# 2022 TECHNOLOGY REPORT







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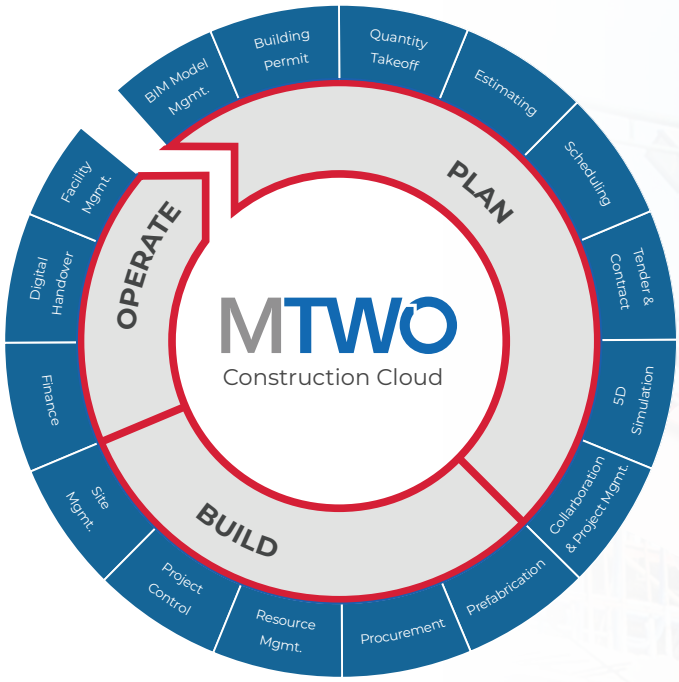


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# WELCOME LETTER

On behalf of SoftwareONE, we are pleased to be sponsoring *On-Site* magazine's 2022 Construction Technology Report. Technology is such an integral part of the building process and has transformed the way projects are completed. It has also played a pivotal role in keeping teams connected and businesses up and running during the challenges of the past few years.

While the industry has historically been slower to adopt new technologies, we've seen an uptick in recent years. Mobility and real-time project insights are no longer "nice-to-haves." They are business critical in order to survive and thrive in this competitive landscape.

Even though technology usage is up in the AEC space, productivity remains largely stagnant. This can, in part, be attributed to the prevalent use of unintegrated point solutions. Utilizing disparate systems can lead to a number of problems, including redundant and error-prone doubling and tripling (and sometimes more) of data entry, and data silos.

Although construction businesses generate a ton of data, this information is severely underutilized. In fact, 95 per cent of data in the AEC industry goes unused. Luckily, we are making strides to remedy this. Connected systems such as an integrated cloud platform can help ensure businesses are maximizing the power of their data. Cloud platforms are equipped with comprehensive functionality and customizable workflows while connecting the entire construction lifecycle. Plus, with an open API, businesses can integrate different functions and data from existing standalone systems.

The industry is beginning to catch on to these advantages. A recent Deloitte study found that 76 per cent of engineering and construction decision-makers are putting more money into connected technologies because of the connected data that comes with them. Connected platforms will continue to have a big impact on the industry as businesses turn to technologies that deliver streamlined workflows and significant productivity gains.

Contractors work hard to stay on top of their businesses and meet the growing demands of the industry. But it's not always easy. With bigger and more complex projects, unstable supply chains, and low profit margins, there's little room for error.

Amidst these challenges, we strive to make things simpler. At SoftwareONE, we empower AEC firms and owners to digitally transform their businesses while winning purposeful work, improving project predictability, balancing risk, and reducing their environmental impact. We provide solutions and services on a truly global scale with a local touch. Our people are where it matters most – by our customers' sides.

As the needs of the industry change and grow, so do we. We never stand still when searching for the best solutions and services to help our customers build faster, smarter, and better.

We are proud to serve this dynamic industry as a trusted technology partner and are excited to see what the future holds. The sky's the limit to what we can build together!

All my best,

**Dustin Anderson**
President/Global Head of Business, AEC Vertical at SoftwareONE

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# VDC MOVEMENT GROWING

## Contractors making greater use of digital models as capabilities continue to evolve.

BY ADAM FREILL

In late August, *On-Site* magazine hosted a panel of Virtual Design and Construction (VDC) experts to explore how 3-D models are currently being used in the building world, as well as how they are evolving in their capabilities and application.

In addition to providing advice about entering into this digital project workflow environment, panellists, Aaron Akehurst of PCL, Stephen Bianchi of Hatch, Hammad Chaudhry of EllisDon, and Steve Rollo of Graham Construction, shared insights into how their companies have been integrating such technologies as Building Information Modelling (BIM) and 3-D digital modelling into their projects.

They also discussed the evolution of these digital technologies and how the next generations of the platforms are looking to integrate jobsite and third-party data, which will open the door to more robust modelling in the years to come.

"All of our major projects are leveraging some form of VDC workflows," stated Akehurst, explaining that the use of VDC and BIM may not be as prevalent on smaller projects, generally due to the time necessary to set each project up, but acknowledging that even smaller or specialty projects are becoming targets to take in the benefits offered with 3-D visualization and planning tools.

"The biggest thing that defines whether it makes sense to implement these VDC processes or BIM processes is the scope and the complexity of said scope," added Rollo. "Five to 10 years ago, we might have looked to assign a dollar-value of a project to define if we're going to implement BIM or VDC processes on it. And while typically, the larger the dollar value, the more complex the project is, and the more benefit you would gain from these processes, that's not always true."

Using a basic but large warehouse and a smaller but more complicated renovation as examples, he illustrated how the smaller project and its scheduling and building system integration concerns would glean greater VDC benefit than the relatively basic design of the warehouse project that could be four-times the cost to build.

"I do believe VDC is a must for all

PHOTO: © BLACK_MTS / ADOBE STOCK

major projects, as well as most minor projects, but it does depend on the scope and the scale of the job," agreed Bianchi.

He explained that it wasn't long ago that most of his company's projects would be designed in 2-D, with VDC elements being designed from that step, if they were needed. "For some time now, we've been shifting away from the old traditions, and we're pushing to generate our designs in 3-D."

Going that route from the get-go offers such benefits as clash detection and the early identification of issues for more efficient resolution, but there are other benefits as well, he stated. "It also generates a very collaborative environment for the team."

And companies are growing their digital teams to harness the benefit of having more experts and stakeholders weighing in at the planning stages. Not long ago, a BIM department may have consisted of a single digital expert who could provide insights when a BIM or 3-D question came up. Those departments are growing, and digital tools are making companies adjust focus. For example, Akehurst explained that his company is moving to take the idea of VDC and BIM to "move it to the centre of the project so that our entire project teams have access to the 3-D model."

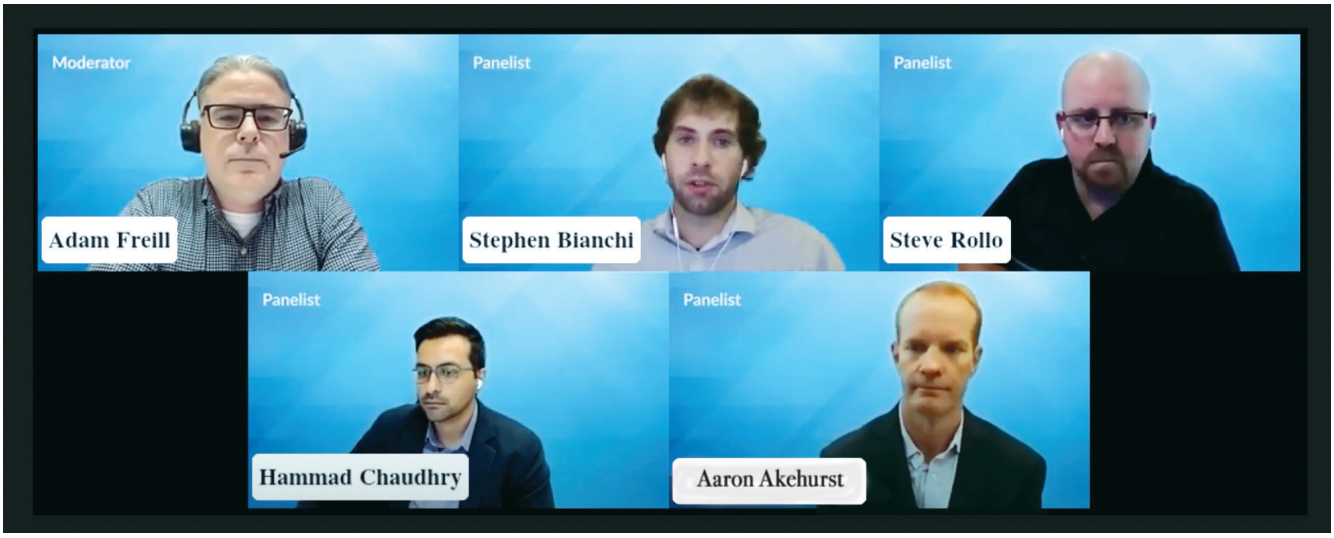
With that focus, digital departments are expanding to play a role in more projects, and staff from outside digital departments are also expanding their skillsets to provide input into the planning and execution ecosystems.

"I think a little bit of the shift is coming as upskilling of traditional project coordinators to be able to use those tools without having dedicated VDC folks," explained Chaudhry.

"It allows a lot of the different disciplines to come together in a coordination model," added Bianchi.

Looking at external members of digital teams, the panel agreed that collaboration was a key to success when working with these technologies, adding that collaboration works best when it includes property owners as well as subtrades.

"The projects where we are having the best data structure and just general




setup are the projects where the owner is requesting something as a deliverable," said Akehurst. "But the more stakeholders that we engage in that process, the more we get out of it, and the more the project benefits as a whole."

"We see almost tenfold greater success when the sub-trades are brought into it as well," stated Rollo. "They're the ones that are constructing on site… the more input we get from those people actually executing the construction, the better, in my opinion."

Having a strong team is not the only key to success, however. Much like how a tower's strength is dependent upon the quality of its base, when it comes to VDC, BIM and the use of digital twin technologies, the quality and format of the data can be critical.

"We still have to understand that there is a disconnect in the industry from a garbage-in garbage-out perspective, as far as what data we receive inside the model to effectively extract that data," warned Rollo. "If those parameters aren't specified at the right time, or if we, as the GCs, are not at the table at the right time to articulate what we would want to extract, that makes it very difficult to effectively and efficiently do those takeoffs properly."

"Making sure of that similar work breakdown structure in your schedule and your model is critical," explained Akehurst. "If you're starting from two different places, you're just going to be square peg-round hole for the entire project. You have to know where you want to go when you start your schedule and your model so that you can combine those two pieces together efficiently."

Bianchi said that a major focus for him at Hatch has been "to try to ensure that these models are set up with trustworthy quantities, the right attributes, the classifications, so that it could feed into these types of systems and provide a little bit more automation and trust."

His company has also been putting a lot of focus on data-rich models. "These models will contain many attributes built into the model, so it'll be a lot more than just a 3-D shape," he said.

Chaudhry also illustrated some of the benefits that modelling tools can offer when they extend beyond simply visualizing a project to bring more business-side attributes into the integrated plans – a theme that was extended on by the rest of the panel. "We have had clients and projects at EllisDon where we've done that cashflow analysis with the model and tracking. But again, that's not commonplace," he said

When a time component is included in the digital model, some in the industry have suggested the use of the term 4-D, with the term 5-D being used to reference a cost management feature of an evolved digital modelling application, although much debate remains about the naming conventions used. Despite some disagreement on terminology, the theories at play do point to the growth potential that exists for VDC systems that rely on jobsite feedback from various inputs, including digital Internet of Things (IoT) sensors.

"The thing that we're shifting towards a lot now is this overall idea of digital construction as opposed to just BIM or VDC," said Rollo. "Because it encompasses so much more than things like drone capture and amazing scanning."

"The naming convention, I don't agree with, but the idea behind it, I think there are bits and pieces that are getting into the industry; maybe not at a Hollywood-level style, but definitely in terms of, 'Hey, how do we get that in that process?'" said Chaudhry.

While it may be a little early to be relying on digital models to automatically track projects and forecast any costing or timing changes, the needle is moving, and many companies are starting to incorporate more advanced capabilities housed within some VDC software offerings, or at least exploring the ability to use such capabilities.

"The anticipation or the drive is there within the industry to want to leverage it for specific model-based quantity, takeoffs and everything like that," said Rollo, although he warned that the ability to make effective use of the information is reliant on the quality of the data being measured

and collected. "The drive is there for it, but I think it's still in its infancy as far as finding out the best way to most efficiently execute," he said.

The path to making effective use of data from a jobsite, said Akehurst, is going to be reliant on data structure and data standards. "I think that that's the foundation that we need to be able to build out. Whether it's connecting IoT sensors or tracking progress, or all of those kinds of things, we need that well-built data foundation to be able to connect."

"Ultimately this goes right back to the beginning of when you have a project. 'I have a plot of land. I want to come up with different design scenarios, and different methods of schedule execution…' but with technology as the focal point," said Chaudhry. "The evolution of VDC is not about how do we do 3-D coordination; it's more about the sophisticated technologies that are trying to look at automated data capture to inform decision making."

While this may look daunting for companies that have yet to dive into the VDC ocean, the panel offered some guidance to help contracting firms get started.

"My first piece of advice is start," advised Akehurst. "The second piece would be… leveraging champions. One thing we've done at PCL, around when I started in this role, was we identified that we needed these technology champions in each of our districts. So, we created this role for that."

"I think, the onus is on the GCs now to start to educate our clients about the different complementary construction technology around VDC and the evolution of how these artificial intelligence-based systems can start to come back and inform decisions," said Chaudhry.

And while not all contractors have the ability to take on a full-time VDC or BIM expert of champion, Akehurst explained that finding someone within the company who could take on the task of exploring how to best leverage technology and BIM in a way that aligns with the contractor's structure can only help as more and more projects go digital.

He also advised to not get hung up on the odd misstep along the learning curve. "Every single time we start a new project, we're adding to what we already what we did on the previous project," he stated. "We accept that it may not work on the first go-round. We're going to learn on the next project or the next segment of work within that project."

"If you're not already engaged in leveraging these technologies and processes… I think one of the biggest things that I'd say coming from not only the GC end but from a previous life working for an implementation firm is, don't anticipate doing everything at once," said Rollo. "Take it in small chunks… Define your strategy and take it in steps. Understand that it's going to be a journey, and it's going to take some time to gain efficiencies on it." ☐

By Jacob Stoller

# Operating at a distance

Remotely operated equipment is expected to ease the worker shortage while improving safety, job quality, and efficiency on construction sites. It will also be an important step towards autonomous operation.

First page web search results for remote-control construction equipment are mostly about toys. As we've seen with radio-controlled airplanes, racing cars, boats, and drones, operating a scaled-down dozer or excavator has immediate appeal for hobbyists, and sales appear to be brisk.

On real-life construction sites, however, remote control operation, also known as supervised autonomy, isn't as easy as these simulations suggest. While there have been several recent examples of far-away loaders and excavators controlled from trade show booths, there are hurdles that make wide adoption several years away.

"Many of the prerequisites for this are already in place — the technology maturity and so on," says Christian Spjutare, advanced engineering program manager at Volvo Construction Equipment AB. "The main challenge related to adoption is scaling the technology to be competitive not only in special use cases, but in more general mainstream applications."

Many hope the technology will help ease the perennial shortage of skilled workers and support the existing workforce by eliminating hazards, reducing physical stress and strain for operators, and making heavy equipment operation more appealing for younger workers.

"The three main reasons why companies are exploring supervised autonomy in construction are safety — keeping workers out of harm's way, operator recruitment and retention, and the operational improvements that lead to predictable results, reduced wear and tear, and volume gains," says Kris Troppman, manager of smart construction at Edmonton-based equipment solution provider SMS Equipment.

Much of the technology is seeing wide use in mining, where work sites are static in comparison with construction, making them easier to automate. In construction, use cases for remote control on large machines like excavators, dozers and trucks tend to be industrial-type operations where the equipment remains static over an extended period. These include remote timber handling sites, concrete batch plants, aggregate production, or deconstruction of old mine sites.

A key barrier to broader deployment in construction is the cost and effort of setting up jobsite control networks.

"There's a mesh network that's required to be set up in order to utilize this technology, and that's not easy to do,"

PHOTO: COURTESY OF CATERPILLAR

says Troppman. "When a contractor has a dynamic workflow where the equipment moves on every few days, that contractor is not likely to use supervised autonomy right now."

## VARIETY IN "REMOTE" TECHNOLOGY

Remote technology for heavy equipment can be deployed at several levels, each progressively more difficult to implement. A machine might be controlled from a handheld device a few feet away, from a control shack on the site, or from a control room many kilometres away.

"We distinguish between two types of remote control," says Spjutare. "One is the traditional remote control, where you can see the machine and control it from a handheld device. We have solutions in that area, but what we're working on mainly right now is tele-operations, where the operator is at a distant location."

The advantages of tele-operations include all the safety benefits of on-site remote control, plus better utilization of both equipment and operators. By dividing the work between operators in different time zones, it's easier to keep an operation going for extended hours. As well, contractors can avoid the perennial problem of having to move operators to where the work is and can deploy their best operators in situations where they are needed the most.

"Operating at a distance avoids the cost of transporting people," says Alan Pumklin, a market professional at Caterpillar, "and it also makes it easier to attract and retain the best talent, because they're not having to leave their families."

## BEYOND REMOTE CONTROL

Another important aspect of remote control is that it is seen as a step, both by vendors and adopters, towards completely autonomous operation where no operator is required. A strong precedent already exists in mining.

"There's a lot of autonomy in mining, particularly in ultra class haul trucks at various deployments around the world," says Troppman. "The oil sands in Fort McMurray have a large number, and we're starting to see that technology in construction. That pathway will be built upon supervised autonomy where there will be an operator."

PHOTO: COURTESY OF HUSQVARNA

"I think the real power of this technology comes into play when we start seeing this as an enabler for autonomous operation," says Spjutare. "A system can do the bulk of the repetitive work autonomously, but you can get support from an operator when you need to move into some sort of complex motion. And then, over time, as the autonomous system gets more advanced, you can phase out the tele-operation and have a completely autonomous system."

## SMALLER MACHINES

Remote control is not just about heavy equipment. Husqvarna Construction has introduced remote control in machines such as trench rollers, wall saws, floor grinders, and demolition robots. "Remote control is becoming more prevalent in a lot of our machines," says Mark Michaels, senior director of product market management at Husqvarna. "Some of our tools have gone to 100 per cent remote control, and we expect many of them to become completely autonomous."

As with larger machines, the most popular advantage is protecting workers from unexpected hazards, repetitive stress, vibration, noise, and dust. "The most applicable situations are situations where it's desirable to get the operator further from the machine," says Michaels.

## CHANGING THE NATURE OF THE WORK

As the industry has seen with recent innovations such as GPS and mobile apps, the key to adoption will be absorbing changes to existing work processes.

"The most difficult challenge of this technology isn't necessarily the technology itself; it's the change management, where we take the technology and incorporate that into specific work processes," says Pumklin.

One of the keys is helping workers develop confidence that the technology won't make them less productive.

"We've found that the most experienced operators are the ones you need to convince first," says Michaels. "They might be more resistant to the technology because they are so used to feeling their work. They can feel their productivity through the noise that the machine or the tool makes, or through the amount of vibration. It might even be sense of smell, for example, when they hit a reinforcement bar, or they're not using enough water. So, they're afraid that if they lose all that, they won't be as productive. Especially when they're on a learning curve and a little awkward with the controls."


PHOTO: COURTESY OF BROKK

The adjustment, however, is generally successful. Workers find that feedback signals, such as sound, are different, but they get used to them. Additionally, being a few feet away from the equipment can provide a "big picture" view of the work.

"Our experience is that once operators get used to remote, they say they would not go back to manual operation," says Michaels.

When operating large machines at a distance, the adjustment factors are different, but the transition is similar.

"We get a lot of feedback from operators, and the first thing they say they miss is the sound of the machine," says Spjutare. "But when they've tried this for a number of days, generally sound is not a problem. What's more important is sensing distance; how far they are from an object."

"These operators go from a 3-D to a 2-D world, and that's challenging," says Pumklin. "There is a transition period. But overwhelmingly, operators around the world that have been using this have been successful."

Another aspect operators miss is the feeling of motion. Volvo and other vendors use remote operator seats that provide motion feedback, much like the flight simulators used to train commercial pilots but, says Spjutare, operators often say they no longer need that after an adjustment period.

PHOTO: COURTESY OF CATERPILLAR

## BETTER TECHNOLOGY

As in other areas of automation, rapid technology improvements are narrowing the gap between remote control and manual operation, improving operator comfort with the technology and expanding the range of tasks where the technology can be applied.

"When you're operating a machine remotely, you lose a lot of sensory input," says Spjutare, "so we need to work on introducing different diagnostics or systems where we can compensate for that."

The consumerization of remote control, as we've seen with drones, is driving rapid improvements in the user experience.

"With gaming devices, we've seen that handheld controllers are getting a lot more sophisticated, and the same is happening in construction," says Michaels. "As remote-control systems get more sophisticated, you can add more features to them. So, the ergonomics of the controllers are better, and the screens are more intuitive and user-friendly."

Improving wireless communications to reduce latency and improve resolution is another top priority.

"At Caterpillar, we've done a lot of research and development on optimizing bandwidth," says Pumklin, "so that we can pack video and sound machine control information into a single stream back to the operator who might be on site, or in a different country."

The technology is expected to evolve rapidly over the next few years thanks to parallel developments in manufacturing, mining, and agriculture.

"It's a growing segment for us, and it's getting more and more popular," says Michaels, "and we believe that as it gets more exposure, it's going to create an even bigger demand." ☐

**Jacob Stoller is principal of Stoller-Strategies. Send comments to editor@on-sitemag.com.**

# Bits & Mortar

## Marrying AI and construction knowledge.

BY RORY SMITH AND HAMMAD CHAUDHRY

The technology sector, or as we often refer to it, "Silicon Valley," loves to disrupt industries, and specifically legacy industries, so the construction sector has been a prime target, but we've yet to see the kinds of change that removed VCRs from our homes and companies like Blockbuster from our shopping malls.

So, what's the hold-up? Disruption is kind of like a puzzle; solving it requires understanding all the pieces. In the case of construction, that means understanding the development, design and enough of the construction process to better plan and mitigate risks. If technology wants to disrupt our industry, it will need a complete picture, and an understanding of how all the pieces fit together.

Organizations throughout the industry are diving into data collection. Be it in the design, construction, or operational phases of a project, the fragmentation of our industry is making it difficult to both collect data and see how it fits together. There are multiple reasons for this, including the confusion and risk surrounding what information you can and cannot share, whether it is confidential or proprietary, etc. In addition, developers, designers, and construction firms are not eager for their competitors to benefit from their data, so they often hold it close to their chests.

Unfortunately, this siloed approach in the industry has not yielded great results for technological innovation. We have seen attempts to implement foundational changes, such as the introduction of different contract types (public-private partnerships, design-builds, integrated project deliveries, alliance, etc.) coupled with advancements in technology like BIM and reality capture (laser scanning, drones) to mobile devices (iPads, phones, apps) but we have not yet been able to see the entire industry unlock its full disruptive potential. Still, we are betting that that will change soon, thanks in part to the advancements in computer vision as well as artificial intelligence and its subset of machine learning.

Developers and government bodies are trending toward a data-forward approach, accelerating the progress towards better leveraging data for future use, however it is not as simple as having Silicon Valley enter with a new platform or solution, or even throwing venture capital money at a new approach to industrializing construction projects. The key here will be to have skin in the game; having the knowledge of design and construction so that it can be paired with technology to offer efficient solutions effectively.

So, it is not a technology problem we are facing in the industry; it is a paradigm shift towards embedding these new technologies into how we do business.

Construction sites have seen an influx of sensors — data collectors — all through the supply chain. These are installed in drones, cranes, trucks, software and handheld devices. Through the use of these sensors, projects have become data foundries. Our jobsites make mountains of data every day, but they can quickly become data sieves. Machine learning programs

PHOTO: © SOMKID / ADOBE STOCK

are the only thing capable of crunching the numbers, but even artificial intelligence has to know what to look for. Feed an AI system 10,000 dots and it will find the shortest line between them in seconds, but construction has never been that simple.

Artificial intelligence and machine learning are missing context. Different sites have different circumstances, different clients and different contractors, and no two are the same. The reality is that different builders build differently. If artificial intelligence is going to make sense of all that, even with the advances in machine learning, it will need some help.

It might be helpful to look at machine learning as it's been deployed to optimize climate controls in facility management. Smart buildings can control all of their parts, so it is possible to harness machine learning to monitor and adjust the climate as needed throughout the day.

Machine learning and artificial intelligence can learn the particulars of our hypothetical building and its climate, and the optimized climate controls will reduce waste as well as save on operational costs, so it sounds like tech has saved the day. The problem is that the building's life-cycle maintenance cost schedule is now shot since most mechanical rooms are not built to be switched off and on 10 times a day. That's the power of machine learning minus the operational context.

As another example, let's examine the use of AI to help monitor the progress of a construction project.

We have a lot of technology available to use. We can create sophisticated 3-D models that serve as the base of our design. We can fly drones that capture hundreds of photos to create a digital replica of the project. And an AI system can compare the data gathered to our project schedule. All of this can provide an objective breakdown of current progress compared to the planned schedule, and it can be broken down even further into scopes of work.

It sounds like another area where technology should be revolutionizing the industry, right? The only caveat is that the current industry and paradigm do not support a data-first approach to projects. Therefore, the vast majority of projects would not be able to use a robust 3-D model as a base.

Disruption will inevitably come to the construction industry; there is simply too much opportunity to ignore the sector. But, from all that we have seen, it will take a marriage of the latest technology with legacy expertise. In the quest to find the best path forward, Silicon Valley will need us as much as we need them. ☐

**Rory Smith and Hammad Chaudhry are both with EllisDon where Rory is the manager of DDE marketing and Hammad is national director of digital project delivery services.**

# Layers of potential

## Advancements in remote technology are increasing safety while creating new opportunities for diversity.

BY MATT WILLIAMS

If you're running a construction site today, safety, productivity and sustainability are probably three key priorities where technology is helping you stay ahead of the game, but new and emerging technologies, including remote-operation stations, hold much promise on the human resource front as well. These digital systems can help support diversity and inclusion initiatives in the construction industry which, in turn, can help offset labour shortages.

As remote technology advances for machinery operation, an emerging concept is the ability to move operators fully off-site. Remote-operator stations completely replicate the cab environment and provide multiple video feeds for a steady stream of data, as if the operator were operating the equipment right on-site Onboard electronic and visual systems even allow several machines to be controlled remotely at once.

Still new to the construction sector, remote operation has proven itself in heavy equipment applications like mining, so the technology is now gaining ground for the construction industry as well.

The safety benefits from these stations are significant as operators are completely removed from hazardous areas. Productivity gains are also substantial as operators can control more than one piece of equipment at a time.

While safety and productivity are important benefits, the industry also has the opportunity to harness the technology to help with the additional priorities of diversity and inclusion.

Worker retirements, skills gaps and overall labour shortages are big challenges ahead for the construction sector. BuildForce says Canada's construction industry needs 309,000 new workers by 2030.

Tapping into a wider talent pool of skilled workers will be an important component of remaining competitive, safe and productive, and this technology holds potential to attract workers who may have not have considered a job on an active construction site.

For people with disabilities, remote operation opens new opportunities. Operator stations remove the barriers found on a traditional jobsite, including having to maneuver through muddy, rocky or uneven terrain to sit in a machine. Climate-controlled, safe and comfortable, the consoles increase longevity for all operators, reducing issues associated with machine vibration, dust and noise.

Remote operation also has the potential to support Indigenous communities with the technology holding potential to provide new employment opportunities as remote operating stations can be installed within communities to help remove barriers like the need to travel far or move away for work opportunities.

Although these modern devices may sound like the perfect solution to the construction industry's problems, no technology can solve all problems immediately.

Making the shift to remote applications is a complex undertaking, particularly in isolated locations. The infrastructure needed for connectivity has been a barrier to wider adoption. And we've learned from early implementers that the biggest challenge isn't the technology itself but the impact it has on people and process. A significant amount of time needs to be spent on change management.

Successfully implementation of remote technology holds significant potential to help the construction industry, however. ☐

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Matt Williams is the technology platform specialist for CAT Command at Finning Canada.

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