DESIGNED FOR SUCCESS:
DX IN THE AEC INDUSTRY

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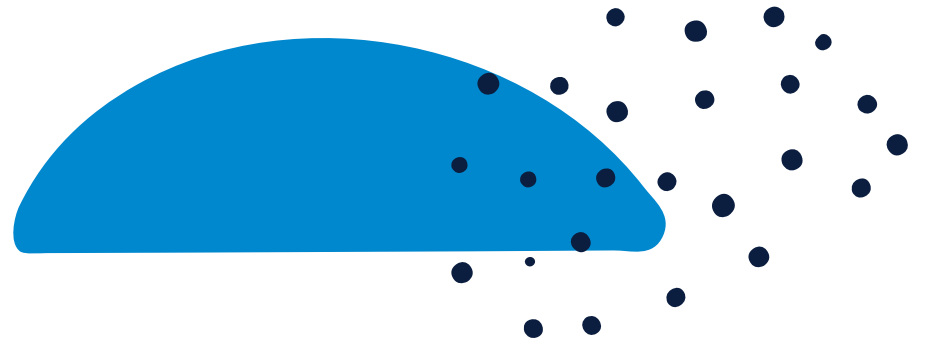
CHANGE IS BUILDING

In an industry that can create pencil towers (skinny skyscrapers) and bridges that are engineering marvels, it's surprising that architecture, engineering and construction (AEC) companies have a relatively slow technology adoption rate. But then technology moves fast, building projects generally don't, and change is hard.

Nonetheless, the AEC industry is on the cusp of significant disruption that will change how buildings and other structures are designed and constructed.

Previously, design, preconstruction, cost estimation, bidding, project management, and operations have often been disconnected. This is changing, as AEC companies strive to establish a unified view of data-rich models and employ greater collaboration across all disciplines.

AEC companies are also increasingly adopting technologies and methodologies from the manufacturing world. Manual, human-powered processes are giving way to automation. Activities across the design and construction spectrum are being handled by robotics and artificial intelligence (AI). The result: increased accuracy, efficiency, safety and, in many cases, more innovative designs and more sustainable structures.

In this eBook, we look at some of the obstacles that exist, the progress being made, and few of the IT solutions that can help accelerate much-needed digital transformation (DX).

THE OBSTACLES

AEC companies face more than their share of challenges, most of which don't make new technology adoption easy. They're dealing with constantly growing volumes of complex files and data. Their project teams are comprised of professionals across numerous disciplines — and often across geographies and time zones. Information is often siloed. They're clients' expectations continue to rise.

They're constantly under pressure to meet tight deadlines and even tighter budgets. They're subject to what seems like a never-ending list of regulatory mandates. Given the benefits that DX offers — like increasing productivity and enabling collaboration — the AEC seems like a prime candidate for transformation by way of technology.

Unfortunately, one of the biggest obstacles AEC companies face in their DX journeys is human resistance. Humans, by nature, are resistant to change. Familiarity is comfortable. Doing things differently isn't.

There's also a fear of failure — and fear of replacement. Studies of technology adoption in the AEC industry have consistently identified ingrained resistance to change in middle managers who see their skills being replaced by technology.

Plus, success in the AEC industry is fleeting. It's difficult to carry momentum from one project to the next. No two projects are the same, so it's inevitable that some processes may be reinvented with each one to accommodate client needs or unique circumstances.

On the IT front, there's also the shortage of professionals that plagues other industries. Cybercrime is up, keeping IT staffs busy in addition to dealing with day-to-day operations. Sizable investments may have already been made in workstations, complex software, and other equipment, limiting what's available for new technology. The list goes on.

THE DX DRIVERS

Obstacles aside, as is the case in just about all industries, DX really is necessary for companies in the AEC industry to remain competitive. Organizations that leverage advanced technologies and adapt quickly will triumph. Those that are slow to adopt new technologies are more likely to lose business or go out of business entirely.

AEC companies also face other pressures — and have responsibilities — that require them to embrace technological changes and new ways of doing business. One of the biggest drivers for DX: the human race. By *2050*, the world's population is expected to reach 9.7 billion and could peak at nearly 11 billion around 2100.

To keep up with global demand, the AEC industry must employ smarter, more efficient ways to design and build. They must create spaces that are more resilient and can adapt to changing conditions and needs. They must be leaders is sustainability, building structures with the future and low-energy requirements in mind. They must use products and practices that generate less waste and fewer harmful byproducts.

DX — and the technologies it entails — can help make it all happen.

The UN Department of Economic and Social Affairs projects that 2.4 trillion square feet in new construction will be built by 2060. That's the equivalent of one Paris every week, one New York City every 34 days, or almost one Tokyo each quarter.

BIM AT THE HELM

For AEC, DX entails the use of many of the same technologies that are changing "business as usual" in other industries. Among them: drones, robotics, Internet of Things (IoT) devices, 3D printing, laser scanning, virtual reality (VR), and augmented reality (AR).

What's considered by many to be the foundation of DX in the AEC industry, however, is Building Information Modeling (BIM). It's not a new concept, but it is a powerful one that connects teams, workflows, data, and technology to change how building projects are done. It's also growing in sophistication and capabilities as it's increasingly integrated with technologies such as IoT and AR.

BIM integrates multi-disciplinary data to create detailed digital representations of assets, like buildings or bridges, across their lifecycle. These intelligent models are managed in an open cloud platform for real-time collaboration.

Combined with computer-aided design (CAD) tools, BIM facilitates project delivery from early-stage design through construction. It enables design, engineering, and construction teams to work more efficiently and generate better outcomes. Importantly, it facilitates the capture of data throughout the various processes to benefit operations, maintenance activities, and more.

Over 98% of large architecture firms in the U.S. have adopted BIM; over 30% of small firms use it for some modelling and documentation. The collective BIM adoption rate in the design industry is nearly 80%, according to BIModular, a global BIM consultancy.

INNOVATION IN ACTION

BIM may be the DX leader in the AEC industry, but there are also numerous other technologies that are changing how structures go from idea to reality.

In many cases, they're not just speeding up the various processes entailed, shortening project schedules or reducing costs. They're facilitating innovation, as well as sustainability, safety, and building resilience.
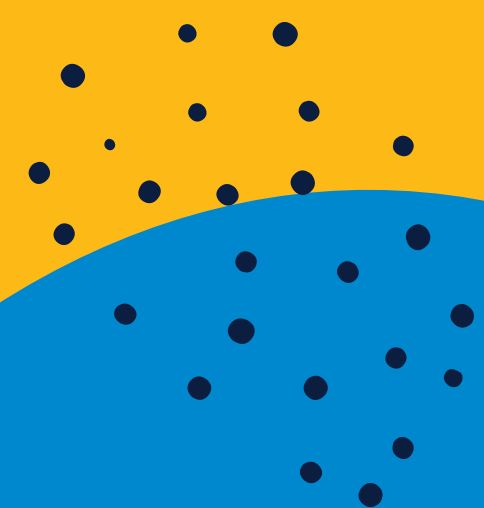
With the help of robotics, AI, and 3D printing, architects and engineers can produce extremely detailed models, try out different building materials, and test how structures will perform under a variety of conditions. Using AR and VR, architects and their clients can experience a design before construction begins.

Robots and AI are also finding their way onto conventional work sites. An increasing variety of robotic equipment can now handle specialized construction tasks onsite, including welding, rebar tying, concrete repair, bridge painting, and drilling. Construction machinery such as diggers and dozers can operate autonomously under just about any conditions, while autonomous vehicles can ferry building materials to where they're needed.

Sensing technologies are increasingly being used to track the movement of materials and workers around work sites. Software can automatically flag if a job is falling behind, or if something has been installed in the wrong place. IoT devices integrated into buildings can constantly monitor factors like temperature, air quality, and light.

The top technologies in use among BIM users are cloud computing (42%), model-based simulation (33%), virtual/augmented/mixed reality (28%), 3D printing (25%) and reality capture (25%).
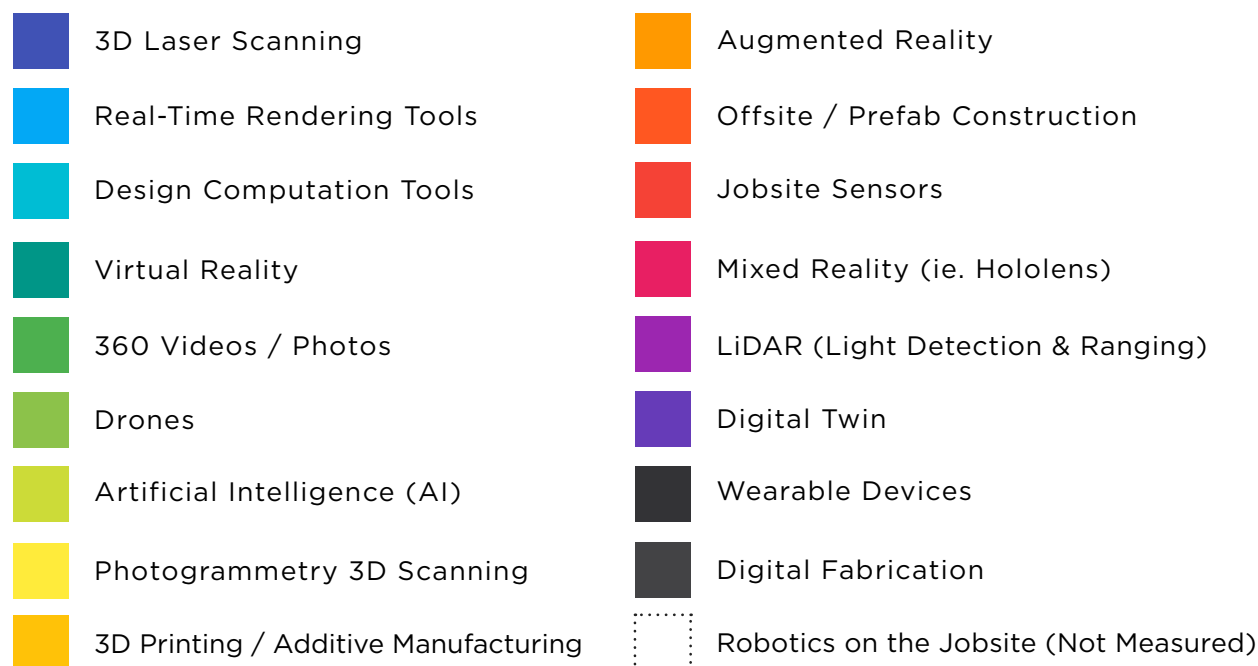
Accelerating Digital Transformation Through BIM, SmartMarket Report

OPTIONS AND OPPORTUNITIES

BD+C Giants 300 Technology and Innovation Study 2019

Legend

- 3D Laser Scanning
- Real-Time Rendering Tools
- Design Computation Tools
- Virtual Reality
- 360 Videos / Photos
- Drones
- Artificial Intelligence (AI)
- Photogrammetry 3D Scanning
- 3D Printing / Additive Manufacturing
- Augmented Reality
- Offsite / Prefab Construction
- Jobsite Sensors
- Mixed Reality (ie. Hololens)
- LiDAR (Light Detection & Ranging)
- Digital Twin
- Wearable Devices
- Digital Fabrication
- Robotics on the Jobsite (Not Measured)

+ **3D Laser Scanning.** Laser scanning is a highly accurate method to capture the details of an existing building or construction site. By using laser light, advanced scanners create 3D representations known as point clouds. These point clouds contain data that is used to create a map of the precise shape and size of physical objects.

+ **3D Printing.** 3D printers aren't limited to a flat document but instead use a variety of materials to create objects, building models, building components or even entire structures.

+ **5-D BIM.** A 5-dimensional representation of a project's physical and functional qualities considers a project's cost and timeline, as well as the usual 3-D spatial design characteristics. Geometry, specs, aesthetics, thermal, and acoustic qualities are also included.

+ **AI and Machine Learning (ML).** AI is the broad science of mimicking human abilities, while ML is a subset of AI that trains a machine how to learn. Both have countless applications in the AEC industry, from automating routine tasks to pushing the boundaries of designs through the use of simulations, more efficient parametric architecture, and other AI-powered processes.

+ **Augmented Reality (AR)** is a digital layer of information that enhances a view of the real world. AEC professionals, and even clients, can look at a job site with additional information laid directly on top of the picture. T Mixed Reality (MR) is a combination of virtual reality (VR) and AR. This means that the virtual component in question is anchored so well in reality that it seems to be a part of the real world, just like a hologram.

+ **Construction Exoskeletons (exosuits)** are wearable machines with motorized joints that provide extra support and power during repetitive movements like bending, lifting and grabbing. While exoskeletons originated in rehabilitation programs, they are gaining attention as a tool to reduce injuries and increase efficiency for construction workers.

+ **Construction Robots** include factory robots that can perfectly and repeatedly perform a single job, like simple manufacturing tasks. Collaborative robots can be used on a job site to ease the burden on a human companion by carrying tools or equipment, for example. There are also fully autonomous robots that can scan an environment and perform complex tasks with tools independently.

+ **Digital Collaboration.** These solutions digitize workflows, and deliver a seamless real-time experience across design management, materials management, scheduling, QC, crew tracking, and more. Simply replacing manual paper-based documents with digital construction forms and automated workflows, teams are able to collaborate more, eliminate redundancies, and streamline inefficient processes.

+ **Digital Twins.** A digital twin is a virtual representation that serves as the real-time digital counterpart to a physical object such as a building or bridge. The "twin" can continuously learn from multiple sources, including advanced analytics, AI, and ML algorithms, to generate valuable insights into the performance, operation, profitability, and the optimal design of a project, as well as to allow for experimenting and analyzing outcomes before making changes that impact the actual physical building, structure or work site.

+ **Drones** can be used in just about any on-the-job environment imaginable to create 3D or topographical maps and models, and take volume measurements. They also can safely inspect hard to reach places such as bridges or around tall buildings, help survey large amounts of land quickly, keep track of all equipment on site, and more.

+ **Generative Design.** Generative design is a technology in which 3D models are created and optimized by computer software. A user sets up requirements for the model, such as manufacturing processes, loads, and constraints, and then the software offers designs that meet those requirements. AI algorithms have facilitated mainstream generative design tools, allowing architects and engineers to create thousands of design options and select the design that best meets their needs.

+ **Hosted Desktops** transform computers into more powerful workstations without having to purchase expensive PC hardware. A hosted desktop is ideal for AEC firms running multiple AutoCAD workstations. Scaling is also a breeze as hosted desktops can increase their resources to handle any task. A hosted desktop transforms cheap laptop or tablet devices into a powerful workstation. The kind of devices that can launch power-hungry programs and model complex drawings. That makes it great for the crew out in the field who don't normally have access to powerful computers.

+ **IoT.** IoT describes the network of physical objects that are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet. Placing embedded sensors in and around any building or construction site gives stakeholders greater insight into variables such as energy usage trends and air quality. The true value comes from transitioning or adapting from a BIM model to a digital twin, ensuring that real-time data from sensors are incorporated into the model to create a realistic simulation.

+ **LiDAR.** LiDAR, which stands for light detection and ranging, is a technology that can be used in surveying to gather data from all types of surfaces, from areas with existing buildings to sites covered in dense vegetation. It can produce high-quality 3-D images that can be combined with project-planning software like building information modeling (BIM).

DX-ENABLING IT INFRASTRUCTURE

The technologies changing the AEC industry are exciting, their benefits are promising, and their potential for future applications still untapped. They're also forcing all players in the AEC space — architects, engineers, construction professionals, OEMs, suppliers, manufacturers, and others — to rethink their IT infrastructure and related needs.

Leveraging advanced technologies requires real-time, seamless collaboration and communication among distributed project teams. It necessitates the ability to gather, store and process large volumes of data, and have scalable compute power to perform complex calculations or data analyses when needed. Data and applications must always be available; no company or project can afford downtime.

To progress in their DX journeys, AEC companies require:

+ High performance computing resources that can handle the huge number of calculations, multiple large data sets, and other requirements associated with advanced technologies — particularly those specific to the AEC industry like BIM

+ Scalable storage capacity, storage technology options, and choices in storage systems architecture to accommodate increasing data volumes, address cost issues, and meet data privacy, security, access and retention requirements

+ Scalable, high-bandwidth, low-latency networks

+ End-to-end, multi-layered security to defend against cybercrime, protect customer and business information, and ensure secure collaboration and communication for an increasingly distributed and mobile workforce

One solution that handles all the above criteria — and avoids capital investment and ongoing maintenance, upgrades and labor costs — is the cloud.

Small and large firms tend to store a high percentage of their data in the cloud, with an average of 51.5% and 55%, respectively. Medium-sized firms store 17.6% of their data in the cloud on average.

Microdesk

THE POWER OF THE CLOUD

The cloud delivers the robust compute, storage and networking resources that are required for powering big data analytics, cognitive computing, AI, IoT, and other advanced technologies and emerging trends in the AEC industry. These resources are on-demand and scalable, offering maximum flexibility.

They're also offered on a pay-as-you-go or know-what-you're-getting subscription basis. No infrastructure purchases or maintenance are required.

The cloud enables real-time collaboration by making it easy for teams to securely share information. Files stored on the cloud can be securely accessed from anywhere.

Cloud services, at least those delivered by reputable cloud services providers (CSPs), employ multiple security technologies and processes to ensure greater security and customer peace of mind. CSPs count on their customers' satisfaction for their own success, so they invest in, deploy and monitor the latest and most advanced security technologies. Many also offer managed security services to supplement what their cloud services already provide.

As AEC companies expand, so can their cloud-based systems. Done right, cloud services can also help with regulatory compliance requirements and much more.

AEC firms are increasingly using Software as a Service (SaaS), in which they access software hosted in the cloud via subscription instead of purchasing it and uploading to their own data network. The cloud provides a framework that allows for expandability using APIs. For example, if a company finds a third-party solution that can provide better workflows and doesn't require proprietary components, it can quickly update that workflow into their SaaS applications using APIs.

NO TIME FOR DOWNTIME

In the AEC industry, data must always be safe but accessible (at least to authorized users). Communication and collaboration must always be enabled. There is no time for downtime — at least without affecting schedules and budgets. Mitigating potential downtime is another area where the cloud can help.

Cloud-based disaster recovery — in the form of a Disaster Recovery as a Service (DRaaS) solution — can mitigate the effects of business-disrupting events such as successful ransomware attacks or natural disasters.

A third-party provider handles the replication and hosting of physical or virtual servers to provide business continuity in the event of any kind of disaster. There's no infrastructure for AEC firms to purchase.

DRaaS offers quick, SLA-backed recovery time objective (RTO) and recovery point objective (RPO) in minutes, seconds, or even near-zero seconds. Many CSPs offer managed and unmanaged options.
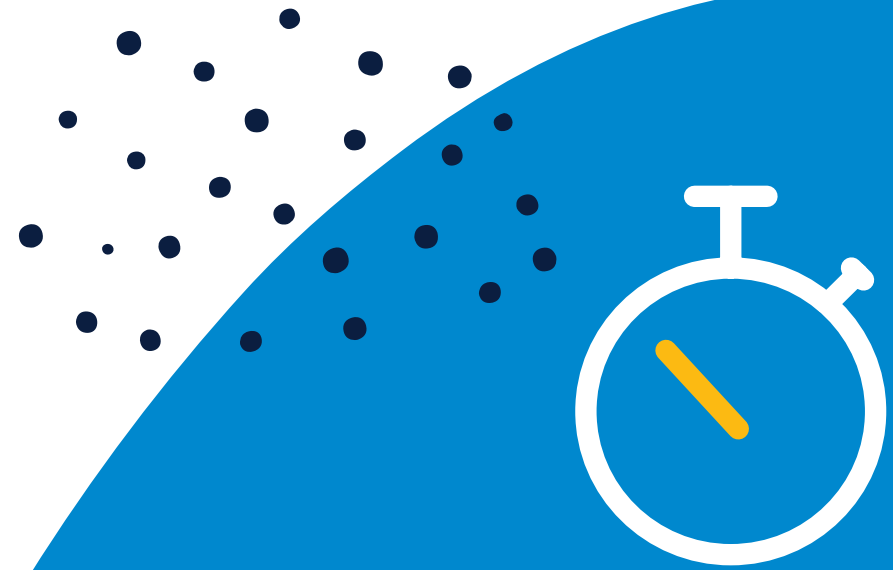
A majority (76%) of companies cite data breaches as the top cause of server, operating system, application and network downtime.

ITIC 2022 Global Server Hardware Security Survey

HYBRID IT TO THE RESCUE

As AEC companies migrate to the cloud, they still may have to deal with legacy systems and applications. The good news is that they don't have to move everything to the cloud to take advantage of its benefits. Instead, they can adopt a hybrid IT strategy.

Hybrid IT entails using different IT environments, so that workloads can be run where they'll perform best. Those environments could include on-premises private clouds, hosted private clouds, public clouds, off-site colocation, edge data centers or, more than likely, a mix of on-premises data center and cloud and colocation environments. With multiple IT environments to choose from, AEC companies are better equipped to handle changing business needs.

Workload optimization is a key benefit, but there are others as well. For example, a hybrid IT strategy enables AEC companies to add the cloud to their IT services portfolio without having to move everything or carve out a large budget for a cloud migration. It also provides them time to determine how best to address legacy apps — retain them, refactor them, rehost them, rebuild them, replace them, retire them, — if necessary.

According to the Flexera 2022 State of the Cloud Report, 89% of survey respondents reported having a multi-cloud strategy; 80% are taking a hybrid approach by combining the use of both public and private clouds.

BUILD YOUR FUTURE

To be competitive today's world, AEC companies must increase their ability to collaborate and communicate, to adapt to new market conditions and trends, and to adopt new technologies. They must drive greater efficiency and reduce errors. They must make safety, sustainability, and resilience key performance indicators.

DX, particularly in the form of cloud services and the technologies they enable, can help make that all happen. So can US Signal.

US Signal has extensive experience in working with companies throughout the AEC industry. We understand the diverse business needs and IT challenges associated with these organizations, and can help develop and implement IT solutions to overcome them.

Learn how we can help your organization build a stronger future with the right IT solutions and strategies.

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