

**FMI**

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# **Technology: Reshaping the Built Environment**



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## Message From FMI's Technology and Innovation Practice Leader

Jay Snyder

Welcome to this year's second edition of the FMI Quarterly. We devoted this entire issue to technology, and for good reason. In this traditionally slow-to-adapt industry, many organizations are either unprepared for or overwhelmed by the magnitude of new emerging technologies.

As a result, executives often struggle to deploy useful technology solutions to help their firms effectively improve their businesses. However, we are also witnessing engineering and construction (E&C) firms that are paving the way into a new data-driven, digitized future, challenging traditional thinking and bringing new business models to the table.

Generally speaking, the business environment tends to incorporate people, processes and technology when seeking out ways to improve its overall operations. More than ever, those three categories are overlapping in the built environment, where technology can help both people and processes perform better. This has been a focus for FMI for decades, and it's something we take very seriously. Our Technology and Innovation practice, for example, helps companies 1) improve processes and 2) layer in technology that not only helps solidify process improvements but also helps employees, managers and leaders perform more effectively.

Slow to adopt technology in the past, the built environment has seen the introduction of over 2,000 different technology solutions over the last 10 years. This has caused new levels of confusion, but it has also created significant opportunity for E&C companies that want to leverage these technologies. In this edition of the Quarterly, we have a collection of articles across all stakeholder groups in the built environment that talk about how technology is impacting and influencing businesses across the value chain.

Russ Young will show you how Amazon is shaking up building product manufacturers. What started out in 1995 as an online bookseller and then subsequently brought giants like Borders and Books-a-Million to their knees has since turned into a B2B powerhouse that has companies across all industries worried about what's around the next corner.

“As Amazon Business continues to make headway in the building products distribution industry,” he writes, “BPMs ought to be thinking about Amazon's impact on the way business is being done.”

In “Artificial Intelligence: Possibilities for Engineering and Construction,” James Boileau shows how, as technology continues to disrupt many industries, it's also offering exciting and meaningful opportunities to improve how we work and deliver evermore complex projects for our customers. And while the technology solutions being proposed and/or implemented in E&C are still in the early stages, they include advanced options like 3D printing, robotics, digital twin technology, AI and modularization.

Also check out Alyssa Menard and Ryan Howsam's informative piece on “Technology and Risk Mitigation in the Built Environment,” which details the relationship between technology adoption and good risk management. The authors also share some key insights from [FMI's recent Risk Study](#), conducted in collaboration with AGC.

It's no secret that the competitive nature of the built environment, combined with current workforce dynamics, is pushing E&C companies to consider different ways to perform in the industry. Technology is an enabling solution, and it should be part of your plan. In this issue of the Quarterly, you'll find the tools you need to get started and to implement a technology approach that helps your company “win” in any business environment.



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## Today's Technology Catalysts in the Built Environment

By Andrew Henderson

The E&C industry plays a key role in identifying technology and bringing it to end users through the design and construction of the built environment.

Today's great minds are inventing some of the most advanced technology that improves our lives without us even knowing it. Unfortunately, while these inventors can create amazing technology, they don't always have the means or knowledge to bring those technology solutions to market. Engineering and construction (E&C) firms, in their own forward-thinking way, identify this future technology and facilitate broad market adoption by making it a key building block of the built environment.

In fact, many E&C companies play important roles as facilitators of technology—from the bright minds that invent and manufacture advanced products to the end users who take the technology surrounding them for granted. Consider the room that you're sitting in right now, where there is strong likelihood that:

- High-efficiency LED fixtures are helping light the space more effectively.
- Advanced HVAC control systems are keeping the room temperature comfortable.
- Power is being driven by a utility-scale solar farm (and supported by an on-site battery backup system).
- The list goes on.



Put simply, none of the technology embedded in the built environment would be there had it not been for the E&C firms that identified this best-in-class technology and designed and constructed it within the facilities we use each day.

Having completed over 700 transactions in the E&C space, FMI has seen the industry's role in technology enablement flourish. Each of the 30-plus deals we completed in 2018 held some aspect of technology. As M&A advisors, one of our key roles is to identify the underlying technology skill sets within each of these businesses; understand the target markets most impacted by that technology and skill; and match those companies with the appropriate counterparty that maximizes the impact of these technology-enabling solutions.

When doing a deal, we always talk about synergies and financial benefits to the buyer and seller. One key stakeholder that is commonly ignored is the end user who benefits from the products and services these companies offer. In this article, we highlight how one manufacturer merged into a larger entity in order to stake a bigger claim in the world's solar market.

## A Powerful Force in Alternative Energy

When Esdec acquired EcoFasten Solar in 2018, the potential power of this combined duo was immediately obvious. Working with FMI, the manufacturer of watertight solar roof mounts and components was sold to the solar rooftop mounting solutions provider, giving the Netherlands-based acquirer a foothold in the U.S. residential and commercial markets and expanding its reach into new territories.

"FMI spent a significant amount of time fully understanding the unique environment we face in the solar market," [said Brian Stearns, EcoFasten's founder and president](#). "At the end of the day, this transaction presented and negotiated by FMI sets up a true partnership and growth opportunity for both companies."

Historically, a European-focused solar racking provider, Esdec successfully launched its U.S. subsidiary in 2018. It combined the EcoFasten Solar line with its other U.S. offerings, including the FlatFix system, a lightweight, clickable solar mounting system for flat commercial and industrial roofs.

"The combination of Esdec and EcoFasten Solar creates a major solar rooftop mounting player with 5 GW installed worldwide," [Solar Power World](#) noted at the time. EcoFasten Solar's patented, rail-less racking and mounting for multiple roof types have supported over 3 GW of U.S. installations, with the company supplying just under 500 MW in 2018.

Esdec, the Netherlands' largest mounting manufacturer with 1.9 GW of its systems installed across Europe, has seen increasing adoption of its FlatFix commercial flat-roof offering, fueling the company's expansion into the U.S. market, Solar Power World reports.

## The Perfect Marriage

The marriage of Esdec and EcoFasten created a major solar rooftop mounting player that provides installers, distributors and the market as a whole with a compelling, diversified product offering for both the residential and commercial markets. Now a full-service rooftop mounting provider with installer friendly, reliable mounting solutions for any type of roof, the combined company is in a much stronger position to serve the \$80 billion-plus worldwide solar market.

This deal highlights a much less discussed but equally important technology within the solar market: solar racking components. The more often discussed technology, solar modules, make up less than half the total price of a fully installed solar system. This provides ample opportunity for advancements in the other components to drive costs down. Key technological building blocks of a successfully integrated solar project, solar racking systems go beyond just simply connecting panels to a roof.

Rooftop solar installations can be mounted onto houses, commercial buildings and structures like garages and sheds. The solar panels are secured in place with specially designed racks, according to structural and safety requirements and all while maximizing power output.

Because their racking systems minimize installation costs, Esdec and EcoFasten also decrease the payback period before residential and commercial solar systems become profitable. This, in turn, makes solar energy accessible to a wider swath of commercial and residential customers.



## Making Solar Affordable

With global uncertainty causing significant variability in fossil fuel prices, stable, affordable renewable energy resources are paramount to residential and commercial property owners, not to mention governments worldwide. Solar prices have dropped significantly over the last several decades, and it's now up to solar researchers and manufacturers to make sure that trend continues.

The combination of EcoFasten and Esdec not only made sense for both companies strategically and financially, but also it's beneficial for the broader solar market. By delivering an innovative commercial and residential mounting system to the market—and by offering installers a simpler, quicker to install solution—the company funnels large-scale research and development, patented advanced technology and customer input into its rapid product development, all while continuing to make solar more affordable for a greater number of people.

“Esdec and EcoFasten are a perfect fit,” [said Esdec CEO Stijn Vos](#). “By combining these two customer-oriented forces, we are providing installers, distributors and the market with a very compelling, diversified product offering for both pitched and flat roof projects.”

## Creating Big Impacts

Massachusetts Institute of Technology (MIT) researchers identified “research and development activities” as having the biggest impact on solar cost reductions—a point that makes the Esdec-EcoFasten deal even more significant. Along with introducing a market-leading catalog of racking solutions, the two companies are now becoming technological powerhouses in the solar research and development space.

Esdec opened its Innovation Centre in the Netherlands, where its staff works closely with the EcoFasten Solar team to fast-track the research, development and commercialization of new racking and mounting products for the U.S. and European markets. There the two entities contribute to innovation in the solar industry and to improved renewable global energy and sustainability efforts.

Looking ahead, the future remains bright for renewable energy construction in North America as technology and research continue to focus on improving reliability, increasing capacity factors and reducing costs. Along with declining costs, state-driven Renewable Portfolio Standards and corporate sustainability practices are both increasing the demand for renewable energy.

Many large corporations have even pledged to move toward 100% renewable energy. Finally, ongoing energy storage developments will further increase reliability on renewable sources for generations—even during periods when these sources are not available. This will require technology and investment in redesigning the grid to more efficiently use and store generation from renewable sources.

## More Innovation to Come

Construction innovation is at an all-time high, with more companies exploring how to use everything from the Internet of Things (IoT) to advanced materials to provide customers with the most effective, cutting-edge technology available. Wind turbines would not be supporting many of the power grids across the country had E&C firms not been there to erect them. Manufacturing plants would be extremely inefficient and lose billions annually had E&C firms not installed advanced sensors and monitoring systems.

Even the streets you drive on would be impassible were it not for the advanced technology ingrained in the chemistry of the asphalt pavement on the roads we drive. And while superintendents on construction sites may not have the latest wearable technology on their vests, they probably do possess the knowledge and skills necessary to support the construction of a technologically advanced office building.

With technology accelerating at a rapid pace, inventors and entrepreneurs must remain aware of their delivery channels to market. Serving as one of these key channels, E&C can't stagnate. It's up to the industry to continue to adopt this new technology within its bill of materials so that each and every one of us can enjoy the benefits within the built environment.



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# Technology and Risk Mitigation in the Built Environment

By Alyssa Menard and Ryan Howsam

Once you know what you want and need from your technology solutions, you can begin to extract meaningful insights to help your organization manage risk more effectively.

In today's age of digital disruption, it comes as no surprise that technology adoption is a critical aspect of managing risk. And while technology and data-driven insights have proven themselves to be great assets in the risk management battle, these innovations also present their own unique set of challenges for the engineering and construction (E&C) industry.

Here's why: In this traditionally slow-to-adapt industry, many organizations are either unprepared for or overwhelmed by the magnitude of new emerging technologies. As a result, executives often struggle to deploy useful technology solutions to help their firms effectively manage risk.

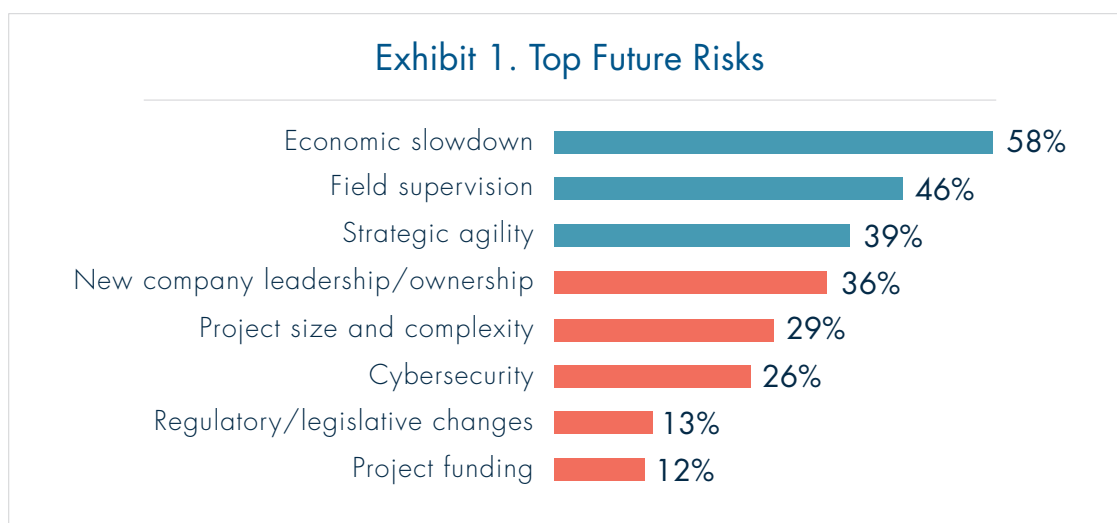
## Technology as the Great Enabler

Technology can be a useful tool for managing risk, but knowing which tools to use and how to implement them is still a big hurdle for many E&C firms. In a recent [Dodge Data report](#),<sup>1</sup> 68% of contractors rate "on-going project management risks" as medium or high difficulty, and 51% find identifying projects risks at least moderately challenging, demonstrating the need for more training and knowledgeable staff to aid in technology solutions.

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<sup>1</sup> "Using Technology to Improve Risk Management in Construction." SmartMarket Insight. Dodge Data & Analytics. 2019.

Data from the 2019 AGC/FMI risk study also reveals that over one-third (39%) of E&C organizations believe that strategic agility—or the ability to implement and leverage technology—will be a top risk for the next five years (**Exhibit 1**). But even in the face of this risk, just 19% of contractors have an established budget for risk data analytics and consulting, and few contractors have the expertise in-house needed to analyze such data.<sup>2</sup>



Source: 2019 AGC/FMI Industry Risk Survey

## Jumping the Hurdles

Despite the challenges associated with deploying the right technology within an organization, current trends show that the E&C industry is starting to place greater value on companies that are technologically savvy. For example, the [Dodge Data report](#) shows that around 40% of contractors are highly engaged with using technology to document safety incidents, analyze job site hazards and complete worker certifications. Because the construction industry is behind the curve in deploying technology solutions, E&C firms can leverage lessons learned from other industries to become more effective in selecting and implementing a technology strategy when choosing what tools to use for their business needs.

In our most recent [annual M&A trends study](#), 48% of respondents reported that the acceleration of technology adoption in the E&C industry will positively impact merger and acquisition activity over the next 24 months, and 46% of companies reported that they were considering acquiring a technology solution or commercializing in-house technology solutions. According to our survey, the verbatim reasons for this increased interest in tech-centric E&C firms include:

- “Companies that are perceived as having a technological advantage will become attractive targets.”
- “The potential for technology to be an enabler for a more disruptive entrant has encouraged private equity firms to become more active than they were in the industry. We believe this will continue to be a driver.”
- “Non/slow adopters of technology will be acquired for their construction capabilities by larger and more tech-focused competitors and GCs rounding out their self-performance portfolio.”

<sup>2</sup> Ibid.

- “Companies unwilling to make technology investments will have to sell at some point.”
- “Companies are targeting competitive advantages through technological advancement and trying to achieve through acquisition.”
- “Companies are looking to gain a competitive edge by leveraging technology for both revenue gains and efficiencies.”

As technology continues to penetrate every corner of the business world, expect to see even more E&C firms diving into the pool, experimenting with their options, and finding new ways to use these tools to manage risks. In fact, within the built environment, E&C firms are already recognizing the importance of effectively deploying technology to help manage organizational risk. For example, FMI’s research shows that 56% of organizations have a technology strategy and road map for implementing technology-based solutions for the business.<sup>3</sup>

## Searching for the ROI

While getting the right risk management tools in place may be as fundamental as buying a software program or investing in mobile devices, finding people who understand how to implement and use those technologies is more difficult. Right now, many E&C organizations need chief information officers (CIOs) or chief technology officers (CTOs) to help manage and implement new technology rollouts across the organization. In fact, recent industry research shows that 67% of E&C firms do not currently employ a CIO—an indication that E&C companies may need to look outside traditional labor pools to recruit the best talent for these types of roles.<sup>4</sup> Credit a lack of internal resources, budgets for new technology rollouts, and the challenge of demonstrating a measurable return on investment (ROI) to decision-makers with creating this dearth.<sup>5</sup>

In the E&C industry, less than 1% of annual revenue (on average) is funneled into research and development or innovation. This makes guaranteeing a good ROI challenging for two reasons:

- For starters, without strategic planning, jumping onboard with a new technology solution may produce less than desirable results and poor companywide implementation. This is especially true for organizations that don’t carefully consider the reasons (or “why”) they are implementing the new processes or technology in the first place.
- Moreover, the organization must invest not only in technology but also in the right people to help guide it through these changes. This can prove to be an expensive proposition, particularly for small to midsized firms. The current labor market and historically low unemployment rates can also impact a company’s ability to hire these C-level positions.

With the pace of innovation increasing, understanding how and when to implement new technology is critical. It’s particularly important for recognizing and managing the risks that may come along with these new technologies.

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<sup>3</sup> Nonresidential Construction Index. Q2 2018. FMI.

<sup>4</sup> Ibid.

<sup>5</sup> “Using Technology to Improve Risk Management in Construction.” SmartMarket Insight. Dodge Data & Analytics. 2019.



This challenge isn't limited to smaller companies either. In 2018, 55% of E&C firms reported<sup>6</sup> that they were actively seeking new technology solutions, and nearly half of contractors reported frequently measuring overall project risk.<sup>7</sup> More specifically, our research<sup>8</sup> shows how E&C organizations are using technology more strategically to manage organizational risks in areas like resource allocation, productivity and efficiency, safety, financials, design and information security.

## Watching Out for Security Breaches

The more technology E&C companies utilize, the greater the chances of a security breach. And as digitization and interconnectedness continue to increase, these risks grow exponentially. According to recent research,<sup>9</sup> 83% of construction firms reported some type of fraud in 2017. Information theft, loss and attack were the most reported types of fraud (33%) that year in the construction industry, with regulatory breaches and vendor/supplier fraud close behind at 30%.



Cyberattacks on construction firms also increased by 13% in 2017.<sup>10</sup> The firms that don't leverage new tools and technology for managing such risks put themselves in greater danger of a security breach, compared to firms that deploy protective measures against these types of attacks.

This is a particularly big concern for E&C companies, which are prime targets for data breaches because not only do they have their own project data to protect (e.g., building plans, bids and customer data), but also they must guard their employees' sensitive information. The good news is that firms across the built environment are paying more attention to these types of risks and are deploying technology solutions to manage cybercrime and fraud. In this year's AGC/FMI risk study, 26% of organizations recognized cybersecurity as a top future risk (**Exhibit 1**), and another 39% of organizations said that they leverage data analytics to manage risk within their organization.

Managing risks around your organization's data and information is critical, and companies that don't protect their systems (and their customer data) can lose their customers' confidence, loyalty and support—all while losing business over time.

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<sup>6</sup> Nonresidential Construction Index. Q2 2018. FMI.

<sup>7</sup> Ibid.

<sup>8</sup> 2019 AGC/FMI Industry Risk Survey.

<sup>9</sup> "Global Fraud & Risk Report: Forging New Paths in Times of Uncertainty." 10th Annual Edition – 2017/18. Kroll. 2018.

<sup>10</sup> "Global Fraud & Risk Report: Forging New Paths in Times of Uncertainty." 10th Annual Edition – 2017/18. Kroll. 2018.

## Six Steps to Success

Companies that take a reactive stance to technology adoption will find themselves playing catchup in a world where advanced technologies like the Internet of Things (IoT), artificial intelligence (AI) and machine learning (ML) are playing a larger and larger role. In fact, MIT Sloan Management Review<sup>11</sup> reported that companies that don't use technology to solve their problems are at risk for three times more loss in revenue versus the 25% of firms that are digital disruptors.

To successfully implement new technology solutions, assemble a team that has not only a background working within the built environment and understands the life cycle of project work, but also has strong research and analytical skills to best leverage your data to improve business performance.

It also takes a clear vision of the “bigger picture” to get all stakeholders working from the same playbook. As part of that process, utilize open communication to develop and apply a well-thought-out technology strategy that achieves that vision. Here are six ways to get started:

1. Refer to your company's existing technology strategy to ensure that the initiative aligns with it. If you don't have one, develop one.
2. Develop a business-use case for the technology (i.e., the business “need”), focusing on the details of the problem you are addressing.
3. Review the technology strategy to make sure it supports the firm's overall business strategy. If it doesn't, reconsider the business need before moving forward.
4. Determine the magnitude of the problem and define the scale that the solution must be able to handle.
5. Evaluate the company's culture and how employees will respond to technology as part of the solution.
6. Assess the company's and employees' level of technology and/or innovation fatigue. For example, has the amount of change (and/or new technology or innovation initiatives) been overwhelming to the organization? Does the company have an appropriate change management process when introducing new technology tools into its business processes?

In the end, it's about knowing which risk management technology solutions to use and then applying them to develop a strategic advantage—a mission that requires careful planning and a clear understanding of your organization's overall goals and vision. Once you know what you want and need from your technology solutions, you can begin to extract meaningful insights to help your organization more effectively manage risk.

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<sup>11</sup> Bughin, Jacques and Nicolas Van Zeebroeck. “The Best response to digital disruption.” MIT Sloan Management Review. 2017.



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# Building a Capable Technology Stack

By Jay Snyder

With the universal growth of platforms powering business functions, the importance of a technology stack is being recognized by companies of all sizes in the built environment.

In today's market, it's easy to get swept up in the buzz of new technologies that may or may not be fully developed, commercialized, staffed and ready for your engineering and construction (E&C) firm to use. There are also antiquated systems that haven't properly maintained or upgraded their back-end programming or ease of use by the field, but which may be showcasing a new release that is little more than a polished user interface.

The good news is that companies can avoid being distracted by this sort of technology by understanding their business requirements. They should also take time to translate that into systems requirements that ultimately act as a performance specification to guide the technology road map and selection process. The better news is that by using a capable technology stack—or the combination of all the technology services used to build and run a single application—companies can focus only on those solutions that actually help enable better business or project performance, or possibly actuate new or needed capabilities to succeed in today's competitive markets.

## Starting at the Beginning

The term technology stack is misleading, as it suggests a physical pile of solutions; today fewer solutions are installed on premises and are now cloud-based, simplifying infrastructure and support. A company's suite of solutions is now often managed remotely by outsourced IT services companies, vendor technical support and customer success teams. Oftentimes systems and databases are hosted on dedicated virtual servers or a shared virtual server environment to allow for flexibility and scalability, all managed by a third-party provider.

This suite of solutions that we call a tech stack has become the backbone of contractors' business operations. Over the last 10-15 years, technology has shifted from being a budget line item to taking a larger position in strategic planning and execution of business services and operations. It has moved from being a consideration to being an enabler or even an actuator that allows firms to develop services and capabilities in their business that they otherwise couldn't create.

Because of this, companies in the built environment are now placing more importance on the overall configuration, support and ability of their technology stacks.

## Exhibit 1. Example of a Tech Stack

<div>PROCORE™</div> <div>The Largest Construction Tech Marketplace</div>	ACCOUNTING		DOCUMENT MANAGEMENT		PRE CONSTRUCTION		ANALYTICS		BIM	
	<div><div>sage</div><div>COMPUTER MULTIVISTA</div><div>XERO</div></div> <div><div>Boomi</div><div>FileBound</div><div>Oracle</div><div>JDEdwards</div><div>quickbooks</div><div>mri</div><div>Spectrum</div><div>Viewpoint</div><div>PeopleSoft</div><div>Acumatica</div><div>Explorer Eclipse</div><div>CONSTRUCTION SOFTWARE</div><div>ComputerCase</div><div>Builder's Choice</div><div>FITECHGELB</div><div>YARDI CONNECTOR</div></div>	<div><div>DocuSign</div><div>NEWFORMA</div><div>Dropbox</div><div>HingePoint</div><div>BLUEBEAM</div><div>EGNITE</div><div>CPype</div><div>EBIX</div><div>Tonic DM</div><div>NOTE VAULT™</div><div>ape</div><div>REALLY</div><div>Bulldip</div><div>BRICKCHAIN</div><div>box</div><div>HONEST BUILDINGS</div><div>BUILDR</div><div>goformz</div></div>	<div><div>BUILDINGCONNECTED</div><div>SMARTBID™</div><div>Salesforce</div><div>ProEst</div><div>ONETeam</div><div>Majenta</div><div>TopBuilder SOLUTIONS</div><div>iSqFt™</div><div>COSENTIAL</div><div>GEMAIN</div><div>uCOREM</div><div>PANTERA GLOBAL TECHNOLOGY</div><div>pipelineSuite</div><div>Core360</div><div>Project and Report</div></div>	<div><div>tableau</div><div>DOMO</div><div>Dynamics</div><div>anterra</div><div>PRONOVOS</div><div>Power BI</div><div>SQL Server</div><div>PROLINK</div><div>ACUITE</div><div>Construction II</div><div>Excel</div></div>	<div><div>A2P Toolkit</div><div>assemble</div><div>BIMtrace</div><div>revizto</div><div>VERITY</div></div>					
SITE DATA COLLECTION		REALITY CAPTURE		RISK MANAGEMENT		SCHEDULING/RESOURCE PLANNING		QUALITY & SAFETY		
<div><div>Microsoft Azure</div><div>NYFTYAI</div><div>VOLANTI DISPLAYS</div><div>voxer</div><div>jamf</div><div>NOW</div><div>FieldChat</div><div>M</div><div>Push-to-Talk</div><div>by Talk2Cam</div><div>okta</div><div>DEWALT</div><div>IPlanTables.com</div><div>mobelisk</div><div>zapier</div></div>	<div><div>StructionSite</div><div>SENSERA</div><div>DroneDeploy</div><div>OPENSOURCE</div><div>HANGAR</div><div>matterport</div><div>EarthCam</div><div>HOLO BUILDER</div><div>WORK ZONE CAM</div><div>Ox Blue™</div><div>Botlink</div><div>MULTIVISTA</div><div>dronomy</div><div>SITEAWARE</div><div>TRUELOOK</div></div>	<div><div>@claimant™</div><div>LEVELSET</div><div>VeriSource</div><div>lienwaivers.io</div><div>PINS Advantage</div><div>myCOI</div><div>zlien</div></div>	<div><div>busybusy</div><div>ORACLE</div><div>PRIMAVERA P6</div><div>BOLT</div><div>VOYAGE</div><div>CONTROL</div><div>Manufacture</div><div>TRESTLES</div><div>Touchplan.io</div><div>Asta</div><div>ProjectControls</div><div>online</div><div>smartsheet</div><div>GRIT</div><div>TRIVA</div><div>eyrus</div><div>FC</div><div>Construction Services</div><div>BOSCH</div><div>IntelliBuild</div></div>	<div><div>RAKEN</div><div>buildup</div><div>SMARTVIDJO</div><div>FTQ360</div><div>GIATEC</div><div>myComply</div><div>SignOnSite</div><div>indus.ai</div><div>GAINTAL</div></div>						

Sources: Procore

## Software Stacks Versus All-in-One

A real enabler for E&C firms, technology is playing an increasingly important role in today's built environment. Here's one analogy that all E&C firms can relate to: "When building a skyscraper, you don't start with the marble facade or the fountain in the lobby," time tracking software maker [Hubstaff](#) points out. "You start with a deep foundation and girders to hang everything else on." In this example, your tech stack is the core capabilities that ensure the company is enabled and supported.

To determine whether a tech stack or an all-in-one solution is the best bet for your situation, you can look at all-in-one enterprise resource planning (ERP) solutions such as Accumata, HCSS, Plexxis, Viewpoint and Sage 300. With these solutions you will usually benefit from tighter integrations among various modules within the platform.

The problem is that these solutions aren't always as customizable as an E&C firm might like in terms of general workflow or automation. "And if you don't like one function," Capterra adds, "say, accounting—you have to throw the baby out with the bathwater and get a whole new all-in-one app," or in this instance, keep the rest of the platform but adopt an accounting system that doesn't integrate—an extremely inefficient situation.

Tech stacks built as a system of systems, on the other hand, take a bit more work to put together but offer a level of customization and flexibility that all-in-one solutions can't match. Here's a sample application stack:

- Accounting
- Project Management
- Estimating and Quantity Takeoff
- Invitation to Bid
- CRM
- Collaboration
- Time Tracking
- Fleet Management and Asset Tracking
- Email and Office Solutions

"These are all great applications with a lot of features for a small-business owner—and if you don't care for one [solution], you can swap it out for another app that works the way you'd like," Capterra notes.



## Steps to Success

Building a capable technology stack requires solid buy-in from the E&C company's leadership team, a technology strategy that aligns well with the firm's overall vision and goals, and a solution that both fills in the gaps and eliminates redundancies. Here's why:

- **Align as a leadership team.** Experiences and sophistication with technology vary widely in the industry and even within a company. It shouldn't be surprising that a company's leadership team often feels differently about embracing technology in the business. Some see technology as a high-maintenance annoyance while others consider technology as valuable as the hand tools of their craftsmen.
- **Enable business objectives.** Once the leadership team agrees on what technology means to the business, it's important to consider overall business objectives and how current technologies are enabling or prohibiting those objectives. Enabling technologies should be supported, and those that create barriers must be assessed and potentially replaced. An assessment of these tech solutions will determine whether it is an issue with user adoption and leveraging all features, or whether the technology simply doesn't have the appropriate functionality (or perhaps that there is a gap in tech capabilities).
- **Fill gaps and eliminate redundancy.** As a company assesses its tech stack, gaps and redundancies across the current technology solutions will start to surface quickly. A clear inventory of technology solutions and understanding of the capabilities needed to support the business will expose gaps quickly (e.g., a system to monitor and assign resources, track project pursuits, coordinate design changes, etc.). Gaps may not be readily apparent within major functions like accounting or project management, but a closer look may reveal specific capability gaps around how those systems integrate with one another. Redundancies will cause inefficiency with managing data and

sharing knowledge, with document management being the biggest redundancy culprit. Nearly all technology solutions have some form of document management capabilities, which means that there could be files saved in a dozen solutions, making retrieval cumbersome and inhibiting awareness/business intelligence.

- **Address the needs of employees (both field and office).** The tech stack should equally support the office and the field. For far too long, technology only improved business office processes and workflow. Now that project sites are more “connected” and devices prevalent in the field, technology solutions can more adequately address the needs of the field. The importance of gaining feedback from employees cannot be overstated. While companies don’t necessarily want to encourage employees to provide limitless “wish lists,” employees need to feel like they’re being taken seriously. Companies should ask their employees to share which technology solutions work well and which ones don’t or what may be lacking.

## Capability Versus Compatibility

When developing their tech stacks, E&C companies can follow one of two philosophies. They can either commit to a core ERP that includes accounting, human resources, project management and document management capabilities, or they can opt for a “system of systems” approach, which usually centers around either an accounting or project management platform.

Each of these choices comes with its own benefits and tradeoffs. Going all in on an ERP can mean accepting a technology suite that is good at all things but isn’t *really great* at any of them. A “system of systems” approach means managing multiple service agreements and system integrations (*if* they integrate). It’s also important to note that ERPs are much more difficult to change out if a company determines that it has outgrown the platform (while a systems approach makes replacing point solutions theoretically easier).

Remember that even with an ERP, there will be additional solutions required to meet the needs of the office and the field. So, whether it is an ERP or system of systems, choosing a path that will maximize data integration is crucial to leveraging the tech stack. The key benefits that come from this process typically include reduced duplicative data entry, fewer data errors, and an enterprisewide ability to unlock insights in the form of visualizations and actionable business intelligence dashboards.

## The Right Choice

During the technology selection process, E&C companies can avoid being drawn to shiny objects by understanding their business requirements and taking time to translate that intelligence into actual system requirements. By taking an iterative process of generating those requirements and then revisiting it while increasingly breaking the business need into technical requirements, even someone who lacks tech expertise can make good choices in this area. From this process, companies should come up with a “requirements traceability matrix” that will serve as the specification for the technology stack.

“Consider the benefits of a technology that is compatible with your company’s industry partners and clients,” IBS advises. “With the universal growth of platforms powering business functions, the importance of a technology stack is being recognized in all industries, old and new, small and large.”



## Key Capabilities for Today's Builders

- HRIS
- Accounting, including Payroll, AP, AR
- Time Tracking
- CRM
- Document/Plan Management
- Project Management (RFI, CO, Submittals, Job Costing)
- Prequalification/Invitation to Bid
- Quantity Takeoff/Estimating
- Scheduling
- Asset Tracking/Fleet Management
- Safety
- Resource Planning
- Procurement/Inventory Management
- Reality Capture/Site Data Collection
- BIM/Design Software
- Quality Control/Lessons Learned/ Knowledge Management
- Detailing/Fabrication
- Supply Chain Management/Inventory Control/Procurement
- BI Dashboard/Centralized Analytics



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# Artificial Intelligence: Possibilities for Engineering and Construction

By James Boileau

## Four ways artificial intelligence can transform an industry that's finally poised to embrace technology.

As technology continues to disrupt many industries, offering exciting and meaningful opportunities to improve how we work and deliver evermore complex projects for our customers, it has long been acknowledged that construction has been slow to implement these tools.

Although the most sophisticated engineering and construction (E&C) professionals collect data and use technology to analyze that data and become more effective, in my experience, it's still a small percentage.

The tide appears to be changing, necessarily so: Projects continue to grow in number and complexity while the labor shortage continues to challenge the industry. Recent investment in construction technology has been robust, according to recent research, noting that between 2008 and 2012, construction technology received \$9 billion in cumulative investment. That number doubled to \$18 billion between 2013 and February 2018.<sup>1</sup>

The technology solutions being proposed and/or implemented in E&C are still in the early stages and run the gamut—3D printing, robotics, digital twin technology and modularization are a few examples. The applications that promise to drive real change involve artificial intelligence (AI) and machine learning. AI's capabilities include, but aren't limited to, document analytics, cognitive services and cameras, risk analysis and prediction, and data analytics.

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<sup>1</sup> Blanco, Jose Luis, et al. "Seizing Opportunity in Today's Construction Technology Ecosystem." McKinsey & Company. September 2018.

## AI and Machine Learning

AI consists of software or computer systems that, upon receiving either structured or unstructured data and learning from it, can mimic human decision-making. Given that the E&C industry can now collect enormous amounts of data, the possibilities for AI truly are exciting.

To cite one example, if you input thousands of images of people wearing hard hats as well as thousands more images of people without hard hats, a computer can learn to identify noncompliant workers, whatever their size, shape or gender, on any given building project. The more data a system receives, the closer it will come to attaining complete accuracy in its assigned task.

For the purposes of this article, we consider machine learning a subset of AI. Machine learning differs from AI in that it uses statistical information to provide computer systems the ability to learn from data, but within a stricter framework. For example, let's say you want to prevent a fire. If you teach a machine to alert you when the temperature in a room has exceeded 100 degrees Fahrenheit and to shut off the thermostat at that temperature, that would be machine learning. To meet the definition of AI, the machine would be able to recognize fire and make independent decisions based on that event.

Most applications currently used in E&C involve machine learning. However, AI has the potential to transform the industry in many ways, helping us keep projects on track and boosting the safety, efficiency and bottom line of any given work site.

Here are four examples of AI's potential that we find particularly intriguing:

- 1. Predictive Analytics.** As its name suggests, this type of analytics can predict future events based on current and historical data. The E&C industry has always collected data, but we haven't always known what to do with it. We are capable of collecting a dizzying amount of data—roughly 2.5 quintillion bytes every day<sup>2</sup>—so the potential applications of AI in our industry are vast. For a construction job site, examples could include optimizing supply chain logistics, identifying the impact of weather trends on project scheduling, or managing budget overages through analysis of the team's experience level and contract type. As a risk engineer for an insurance company, I especially welcome how predictive analytics can predict safety hazards on a job site, thus allowing stakeholders to track and mitigate risk.

John Mavros, sales and marketing director for Predictive Solutions, a company that uses predictive analytics to reduce workplace injuries and fatalities, explains how predictive analytics can help general contractors (GCs): “On any given project, you might collect 5,000 to 6,000 data points a month. If a GC has 50 different projects, do the math and you realize how difficult it is to digest and interpret all that information at the same time,” Mavros says. “A predictive analytics model is essentially interpreting all of that information for you and delivering a more intelligent data point that is capable of considering everything all at once and presenting you with the risk.”

By recording data from inspections and on-site observations, the model creates a matrix of leading indicators and predictions on future risk in real time.

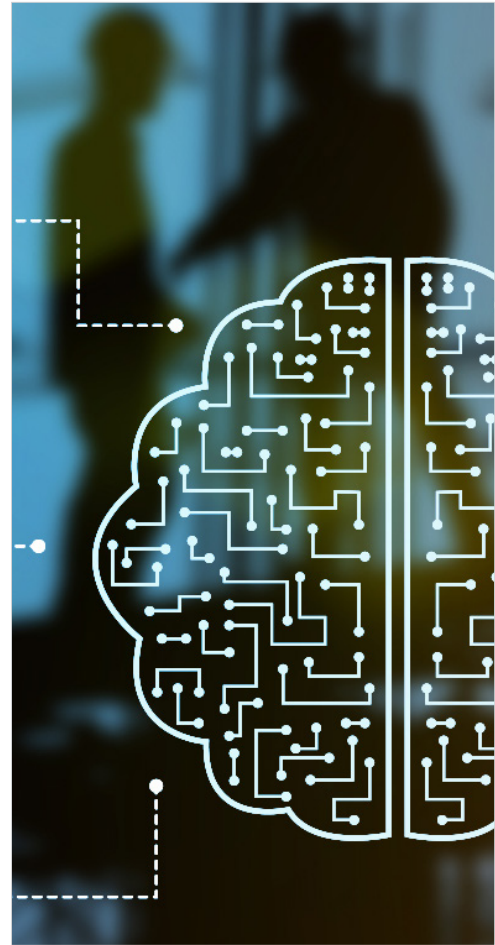
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<sup>2</sup> Marr, Bernard. “How Much Data Do We Create Every Day? The Mind-Blowing Stats Everyone Should Read.” *Forbes*. 21 May 2018.

“We can provide intel on not only whether a location has a high-risk score but also the top high-risk elements on any given site—say, falls, struck-bys, caught-between— that the model is triggered to detect,” Mavros says. “We put certain services around that to say, ‘Okay, when it triggers, what are the appropriate actions to take?’ So you can ultimately plan how to mitigate that risk before it actually happens.”

As more data is added, a predictive analytics model becomes even more intelligent, eventually able to identify what “normal” is for a particular project and eventually what “good” looks like. With the Internet of things (IoT), he adds, the increased ability of passive devices, such as optical fibers and electrical resistors to record data, further expands the enormous potential.

2. **Photo Documentation.** Capturing images to provide data is one of the more exciting applications of AI. Software is now capable of recording photos and highlighting meaningful information to help GCs monitor projects and track progress.



OnSiteIQ is one company that is doing this work and expanding the possibilities of photo documentation with AI. “We walk through a customer’s entire site every week, so they’ll always know the current conditions of every single square foot of their project as we build a digital archive of its progress,” says Ardan Khosrowpour, CEO and co-founder of OnSiteIQ.

After capturing high-resolution 360-degree imagery (think of the experience on Street View), the tool can collect a variety of information, allowing stakeholders anywhere in the world to view the results and collaborate on the model’s outputs. This technology can also be used to narrow its focus to perform more specific tasks. For example, teaching a system how to identify a defective ladder would allow it to inspect all of the ladders on a 1 million-square-foot job site in a matter of minutes.

“It would take a person a long time to complete this task, and there’s no benchmark for human accuracy in finding, say, all of the ladders that might be defective and need to be removed,” Khosrowpour says. “Plus, remember that a machine doesn’t get tired like a person can. It will detect all the ladders and is able to identify the defective ones, with a very high probability that you aren’t missing any. This is an example of AI allowing your skilled employees to focus on more difficult and complex tasks.”

3. **Augmented Reality (AR) and Building Information Modeling (BIM) Technology.** BIM creates a 3D computer-generated model of an entire project before a shovel even hits the ground and includes the schedule of erection. It has already begun to transform our industry.



On a construction site, it's all about the schedule. Applying AR to a BIM model allows stakeholders to see not only what the building is supposed to look like when it's completed, but also where they're at in any given moment—as well as the ability to step back in time or look ahead, courtesy of a digital archive built within the system. By teaming this up with AI, the computer can compare in-place construction to the model and where stakeholders are in the process (compared to the schedule) at any given point in time.

Imagine putting on a pair of glasses and viewing the project in every phase of its development. You can stand in a “room” at the beginning of a project and see where it is at the moment and where it's supposed to be in one month, two months or further down the road.

To offer an even more basic example of AR's value: If the computer shows you on day five that a stud is in the wrong place, it takes very little effort to get back on track on day six or seven. If that misplaced stud is discovered weeks or months later, it will take a lot more effort to correct that problem and get back on schedule. This is particularly significant, considering [a recent survey from FMI and PlanGrid](#), which found that poor communication and poor project data collectively accounted for a total of \$31.3 billion in rework in 2018 for the U.S. construction industry.<sup>3</sup>

Moreover, once a project is completed, AI can create ever-smarter buildings that can optimize energy usage and enhance safety, among other capabilities.

4. **Autonomous Vehicles.** Heavy construction equipment is becoming semiautonomous and even autonomous, creating the potential for huge productivity boosts. Feed a machine structured data—information you typically get from a drone or laser scanner—and let it identify the most effective way to do the job. Think of cranes, bulldozers and dump trucks not only doing the work, but also making intelligent decisions. More realistically in the near future, consider a backhoe that can optimize the way to dig a ditch: It can recommend the specific size and depth to excavate and can correct itself, when necessary, to decrease or increase the amount of material it's cutting.

A few companies are already beginning to use these smart vehicles in their construction fleets to boost efficiency and productivity. One example is a 400-ton hauler truck that can make 20 trips per day. The safety impact can't be underestimated either, because these machines are operated remotely, keeping workers out of harm's way. Remote diagnostics also boost efficiency, ensuring equipment lasts longer and is more fuel-efficient.<sup>4</sup>

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<sup>3</sup> Schott, Pete. “Construction Disconnected: The High Cost of Poor Data and Miscommunication [Report]: New Construction Survey Reveals a \$177 Billion Industry Problem.” PlanGrid. 1 August 2018.

<sup>4</sup> Alderton, Matt. “The Robots are Coming! Driverless Dozers and the Dawn of Autonomous Vehicle Technology in Construction.” Redshift by Autodesk. 3 May 2018.

## Tech's Time Has Come

Although E&C will be playing catch-up compared to other industries in technology adoption, research suggests that AI applications in other sectors, such as transportation and retail supply chain, may have relevance for the E&C industry as well.<sup>5</sup>

Despite some early adopters in the E&C space, leadership across the industry must step up its game and recognize the opportunities that technology offers. E&C leaders also need to address the industrywide reluctance to technology adoption by reassuring their teams that these new systems are designed to optimize the skills and knowledge they bring to a project.

“Technology, including AI, is empowering the construction industry to focus on the things that matter,” Khosrowpour says. “But the state of AI right now can’t fill the human connection for the foreseeable future. At OnSiteIQ, for instance, we do a lot of risk assessment. We never claim that what we’re doing is risk management. A machine cannot attain human emotion and intelligence for now, and it’s hard to imagine AI fully replacing that.”

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<sup>5</sup> Blanco, Jose Luis, et al. “Artificial Intelligence: Construction Technology’s Next Frontier.” McKinsey & Company. April 2018.



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# Picking the Right Technology for Your E&C Firm

By Russ Young

How to get everyone onboard with successful technology implementations that benefit your entire organization—from the field worker to the senior-level executive, and everyone in between.

This is an exciting time for the engineering and construction (E&C) industry, but it's also a time for trepidation over how to best integrate new technology tools and applications into an industry that's not exactly known for its forward-thinking ways when it comes to technology and innovation. Those companies that have dipped a toe in the pool are already seeing significant rewards: According to the World Economic Forum (WEF), E&C companies that invest in technology are seeing, on average, a 7-8% uplift in margins.

Many of the early “wins” are coming from digitization of paper process and workflow in project management and related software, but BIM, robotics, autonomous vehicles, and virtual and augmented reality are also starting to show some promising returns. Cumulatively, these and other innovations are helping E&C companies overcome the widespread labor shortage, tackle project complexity, work within tighter time frames and save money on costly rework.

So, if a small percentage of leaders is already posting bottom-line benefits from their technology investments, why isn't everyone else scrambling to invest more in technology right now? According to data from PlanGrid and FMI, which was collected from various studies over the past 18 months, the lack of maturity in E&C technology implementation is profound. Some of that could be directly related to the fact that companies don't do their homework or put energy into picking the best technology for their specific needs. Instead, they grab for the bright and shiny objects that are placed before them, hoping that those technologies will help them work more efficiently.

The problem is that when you don't invest enough resources into a detailed plan for any kind of change management, the result can be the costly, large-scale, failed implementations that we hear about so frequently. Fearful about moving forward with their own implementations, companies fall into a sort of "technology purgatory" that keeps them from realizing the full benefits of today's tech tools, platforms and applications.

## Getting Field Staff Onboard

FMI recently partnered with PlanGrid to survey nearly 600 construction leaders worldwide. According to the survey, 52% of general contractors (GCs) and subcontractors said the needs of field staff are a top consideration when investing in technology. However, just 28% of those firms gather feedback from those potential users of new technology before buying.

From the PlanGrid study, we also learned that 75% of GCs and subcontractors provide mobile devices to project managers and field supervisors, yet just 18% of GCs and subcontractors consistently use applications on mobile devices to access project data and collaborate with one another. So the devices are in managers' and supervisors' hands, but those upper-level employees aren't really using the technology for its intended purpose. This obstacle can be overcome by ensuring that field users are properly trained on the devices and shown how those tools can make their work lives easier (versus adding yet another responsibility or burden to their to-do lists).

When asked why technology fails them, 36% of construction leaders said poor fit with current processes and procedures is the main culprit. Twenty-five percent blamed low adoption rates. Other issues included inadequate training, difficulty using the technology, and the fact that it doesn't always integrate well with existing software and solutions. And despite what some may assume, these usually involve implementation and planning failures versus technological limitations.

## Adopting and Adapting

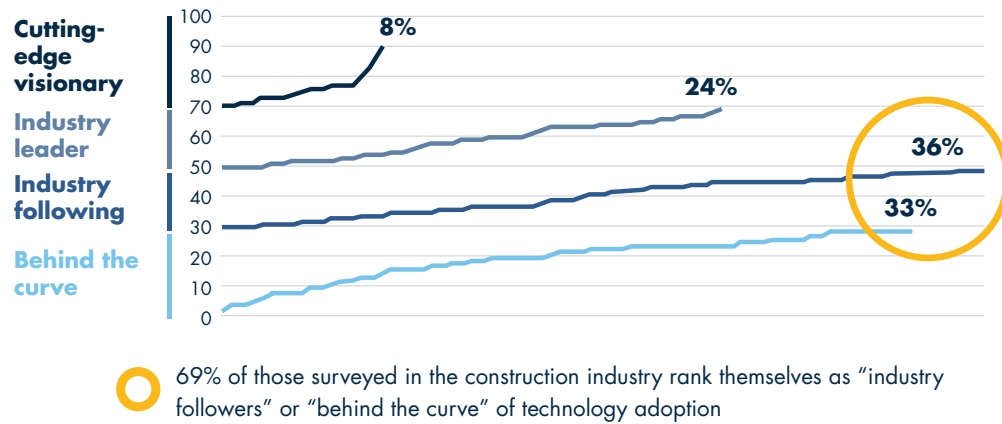
The way contractors use technology hasn't changed much over the last 10-15 years. This needs to change, according to Oracle, which says that those companies that are willing to adopt new technologies and adapt to a changing landscape will hold the biggest competitive advantage in the future. Often considered a "laggard" when it comes to technology adoption and digitization, the E&C industry is in a prime position to turn this tide and start benefiting from the many different advantages provided by technology and digitization.

The recent PlanGrid/FMI study also found that the industry is well-positioned to leverage some of the hard lessons learned by other industries whose digital transformation is already well underway. This is one instance where being more of a "follower" than a "bleeding-edge leader" can be a significant advantage for a very traditional, established industry where...

- Construction employees spend up to 14 hours a week—roughly 35% of their time—looking for project data or information, dealing with mistakes or rework and handling conflict resolution, according to the PlanGrid Study.
- 52% of all rework is caused by poor data and miscommunication, costing around \$31.3 billion in the U.S. alone in 2018.
- 57% of the PlanGrid survey respondents said that they spend time on nonoptimal activities due to difficulty gathering data, lack of responsiveness around information/data delivery, and lack of confidence in the accuracy of the data/information they've received.

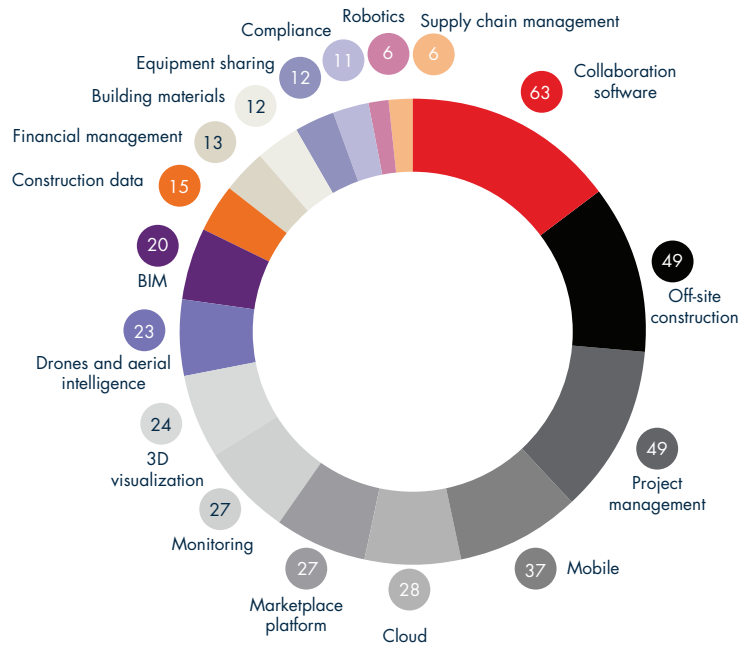


## Exhibit 1. Technology adoption spectrum



Source: Acute Construction Intelligence

## Exhibit 2. Where innovation is happening in construction technology.



Source: CB Insights, JLL Research

## Find the Weakest Link and Fix It

E&C firms that want to turn the tables and start maximizing their technology investments can use a simple survey to figure out what is and isn't working. Start with a single implementation and focus on finding the weakest link and fixing it. If, for example, you invested in a great piece of technology that was put out into the field and never used, figure out why that happened. Were the users not properly trained? Did you not involve them in the technology selection process? Were they already using something that did the job perfectly well?

In our mobile-focused world, we've seen companies invest in hundreds of tablets that field supervisors and managers were supposed to start using to gather and report project data. Even with that technology at their fingertips, those employees continued submitting paper forms. The same issues apply in the information retrieval world, where people spend an inordinate amount of time searching online and offline every day. A simple survey will surface these gripes and help you make better technology investment choices—the kind that no CIO sitting in an office, talking to vendors, can make on his or her own.

Another good strategy that E&C firms can use is to learn from the lessons of those who came before us. As a laggard industry in technology, we can study the models that have proven successful over the past 20 years in technology adoption. We can look at the early and successful movers in our industry to learn how to invest properly to be successful.

These leaders regularly gather all survey data from everyone that's going to be touched by the technology. They also know their specific business needs—and the needs for each role—intimately. They understand the benefits and limitations of the technology that's being purchased. Most importantly, they have a detailed plan for how they implement new technology, including training, new workflow, integrations and agreed-upon key performance indicators (KPIs) for measuring success.

Here are eight ways you can borrow a page from technology leaders and start using them in your company right now:

1. **Uncover some of the easier “wins” that your company can act upon right now.** A Technology Readiness Assessment (TRA) can help you identify where you are now and what technology your company needs to be able to improve processes, gain efficiencies and enhance its bottom line.
2. **Assemble a technology selection team.** Be sure to include representation from all office and field roles that will interact with the technology that you're buying and implementing.
3. **Identify the initial areas for change.** Then build a business case for the technology that will support those changes. Translate your business needs into the “must have” features and functionalities that the technology must provide.
4. **Use “create and run” surveys.** Gather data from everyone who will be touched by the technology (and the processes that it will enable), including the field, office, plant, shop and so forth. The survey may also include input from the ecosystem that your firm works with (i.e., other general and specialty contractors, engineers, architects, owners, developers and trusted technology partners).

5. **Break down the silos.** With 56% of contractors using at least three or more different software applications, according to JB Knowledge, and 30% of firms using software programs that do not integrate with any other programs, the data silos they're creating interrupt information flow, reduce accuracy levels, and can negatively impact intercompany collaboration.
6. **Analyze the data.** According to the FMI/PlanGrid study, 71% of construction firm owners find that capturing and retaining more data during design, construction and closeout either "reduces" or "significantly reduces" life cycle operation costs. Incorporate data with your current technology and tool stack to come up with ways to improve your technology over the next one or two years.
7. **Factor in your implementation needs.** This should include change management needs like training, data migration, integrations and any support needed during this transition period.
8. **Find the right technology partners.** Look for vendors that have teams in place to support your company for the long term. Key questions to ask include: Do you offer 24/7/365 customer support? Will we have a named account manager and/or customer success manager? Do you have user groups in our geographic region and/or industry vertical?

If you think of buying new technology like buying a new house, remember that this move requires detail, preparation and planning to execute successfully. Construction companies that cut corners in the implementation process take on additional risk, and that risk of failure is expensive. Our industry routinely creates and executes daily and weekly detailed plans with multiple partners on our building projects; we need to quickly mature to the same level of detail and planning with our technology implementations.



**Russ Young** is a senior consultant and leads FMI's technology partnering program, having worked with tech partnering programs his entire career. Russ also provides experienced consulting to stakeholders in the E&C industry, enabling them to maximize the benefits of technology solutions in their business. He can be reached via email at [ryoung@fminet.com](mailto:ryoung@fminet.com).

# Is Your Company Ready for the Beta User Experience?

By Jay Snyder

Being a beta customer is not an easy decision and shouldn't be taken lightly. Here's how to make sure your experience is a good one.

As the built environment seeks out ways to alleviate industry pressures, startup technology solutions are proliferating. These solutions are a welcoming source of options, as people and processes alone are incapable of addressing some of the more pervasive and complex issues, including the labor shortage, productivity, project complexity and schedule compression. However, many of these startup technologies are still in their beta phases. In other words, still in development, but viable enough to begin delivering value.

Startup technologies often need beta users to test their solutions in practice to help tech developers focus research and development or further refine features for a fully commercialized product. Some companies prefer to be lagging adopters, leaving beta user or test pilot status to others. Where there is risk, there is also reward for those companies that opt to deploy early-stage technology.

Because serving as a beta user requires more effort than simply adopting a fully commercialized mature technology, this investment in resources shouldn't be taken lightly. You may, for example, lose time, money, interest, reputation or trust in the process. In the event that the beta technology creates inefficiencies, a potential safety concern or a burden on employees, there is also a risk to the company's reputation and an erosion of trust in leadership.



## Reasons to Be a Beta User

There are many advantages for becoming a beta customer of an emerging technology. Companies that explore startup technologies tend to have a culture of innovation and curiosity. This type of culture is inherent in a company that seeks ways to improve the business rather than accepting efficacy of age-old processes. Innovation cultures tend to be rooted in excellence—a cornerstone that creates trust and bonds among teams. The culture of innovation and curiosity certainly requires business rules for who, what, when, where, why, how opportunities should be pursued—lest it breed an environment of chaos and unaccountability.



Another benefit of being a beta user is the opportunity to create a competitive advantage for the efficiency or capability that an emerging technology could offer. While this competitive advantage may only be available until the technology is commercialized and widely available, it can help your company differentiate itself in the marketplace (i.e., via better quality, cost or schedule, or a combination of all three). These advantages can all provide new avenues for winning work and retaining clients.

Beta clients can also influence how the technology itself is developed. Their feedback allows the developers to focus on fixing bugs, adding features, adjusting capability, and refining insights around the use-case that fits their target markets. Your company represents a part of that market, so it benefits as well. While most startup companies must ensure their solution meets the needs of the majority of their target market, beta customers have a loud voice when it comes to guiding product development.

## Advice for a Good Beta User Experience

In discussions with several industry influencers, we gathered noteworthy advice for a well-prepared and positive beta experience. Jim Andrews is CEO of SubHQ, a cloud-based subcontractor-focused project management platform. Jim is also the former CEO of American Ironworks and Erectors. After demo-ing and implementing several project management solutions, Jim realized that current PM solutions simply weren't designed for how subcontractors run projects, prompting him to develop an in-house solution that was a viable, resilient and deployable technology.

As a past technology buyer and current tech startup company owner, Jim brings a unique perspective to the table and offers this guidance to companies that want to be beta testers:

- Realize that the technology being piloted may have bugs or may not have all functions released.
- Have patience as the tech company builds its support team or prioritizes which bugs and features to address.
- Be willing to offer regular feedback.
- Understand that while most feedback will be addressed or will drive R&D, the technology is being developed for the market, not just one user.

Brendan Dowdall, CEO and founder of Concrete Sensors, adds these three tips:

- **Start with clear goals and expectations.** Perhaps the most important part of entering a beta trial is before it begins. We find the most success when we can sit down and outline the goals and expectations ahead of a trial. Without considering the objectives, you end up kicking the tires rather than developing a baseline to measure an ROI. At the end of the day, the opportunity to show an ROI immensely enriches the story you tell later and the value your company gets from the technology.
- **Get everyone involved.** When investing in a trial, consider the next steps. If a trial is going to be the basis of the “go” or “no-go” decision for the company, consider all the stakeholders within the company. Who else needs to be part of the decision to make adoption seamless? Construction organizations are typically flat, making a full-scale adoption difficult for most companies.
- **Develop a culture of innovation.** Beta success isn’t just about the technology. In fact, culture is the biggest obstacle to ensuring your company is staying ahead of the curve. Make new technology adoption celebrated and rewarded. Even if the outcome is not a strong fit, celebrate the process of trying new things. Doing something new means you have to try something new.

I also spoke with Dave Burns, director of field technologies at McCarthy Building Company. Dave’s perspective in selecting and deploying technology across a large multioffice enterprise keeps risk mitigation in mind and a solid approach to measuring success. He offers this sage advice:

- **Plan a test with the end in mind.** Beta testers usually focus on newly introduced features and functions, as opposed to deliberately planning the measurement of real business or process outcomes. Users must challenge themselves to think through and document those anticipated benefits (e.g., a more efficient process, greater quality of outputs, improved business decision-making and so forth) and then track the progress of the solution against those measurements.
- **Don’t measure outcomes right away.** Most new technologies drive change, and there is typically a dip in productivity when introducing any change to users or processes. Allow some time for a user or team to get comfortable with a solution before collecting feedback and measuring that solution’s value.
- **Do your homework before moving forward with a test.** Understand what alternative solutions might exist that match (or beat) the solution in question. Reach out to people who serve in technology leadership positions (both in and outside the company) to help understand if the solution has been tested and/or compared with other solutions.

## Finding Opportunities to Be a Beta User

If you’re interested in becoming a beta user, you may be wondering how to find emerging technologies that meet your interests and business objectives. The good news is that it’s not that difficult. Here are three sure-fire ways to connect with startup companies seeking early adopters:

1. **Accelerators** come in all shapes and sizes and include incubators, lighthouse program and market accelerators, to name a few. Accelerators advise startup companies and assist with such activ-

ities as R&D and go-to-market strategy. Some, like FMI's Technology Market Accelerator, also assist with matching young tech companies with willing beta user companies. Accelerators can have up to a dozen or more companies in their programs (and many more in their networks).

2. **Venture capital (VC) firms** are a great way to make introductions to tech startups. Usually this is limited to the technology companies within the VC's investment portfolio. These technologies will have the added benefit of VC funding and advising, but their founders are usually still running the company and its operations. VC relationships have the benefit of reaching many tech startup companies at once. VCs can have access to several dozen technologies within their current and past portfolios, in their deal flows or simply within their overall networks.
3. **Conferences and industry meetups** are another practical way to meet young technology companies that need beta users. Events held by organizations such as BuiltWorlds or the Society for Construction Solutions are great sources of beta user opportunity. Those organizations and other industry conferences attract early-stage technologies that are seeking market feedback on their solutions. The companies usually test their products and messaging in the market as an exhibitor or sometimes during a "demo day," where tech companies briefly explain their technology and invite critiques from an audience.

While being a beta user of an early technology isn't for everyone, it does offer exciting opportunities to move the industry forward in the development of viable technology solutions based on user feedback and industry-driven development. If the beta user experience is for you, be sure to reach out to the venture capital firm, conference organizations/association or FMI to learn more about it and mitigate some of the inherent risks associated with the experience.



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## Amazon Business Shakes Up Building Product Manufacturers

By Russ Young

As Amazon Business continues to make headway in the building products distribution industry, we're beginning to see the Amazon effect disrupt the purchase and delivery of building products to the job site.

Building Product Manufacturers (BPMs) ought to be thinking about Amazon's impact on the way business is being done: whether BPMs are pure business-to-business (B2B), pure business-to-consumer (B2C) or a hybrid. Amazon's technology has enabled companies to reach further into the value chain than ever before. BPMs may wish to embrace or avoid Amazon, but they cannot ignore it. Other industries give us insight into how to succeed (and how to fail) as BPMs choose to compete or cooperate with Amazon.

What started out in 1995 as an online book seller and then subsequently brought giants like Borders and Books-a-Million to their knees has since turned into a B2B powerhouse that has companies across all industries worried about what's around the next corner.

We're talking about Amazon, of course, and more specifically its B2B arm — "Amazon Business." Rebranded from "Amazon Supply" seven years ago, Amazon Business "combines positive attributes of Amazon's consumer marketplace," such as broad selection and delivery convenience with the products and benefits that are "tailored for businesses, government organizations and the education sector," [Bank of America analyst Justin Post said](#).

In the past, BPMs could argue that being a B2B company meant not having a sophisticated online presence beyond a content-rich website; today that statement might not hold true anymore. Amazon's success in providing B2B solutions should make BPMs question their online presence. The proof is in the numbers: [According to Amazon](#), its B2B division has more than \$10 billion in annual sales. In the U.S. alone, it serves nearly 80% of the 100 largest enrollment education organizations, 55 of the Fortune 100 firms, and more than half of the 100 largest hospital systems.

"Amazon Business also offers access to nearly 150,000 U.S. business sellers — hundreds of thousands globally — and hundreds of millions of products," the company pointed out in a recent blog. These and other milestones are making more companies sit up and take notice of Amazon, which for years focused primarily on the B2C market. Having established its Prime (one- and two-day shipping) program within that sector, it's now applying the same strategies in the B2B market.

Analysts are recognizing the potential. Robert W. Baird & Co. Inc., for example, envisions Amazon Business' sales volume exceeding \$25 billion by 2021.<sup>1</sup> "The program uses Amazon's existing warehouse and delivery network built for its retail customers," Bloomberg's Spencer Soper writes. "And it follows the retail model of offering one-site shopping for hundreds of millions of goods, with computer keyboards, janitorial supplies, office supplies and breakroom snacks among the top categories."

With nearly 50% of Fortune 100 companies already buying from Amazon Business, BPMs need to take a closer look at what that means to them, and what they need to do to compete effectively in a world where customer preferences and needs are changing almost daily.

Amazon is aware of this and is continually reinventing itself to meet those changing needs. For example, in 2018 it rolled out a new mobile feature that lets customers point their camera at the item in question. Amazon then scans it, matches it and directs the buyer to matching items from its product catalog. Currently capable of identifying over 100 types of fasteners, Part Finder was built using technology developed by Partpic, a company Amazon acquired in 2016, according to [TechCrunch](#).

More recently, the company introduced a [new "Amazon Day for Business" program](#), which lets buyers on Amazon Business consolidate shipments and choose to receive deliveries on the same day each week. These are just some of the trends that are pushing BPMs to think hard about whether they want to embrace Amazon or go up against the giant. Regardless of which tack they choose, BPMs can't ignore the e-tailing behemoth.

Other industries have already provided insight into how to succeed — and how to fail — as they choose to compete or cooperate with Amazon. Macy's, Costco, Barnes & Noble, Foot Locker and "literally every grocery store on earth" make up just a handful of the companies that the e-tailer is slowly suffocating and putting out of business, according to [Investopedia](#).

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<sup>1</sup> Spencer Soper. "Amazon Says Business Sales on Pace For \$10 Billion Annually." Bloomberg. September 11, 2018.

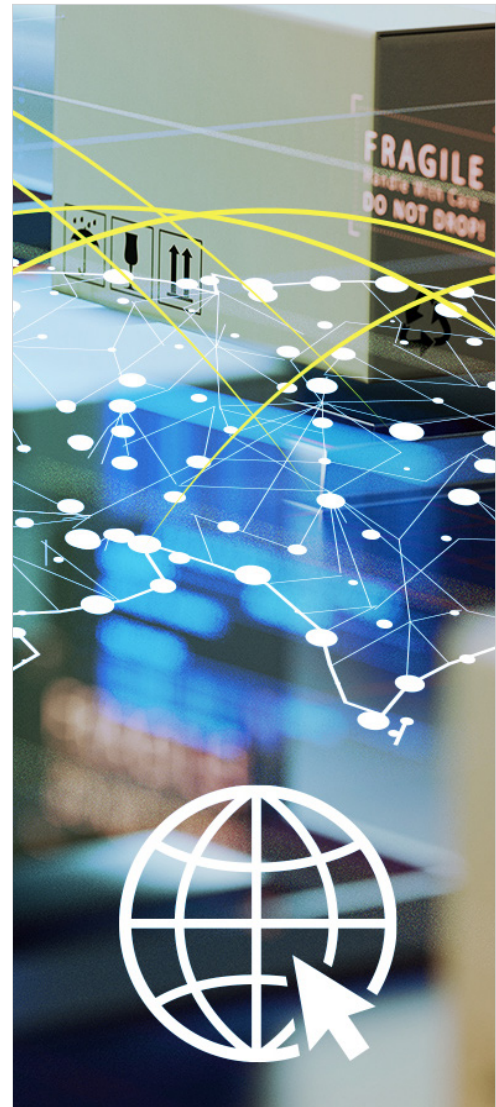


## High Hurdles to Jump

While everyone clearly agrees that having an e-commerce presence is both interesting and appealing, most B2B companies (BPMs included) are struggling with their online presence. And as e-commerce has grown (to the tune of more than \$1 trillion this year for B2B alone, according to [Forrester](#)), the need for a customer-centric web presence that facilitates everything from research to ordering to delivery tracking has grown exponentially.

The hurdles are especially high for the BPM industry, which is dealing with more than its fair share of e-commerce-related pain points right now. Most of the time, BPMs maintain direct contact (i.e., “feedback”) with their direct customers that include large general contractors or distributors (Home Depot, Lowe’s, Oldcastle, etc.). Unfortunately, this direct connection doesn’t translate well online, where customers of customers (e.g., subcontractors) are generally the ones who create the “pull” for products. A BPM’s online presence simply doesn’t cater to these subcontractors.

Finally, within the value chain, there are other heavy influencers of customer purchases. Engineering and architecture firms, for example, generate “push” for product sales via their specifications. Again, BPMs have yet to develop an effective online presence that aids all stakeholders within the value chain with these and other customer-facing tasks. Combined, these challenges tend to make e-commerce especially onerous for the typical BPM.



## Three Key Lessons Learned

You’ve read the realities and heard where BPMs tend to go wrong when implementing and/or orchestrating e-commerce, but here’s the good news: There are some clear lessons to be learned, and takeaways that manufacturers can use, to get things moving in the right direction. Here are three that no BPM can afford to ignore right now:

**Lesson 1: Build versus buy.** In the early days of B2C e-commerce, we saw many folks trying to build their own e-commerce platform; yet many of them failed. Unless building, owning and operating all the technology of a robust e-commerce platform is part of your company’s vision and strategy, lessons learned indicated that utilizing a technology partner will get you there faster, better and cheaper.

Many of the e-commerce technology platforms that focused on B2C functionality have spent the last few years building out B2B functionality that will be a “must-have” for BPMs and other players in this space. These are not limited to, but include the likes of, Magento, Shopify Plus, Episerver and Big Commerce.

Here's the bottom line: If you want to compete with Amazon, you will not win based on technology itself. To compete and win, select a technology partner who understands your business and who can develop a technology road map in support of your customer vision and strategy.

**Lesson 2: Consider a multichannel approach.** When you want to buy your new Nike shoes, you have several choices. For example:

- Want the full experience with knowledge experts, consumer stories and the like? Then go to [nike.com](https://nike.com).
- Know exactly what you want and like to shout your shoe order to Alexa from your kitchen? Buy it from [amazon.com](https://amazon.com).
- Want to try it on first? Then go to a Nike store.
- Want to try other brands or want to go someplace close? Go to your local shoe or sporting goods store.

The lesson in all of this is: Think about which channels make the most sense to your business and which ones add the most value to your customers' buying experience. You don't have to decide between Amazon or your own e-commerce offering — or other marketplaces for that matter. BPMs considering a multichannel approach need to think about listening, interacting and servicing everyone in the value chain beyond just their paying customers.

An e-commerce platform might address the needs of your paying customers, but how are the rest of the stakeholders in the value chain going to benefit from your technology offerings? How can you support architects/engineers to specify your product in a way that serves their needs? How can you support sub-contractors, who in many cases are the final user of your product, with tools for them to push your product to GCs and architects? Many companies are succeeding with a multichannel offering — would this fit your company vision and strategy?

**Lesson 3: Know who owns your data and what you can do with it.** Companies using Amazon might have several regrets, including giving up margin, lowered brand experience for the customer, and difficulty differentiating themselves with value-added knowledge.

Also remember that Amazon can typically own your customer data. Want to follow up with your customer via email on an order? You'll probably have to do it through Amazon, so know what you're signing up for.

Amazon has amazing technology that can delight your customers with its ease of use for search, shipping, order fulfillment and payments. However, you want to make sure you know the limitations regarding data transparency, customer outreach, personalizing your experience and showcasing the immense amount of product knowledge that BPMs bring to the table.

## Making Headway

In the B2C arena, Amazon has all but annihilated traditional retail by offering a seemingly endless array of products online at very competitive prices. And to cap it off, those products are delivered within hours of ordering, thanks to the company's unbeatable logistics infrastructure.

As Amazon Business continues to make headway in the building products distribution industry, the magnitude of its push is unprecedented. Within FMI's consulting practice, we're beginning to see the Amazon effect disrupt the purchase and delivery of building products to the job site.

In the short term, largely due to a strong economy and 10 years of construction spending growth, building product distributors' sales have remained strong. But as Amazon continues to grow rapidly, and as more B2B sales move online, this situation could quickly change. Add a slowdown in construction spending or disruption in the U.S. and global economy to the equation, and we could see some real threats to BPMs and their supply channels.

It makes sense for BPMs in the distribution channels to act now while sales are strong. Because once the economy takes a turn, it will be more challenging to invest in the appropriate resources to remain competitive with Amazon's business.



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# What Happens to Construction Tech During an Economic Downturn?

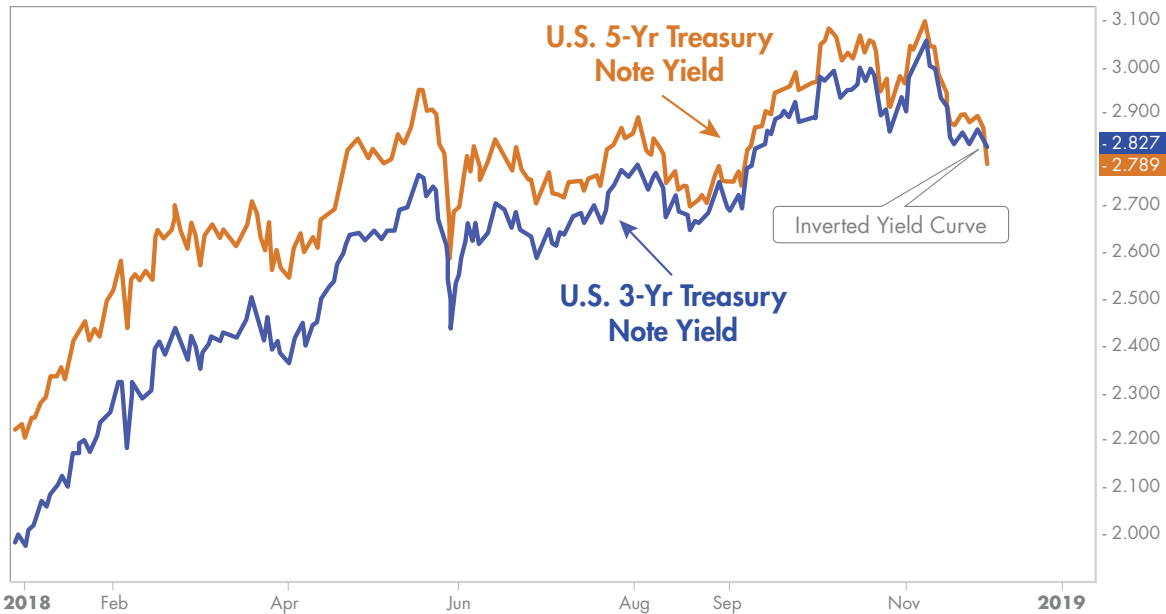
Here's how past recessions have influenced the technology industry and what new construction tech companies need to be doing now to get ready for the next one.

Although the U.S. technology market has been on a full growth swing since the Great Recession, most economists agree that a global economic downturn is likely to happen in the near future. Just a few months ago, it looked like the current boom might go on forever, with no real end in sight. However, when we turned the calendar over to 2019, issues like trade wars, a possible softening of the housing market, potential increases in interest rates, and other social disruptions began to measurably affect the stock market.

Add realities like global terrorism, geopolitical strife and natural disasters to the mix, and it's easy to see just how quickly the "good times" can shift over to a less than desirable business climate. For example, we track the yield curve—which is the yield of fixed-interest securities versus the length of time they have to run to maturity—very closely. When the yield curve inverts, longer-term debt carries a lower yield than shorter-term debt does. Healthy economies generally sport a noninverted yield curve, and it has long been a telltale sign of an oncoming recession when the yield curve does invert. As of December 2018, the five- and three-year note yield curve briefly inverted, and the yields have been neck and neck ever since (**Exhibit 1**).

"It should be noted that when most market watchers and economists warn about inverted yield curves, they're talking more about the 10-year and two-year note yields the vast majority of the time, and not the five- and three-year yields," [Investopedia](#) points out. "With that being said, although the 10-year and two-year note yields have not yet inverted, the spread between the two has become the narrowest it has been since 2007 (when the yield curve was actually inverted). This means that the possibility of an impending inversion has very likely increased."

## Exhibit 1. U.S. Treasury Note Yields (three-year and five-year)



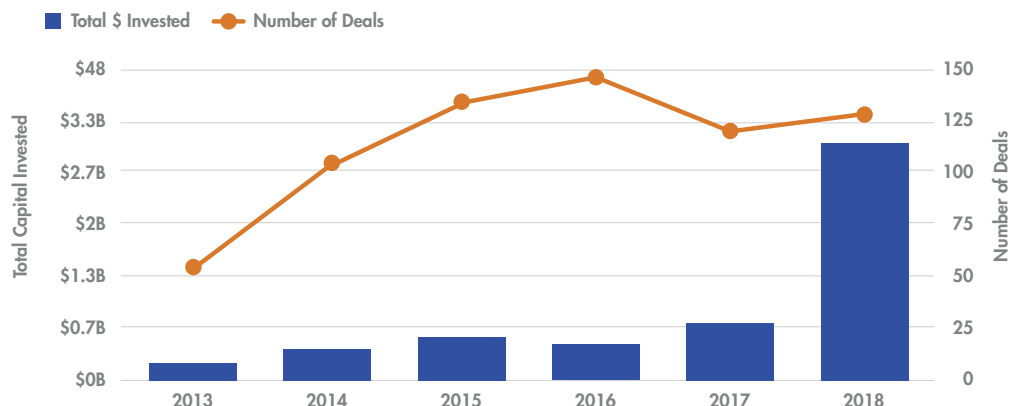
Source: Investopedia

## What Does This Mean for Technology Startups?

Last year was one for the record books on the fundraising front. More than 5,000 startups in the U.S. collectively raised nearly \$100 billion, and global venture capital funding increased to \$207 billion. New York and San Francisco set entirely new historical records for funding in an environment that we haven't witnessed since the infamous dot-com boom in 2000.

## Exhibit 2. VC Investment in U.S. Construction and Building Companies

Based on reported venture funding data for companies in Crunchbase's construction, building material, smart building and green building categories. Excludes PE, debt, post-IPO, and non-equity transactions.



Source: Crunchbase News



In this sea of historical growth, we also watched seed-stage deal share fall for the third consecutive year as investors concentrate more of their funding on later-stage deals, according to [CB Insights](#). As a result, funding opportunities for new startups are becoming more and more limited—a sign that venture capitalists are steering clear of riskier investments in favor of later-stage companies that are already starting to see monetary returns.

This could pose a problem going forward. In an economic downturn, many startups fail because they are “default-dead” to begin with and depend on each funding round to survive or risk running out of cash; this is what killed a lot of tech startups during the dot-com boom and eventual bust.

An example of a probable default-dead startup is WeWork (recently rebranded as “The We Company”)—the workspace sharing company that burst onto the scene in 2017 as another creative addition to the sharing economy. While undeniably popular with the gig economy worker who enjoys rubbing shoulders with other entrepreneurs (and having a beer in the office on Friday), WeWork simply isn’t making any money.

Here’s proof: According to [Crunchbase](#), WeWork has posted around a -105% net margin for two years in a row. In 2018 the company had a revenue of \$1.82 billion, and net losses totaled \$1.9 billion, with assurances from its CFO that growth will “turn positive once the company’s infrastructure costs are out of the way,” [the publication reports](#). Long term, WeWork is expecting to experience massive returns, but this is a model that’s very much at risk during a downturn.

Default-dead startups have become increasingly more common in the past few years because of the sheer abundance and accessibility of venture capital, [Crunchbase](#) asserts. But for a company to weather an economic downturn, it needs to have enough cash in the bank to outlast the recession, or it will be forced to raise money on less than ideal terms.

## Haven’t We Done This Before?

When we think of downturns, the Great Recession of 2008 immediately comes to mind. It was the most recent major downturn, and it affected nearly every business and citizen in the U.S. For the tech industry, however, a far worse recession occurred in 2001 after the internet boom suddenly burst. When this happened between March 2000 and December 2002, the tech-heavy NASDAQ index lost three-quarters of its value.

“If the NASDAQ today experienced a drop like it did in 2000-2002 and the index lost [three-quarters] of its value,” [Axios](#) reports, “it would fall to 2000, squashing today’s cushy portfolios, beheading unicorns and destroying trillion-dollar valuations.”

Of course, there weren’t too many construction tech companies around prior to the dot-com frenzy of 2001. Of the companies that did exist, several of the largest players were internationally based firms (e.g., Sage and CMiC) and therefore weren’t hit as hard when the bubble popped in the U.S. market. The few companies that were publicly traded at the time saw a spike in their stock value toward the end of 2000, and a corresponding drop in 2001.

The handful of domestic industry giants that existed prior to 2000—and that are still around today (e.g., Viewpoint, Trimble and HCSS)—may have avoided the complete and catastrophic failure that the rest of the tech world experienced in 2001 because of the dependence on the construction industry. As it happens, construction wasn’t in a down cycle during that period and was, in fact, going pretty strong.

## How's the Market Reacting?

The greater tech industry recovered slightly during the early 2000s, but it wasn't immune to the Great Recession that took hold just eight years later. Even though technology as a whole bounced back from the recession faster than the rest of the economy and has been in full bull market territory since then, construction tech companies weren't as resilient: Those founded prior to 2007 actually witnessed a sharp decline in valuations in 2008. History repeated itself a year later as those valuations dropped further in 2009.

In the construction tech world, this translated into a drastic contraction in revenue for a lot of companies. Some went bankrupt, and others were forced to significantly reduce overhead. According to [Forbes](#), Procore's staff, which today numbers 1,300-plus full-time employees, shrank to seven people, and both the CEO and his No. 2 were forced to forgo their salaries.

Fast-forward to 2019 and the environment is decidedly more nurturing for technological innovators and the E&C industry, both of which have been enjoying a robust U.S. economy for several years now. The good times may not last. Having recently exited a bear market that reared its head in late 2018, thoughts of recession are clearly on everyone's minds: A recent analysis of Google search terms reveals that the keyword "recession" is at its highest search volume since 2009, with a noticeable spike in the trend in December 2018, when the five- and three-year treasury bond yield curves inverted.



"I'm 100 percent sure there's some kind of downturn on the horizon," Lux Capital's Bilal Zuberi told [Bloomberg](#). "It will be a massive correction." To prepare for the inevitable, he's been encouraging startups to raise as much money as they can right now, trim their costs where possible, and become more disciplined with their financial reporting. He's also advising companies to stockpile cash for acquisitions in case less prepared competitors are forced to sell themselves or their assets on the cheap, according to his interview with [Bloomberg](#).

This advice is already resonating in the market, where many startups are raising funds to have as much padding for the looming recession as possible, regardless of whether they're already hitting (and sometimes surpassing) their growth targets. Procore, the unicorn-status project management software platform, just raised an additional \$75 million in December, thus tripling its valuation despite nearly doubling its revenue and reaching growth goals year over year since 2014, [Crunchbase](#) reports.

## So What Do We Do About It?

Since 2009, cash has flooded into the technology industry as global investors sought out higher returns during a long era of near-zero interest rates set by central banks trying to encourage broader economic recovery, Axios notes. Looking forward, many economists predict a downturn in late 2019 or sometime in

2020. In “[Here Comes the Downturn](#),” Jon Evans writes that “startups and initiatives with experimental initial offerings and potential long-term value will be hardest hit by a sudden unavailability of funding.” So what can startup construction tech companies do now to prepare? Here are five good rules to follow:

1. **Don't deepen your debt.** Don't deepen your bench farther than it needs to go. Don't bet the company on a new project/product offering, and don't completely pivot your company's go-to-market strategy and raise money while you can.
2. **Build a painkiller, not a vitamin.** “Creating something foundational that people really need as an essential element of their business will allow your company to thrive when the markets are low and when they're high,” Techcrunch adds.
3. **Hold onto your cash.** As we've seen in the past, companies that don't have enough cash to make it to the next round of funding before going bankrupt are the first companies to fail in an economic downturn. Having positive cash flow is essential for continued growth in a recession.
4. **Prove you don't need the money.** “By proving you don't need outside investment to survive, you are making yourself much more appealing to potential investors,” Techcrunch states, “even if their access to capital is limited while market activity is low.”
5. **Embrace the shakeout.** Back in 2000, the landscape of the construction technology industry was littered with tiny companies like Procore, which, at the time, did not relish the competition but recognized that a downturn represented a unique opportunity if it could make it to the other side. “Every single one of them disappeared,” Procore's Craig Courtemanche tells Forbes. “If it wasn't for 2009, that landscape wouldn't have been eviscerated, and I can't tell you that Procore would've been the one that emerged.”

With the next economic downturn lurking around the corner, now is the time for construction technology firms to shore up their financial reserves and factor in hard lessons from the past when making business decisions. Even when the business environment is robust and promising, good planning and preparation are the perpetual keys to success.



for the Built Environment

## About FMI

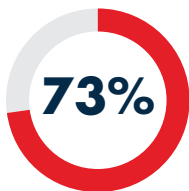
FMI is the leading consulting and investment banking firm dedicated exclusively to the built environment.

FMI serves all sectors of the industry as a trusted advisor. More than six decades of context, connections and insights lead to transformational outcomes for our clients and the industry.

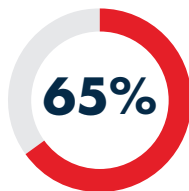
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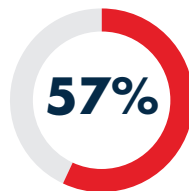
## FMI Client Highlights



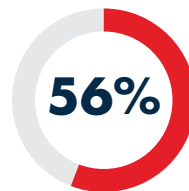
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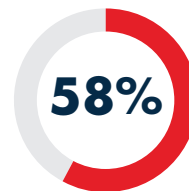
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