AECOM

DRIVING INNOVATION PRODUCTIVITY AND EFFICIENCY

CULTIVATING INNOVATION IN RISK-AVERSE INDUSTRIES

Given the budgets and timescales involved in the delivery of big infrastructure projects, it's not surprising the industry has traditionally prioritized operational excellence over innovation. There's a growing realization, however, that innovation is needed to stay competitive, say AECOM's **Orla Pease** and **Colette Munro**.

Urban infrastructure is coming under pressure like never before. The United Nations [1] estimates two-thirds of the world's population will live in urban areas by 2050. Even if this projection is affected by coronavirus still we are likely to see increasing demand for water, sanitation and transport services — not to mention places to live and work. At the same time, climate change is making demand volatile at a time when margins are being squeezed. Business as usual is no longer an option.

Transforming risk-averse industries such as water, transport and commercial real-estate is no easy task however. Moving from a culture that minimizes risk to one that rewards risk-taking is a big ask. In an industry where even small errors can be very costly, it's natural to be cautious about deviating from old ways of doing things, particularly for those who'll be held responsible if things go wrong.

In the following section, we take an in-depth look at three AECOM innovations developed to help our clients do business better and highlight some of the lessons we learned along the way.

> "TRANSFORMING RISK-AVERSE INDUSTRIES SUCH AS WATER, TRANSPORT AND COMMERCIAL REAL-ESTATE IS NO EASY TASK

WATER

To date, the industry's track record on innovation has been mixed. It has invested large sums in research and development, but has sometimes failed to turn that knowledge into value.

The multitude of challenges facing the industry means that is changing. Here we look at an example of innovation driven by environmental need.

Algae removal technology

In summer, slicks of mossy green sludge coat the surface of many of our lakes, rivers and seas. Lapping up the sun's energy, these algae blooms can multiply rapidly, feeding on nitrogen and phosphorus in the water. When they die, they can release toxins, posing a threat to public health. As well as raising treatment costs for drinking water, such harmful algae blooms (HABS) can have severe impacts on the health of humans, animals, aquatic ecosystems and local economies. In the United States alone, HABS cost $1 billion a year in damages. HABS are becoming more frequent, severe and lasting longer due to a combination of growing populations and climate change, which is seeing floods and hurricanes sweep agricultural nutrients from fertilizers and runoff into lakes and rivers.

Results from the algae harvesting technology platform

95%
Phosphorous removed

82%
Nitrogen removed

97%
Microcystin toxin removed

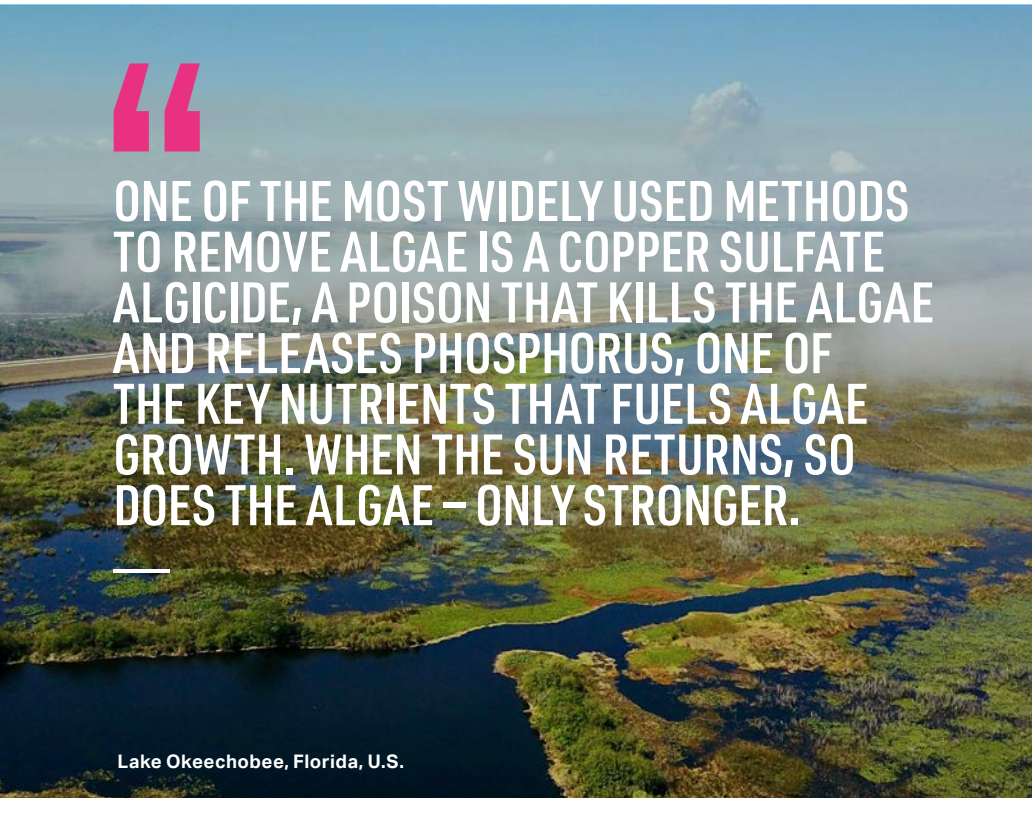
In July 2016, Florida Gov. Rick Scott declared a state of emergency when nutrient-rich water from Lake Okeechobee was discharged seaward to both coastlines, resulting in HABS formation and the closure of the beaches. AECOM's Dan Levy, a geologist and long-time Floridian, realized this crisis was a new type of situation. Despite decades of research, a long-term solution was lacking. The issue, as with most HABS, was that no single entity was responsible, making it difficult to pinpoint how clean-up efforts would be funded.

Levy's first step was to appraise current technologies, finding them limited and involving unwanted environmental side-effects. One of the most widely used is a copper sulfate algicide, a poison that kills the algae and releases phosphorus, one of the key nutrients that fuels algae growth. When the sun returns, so does the algae — only stronger. Levy set about looking for ways to physically remove the key nutrients that fuel algae growth from the water without harming the environment. He established a team of environmental experts who began exploring ways to use dissolved air flotation. Pilot tests conducted in Florida showed it was effective and could be scaled.

Two years later, the beaches were again closed for 2½ months at the height of the holiday season. Realizing the devastating effect on the Florida economy, Governor Scott declared a state of emergency which allowed the two hardest hit areas, Lee and Martin Counties, to use AECOM's algae harvesting technology.

At the same time, America's Water Infrastructure Act was prompting the US Congress to free up funds to support HABS research and mitigation strategies. The US Army Engineering Research and Development Center (ERDC) enlisted support from AECOM for its HABITATS research. Key elements of HABITATS were pilot tested on Lake Okeechobee last summer and proved effective. Additional field testing to transform the recovered algae into biofuel is planned this year in Florida and New York.

In the past three years, AECOM scientists have shown that the algae harvesting technology platform has been effective in removing over 95 percent of phosphorus, 82 percent of nitrogen, and 97 percent of the microcystin toxin. The process provides an algae biomass feedstock that can be transformed into biofuel and commercial biofoam products to support a green economy. To prevent future outbreaks of harmful algae blooms, the system can be used to reduce the nutrient loading into our nation's waterways.



Lake Okeechobee, Florida, U.S.

TRANSPORTATION

> FOR ENGINEERS DEALING WITH THE COMPLEXITY OF SUCH PROJECTS, NEW TECHNOLOGIES ARE EMERGING THAT VASTLY REDUCE THE TIME NEEDED TO UPDATE ALL PARTS OF THE DESIGN WHEN CHANGES ARE MADE.

Large-scale transport infrastructure projects are by nature complex and uncertain. The risks of failure are high financially, environmentally, technically, managerially, politically and legally. It's no wonder that the promoters and financiers of such projects tend to be wary of innovation.

At the same time, to be sustainable, these transport projects need to understand the needs of their future evolution. This requires visionary leadership, persuasive arguments, innovative thinking and the ability to launch and learn.

Re-imagining tunnels

Constructing a tunnel is one of the most complex tasks in civil engineering. Not only does the tunnel need to be excavated, but the attributes of the rock or soil encasing the tunnel needs to be considered, as well as how each part of the structure will be impacted by the weight of the people and vehicles moving through it. In short, it's a complex process that is difficult to picture.

Digital technologies are changing all of that. 3D modeling and virtual reality technologies make the tunnel easier to visualize, particularly for those who aren't trained to do so, such as project sponsors or the general public. For engineers dealing with the complexity of such projects, new technologies are emerging that vastly reduce the time needed to update all parts of the design when changes are made.

In Auckland, New Zealand, AECOM was appointed as part of the Link Alliance Consortium [2] to deliver an ambitious project to double the city's rail capacity via a new two-way through-station. The City Rail Link (CRL) project is a 3.45 kilometer twin-tunnel underground rail link up to 42 meters below the city center and is due to open in 2024.

As part of its solution, AECOM adopted parametric modeling, or the use of algorithms to automatically generate digital models. Over 200 designers and engineers working in different locations and across eight teams are involved in the project. Coordinating them — and ensuring everyone is working on the latest design — was a huge logistical challenge.

AECOM's digital engineering teams knew the team needed to be able to live-share, interrogate and review the current design simultaneously. To do this, they set about creating a common data environment encompassing 50 different models that could be accessed via a single online location, without the need for additional software or hardware.

Through a combination of traditional BIM modelling processes and parametric design, they enabled the model to be automatically updated by internal logic arguments rather than being manually manipulated by engineers or modelers. This combination has reduced the modelling time for the design of the CRL tunnels from weeks to hours.

It was the first-time parametric design has ever been used in tunnel construction. The team is now applying these techniques to other parts of the CRL project.

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CONSTRUCTION

Although the construction industry was seen as a late adopter of digital technologies, it is embracing cloud-based tools at speed. This is because the potential of 5D Building Information Modelling (BIM), digital collaboration and mobility, the Internet of Things and advanced data analytics have huge potential in streamlining processes, saving time and money. [3]

Better coordination

Renowned for delivering some of the world's most iconic buildings — from One World Trade Center, the tallest tower in the Western Hemisphere, to CityCenter, the largest privately funded development in U.S. history in the heart of the Las Vegas Strip — AECOM Tishman has built more than 1.5 billion square feet over the past century. They've been able to leverage their experience to innovate over the years.

As the capabilities of 3D modeling software advanced, the AECOM Tishman team began looking at how this technology could be used to reduce frequent bottlenecks in planning the mechanical, electrical and plumbing (MEP) infrastructure of tall buildings. MEP infrastructure is like the central nervous system of a building. To be efficient, all systems must run in synergy — requiring a lot of coordination during construction.

Historically, one of the most critical phases occurs after trade contracts are awarded. This is called the shop drawing development phase, typically led by our construction management team in conjunction with the design team and the detailers, drafting people from each of the relevant trade contractors. Together, this team works collaboratively to resolve conflicts and develop a set of fully coordinated shop drawings that serve as a roadmap for efficient construction. The process is time consuming, requiring coordination and approvals from a variety of stakeholders. In short, it frequently becomes a bottleneck.

AECOM Tishman realized this process could be dramatically improved if the coordination occurred before the trade contracts were awarded, so that the cost and schedule benefits of this coordination effort could be incorporated into the bid documents and then realized during the procurement process. Using 3D modeling software and other software platforms that enhance collaboration and enable faster sign-offs, we created a proprietary process called OneDesign that has been proven to save our clients time and money.

Used on several recent tower projects in Manhattan, we've seen OneDesign reduce the range of multi-million dollar trade contractor bids by more than 50 percent, which provides increased price certainty and helps clients lock in more favorable financing terms sooner. The OneDesign process also leads to construction documents that are clearly coordinated and buildable, which presages a lack of field clashes during construction.

As with many great inventions, the solution looks simple in hindsight. The complexity lies in its execution, which is only possible thanks to BIM technology. A number of sub-processes must work concurrently to preserve critical design-bid-build roles, responsibilities and liabilities. OneDesign requires the skillful use of technology and the administration of a carefully organized coordination process that cannot be easily duplicated.

Jeff Atherton, Dan Levy, Chrysostomos Loizou, David Philp, Ian Small, and Ashley Weyell contributed to this article.

INVESTING IN PEOPLE

To prevent caution from stifling innovation, AECOM's experience is that ideas, and the people who put them forward, need to be protected until they are robust enough to stand on their own.

As innovators, we're always thinking about how to improve what we're doing. To encourage like-minded colleagues, we launched Mindblazer, a tool designed to encourage ideas that support technical excellence, innovation and collaboration on AECOM projects. Every three months we put out a call for ideas — with a two-week window for submission for anyone within AECOM. We focus on projects that address a burning need and/or have a transformative effect, versus routine proposals.

Our employees are our biggest asset and our mission is to provide them with a supportive environment that allows and encourages innovative ideas. We believe the process of thinking creatively has wider benefits, but not all ideas advance to implementation. As these three examples show, innovation is most effective when carried by the momentum of a burning need. WL