



Digital Transformation NETWORK

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Construction

Digital Tools Help Build a Better Future

Construction is one of the world's longest-established industries: humans have been building places to live, work, and play for millennia. It is also a sector with great opportunities to gain from digital transformation. Architecture, Engineering, and Construction (AEC) activities require an extensive, diverse range of skills. Contractors vary significantly by region, size, and purpose and are often bespoke in nature—all of which has sometimes impeded the industry's digital transformation.

The upside of this is that the growth potential is immense. McKinsey reported in 2017¹ that if construction sector productivity were to catch up with that of the total economy, it would add around 2 percent to global gross domestic product. And according to the Global Infrastructure Hub,² a \$15 trillion gap exists in global infrastructure investment from now to 2040. Digital transformation within the construction sector, the McKinsey report asserted, could help deliver those investments more efficiently by reducing costs by 4–6 percent and increasing productivity by 14–15 percent.

That journey is underway, spurred by forward-thinking governments and AEC companies recognizing the value of deploying digital tools for major infrastructure projects. Building Information Modeling (BIM) and the power to instantly move data worldwide are fundamentally changing the sector with proven efficiency gains.

This report explores the digital tools and processes that enable architects, engineers, and contractors to design, construct, and maintain the built environment worldwide. From tackling the industry's labor shortage, to using digital twins to find and fix faults before a single brick has been laid, digital transformation is helping to address some of the issues that have long vexed the construction sector and setting it up for future growth.

Software companies have created products that work for and with the industry to enhance safety, eliminate inefficiencies, promote sustainability, and enable continuous project monitoring and improvement. And AEC companies are investing in the necessary skills and helping to change mindsets to better integrate digital tools into the office and on jobsites.

There are quick wins and long-term strategic changes for the industry, suppliers, and clients. Changes on the ground can represent massive progress for construction companies: from connected machinery to safety reporting apps, digital assets can make building sites safer and work smoother.

Ensuring a regulatory environment that supports this and a workforce that sees digital assets as part of their toolbox will enable the sector to play its role in meeting the UN Sustainable Development Goals. With 68 percent of the world population projected to live in urban areas by 2050, [according to the UN](#),³ we need sustainably built homes and infrastructure to support Planet Earth's rapidly-expanding population.

First Things First: Planning and Design

BIM, Bam, Boom

→ **BIM is a relatively new concept: the result of collaborative thinking between software makers, architects, builders, governments, and other end users, it has become established in recent decades⁴ and has completely transformed the sector.**

In 2012, the [UK government called BIM](#)⁵ “a key agent for economic growth in both domestic and international markets.” Since then, countries including Chile, Singapore, and Vietnam have recognized BIM's power to make the industry more competitive.

BIM isn't one tool but a whole ecosystem encompassing technologies, standards, skills development, budgeting, and project management throughout the entire life cycle of the building—not just the construction—phase. With BIM, project data can flow freely, removing the barriers that have traditionally existed between various stages in the value chain.

Architects, project owners, consultants, construction firm workers, and subcontractors can instantly access a site location from virtually anywhere around the world—a game changer for the industry. Using the same digital file, experts from Baltimore can work on a project in Bangalore, improving transparency, increasing sustainable outcomes, and creating a record for the future. Our members have made a raft of BIM products for projects of every size.

→ Transforming Architecture, Enhancing Sustainability: Digital Design

BIM has its roots in 3D-modeling software, which has been an indispensable tool for architects, designers, and builders for decades. They can share designs in the cloud, bringing together all the benefits of collaboration, including across borders. Using big data and artificial intelligence (AI) technology has led to modeling capabilities that go far beyond simply drawing a 3D blueprint for a project. Users can decide on the best materials for the project, model wind patterns, explore the impact of and impact on climate, and examine every aspect of sustainability.



→ New Technology, Old Buildings: A Quiet Transformation

Lloyd Architects is a community-oriented, environmentally responsive design firm based in Salt Lake City, Utah, focusing on creating “quiet architecture.” They recently transformed a property that sat dormant for decades in the warehouse/railroad district of Salt Lake into a quirky combination of bouldering gym, retail, and hotel space. The oldest building dates to 1891, and the site measured more than 100,000 sq ft. [Graphisoft’s Archicad design software enabled them to model it all.](#)⁶

“Being able to take a 3D point cloud and import that into Archicad really is the Holy Grail,” with hand-measuring a building of this scale impossible, says Warren Lloyd of Lloyd Architects. “We were able to scan and get it into a model where it’s usable and helps us visualize the overall picture.” Each tenant had independent budgets and could choose different contractors to do work, requiring a lot of coordination, “so being able to control the Archicad model was really an essential piece of that.”

On a Road to Somewhere: BIM and Infrastructure

One of the clearest benefits of BIM is improving massive infrastructure projects, where the fragmentation of the AEC industry and sheer scale of investment have long presented significant challenges for major works.

In the words of the United Nations Economic Commission for Europe (UNECE), [road building “suffers from the presence of systemic shortcomings”](#)⁷ including...limited investment in technology, research and development.” These shortcomings often result in lower efficiency, higher financial risk for investors, delays, and overshooting budgets. BIM can change this, UNECE says, noting the benefits BIM technology brought to the Trans-European North-South Motorway project.

In the US, the Bipartisan Infrastructure Law confirmed the need for digital transformation by authorizing \$100 million over five years for a program to accelerate adoption of digital design and construction technologies on transportation projects. This funding will help US state and local governments build better, more cost-effective, and more sustainable infrastructure.

As the US Department of Transportation Federal Highway Administration puts in its roadmap “Advancing BIM for Infrastructure,” addressing inefficiencies through BIM allows state DOTs to “save time, mitigate risks, reduce transaction costs, improve quality of outcomes, minimize loss of information, clarify workflows and schedules, improve global competitiveness and market position, and provide an economic stimulus to one or more non-transportation industries (e.g., the technology sector).”

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AUTODESK

Connecting Transport Routes with BIM

Port of Antwerp-Bruges is the second largest port in Europe, with more than 300 liner services to 800 destinations. It handles around 290 million tons of international maritime cargo a year. **Autodesk** Construction Cloud is at the heart of the port’s successful digitalization efforts.

With [Autodesk Docs as its common data environment](#),⁸ the port can centralize BIM workflows in one place using the same core principles for folder structure, file naming, and information sharing when setting up new projects. A pre-emptive reduction of errors means fewer issues for the port to navigate during its construction projects and offers added reassurances.

“The accessibility of data makes decision-making much easier,” says Peter Rollier, BIM Office Manager at Port of Antwerp-Bruges. “We use the model as the center of our discussions in weekly meetings...Meaningful data sits at the heart of this, and breaking down information silos helps us work together for better outcomes, which is a fantastic motivator.”

Building Bridges, Literally

Autodesk has an entire [suite of tools designed specifically for large-scale infrastructure projects](#).⁹ And their customers need them; with a third of American bridges requiring repair, they are a critical area for infrastructure investment.

Digital tools enable structural analysis and simulation, helping engineers to assess the structural integrity of their designs more effectively. They can bring custom bridge parts and components into the design process to minimize material waste while adhering to grading elements.

Twice as Nice: Digital Twins

Closely related to BIM,¹⁰ a so-called “digital twin” enables developers and contractors to “build” and “monitor” an entire project before laying a single brick. Using AI and data gathered from sensors in similar projects, clients can create a realistic and dynamic digital representation of a physical asset, system, or city. They can access this at any time and see how changes would affect any part of the project.

Digital twins connect the virtual and physical worlds. They allow construction teams and building owners and operators to know their assets, performance, and when change is needed. Thanks to the cloud, they can be accessed remotely at any time, and are very useful for decision-making, safety training, and analyzing how people use buildings to improve future projects.

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→ SIEMENS

Ingenuity for Life

“Build” It Twice, Get It Right

Siemens’ Digital Native Factory in Nanjing¹¹ was entirely planned using digital technologies. A simulated digital twin optimized the building process and detected and mitigated potential problems early. This process helped to avoid planning errors, both small and big, that in the past would have added time and financial costs. Using ongoing simulation during operations has enabled the company to increase manufacturing capacity by 200 percent and productivity by 20 percent.



→ Cleared for Takeoff: A Digital Twin for Vancouver Airport

Vancouver Airport Authority wanted to expand its role in the local economy and take advantage of the digital transformation by creating a digital twin. YVR uses the digital twin to improve passenger experience, logistics handling, and sustainability.

Unity, the world’s leading platform for creating and operating real-time 3D (RT3D) content, worked with local partners to create a virtual, real-time interactive representation of YVR’s terminal and airfield.¹² The digital twin enables training, optimization, future planning, simulation, testing, and more by visualizing data gathered from sensors and historical operations. Another way YVR is trialing the use of its digital twin is through modeling aircraft movements and activity on the airfield to reduce greenhouse gas emissions, as part of YVR’s initiative to become the World’s Greenest Airport.

“At YVR, we want our people to have the tools they need to succeed in a dynamic environment and the digital twin technology solves many airport-related challenges,” said Lynette DuJohn, Vice President, Innovation and Chief Information Officer at YVR.

Constructing the Future: Digital Tools in the Building Stage

Virtually Built: AR, VR, and Beyond

Closely connected with digital twins, augmented reality (AR) and virtual reality (VR) technologies allow visualization of every stage of the building process. Adoption of these tools within the construction sector accelerated during the pandemic, when many building inspections had to be carried out remotely, and the efficiency gains are here to stay. This ranges from using drones, rather than sending a person up a ladder to “snag” building works, to enabling project teams to “walk through” a planned building wearing a VR headset.

It forms part of a broader phenomenon known as the industrial metaverse, where digital twins and VR technologies enable the design of a product or service to be carried out entirely digitally before going to production, avoiding costly mistakes.

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Berlin's Newest Destination: The Metaverse

Infrastructure software provider **Bentley** and technology giant **Siemens** have joined forces to build, operate, and optimize intelligent infrastructure. [Siemensstadt, Berlin is a modern urban district](#)¹³ planned on land Siemens started purchasing more than a century ago. By 2035, this space will be occupied by industrial operations, commercial activities, research, education, and social, sustainable infrastructure.

To achieve this vision, Siemens is building the district twice—first in the digital world and then in the real one. During the planning and designing phase, the general public will have access to the digital twin, enabling city planners to integrate their concerns and ideas as construction progresses. They can explore and discover the city before it's even built—using digital tools to improve construction and engage the community.

Virtual Reality, Real Tours

The Climate Pledge Arena is home to the Seattle Kraken ice hockey team and recently had a \$1 billion redevelopment to improve the visitor experience and ensure 100 percent of the energy used to operate the building is offset by new renewable energy.

U.S. builder [Mortenson turned to Unity](#),¹⁴ the world's leading platform for creating and operating RT3D content, to create a virtual walkthrough of the arena so it could explore various use cases, including design reviews and sales/marketing initiatives.

Projects like this are a paradigm shift for the AEC industry's use of immersive VR. “Various hardware and software improvements are reducing friction for users and facilitating comfort for longer periods of use,” says Will Adams, VR Developer at Mortenson. “Users are experiencing environments intuitively, as if they were walking together, discussing issues and features naturally. It played a pivotal role in creating Climate Pledge Arena.”

If You Build It, They'll Collect: Off-site Manufacturing

More than a century ago, Sears sold kits to build entire houses, shipped by railroad. Off-site assembly is a very modern application of this solution, building everything from whole homes to specialist parts remotely and assembling them in urban areas to minimize disruption to citizens, traffic, and cities. This process is only possible with a whole suite of digital tools, managing everything from the logistics of delivery to guiding building industry professionals through assembling them.

Factory OS builds multifamily homes 40–50 percent faster and 20–40 percent less expensive than conventional housing. They build the bulk of the home off-site—right down to the toilet paper holders—ship them, then assemble them onsite.

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Mastercam

Check Twice, Cut Once: CAM for Correct Parts

Mastercam creates software and services that solve the world's manufacturing challenges. [Computer-aided manufacturing \(CAM\)](#) serves as the link between computer-aided design (CAD) and physical manufacturing. This CAM system writes the code to control the manufacturing machinery that creates the part.¹⁵ It tells the machine exactly where and how to move so that the part is made to the exact specifications.

This saves manufacturers time and effort: human error is eliminated and jobs are completed faster. CAM software saves hours of hand-programming time, and the best CAM systems reduce production flaws, continuously analyze stock material for warping or other issues, and use tools as efficiently as possible.

Safety First! Why Communication Matters

Digital technology can improve safety in the construction workplace on multiple levels. BIM and digital twins can identify and mitigate risks before breaking ground, but it goes much further. Companies can use apps—either developed in-house or by software companies—to enable onsite workers to report faults or safety concerns, anonymously if needed.

McKinsey has identified poor communication as a critical issue for construction sector productivity, noting that inconsistencies in reporting mean that subcontractors, contractors, and owners [need a common understanding of how the project is faring at any given time](#). It affects onsite safety as well.

On top of that, the industry is fundamentally changing. As building industries continue to work toward upskilling their workforce for a digital age, online learning resources and apps that are specifically designed for the construction industry can be used to train and enhance workforce skills. Using digital assets in a useful and practical way for construction sites can improve skills and safety standards across the industry.

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WORK→ **Tools and Training: Lifelong Learning**

One of the biggest issues impacting construction is an ongoing labor shortage: according to the [latest annual survey](#)¹⁶ by Associated General Contractors of America and **Autodesk**, 93 percent of respondents say they have open positions and 91 percent indicate they are struggling to fill at least some of these roles. This issue is particularly pronounced among craft positions, which comprise the bulk of construction work on jobsites.

Autodesk is using digital skills to fix this. The Autodesk Membership Training Provider Program brings together more than 215 trade unions and industry associations to increase the digital skills of members. And to upskill current construction workers, [Construction Master Class and the Autodesk Construction Cloud Learning Center](#)¹⁷ enable industry professionals to learn new skills, advance their careers, and future-proof their businesses.

Save Time, Save Money

The AEC sector is extremely diverse when it comes to billing and budget requirements: a typical project requires skilled craft positions, charged at an hourly rate, work by specialist small- and medium-sized enterprises (SMEs), and multiple subcontractors. Completing paper contracts for this work can add weeks to completion dates and increases the chance of human error due to lost papers and poor handwriting. Keeping documentation in the cloud on a BIM platform can massively reduce costs, wait time, and mistakes.

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WORK→ **DocuSign**

Scrawl That Matters: E-Signatures Save Time and Eliminate Error

A [DocuSign survey](#)¹⁸ found that only 42 percent of construction companies use an e-signature solution, despite most professionals completing more than 100 projects a year and signing an average of 50 documents per project. As a result, many builders need to take advantage of an opportunity for greater efficiency.

The industry urgently needs to speed up how it signs and manages contracts, and embrace the sustainability gains of going paperless. With this goal in mind, DocuSign has partnered with Autodesk Construction Cloud to help general contractors, specialty contractors, and owners stay organized and on schedule with digital agreement technology.

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salesforce

License to Build: Increasing Efficiency in Arizona

The Arizona Legislature established the Registrar of Contractors (AZROC) in 1931: Today, AZROC issues more than 43,000 licenses to construction companies and investigates roughly 7,000 claims per year. New license applications used to take up to four months to process—unthinkable in an online world. To speed things up, AZROC launched its licensing, renewals, and investigations solution on the FedRAMP-authorized **Salesforce** Platform.

The information submitted through the system is captured in a profile-like setting, giving [AZROC a 360-degree view of the customer request](#).¹⁹ And the results speak for themselves: the estimated savings include eliminating 8,000 hours of data entry, reducing returned/rejected mail by \$25,000 from using built-in address verification, and reducing application deficiencies by 59 percent.

Life Cycle Management of Projects: Don't Just Build and Run

Track Your Assets

One of the biggest challenges for increased digitization of construction is that every job is unique. Every plot of land, client specification, and architectural design has quirks. At the same time, the tools are heavy, valuable, require specially trained operators, and are costly to move from one site to another.

Construction firms, from SMEs to multinationals, need to track their machinery fleets, ranging from cranes and earth-moving equipment to cement mixers and pavers. Minimizing downtime for tools equates to productivity gains, so fleet and asset management is an indispensable tool for the construction industry.

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SAP

Vast Scale, Managed Effectively

In India, major infrastructure projects such as roads and bridges are key growth enablers. Founded in 1987 and headquartered in Bhopal, India, Dilip Buildcon Limited is the largest roadbuilder in the country and employs more than 35,000 people. With more than 65 sites and high raw material costs, it took time to gain a single, accurate view of the business's assets, liabilities, and capital.

[more >>](#)

Vast Scale, Managed Effectively (continued from page 9)

The company wanted to minimize risk as it ramped up capital-intensive infrastructure projects. It sought tighter control over cost but siloed ways of working made it challenging to identify efficiencies. [Working with Kyndryl,™ formerly IBM Infrastructure Services, Dilip Buildcon deployed integrated and standardized workflows](#)²⁰ powered by **SAP S/4HANA** applications running on a managed IBM Cloud.

“Ours is one of the largest deployments in our Industry in India,” says Devendra Jain, Executive Director and Chief Executive Officer at Dilip Buildcon Limited, who uses the dashboard provided to personally make decisions. “To me, the functions that have made the best use of this solution are Asset Management, Fuel & Procurement and Project Management—especially in contracts and billing, human resources and production.”

Making Sense of Sensors: Big Data and Beyond

It used to be that projects were considered finished upon delivery to a client, enabling a builder to move on to the next project. Now, Internet of Things (IoT) solutions and sensors mean that modern buildings provide vast streams of relevant, anonymous data, enabling buildings to continually improve their sustainability performance and make life more pleasant for those who live and work in them.

For big data to be adopted by the industry, solutions must be intuitive: building managers, maintenance staff, and residents aren’t information and communication technology specialists, but all need to interact with systems. Resulting improvements in sustainability, energy savings, and compatibility with the circular economy are all compelling reasons for the industry to take advantage of digital tools.

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alteryx

Alteryx knows that breakthroughs don’t just happen. They worked with Takenaka Corporation, a long-established general contractor in Japan, to enable them to leverage the vast swathes of data the company had accumulated over 300 years to improve building designs and train and empower their workers. They used Alteryx to bring together plans, notes, and data about projects in a way that can be understood and used by anyone, not just programmers.

[Alteryx’s AI-enabled tools help them draw insights from their data sets](#)²¹ enabling them to predict building specifications and performance for new projects. “Just as the master carpenters of old used to build using their trusty construction tools, I would like for today’s designers to use the information obtained through Alteryx and apply it to future buildings,” says first-class architect Mr. Uesugi, one of the customers. “It is my hope that we can make use of the wisdom and imagination of our predecessors going back 300 years to create a project that still stands 100 years in the future.”

Smart City, Smart Citizens: Buildings in Networks

Modern, BIM-designed buildings aren't standalone structures. They are nodes embedded within a smart city and integrated into networks using sensor data to improve people's lives. They are continually improved, with BIM and digital twins meaning that potential changes can be road tested—without closing a single road.

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Bentley has partnered with Dublin City Council's Smart Dublin program to make the Irish capital greener, faster, and safer. At Dublin City University (DCU), leading-edge digital innovations are being conceptualized, developed, trialed, and tested in one of the world's most high-tech sandboxes. Through its Smart DCU program, the [Glasnevin campus has been transformed into a small-scale smart city.](#)²²

"The importance of bringing new and emerging technology to life in a way that is addressing real problems and challenges that the city faces and making innovation real," says Jamie Cudden, Smart City lead in Dublin City Council. "We are working with Smart DCU and Bentley to understand new approaches to topics such as air quality modeling in the city."

The digital information being connected here includes IoT sound sensors, digital crowd counting, and environmental sensors, all of which aim to support intelligent routing (with the least traffic, people, and noise, for example), whether inside or outside. As well as the apparent sustainability benefits, this data enables people with autism to navigate the campus in the least stressful manner using their mobile devices.

Moving Forward, Together

"Connected construction is likely to become the norm quickly, as innovative solutions demonstrate the potential to increase productivity, reduce costs, and improve safety for the E&C industry of the not-so-distant future," wrote Deloitte in their report [Winning with Connected Construction: Digital Opportunities in Engineering and Construction.](#)²³

BSA members are constantly creating, improving, and expanding software products for the construction industry. Increasing productivity, improving sustainability, and enhancing skills and safety: AEC companies, their clients, and the end users who live, work, and relax in the buildings they create all stand to gain from digital transformation.

Endnotes

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