for future storms. The team selected FC Façade panels by Kalzip, an Indiana-based company specializing in metal roofs and wall cladding. These panels were easy to install and replace while also providing impressive strength and important rain screen protection.

Anodized aluminum from Lorin Industries, Inc. provided the finishing touch – the material to be formed into the Kalzip panels. Trahan Architects tasked Lorin with matching the original aluminum color of the Superdome in order to return it to its original aesthetic appearance of 1975.

To achieve this goal, Lorin developed a new product by using its color consistent processing capabilities and continuously communicating with the experts involved in the project to ensure its product would bring the vision to life. The resulting aluminum enhances the natural characteristics of the metal through an environmentally embracing oxide layer that protects and enhances the multi-dimensional look that no coating can repeat.

At the Superdome, a Partnership is Born
Lorin faced a formidable challenge: matching the original look while meeting all stringent finish and performance standards of modern-day exterior building systems. Trahan Architects determined that only Lorin could meet these challenging finishing requirements. The Lorin Light Bronze ColorIn® Stucco embossed anodized aluminum provided to Kalzip performed extremely well during production making it a great solution for an aesthetic, functional finish to its roll-formed products.

A Landmark Restored, by the Numbers
When the aluminum panel installation was complete in 2010, 365,000 square feet of finished aluminum panels on the new Superdome gleamed out over the resilient city of New Orleans. More than 400,000 pounds of Lorin Light Bronze ColorIn® Stucco embossed anodized aluminum with an architectural Class I anodize layer covered the exterior. Each panel, covered with a fade-proof finish, measures 1x25 feet and weighs approximately 27.5 pounds.

The Superdome’s impressive technology and myriad fan amenities also make it one of the most advanced stadiums in the world. The walk around the Superdome’s exterior plaza stretches .65 miles. In October 2011, an LED lighting system consisting of more than 26,000 lights was installed to illuminate the stadium’s aluminum exterior. This exterior illumination system can reproduce any color, pattern, or image onto the smooth Lorin finish of the stadium panels, which often helps raise awareness for charitable causes.

No lights are expected to require replacement until 2057, thanks to the energy-efficient system. In 2012, the LED lighting system won the “Excellence in Design” award from Live Design Magazine, a leading architecture, design, and event production publication. Such illumination would not have been possible without the resilient, shining finish of Lorin anodized aluminum.

The partnership between Kalzip and Lorin ensures that the Mercedes-Benz Superdome will long shine with the luster of Saints gold, drawing in visitors and New Orleanians alike as an enduring symbol of resilience and pride.

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NEW TECHNICAL DOCUMENT DETAILS OPTIONS FOR SUB-DIVIDING HDPE CONDUIT USED IN POWER AND COMMUNICATIONS SYSTEMS

THE PLASTICS PIPE INSTITUTE, INC. (PPI), has published a new document about adding or replacing cables in high-density polyethylene (HDPE) conduit. Available free on PPI’s website, TN-59 “COMPARISON OF HDPE CONDUIT AND FABRIC DIVIDER INSTALLED AS INNERDUCT” discusses options for sub-dividing larger conduit. PPI is the major trade association representing all segments of the plastic pipe industry.

“This is an important technical piece as it focuses on comparing each technology’s installation techniques, advantages, and protection capabilities, along with cable installation considerations,” said Lance MacNevin, P. Eng., director of engineering for PPI’s Power & Communications Division (PCD). “It is intended to assist specifiers, contractors, and others with useful selection criteria when determining which technology to employ, especially when considering the need to add additional fiber into conduit in the future.”

Published on PPI’s website directly at https://plasticpipe.org/pdf/tn-59.pdf, TN-59 is one of several PPI documents related to the design and installation of PE conduit which are published as a service to the industry by PPI’s Power & Communications Division.

High-density polyethylene innerduct or micro duct, and fabric dividers, sometimes referred to as fabric innerduct, are three options for sub-dividing an installed empty or occupied conduit for current and future installation of additional fiber optic cables. Both HDPE conduits and fabric dividers can be installed into empty or occupied conduits. Occupied conduits are in-situ conduits, typically where one or more cables are already installed. When HDPE conduit or fabric divider is installed into occupied conduits, the process is referred to as an override.

“The comparison indicates that fabric divider does not provide the wide range of physical properties and performance capabilities inherent in HDPE innerduct or micro duct,” MacNevin continued. “As one example of the differences, cables can be jetted into HDPE innerduct and micro duct over long distances, significantly lowering cable installation costs, whereas fabric dividers require the cables to be pulled or winched into place, resulting in shorter installation distances; jetting is not an option.

“Diverse installation methods combined with superior affordability makes HDPE conduit a more versatile end-to-end design solution. HDPE innerduct and micro duct provides designers and end-users the greatest flexibility when designing, installing, and protecting fiber optic cable networks for both current and future needs.”

HDPE conduit, also known as PE conduit, is the preferred material to house and protect electrical power and communications cables in typical applications such as power utilities, telecommunications, CATV, SCADA, FTTH, ITS, highway lighting, and other underground utilities. Benefits of HDPE conduit, according to PPI, include availability in long lengths without joints, high strength, flexibility, proven reliability and installation toughness. PE conduit is widely used in trenching, horizontal directional drilling (HDD) and plowing installation methods.

Additional information about conduit for Power and Communications can be found online at www.plasticpipe.org/power-comm.
Dodge Data & Analytics has released its 2020 Dodge Construction Outlook. The report predicts that total U.S. construction starts will slip to $776 billion in 2020, a decline of 4 percent from the 2019 estimated level of activity.

“The recovery in construction starts that began during 2010 in the aftermath of the Great Recession is coming to an end,” stated Richard Branch, Chief Economist for Dodge Data & Analytics. “Easing economic growth driven by mounting trade tensions and lack of skilled labor will lead to a broad based, but orderly pullback in construction starts in 2020. After increasing 3 percent in 2018 construction starts dipped an estimated 1 percent in 2019 and will fall 4 percent in 2020.”

“Next year, however, will not be a repeat of what the construction industry endured during the Great Recession. Economic growth is slowing but is not anticipated to contract next year. Construction starts, therefore, will decline but the level of activity will remain close to recent highs. By major construction sector, the dollar value of starts for residential buildings will be down 6 percent, while starts for both nonresidential buildings and nonbuilding construction will drop 3 percent.”

The pattern of construction starts for more specific segments is as follows:

- The dollar value of single-family housing starts will be down 3 percent in 2020 and the number of units will also lose 5 percent to 765,000 (Dodge basis). Affordability issues and the tight supply of entry level homes have kept demand for homes muted and buyers on the sidelines.
- Multifamily construction was an early leader in the recovery, stringing together eight years of growth since 2009. However, multifamily vacancy rates have moved sideways over the past year, suggesting that slower economic growth will weigh on the market in 2020. Multifamily starts are slated to drop 13 percent in dollars and 15 percent in units to 410,000 (Dodge basis).
- The dollar value of commercial building starts will retreat 6 percent in 2020. The steepest declines will occur in commercial warehouses and hotels, while the decline in office construction will be cushioned by high value data center construction. Retail activity will also fall in 2020, a continuation of a trend brought about by systemic changes in the industry.
- In 2020, institutional construction starts will essentially remain even with the 2019 level as the influence of public dollars adds stability to the outlook. Education building and health facility starts should continue to see modest growth next year, offset by declines in recreation and transportation buildings.
- The dollar value of manufacturing plant construction will slip 2 percent in 2020 following an estimated decline of 29 percent in 2019. Rising trade tensions has tilted this sector to the downside with recent data, both domestic and globally, suggesting the manufacturing sector is in contraction.
- Public works construction starts will move 4 percent higher in 2020 with growth continuing across all project types. By and large, recent federal appropriations have kept funding for public works construction either steady or slightly higher — translating into continued growth in environmental and transportation infrastructure starts.
- Electric utilities/gas plants will drop 27 percent in 2020 following growth of 83 percent in 2019 as several large LNG export facilities and new wind projects broke ground.

The 2020 Dodge Construction Outlook was presented at the 81st annual Outlook Executive Conference held by Dodge Data & Analytics at the Renaissance Chicago Downtown Hotel in Chicago, IL. Copies of the report with additional details by building sector can be ordered here or by calling (800) 591-4462.