CONNECTED CONSTRUCTION: REDEFINING THE BUILT WORLD THROUGH COLLABORATION
Why Using Big Data Mitigates Risk and Helps Construction Businesses Take Flight

GIS and BIM Integration Will Transform Infrastructure Design and Construction

5 Ways Digitalization Fosters a Collaborative Culture in Architecture

4 Tips From Steel Fabricators to Bridge the Design-Construction Gap

Construction Giant Skanska Sweden Has Big Plans to Go Completely Digital by 2023

How Lean Construction Methods Gave BAM Ireland Its Day in Cork

4 Ways Architects Can Extend Their Client Services Post-Construction
CONNECTED CONSTRUCTION: REDEFINING THE BUILT WORLD THROUGH COLLABORATION

Introduction

The architecture, engineering, and construction (AEC) industry has traditionally been anything but connected. If you work in the industry, you’re all too familiar with the impact of disconnected processes and data. Today, most construction sites suffer from a lack of communication and collaboration between the numerous teams involved. Contractors and trade specialists often find themselves working with outdated data and plans that are rife with errors and omissions. That’s because between every phase of a building or infrastructure project, data is lost due to the use of nonintegrated software at different project stages.

Data silos, disconnected teams, and poor visibility into real-time information all affect project performance, leading to costly delays, rework, and waste. It’s no surprise that the US construction industry lost $177 billion from poor data and communication in 2018, according to a report from PlanGrid and construction industry analyst firm FMI.

The time has come to rethink construction at every stage. This starts with building a foundation that connects teams, workflows, and projects to enable seamless data-sharing and collaboration—from the earliest phases of design, through planning and construction, and long into the operations phase.

In these pages, Autodesk executives and industry experts from various disciplines describe how connected data and next-generation construction technology improve collaboration, reduce risk, and deliver projects faster. Leading construction firms are featured, as well: Learn how collaborative planning processes and tools helped BAM Ireland bring together all disciplines on a large project. And read about how Skanska Sweden is implementing an ambitious plan for an all-digital future.

The construction process requires collaboration, but the lack of seamless data-sharing often leaves stakeholders pointing fingers instead of celebrating a job well done. By providing better access to data—and by fostering better collaboration—connected construction helps redefine the way things are built. And that’s something the AEC industry can certainly celebrate.

ALLISON SCOTT
Director, Thought Leadership and Customer Marketing, Autodesk Construction Solutions
WHY USING BIG DATA MITIGATES RISK AND HELPS CONSTRUCTION BUSINESSES TAKE FLIGHT

BY JIM LYNCH

Machine-learning tools can help find the root causes of quality and safety issues—and prevent them from cropping up again, says Autodesk’s vice president and general manager of the Construction Business Unit.

Construction companies that adopt technology to accelerate delivery can achieve real efficiencies. But if they aren’t also gaining insight from the project data, they’re missing a major opportunity. It’s like building a better, more powerful jet engine and then never actually leaving the ground.

Digitizing all those construction documents creates a wealth of information, but most contractors don’t have time to spare for data analysis while juggling multiple projects. Machine-learning tools can automate the process, helping find the root causes of persistent problems. From quality issues to safety risks, companies can use big data to identify construction trends and drive better outcomes on future projects.
The companies I talk to say they need to reduce risk and build more predictability into their projects. If they can do that, they can be more productive and achieve better margins. Adopting construction-management technology is the first step toward managing risk. When all project-related documents are captured digitally—including things like change orders, requests for information (RFIs), submittals, and issue reports—significant information is amassed and grows significantly with each new project. Machine-learning tools look at the project data to find and report trends in quality and safety, then flag the risks. The more relevant the information put into the system, the more predictive the results.

The question is, are contractors ready to make that cultural shift—eschewing disconnected paper trails in favor of digitizing the process—and gain access to information about how their companies are doing across key performance indicators (KPIs)? Are they open to applying new technology to what has always been a manual process or switching to a new process altogether?

The reality is, contractors are already working hard to keep up with demanding schedules, especially when they don’t have the full workforce needed to fulfill the demand for construction projects. On one hand, they are slammed with work, and automation would alleviate some of the pressure on their workforce, introduce more predictability into their processes, and lower project risk. On the other hand, these companies don’t have time to stop and retool—the equivalent of changing that jet engine midflight. No general contractor is going to say, “I’m going to stop taking on new work while I put this digital process in place.”

Construction’s Major Cultural Shift

A decade ago, construction was near the bottom of the list of industries that had adopted technology in a significant way. It was a bad rap for the industry, but it also effectively threw down the gauntlet. There’s been a huge shift in the industry as construction companies realize that technology needs to be a core part of their business.

Construction isn’t just about the manual labor and equipment on the jobsite; technology is a valuable tool in a firm’s toolbox. That’s the mindset that wins jobs, drives productivity, and delivers better projects. It’s also the attitude the construction industry will need to adopt to meet the tremendous demand for buildings and infrastructure through 2040.
The companies that have successfully transitioned to automated processes have made a major cultural shift in their organizations. They’ve empowered expert teams to deploy technology wherever it will have the most impact. These teams look at the technology landscape and the existing processes, then introduce technology that can address a company’s specific challenges. It takes a dedicated effort.

One example of successful adaptation is **Suffolk Construction**, where a culture of innovation is driving a more predictable construction process with fewer mistakes. Executive Vice President and Chief Data Officer Jit Kee Chin takes the company’s technology strategy extremely seriously. Suffolk is ahead of the curve, using machine learning to analyze data, predict risk, and deliver better buildings.

Whether construction companies hire a chief data scientist, chief technology officer, or technology strategist, embracing technology means having someone on board who wakes up every morning wondering, “Okay, what are the challenges that we have as a business, and what are the technologies out there that could help us?”

**Looking Beyond KPIs**

Adopting construction technology doesn’t stop at automating construction management. Contractors are looking to technology to help deliver better outcomes across the board for their employees, their companies, and their clients. It’s possible to amass enough information in just one to three years to predict the risk factors and make changes to improve performance on future projects.

To help manage risk as a general contractor, **Swinerton** uses the **Construction IQ** machine-learning engine in Autodesk BIM 360 to flag high-risk subcontractors—repeat offenders who have racked up more issues or made repeated mistakes. Limiting the company’s risk exposure can prevent the kinds of problems that create cost overruns and schedule delays. Combing through the data manually is not practical and would be unlikely to yield useful results. With machine-learning tools, it’s quick, and the accuracy improves as the tool gathers more data and learns over multiple projects.

If contractors use machine learning to benchmark KPIs for quality and safety and set goals with a net-positive impact on the business, margins will improve. Ultimately, profits will improve, too. Quality and safety are two of the biggest factors that affect productivity on the jobsite and, therefore, profitability. Anything a general contractor can do to reduce risk, to make sure workers leave the jobsite safely every day, will have a huge impact on its bottom line.
Correcting Root Causes

When multiple companies and project teams come together to execute a complex project, there is potential for multiple points of failure. These issues can originate at the design stage and propagate through on-site construction, where they may not be discovered until it’s too late to fix.

Whether it’s a design error that has to be corrected or construction that has to be reworked, mistakes pose real safety concerns on the jobsite. Quality affects safety, and safety affects quality. The challenge is to prevent issues from occurring in the first place.

The solution is identifying the root causes using the abundant data captured by construction technology. Machine-learning tools can predict, flag, and prioritize quality and safety issues that need to be addressed, preventing problems on future projects. Any construction company will tell you that it needs to reduce risk and make projects less complex and more predictable. Technology is the way to do that—preventing frustrating holding patterns and getting the business on a safer and faster flight path.
An unfortunate fact of the AEC industry is that, between every stage of the process—from planning and design to construction and operations—critical data is lost.

For example, when you move data between phases of the usable lifecycle of a bridge, you end up shuttling that data back and forth between software systems that recognize only their own data sets. The minute you translate that data, you reduce its richness and value. When a project stakeholder needs data from an earlier phase of the process, planners, designers, and engineers often have to manually re-create that information, resulting in unnecessary rework.
The good news is that a disruption is brewing in the **GIS** (geographic information science) industry as it rapidly moves toward 3D modeling. This evolution mirrors the transformation that the design and construction industry is experiencing as it moves from 2D to 3D BIM (Building Information Modeling), and it signals the emergence of GIS and BIM integration into one holistic environment.

**The BIM/GIS Integration Begins**

While GIS information is necessary for planning and operating roads, bridges, airports, rail networks, and other infrastructure in the context of their surroundings, BIM information is key for the design and construction of those structures.

Through GIS integration, you blend a layer of geospatial context into the BIM model. What this means, for example, is that GIS can provide insight about flood-prone areas and give designers accurate information to influence a structure’s location, orientation, and even construction materials.

And then there’s scale: GIS information operates at city, regional, and country scales, whereas BIM data applies to designing and building a specific shape or structure. Now, in BIM, you may design a physical structure at an object level—sketching a door, a window, or a wall. By adding GIS, you’re managing that structure in the context of a larger, smarter landscape. A building will be connected to a parcel of land, utilities, and roads.

When you bring together these two relative scales and move information seamlessly between them, you eliminate data redundancy. Adding better geospatial context to the BIM process means the project owner gets better designs and saves money.
With all GIS and BIM information stored in the cloud, stakeholders in both infrastructure and building projects will be able to manage data in any environment in any part of the world, yet reuse and repurpose that information in other contexts without having to continuously convert data.

**BIM + GIS Location Data = Better Design and Long-Term Savings**

Whether general contractors bring the construction process into a factory for prefabrication or turn the building site into an open-air factory, there’s a new focus on improving logistics scheduling and minimizing job time and waste. Using GIS and BIM to bring a spatial dimension into this new industrialized-construction process will increase the efficiency of every project being built.

**Esri** and Autodesk are working on improved software interoperability for BIM and GIS, which will create a “digital twin” of a physical structure to enable better design in the context of the real world, making both construction and operations more efficient.

In the meantime, synthesis of the technologies is already underway. Case in point: Global engineering and design firm **Mott MacDonald** is integrating GIS and BIM to support the rehabilitation of the lower Catskill Aqueduct on a project in New York. The resulting digital work product provides a progressive way for information to be recorded, indexed, and easily retrieved to support the successful delivery of the project.

**The Science of “Where” in Risk Assessment**

Maximizing the long-term value of new roads, bridges, and facilities means delivering better designs to solve many of the sustainability and resiliency issues facing cities today. This will require optimizing dynamic data interchange between BIM, CAD, and the geospatial information provided by GIS.

Placing a digital design in a real place, within real geography, eliminates much of the front-end risk of designing and building. The biggest delays in large infrastructure projects come from the planning and permitting phases, which involve a lot of assessments of social, economic, and environmental impacts. Engineers and
planners do much of that assessment outside of the design process using geospatial data; that’s how they look at floodplain maps or locate underground utilities. So, why not design using GIS and BIM data simultaneously?

This GIS and BIM integration is equally useful once a structure is built. Rather than oversimplifying the end data provided for facilities management, the flexible model—connected to GIS—delivers everything operations need. Customers have the ability to reuse that data throughout the structure’s lifecycle.

For example, operating a road in the real world means managing utilities, managing guardrail installation, maintaining striping, and overseeing maintenance crews. There’s a lot of retrofitting and renovation. When GIS, CAD, and BIM are connected, you’re improving operability and eliminating errors. This technology convergence will play an important role in predictive maintenance, too.

Closing the Data Loop

To create smarter cities, we need to make smarter planning decisions, which is why connecting BIM and GIS is so critical. Think of what integrating these systems can do for the evolution of autonomous vehicles. Car sensors are constantly collecting real-time information. However, they rely upon a highly accurate machine map for navigation, local geometry, and the creation of their electronic horizon.

The machine map, which can be interpreted by computers, is best described as a 3D highway-design file enriched with real-world geospatial information. As the autonomous vehicles of tomorrow collect updated road geometry information such as lane closures or changes due to construction, they will identify high-risk areas, which can be fed back to planners designing and maintaining future roads. The whole process will become more seamless, and the Department of Transportation will become more responsive when fixing deteriorating roads.

Connecting real-time sensor systems, geographic data, and modeling data improves everyone’s insight, leading to better infrastructure-design decisions at any scale.

Integrated Technology and Data Visibility Boosts Trust and Collaboration

A recent study on trust, conducted by Autodesk and FMI with 2,500 industry stakeholders, found that organizations can not only measure their trust levels but can actively improve them. Having a higher level of trust internally also makes a firm more focused on collaboration.

Organizations with the highest level of trust report millions of dollars’ worth of benefits:

- Lower voluntary turnover that would otherwise be spent on replacing staff, saving up to $750,000.
- Fewer missed schedules, resulting in gains of up to $4 million annually.
- Higher levels of repeat business, driving gross margins 2%–7% higher.

Source: Trust Matters: The High Cost of Low Trust, Autodesk and FMI
In 2017, CannonDesign broke ground by hiring Hilda Espinal as its first chief technology officer—an atypical position for many large architecture and engineering firms.

With her background in architecture, information technology, and project management, Espinal helps the firm use technology to develop better design and stronger partnerships. This approach, she believes, leads to higher productivity, competitiveness, and profits for everyone involved in a project, from the designers to the builders to the building occupants. Firms might once have kept information close in the name of differentiation, but Espinal is seeing more of a collaborative spirit in the industry: an open-sharing environment that helps everyone start the race from farther down the track.

Though BIM is at the core of this shift, Espinal says a culture of sharing has spurred other practices, such as bringing subject-matter experts in-house for planning and design. Here, Espinal offers five lessons that illustrate ways digitalization is transforming the culture of collaboration for architects, engineers, contractors, and occupants and owners.

When it comes to knowledge-sharing and collaboration, the CTO of architecture firm CannonDesign says earlier is better.

5 WAYS DIGITALIZATION FOSTERS A COLLABORATIVE CULTURE IN ARCHITECTURE

By Kim O’Connell

The CannonDesign team collaborates using virtual reality (VR) and other visualization tools. Courtesy of CannonDesign.
1. Sharing Information Facilitates Progress

Project delivery is not a linear process, but it’s often presented that way, Espinal says. In reality, many aspects of it are often cyclical, and therefore, the opportunities to share information are rich. “I’m a licensed architect, and while our expertise is crucial to a project, it is limited,” she explains. “Imagine how much better it would be if we had the additional insight of a contractor—early on—to help further educate us on constructability realities and help each other avoid design-to-build pitfalls. Because when we operate in silos, we are simply not equipped to foresee.”

When computer modeling first became part of design, it required such a massive investment of technology, time, education, and content building that firms were reluctant to share information, Espinal says. Now, the technology has evolved to a point where nearly everybody in developed economies can access it. Espinal hopes that best practices for using modeling and visualization software will be established for each industry sector; adopting a common approach could get people at all stages of a project on the same page much quicker.

“Information is power—when it’s shared, not when it’s kept to yourself,” she says. “That’s when we start to evolve and improve upon each other’s knowledge. Being able to free resources up, it’s ultimately going to benefit the actual product, whether it’s a building or a city.”
2. Generative Design Enhances Productivity

Generative design uses software to create multiple design options based on specified data and constraints; some say it’s the future of the design and construction industries. Yet, Espinal understands that some architects and engineers are resistant to change and harbor fears that generative design means robots will soon take over their jobs.

The truth is that generative design can improve efficiencies and is a way for designers to bring value to a project. “It’s in our best interest to be participants in determining what’s going to be generative-design related, what’s going to get automated, and what’s not,” Espinal says. “Take, for example, if we need to calculate parking spaces for a site. Do I really need a high-demand designer to do that? No. The computer should do it algorithmically instead. It can sort through information, formulas, goals, and constraints and generate a multitude of options that can be scored; it will be trained to improve until it achieves a series of optimal solutions I can select from.”

Generative design can be both tactical and practical, with the potential to modularize construction on a large scale—an approach that is becoming essential as the global population is expected to hit nearly 10 billion by 2050. “People typically think of generative design as surrendering creative processes to a computer’s optioneering or complicated form making,” Espinal says. “But we seem to often bypass its great potential for optimization, regardless of complexity, which is conducive to mass production and therefore volumetric savings, prefabrication, and so on.”

Espinal says designers will continue to be in the driver’s seat: “Let us think again about our role as architect and how it’s often about managing client expectations—something we’re not going to leave up to the computer.”
3. Collaboration Must Begin Within

In the next five years, Espinal says she’d like to see more digital collaboration happening within design, engineering, and construction firms, which will lead to better information sharing with other collaborators. On a strategic level, firms can start by having conversations about what they’re comfortable sharing and what they aren’t, so it’s all very intentional.

“Knowledge sharing and knowledge capture really need to grow at the micro level and within our own firms, where we should make a more concerted effort toward digitizing our knowledge,” she says. “You need to not just have it all in your head; you need to record it somewhere and make it accessible and shareable. That’s the very first step.”

Because CannonDesign’s portfolio includes major health-care projects—such as UC San Diego Health’s Jacobs Medical Center and the Kaiser Permanente Radiation Oncology Center in Anaheim, CA—the firm has taken the uncommon step of hiring staff medical professionals that are integrated in project design from the get-go. Its practice, therefore, includes early advisory services all the way through post-occupancy engagement and facility-optimization solutions.

4. Visualization Software Is Here to Stay

There are many ways to approach client collaboration. When CannonDesign created the new student center for Toronto’s York University, for example, it engaged 11,000 students in every aspect of the process, working to ensure that inclusivity and wellness were at the forefront of the design. Designers are trained in a vocabulary of drawings. They can present building sections and elevations and convey what they represent to project stakeholders. But immersive visualization platforms—VR, augmented reality, and the like—improve dialog with clients and project partners, Espinal says.

“With the advent of technologies like virtual reality and augmented reality, we can say, ‘Here, please try on these goggles,’ and you can walk in this space and ask, ‘Does that ceiling feel too low? Does the width of this hallway feel right?’” she explains. “Now, clients can really experience design. It gives them a much louder voice to say, ‘Hey, this works; this doesn’t’—they become a further part of the design process.”

York University’s new student center in Toronto. Courtesy of CannonDesign.
5. Information Sharing Is an Ecological Responsibility

Climate change puts increasing pressure on designers to create sustainable, resilient spaces—reusing materials, reducing waste, and orienting buildings to maximize daylight or other conditions. Because climate change poses threats to the built environment, it may not be ecologically responsible for individual firms to spend time and resources developing their own sustainability solutions when the greater community could benefit from those ideas.

“If you’re committed to being sustainably sensitive, you start to think about glazing versus opaque surfaces or about the orientation of a building, modeling it and testing options,” Espinal says. “After a few times of trying it, it becomes part of the intel.” She says designers have a responsibility to share this insight: “Ultimately, being responsible to the environment is just something we need to do and certainly not an area to be competing about. We have one earth to share and need not keep knowledge gained and best practices to ourselves.”
With its barrel-shaped metal roof paying homage to the waves of the nearby Pacific Ocean, the Imperial Beach Library is a modern landmark for a small community a stone’s throw from the Mexico-California border.

The 14,830-square-foot structure opened in 2017 and has won multiple architecture awards, including the ENR California Small Project Award of Merit and the San Diego Architectural Foundation Orchids Awards. While designers and architects collect the trophies, builders know that any lauded project is a team effort that includes engineers, suppliers, and contractors helping realize the design studio’s vision.

In this project, two behind-the-scenes heroes are Lance Richardson—whose company, Richardson Steel, provided the structural members that support the rolling rooftop—and Steel Detailing Online’s Bart Rohal, the steel detailer who worked with Richardson on the job.

From adopting universal technology to holding postmortems, two steel experts detail a plan for more efficient construction projects.

4 TIPS FROM STEEL FABRICATORS TO BRIDGE THE DESIGN-CONSTRUCTION GAP

BY JOSHUA GLAZER

Steel fabricators have ideas for improving communications throughout complex construction projects.
There was a complexity that could’ve led to a lot of problems,” Richardson says. “The shape shifted from one radius to a second radius and then to a third radius. It’s hard stuff to locate without modeling it. Fortunately, that job was run quite well and there was good communication so that everyone’s stuff worked in conjunction with everyone else’s stuff. Because of the communication and the shared use of technology, we averted those problems, and everything went in really well for all the trades involved.”

The software used on the job included Autodesk Revit, Navisworks, BIM 360, and Advance Steel; but while BIM technologies make jobs such as the Imperial Beach Library more streamlined, inconsistent adaptation has created information gaps that occur as a project proceeds from the architecture and engineering phases to construction itself.

In most cases, a breakdown can consume hours of additional time to correct. At worst, it can mean a more serious waste of time and materials. To minimize the former and avoid the latter, these two steel experts share four tips on how they would improve the processes they see every day in the architecture, engineering, and construction industries.

1. Embrace Universal Technology

The solution to many challenges in steel fabrication is the universal adoption of software technologies. Richardson and Rohal agree that BIM adaptation is accelerating and hope this trend will lead to a future in which everyone is on the same page (or, rather, on the same 3D team).

Richardson and Rohal take on many custom steel projects that require extra attention to detail, and they recall another collaboration in which software made fabricating highly detailed metalworks a breeze.

“Lance had another detailer, who detailed everything in appropriate 2D fashion,” Rohal says. “These aluminum trusses are very pricey and very architecturally driven. He gave me the drawings, and I did them in 3D, which only took me a day or two to create the specific cut tubes, delivered in IGS files, and that saved him hundreds of hours.”

“Our tubing supplier and our machine shop were both able to import the 3D IGS files from Advance Steel into their 5-axis lasers and CNC mills and cut the braces for a perfect fit with very little labor,” adds Richardson, “whereas the manual layout and cutting of the parts would have come at a cost of several hundred hours.”
2. Start Collaborating Sooner

Richardson and Rohal believe that if steel professionals were brought into the architecture and engineering process earlier, the result would be significant savings and education for all involved.

“There are a few architects and a number of engineers who solicit my input in the early stages of project design—often when I am not contracted to provide the steel and have no assurances that I will be,” Richardson says. “I cannot overstate how beneficial this has been to these projects once construction begins. I would urge every engineer and architect to develop relationships with members of the construction trades and to use them as a collective resource.”

Rohal takes this idea further, inventing a new position he would like to see at the architecture and engineering level. “I believe it would be prudent for the project owner in the architecture and engineering industry to subcontract what I will coin as a ‘qualified QCSD,’ or Quality Control Steel Detailer, to review a steel project between the DD [design development] and CD [construction documents] stage. This does not require the QCSD to be the contracted steel detailer, but rather more of a steel consultant before it goes out to bid. This can save the owner on a steel project substantial overall steel costs and delivery time. In addition, the architecture and engineering team will pick up valuable steel tips that can be applied on future projects.”

3. Model to AISC Standards

The American Institute of Steel Construction (AISC) dictates that steel-construction drawings be detailed within tolerances of 1/16 inch and four-decimal-degree angles. The challenge for detailers like Rohal is that not all design plans or models follow the specification, requiring him to create an RFI for the basic steel layout.

“2D designs and 3D BIM models need to be set to AISC standards at the beginning of a project,” he says. “If not modeled to AISC specs, steel detailers would rather start from scratch than recheck or verify the entire Revit model first.”

When stakeholders adopt universal software technologies, errors are minimized, saving time and money. Courtesy of Steel Detailers Online.
The cost for not following AISC is immediately apparent, Rohal says. “We, as steel detailers, will bid detailing as if we detailed steel once. If noted on designs ‘to be VIF [verify in field] before fabrication,’ we will incorporate steel detailing at a higher cost, as it will be done once for the review-submittal process and once again for construction. This also can delay steel delivery, especially if steel is galvanized.”

4. Incorporate a Post-Project Review

With the construction industry booming, most professionals move on to the next project immediately after the previous one is finished. However, Rohal suggests that reviewing RFIs after a project can be an invaluable learning experience.

“Architecture and engineering firms should incorporate an [in-house] post-project review on specific projects with steel-savvy RFIs,” he says. “This will incorporate ideas on future projects and adjust their standards to suit the most economical and structural sound process.”
CONSTRUCTION GIANT 
SKANSSA SWEDEN 
HAS BIG PLANS TO GO 
COMPLETELY DIGITAL 
BY 2023

BY BLAKE SNOW

There’s a reason a barge needs more than a third of a mile of space to turn around: It’s huge. The same is true for behemoth construction firms; their size alone can make it difficult to change course. Factor in quality control, safety, and costs, and transformation becomes a daunting prospect. In construction—which is one of the least digitized industries, with only 1.2% of revenue going toward technology investment—how does a giant global company buck the trend?

Skanska, the world’s fifth-largest construction firm, is getting future-ready by setting ambitious goals to become a more competitive and sustainable organization. Using its Skanska Sweden division as a pilot program, the firm is rolling out initiatives to reduce construction costs by 20%; cut construction time by 25%; and improve the division’s overall health, safety, environmental record, and social responsibility by 2023. And it plans to get there by implementing the latest
and greatest digital technology, with the intent to create a domino effect in its divisions around the globe.

Henrik Ljungberg, Skanska Sweden’s digital innovation manager, says the next few years will be a marathon, not a sprint, focused on the digital infrastructure needed for future success. “It’s more about setting up the technical capabilities required to make our fast-approaching deadline possible,” he says. “We don’t have any projects delivering on our goals just yet, but we’re putting ourselves in the right place to succeed.”

**Two Initiatives, One Destination**

Pivoting an organization of this scale involves fundamental cultural and technological shifts. For Skanska Sweden, that meant launching two new organizational programs: DigiHub and the Digital Construction Platform (DCP).

**DigiHub** is a development initiative promoting research and innovation—think of it as a kind of innovation center. Within it, the company can test new products and services on a smaller scale before they are implemented throughout the organization. For example, Skanska is exploring new technology initiated by the DigiHub in its design of the Sthlm New Creative Business Spaces mixed-use complex in Stockholm.

The bulk of the company’s digitization, however, is taking place on its DCP, which will better connect coworkers, partners, subcontractors, and customers through updated technologies and coordinate the large amounts of data used in building projects. Skanska plans to incorporate machine learning, Internet of Things (IoT) sensors, carbon-footprint tracking, and real-time tracking of jobsite equipment on this platform.

In short, the DCP is a single source of truth that will save time, reduce errors, and prevent change orders.
on-site. In the near future, it will be the place to collect data (drawings, models, quality issues, and checklists) from past projects, analyze them, and then use the results to benchmark and improve current project performance.

**Power to the People**

“Everything is about making digitalization a natural part of every employee’s everyday life,” says Skanska’s DigiHub manager Lotta Wibeck. “We want to use the technology to support the work and make information about drawings, deliveries, and planning available in real time.”

To make this transition, Skanska is decentralizing technology for each business unit (country) rather than taking a one-size, company-wide approach. “We think that our biggest challenge is not the technical part,” Wibeck says. “It will be people and the mindset towards digitization, since everybody is affected in some way and we are all at different proficiency levels with different short-term goals.”

To that end, for several years, Skanska has made digital coaches available to individual employees and departments to help them work in more efficient, technology-supported ways. “The digital coach bridges our employees and construction sites with our colleagues and subcontractors,” says Patrik Johansson, a Skanska solutions architect and digital lead. “For example, we’re collecting data on our carbon footprint to improve our impact on the environment. Together with Autodesk, we’re then able to pick the right material for the job during the design process and easily see the impact of different materials.”

**But First, a Better Foundation**

All of these organizational shifts revolve around developing a strong DCP. “It is our foundation,” Johansson says. “It was built on both BIM360 and Autodesk Forge, together with Microsoft and Bluebeam; collaboration is key. Here we store and parse past project data, analyze it, and use our own set of internal tools to inform current projects.”

By centralizing this information, he says, “Our end users can review all previous 2D drawings, 3D models, and documents from any device, instead of relying on often outdated and costly misinformation like before.”

Various integration points, data sources, and API (application programming interface) layers are used in service of this goal. “The challenge today is that it is hard to analyze structured data with unstructured relationships,” Johansson says. “Our idea is to collect and relate data from different systems to each other logically, and we are
convinced that this will unlock the possibility of both AI [artificial intelligence] and machine learning. And that will help us make better informed, faster, and more confident decisions.”

By using AI and machine learning, teams will be able to interpret and analyze bigger amounts of data and create new insights on safety, sustainability, and efficiency. “We can make insights available to our site colleagues in real time,” Johansson says. “This leads us to work proactively instead of reactively with challenges, project plans, risks, and cost controls.”

Skanska is also using object recognition to discern patterns in on-site safety and efficiency. This can alert the company to colleagues and subcontractors moving in risk areas and ensure those workers on-site have the proper safety equipment—which can all be visualized with the tools being used, such as BIM 360.

A New Way to Work

The platform is constantly evolving. “We already have a lot of data and information coming in from existing equipment, sensors, and cameras, but we still haven’t been able to automate its analysis,” Johansson says.

He adds that the data is already becoming more useful and relevant to current projects. “With the help of machine learning, we hope to interpret and analyze bigger amounts of data and share those insights with project leads and subcontractors to ultimately improve our safety, environment, and efficiency.”

So, what will it take to move the needle on Skanska’s goals? Ljungberg reiterates the importance of teamwork over technological know-how. “No one can sort through digital construction on their own,” he says. “Collaboration is key between our employees, partners, and standards.”

In short, “The winner is not the one with most digital tools, apps, sensors, and scanners,” Ljungberg says. “The winner will be the one who gets the whole company to embrace this new digital way of making and building things to the point of it becoming the way we work now. That’s what we’re hoping and betting both our DigiHub and Digital Construction Platforms can do.”
There’s no “winging it” when it comes to justice. A trial is a structured affair. There are opening and closing arguments, witnesses and evidence, motions and briefs—all designed to move proceedings forward quickly, efficiently, and equitably. Because taxpayers’ money and defendants’ freedom hang in the balance, there’s no room for waste; appeals notwithstanding, justice has to get things right the first time.

While general contractors strive for that kind of efficiency, construction sites rarely resemble courtrooms. According to McKinsey, major construction projects can experience, on average, delays of one year and costs soaring 30% over budget.
But when Ireland’s Department of Justice and Equality selected engineering and construction company **BAM Ireland** (the Irish subsidiary of Dutch **Royal BAM Group**) to construct seven new courthouses in Ireland as part of the Courts Bundle PPP (public–private partnership), the firm approached the project procedurally. Like the judges that would occupy its chambers, BAM established processes and sustainable construction methods to shepherd the project toward completion, like cases on the court’s docket.

“The whole principle of ‘right first time’ is the cornerstone of what we’re trying to achieve within BAM,” says BAM Ireland’s Technical Operations Manager Michael Murphy. “Getting it right the first time is key to our financial success.”

But it’s not just the purse strings that benefit from a right-first-time mentality; it’s also the planet. “From a delivery point of view, we wanted to better coordinate the information that was being issued by our designers and our supply chain to avoid clashes and other issues on-site,” says BAM Ireland Digital Construction Manager Michael O’Brien. “One of the outgrowths was in and around sustainability.”

**Moving Forward by Working Backward**

Part of a €154.5 million (approximately $173 million) project for the design, construction, finance, and 25-year maintenance of seven federal courthouses, the Cork Courthouse Project was completed in May 2018. The project included refurbishing and expanding the existing historic courthouse building to include six courtrooms, improved custody facilities, court offices, and a regional Justice Department office.
On projects this large, design clashes—like a water pipe running through an HVAC duct or a concrete beam—are a costly yet common problem. Avoiding them was paramount on the Cork Courthouse Project, according to O’Brien; BAM Ireland faced strict deadlines from the Justice Department, which was scheduled for court hearings immediately after the delivery date, which meant expensive penalties for even the smallest delays.

To finish the courthouse on time—defect- and penalty-free—BAM Ireland relied on lean-construction principles, which spotlight collaboration. Traditional construction schedules are “pushed” to stakeholders by one person or a small team. BAM Ireland chose instead a “pull” planning process with the general contractor, design team, and subcontractors. This meant that each discipline participated in a planning session together, where they worked backward from the project's delivery date to its start date, aligning activities to preempt and resolve issues.

“We needed to make sure there were no roadblocks in our way,” O’Brien says. The general contractor used Autodesk BIM 360 Plan to create a single, shared view of all construction activities, dependencies, deadlines, and inquiries, ensuring accountability from the designers conceiving the courthouse to the trades building it. The result: more transparency, increased accuracy and efficiency, and fewer change orders—all of which kept delays at bay.

The courthouse lobby. Courtesy of BAM Ireland.
From Lean to Green

Ultimately, efficiency in communication led to efficiency in construction. O’Brien says BAM Ireland’s pull-planning process (in conjunction with production planning and supply-chain management) made it possible to leverage just-in-time delivery of materials and assemblies, which reduced waste because supplies couldn’t get damaged while sitting on-site.

Digital modeling also made the site more sustainable. The same tools that provided a shared view of construction plans and activities—Revit, Navisworks Manage, and BIM 360 software—helped the team order, inventory, and track materials to deploy supplies in the right quantities without wasteful surplus. Plus, everyone reduced paper.

“Before, we had a paper-based system for documenting construction,” says BAM Ireland Technical Development Specialist Simon Tritschler, who adds that the firm’s projects that use BIM are now 95% digital. “Instead of a room full of shelves filled with paper, now we have only a couple of folders for documentation that legally has to be kept on paper. We’ve gotten much more control over information. We’re making environmental savings. We’re saving on storage. And we’re saving on accessing, handling, and transferring data.”

A Lean-Construction Future

The ways that lean and digital construction enabled sustainability on the Cork Courthouse Project were certain yet subtle. More explicit were the ways that the completed facility was set up for a more sustainable future.

Because BAM Ireland has a 25-year contract to maintain the courthouse, it had a vested interest in creating a building that would also be operated sustainably, according to O’Brien. He adds that the facilities-management team inherited the construction team’s digital model and will use it to identify preventative-maintenance needs, ensuring that building systems run efficiently and reach their maximum lifespan.

“Using BIM 360 Coordinate, we were able to ensure that what was actually installed on-site was represented in our 3D model, which we uploaded to BIM 360 Field and pushed the data through to Autodesk BIM 360 Ops to give our facilities-management team the full traceability and history of an object, whether it’s a sink or a radiator,” O’Brien says. “If you have a boiler and a pump system, for example, all the data sheets for that equipment are linked through QR codes and accessible on a mobile device. If the facility manager wants to do scheduled maintenance on that equipment, he simply scans the QR code and all the information comes up on the digital plan.”

During construction and operation, the bottom line is, do things right the first time. “Construction takes a lot of time and costs a lot of money,” O’Brien says. “3D modeling reduces time, energy, and cost.”
Plamena Milusheva, a designer at Seattle architecture firm LMN, is working on a way to get architects back into their buildings long after construction ends and they’ve turned over the keys.

The trick isn’t a lockpick kit or any sort of clandestine sneaking technology; it’s a networked device she’s developing at LMNts (LMN Tech Studio)—LMN’s research and technology group. The device, called the PODD (Post-Occupancy Data Device), monitors and records factors that influence human comfort, along with other post-occupancy data.

The PODD is a compact (6 by 5 by 4.5 inches) unit that monitors seven metrics: air quality, carbon-dioxide levels, carbon-monoxide levels, air temperature and humidity, light, sound levels, and radiant temperature. Milusheva says this multifaceted data can show designers “how we learn from our buildings to make even better buildings.”

4 WAYS ARCHITECTS CAN EXTEND THEIR CLIENT SERVICES POST-CONSTRUCTION

BY ZACH MORTICE
This information helps architects understand ways buildings might be running inefficiently or making occupants uncomfortable. When every electron needs to be conserved, robust post-occupancy studies are the only way to determine which rooms are warmer (or cooler) than they need to be and how natural light shifts throughout the day.

Beyond the PODD, LMN’s research has yielded valuable lessons for architects who can expand their business by managing a building’s functions after the ribbon-cutting. Here are four ways architects can keep getting invited back to help clients throughout a building’s lifecycle.

1. Build Your Own Tools

Gathering extensive post-occupancy data is a relatively new frontier—one that may radically expand the scope of an architect’s practice. Few existing devices integrate multiple sensor types for permanent monitoring of buildings, so creating your own toolset, like the PODD, is sometimes necessary.

The PODD, currently in a prototype phase, is meant to be placed in close proximity to building occupants (on a desk, for example) to simulate their experiences. Each unit is powered by a rechargeable lithium-ion battery and can last two weeks on a charge. One unit within a set is the designated coordinator unit, which is connected to an Ethernet or cellular network. The other units gather data and pass it along to the coordinator, which interfaces with the system’s software and web-based display platform.

The data-visualization features are still in progress; so far, they’re mostly a series of line graphs divided by sensor types and unit, arranged chronologically. The PODD’s technical specifications are all open-source on GitHub. Beyond the size of the space being monitored, there is no upper or lower limit to the number of units that can be used in a network; tests so far have linked as many as 15 units.

Milusheva says that the PODD is primarily conceived as an LMN in-house tool for architects to better refine their designs, though “it can also be a tool for us to talk to clients and building owners about ways they can improve the building performance.

“We developed the PODD because nothing like that exists on the market currently, and we feel it is essential for us to have this normally unavailable information about our buildings,” Milusheva says.
2. Layer the Data

Milusheva is careful to clarify that the PODD collects “proxies for human comfort,” not actual human comfort levels. For that information, you have to talk to actual people. And to fix it, you have to talk to the building. “PODD data really doesn’t work in isolation,” she says. “It needs to be layered with building data collected at the same time from mechanical systems, as well as qualitative survey data—the soft side of human comfort and occupancy.”

For example, according to ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) standards, PODD data might indicate that climate systems are perfectly calibrated at a cozy but not sweltering 72 degrees, but qualitative survey data might tell a different story. With this kind of discrepancy, Milusheva says it’s important to investigate what “the building thinks is happening” at those moments by looking at what’s happening with MEP/HVAC systems.

“Each of those things on its own is only giving you a piece of a bigger picture,” Milusheva says. “Until you get all three of them in place, you wouldn’t be able to see if there are any misalignments or shifts in expectation.” With these three different data sets, “you can really start to piece things together and develop a much clearer picture of where to dig further,” she says.

3. Check in With the Right People

Tracking post-occupancy data isn’t just a deal to be made between architects and clients; it also involves builders, everyday occupants, building-maintenance crews, and building owners, who are not always the same set of people as the client. Ideally, these partnerships can last as long as the building itself. Coordinating stakeholders was one of the PODD project’s biggest challenges, Milusheva says. “There are really a lot of people that have to be on board. And those people have their own technical hurdles.”

Absent a full suite of PODD units, architects can still keep clients thinking about the post-occupancy performance of their
buildings. “Architects can be reaching out to building occupants with simple surveys to check in and say, ‘Are you comfortable in the space?’” Milusheva says. Remember, she says, “building systems already have sensors in place.” In many buildings, basic HVAC information about factors such as temperature and humidity is attainable, and off-the-shelf smart-building sensors, while much less informative than the PODD units, provide access to real-time data.

Milusheva says temperature, humidity, carbon-dioxide levels, and light levels are the most critical data points to track. Carbon-dioxide level is an often-overlooked factor, and Milusheva says it’s not just a function of stagnant air in an uncomfortably stuffy room. “If you have a two-hour meeting in a closed room with five to 10 people, depending on how well the space is ventilated, you’re going to see spikes of CO2 levels, and that’s correlated with lowered cognitive function and general feelings of tiredness,” she says.

4. Bring Up Post-Occupancy Early

It’s always best to address post-occupancy studies with clients as soon as possible—“the earlier the better,” Milusheva says. LMN brings PODD units to first meetings with clients—even to the interviews set up to win the work in the first place.

It helps that the PODD prototype’s transparent plastic shell draws people in by putting its internal components (circuit boards, wires, and a bulbous, spherical temperature sensor) on display. As project team members slide the PODD across the desk, they tell clients, “This is something we hope to deploy and learn from this building when it’s done.”

Milusheva says seeing the physical tool has a big impact on clients. “People get excited about it. It’s much more concrete, rather than talking about the idea of collecting data in abstract.” And that understanding can lead to a whole new appreciation for ways architects can help keep buildings operating at peak performance, long after construction is complete.

*Transparent PODD boxes put internal processing on display. Courtesy of LMN.*
TAKEAWAYS

Connected construction involves every discipline throughout the AEC industry. By linking teams, workflows, and projects, it enables seamless data-sharing and collaboration—from the earliest phases of design through turnover and building operations.

A few key points:

Data loss is a key issue in the AEC industry.

Critical data is lost between every stage of a project—from planning and design to construction and operations—due to the use of different platforms at different project stages.

Connected construction preserves data integrity.

Creating a single source of information unifies all disciplines and helps avoid duplication and mistakes.

Early collaboration is key.

Bringing trades and other professionals into the architecture and engineering process earlier leads to better insights and significant savings for all.

New construction technologies bridge information gaps.

Next-generation tools and processes help integrate project teams, improving collaboration, reducing risk, and delivering projects more quickly.
From the design studio to the jobsite, seamless collaboration helps project teams identify and solve issues in real time.
Get smart on the future of making.