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THE AEC PROFESSIONAL'S **ESSENTIAL GUIDE** TO CONNECTED CONSTRUCTION

Embracing a new way of working to solve construction's oldest challenges.

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INTRODUCTION

The thin margins, poor productivity, and labor shortages that characterize the construction industry aren't new problems. Those of us who work in the AEC world have been dealing with these challenges for years. And if we're being honest, we're getting a little tired of hearing about them.

The problems with productivity, profitability, and personnel shortages have been discussed so much, they've lost some of their impact and immediacy. Plus, there are new issues that require our attention like increased health and safety requirements and regulations calling for more sustainable materials and construction processes . At the same time, rising raw material costs and distributed work teams require new and more efficient approaches to how the work is done.



90%

90% of AEC professionals expect to be impacted by sustainability regulations within the next 10 years; 20% expect to be impacted much sooner.

SOURCE: MCKINSEY. THE NEXT NORMAL IN CONSTRUCTION. JUNE 2020.

When you have no shortage of pressing to-dos, it's easier and sometimes necessary to shift focus to what you can control today. Or secretly hope that someone else will figure it out. But we all know that's not how problems get solved.

As individual stakeholders, it's on us to make the changes needed, and we all must do our part. We can't let fatigue lull us into inaction or the perceived enormity of the issues keep us from doing what's needed to tackle the tough problems we face.

NEW WAYS OF WORKING PRODUCE NEW RESULTS

THE GOOD NEWS IS THAT PROGRESS
IS ALREADY BEING MADE.

The pace of organizational change—and specifically digital transformation—was accelerated in 2020. The pandemic forced a shift to cloud computing, mobile technologies, and remote work that have forever changed the way we do our jobs.

Those who weathered the storm with minimal damage rallied their teams around using the technology available to make needed process improvements. In doing so, they’re reaping the benefits of digitization.

11 LEED Gold Westminster Case Study, Trimble, Nov. 3, 2012.
12 Kenley, Russell; Seppanen, Ollie. "Location-Based Management for Construction: Planning, Schedule, and Control". Spon Press. 2010.
13 Ibid.
14 "Vico Software Introduces Vico Office R3." Marketwired. March 30, 2011. Construction Technology Report 2018. JB Knowledge.

Insanity is doing the same thing
over and over again and expecting
a different result. — Albert Einstein



- UP TO A 50% INCREASE IN FIELD PRODUCTIVITY
- 80% REDUCTION IN REWORK
- 10% COMPRESSION OF SCHEDULES
- IMPROVED PROJECT PREDICTABILITY

While it may not have felt like it at the time, the changes forced by the pandemic provided the impetus the industry needed. There's no looking back, and why would we want to?

To borrow from Albert Einstein, the definition of insanity is doing the same thing over and over again, but expecting different results. Said another way, to get new results, you need to do new things.

Fortunately, the wheels are already in motion. We simply need to maintain this forward momentum and make the additional shifts needed to finally address construction’s age-old problems.



Seek culture change

TECHNOLOGY HAS LONG BEEN POSITIONED AS THE WAY FORWARD. AND THERE'S NO DENYING THE PRODUCTIVITY GAINS THAT CAN AND HAVE BEEN ACHIEVED THROUGH GREATER ADOPTION OF CONSTRUCTION TECHNOLOGY.

BUT TECHNOLOGY ALONE ISN'T A CURE-ALL FOR CONSTRUCTION'S CHALLENGES. WE MUST ALSO CONSIDER THE ROLE PEOPLE AND PROCESSES PLAY.

There are many still-untapped opportunities to improve how teams are doing the work and working together across the project lifecycle. Owners, engineers, contractors, and other stakeholders are often not collaborating, communicating, and cooperating as effectively as they could to drive more predictable outcomes and more successful projects.

Because each stakeholder team is relying on their specific tools to do the work, data too often ends up siloed or lost entirely. A lack of data integration makes it difficult to access information to inform decisions or identify areas for improvement.

Even companies with robust ERP systems may still be fighting against disparate data sources and inefficiency because their systems aren't fully integrated. And lacking the incentive or requirement from owners to change, it's all too easy to maintain the status quo.



People process technology model of process improvement



SEVEN UNMISTAKABLE SIGNS

that disconnected construction
processes are working against you:

- 01 · LOW MARGINS
- 02 · DUPLICATE WORK
- 03 · ERRORS AND INEFFICIENCIES
- 04 · LACK OF VISIBILITY
- 05 · TOO MUCH DOWNTIME
- 06 · MISALIGNMENT BETWEEN LABOR/EQUIPMENT/MATERIALS AND SCHEDULES
- 07 · SLOW PAYABLES/RECEIVABLES

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CONNECTED CONSTRUCTION: INTEGRATING DATA ACROSS THE PROJECT LIFECYCLE

Certainly technology plays a key role in digital transformation, but it's the data technology provides that's truly transformational. Each stakeholder's ability to access and use that data when they need it is what makes massive improvements possible.

Standalone point solutions can transform a single workflow, but transforming project delivery requires bigger thinking.

When disconnected teams are producing siloes of disparate data, the losses begin to strip away at the gains at the project level faster than the individual teams can make them.

On the other hand, when the right data is accessible to the right people at the right time, the potential gains to project delivery are transformational. You're able to make big process improvements in the areas that matter most:

- **PRODUCTIVITY**
- **QUALITY**
- **SAFETY**
- **TRANSPARENCY**
- **SUSTAINABILITY**



Sample Technologies & Tools

- GNSS
- LASER SCANNING
- BIM
- MACHINE CONTROL
- CONSTRUCTIBLE CONTENT
- CLOUD COMPUTING
- AI
- ROBOTICS
- MIXED & AUGMENTED REALITY
- IOT
- AI
- WORKER WEARABLES
- COLLABORATION PLATFORMS
- FEASIBILITY SOFTWARE
- ESTIMATING SOFTWARE

Tech drivers of connected construction



PRODUCTIVITY

Hardware and software technology alone or in combination increase the chance of on-time delivery and improve quality improving both task and process oriented workflows.



SAFETY

Task productivity tools help reduce the need for workers to be in risky situations, for instance taking measurements virtually instead of in the middle of a road or creating a constructible BIM model in advance of physical work and running safety scenarios.



QUALITY

Hardware and software technology alone or in combination increase the chance of on-time delivery and improve quality improving both task and process oriented workflows.



TRANSPARENCY

Open collaboration enables key stakeholders to access all of the project data that can help them better understand how to build and report on progress throughout.



SUSTAINABILITY

Minimizing rework is good for both the planet and the bottom line. With Connected Construction, team efforts are directed to optimizing project delivery

TO ADDRESS THE INEFFICIENCIES OF DISCONNECTED DATA, POINT SOLUTIONS AND TECHNOLOGIES ARE BEING INTEGRATED TO FORM BROADER PLATFORMS THAT SOLVE BIGGER PROBLEMS THAN INDIVIDUAL POINT SOLUTIONS EVER COULD.

For example, Trimble Connect, a cloud-based collaboration platform, provides coordinated construction information for all stakeholders across the project lifecycle. By giving everyone involved the ability to share, review, coordinate and comment on data-rich building models in real-time, Trimble Connect closes the disconnects between design and construction processes to keep projects on schedule and on budget.

For infrastructure projects, Trimble Quadri is increasing BIM collaboration by providing a common data environment for stakeholders to share 3D models throughout the project lifecycle. By centralizing design and planning data in a single location, Trimble Quadri helps engineers, owners, and contractors coordinate efforts before ground is ever broken, as well as efficiently manage assets after construction is complete.

WATCH VIDEO:



Deliver with confidence.

What you can achieve with connected construction

CONNECTED CONSTRUCTION IS CAPABLE OF SERVING AND CONNECTING ALL STAKEHOLDERS ACROSS THE LIFECYCLE OF CONSTRUCTION PROJECTS.

By closing the gaps between people, processes, and technology, Connected Construction helps everyone make better decisions from the start. And when problems do arise, you're able to identify and resolve them faster.

The hallmarks of Connected Construction are an open ecosystem, shared data, and real-time updates to that data. When you combine these powerful capabilities, you unleash the ability to make dramatic improvements like:

- **Expand margins and market share**
- **Overcome the labor shortage**
- **Increase efficiency and sustainability**
- **Improve worker and jobsite safety**
- **Gain a competitive advantage**



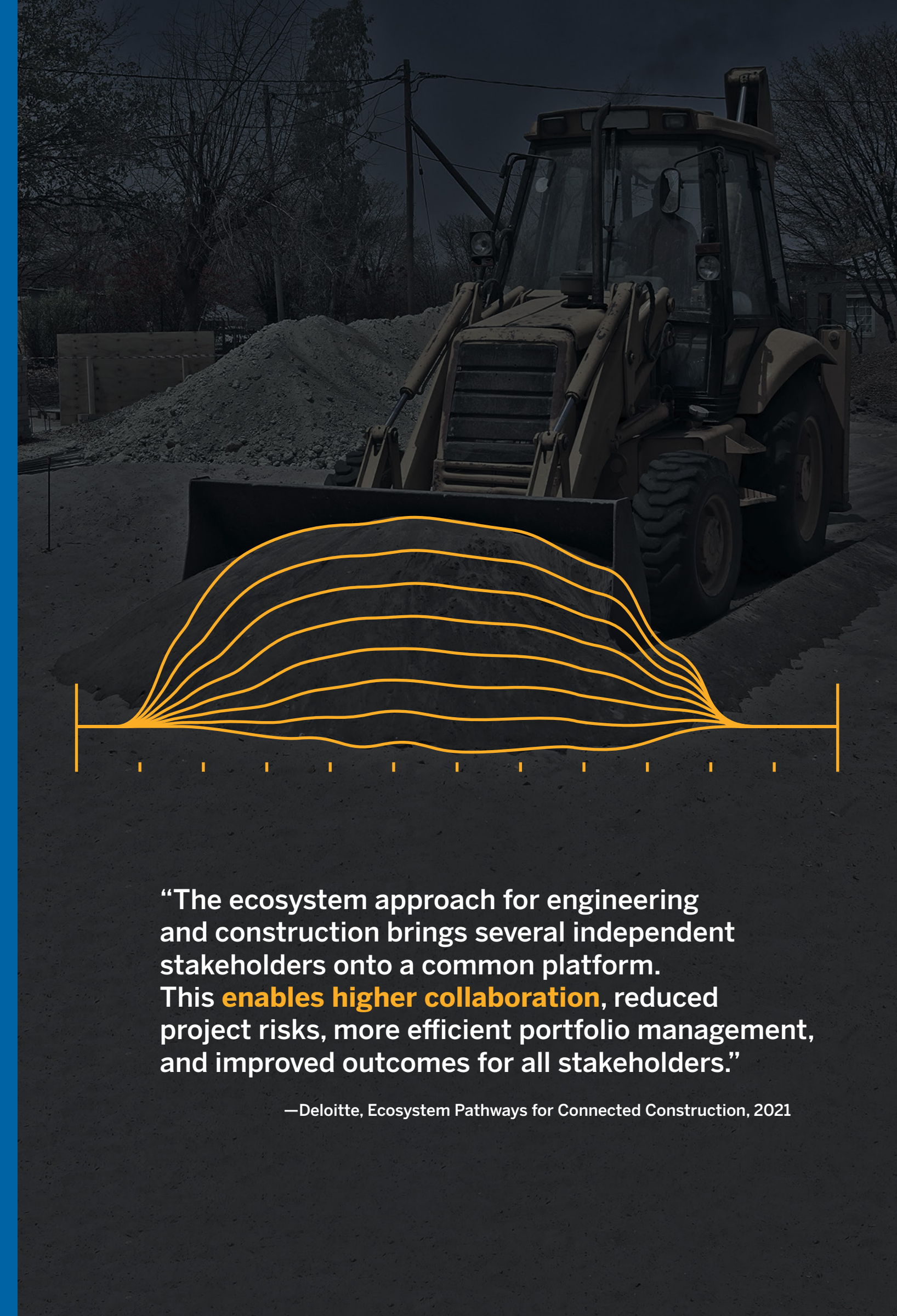
“Connected construction technology could **enhance** how E&C companies deliver construction and infrastructure projects, drive down costs, and improve overall project execution and timeliness.”

—Deloitte, Winning with Connected Construction, 2019

OPEN ECOSYSTEMS FOSTER COLLABORATION, AND **SAVE TIME AND MONEY**

Imagine providing coordinated construction information for everyone across the project lifecycle. Every stakeholder can share, review, coordinate and comment on data-rich building models in real-time. Connected Construction makes this level of collaboration a reality.

By enabling co-located data and data sharing in an open ecosystem, Connected Construction gives everyone access to the same information and ensures everyone is on the same page. You can feel confident knowing that all stakeholders have the most recent set of plans and are working toward the same goals.



“The ecosystem approach for engineering and construction brings several independent stakeholders onto a common platform. This **enables higher collaboration**, reduced project risks, more efficient portfolio management, and improved outcomes for all stakeholders.”

—Deloitte, Ecosystem Pathways for Connected Construction, 2021

Case study

Volkerwessels drives technology innovation and transformation across the construction lifecycle.

CHALLENGE:

As a large, global construction company, VolkerWessels was challenged to efficiently share high-quality, timely project information among key stakeholders. The volume of data scattered across the company and their projects often slowed productivity and increased (failure) costs, making it difficult to rely on information to make informed decisions.

SOLUTION:

Trimble Connect, Trimble ProjectSight, Trimble Vico Office and more.

RESULTS:

- **Building a data-centric approach to BIM: Bringing together unstructured data into a common data environment is adding order, richness and value to project data while improving information sharing.**
- **Unlocking the value of the constructible process: A common data environment enabled by Trimble technology is the key to unlocking the real value of building information and workflows based on constructible data.**
- **Streamlining and enhancing collaboration: More efficient sharing of 3D models, data and project information between key project stakeholders facilitates enhanced collaboration.**

Driving greater value: Using constructible models to guide decision making enhances the accuracy and efficiency of the design, build and operate phases of construction

READ THE FULL STORY

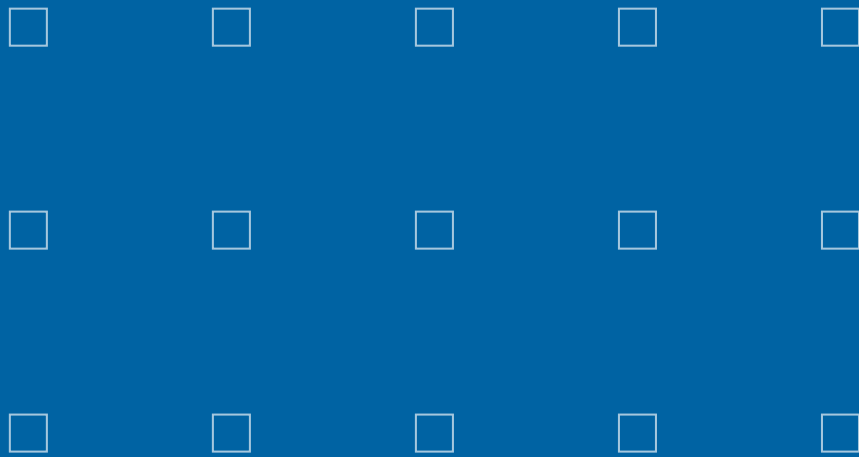


Shared Data makes outcomes more predictable and sustainable

While some people have the experience or natural ability to visualize 2D information and form an accurate picture of the final product, many more do not. By giving stakeholders access to 3D models, you're able to help them develop a shared understanding and visualization of the desired result and work together to achieve it.

Connected Construction enables this data sharing, ensuring everyone is in sync. It also supports the use of federated BIM models. Federation allows each stakeholder to use their own detailed models. These individual models are then federated to create a single, complete model of the overall project. Each team is able to use their specific models to guide their work, while also understanding how this work fits into and impacts the bigger picture.

When everyone understands where things stand and what needs to happen next, there's less room for error. And fewer errors mean less rework and waste. All stakeholders gain the data access needed to accurately and consistently visualize the end goal — and produce more predictable and sustainable outcomes.



5 WAYS CONNECTED CONSTRUCTION INCREASES SUSTAINABILITY.

The answer to increasing environmental sustainability and lowering the construction industry's carbon emissions, costs, and material waste lies in Connected Construction. However, in order to eliminate waste, boost productivity, and truly enable a connected team, changes must be applied across the entire construction continuum. Here are five ways Connected Construction technologies help clean up construction.

1

Before construction begins, architects, engineers, and designers can use software and analytics technology such as **SketchUp PreDesign and Sefaira** to create eco-friendly models, while also considering other aspects of the project's environmental impact such as material, water, and energy needs.

With advances in technology, users can explore different concepts nimbly and with ease, without fully defined parameters, to make **sustainable design** decisions.

2

During site prep, augmented reality on excavators gives operators the ability to view **3D models in a real-world** environment at a true-life scale, right inside the cab in the context of their existing surroundings.

These machine control systems are improving the accuracy and efficiency of heavy earthmoving equipment, thereby accelerating job completion and using less fuel.

3

3D scanning technology in the field is also reducing waste throughout a project's lifecycle. Field layout is an essential task in which accuracy is a necessity and errors can lead to rework and delays that can come at significant economic and environmental costs.

Using advanced 3D scanning technology provides more precise data, and exporting the exact point data from a **constructible model** to a total station can eliminate errors and dramatically increase productivity in the layout process.

4

File-sharing systems such as **Trimble Connect and Trimble Quadri** can ensure that everyone has the most recent set of plans and is working toward the same goals.

By collaborating with all stakeholders, knowing what is expected and having the right equipment in place, there is less room for error.

5

With intelligent data fueling fabrication and offsite prefabrication, companies can generate more **accurate material estimates** that reflect the actual project requirements.

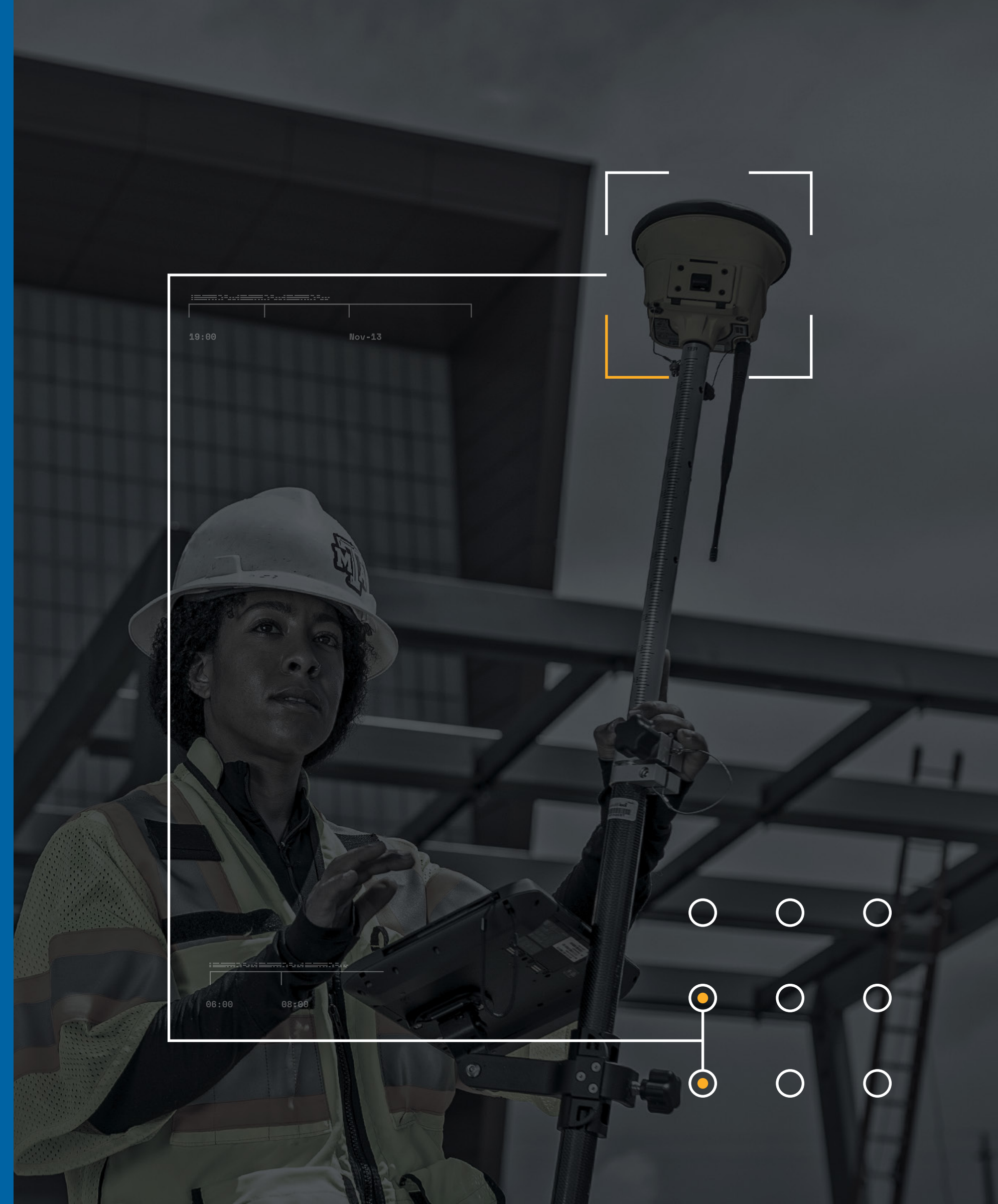
This alleviates the tendency to order extra building supplies "just in case," which contributes to several forms of unnecessary waste.

Breaking down communication barriers and encouraging collaboration and data sharing across project teams is critical for reducing waste and wasted effort. A constructible approach grounded in a Connected Construction ecosystem helps streamline construction throughout all phases of a project, eliminating waste and leading to greater sustainability, which will benefit businesses and the environment for years to come.

REAL-TIME INFORMATION ENABLES **FASTER DECISION** MAKING AND GREATER EFFICIENCY

Decision Making and Greater Efficiency
Bridging the gaps between the field and office is the key to unlocking greater productivity. Connected Construction provides the real-time project information teams need to make better and faster decisions. Given that it traditionally took days or months to collect and analyze data from the field, this presents a significant opportunity.

Without up-to-date information on project changes, job costs, equipment usage, defect reports, and other facets of the project, the potential for errors and costly rework is high. Connected Construction makes it possible to roundtrip data from field to office to shop and back again to ensure everyone has the most up-to-date and accurate data possible.



Case study

Dave Steel Company uses real-time data insights to save time & speed decision making.

CHALLENGE:

Dave Steel Company has been fabricating structural steel for projects throughout North America since 1929. The company was using a mix of disconnected software and external processes that made functions like job costing and purchase orders time consuming. They needed more accurate, timely and insightful data to be as productive, adaptable, and profitable as possible..

SOLUTION:

Trimble Viewpoint, Tekla PowerFab

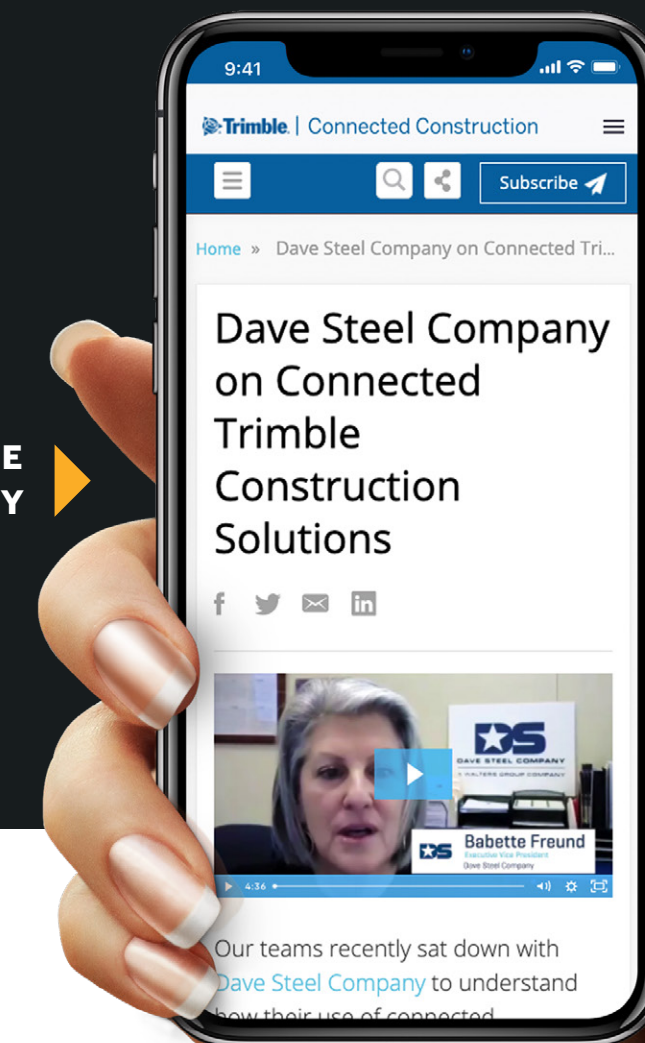
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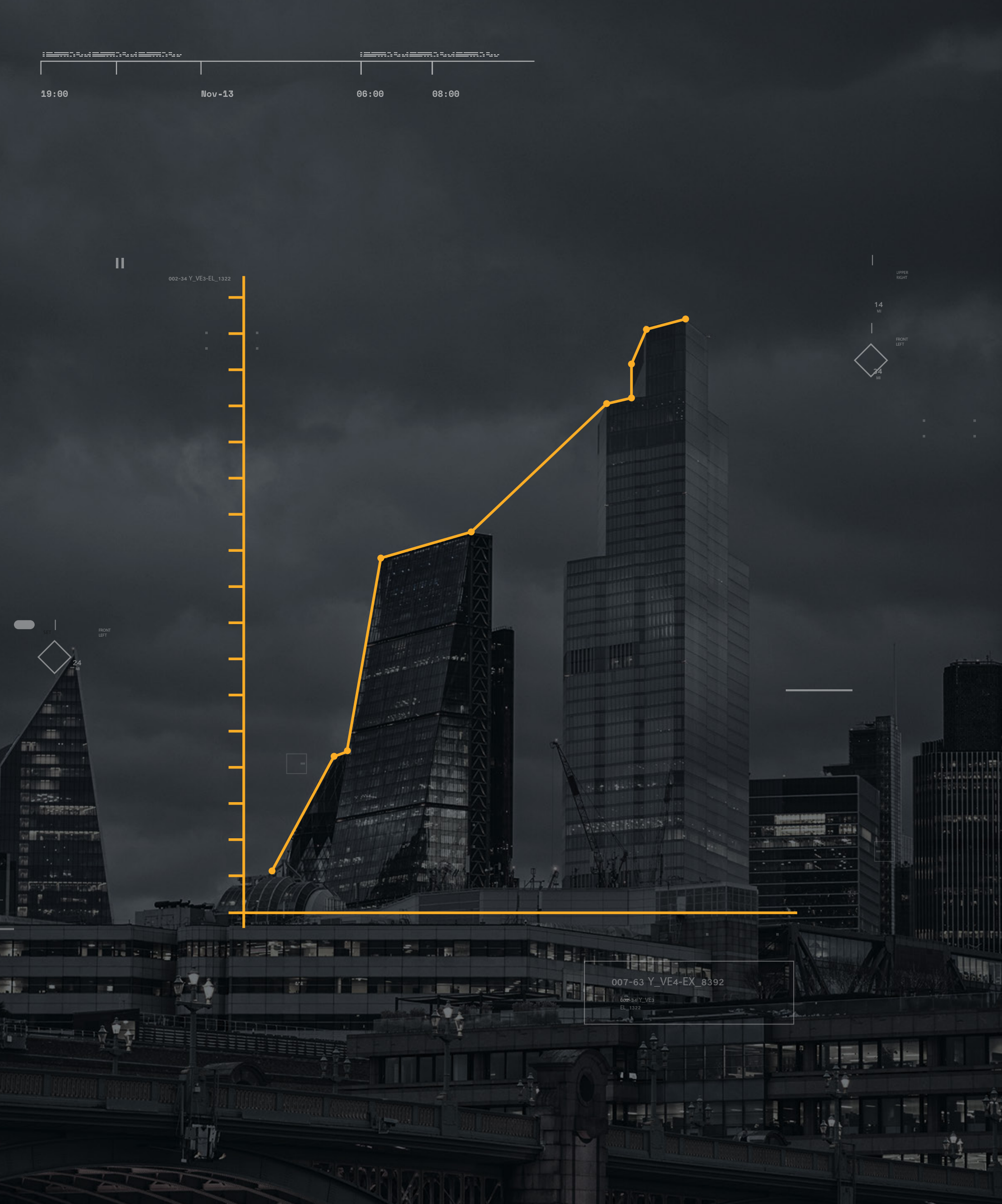
- **Gaining more accurate, timely, and uniform data: A truly connected construction and fabrication process and fluid workflows between ViewpointOne and Tekla PowerFab solutions provide the real-time data needed to make better, faster decisions.**
- **Reducing admin demands: Real-time data capabilities, automated workflows, and cross-functional collaboration between the back office and the shop eliminate the need to reconcile data across functions, yielding significant time savings.**

“The best decisions are based on data and the riskiest decisions are based on intuition. Any time you can maximize technology use and combine that with empowering your team to truly understand what they’re doing and why, you’ve given yourself a competitive advantage.”

— Babette Freund,
Executive Vice President, Dave Steel Company

READ THE
FULL STORY





Making Connected Construction work for you

Given the costs and risks, maintaining the status quo really isn't an option. Transformation is both necessary and achievable, and it starts with a long-term commitment to making needed improvements.

Large-scale organizational change is generally best driven from the top down. Support from the highest level gives transformation efforts not just the attention they need but the cross-functional collaboration they require. Alignment across goals, people, process, data, and tools is critical to success.

HERE'S HOW TO GET STARTED



1

IDENTIFY YOUR OBJECTIVES

Every transformation initiative should start with clear objectives that tie to larger company goals. This will ensure that the initiative receives the attention, support, and focus needed. The outcomes of Connected Construction become even more valuable when they align with larger strategic initiatives and economics within the company.

Like any objective, the more specific you can be, the better. Quantify the objectives in terms that are clearly measurable and easily remembered. Some examples include maintaining a zero-incident safety goal, cutting material waste by 50% over a 24-month period, or in the case of Barton Malow, doubling efficiency by 2024.

“Leveraging a constructible process was instrumental in helping us achieve our efficiency goals.”

— Matt Hedke, Manager of Self-Perform, Barton Malow.

Barton Malow makes strides to double efficiency by 2024.

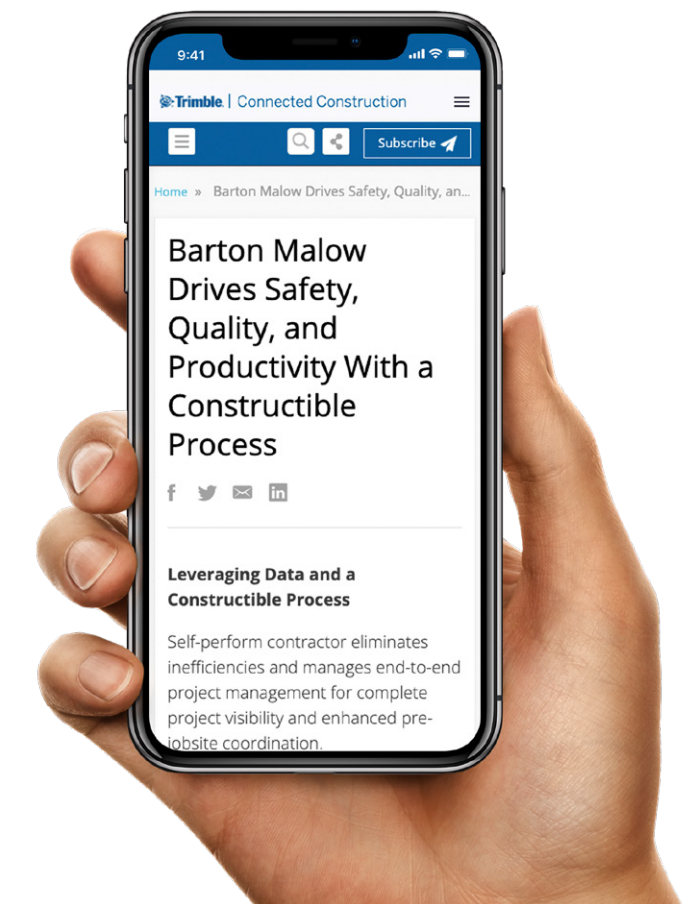
A full-service general contracting firm with clients across the U.S., Barton Malow is taking a constructible BIM approach using Trimble technology. Combining design, project management and engineering models into Trimble’s collaboration platform, Barton Malow can use data from different sources to make more informed decisions before build and beyond.

This proactive method gives all stakeholders complete visibility so they can coordinate, adjust or modify project aspects before arriving on a job site. By minimizing workflow inefficiencies, all stakeholders across the entire project lifecycle can achieve a final result that’s built to its best potential and creates a competitive advantage.

Building off of their strategic initiative to double efficiency by 2024, Barton Malow’s self-perform division has achieved:

- A 15% increase in concrete rebar productivity.
- Improved accuracy and enhanced knowledge transfer between stakeholders.
- Better analysis of BIM models to uncover “clashes,” streamline workflows, and bring greater transparency to all building projects.

READ THE FULL STORY



2

READY THE ORGANIZATION

Your Connected Construction initiative needs more than a budget for technology; it needs top-down support and endorsement. Collaboration must become integral to your culture, focus, and execution.

For processes to change, a company needs to help teams see the value of the new process and provide ongoing support through frequent communication and skills development. Whether implementing a new way to do quantity take-offs or moving to fabrication-level models, mechanisms are needed to build trust and confidence in the re-engineered process and help drive innovation and efficiency across functions and business areas.

Your transition to Connected Construction won't happen overnight. To ensure momentum is maintained, it must be anchored in milestones and measured with clearly defined metrics. This way, you can track and communicate results, celebrate successes, and keep everyone focused for the long haul.

Photo courtesy of VolkerWessels/DigiBase

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CAPITALIZE ON EXISTING DATA

Inventory the data your company currently collects, quantify the value you're getting from it, and explore new ways it can help you make better and faster decisions. Also consider the type of data you could be collecting with the tools you already use.

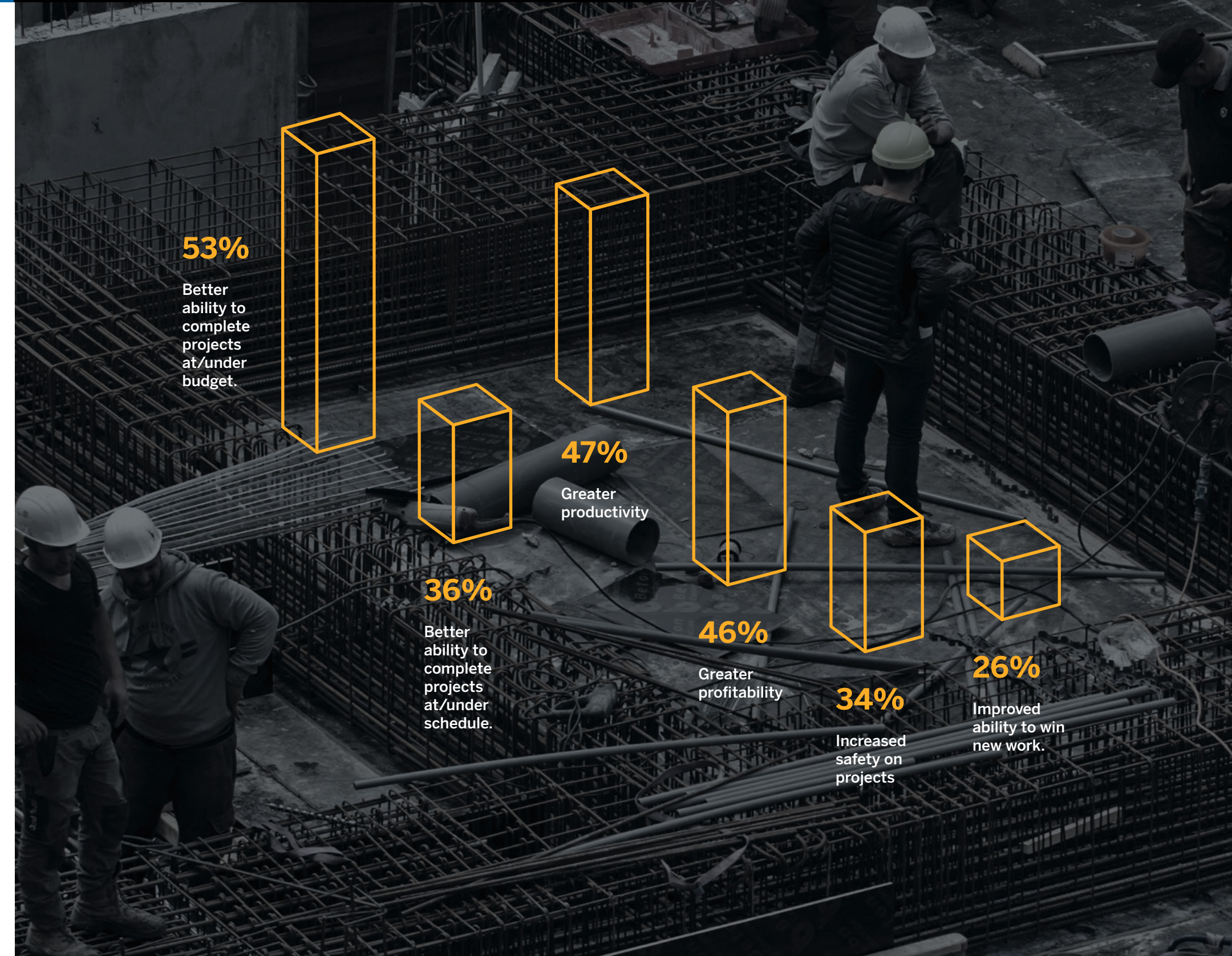
With this understanding, you can finetune your focus and create a plan that produces early wins. Because data is invaluable in a Connected Construction ecosystem, fostering a company culture that values data as a core asset and continually seeks to capture, curate, and use data for maximum effect is key to maximizing the benefits Connected Construction will produce for your company.

BENEFITS OF IMPROVED DATA GATHERING AND ANALYSIS CAPABILITIES.



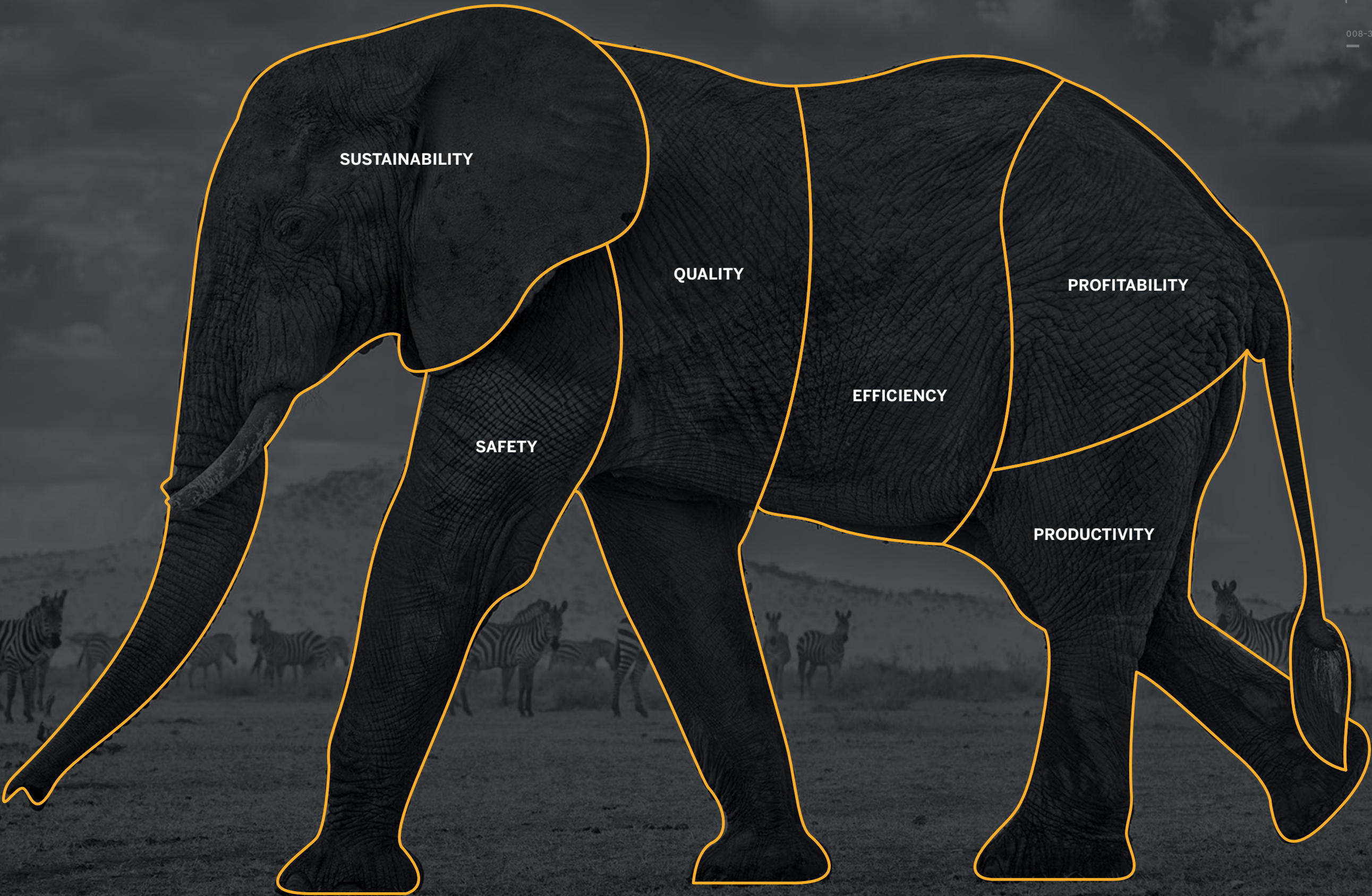
Contractors who reported improved data gathering and analysis selected the top three benefits generated by the improvement. below are the percentages that include each benefit among the top three.

Better budget compliance tops the list, followed closely by improved productivity, profitability and safety.



While making these shifts is admittedly easier said than done, the costs and risks of doing nothing make it well worth the effort. There's a saying that **the way to eat an elephant is one bite at a time.** The same is true of implementing Connected Construction at your company.

By taking the steps needed to get your transformation off to a good start, you'll reap the benefits in the form of improved productivity, quality, safety, transparency, and sustainability.



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The construction industry has dealt with the same problems for decades now. **Point solutions can make incremental improvements**, but to make massive strides we need to address the disconnects between people, processes, and technology that exist today.

Connected Construction closes the gaps and creates transparency by providing an ecosystem for all stakeholders involved in the project lifecycle to access and share data, and work collaboratively toward a common end result.

From designers, architects, and engineers to general contractors, subcontractors, and building materials suppliers, **when every stakeholder knows** what decisions are being made, who is making them, and why, the results of those decisions are more positive, predictable, and profitable.



**Give
the right people
the right data
at the right time
to make the right
decisions.**



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