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civil + structural ENGINEER

CELEBRATING DESIGNERS OF THE WORLD AROUND US

SIGNIFICANCE OVER SUCCESS

PENNONI'S TONY BARTOLOMEO
RETIRES AFTER 20 YEARS AT THE HELM

LA COLISEUM RETROFIT
A BRIDGE IN YORKSHIRE
SURVEYING SWEDISH BUS STOPS



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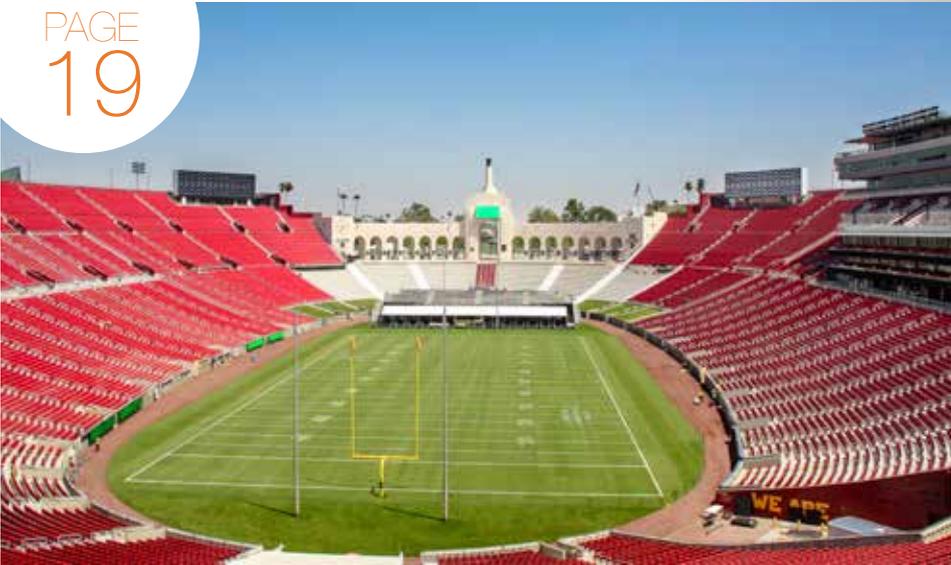
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JURY DUTY

BENTLEY SYSTEMS AMAZES AT SINGAPORE CONFERENCE

Richard Massey

the digital movement, always looking to the future for the next set of challenges to overcome. As a global software company looking to outpace urbanization and the infrastructure it will require, that's exactly where Bentley needs to be.

During the conference, Bentley took the opportunity to issue a series of press releases, two of which stood out as particularly newsy. Bentley announced the acquisition of global mobility simulation and analytics software provider Citilabs, as well as 3D and mobile mapping software provider Orbit Geospatial Technologies. The acquisitions will enhance Bentley's ability to provide Digital Twins for proposed and existing roadway assets.

In what could prove to be a blockbuster, Bentley and Topcon Positioning Systems announced that a jointly owned company, Digital Construction Works, is open for business. Among other things, the new company is focused on improving and institutionalizing digital workflows in construction.

All of this is heady stuff, and if you add in the breakout sessions, keynote speakers, project presentations, and quality of the 1,000-plus internationals who attended the conference, you couldn't leave Singapore without being impressed, or even overwhelmed. As a member of the 130-person press pool, I know a lot of people went back to their keyboards with more than enough to write about. That was the point, and in that regard, Bentley succeeded.

The location was fitting. Singapore, the glittering island city state of 5.6 million nestled off the south coast of Malaysia, is famed for its multicultural society and powerhouse economy. It's also known for its robust public transit, forest of office and residential towers, and top-tier infrastructure. So, it came as no surprise that two of the category winners came out of Singapore.

One of them, the Tuas Water Reclamation Plant, is part of the S\$6.5B Deep Tunnel Sewerage System Phase 2 project. Tuas includes BIM authoring across global offices, features the world's largest membrane bio-reactor facility, will treat Used water and NEWater, will be energy self-sufficient, utilized nine Bentley brands during the design phase, and had a model-based tender process stipulating 6D outputs for time, cost, and asset management, thus enabling a Digital Twin. The project, by Jacobs Engineering Group and Singapore's National Water Agency, PUB, edged out a desalination plant in Singapore, and a water purification plant in Houston, to win its category.

If the Tuas facility sounds like an amazing feat of engineering, it's because it is. But at The Year in Infrastructure 2019 in Singapore, amazing was the only thing on Bentley's agenda.

I recently returned from The Year in Infrastructure 2019, a conference and awards gala hosted by Bentley Systems, Incorporated. The four-day October event in Singapore was a global celebration of technology and infrastructure, as industry experts selected 18 award winners from an impressive 571 project nominations, which came from more than 440 organizations representing over 60 countries.

I had the honor and privilege of serving on the jury for two categories, Water, Wastewater and Stormwater Networks, and Water and Wastewater Treatment Plants. Finalists were judged in part on their innovative use of Bentley software to design and deliver their projects. The presentations, given by three finalists in each category, were spirited, the deliberations difficult and, in the end, the winners deserved the accolades they received.

At the heart of this year's conference was the concept of Digital Twins, a 6D delivery model that gives project owners a virtual replica of the physical asset, thereby allowing them to efficiently maintain and operate the asset throughout its lifecycle. The very definition of a value add, Digital Twins is expected to issue in a new era for project delivery, one in which the value of services replaces the simple selling of billable hours, and where static documents give way to living, breathing analytics that function well beyond the end of construction. Digital Twins necessitates the use of Cloud computing, a vast array of software, upskilling, and a commitment to the journey, not the destination.

Bentley representatives stated quite clearly that Digital Twins in the AEC industry is still in its early stages, and that its implementation across all facets of design and engineering will require an ongoing effort. While this is certainly going to be a labor-intensive endeavor, it puts Bentley at the forefront of



MINIMUM REQUIREMENTS

YES, REVENUE AND PROFIT,
BUT ALSO HUMANITARIANISM
H. Kit Miyamoto, Ph.D., S.E.



Kit Miyamoto recently visited an “irregular community” near Guadalajara, Mexico. In these communities, many of the buildings are made of unreinforced masonry, which easily collapses during an earthquake. Miyamoto is trying to enhance the quality of construction in places where this type of construction is common. *Photo: Miyamoto*

The room is small and dark. I came in from the mid-day sun and my eyes take some time to adjust. I smell a mixture of urine and cooking beans. On the bed, which dominates most of the space in this small family dwelling, a physically disabled boy shakes uncontrollably. His mother explains to me in her broken English how difficult and expensive it is to get glaucoma medicine for her son. I can see one of his eyes has no sight. She explains to me how much the earthquake tremors scare them. I look at the crudely built, heavy masonry walls around them. This place is not far from the where an M7.7 earthquake in 1875 flattened the whole area.

I am near Guadalajara, Mexico. This settlement is called an “irregular community” by locals. The area is inhabited by indigenous people who mainly live in makeshift, unreinforced masonry houses. It is one of the most dangerous building types around in the event of an earthquake. More than 50 percent of earthquake deaths in the past 30 years have been caused by this type of structure.

A powerful woman with humble traditional garb in her mid-40s comes in and asks our team to examine nearby construction. We follow her on foot through small, winding roads, leading to a three-story building. It is a half-built mess. We literally climb onto the roof to meet the contractor. He welcomes us with a large friendly smile and shakes my hand with an oversized, rugged hand. He proudly asks what I think of the construction. I look around and simply tell him: “This is probably worse than anything I’ve seen. The materials are even worse than what I saw in Haiti, where this type of construction killed more than 300,000 people back in the 2010 earthquake.”

I know it is blunt, but I cannot sugarcoat this one. The contractor’s big smile turns to anger. I start to explain about rebar size and he interrupts. He says in rapid Spanish: “Ok, I understand. If you are so smart, why don’t you teach us to do it right? I don’t need your money; I need your knowledge.”

Forty-eight hours earlier, I was standing in front of 300 engineering executives on a Las Vegas stage. My talk was about how to build a purpose-driven business and, at that same time, elevate the industry as a whole. My core message was to utilize our well-organized, high-performance companies to also impact people who are less fortunate. As a business, making profit and growing revenue is a minimum requirement, but we can do so much more than that if we want to. It was a fantastic event and many committed money and time for others. It’s a truly great industry we are in.

Back in that dusty settlement in Guadalajara, I say to the woman and contractor: “We would like to organize masonry training sessions here. I know there are plenty of talented engineers and companies here who deeply care about others. I think there are ways to connect all these dots.” They mentioned to me that the mayor of this district visited here a few weeks ago, so I know there is a political interest to make it better for irregular settlements.

I believe the AEC industry can change lives, rich and poor. I know that organizations can do a lot for humanity. For more information on how you can help, please visit [Miyamoto Relief](#).

H. KIT MIYAMOTO, PH.D., S.E., is the CEO and a structural engineer for Miyamoto International (<http://miyamotointernational.com>), a California seismic safety commissioner, and president of the technical nonprofit Miyamoto Global Disaster Relief. He specializes in high-performance earthquake engineering and disaster mitigation, response, and reconstruction.

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KEEPING TIME

An engineering firm on the East Coast is suing because it says it hasn't been paid for services rendered. In the case, filed in US District Court for the Southern District of New York, the firm says it's owed as much as \$650,000 in unpaid invoices. We all know how important accounts receivables are in the AEC industry, and an outstanding amount of that magnitude must hurt. A lot.

The work and the disputed invoices are tied to subcontracted inspection services on the \$1.5B replacement of the Goethals Bridge from Elizabeth, New Jersey to Staten Island, a six-lane span over the Arthur Kill. Among other claims, the plaintiff is alleging Unjust Enrichment, saying the defendants received the contractual services but kept the money instead of paying it out. The plaintiff is demanding a jury trial, which has yet to be set.

Meanwhile, one of the defendants has responded with allegations of their own. In its counterclaim – a claim denied by the plaintiff – the defendant says the plaintiff's timesheets were problematic and did not adhere to the specifications of the subcontract. The counterclaimant contends that signed time sheets appear to not have been "individually signed by the subconsultant employees but, rather, were signed with an electronic signature or a copy of a previous signature that was affixed to the time sheet, or, in some instances, by a signature that does not appear to be the employees'."

The defendant also accuses the subcontracting firm, among other things, of double-dipping. "Upon information and belief [the subcontracting firm] submitted redacted time sheets which concealed that some of the time charged to the project was also charged to other projects and invoiced to other clients."

The defendant is claiming Breach of Contract and Unjust Enrichment. What a mess. The good news is that the bridge from New Jersey to Staten Island is done. It was finished in late 2018 and is open to the public. It features 12-foot wide shoulders, a central strip to accommodate public transit, and a bike path. The bridge over troubled waters, on the other hand, is still under construction.

OUTER SPACE

Did you know there's a spaceport on Kodiak Island in Alaska? The facility provides "access to planetary orbital space for commercial and government interests." The Alaska Aerospace Corporation is a public corporation of the state of Alaska, created in 1991, and it owns and operates the Pacific Spaceport Complex-Alaska.

Well, a few years back, one of its facilities, the Spacecraft Assembly and Transfer facility, was damaged during a launch. The SCAT, as it's known, is integral to the spaceport's operations. It's a mobile, roller-mounted structure used to transport launch vehicles and payload assemblies to the actual launch site.

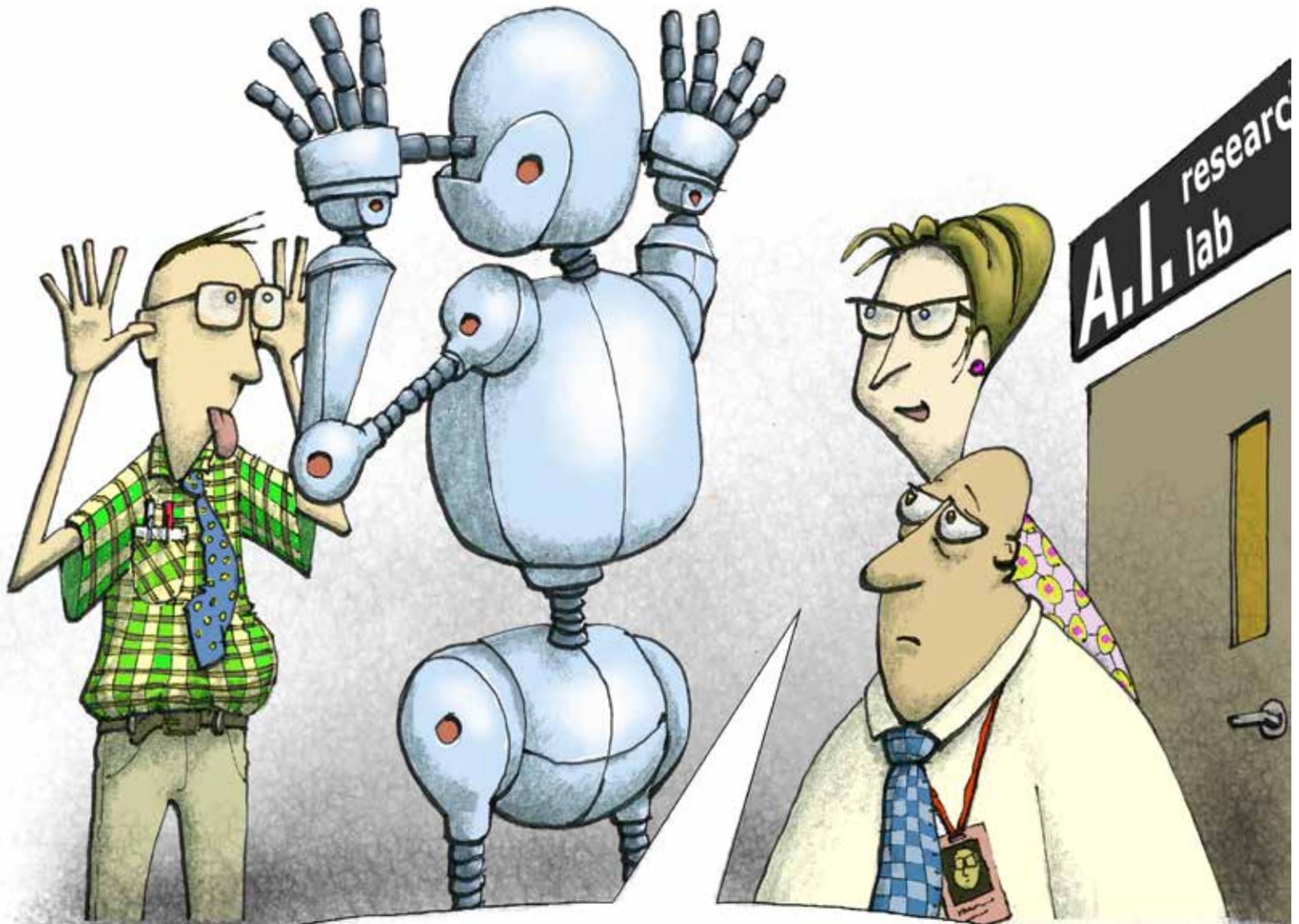
During the lead-up to the repairs, an engineering firm determined that the existing SCAT rails did not have to be replaced. So, they weren't. But, according to a lawsuit pending in US District Court for the District of Alaska, the rollers atop the SCAT rails did need to be replaced. So, they were. And that's where the trouble began.

According to the suit, filed by the Alaska Aerospace Corporation, the wrong kind of rollers were installed and, last year, aerospace officials noticed that the rails had started to deform, bending downward and that a convex groove had formed on top of the rails. The result? More new rollers and a new set of rails. Alaska Aerospace blamed the engineers, making claims of Breach of Contract, Breach of the Implied Covenant of Good Faith and Fair Dealings, and Professional Negligence.

Thoughts of outer space have intrigued mankind for a long time. The moon landing. Mars. The International Space Station. And, of course, Star Trek, Star Wars, and Alien. According to the United Nations Office for Outer Space Affairs, over 5,000 "objects" launched into outer space are in orbit at this time. A handful of those have blasted off from the Kodiak Island facility for weather and communications purposes. This lawsuit reminds us that it's okay to gaze into the stars, as long as you have a good pair of boots on the ground.

If you know of an interesting or off-kilter story taking place in the AEC industry, please contact C+S at rmassey@zweiggroup.com.





"HE'S A GENIUS
WITH ARTIFICIAL INTELLIGENCE...
IT'S HIS ACTUAL INTELLIGENCE I WONDER ABOUT!"



Pennoni provided structural design, construction administration, and threshold inspections for the Opal Sands Resort in Clearwater Beach, Florida. Photo: Ocean Properties, LTD

TONY BARTOLOMEO: SIGNIFICANCE OVER SUCCESS

PENNONI'S 20-YEAR PRESIDENT AND CEO HANDS REINS TO SUCCESSOR

By Richard Massey

IN HIS 20 YEARS as President and CEO of Pennoni, Tony Bartolomeo has just about seen it all. Three recessions, ideas that worked and ideas that didn't, heart-wrenching decisions and, above all, plenty of rewarding wins. Having been with the EPA for 11 years, in 1986 Bartolomeo joined Pennoni, where he established a one-man environmental practice. He became the go-to guy for the remediation of hazardous industrial sites, bridging the divide between government regulation and private land development. Based on the East Coast, once a manufacturing super hub, there was plenty of work to do. The environmental division expanded and became central to the firm. Over time, Bartolomeo familiarized himself with an array of Pennoni's service lines, staff, geographies, and clients. He said he never had the role of President and CEO in his sights. But in 1999, when firm founder Chuck Pennoni asked him to become just that, how could he refuse? During his tenure, Pennoni has been a profitable firm that, through organic growth and acquisitions, has more than 1,200 employees with offices up and down the Eastern Seaboard. As he heads into retirement, Bartolomeo knows Pennoni is in good hands. David DeLizza, the firm's former COO and a 40-year member of the company, took the reins in July. As the lead-

ership transition winds down, Bartolomeo can look back on the last three decades and feel good about what he sees – his role in the firm's commitment to reputation, profit, growth, and community service.

"I'm proud of being associated with Pennoni since 1986," he said.

A Conversation with Tony Bartolomeo

Civil + Structural Engineer: You've spent 33 years of your career at one firm. There must have been more than a few ups and downs. What kept you at Pennoni all that time?

Tony Bartolomeo: The values of Honesty, Integrity, and Service which frame all decisions made by Pennoni's leadership team and permeate throughout our firm has created an environment where our colleagues flourish as professionals and as individuals.

C+S: David DeLizza, the incoming president and CEO, is an accomplished engineer and executive in his own right, and has been with Pennoni since 1979. But even with stability, leadership transition is tricky. What steps did you and the Board take – and over what timeframe – to prepare for this moment?

TB: My initial discussion with our Board regarding my plans occurred in the fall of last year, and once fully developed it was announced to our staff in February of this year. This schedule allowed for an open and transparent process to select my successor and the time to transition smoothly.



Pennoni worked directly with the Phillies and Architect EwingCole on the \$350M Citizens Bank Park in Philadelphia. Initial services included site boundary, and topographic and utilities surveys for the 100-acre site. *Photo: EwingCole*

Dave was selected to be the President and CEO of Pennoni, assuming the role on July 1. He has been on the Executive Team for nearly 20 years, over which time we have worked closely together on operational and development issues, so the internal role of the President and CEO are quite clearly and thoroughly understood by Dave. For the past several months, Dave and I have been assessing the positions I hold in a number of organizations external to Pennoni to determine to whom and when these engagements should be transitioned.

C+S: You were president and CEO before, during, and after the Great Recession. With talk of another economic downturn in the air, what advice can you give to AEC leaders as they prepare for changing times?

TB: Since I have been with Pennoni, three recessions have occurred. The first was in 1990-1991 and was precipitated by the savings and loan crises. The second occurred in 2001 with the boom/bust in the dotcom industry and was exacerbated by the attacks of September 11th. The third and most recent one was the “Great Recession” attributed to the subprime mortgage crises, which lasted from December of 2007 to June of 2009, and had a global impact. During each of these downturns, we were able to sustain profitable performance at Pennoni,

mainly because of our base of public sector and private sector clients, and the diversity of services we provide.

In preparing for changing times, several analyses could inform firms’ leadership regarding potential mitigating measures that could be considered as economic conditions evolve. One is to perform a stress test on backlog to determine how much is under contract and liquid, for example, versus based on task order contracts which may not reach the anticipated level of effort forecasted by management. A routine exercise most firms perform is balancing staff to backlog to ensure that commitments to clients will be met and the financial integrity of the firm is assured.

Another measure to evaluate is the balance across sectors of a firm’s client base. Invariably in an economic downturn, private sector activities generally contract, and opportunities may arise in the public sector. At Pennoni, it seems that we have been close to a 50-50 public/private mix over the years, but that ratio has ranged to near 60-40 (or vice versa) depending if our economy was in a growing or contracting cycle.

A final consideration should be to assess initiatives that have been

undertaken to determine if there is value in sustaining them through a downturn. Such initiatives could include service offerings, geographic locations, or technology investments that have been made but have not yet reached the level of performance projected.

C+S: As the long-time president and CEO of a large and important firm, you have an in-depth understanding of leadership. If you could boil all of it down into a few sentences, what would you say to a young engineer with an eye on the C-suite?

TB: I would advise a young engineer to take on assignments with energy and enthusiasm and make it your objective to perform well and treat every project as an opportunity to learn and expand your skills and capabilities. If you are associated with a good organization, your performance will not go unnoticed, and you will be offered positions with greater responsibilities which will advance your professional career and personal development.

C+S: Let's talk about cross-pollination. During your tenure with the World Trade Center of Greater Philadelphia, what did your experience as an engineer bring to that agency, and what did that agency bring to your work as an executive and engineer?

TB: Engineering is mostly about identifying problems and developing solutions through sound and rational thinking. Most organizations have ambitions and goals, but at times get bogged down in trying to determine the impediments to achieving their mission, and how to overcome them. Strategies which are incorporated into engineering analysis, such as data-driven decision making, and risk-based prioritization, can contribute strongly to deliberations of any organization on how to best use and optimize their resources to achieve the organization's mission.

When I first became engaged with the World Trade Center of Greater Philadelphia (WTCGP), I was intrigued at the time with the vision of the World Trade Centers Association (the global organization of which WTCGP is a member) – “Peace and prosperity through trade.” It made sense that if folks and businesses of different countries had mutually



After more than 30 years at Pennoni, Tony Bartolomeo hands reins to David DeLizza. Photo: Pennoni

The Bartolomeo File

- Spouse of 42 years is Sandi; 4 children and 4 grandchildren.
- Last books read: “The Second World Wars”, by Victor Davis Hanson; “The Great Gatsby”, by F. Scott Fitzgerald.
- Music: Sinatra, Jimmy Buffett, Motown, Beatles, Billy Joel and Hawaiian – have playlists of each that are hours long.
- Food: Italian, Greek, French, and Indian.
- Travel: Island time...Hawaii, St. John, and throw in the North Carolina Outer Banks.
- Hobbies: reading, grilling, and walking in the park.



beneficial business dealings with each other, peaceful and stable relationships would best serve the sustainability of such benefits. As Chair of the WTCGP, I had the opportunity to attend several conferences and general assemblies where my exposure to people from around the globe enlightened me regarding the subtle yet profound impact of culture in conducting international business. That appreciation of the importance of culture has enriched my experiences in working with colleagues, clients, and communities here in the United States.

C+S: Pennoni seems synonymous with Philadelphia and the state of Pennsylvania. As president and CEO, how did you honor the relationship between the firm and both its public and private clients at the state and local level?

TB: From the founding of our firm by Chuck Pennoni in 1966, a major emphasis has been placed on community service; in fact, it is one of the three values that guide our priorities and decisions, the others being honesty and integrity. One of my major responsibilities over the years has been to engage with civic, business, and professional communities and strive to have a positive impact on the missions of each. The opportunities to do so included education and workforce development programs in both the City of Philadelphia and the Commonwealth of Pennsylvania; the American Society of Civil Engineers; and the Greater Philadelphia Chamber of Commerce. All these organizations contribute to the creation of opportunities in our communities via education and economic development and have in common the notion of inclusive prosperity.

C+S: Judging by your resume and experience, community involvement is very important to you. What did you get out of giving back?

TB: I grew as a person, more than professionally, from my involvement, getting much more than I gave. Understanding conditions that are impediments to individuals' progress in their education, work opportunities, or life challenges, and determining how the organizations in which I was involved could help overcome such impediments for the people, and then implementing solutions, was quite rewarding.

C+S: Looking at your entire body of work, what stands out as your greatest achievement, whether it be as an engineer or as an executive?

TB: I would say that deciding to choose significance above success, which is probably the most valuable lesson I learned over the years from Chuck Pennoni, observing what he did and not just what he said.

C+S: You were only the third president and CEO in the firm's history. Go back to that first year or two. What was the biggest misstep you made, and how did you respond? On the other hand, what was your biggest "win" in the early years?

TB: I became President in 1999, and two years later the 2001 recession occurred. I should have had a phased plan of action to adjust to the economic slowdown versus having to abruptly reduce 10 percent of our staff. Lesson was learned: We dealt with the Great Recession much more adroitly, deliberately, and successfully.

C+S: Your wheelhouse is environmental engineering. What strides has the industry made during your career, and what still needs to be done? How did your background and expertise influence Pennoni's environmental services?

TB: Over the years, it seems as though cooperation, if not a partnering approach to addressing environmental issues, has become more prominent in our communities. Industries have realized that environmental stewardship makes good business sense; governments have adopted policies that incentivize beneficial projects such as energy conservation and storm water runoff reduction; and the general public has a greater appreciation of the value of open space and its impact on the health and vibrancy of people in their communities.

My experience at the Environmental Protection Agency gave me a solid appreciation for the advantages of cooperation versus confrontation in dealing with the regulated communities, be they state and local governments or industries. Certainly, all parties were aware of the enforcement powers of the federal government when it came to compliance with environmental laws and regulations; however, the path to resolution of matters was generally timelier and less costly through successful negotiation than litigation.

When I arrived at Pennoni in 1986, it was a time of heightened sensitivity to environmental issues, especially as they related to hazardous waste disposal and site contamination issues. Specifically in our land developments practice, the liability associated with cleanup costs and time delays often would place the successful development of projects in jeopardy. Our ability to serve the best interest of our clients by assessing risks, developing mitigation plans, and conducting effective negotiations with the government agencies, thus avoiding litigation,

often led to the beneficial redevelopment of abandoned industrial sites. It was professionally gratifying to be relied upon by clients as trusted advisors and a member of their development team.

C+S: Backlog. Work-in-progress. Utilization. Fees. Profitability. Staffing. Technology. Differentiation. Value versus commoditization. Recruiting. Culture. Growth – and on and on. A CEO must monitor an endless list of metrics and indicators. What did you focus on to make sure Pennoni was always moving in the right direction?

TB: It is said that what gets measured gets managed. Our leadership team focuses on a few common metrics, such as utilization, multiplier, and cash flow to ensure that the baseline performance of our operations is sound. In addition, we look to sustain our success by investing in initiatives in technologies and geographic areas which hold promise for our future growth of services and market expansion. At times, such initiatives are measured more subjectively than established groups in our firm; their secondary and tertiary benefits are assessed, and the level of effort and investment needed to sustain them is evaluated.

However, our standing corporate goals of enjoying an excellent professional reputation, and achieving profitable growth, are paramount priorities for us.

C+S: Team building. What's the secret to putting the right people in the right places?

TB: I guess the first step is learning the strengths of the members of the team and understanding the best position within the firm for them to have a positive impact. The next is to know the difference between patience and tolerance. It is said that you get what you tolerate. That does not serve the organization, nor the individual whose performance is being tolerated, quite well. And it does not necessarily mean termination of employment; if the person is committed to the firm's success and has skills and attributes that could benefit the firm, the objective of the leaders should be to ensure the right fit.

C+S: As president and CEO, what's the most difficult decision you ever had to make, and why did you have to make it?

TB: It was probably when we had to reduce our staff by 10 percent during the recession of 2001. It is difficult to let folks go who relied on our firm to support themselves and their families, but the financial integrity and long-term sustainability of our firm and the livelihoods of the other 90 percent of our colleagues depended on such a tough decision being made.

C+S: Looking at retirement, what are your plans?

TB: Goal: Do what I enjoy doing, with whom I want, and when I want. This applies equally to my professional and personal endeavors. Nice work if you can get it.

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TOPCON'S NEW VERTICAL CONSTRUCTION TECHNOLOGY

A SCANNING ROBOTIC TOTAL STATION
COMBINES TWO FUNCTIONS

By Jeff Winke



The GTL-1000 by Topcon Positioning Systems is a compact scanner integrated with a fully-featured robotic total station, offering a site manager a dual-function instrument designed to complete a layout and scan on a single set-up. Photo: Topcon

IN THE 1950S, Ace Books began publishing Ace Doubles, which were two separate novels combined in a single volume. For example, a reader could read "Secret Agent of Terra" which ends at about the middle of the book. The reader could then close the book; do a head-to-toe flip of the volume; and there would be the cover of the second book, "The Rim of Space."

The reader is happy because they get a twofer – two separate novels for the price of one (which was 40¢ back then). The two-novels-in-one book concept clearly provided great value to the avid reader.

That same kind of twofer value proposition can also be seen in a new product for the vertical construction market. Available from Topcon Positioning Systems, Livermore, Calif., the GTL-1000 is a compact scanner integrated with a fully-featured robotic total station, offering a site manager a dual-function instrument designed to complete a layout and scan on a single set-up. The data can be processed, mapped, and provide construction verification.

"The key benefit that got me most excited by combining layout and laser scanning into one device is keeping that device in the right person's hands," stated Taylor Cupp, technologist with M. A. Mortenson Company, Minneapolis, Minn. "On our projects, that is the layout professional – now we can empower them to not only do layout, but also capture what is built for quality control. It's very beneficial because the person that knows how they've set up the job in terms of control points and those kinds of things can be the one to do that capture and get it as accurate as possible with one device."

All work-flow components are integrated and provide users with a live, "as built" model of projects, allowing the contractor to identify and rectify any discrepancies. Topcon describes it as a first in the industry.

"Our field engineering team has expressed interest in a product like the

GTL-1000 for many years – a product that allows them to survey and scan within the same workflow and not have to spend time in the office registering scan data," stated Paulina Acosta, senior applied technology specialist with Rogers-O'Brien Construction, Dallas, Texas. "Each point cloud is geo-located before you leave the field. This makes them feel confident that the point clouds will be correctly positioned to our 3D models, without the need for visual alignment or the need to return to the field to acquire more data in order to make the registration work."

Nick Salmons, principal laser scanning surveyor at Balfour Beatty Construction, London, UK said: "The new Topcon robotic scanning solution will increase productivity on site by accelerating the construction process and identifying design challenges more efficiently than traditional methods."

Salmons also said it will benefit the industry as a whole by "reducing cost and program duration, for both clients and contractors alike."

The system is designed so the user can initiate a scan with the press of a single button. A full-dome, 360-degree scan can be created in a few minutes, according to Ray Kerwin, Topcon director of global product planning.

"More traditional systems and methods take considerably longer," Kerwin said. "So, depending on the job site conditions, a contractor can get in and out quicker and thus minimizes safety concerns."

A benefit Acosta likes: "We liked the ability to take individual as-built points with the GTL-1000 after it completes a full scan. This is helpful when you are trying to ensure that you captured the center point of a sleeve or a structural connection. These points appear in the point cloud after they are processed and eliminate the time spent by our 3D modelers trying to determine the positioning of specific items in a point cloud."



The GTL-1000 by Topcon Positioning Systems being used in the field. Photo: Topcon

The scanner is used in combination with ClearEdge3D Verity, a software tool designed to automate construction verification.

“The seamless integration of the GTL-1000 and Verity creates a complete package that is perfect for construction verification using 3D modelling techniques,” Kerwin stated. “The result is a system that offers full-dome scanning which can quickly capture duct work, columns, beams, girders, flaps, penetrations, and structural steel. It

helps to improve quality assurance, providing clear visual indication of construction-quality heat maps to minimize the effects of mistakes before they become expensive problems.”

The system is designed to build upon proven prism tracking and accuracy that allows operators to establish points in most construction environments. The product includes on-board MAGNET Collage field software designed to process the data and offer real-time field-to-office connectivity.

A key productivity benefit of the GTL-1000 scanning robotic total station is that the site engineer requires no additional training and does not need to rely on outside scanning services. The new system is designed to take what was previously a rather lengthy, specialty process and compresses all the steps, reducing the overall verification time.

The GTL-1000 was originally tested in the field by the infrastructure group Balfour Beatty.

“In our use and testing, we have found that the new Topcon robotic scanning solution will increase productivity on site by accelerating the construction process and identifying design challenges more efficiently than traditional methods,” Salmons said. “We are delighted to have collaborated with Topcon over the last 12 months to trial this new tool, which will significantly benefit the industry as a whole; reducing cost and program duration, for both clients and contractors alike.”

The benefits of the combined scanning robotic total station are also said to extend to sub-contractors, who can share the verification data, meaning all parties are working from the same construction-quality heat maps. For example, the first electrical ducts and conduits can often cause problems, as alterations can often occur that go unnoticed. With Topcon’s new system, the speed at which everybody working on the job can understand mistakes means the effects can hopefully be minimized before they become expensive problems.

As efficiency becomes increasingly important in the market, time cannot be wasted and mistakes cannot be tolerated. Clearly, the demand for quick construction verification is on the rise, which supports the need for new technologies that can help.

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QA/QC: New Methods and Tools

By Rob Dunn

There's one question every engineer asks, every day: "Who made this change?"

Fast and clear communication has always been at the center of logistics. Today, communication is instantaneous between unlimited parties, but that speed can hopelessly tangle information in complex processes. For design and construction professionals in particular, QA/QC can feel like a minefield of notes, changes and checks they must cross together. For large projects, companies might require thousands of hours for QA/QC, and then hundreds more to check on compliance to their own processes.

Steve Tissier, P.E., is a Structural Engineer at American Consulting Professionals. One of Tissier's tasks at a previous company was to develop a more efficient QA/QC process, something that took full advantage of Bluebeam technology and was more than a digital facsimile of the company's "old school" pen and paper process, according to Tissier. They were already beginning to use Bluebeam Revu, but only to replicate their existing process in the digital environment. While this was an improvement, they still were not taking full advantage of the suite of tools in Revu, such as custom statuses and the Markups List.

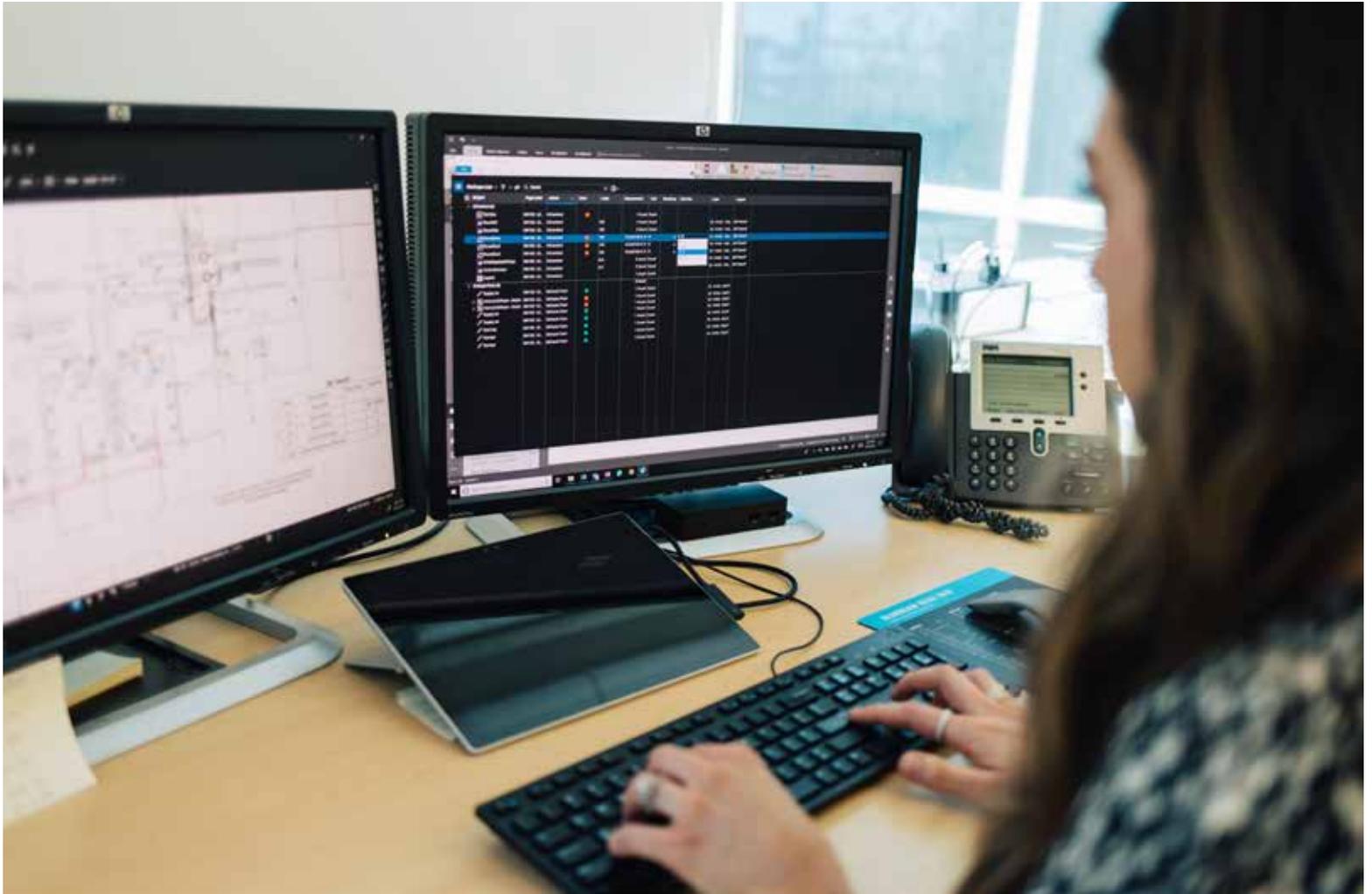
Tissier took a two-pronged approach to the problem. First, there was the matter of tracking and communicating changes in a simple manner, and then there was the review to ensure that the QA/QC process was actually followed and completed. As it turns out, the solution to the second problem was built into the first, and simply awaiting the right technology.

Tissier identified that the first problem wasn't simply a matter of organizing information so much as it was the waiting on the current step to complete before starting the next. As Tissier described it, the problem was that QA/QC was a "linear, finish/start relationship where step three can't start until step two is finished, because the reviewer has the physical copy or the file is locked." To eliminate the wait, Tissier looked to Bluebeam Studio Sessions, which enables a concurrent workflow as numerous parties work simultaneously on a single document—which leads to faster completions. In Studio, the documents had a "start/start relationship," where numerous QA/QC hands at every step could be instantly alerted to changes and approvals, and could collaborate without losing track of the status of any particular change.

However, this required that every collaborator use the same system of custom statuses, so Tissier developed custom statuses to track each step of the QC process for each comment. Tissier's goal was a QC process that "reduced the need for additional markups that specified what step of the process a comment is on. Now, you have just one comment that gets updated through the lifecycle of a QC." Using Tissier's process, the color of a comment automatically changes to a unique color when the participant updates the status of that comment. This enabled the status of a comment to be tracked both graphically on the drawing and textually in the Markups List Status column in Revu.

Tissier's approach worked extraordinarily well upon implementation, as six-day QC schedules were regularly completed in four, and "in one case, nine days were scheduled for the QC process, but the work was completed in five," Tissier explained.

Tracking all of these changes in a digital environment created the answer to the second challenge of ensuring process compliance. Tissier took the metadata of every change, which included who did what step of the QC process and at what time and day, and put that into an Excel spreadsheet tool of his own design. The result, according to Tissier, was a tool that would "run through a thousand comments and check them all to make sure that the process was done correctly in a matter of seconds, as opposed to someone taking hours or days going through to verify that the QC



Developing a more efficient QA/QC process requires improving communication and accountability, and many companies are turning to solutions like Bluebeam Revu to prevent and identify issues faster and more accurately. Image ©2019 Bluebeam, Inc.

process was properly followed. This tool essentially guaranteed 100% compliance with the QC process, which really can't be done without something like it. Overall, these changes led to savings anywhere from 10% to 30% on the QC time and budget."

In a live poll that Tissier did with engineers at the 2019 Bluebeam Extreme Conference, the audience reported that the "majority of them had company-specific QC processes, but only 40% said they truly follow the process, and 95% said they wished the process was better." Tissier's methods, which he's presented twice at Bluebeam Extreme, have been implemented by many other design and construction professionals looking to make their QC process more efficient and reliable. As Tissier described it, "Architects, engineers, contractors, we all do QC. We all have to review documents to make sure that they're correct. So, it's a universal process and that's a universal tool that can be applied to any of the three AEC industries."

Bluebeam Studio creates a shared digital environment for project design and review, but like all tools, it's only as effective as the user. For Tissier, Studio was an opportunity to completely rethink the traditional QA/QC process, using technology to push his entire industry a step forward.

LOS ANGELES MEMORIAL COLISEUM: MODERNIZING AN ICONIC SOUTHERN CALIFORNIA LANDMARK

By Elizabeth Valmont

SINCE ITS 1923 OPENING, the Los Angeles Memorial Coliseum has been an iconic fixture of Southern California and sports history. The storied venue has hosted more than 4,500 events, including two Summer Olympics, countless football and soccer games, concerts and notable cultural events. In 2028, the Coliseum will become the only stadium to hold three Olympic games, welcoming athletes and fans from all over the world. As the Coliseum has become an essential part of Southern California culture for almost 100 years, it was important to ensure that it stay an iconic landmark and continue to thrive for another century.

At Arup, we had the unique opportunity to work with the University of Southern California (USC), project architect DLR Group, and the design team to bring the Coliseum into the 21st century while preserving its history and legacy. Our teams sought to provide major upgrades to the stadium that would improve patron experience and ultimately modernize the venue.

As a global engineering and consulting firm, Arup was able to provide multidisciplinary engineering services for the stadium's new 231,340SF Scholarship Club Tower, including mechanical, electrical and plumbing (MEP), audio-visual (AV), information technology and communications (IT&C), and acoustics services, as well as for the entire stadium, for which we also provided IT&C and AV services. Along the way, our team encountered a series of unique design challenges that allowed us to bring innovative solutions to the table. The key challenges we faced included: 1. Bringing the historic stadium into the modern age and preparing Los Angeles for major sporting events over the next decade; 2. Upgrading the stadium to be multi-use; and 3. Overcoming the design challenges posed by the layout of the new Scholarship Club Tower.

Bringing a Historic Building into the Modern Age and Preparing it for the Future

As is relatively common in many college sporting venues, WiFi and cellular coverage was unreliable and inconsistent at the Coliseum. Additionally, the 96-year old stadium warranted a digital infrastructure overhaul for its existing IT systems and AV components to meet the needs of today's fans. However, before we could implement these much-needed upgrades, our team had to tackle several challenges related to the stadium's historic status and design.

The slope and incline of the Coliseum's bowl did not provide enough signal isolation and caused frequent interference for WiFi and cellular coverage. Compounding this challenge was the fact that the bottom



Arup provided multidisciplinary engineering services for the Los Angeles Coliseum's new 231,340SF Scholarship Club Tower, including mechanical, electrical and plumbing (MEP), audio-visual (AV), information technology and communications (IT&C), and acoustics services, as well as for the entire stadium, for which Arup also provided IT&C and AV services. © Arup

of the bowl is built on concrete, requiring saw-cutting to accommodate WiFi and DAS cables. Using simulations and Radio Frequency (RF) models, we were able to model the exact slope of the bowl and determine specific locations of end devices to avoid rework. Our team used RF modelling software iBwave to leverage the tower's 3D Revit model and produce heatmaps of WiFi coverage. With the model, we also simulated variations of mounting styles of access points to inform our coverage options. We ultimately determined that an under-seat WiFi installation provided the best solution for coverage with the most limited interference and had the added benefit of hiding the technology from spectators. Due to this method of implementation, we were able to achieve our goal of connecting every fan, no matter where they are seated within the stadium.

The historical designation of the Coliseum presented another problem, as we were unable to mount objects on the façade of the stadium. As wireless access points are typically situated on a stadium's exterior, we had to look to alternate locations to mount the wireless access points. We were able to identify less conspicuous locations for the approximately 1,408 wireless access points by strategically and architecturally integrating the devices around lighting fixtures and concessions, which eliminated the need to mount objects on the historic façade.

We also incorporated wireless and cellular infrastructure that is built for current technology but is scalable when new technology becomes available. As we recognize that today's technology develops at a rapid pace and has an increasingly short life cycle, we found it important to provide flexibility for future upgrades. We also provided IT consulting services that enabled USC to unite a previously siloed network and operate different systems from one converged network. Ultimately, the Coliseum's investment in expanded connectivity will allow the stadium to provide fans with customized opportunities and event engagement, further heightening their experience.

Upgrading The Stadium to be Multi-use

Although the Coliseum is primarily used as a sports venue, throughout its history, the stadium has also hosted additional types of events in-



Arup used an under-seat WiFi installation, which provides the best solution for coverage with the most limited interference while hiding the technology from spectators. © Arup

cluding concerts and large-scale speaking engagements. To accommodate a variety of event types slated to take place over the next decade, the stadium demanded additional technical upgrades.

The stadium needed robust broadcast capabilities with equipment that is reliable during full occupancy. We wanted to ensure that the fan experience was optimized both for patrons experiencing the stadium firsthand and those viewing events remotely.

Our team was able to achieve this by providing AV design and consulting services for the new press box inside the Scholarship Club Tower. The press box features a fully IP-based control room and production facility, and a broadcast booth designed for the next generation of in-house production. This type of production will elevate fan experience and crowd engagement as it will be able to handle broadcasts for a variety of events. Through this upgrade, fans are afforded the opportunity to enjoy sporting events and concerts from anywhere in the world.

We also provided updated AV services for the whole stadium to better engage fans by including new large format, high-brightness LED scoreboards, game clocks, timers, building-length ribbon boards, IPTV displays and 805 audio loudspeakers. In total, approximately 650 IPTV displays are now in the facility, as well as multi-functional video walls, digital menu boards, and in-game views throughout the suites and concourses. The deployed IPTV platform sits on the building-wide converged network, and uses high resolution, low-latency IP-technology for real-time viewing.

Two new large-format LED scoreboards at the east end of the bowl are each approximately 100-feet wide by 27-feet high, and feature 15mm pixel pitch resolution and 11,000 nits of brightness to be suitable for daytime use in the California sun. The new video processing and show control were also integrated into the existing scoreboard at the western end, creating a single show control throughout the facility. Supporting these improvements required a significantly updated electrical infrastructure upgrade to improve reliability and capacity.

Overcoming Design Challenges of New Stadium Additions

The new seven-story Scholarship Club Tower provides an incredible 360-degree view of Los Angeles and program additions that will serve as a major revenue generator for years to come. However, it needs to be constructed within the existing façade of the stadium. As a result of the historic provisions, there were space constraints with limited floor-to-floor heights and staggered floor plates that reduced the space available for MEP equipment and distribution.

The MEP system needed to service various programs including the press box, premium suites, loge boxes and club seats, as well as full-service kitchens and food and beverage facilities to improve patrons' game day experience. The kitchens and food and beverage concessions also created a need for more ventilation ducts and piping to fit into already tight ceiling spaces. Another hurdle was to design building systems with floors that do not stack vertically. The edge of one floor could land in the middle of the floor above it, making it difficult to route services.

Our team heavily coordinated with the contractor and the rest of the design team to design pathways for electric conduits, ductwork, plumbing and other services in a highly compact manner to fit into the short floor-to-floor height. By exploring the use of Revit to coordinate with the contractor and the rest of the design team, we were able to combine MEP systems with ventilation and run clash detections to best optimize space. The digital collaboration enabled us to understand the system holistically and create a services-intensive system that takes minimal space while enabling high-quality services for patrons.

Conclusion

The Coliseum has been a fixture in the Los Angeles community for almost a century and has become a key part of the city's identity and pride. Whether or not you are a sports fan, there is a certain value in retaining history. Our team at Arup, working with the design team, was able to ensure that the stadium was brought into this century without compromising the stadium's unique historic design features. Ultimately, the modernized stadium will provide fans with an enhanced visitor experience and will ensure the longevity and sustainability of the stadium for decades to come.

ELIZABETH VALMONT is an Arup Associate and Los Angeles Acoustics Group Lead. She has led the design and construction of global projects in the arts and culture, aviation, education, government, commercial, rail, retail and sports sectors.

ARMY CORPS CONSTRUCTS SCHOOL THAT'S STEAM TEACHING TOOL

By JoAnne Castagna, Ed.D.

ELEMENTARY SCHOOL STUDENTS are looking out their classroom windows at a nearby construction project and jotting down what they see. They're interested because what's being constructed is their new school that they helped to plan out.

The U.S. Army Corps of Engineers, New York District, is constructing a new state of the art elementary school for the children of Army Soldiers and Department of Defense civilians who live on the installation at the U.S. Military Academy at West Point, New York. The students are playing an active role in the planning out of their school as a way for them to learn about careers in science, technology, engineering, art and mathematics, or what is called STEAM. When completed, it will be an energy efficient structure that will continue to serve as a STEAM teaching tool.

The Army Corps has constructed many of the structures on the historic 200-year old campus. Now it's creating a new school for the Department of Defense Education Activity. The DoDEA had a paradigm shift in its methodology. It's changing the way teachers instruct and students learn by using an assortment of technological tools to better prepare students for their future.

To help it do this, it's making all of its new schools 21st Century Education Buildings. According to the DoDEA website, this is a school that has a flexible and adaptable design to provide different kinds of learners the environments they need to learn.

"Students learn in different modalities and environments. As educators, we want to create this learning environment for them," said Denise DeMarco, Principal, West Point Elementary School.

21st Century Education Building

The new West Point Elementary School will replace an outdated structure that was built in the 1960s. It will serve 509 students from pre-kindergarten to fifth grade and will be located near the campus' middle school and gym. The multi-story, 95,552 square foot school is being built into the side of a mountain and will have beautiful views of the Hudson River, the river valley, and the surrounding forests. Its design will embrace this beauty as a way to educate students about their region and the local culture.

Features that will help to do this include large windows and the use of a wide variety of colored paints and bricks to be used for the floors and ceilings. This will bring the vibrancy of the region into the building. What will also do this are the interior structures.



The school's internal mechanical piping, wiring and cabling systems that students will be able to view through hallway windows. *Photo: Dan Desmet, Public Affairs.*

"For example, instead of having utilitarian staircases, the stairwells will be painted with pleasing colors for a pastoral feel," said Timothy Pillsworth, Project Engineer, New York District, U.S. Army Corps of Engineers.

Speaking of utilitarian, instead of having corridors with classrooms to the left and right, students will learn in flexible learning spaces called Learning Neighborhoods. There will be five Learning Neighborhoods. Inside these neighborhoods there will be six learning studios and a teacher collaboration room surrounding a central learning Hub. The studios can be used for large or small groups and one-on-one instruction.

"These flexible spaces will provide teachers an opportunity to be more collaborative in their teaching and they will be able to group students with like interests, needs, and learning goals," DeMarco said.

Another benefit of these spaces is that it makes the best use of time during a day. Instead of students leaving their neighborhoods to see different instructors, the instructors will come to them in the neighborhoods. The center Hub area will serve as a seating and learning area and will have a variety of different chairs and tables for students including couches, beanbags, and pillows.

"Some students learn better at a table and chair and others sitting on the floor or on a bean bag," DeMarco said.

In these neighborhoods and throughout the building, there will be moving partition walls that open and close like accordions, allowing the teachers to expand or limit the areas where they give their lessons. Also throughout the school there will be LED light fixtures. These lights will have sensors that will turn off or dim the lights depending on the amount of natural light entering the large windows and if there are people occupying the room. Natural light will be provided to its fullest. Besides having large windows, there will also be light wells throughout the structure letting in natural light.



Renderings of the front and back of the new West Point Elementary School. This is what the completed school will look like in 2020. *Photo: DoDEA.*

Besides sufficient light, adequate heat is also important, especially in this region. To efficiently regulate the room temperature, a special pump system is being set up. Instead of having one big boiler for the entire school, the building will have three smaller ones. If heat is needed, one of the boilers will run up to 30-40 percent of its capacity. If additional heat is needed, the second one turns on, and so on. They will ramp up or down depending on the need.

“Smaller boilers work more efficiently when they don’t run at their full capacity and they last longer,” said Pillsworth.

The boilers will be part of a radiant heating system. Radiant heating systems supply heat directly to the floor or to panels in the wall or ceiling of a structure. In the school, heated water will circulate through plastic tubing within the floors.

“When students sit on the floors in the wintertime, the floor will be warm,” Pillsworth said.

During the warmer months, the students will have air conditioning – something they never had before – provided by an efficient central chiller plant. Some of the building’s energy will be generated from solar panels and a wind turbine on the roof of the building. Outside there will be playgrounds for the different age groups, an outdoor patio for art classes, and an amphitheater for instruction, gatherings, and performances.

“Just like children learn differently, they also play differently,” De-Marco said. “Some may want to play ball with a group or they may want to read alone in the amphitheater area.”

The Army Corp is also constructing an enclosure that will connect the new school to an existing gymnasium, so the students won’t have to walk outside to get to their physical education classes.

In addition, the old elementary school will be demolished and will provide space for a main access drive, bus drop-off, parent drop-off, and 123 parking spaces. Other features include water bottle filling stations, interior soundproof windows, and a full service cafeteria.

All of the energy-efficiency work the Army Corps is performing on this project meets the environmental requirements to be certified LEED Silver by the U.S. Green Buildings Council. What also qualifies the project for this certification is how the Army Corps is involving students in the project, as a way for them to learn about STEAM careers.

Student Involvement

The students have been involved with the project even before the Army Corps broke ground. Before construction began, trees needed to be removed to make space for the new structure.

“The students were concerned that removing the trees would harm wildlife,” DeMarco said.

She saw this as a great learning opportunity for the students to learn from a real life situation. A meeting was organized so that the students could talk with wildlife experts about their concerns. Together they came up with solutions that safeguarded wildlife and put the students at ease.

Student involvement didn’t stop there. Not only did they talk with wildlife experts, they are also performing engineering studies with project engineers and reviewing maps and prints with architects. DeMarco said that this experience has made many students extremely interested in architecture and planning. In addition, the students are taking lessons that educate them on what’s involved with planning and constructing a new school. This includes listening to guest speakers, including architects, environmental specialist and civil engineers.

“Speakers discussed the removal of the earth to prepare for the building. From this the students learned about slopes and the differences between different soils and terrains,” DeMarco said.

The students also have a say on what they want their new school to look like. For example, for each neighborhood, the students voted on a mascot to represent that neighborhood. The mascots are animals indigenous to that region. Some of the mascots they selected include the Snow Owl, turtle, Black Bear and raccoon. A mural of these animals will be displayed in the entrance of each neighborhood.

The students are also selecting the color scheme and furniture for the Hub areas of their neighborhoods, such as couches, wobble chairs, chairs with lumbar support and different table configurations. While sampling the furniture, one student told DeMarco, “It’s more comfortable to learn in these soft seating areas.”

And now that the school is under construction, there is continued interest. DeMarco said, “The second and third graders, who are strategically located right outside of the construction area, are keeping journals and are making daily entries about the changes they observe week to week.”

School as teaching tool

“The DoDEA 21st Century Education Buildings are designed to be used as a teaching tool and teaching environment,” DeMarco said. “The design teams examined how every square foot in a facility might contribute to education. Building systems and architecture can be used to illustrate and compliment STEAM education.”

When students enter the building, the floor in the main foyer will display the granite that was removed to make way for their new school and to show them what was there before. Eight thousand cubic yards of granite was blasted, excavated and recycled. Some of the rock is being used as fill in the construction and some is being used by the academy. As they continue to walk throughout the building, students will see colored concrete on the floor with contoured lines, showing them the original foundations or grades.

“Students will be able to use these grades to create topographical maps,” Pillsworth said.

“So if we are giving a class about geography or topography, we can take them to these contoured floors to discuss it,” DeMarco said.

In the hallways, the students will be able to see and learn about the building’s internal operating systems. “There will be glass windows on the hallway walls, displaying the guts of the building, such as the heating pipes inside the walls,” Pillsworth said.

Above them, students will be able to look inside a 20-foot long window, exposing the school’s internal mechanical piping, wiring and cabling systems at work. “There will be signs stating, ‘This is your chill water pipe where your air conditioning comes from’ and, ‘This is a fire sprinkler pipe for fire protection,’” said Pillsworth.

On the roof of the building, additional energy will be generated from solar panels and a wind turbine that the students will be able to monitor. This will educate the students about renewable energy.

“The students will have an energy dash board that will tell them, ‘Hey, today is a sunny day or a windy day. We will be generating this much electrical power,’” said Pillsworth.

Outside, there will be a walking path around a storm-water detention pond. Pillsworth said, “Classes can walk around this system and see the vegetation and animals, and how the system works to protect the environment. It’s also a way for students to see how local plants and grasses can be integrated into construction projects.”

“We are very much looking forward to the opportunity to start tours with students and parents,” DeMarco said. “In the interim, we are taking photos and sharing them with the community to keep them abreast of the progress that is being made.

“As the interior walls of the flexible learning spaces start going up, stakeholders are starting to visualize what the school will look like and excitement is building.”

In the spring of 2020, the students and teachers will start to use the almost completed new West Point Elementary School. The students who were once watching the construction from the outside will now be inside experiencing their new 21st Century Education Building. They will be proud to know they helped create their new school. If this experience sparked an interest in a STEAM career, they can further explore it in their new school that is a STEAM teaching tool.

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Emulating Tobacco Barn Charm with Modern Building Materials

By Phil Pearce

Traditional tobacco barns owe much of their charm to the imperfection of wood. Built primarily in the 1800s, their exteriors have become weathered, creating a darkened appearance. Meanwhile, wood on the interior has enjoyed protection from the elements and retains a bright tone. In addition to this characteristic tonal pattern, the structures' exposed wood clearly shows its vertical grains. These simple buildings cut angular profiles against their backdrops of the verdant fields and glens of Kentucky.

Tasked with designing the new Convention Center for Owensboro, Kentucky, Brad McWhirter, AIA, dreamt of tying his modern architecture to the antique flavor of the region.

"We were trying to find a building typology and something to draw from that was a vernacular architecture of the area," he said.

However, the picturesque tobacco barns that dot the surrounding farmland and define the area's aesthetic roots could not simply be imitated — their essential wood material would not perform for a modern community hub. A replacement was required, but what material could reflect woodgrain and match the right colors while providing exceptional architectural performance?

Matching Color with Performance

In addition to his aesthetic goals, McWhirter required Exterior Architectural Grade Class I performance. McWhirter considered a number of options, but he had no answers by the time he ran into a familiar face at a tradeshow. When the architect resurfaced the Louisiana Superdome after Hurricane Katrina, Lorin Industries supplied 365,000SF of anodized aluminum, carefully color-matched to the original hue of the historic stadium.

"He was saying, 'I've got another project and I have this theme in mind and a light-dark concept,'" says Phil Pearce, Vice President of Global Sales and Marketing, Lorin Industries, Inc. "Let me just see what you have."

Coil anodized aluminum offers a unique set of benefits to architects in the market for something very specific. Controlling the oxidation process through continuous coil anodizing creates a clear, translucent aluminum oxide layer that shows off the beauty of the natural metal. The resulting anodic layer can be colored, with the continuous coil process delivering a consistent tone. Lorin created a number of samples in different colors and finishes, like darker bronzes in mill finishes for McWhirter, in their lab. In the end, Black Matt® Long Line Brushed and Clear Matt® Long Line Brushed finishes — for the exterior and interior, respectively — matched the architect's vision. Lorin measured the three-dimensional colors of the specified samples using the Hunter L, A, and B scales, ran a trial run, and then began processing the product, which they were able to do with color control across all the material throughout the entire manufacturing process. Delta E measures the difference between colors on a scale from 0 and 100. For the project's production runs, Lorin achieved high color consistency with a Delta E of just 1.5.

Emulating Woodgrain with Anodized Aluminum

However, to truly emulate the tobacco barns, more than just color would have to match. Integrating the material into the sleek design while revealing a wood-like texture required careful coordination with the panel manufacturer.



The Lorin anodized aluminum panels of the Owensboro Convention Center reflect dusk on the banks of the Ohio River. Design by Trahan Architects. Products by Lorin Industries. Photo: Tim Hursley



The Owensboro Convention Center uses Lorin anodized aluminum to reflect the characteristic tones and woodgrains of Kentucky tobacco barns. *Photo: Tim Hursley*

"Back when I used to sell wood, when you change the grain it creates a flashing effect where two identical products can look dissimilar because of the angle of light reflection," Pearce said. The Long Line Brushed finish of the anodized aluminum reflects light in much the same way textured wood does – "While not trying to be wood, it does have a texture you can feel," Pearce said.

This was a feature for McWhirter, who appreciated the long grains in the reference architecture, but incorrectly manufactured or installed panels could defeat the effect.

"We tried to create this smooth, vertical finish that would allow the building to feel like these vertical panels are very similar to the vertical woodgraining of the barns," McWhirter said.

Sharp, angular wings mark the North and South ends of the Convention Center, posing a particular challenge to ensure a consistent vertical grain look. Charged with fabricating hundreds of panels with ranging lengths that required an angle, panel manufacturer MetalTech-U.S.A. had not worked with anodized aluminum before the project. As anodized aluminum experts, Lorin confirmed with MetalTech to roll-form panels in the direction of the grain created during the coil anodizing process, ensuring a consistent finish. These pieces fit tightly into a seamless smooth exterior, achieving the angularity of the buildings that inspired the structure, while ensuring the effect of grain was not lost. "When the sun hits [the panels]," McWhirter said with a smile, "there's this vertical reflection, very similar to some of those woodgrains you see on the tobacco barns."

As Barns Fade, This Project Stands

In all, Lorin supplied coil anodized aluminum for 170,000SF of interior and exterior paneling, allowing the project to successfully reinterpret the region's historic barns with tonal and textural flair while protecting the project with high-performance material. Unlike the structures that inspired the award-winning Owensboro Convention Center's design though, it will not fade with time. Instead, it is built for durability. The crystalline aluminum oxide layer on the panels belongs to the same family of gemstones as sapphire, and is second only to diamonds in terms of hardness. Architectural Grade Class I panels provide at least .007 inches of anodic layer for increased protection and greater longevity. Unlike paint or coatings, the anodized later does not chip, flake, or peel, and does not require special cleaning solvents. So, while wood could not have succeeded for the project, the project will stand as a durable testament to the humble architecture that inspired its design – and will continue to inspire pride in the local community.

"We couldn't use wood as the exterior, but [the design picks] up on some of that color palette that you see, where the black woods [are] on the exterior of the barns, and the interiors, which weren't as weathered and have lighter wood," McWhirter said. "It was something that was rooted in place in Kentucky."

Phil Pearce is the Vice President of Global Sales and Marketing for Lorin Industries, Inc. In this role, Pearce oversees strategic domestic and international sales and marketing for Lorin.

KEEPING THE WATER RUNNING TO LAS VEGAS

INNOVATIVE, ELABORATE PROJECT HELPS GUARANTEE SUPPLY TO NEVADA'S LARGEST CITY

By Thomas Renner

SNOWSTORMS RACED THROUGH the Western region of the United States with alarming frequency in early 2019. Snow fell even into June, when the opening day of summer **saw up to 20 inches** bury the high terrain of the Colorado Rockies. Colorado's snowpack was **at 132 percent** on average in May, according to the Denver Post. Skiers and winter sports enthusiasts enjoyed a banner winter, and so did reservoirs. The state's water storage levels **were at or above average** for only the fifth time since 2000.

Colorado was not the only state to savor the bounty from winter's steady snowfall. The Las Vegas Valley draws 90 percent of its water supply from Lake Mead. Snowmelt in the mountains that feed the Colorado River filter to Lake Mead, a man-made lake about 24 miles from the Las Vegas strip. It is the largest reservoir in the United States in terms of water capacity, and serves water to Arizona, California, Nevada and some parts of Mexico. The lake is 112 miles long and has 247 square miles of surface area. Hoover Dam, the national landmark that delivers water and produces electric power to southwestern American states, sits just seven miles away from Lake Mead on the border between Nevada and Arizona.

A drought that has extended for nearly two decades, however, has gripped the region. The water level at Lake Mead, the primary source of the community's drinking water, dropped more than 130 feet since January 2000. The federal government is projecting a high probability that Lake Mead water levels may fall below 1,075 feet in 2021, triggering the first-ever shortage of Colorado River water and possibly reducing the amount of water available to Nevada. The record snowfall in the first few months **added three feet** to Lake Mead, but did little to alleviate water shortage concerns.

The Southern Nevada Water Authority is already taking steps to avert any disruption of water service to Las Vegas. Next year, it will start operation of a \$650 million project that provides a water safety net for city residents. The Low Lake Level Pumping Station will have the capacity to deliver up to 900 million gallons a day to two water treatment facilities. The project is one of the most sophisticated, expensive and largest pumping stations in the world, and is a critical step toward ensuring the region's water supply over the long term.

"It is a backup, redundant pumping station to use in the event our other two pumping stations are unable to pump due to lowering lake levels," says Erika Moonin, SNWA project manager. "The Bureau of Reclamation is the governing body that forecasts watershed along the Colorado



The Southern Nevada Water Authority is overseeing a \$650 million project, called the Low Lake Level Pumping Station, at Lake Mead to help guarantee water supply to Las Vegas. Photo: Daniel Shummy

River. It will take many years of incredible snowpack for Lake Mead, Lake Powell and other reservoirs to recover from this long-standing drought and the consequences of climate change."

A Look at the System

The complex pumping station includes a 525-foot deep access shaft, with a 26-foot finished diameter. There are 34 deep well shafts equipped with submersible pumps that feed the pumping station. Barnard of Nevada, Inc. serves as the general contractor for the project. Its team worked closely with the SNWA and the construction manager, Parsons. Among the first steps in the project was to create a forebay, a 12,500SF cavern that is 500 feet beneath the pumping station. Pumps draw water from the forebay, and the water then enters the header pipe and flows through two large-diameter aqueduct systems to deliver water to two treatment plants.

Twenty-two low lift pumps will deliver raw water to the Alfred Merritt Smith Water Treatment Facility, and 12 high lift pumps will deliver raw water to the River Mountains Water Treatment facility. The water is treated with ozone and then goes through a filtration system before entering the transmission system and eventually, the homes in the Las Vegas valley. There are more than 2.25 million residents in the region, the most densely populated area in Nevada. Las Vegas also welcomed more than 42 million tourists in 2018.

"A scale model was developed at Utah State and tests were performed to assess the many factors of how water entered the forebay from the intake tunnel, how it traveled to each of the 34 well shafts, its velocity, and more," Moonin said. "Engineers used the data from this model testing, among many other things, to determine the appropriate size of the forebay."

Powerful Pumps

The pumps at the Low Lake Pumping Station provide the power. The



Workers created a 12,500 square foot cavern that is 500 feet beneath the pumping station. 22 high lift pumps and 12 high lift pumps will deliver raw water to two water treatment facilities. *Photo: Daniel Shummy*

22 low lift pumps, which weigh approximately 68 tons, are 23 feet long and can produce up to 30 million gallons of water per day, according to Moonin. The high lift pumps weigh 79 tons and are 28 feet long and can also produce 30 million gallons of water per day.

Installing them was one of the most pressing challenges in the project. The team first created the forebay, access shaft and riser shaft by drilling and blasting and removed more than 58,000 cubic yards of blasted rock. According to SNWA, it used 271 controlled blast rounds and more than 98,000 pounds of package blasting explosive materials. The forebay was completed in the summer of 2018.

Concurrently, workers used the blind bore drill method to excavate 34 pump shafts. The shafts reached 500 feet down to a precise location in the forebay. Pumps were dropped into the cavern with a gantry crane with a capacity of 220 tons.

“The rock is hard but fractured, and water flows through the fractures with direct connectivity to Lake Mead,” Moonin said. “In order to proceed with excavating the underground caverns and well shafts in these challenging work conditions, a significant grouting program was used to prepare the ground for drilling of the well shafts and drill-and-blast excavation of the forebay.”

Core sampling and extensive geotechnical studies helped identify as many ground condition challenges as possible, Moonin said, and the grouting campaign and careful excavation led to successful completion of the underground work.

Heavy Duty Doors

Valves at the pumping station are protected by 12 floor doors manufactured by The BILCO Company of Connecticut. The doors are strategically placed on the project’s vaults, which house and provide access to large diameter valves. The doors are reinforced for AASHTO H-20 wheel loading.



Single and double leaf doors were used at the project, which will have the capacity to deliver up to 900 million gallons of water per day. *Photo: Daniel Shummy*

Single- and double-leaf doors were used in the project, and will allow workers to access valves that require adjustment and perform maintenance on the pumps. Although the doors are quite large and heavy, they are supplied with BILCO’s engineered lift assistance to ensure safe and easy one-hand operation.

“There are conduits and drain lines that required access,” said Tyler Askin, Barnard’s project engineer at Lake Mead. “The doors were a product that one of our suppliers had used in the past and had the most experience with, and the specifier thought they would be a good choice, especially for this application.”

‘We Must Remain Vigilant’

The above-average snowpack from the winter of 2019 will help in the short term. But conservation remains a priority in the community, and community officials warn the region could still face a water crisis.

“While we appreciate this year’s above-average snowpack, one good year doesn’t mean the drought is over,” Brenda Burman, U.S. Bureau of Reclamation Commissioner, said after the release of a report in August. “We must remain vigilant.”

The Lake Mead Low Level Pumping Station will take a big step toward providing corrective action. Lake Mead is situated about 32 miles from Las Vegas, far away from the public eye and the glitz that is associated with the city. Shows, entertainers and casinos may drive Las Vegas’ tourism industry, but the pumping station plays a more important role: guaranteeing the city’s water supply.

“It’s really an unsung project, but it’s important for the Las Vegas community to guarantee their water supply,” Askin said. “It’s one of those projects a lot of people are unaware of. It’s not alongside a highway where you can see progress every day. Water’s not something people think about it until they don’t have it. This will help make sure that doesn’t happen.”

THOMAS RENNER writes on building, construction, manufacturing and other trade topics for trade publications throughout the United States and Canada.

KEEPING THE WATER ON

HOW ENGINEERS CAN HELP THE MUNICIPAL WATER SECTOR

By Graham Nasby

EACH YEAR the American Water Works Association (AWWA) publishes a report card on the current state of water utilities and the challenges facing them. Similar reports are available from the Water Environment Federation (WEF) and the American Society of Civil Engineers (ASCE). The theme is consistent: The current challenges to our municipal water infrastructure are many, and there is no magical way to fix everything.

One of the major challenges, particularly in North America, is that water infrastructure assets are typically out of sight and very long-lived. The postwar period—the 1950s to the 1970s—was a period of rapid economic growth, and this growth funded the creation much of the municipal water infrastructure that we use today. The catalog of our collective water assets is a long one, including purification plants, pumping stations, reservoirs, towers, distribution systems, sewers and wastewater treatment facilities – just to name a few, and it was not built overnight. In fact, I remember my dad telling me that it wasn't until the late 1950s that city sewers made it into his neighborhood in Hamilton, Ontario, Canada. Can you imagine a modern family of five in a major city still using an outhouse or latrine? In the 1950s and 1960s, this was a common story for many communities in North America.

The investments in water infrastructure made by our grandparents' generation have served us well. The difficulty is that many of those investments, after a very long and productive service life, are now becoming due for replacement. We also now have much higher expectations for water purification and wastewater treatment. This time around, however, we do not have a postwar economic boom to fund the work.

The theme of infrastructure renewal is not a new one. Much has been written on this topic in the past 20 years. Many professional associations, concerned utilities and engineering firms have published a wide range of opinion pieces about the issue. Regulators have also chimed in with new regulations, requiring utilities to look at the entire asset/operations life cycle and move away from the shortsighted year-to-year budgeting that has often plagued the water sector. A central tenet is that we need to be using better and more sustainable funding models to drive more effective water operations, maintenance and asset renewal. We cannot rely on large capital investments to miraculously appear when our current infrastructure is on its last legs. Sustainable funding models and continual improvement are responsible efforts that we all need to support.

Aging infrastructure and the development of responsible funding models are not the only issues facing the municipal water sector. We as engineers play an important role, and we can and should be doing more. In this article I will outline what we engineers could be doing to better support this critical part of our collective municipal infrastructure.



Yes, Funding Is Important

From the standpoint of economics, the municipal water sector is challenging. Providing water and sewage service is typically built around a cost-recovery model. Water rates are often set to cover the cost of delivery, but not all utilities are collecting enough money to also cover preventive maintenance and asset renewal. Compared with other high-value industries such as oil, gas, chemicals and mining, the amount of potential profit in water and sewage is low, and the regulatory burden is high. Assets are expensive and usually hidden, and most of the customers are municipal ratepayers. Also, there is little to no tolerance for service outages. This is a challenging mix of conditions.

As engineers, we need to be aware of these challenges and incorporate them into our thinking when it comes to working in the water sector. When we work with clients on water projects, we should be asking them how the assignments they give us fit into their long-term funding models and asset plans. Maybe we can design or sequence a project better to help it fit with available long-term funding. Perhaps we can provide engineering expertise to help utilities tailor their funding models to align with their operational and long-term asset needs.

Understanding What Engineering Is and Isn't

We live in a capitalist society, and at the end of the day everyone needs to get paid. To put it bluntly, engineering is a business, and anyone who tells you otherwise is either unobservant or not telling the truth. In our engineering schools, and when we are working with junior engineers, we need to take the time to talk about how the business of engineering works. Understanding the business model is central to being able to deliver good projects and services.

No one tries to deliver a bad project, but sometimes we as engineers set ourselves up for failure. If a client does not have enough funding to execute a project properly, we should have the strength to say no, and then take the time to educate our client about why the request isn't feasible. When a client's funding is tight, we need to work with the client to help them make informed decisions on what aspects of a project can be cut, and which cannot. Many a project has gotten in trouble when QA/QC oversight has been reduced, or when junior staff have been used without adequate supervision, in order to meet a budget target. We have a duty to avoid these situations and to educate our clients about what is needed for successful project completion.



Graham Nasby

Keeping Long-Term Client Interests in Mind

When we undertake water projects, we as engineers should start by asking our clients how the project fits into their long-term plans for their utility. By getting answers to these questions, it enables us as engineers to properly service the needs of our clients. If we find that client has not thought about the long-term implications of a project, this could be opportunity for us to help them identify potential lifecycle cost-savings/opportunities by using a longer term approach.

Promoting Best Practices

The municipal water sector is unique in that water utilities are rarely, if ever, in competition with one another. Providing water and wastewater service is also unique in that it is pretty much a natural monopoly, centered on a common public good. The resulting business environment makes it much easier for best-in-class designs and construction practices to be shared among utilities and engineers. Engineers should take advantage of this! The use of best practices and lessons-learned

results in savings for everyone involved. The easiest way to do this is to keep abreast of industry developments, maintain regular communications with colleagues and share project experiences through articles and presentations.

Documentation Matters

We as engineers need to do a better job of documenting our projects. From a utility perspective, as-built drawings and documentation are one of the most important deliverables of a project. Knowing what has been installed, where it is and how it works is critical to being able to operate and maintain an asset during its entire service life. Government regulators and inspectors are also taking an increasing special interest in as-built documentation, such as P&ID (piping & instrumentation diagram), electrical and structural drawings. Furthermore, when repair, upgrade or replacement work is to be carried out, having drawings that correctly reflect what is on site makes future engineering work so much easier. As part of the project planning and execution process, we need to make sure that enough budget is held in reserve to guarantee that, at project end, accurate, site-verified as-built drawings are created.

Developing Our Workforce

We currently have a shortage of experienced senior engineers, and this shortage is hurting the ability of engineering organizations to service clients. Read any article about workforce development; it will talk about the impending challenges of retirements, skills shortages and lack of training. This is not someone else's problem. We as engineers need to take a more active role in developing the future workforce. What this means is taking the time to make sure that our junior staff get the right experiences, right project exposures and proper mentoring. As junior engineers develop in their careers, they will be able to complete projects more quickly, be more efficient in their work, and require less oversight – resulting in cost savings (and higher profits) for everyone involved.

Like the water utilities, we as engineers need to adopt a longer-term outlook when it comes to managing staff. Yes, we still need to focus on getting projects out the door, but we also need to take a more active role in developing our own employees in the process.

On the Shoulders of Giants

The current water infrastructure that we enjoy today was not built overnight. It was the result of many, many years of hard work by generations of engineers, contractors and other specialists. As we embark on the asset-renewal, growth and operations challenges of the 21st century, we as engineers have an important role to play in the municipal water sector. We've come a long way from the water truck and outhouse of my father's childhood. Let's keep it that way.

GRAHAM NASBY, P.ENG, PMP, CAP, works as a professional engineer for a municipal water utility in Guelph, Ontario, Canada. Before joining the utility in 2015, he worked in the engineering consulting community for 10 years. Graham is an active member of the AWWA, WEF and ISA. During the past 15 years he has published more than 40 technical papers on a wide range of topics. Contact: graham.nasby@guelph.ca.



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The 400-foot deep Bellwood Quarry – a recognizable filming backdrop for TV shows and movies – is being repurposed into Atlanta’s largest water reserve container. Oldcastle APG’s Echelon Masonry and Belgard permeable pavers, both sustainable materials, are being used for the site’s facilities. *Photo: PRAD Group Architects*

OLDCASTLE APG’S ECHELON AND BELGARD SUSTAINABLE MATERIALS INTEGRAL TO ATLANTA’S WESTSIDE PARK AND RESERVOIR MEGAPROJECT

By Dave Jackson

LONG ESTABLISHED as the commercial hub of the Southeast, Atlanta has experienced an abundance of growth in the past decade driven by an influx of new residents, expanding businesses opportunities, and the implementation of the Atlanta BeltLine – a pedestrian/bike pathway designed to eventually loop around the entire metro area.

With the city reconfiguring, the long-neglected Westside is undergoing a massive overhaul as its 400-foot deep Bellwood Quarry – a recognizable filming backdrop for TV shows and movies – gets repurposed into Atlanta’s largest water reserve container. The reservoir’s surrounding kudzu-invaded grounds are being developed into Westside Park, a 280-acre multi-use recreational space. This ambitious multi-phased effort

addresses several issues associated with the city’s exploding population – water shortages and surpluses, an aging infrastructure, and initiatives to balance development with environmentally responsible practices.

After years of conceptualizing the Westside Park/Bellwood Quarry project, contractors dramatically broke ground in 2018 by activating a powerful boring machine nicknamed “Driller Mike,” to burrow out a 5-mile-long, 10-foot diameter tunnel connecting the Chattahoochee River to the Bellwood Quarry and the Hemphill Water Treatment Plant. Tunnel supervisor, Larry Weslowski, explained, “Once it was activated, Driller Mike was on duty round-the-clock for almost a month.”

No longer will the gorge be featured as a Walking Dead zombie pit or a Stranger Things supernatural playground. This 2.5-billion-gallon capacity gorge will soon hold a large portion of Atlanta’s potable water surplus, increasing reserves from three to five days to 30 to 90 days with city water supplies processed at the nearby Hemphill and Chattahoochee Water Treatment Plants.

According to Atlanta’s Senior Watershed Director, Ade Abon, “The increase in raw water reserves will prove crucial if ever the city experiences a day without water from the Chattahoochee River – its only source – with an economic impact of \$250 million a day.”

As the connective tunnel took shape, construction began at the plant and quarry sites. Designed for functionality, these structures – designed to house pumping stations, office space, workshops, and electrical equip-



Oldcastle APG's Echelon and Belgard sustainable materials are being used for the facilities at the Bellwood Quarry. *Photo: Echelon Masonry*

ment – will also become part of the Westside landscape. To combine sustainability and visual appeal, architects chose two products from Oldcastle APG's Echelon Masonry brand – the InsulTech™ Insulated Concrete Masonry System (ICMS) complemented by Trenwyth Trendstone® and Mesastone® masonry units. Oldcastle APG's Belgard Aqualine permeable interlocking concrete pavers (PICP) were used as part of the Hemphill site's storm water management system. The masonry and paver materials were sourced through Oldcastle APG's Atlanta-based GMS facility.

The Atlanta-based PRAD group, a firm experienced in environmental watershed projects, has been a key player in several phases of this long-range venture. Senior architect Tom Steele, the lead designer of the quarry and treatment plant pump station structures, explained how InsulTech's pre-assembled single-wythe structural masonry units fit the distinct specifications for the project.

"Low-maintenance materials were a priority for both the Hemphill and Bellwood Quarry sites," the designer noted. "InsulTech provided the insulation, durability, and minimal maintenance we wanted to achieve, in a three-part system that made it cost-effective."

As it routinely does, Echelon provided in-person assistance at both sites in order to help streamline installation of the innovative – if unfamiliar – design of the InsulTech™ masonry system.

"This was the first time InsulTech was used in Georgia, so we all required some training with the system," explains Drew Lamberson, project manager/estimator with Bibler Masonry Contractors, Inc. "The GMS and Echelon teams did a really nice job educating all of us. Len Browning, Echelon's technical advisor, came down and showed us how to lay the blocks to make the process go as smoothly as possible. Once we understood how it worked, it saved time and labor because we finished the interior and exterior walls, insulation, and waterproofing all in one step."

By combining structural CMUs, EPS foam insulation, air/water barrier and exterior veneer into a single 12 ¼-in unit, the InsulTech™ system has been shown to dramatically reduce labor time and costs as compared to traditional insulated cavity walls. Just as importantly, the system delivers true continuous insulation rated at R-16.2 – far exceeding requirements of IECC 2015 – without sacrificing the masonry aesthetic.

Steele discovered just how adaptable the InsulTech™ system was during installation at the Bellwood Quarry Pump Station, which involved executing a multipurpose design to house the pumps as well as electrical systems, conference and office spaces, a workshop, and rest rooms. "For the interior, it made sense to have hard surfaces that were insulated and had some thermal protection, Since the space where the pumps operate will not be climate controlled," said Steele.

He said temperatures can range from 55 degrees F to 100 degrees F in the summer months.

"InsulTech was perfect for this," Steele said.

He actually flipped the InsulTech 3-part block, so the Trendstone™ in Sundown color faced inward, for a nice aesthetic.

The architect's vision resulted in a magnificent blend of form and function. The grand structure features a native precast concrete outer shell, with a focal-point entranceway bookended by two soaring pilasters, which form a gateway for a striking arched-glass doorway. The complex will serve as the anchor for the evolving park aesthetic, and will soon be complemented by the adjacent Bellwood Reservoir, the next addition to this sweeping transformation.

Although smaller in scale, the Hemphill Water Treatment Plant Pump Station required some complex coordination by masons. Lamberson found Browning's technical advisement team to be particularly helpful during this phase of the installation. The structures included a workshop with 12' walls and an electrical facility with 18' high walls. In addition, three different veneer colors were used on the buildings' façades.

The contractor recalled, "Space constraints on site made it difficult for us to lay out the pattern on the ground. This was another area where working with Len really made the difference. His diagrams showed exactly how many blocks of each color went where."

Since these buildings will blend into the Westside landscape, Trendstone™ and Mesastone™ architectural units – prefinished, integrally colored concrete blocks – were chosen as the finished outer faces for the InsulTech system. The units are manufactured with one or more faces ground to expose the variegated colors of the natural aggregates. A pre-applied clear satin gloss acrylic enhances moisture resistance and adds a glossy finish.

During the design phase of the Hemphill Pump Station, Steele noted the mixed-style architecture of the surrounding buildings.



Architect Tom Steele turned the InsulTech 3-in-1 blocks around so the nicer exterior ground face was on the inside of the building, which is mainly un-air conditioned, providing a nice aesthetic for workers, minimal maintenance, and maximum energy efficiency for the central electrical room and offices around the perimeter of the central space. *Photo: PRAD Group Architects*

"It's in a light industrial area where there's everything from a blue Ikea store to traditional brick buildings, as well as stucco apartments and others that have been there a long time," he said.

With the Westside area predicted to undergo widespread development, architectural trends are somewhat difficult to predict. Therefore, the decision was made to design something as simple as possible for cost but with a little extra pizzazz for up-close viewing.

"It has a little more flair than a typical industrial building yet is still something that will stand for a long time and not need maintenance," the architect said.

Echelon's comprehensive masonry offerings enabled Steele to strike the perfect balance. He created a pattern that alternated between Trendstone and Trendstone Plus, both in Haydite color. The "Plus" version delivers a smooth terrazzo finish, which added a glittering effect to the exposed wall – with Mesastone textured CMUs in Sedalia color as a light-colored accent strip.

"There were a lot of control joints that made the mason's work more complicated because of the pattern I put in, but we achieved what I was looking for," the architect recalled. Despite the functional design of the buildings, he noted, "If you see them up close, you're pleasantly surprised by the pattern you might find in the wall. Despite being straight-forward buildings, InsulTech with the Trendstone and Mesastone finishes give them a nice feel. We want folks to know municipal funds are going toward something nice, especially since these are very permanent structures."

As a publicly accessed municipal project, Atlanta planners needed the materials to be highly durable and easy-to-clean. This was essential for the Hemphill site, where the exterior is susceptible to graffiti.

"With the sealant that's integrated into the block face at the factory, that shouldn't be a problem to clean, if it should occur," Steele said.

In the past, Steele and his associates have worked with the Atlanta Watershed Department on several projects to ensure optimal storm water drainage on new sites. With an aging sewer system, water runoff is a central concern for any new municipal projects. As more land gets covered by buildings and pavement, storm water runoff has fewer places to drain in a highly impervious urban environment.

For the Hemphill access way, "We chose Belgard's Aqualine™ 9L Permeable Paver, a 9X9 inch profile, because the L-shaped paver fit the area well," Steele said. "It also had the benefits of LEED points and drainage properties, as well as its ability to stand up to the regular heavy truck traffic. Aqualine 9L helps to keep the water on the site just long enough to actually seep back into the earth and prevent run-off." Tunnel supervisor Weslowski said on a recent site tour, "It just rained all night, and there aren't any puddles around here. I love these pavers!"

This was the same paver used in 2016 for the Atlanta streets near the Hemphill project, which had the distinction of being the largest Permeable Pavement retrofit project in North America. According to the Belgard team, "The permeable pavers allow rainwater to pass directly through a wearing surface into an underlying stone reservoir that temporarily stores the surface runoff before infiltrating into the subgrade soil."

These PIPCs have helped with storm drainage in some of Atlanta's most flood-prone areas.

The PRAD Group has developed innovative engineering technologies and partnered in countless full-cycle planning projects to promote eco-friendly solutions to Atlanta's booming expansion. They find single sourcing from Oldcastle APG brands supports their ongoing mission of providing sustainable, environmentally responsible building products to help support these forward-thinking endeavors.

With an injection of public and private funding, change is inevitable for the landscape of Atlanta's West Side with Phase One projected for completion in the spring of 2020. As it expands, Westside Park is predicted to attract droves of real estate and business developers to its surrounding areas. Park trails will eventually connect to the Atlanta BeltLine, making the area even more accessible to city commuters. The Westside transformation is part of a broader vision to ensure that Atlanta continues to live up to its nickname – Empire of the South.

Learn more at www.EchelonMasonry.com or www.Belgard.com.

DAVE JACKSON is the brand manager for Echelon Masonry at Oldcastle APG, a CRH Company. Coming from an ad agency background with a specialization in building products, Dave melds creativity and industry intelligence to help the Echelon team remain the premier provider of modern masonry solutions to architects and builders across the U.S.

EISB: INNOVATIVE IN-SITU TECHNOLOGY FOR TREATMENT OF CHLORINATED SOLVENT COMPOUNDS IN GROUNDWATER

By Steve Ridenour, PG

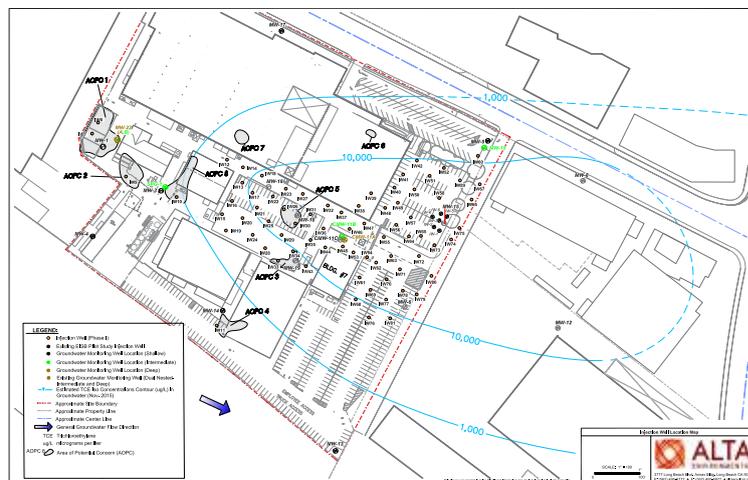
ELEVATED LEVELS of chlorinated solvent compounds, such as tetrachloroethene (PCE) or trichloroethene (TCE), are often present in groundwater beneath sites where manufacturing and industrial operations have occurred. An innovative technology known as Enhanced In Situ Bioremediation (EISB) is being used to cost-effectively treat these contaminated sites. EISB, or engineered bioremediation, is the acceleration of microbial activities to enhance the degradation or detoxification of environmental pollutants in an anaerobic environment. The purpose of EISB is to increase the rate of microbial activity so the rate of reductive dechlorination is increased.

Chlorinated solvents generally biodegrade under anaerobic conditions where the chlorinated solvent (and/or another carbon source) is consumed by microbes present in the aquifer. During reductive dechlorination, anaerobic microbes substitute hydrogen (electron donor) for chlorine on the chlorinated compound molecule, thus converting the molecule to a degradation product with one less chlorine atom. This is the process whereby PCE is degraded to TCE, then to cis-1,2-dichloroethene (DCE), to vinyl chloride, and then finally to ethene (which is benign). EISB therefore eliminates harmful chlorinated compounds or converts the compounds into harmless byproducts. EISB is cost-effective and efficient because it is applied in situ without major disruption to ongoing business activities.

EISB utilizes amendments such as oxygen, electron donors, ferrous iron, liquid-activated carbon, or microorganisms to treat groundwater impacted by chlorinated compounds. These amendments are used to create or enhance the site conditions necessary for the biodegradation to take place.

3-D Microemulsion® (3DME) is an example of an electron donor amendment used in EISB to aid in the anaerobic biodegradation of chlorinated compounds. 3DME is an injectable, highly-distributable liquid material specifically designed for in situ remediation projects where the anaerobic biodegradation of chlorinated compounds through enhanced reductive dechlorination (ERD) processes are possible.

In some cases of EISB, a combination of amendments are used to create optimal remediation conditions. For example, 3DME can be mixed with a technology called Chemical Reducing Solution® (CRS). CRS is a soluble, food-grade source of ferrous iron designed to precipitate reduced iron sulfides, oxides, and/or hydroxides. CRS is used in conjunc-



EISB Final

tion with 3DME to provide the necessary iron to activate the abiotic chemical reduction of chlorinated organic groundwater contaminants, such as PCE, TCE, DCE, and vinyl chloride. The end products of these biogeochemical reductions are ethene and ethane.

EISB technology also addresses the issue of slow biodegradation of intermediate compounds. Bio-Dechlor INOCULUM Plus® (BDI Plus) is an amendment used to accelerate the complete dechlorination of these intermediate, recalcitrant contaminants. BDI Plus is an enriched, natural microbial consortium containing species of Dehalococcoides sp (DHC) capable of completely dechlorinating contaminants during in situ anaerobic bioremediation processes.

EISB is used for remediation at a wide range of manufacturing and industrial sites with chlorinated solvent contamination. For example, at a confidential aerospace manufacturing facility located in Southern California that is under the regulatory oversight of the Los Angeles Regional Water Quality Control Board (LARWQCB), a combination of 3DME, CRS, and DHC was used to treat the core of a major TCE plume measuring ½ mile long by ¼ mile wide. A total of 75 dual-nested injection wells were installed onsite throughout the TCE plume area. Fifty-five (55) of the wells were installed within the core of the plume where TCE concentrations exceeded 10,000 micrograms per liter (µg/l), equivalent to parts per billion.

The wells were installed on an approximately 30-foot by 60-foot staggered grid pattern, screened at 88-98 and 103-113 feet below ground surface (bgs). The wells were then injected with a solution of 3DME, CRS, and BDI Plus, manufactured by Regenesys. One application of 287,194 pounds of 3DME, 114,418 pounds of CRS, and 1,964 liters of BDI Plus (DHC) were injected into the 75 dual-nested injection wells. A total of 701,616 total gallons of the mixed 3DME/CRS/DHC solution were injected. In accordance with the Monitoring & Reporting Program directive issued by the LARWQCB, baseline and post-injection groundwater monitoring and sampling at selected groundwater monitoring wells was conducted on a quarterly basis.

Groundwater sampling results revealed that TCE was reduced in the primary observation well from as high as 25,000 µg/l to less than 100 µg/l (after one year after injection). TCE concentrations in some of the other monitoring wells located within the injection area were reduced

by approximately 50 percent to 90 percent. Degradation products cis-1,2-DCE and vinyl chloride, and significant increases of DHC, carbon dioxide, methane, dissolved iron, and total organic carbon were also detected in the primary observation well. The effects of the full-scale injections are continually being evaluated in the wells on a triannual basis.

Another example of the use of EISB technology was illustrated at a former manufacturing site in Michigan. This site was successfully treated with a combined remedy approach using 3DME, DHC, and PlumeStop®, a colloidal activated carbon. At this site, former industrial manufacturing activities released chlorinated compounds into the shallow groundwater resulting in a ¼-mile-long contaminant plume. The groundwater plume was treated with a multi-phase ERD approach using 3DME, PlumeStop, and DHC. This cost-effective approach significantly reduced the contaminant plume and created conditions for the long-term biodegradation of residual chlorinated compounds.

A further example of the success of EISB is seen at a Santa Barbara manufacturing site. This site formerly conducted manufacturing operations leading to PCE and TCE groundwater contamination. Previous remediation attempts were unsuccessful in achieving site goals and site closure. The goals at this site included the rapid reduction of chlorinated compounds in groundwater and preventing further down-gradient migration of PCE and TCE. PlumeStop, Hydrogen Release Compound® (HRC), and DHC were chosen because they provided a safe and efficient solution for the site. A pre-field remediation test

was conducted to confirm the use of this technology. This test led to cost-saving adjustments in the site design, reducing project costs by 30 percent. The EISB approach successfully eliminated the contaminants and created conditions for sustained treatment at the site.

One of the primary advantages of EISB is that it can be performed in situ. This allows the site to be treated without removing the bulk soil, saving both time and money. In situ treatment is also beneficial because it provides safer conditions for site workers and can be completed with lower operating costs compared to conventional pump and treat methods. EISB can be applied at a wide variety of industrial and manufacturing sites with chlorinated solvent contamination. In comparison to chemical oxidation, pump and treat, and electrical resistance heating, EISB is often both more efficient and less expensive. EISB utilizes amendment technology to efficiently eliminate environmental pollutants in anaerobic environments and is a proven remediation solution for chlorinated solvent contamination.

STEVE RIDENOUR, PG, Senior Geologist III of Alta Environmental, an NV5 Company. He has 28 years of environmental consulting and compliance experience, with a focus on municipal and industrial clients. He is responsible for the management of site assessment and remediation projects, and leads the design and implementation of groundwater remediation projects such as Enhanced In-Situ Bioremediation (EISB) and dual-phase extraction (DPE), including evaluation of soil and groundwater analytical data, interpretation, and reporting. Steve Ridenour can be reached at Steve.Ridenour@altaenviron.com.

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FROM THE MAKERS OF BILLQUICK



How to solve your admin issues and increase your profitability

SMBs in the U.S. spend an average of \$76,000 per year on administrative tasks, according to a report by Sage. Many firms see this cost as a necessary evil because admin tasks, such as invoicing and expense tracking, help a business function. But since time spent on administrative tasks is non-billable, these costs eat into your firm's profit margins and lower your utilization rates.

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Barbours Cut is located on the Houston Ship Channel. *Photo: Port Houston*

MCCARTHY BUILDING COMPANIES BEGINS REHABILITATION AT PORT HOUSTON WHARF 3 AT BARBOURS CUT CONTAINER TERMINAL

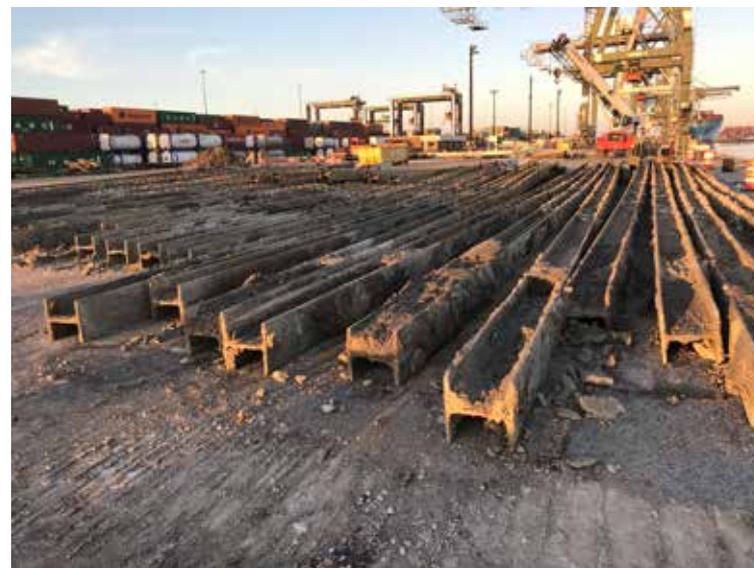
MCCARTHY BUILDING COMPANIES, INC. has begun rehabilitation construction on Wharf 3 within Barbours Cut Container Terminal at Port Houston located in LaPorte, Texas. The project consists of three distinct phases of work on the existing wharf as part of the Port's continued effort to grow and modernize. The project is slated for completion in November 2020.

"McCarthy's marine team has completed rehabilitation construction on Wharf 1 and 2 at Barbours Cut for Port Houston and we are excited to follow suit on Wharf 3," said Mike Schulte, McCarthy's senior vice president. "Our experience in undertaking complex port projects is clearly demonstrated in the quality of work that we deliver. We are proud to continue our nearly two decades long work program with the Port of Houston Authority, one of the premier ports in the country."

The Wharf 3 project includes three scopes of work. The first includes the rehabilitation of Wharf 3, which consists of the reconstruction of 1,000 feet of the wharf, dredging, drilled shafts, fenders, bollards, crane rail, concrete paving, stevedore support building, electric and telecommunications. The second phase will be the construction of the electrical infrastructure, which includes 3,600 feet of underground duct

bank, concrete paving, jack and bore and directional drilling, as well as electric and telecommunications. The final phase includes the demolition of a portion of the Lash Dock, which will consist of the demolition of precast slab beams, pile caps, the removal of 47 drilled shafts with bell bottom foundations and dredging.

Other Port Houston projects McCarthy has completed include 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 at Port Houston as part of the latest expansion of the Bayport Container Terminal and is slated for completion in summer 2020.



The Wharf 3 project includes three scopes of work. The first includes the rehabilitation of Wharf 3, which consists of the reconstruction of 1,000 feet of the wharf, dredging, drilled shafts, fenders, bollards, crane rail, concrete paving, stevedore support building, electric and telecommunications. Pictured here are the extracted H-piles. *Photo: McCarthy Building Companies*



A washed out bridge in the Yorkshire Dales is temporarily replaced with the use of steel from an unused wind turbine project. *Photo: North Yorkshire County Council*

REPURPOSED STEEL FROM WIND TURBINE CREATES BRIDGE OVER TROUBLED WATERS

By Roy Fishwick

THE YORKSHIRE DALES in northern England has long been a tourist trap for those who love its rural vistas and picturesque villages. More recently, it has garnered a reputation as a leading destination for cycling, thanks to hosting the Grand Depart of the Tour de France in 2014 and the annual Tour de Yorkshire races.

In September, Yorkshire was due to host the UCI World Championships, featuring over 1,400 cyclists from 90 countries and broadcast to a worldwide TV audience of 300 million. The Senior Men's Road Race on September 29th was scheduled to follow the route used in the Tour de France, from the city of Leeds, through the area known as Swaledale, to the spa town of Harrogate.

However, heavy rainfall in late July led to flooding in Swaledale, which destroyed a stone bridge on the route. The torrent carried boulders and other debris which tore through the bridge over the Cogden Beck River and destroyed the road crossing, isolating the nearby village of Grinton. North Yorkshire County Council is the municipal authority responsible for maintaining the road network in the Yorkshire Dales. Its engineers began working around the clock in a race against time to reconnect Grinton with the nearby market town of Leyburn, and ensure the cycle race could go ahead.

Its engineering team thought that large tubes deployed in the river could form the base of a temporary crossing, positioned alongside the damaged bridge. They turned to a local steel stockist, Cleveland Steel & Tubes Ltd., to see if it could help. The company had the perfect material in stock for the bridge replacement – steel from an unused wind turbine project.

The steel was part of the substructure which would have supported a turbine in the failed Dounreay Tri project, which aimed to build a 10 megawatt floating wind farm 5.5 miles off the coast of Dounreay in Scotland. The project was shelved in 2017 due to a lack of funding. Cleveland Steel saved the substructure from being scrapped and had stored the sections on its 100-acre stockyard near Thirsk, North Yorkshire, while it found a buyer.

The Numbers

- 1,400 cyclists participate in the UCI World Championships
- The event is watched by 300 million TV viewers
- Each steel tube is 19ft 8ins long
- The tubes weigh 23,148lbs each
- The sections are 7ft 4ins in diameter
- The tube is 1.25 ins thick
- Reusing steel can save 96 percent on carbon emissions

Because Cleveland Steel is located only around 50 miles (80km) by road from the damaged bridge, the Council was able to quickly collect the pair of steel tubes and deliver them to the site, using a truck with a Hiab crane.

Each section is six metres (19ft 8ins) long and weighs 1.75 (3,858lbs) metric tonnes per metre. The giant tubes are 2.25m (7ft 4ins) in diameter and 32mm (1.25ins) thick, forming a solid base with the load bearing capabilities required for a temporary road surface.

North Yorkshire County Council used the Hiab crane to safely unload the tubes, which each weighed 10.5 metric tonnes (23,148lbs). It then deployed a tracked excavator on the river bank, in order to position the giant tubes in Cogden Beck. The operation was a success and enabled the UCI Road World Championships to continue as planned.

Roy Fishwick, Managing Director of Cleveland Steel and Tubes said: “As a local supplier we could immediately provide the tubes, enabling the Council to quickly restore access for residents as well as the tourists upon which this region relies during the summer.”

Cleveland Steel specialises in supplying surplus steel for re-use in major construction and infrastructure projects. Typically it purchases surplus pipe from oil and gas projects. Life cycle analysis from consultants Giraffe Innovation found that repurposing steel in this way can reduce greenhouse gas emissions by up to 96 percent compared to using newly-milled steel – and is far more environmentally friendly than sending steel back to the mill for recycling. The life cycle analysis considered a comprehensive range of factors, including material processing, logistics, and disposal of any generated waste.

“Our repurposed steel is proven to deliver up to 96 percent savings on carbon emissions compared to new steel,” Roy said. “This means that it is an environmentally friendly solution as well as a cost-effective one.

“Total carbon emissions is a metric increasingly required for major construction or infrastructure projects. Surplus steel can therefore



Cleveland Steel & Tubes Ltd. specialises in supplying surplus steel for re-use in major construction and infrastructure projects. *Photo: Cleveland Steel & Tubes Ltd.*

make a significant contribution to reducing greenhouse gas emissions.” High-profile structures that contain steel supplied by Cleveland Steel include the London Stadium which was the centrepiece of the 2012 Olympics; the roof of Wimbledon Court, and the London Eye. The company holds 70,000 tonnes of pipe at Thirsk, enabling it to provide short lead times to its client base. If required, Cleveland Steel can remove any coatings on the pipe and dispose of it responsibly. It has in-house capabilities for inspection, cutting, welding, shot-blasting and coating.

The company uses independent laboratories to verify that the properties and characteristics of its tubes meet the minimum requirements of the specifications set out by the customer.

Roy added: “We were delighted to be selected by the Council to provide steel tubes for the replacement bridge. I have friends and family in the Yorkshire Dales, so I know how important these bridges are in terms of connecting rural communities to the amenities and services in local towns.”

Councillor Don Mackenzie is the executive member for highways at North Yorkshire County Council.

“The damage caused by the unprecedented rainfall in parts of Swaledale has caused unimaginable upheaval to communities in the area,” he said. “We know how vital these roads and bridges are to everyday life for those living in the affected areas, so we are delighted to report we have managed to make so much progress in such a short space of time.” North Yorkshire County Council intends to fully rebuild Cogden Bridge South in the traditional Dales stone masonry style next year.

ROY FISHWICK is Managing Director of Cleveland Steel & Tubes Ltd.

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BRINGING PRODUCTIVITY TO A STOP

GEOSPATIAL PROFESSIONALS IN SWEDEN BLEND TECHNOLOGIES AND SOFTWARE TO CUT COSTS AND INCREASE SAFETY IN UPDATING ROADSIDE BUS STOPS.

By John Stenmark

HOW COMPLICATED can it be to redesign a simple bus stop? For the Swedish Road Administration (SRA) the effort to assess and update roadside bus stops seemed like a simple task. But with thousands of bus stops throughout the 450,000-sq-km country, the redevelopment effort threatened to become an overwhelming task.

In order to design and implement improvements, SRA needed on-site field surveys to assess conditions at each location. The scale of work posed serious issues for teams charged with collecting, managing, and utilizing the survey data.

To solve the challenges, a team of geospatial professionals has combined multiple technologies with customized workflows to collect, distribute and utilize the information. Their efforts reduced field time by 50 percent and cut overall surveying costs by about 30 percent.

Plan and Proceed

The initial work is taking place north of Stockholm in Uppsala County. Initiated in 2018, the three-year project involves reconstruction of stops at 100 locations in the county. With the simple title of “100 Bus Stops,” the project will redesign and rebuild bus stops along two rural roads. The stops will be reconfigured to better serve blind and disabled passengers and improve traffic safety. For example, bus pullouts are enlarged and some trees may be removed to improve sight lines for drivers and pedestrians. Other changes may include pavement marking, adjusting slopes and installing guardrails.

For the planning and design, SRA called on ÅF, a multinational engineering and design company. Founded in Sweden in 1895, ÅF has played a key role in Sweden’s development as an industrial and socioeconomic powerhouse. Lennart Gimring, surveying and mapping manager for ÅF – Division Infrastructure in Stockholm, said that ÅF has a long relationship with SRA on road and transportation projects. The value of that relationship was apparent during project planning meetings where SRA’s confidence in ÅF enabled Gimring to propose new approaches to data collection.

After reviewing SRA’s proposed methods for surveying the bus stops, Gimring suggested alternative techniques that would reduce field time and increase safety for the surveyors. For example, SRA had suggested using total stations for the work, including traversing between benchmarks. Instead of time-consuming traverses, Gimring pointed out that ÅF teams could leverage Sweden’s national GNSS network to collect data at bus stops using total stations, scanning and GNSS. They named the technique “RUFRRIS” (an acronym for “Real-Time Updated Free Station”), which enables surveyors to establish precise georeferenced



Bridget Coulter (left) and Annalena Hellström at work in the Swedish countryside. “There is no bad weather, only bad clothing,” Hellström says. Photo: ÅF

positions in areas where no control points or benchmarks exist.

Gimring assigned the work to two engineers, Annalena Hellström and Bridget Coulter.

“They were given a free hand to plan and execute the project,” Gimring said. “My role was to convince the client that RUFRRIS was the best approach.”

With the green light from SRA, Hellström dug into the budget and planning. She used a simple project management tool that could be shared with stakeholders. To help with the planning, the bus stops were divided into groups of different priorities. The data was also converted into a KMZ file for use in Google Earth.

Because the work covered a large area and was a long distance from their office, Hellström and Coulter needed to plan the fieldwork in detail. In addition to selecting driving routes, they planned their activities at each site.

“A quick look in Google Earth Street View was very helpful in this process,” Hellström said. “In addition to getting ideas on where we could establish our instrument stations, we could also decide where to safely park our vehicle.”

Hellström and Coulter used a Trimble R10 GNSS receiver and a Trimble SX10 Scanning Total Station to conduct the fieldwork. At each site, they first confirmed that they could work safely and stay clear of traffic. Next, they performed the RUFRRIS procedure. Setting the SX10 in a suitable location, they used Integrated Surveying, in which GNSS receiver and prism target on a single pole occupy a point. With the R10 connected to the SWEPOS real-time GNSS network, they obtained positions based on the national coordinate grid and vertical datum. At the same time, the SX10 measured to the point and added the data to the free station solution in Trimble Access software running on a Trimble Tablet controller.

The RUFRRIS technique allowed Hellström and Coulter to establish good geometry for the free stationing and enabled them to quickly orient the SX10 into the coordinate system.



Scanning data output in LAS format is ready for viewing by stakeholders. Designers could work directly in the point cloud and make virtual “visits” to the site. Photo: ÅF



The crew at work at a bus stop. SRA provided the guard truck as an additional layer of safety for the team. Photo: ÅF

“The method was especially useful for us since no existing control points or benchmarks were available and high relative accuracy was required,” Hellström said. “Because we were in the countryside, we had no problems working with SWEPOS and RTK. We had previously compared existing benchmarks against RUFRIIS in other locations. Those comparisons demonstrated that surveying with RUFRIIS was efficient and provided high accuracy.”

Next, they split up the tasks, with Hellström using the R10 with a Trimble TSC3 controller to capture points for terrain modeling while Coulter worked independently using the SX10 as a robotic total station to collect details on pavement, structures and other features. In addition to capturing discrete point data, they used the SX10 to scan and photograph the entire site.

“Depending on conditions we moved the SX10 three times at each location,” Hellström said. “We also completed one to three full-dome scans as needed and captured panoramic photos.”

Before leaving a site, the team established a benchmark point for use in subsequent visits (if needed) and construction.

An Efficient Path to Deliverables

When the team returned to the office, Coulter downloaded and processed GNSS and total station data in Trimble Business Center software (TBC). Because the SX10 automatically combines the multiple scans in the field, she needed only to import the resulting single point cloud into TBC. With all information captured in one georeferenced coordinate system, the different data types fit together seamlessly. After completing quality checks, Coulter prepared files for delivery to ÅF’s in-house engineering team. Output from TBC included drawing files for use in AutoCAD as well as LAS files for the point clouds.

Gimring said they coordinated with the engineering teams to help them utilize the full potential of the multi-sensor field data. In addition to assisting with processes to create digital terrain models from the field data, the surveyors also showed engineers how to work directly in the point cloud.

“By operating in the point cloud, we can bypass the work of modeling 3D objects,” Gimring said. “People can make direct measurements and extract exactly what they need.”

With the complete data in hand, the engineers then developed plans for updating the bus stops. The value of the scanning data became most apparent during the engineering phase.

“It saved a number of revisits,” Hellström explained. “If the client wanted to add lines or objects, it’s easily done from the point clouds. For example, the client wanted all big trees near the bus stops to be included, which was not in the original order. But it was possible to add the trees without returning to the site.”

The finished designs were provided to SRA for construction. Design data from ÅF could be viewed in Google Earth to aid stakeholders in visualizing the planned upgrades. ÅF also exported information on benchmarks from TBC to Google Earth to provide ready access to control information at each site.

The approach developed by ÅF produced both immediate and long-term benefits. In addition to speeding the work at each site, the RUFRIIS approach eliminated the need for traversing and leveling between existing benchmarks (if located) along with the associated issues for safety and guard vehicles. Hellström noted that SRA was satisfied with the results and will promote the ÅF technique in future projects. Other safety benefits included the ability to capture points on the road from the point cloud instead of walking on the road. And reflectorless measurement enabled Hellström and Coulter to collect points on the road without being in or close to the traffic lanes.

The most important benefit came on the bottom line.

“We were able to save time and money while working in a safe environment,” Gimring said. “It’s cutting costs without cutting corners.”

JOHN STENMARK is a writer and consultant working in the geospatial, AEC and associated industries. He has more than 25 years of experience in applying advanced technology to surveying and related disciplines. He can be reached at john@stenmark.us.

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In addition, many of the schools listed here offer online certificate programs in specialized fields of study that, in many cases, can later be applied toward a master's degree.

Arizona State University

<http://asuonline.asu.edu/online-degree-programs/graduate>

- Master of Science, Construction Management
- Master of Science, Engineering, Sustainable Engineering
- Master of Sustainability Leadership

Auburn University

<https://www.eng.auburn.edu/online/>

- Master of Civil Engineering, Pavement and Materials Option
- Master of Engineering
- Master of Engineering Management

California State University, Fresno

www.fresnostate.edu/cge/water

- Master of Science, Water Resource Management

Clarkson University

<https://www.clarkson.edu/academics/engineering/civil-environmental-engineering>

- Master of Engineering, Civil & Environmental Engineering
- Master of Science, Civil & Environmental Engineering

Clemson University

https://www.clemson.edu/graduate/academics/program-details.html?m_id=Construction-Science-Management

- Master of Construction Science and Management

Colorado State University

<https://www.online.colostate.edu/degrees/graduate-degrees.dot>

- Master of Engineering, Civil Engineering
- Master of Engineering, Engineering Management
- Master of Science, Civil Engineering

Columbia University

www.cvn.columbia.edu

- Master of Science, Civil Engineering
- Master of Science, Construction Engineering and Management
- Master of Science, Earth and Environmental Engineering

Delta State University

<http://www.deltastate.edu/artsandsciences/mathematics-and-sciences/mas-git>

- Master of Applied Science, Geospatial Information Technologies

Drexel University

www.drexel.com/online-degrees/masterdegrees.aspx

- Master of Science, Construction Management
- Master of Science, Engineering Management
- Master of Science, Project Management

Embry-Riddle Aeronautical University

<https://erau.edu/degrees/?degree-level=master&campus=worldwide>

- Master of Science, Engineering Management
- Master of Science, Project Management
- Master of Science, Unmanned Systems

Florida International University

<http://fiuonline.fiu.edu/programs/online-graduate-degrees>

- Master of Science, Construction Management
- Master of Science, Engineering Management

Harvard University

www.extension.harvard.edu/academics/graduate-degrees/sustainability-degree

- Master of Liberal Arts, Sustainability

Iowa State University

<https://www.distance.iastate.edu/graduate-programs/>

- Master of Engineering, Civil Engineering (construction engineering and management focus)
- Master of Engineering, Engineering Management

Johns Hopkins University

<https://ep.jhu.edu/programs-and-courses/programs>

- Master of Civil Engineering
- Master of Environmental Engineering
- Master of Engineering Management
- Master of Science, Environmental Engineering and Science
- Master of Science, Environmental Planning and Management

Kansas State University

<http://global.k-state.edu/courses/degrees>

- Master of Engineering Management
- Master of Science, Civil Engineering
- Master of Science, Community Development

Kennesaw State University

<http://learnonline.kennesaw.edu/graduate-programs>

- Master of Science, Civil Engineering
- Master of Science, Engineering Management

Lawrence Technological University

<http://onlinedegrees.ltu.edu/colleges/college-of-engineering>

- Master of Construction Engineering Management
- Master of Engineering Management
- Master of Science, Civil Engineering

Louisiana State University

<https://online.lsu.edu/online-degree-programs/engineering-construction-degrees/>

- Master of Science, Construction Management
- Master of Science, Civil Engineering

Michigan Technological University

<https://www.mtu.edu/gradschool/programs/degrees/>

- Master of Science, Civil Engineering
- Master of Science, Integrated Geospatial Technology

Mississippi State University

<http://www.bagley.msstate.edu/distance/programs>

- Master of Engineering
- Master of Science, Civil Engineering

Missouri University of Science and Technology

<http://dce.mst.edu/credit/degrees>

- Master of Engineering, Geotechnics
- Master of Science, Civil Engineering (environmental, structural, geotechnical, water resources, or construction engineering focus)
- Master of Science, Environmental Engineering
- Master of Science, Engineering Management

Montana Tech

<https://www.mtech.edu/gradschool/distancelearning/pem.html>

- Master of Project Engineering and Management

New England Institute of Technology

<https://www.neit.edu/Programs/Online-and-Hybrid-Degree-Programs>

- Master of Science, Construction Management
- Master of Science, Engineering Management

New Jersey Institute of Technology

<http://www5.njit.edu/online/programs>

- Master of Science, Civil Engineering
- Master of Science, Engineering Management
- Master of Science, Transportation

NewSchool of Architecture & Design

<https://newschoolarch.edu/academics/school-of-architecture/cm-programs/master-of-construction-management>

- Master of Construction Management

North Carolina State University

<http://engineeringonline.ncsu.edu>

- Master of Civil Engineering
- Master of Engineering
- Master of Environmental Engineering

<https://online-distance.ncsu.edu/program/master-of-geospatial-information-science-and-technology>

- Master of Geospatial Information Science and Technology

North Dakota State University

<https://bulletin.ndsu.edu/programs-study/graduate/#masterstext>

- Master of Construction Management
- Master of Science, Community Development
- Master of Science, Transportation and Urban Systems
- Master of Transportation and Urban Systems

Northern Arizona University

<https://nau.edu/online-paths-to-a-better-future>

- Master of Science, Applied Geospatial Sciences

Norwich University

<http://civilengineering.norwich.edu>

- Master of Civil Engineering (structural, environmental/water resources, geotechnical, or construction management focus)

Ohio University

<http://onlinemasters.ohio.edu>

- Master of Science, Civil Engineering (construction engineering and management, environmental engineering, structural engineering, or transportation engineering focus)
- Master of Engineering Management

Old Dominion University

<https://online.odu.edu/academics/degree/masters-degree>

- Master of Engineering Management
- Master of Engineering, Environmental Engineering
- Master of Science, Civil Engineering (coastal engineering focus)
- Master of Science, Environmental Engineering

Pennsylvania State University

www.worldcampus.psu.edu

- Master of Engineering Management
- Master of Geographic Information Systems
- Master of Professional Studies, Community and Economic Development
- Master of Professional Studies in Geodesign
- Master of Professional Studies, Renewable Energy and Sustainability Systems
- Master of Project Management

Purdue University

<https://engineering.purdue.edu/ProEd/programs/masters-degrees/interdisciplinary-engineering/engineering-management-leadership>

- Master of Science, Engineering Management and Leadership

Salisbury University

www.salisbury.edu/geography/msgism

- Master of Science, GIS Management

South Dakota School of Mines & Technology

www.sdsmt.edu/DistanceEducation

- Master of Science, Construction Engineering and Management
- Master of Science, Engineering Management
- Master of Science, Mining Engineering and Management

Southern Methodist University

<https://www.smu.edu/Lyle/Graduate/ProspectiveStudents/Lyle-Distance-Education-Program/Programs>

- Master of Arts, Sustainability and Development
- Master of Science, Civil Engineering,
- Master of Science, Engineering Management
- Master of Science, Environmental Engineering

Southern New Hampshire University

www.snhu.edu/online-degrees/masters

- Master of Business Administration, Engineering Management
- Master of Business Administration, Project Management
- Master of Science, Construction Management

Stanford University (Stanford Center for Professional Development)

<http://scpd.stanford.edu/certificates/mastersDegrees.jsp>

- Master of Science, Civil and Environmental Engineering

Stevens Institute of Technology

<https://www.stevens.edu/academics/stevens-online/available-programs/schaefer-school-engineering-science>

- Master of Science, Construction Management

Texas A&M University Corpus Christi

https://iol.tamucc.edu/online_degrees.html

- Master of Science, Geospatial Surveying Engineering

Texas Tech University

www.depts.ttu.edu/elearning/programs/index.php

- Master of Engineering
- Master of Science, Civil Engineering

The George Washington University

<http://onlineemse.seas.gwu.edu/online-programs/ms-in-engineering-management>

- Master of Science, Engineering Management

The Ohio State University

<https://mgel.osu.edu/tracks>

- Master of Global Engineering Leadership, Civil and Environmental Engineering technical track

Thomas Jefferson University

<https://online.jefferson.edu/online-degrees>

- Master of Science, Construction Management
- Master of Science, Sustainable Design

Trine University

<https://www.trine.edu/online/degrees/index.aspx>

- Master of Science, Engineering Management

University of Alabama – Birmingham

<https://www.uab.edu/online/degrees-certificates>

- Master of Engineering, Advanced Safety Engineering and Management
- Master of Engineering, Structural Engineering
- Master of Engineering, Construction Engineering and Management
- Master of Engineering, Sustainable Smart Cities

University of Alabama – Huntsville

www.uah.edu/online-learning/online-programs

- Master of Science, Civil Engineering (hybrid program, primarily online)
- Master of Science, Engineering Management

University of Arizona

<http://online.engineering.arizona.edu/online-programs>

- Master of Engineering, Mining, Geological and Geophysical Engineering
- Master of Science, Engineering Management

University of Arkansas

<https://online.uark.edu/programs/index.php#filter=.masters>

- Master of Science, Engineering
- Master of Science, Engineering Management

University of California – Los Angeles

www.msol.ucla.edu/sustainable-water-engineering

- Master of Science, Engineering (with Certificate of Specialization in Engineering Management or Mechanics of Structures)
- Master of Science, Engineering (with Certificate of Sustainable Water Engineering)

University of Central Florida

<https://www.ucf.edu/online/masters>

- Master of Science, Engineering Management
- Master of Science, Civil Engineering

University of Colorado – Colorado Springs

www.uccs.edu/easonline/degree-programs/engineering-management-degree.html

- Master of Engineering, Engineering Management

University of Colorado – Denver

www.cuonline.edu/GIS

- Master of Engineering, Geographic Information Systems

University of Dayton

<https://udayton.edu/engineering/departments/engineering-management-systems-technology/engineering-management-systems/engineering-management-ms/index.php>

- Master of Science, Engineering Management

University of Florida

www.distance.ufl.edu/masters

- Master of Engineering, Environmental Engineering Sciences
- Master of International Construction Management
- Master of Science, Civil Engineering
- Master of Science, Environmental Engineering Sciences
- Master of Sustainable Design
- Master of Urban and Regional Planning

University of Houston

<http://www.uh.edu/online/programs/online-programs/graduate/index>

- Master of Science, Civil Engineering
- Master of Science, Construction Management

University of Idaho

www.uidaho.edu/cogs/programs-offered/online-programs/list

- Master of Engineering, Civil Engineering
- Master of Engineering, Engineering Management
- Master of Science, Environmental Science
- Master of Science, Geological Engineering

University of Illinois at Chicago

<http://meng.uic.edu>

- Master of Engineering

University of Illinois at Urbana-Champaign

<http://cee.illinois.edu/academics/graduate-programs>

- Master of Science, Civil Engineering (construction management, infrastructure, transportation engineering, or structural engineering focus)
- Master of Science, Environmental Engineering

University of Louisville Online

<http://louisville.edu/online>

- Master of Science, Civil Engineering
- Master of Science, Computer Science
- Master of Engineering, Engineering Management
- Graduate Certificate, Structural Engineering
- Graduate Certificate, Transportation Engineering
- Graduate Certificate, Cyber Security
- Graduate Certificate, Data Science

University of Maine

<https://online.umaine.edu/grad>

- Master of Science, Spatial Informatics
- Professional Science Master, Engineering and Business (Surveying Engineering concentration)

University of Maryland

www.advancedengineering.umd.edu/programs

- Master of Engineering, Project Management

University of Massachusetts – Lowell

<https://gps.uml.edu/academic-programs/?location=online&planlevels=graduate>

- Master of Science, Engineering Management

University of Nebraska – Lincoln

<https://www.unl.edu/gradstudies/prospective/programs/EngineeringManagement>

- Master of Engineering Management

University of New Haven

<http://online.newhaven.edu/masters-in-environmental-engineering>

- Master of Science, Environmental Engineering

University of New Mexico

<http://unmonline.unm.edu/programs/masters/construction-management.html>

- Master of Construction Management

University of South Carolina

https://sc.edu/study/academic_overview/online_education/courses/degree_programs/online_graduate_degree_programs/index.php

- Master of Engineering, Civil Engineering
- Master of Science, Engineering Management

University of South Florida

www.usf.edu/engineering/imse/graduate/msem.aspx

- Master of Science, Engineering Management

University of Southern California

<http://gapp.usc.edu/den/programs>

- Master of Construction Management
- Master of Science, Civil Engineering (construction or structural engineering focus)
- Master of Science, Green Technologies
- Master of Science, Systems Architecting and Engineering

University of Tennessee – Knoxville

<http://volsonline.utk.edu/online-programs/graduate-programs>

- Master of Science, Civil Engineering (public works or transportation concentration)
- Master of Science, Environmental Engineering

University of Texas – Arlington

www.uta.edu/engineering/future-students/engineering-online/index.php

- Master of Construction Management
- Master of Science, Civil Engineering

University of Texas at Tyler

<http://www.uttyler.edu/academics/graduate/civil-engineering-degree.php>

- Master of Science, Civil Engineering

University of Virginia

<http://cgep.virginia.edu/civil-and-environmental-engineering>

- Master of Engineering, Civil and Environmental Engineering (infrastructure systems focus)

University of Washington

www.pce.uw.edu/online/masters-degrees

- Master of Infrastructure Planning and Management
- Master of Science, Civil Engineering: Construction Engineering
- Master of Science, Construction Management
- Master of Sustainable Transportation
- Master of Science, Civil Engineering: Energy Infrastructure

University of Wisconsin – Madison

<https://epd.wisc.edu/online-degrees>

- Master of Engineering Management
- Master of Engineering, Sustainable Systems Engineering

University of Wisconsin – Platteville

<https://www.uwplatt.edu/learn-online>

- Master of Science, Engineering (structural/geotechnical engineering focus)
- Master of Science, Project Management

Villanova University

<http://www1.villanova.edu/main/online-programs.html>

- Master of Science, Civil Engineering
- Master of Science, Sustainable Engineering
- Master of Science, Water Resources and Environmental Engineering

Virginia Tech

<https://vtonline.vt.edu/MastersDegrees.html>

- Master of Natural Resources

Western Carolina University

<https://www.wcu.edu/learn/programs/index.aspx>

- Master of Construction Management
- Master of Project Management

Western New England University

<https://www1.wne.edu/academics/graduate/engineering-management-mba.cfm>

- Master of Science, Engineering Management/MBA

Worcester Polytechnic Institute

<https://www.wpi.edu/academics/online/study>

- Master of Science, Construction Project Management
- Master of Science, Environmental Engineering

Youngstown State University

https://ysu.edu/academics#t_online-degrees

- Master of Science, Engineering Management

Do you know any accredited colleges or universities not on this list that offer online master's degree programs in civil engineering, structural engineering, or related disciplines? Please send the institution's name and website address to Richard Massey at rmassey@zweiggroup.com. This list will be updated online at <https://cseengineermag.com/online-masters-degree-programs-2019/>

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PERFORMANCE IN TIGHT SPACES

NEW PORTABLE GPR TECHNOLOGY HELPS CONCRETE SCANNERS IMPROVE EFFICIENCY AND PRODUCTIVITY

By Peter Masters

CONCRETE SCANNING companies provide imaging solutions to those who need to see inside of existing infrastructure. The information they provide helps customers understand how something was built and what to avoid if they need to cut into that material. For the most part, scanning concrete is done to avoid structural reinforcement or conduits. This work is critical, but the equipment needed can be heavy and tiring to carry around.

Now, new portable ground penetrating radar (GPR) can help locate rebar, conduits, post-tension cables, and voids. It can also help identify structural elements, including pan deck and concrete cover, and provide real time determination of concrete slab thickness.

This portable concrete inspection tool is equipped with a 2.7 gigahertz (GHz) antenna, positioning system, and control unit combination. It can reach depths of 24 inches (60 centimeters) and is positioned only 8 millimeters off the surface, providing enough ground clearance that it can be used over rough concrete surfaces.

This article offers insights into how and why two professional concrete scanners are using the tool, how they get the most out of it, and their thoughts on new accessories designed to make their jobs easier.

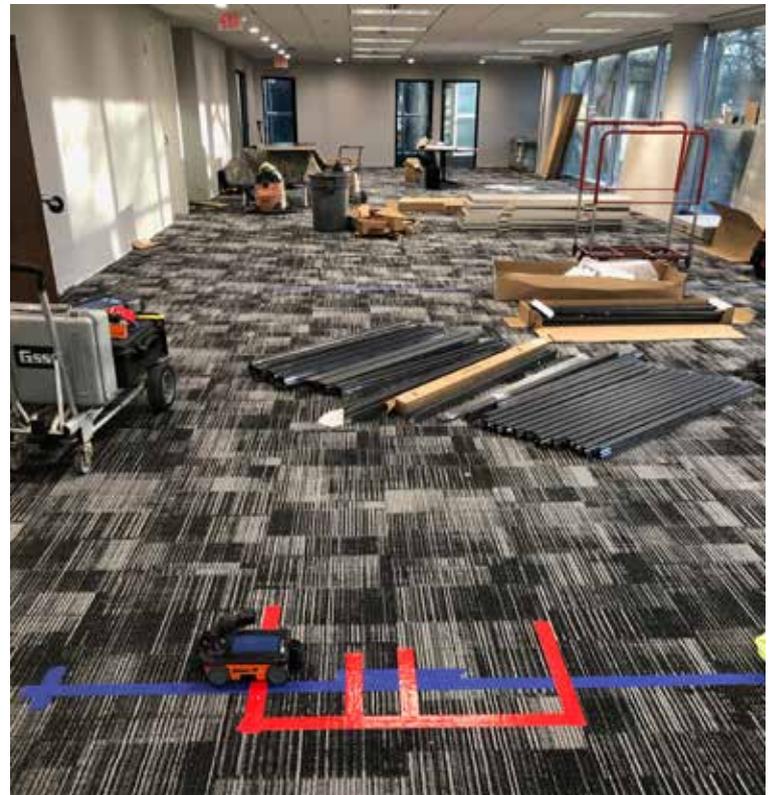
Meet the Scanners

Dan Foley is President of Cobra Concrete Cutting Services, a full-service concrete sawing and drilling contractor, and Rory Foley is his head GPR technician. The Chicago-area company's GPR scanning division tends to focus on tough jobs where their attention to safety makes them stand out in the market place. They work primarily with hospitals, wastewater treatment plants, and heavy industrial plants, along with institutional facilities like higher education, government and the courts. The Foleys point to the adaptability of the new equipment as a key benefit.

"The portability of the GSSI StructureScan Mini XT works well for the situation. It can fit in tight spots, especially those with low clearance. That makes it good for overhead scanning and where pipes are attached to a wall," Dan Foley said.

Rister, President of Lexington, KY-based GPR Engineering, uses the new equipment in what he calls a "forensic engineering investigation environment." To illustrate its importance for this application, Rister cites an example that had a profound effect on his business.

"It was one of those frantic phone calls we all dread," Rister said. "One of my friends, who was involved with a hospital construction project, called me at about 7 a.m., asking me to come immediately to the hos-



GPR scan of a commercial space. Red marks indicate the location of post-tension cables. Photo: GPR Engineering

pital. The owner had chosen not to pay for a concrete scan – and the contractor hit a main electric line right near the six-room operating suite. It all happened just a few minutes before the hospital was due to begin a full day of scheduled cases, as well as keep the OR available for a Helivac situation! When I showed up, a large crew of electricians were desperately trying to piece wires back together. The whole thing was a nightmare, which cost everyone a lot of money."

According to Rister, since then, the hospital requires concrete scanning to be performed before any concrete cutting or drilling work is done.

"I think it has taken instances like that to help educate people in the commercial building community in Lexington, Kentucky, to appreciate what scanning can do for you, and what risks it helps you avoid," he said.

Using the New Equipment

Cobra's Rory Foley explains that the switch from the larger GPR units to the new portable all-in-one GPR concrete inspection system is a great time saver, especially for areas where space is confined and for large trench inspection projects.

Rory Foley adds that the company is now also using a new miniaturized GPR antenna attachment, the Palm XT, which is especially good for smaller roof sections.

"If I'm in a tight spot, maybe only the antenna fits in, or if there's a little clearance area, I can take the handle off, where most of the larger GPR units wouldn't fit," he said.

Where his team runs into pipes that are tight into the wall, or for areas that have smaller lead-up, they are able to spend less time on the job site with the miniaturized antenna attachment, and scan an area that might not be possible to hit with full-sized antennas.

The handheld antenna attachment can be used in cross-polarization mode, a method that highlights non-metallic objects, such as PVC, and deemphasizes metallic objects like rebar and wire mesh. The cross-polarization mode has had a very positive effect on Cobra's business. Rory Foley explains that the company had previously stayed away from plumbing or electrical trench inspection with the previous generation of handheld scanners because they did not have the ability to cross polarize the antenna.

"Now that we can cross polarize the Palm XT antenna, we can interpret data more accurately and distinguish a target from the conduit," he said.

Another advance is the pole attachment, which Rory Foley uses primarily for scanning trenches.

"If I am going to be scanning trenches, I can throw the pole into the truck, and it means I don't have to crawl on the floor while scanning large areas," he said, adding that the equipment is more compact and lighter, which makes a difference for jobs where there are hundreds of feet of trench to scan.

Rory Foley also likes the way he can customize how data is portrayed on the screen, making it easier to interpret. He especially values being able to show the gain in many different ways, make color adjustments, and change the size of the hyperbola, or even view the data in a larger or smaller format.

Cobra has used the new equipment at a number of high-profile job sites in Chicago, including Trump Tower and Wrigley Field. At Trump Tower, his team used a swing stage to provide information needed for drilling holes through the building's surface to attach the sign to the building without hitting rebar. Hanging outside of the building with cables about 75-100 feet in the air and scanning the vertical surface was a challenge. The portable GPR unit's small size and safety strap allowed the team to easily and safely mount the individual letters to the building.

At Wrigley Field, the GPR scanning was aimed primarily at identifying any conduit laid in the deck so other renovation construction would not destroy work that was just installed. Since the job required walking long distances, the unit's portability was key to their success.

A final example was at a hospital in a southern suburb of Chicago, where a construction team was installing a new plumbing trench in a kitchen where 30 conduits were crossing. Here, the Cobra team used the portable GPR unit with the miniaturized antenna attachment to isolate the conduit and ensure plumbers would miss it where they were crossing the trench.

Brad Rister, of GPR Engineering, explains that the portable unit is

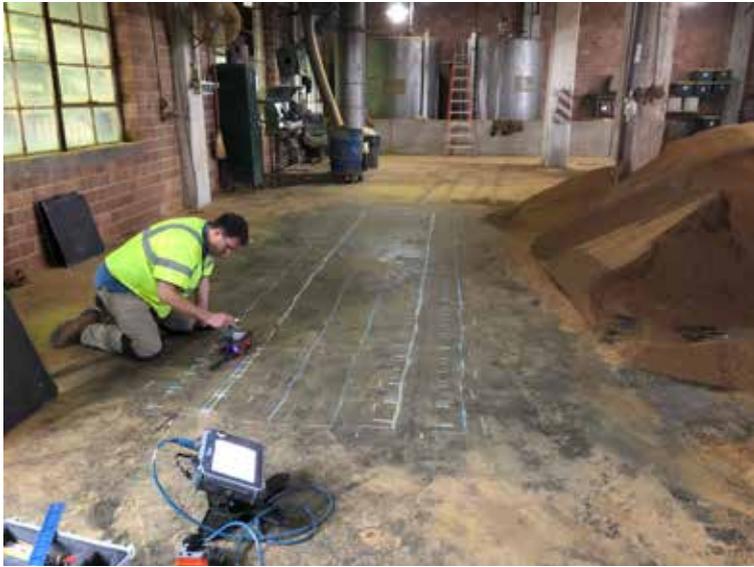


GPR scan of a commercial space. Orange marks indicate the location of post-tension cables and reinforcement. Photo: Cobra Concrete Cutting Services

his newest piece of GPR equipment and represents an evolution of the technology that brings much-needed simplification. "It's the best solution I have seen over the 20 years I've been doing GPR. I like the precision, the accuracy of telling you where something is, and the fact that any wheel can trigger the distance measuring instruments (DMI)," said Rister.

Rister also appreciates how lightweight the equipment is. "When you're scanning overhead, I think it's the only solution that makes those projects even doable, especially with one person. It helps me cut back on my manpower and employee expense. I can now do a lot of things with one person that previously required two people; one to hold the bulkier equipment and another to use the larger antenna." This adds up to more staff availability to complete other projects and bring in more work. "I'm not seeing anything drastically different in concrete with the new portable unit than I did with other equipment I've used; it's just much easier to use and to move around. I would probably say it provides a good 25 percent better efficiency and productivity. And that translates into my bottom line."

Rister also pointed to the extension pole as a life (and knee) saver for performing scans of utility trenches in existing buildings. "It just keeps you off your hands and knees for a good majority of the time." GPR Engineering frequently works on projects in very large, open and vacant commercial construction spaces, where the customer wants to know the location of pole stitching cables. An easy way to obtain this data is to put the GPR concrete scanning unit on a pole, and walk behind it and look down, as opposed to crawling on hands and knees. Another useful feature of the new system is its ability to collect a 3D grid quickly. In the past, Rister had to use software to put all the information together in a post process environment. With the new technology, operators can develop a 3D grid right in the field; by pushing a few



GPR technician using the StructureScan Mini XT to mark concrete reinforcement and utilities in a bourbon distillery. Photo: GPR Engineering

buttons the unit will resolve the information immediately and provide an x-ray like image of the concrete slab.

Finally, Rister points to the usefulness of a new accessory that adds the ability to detect AC power and induced radio frequency (RF) present in conduits. This lets them detect low amplitude AC signals associated with difficult to locate conduits. The accessory can now be used in place of a \$7,000 standalone piece of line detection equipment he had purchased years ago. He calls it a “must-have” add-on and advises any new buyers to have one on hand.

Rister has successfully used GPR technology on thousands of road and bridge scans since the 1990s, and has been scanning concrete structures for more than a decade. GPR Engineering has a wide range of GPR equipment to pick and choose from, depending on the specific project. Most recently he has tended to opt primarily for the portable unit. As he explains it, the more compact equipment and improved work flow enables him to be more efficient. “It’s not the only piece of equipment that I go on to jobsites with, but it just happens to be the first one out of the box. It’s the most efficient tool that I have.”

Education Needed on Benefits of Technology

While scanning is becoming more of an industry standard for dealing with concrete slab, both companies agree that more education is needed on its benefits. Dan Foley said that, with the availability of the new technology, the time is right for slab on grade inspection to become mandatory.

“It’s good for safety and loss prevention and I hope the industry embraces it,” he said. “I believe it should be required on jobsites and I am hopeful it becomes specified, because it avoids so many types of damage both to workers and structures.”

Rister agrees, saying he spends a lot of time educating people on why they need GPR scanning, because it is an expense they have not had to incur in the past. He explains it to customers this way: “Doesn’t the expense of hitting something outweigh the much lower cost of finding out in advance what is there – so you can avoid hitting it?”

The argument is especially effective for any of his clients that need to have constant power service. For example, he’s seen the chaos created for the retail environment at a local mall when power is knocked out, and has done quite a lot of recent work for malls, hospitals, banks, and restaurants, and other businesses that simply cannot afford to be knocked offline.

“In my view, the lines you leave on the concrete floor give guidance to the next person,” Rister said. “My approach to the jobsite is almost like an operation. Like a surgeon, I’m going to come in and tell you what we are going to cut, and what we’re going to avoid. Or, to give another analogy of how I see the important work we do, think of it like a map, where those X’s on a page represent the buried treasure.”

Take Advantage of Training Classes to Become Educated on the Benefits of GPR

There are many ways to become educated on the benefits of GPR technology. Many manufacturers provide theoretical and instructional classes for GPR technicians. For example, Geophysical Survey Systems, Inc (GSSI), the leading GPR manufacturer, offered more than 130 classes GPR instructional classes last year. In addition, several industry associations now offer industry-specific training. Examples include the Concrete Sawing and Drilling Association (CSDA), which has held classes at the World of Concrete conference and offers GPR certification for technicians with more than 2 years field experience; as well as the National Utility Locating Contractors Association (NULCA), which provides utility locating accreditation.

PETER MASTERS is a Senior Application Specialist at GSSI.



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CONTRACTORS, INSURERS EXPECT IOT TECH TO IMPROVE CONSTRUCTION RISK MANAGEMENT

STUDY BY DODGE DATA & ANALYTICS AND TRIAX TECHNOLOGIES SHOWS
TOP DRIVERS FOR IOT ADOPTION ARE REDUCED COSTS, GREATER EMPLOYEE
PRODUCTIVITY, IMPROVED SAFETY RECORDS

A NEW STUDY released by **Dodge Data & Analytics**, in partnership with **Triax Technologies**, a leading provider of technology for the connected jobsite, finds that while contractors continue to struggle with construction site risks, they recognize the benefits of using IoT to mitigate them. According to the report, **Using Technology to Improve Risk Management in Construction SmartMarket Insight**, nearly three-quarters of respondents believe IoT will help them control occupational risks, and about half expect it to reduce risks to the public, as well as financial risks and those related to property damage and construction defects.

The study found that the top motivator for adopting IoT technology is the possibility of lowering insurance premiums (67 percent), followed by recovering lost time due to incidents and winning more work because of a strong safety record.

“These findings are encouraging and confirm what we’ve suspected: that contractors and insurers alike see the value in leveraging IoT technologies to help collect, analyze and act on risk management data,” said Pete Schermerhorn, President and CEO, Triax Technologies.

“Contractors are often a skeptical audience, keeping a close eye on the bottom line,” says Steve Jones, Senior Director of Industry Insights

Research at Dodge Data & Analytics. “But when they see something that will improve their projects and their profitability, they embrace it. Their enthusiasm for IoT technologies suggests that we may see the project jobsite become much smarter in the next few years.”

Respondents report that they are actively collecting key data, and more importantly, using the insights to further their safety and risk practices. More than half of the participants report that they digitally gather (54 percent) or analyze data (59 percent), while 77 percent report that they act upon key safety and risk insights.

However, the study revealed budgetary challenges to tech adoption. Only 10 percent of contractors report a dedicated innovation budget and when it comes to funding new risk-reducing technologies, most contractors either plan to absorb the costs in anticipation of long-term gains (44 percent) or pass on the costs (32 percent).

“These findings highlight an important opportunity to shift the industry towards reliance on objective, empirical data,” said Schermerhorn. “The ability to measure risk is fundamental to managing it, especially in the fast-moving construction environment. It’s essential that contractors dedicate budget and resources to unlock actionable safety and risk insights that can drive improvement in these areas.”

As part of the study, in-depth interviews were conducted with insurers, who agreed that real-time site monitoring can have a high level of potential for reducing risk onsite but that reductions to contractors’ premiums based on technology adoption are unlikely until there is enough actuarial data on the impact of those technologies. However, instituting a cost-sharing program with clients for specific technologies was raised as a possibility, as well as potential savings that contractors could realize from reduced deductible costs and fewer claims.

Download the full SmartMarket Insight for free at www.triaxtec.com/riskreport.

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Selecting the right material for channel and bank stabilization is critical, but the selection process is often complicated by limited performance criteria, abundance of new materials, and limited installation information. Stabilization methods incorporating native vegetation are increasing in popularity because they are engineered to provide stability and enhance overall project designs. Traditionally, performance criteria for channel stabilization materials have focused on hydraulic parameters such as shear stress and flow velocity, but field performance is also dependent on non-hydraulic factors. Material selection, design, construction, and installation procedures are all critical to performance and project success. The objective of this webinar is to illustrate appropriate **Turf Reinforcement Mat (TRM)** applications, summarize necessary hydraulic and non-hydraulic performance determination methods, present paramount installation considerations and provide design examples.



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