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Better Infrastructure with Better Connected Data

A Guide to **Digital Project Delivery** for Owners

ew Investment Presents New Hurdles (and Opportunities)

As asset owners tackle the monumental challenge of revitalizing America's transportation and infrastructure systems, industry stakeholders are confronting the reality that you can't build the infrastructure of the future by relying on outdated processes. To meet the demands of today and tomorrow, infrastructure assets need to be engineered, built, and operated with efficiency, sustainability, and resiliency at the forefront.

Infrastructure owners are under pressure to:

- Prove that projects deliver the value they've promised.
- Meet increasing requirements for sustainability.
- Be transparent about the allocation of public funds.
- Demonstrate job creation and positive socioeconomic impacts.
- Establish clear lines of accountability for budgets and outcomes.

Beyond these challenges is a rare opportunity to leave a lasting legacy by reimagining the critical systems that will serve generations to come. To meet the moment, owners need better visibility into project costs, timelines, and workflows to gain greater control over the factors that cause projects to go over budget and get delayed. Achieving better visibility and control hinges on better collaboration and data sharing among all project stakeholders.

Digital project delivery gives you the transparency needed to reduce risk, make more informed decisions, and gain a deeper understanding of an asset at any given time—whether during the plan, design, build, or operational phase. By having project teams leverage connected construction technologies, you can realize the cost- and time-saving benefits of digital project delivery across the entire asset lifecycle.

Read this guide to learn more about digital project delivery and how it can help you gain the visibility and control you need to deliver the best possible outcomes and demonstrate the value of infrastructure investment.

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Why Infrastructure Assets Need to Be Delivered Differently

Infrastructure projects have generally been touted for their economic benefits. And while taxpayers and stakeholders will continue to scrutinize the economic value of new and improved roads, bridges, airports, utilities and more, new pressures are emerging as well. The landscape of infrastructure investment has changed, and so have the expectations of key stakeholders. Here's how.

Financing

Even with federal funding, additional investment is needed to meet the demand for revitalized infrastructure. Owners must do more with less or seek out public-private partnerships (P3s). P3s come with additional challenges, such as the allocation of risk, that owners must address.

Accountability

When projects don't deliver on their promise or have negative effects on communities, the resulting loss of public trust may put future investments at risk. Owners need the ability to monitor and control costs and outcomes throughout the entire asset lifecycle.

Sustainability

Sustainability is perhaps the largest collective challenge of our time, and infrastructure asset owners face increasing pressure to reduce harm to the environment. For starters, infrastructure sets the foundation for the creation of sustainable communities, where economic development, community development, and environmental protection are considered equally. Sustainable communities are built to meet people's diverse needs while ensuring the availability of resources for future generations. Examples of sustainable community initiatives include reducing car dependence, retrofitting buildings to be grid-flexible, and improving water quality.

Infrastructure is also critical to reducing greenhouse gas emissions. The **Organisation for Economic Co-operation and Development (OECD)** warns against the "lock-in" of greenhouse-gas intensive assets. Whereas most existing infrastructure was built at a time where fossil fuels were cheap and abundant, the next generation needs to accommodate a broader range of energy sources and do so with affordability and equity in mind. Failing to build for future energy demands can create a locked-in effect, which limits our ability to reduce dependence on greenhouse gases.

Financing partners and programs are also concerned with sustainability, as their stakeholders, and the public at large, grow more focused on environmental concerns.

Getting at the Heart of Greener Construction

The impact of rework and RFIs is often overlooked, but these generally accepted construction processes contribute significantly to the environmental harm caused by construction. Every time an error is fixed, materials and fuel go to waste. And it's difficult to recycle materials once they're delivered to the job site. By fostering earlier, more frequent collaboration and data sharing among project stakeholders, owners minimize these inefficient activities and their detrimental effects.

By taking a lifecycle approach to sustainability, you can reduce waste and emissions during construction and extend the lifespan of assets through upgrades and retrofits.

Evolving User Demand

A lot has changed since the last major infrastructure investment. Diverse energy sources—like solar, wind, and natural gas—require new pipelines and storage mechanisms, as well as more flexible energy grids. Electric vehicles are becoming more commonplace every day. Suburbs have expanded into exurbs, and urban areas are undergoing a transformation as well. The way our communities work has changed, and infrastructure has to evolve to support that shift.

Digital Transformation

New technologies, ranging from IoT sensors to digital twins, have the potential to streamline asset operations and maintenance and reduce costs. Considering these technologies during the design and construction phases of a project enables you to maximize their benefits.

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Responding to Change with Construction Technology

To meet the challenges of these changing dynamics, owners need better access to data throughout the project lifecycle. Digital project delivery is the key to gaining that access and promoting the collaboration needed to increase construction project efficiency. Owners can play a critical role in driving technology adoption by requiring the various teams involved in any project—from designers, to contractors, to operators—to leverage tools that break down information silos.

Because cost can be a major barrier to technology adoption, the U.S. government is providing support for owners who want to incorporate digital project delivery into their projects. In addition to existing grants, like the Federal Highway Administration's (FHWA) Accelerated Innovation Deployment Demonstration Program, the **Bipartisan Infrastructure Law** includes $100 million for the deployment of advanced digital construction management systems.

The funding will be allocated to a program with the following goals:

- Support states in implementing technology to maximize interoperability, boost productivity, and reduce project delays and overruns throughout the construction lifecycle.
- Reduce reliance on paper documents to increase the timeliness and effectiveness of information sharing.
- Help state and local governments adopt tools that help them integrate technology into contracts and weigh the costs of digitization more effectively.
- Reduce the environmental impact of construction projects.

Executing infrastructure projects has grown more complex, but these funding opportunities encourage innovation. And, by adopting technology that bridges gaps between project stakeholders, and influencing them to do the same, you can address some of construction's most difficult problems and set yourself up to maximize the long-term performance of your assets. That's why digital project delivery is so important.

What Is Digital Project Delivery?

Digital project delivery is the use of digital data to plan, design, construct, inspect, and record as-built conditions during the delivery of a construction project. It includes the following elements:

Standards

Infrastructure assets are built and maintained by a diverse set of stakeholders. To implement digital project delivery, each stakeholder must march to the beat of the same drummer. That means that guidelines need to be established before implementing technology and before collecting data.

Digital Strategy and Standards

Instead of adopting technology simply for the sake of it, digital project delivery requires a strategic approach. Goals must be set, along with standards that support achieving them.

Execution Plan and Data Standards

To achieve the goals established in the strategy, owners and stakeholders must clearly outline roles, responsibilities, and processes that will be used in the course of a project, as well as the data standards needed to support interoperability.

Technologies

With guidelines in place, teams can start onboarding the technologies that will support digital project delivery. The key aspect that sets these technologies apart is collaboration. They don't just enable teams to digitize project information, they allow for that data to be easily shared among teams.

Common Data Environment (CDE)

Being able to share data depends on your ability to centralize it. A CDE enables all project teams to access and upload relevant information from various systems and devices.

Reality Capture

Laser scanning and photogrammetry technology allow for more detailed, accurate, efficient capture of an object and/or site conditions. These technologies also support the development of 3D models that accurately portray the real assets.

Office-to-Field Technologies

Cloud-based tools that support data sharing between office teams and on-site workers enable all involved to identify and resolve problems more quickly, track progress and materials usage more accurately, and automate workflows like invoicing, RFIs, and more.

Machine-Controlled Construction Equipment

By leveraging data from 3D models, machine control technology improves operator accuracy and speed while also reducing waste. Data from the machines can be fed back to the model or CDE, leading to higher levels of transparency for all stakeholders.

Augmented Reality (AR)/Virtual Reality (VR)/Mixed Reality (MR)

By enabling workers to visualize 3D models in the context of the physical environment, AR, VR, and MR technology can improve planning, progress tracking, and on-site execution.

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Data

While technology makes digital project delivery possible, the data that it provides is what truly empowers owners and other project stakeholders to be more informed and transparent, and to solve the complex challenges of modernizing America's infrastructure.

Existing Conditions

Digitizing data on existing conditions enables more effective planning and problem-solving throughout the project lifecycle. Disparate models can be combined to provide a more comprehensive visualization of the project in progress.

As-Built Conditions

Digitizing as-built conditions requires project stakeholders to collect and centralize data as the project unfolds, leading to better collaboration and data transparency. Digital as-builts also support the development of digital twins.

3D+ Engineered and Constructible Models

Data-rich 3D models that are designed to incorporate all of the detail needed to build and fabricate assets improve transparency and collaboration and allow for early mitigation of risks and resolution of conflicts.

Benefits of Digital Project Delivery

Integrating digital project delivery into your projects yields a number of benefits throughout the asset lifecycle, with the primary benefit being the reduction of risk. The digitization of processes, along with standards to regulate how tasks and information are handed off between teams, enables each contributor to work more effectively. It reduces the guesswork involved in estimating, resource allocation, and equipment management. Being able to visualize models allows team members to identify conflicts proactively, instead of reacting as they arise. And real-time visibility into project progress makes it possible to spot potential delays before schedules and budgets are impacted.

Increase efficiency and productivity

Breaking down data silos and promoting collaboration reduces the errors and miscommunication that lead to rework, materials waste, and unnecessary greenhouse gas emissions. Project teams spend more time on productive tasks instead of hunting down information and making corrections.

Improve decision-making

When data is accessible and actionable across all relevant teams throughout the project lifecycle, every stakeholder has the opportunity to level up their analysis capabilities. That's exactly what's needed to solve complex infrastructure challenges, deliver higher-performing assets, and extend asset lifespans during the operational phase.

Ensure transparency and accountability

Having a single source of up-to-date information gathered from the various project teams empowers owners to better understand the costs and impacts of an asset, and communicate them to the public. It also sets you up for data-driven operations and maintenance, so you can continue to save time and money throughout the asset lifecycle.

Maximize BIM for Infrastructure

Although BIM is useful for stakeholders involved in every phase of a project, it's often used solely in the design phase. To build better, more efficient assets, project teams must move beyond individual BIM deliverables to shared models and 4D/5D data. Digital project delivery encourages designers to design to a higher level of detail and sets the stage for non-design professionals to collaborate using a shared model, ultimately expanding the scope of BIM. With broader adoption of BIM, true constructibility is achievable and AEC pros are better able to mitigate risks before work begins, delivering higher infrastructure value.

Design, Build, Operate

Digital Project Delivery in Practice

To implement digital project delivery, you need connected construction technologies that enable efficient data sharing and collaboration between all stakeholders. Consider requiring project teams to **agree to principles** that ensure the continuity and accuracy of data and processes. For example:

- All parties must agree to maintaining all documents, models, and project data in a common data environment.
- Stakeholders must keep all parties up to date on their progress as the project unfolds.
- 3D models should be geo-located to provide additional context to the design.
- Project teams may use the technology of their choice as long as they are able to meet the requirements of their phase of the project.
- Participants agree to use automations that support efficient workflows.

Design

The technologies used in the design phase of a project heavily influence the capabilities of the teams working in subsequent stages. To support digital project delivery, those tools must be collaborative.

Centralized Data Access and Sharing

Requiring that all stakeholders connect with a single source of truth removes the data barriers and information silos that can hinder large infrastructure projects. Using a system that provides the necessary capabilities of a **CDE**, you can make models and critical project data accessible to the right people, at the right time.

With centralized data access and sharing, you can:

- Mitigate risk by ensuring all parties have access to the same, up-to-date project data.
- Reduce time spent transferring data between various vendors and between the office and the field.
- Enable full data portability without sacrificing the integrity of that data.

While a CDE is used throughout the entire project, implementing it at the design phase is essential to realizing the benefits of digital project delivery throughout the full asset lifecycle.

Digital Design Collaboration

A data-rich 3D model can be the foundation for many other technologies used throughout the project. Starting the design process with a cloud-based digital design collaboration tool (a functionality that can also be supported by some CDE solutions) sets the project up for success.

With the right design collaboration tool, you can:

- Improve transparency for owners by providing access to current model(s).
- Reduce friction between design professionals by allowing them to work in a single environment.
- Support designing to higher levels of detail to reduce errors and rework.

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Build

As the project enters the construction phase, the number of stakeholders increases, along with the potential pitfalls. At this stage, technologies should provide the various teams with the clarity they need to execute tasks more efficiently and confidently.

Integrated Project Management

Internet-based **project management information systems (PMIS)** standardize, streamline, and automate design reviews, bid processes, and other workflows throughout the course of the project. And **job site management software** gives site supervisors and project managers the tools they need to monitor activity on the job site.

To facilitate project visibility and stakeholder accountability, use project management systems to:

- Gain real-time clarity on work progress, machine productivity, and as-built data.
- Enhance accountability by simplifying contractor scheduling and reporting and providing owners with actionable data.
- Integrate with financial/accounting, facility management, design, and mapping systems to improve internal processes and data sharing.
- Be more transparent to taxpayers as design and construction are in progress.

Connected Field Technology

Various technologies, ranging from machine control to **high-speed laser scanners** to GPS-enabled augmented reality devices, connect the office to the field and improve the efficiency and accuracy of activity on the job site.

Use connected field technology in your digital project delivery to:

- Drive more accurate, frequent data collection without necessarily requiring more workers on site.
- Support 3D visualizations in the field, increasing the speed of decision-making and allowing teams to identify issues earlier.
- Relieve site workers from performing tasks that are unsafe or inefficient for humans to do on their own.

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Operate

Once an asset is up and running, connected construction technologies provide operations and maintenance teams with the data they need to make more cost-effective, sustainable decisions while still meeting the needs of asset users.

Digital As-Builts

Specifying the use of a digital as-built (DAB) and/or digital twin unlocks powerful operations and maintenance capabilities for owners. The process of producing a digital twin or digital as-built requires project stakeholders to continuously centralize data in a common data environment as the project unfolds, adding to the benefits provided by the twin itself. Because of their many benefits, DABs are a key focus of the **FHWA's Every Day Counts program**.

Use digital as-builts to:

- Visualize and monitor construction progress.
- Enable connectivity and visualization of data collected by IoT sensors.
- Access asset lifecycle data that simplifies O&M decision-making and eases onboarding of new team members.
- Improve analysis, decision-making, and reporting by adding layers of data in stages, using a phased approach.

GIS-Centric Asset Management

Managing public assets with a system that incorporates geographic information system (GIS) data empowers owners to put the vast amount of geospatial data relevant to an asset in visual context.

Making GIS maps an integral part of your digital project delivery allows you to:

- Track the environmental and human impact of infrastructure projects.
- View multiple assets in tandem to understand how they interact with one another.
- Facilitate the efficient long-term maintenance and operations of the asset across the entire lifecycle.

Tracking Water Leaks with Technology and a Canine

Central Arkansas Water uses a **maintenance management system** to track leaks sniffed out by its water leak detection dog, monitor his accuracy, streamline the workflows triggered, and keep track of associated costs. To learn how Central Arkansas Water implemented this innovative program, read the **case study**.

Optimized Asset Maintenance

With optimized asset maintenance, owners proactively keep the asset network in a state of good repair, instead of being reactive and waiting for major problems to occur that require more costly rehabilitation and reconstruction. This forward-looking approach requires that multiple internal stakeholders—such as safety, asset planning, maintenance operations, contracting, and purchasing teams—work together to accurately forecast maintenance needs. Having the right data via an **asset lifecycle management solution** is essential to making accurate predictions and ensuring the right work is done on the right assets at the right time.

Using optimized asset maintenance, you can:

- Maximize the impact of infrastructure investments by extending the lifespan of the assets.
- Improve the performance of the entire asset network vs. fixing a few "bad" assets.
- Increase mobility by minimizing traffic disruptions and asset downtime.
- Improve asset safety while reducing major repair costs.

Intelligent Rail Monitoring

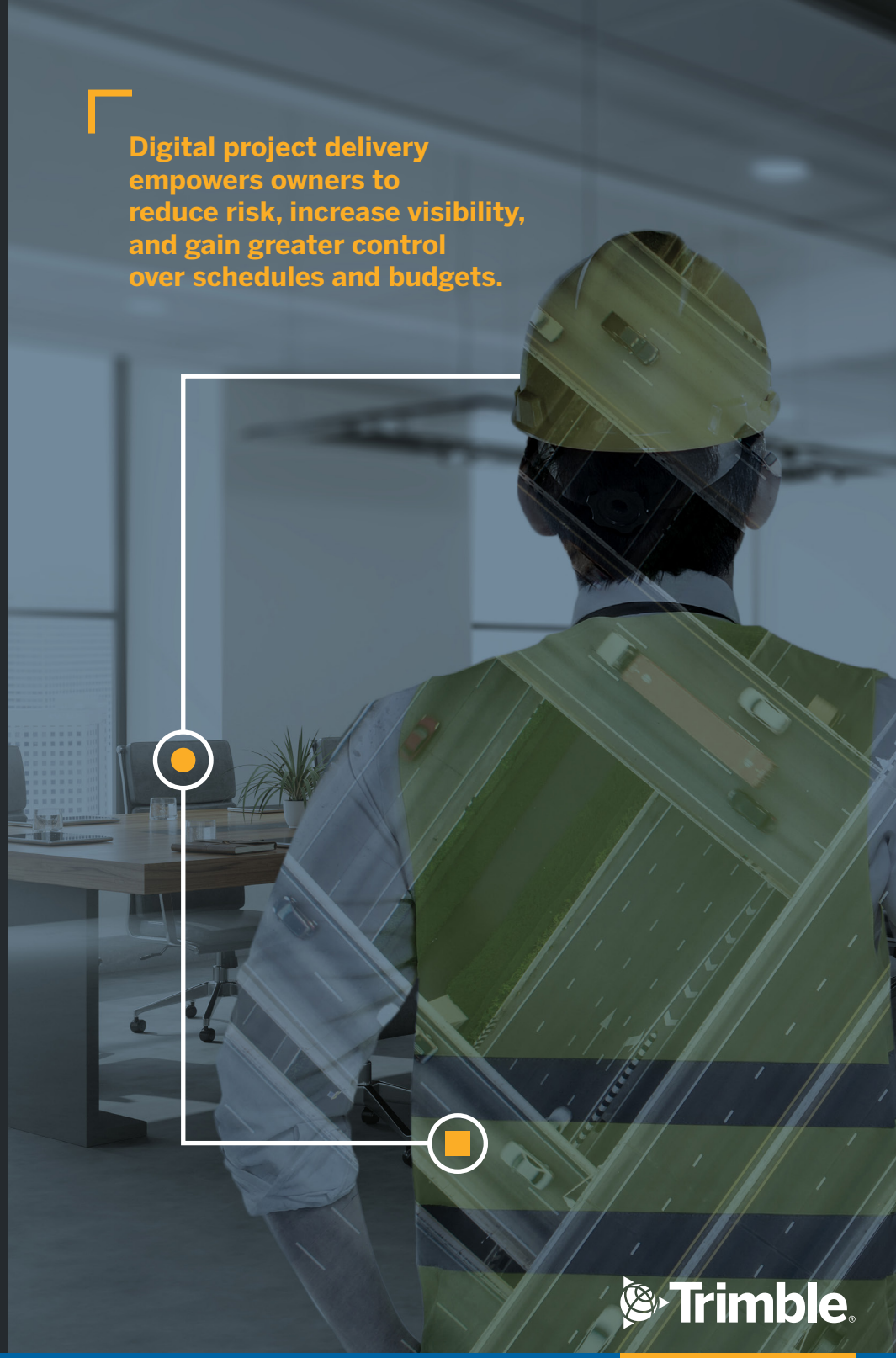
As rail operators seek to improve efficiency and safety, increase service levels, and reduce costs, they rely increasingly on **rail asset lifecycle management solutions**. Using a comprehensive set of on-board and wayside condition monitoring solutions, operators can monitor rail assets in real time to prevent service delays, reduce the likelihood of safety incidents, and control repair costs.

Start Realizing the

Power of Digital Project Delivery

For infrastructure owners, acquiring much-needed funding is just the start. Each project comes with intense pressure to spend taxpayer funds wisely, improve asset sustainability, and increase construction efficiency—all while navigating the realities of rising material costs and labor shortages. Meeting these objectives requires early, frequent collaboration among project stakeholders, with all teams working in an integrated technology ecosystem. Connecting construction and operations provides that ecosystem.

Owners are in a unique position to drive adoption of connected construction processes by requiring digital project delivery. This innovative delivery method empowers owners to reduce risk, increase visibility, and gain greater control over schedules and budgets by helping everyone involved work together more effectively and efficiently. And that level of collaboration is what's needed to renew America's infrastructure and serve the needs of the public for decades to come.



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Learn More

To learn more about how to incorporate digital project delivery into your infrastructure projects, read the **AEC Pro's Guide**.