



INFRASTRUCTURE  
OF TOMORROW

Technology and  
Innovation are  
Driving the Future  
of Infrastructure





Society is wrestling with increasingly complex sustainability challenges in the 21st century: on the one hand, more than six billion people are projected to live in urban centers by 2050, according to the United Nations. On the other, our already aging infrastructure is ill-equipped for the increased strain. Worse, the AEC industry that will spearhead the infrastructure reboot will have to do more with fewer resources.

At a time when we need to re-imagine how we design and build infrastructure to respond to the ever-increasing demands of the world for a better built environment, civil engineers need to connect with teams virtually anywhere and at anytime, break down silos, and transfer data seamlessly throughout the project life cycle – design, build, and operations and maintenance.

The problem is that while many other industries – including mining, manufacturing, retail and more – have accelerated the pace of digitization, the AEC sector is still lagging behind. While the industry has adopted digitization and made progress, it has not yet revolutionized processes. There's still a heavy dependence on 2D processes or pen-and-paper solutions. That situation is poised to change though – it simply has to. Digitization promises to revolutionize the industry. AEC project managers now have to juggle BIM government policies, aggressive timelines and geographically dispersed stakeholders, all while delivering quality at scale.

Heavyweights in AEC are rising to the challenge – they are embracing digitization and powerful new workflows to reshape the built environment and meet the ever-expanding challenges ahead. The Transportation Summit at Autodesk University gave us a peek into how digitization and technology aid in the three critical aspects of an infrastructure project: design, build, and operations and maintenance. We can see a few clear trends emerging in all three aspects, including the following examples.



## Design

- Design automation
- Cloud collaboration
- Virtual reality

The old way of design is a tedious process: as soon as one parameter is changed, every dependency has to be recalculated, leaving the system prone to manual errors and high costs. Building information modeling (BIM) captures every single data point about an infrastructure project and their inter-dependencies, leading to fewer errors and better project outcomes overall. BIM has been a game-changer in the AEC industry for multiple reasons:



### Design automation

Visual programming tools such as Dynamo for Civil 3D eliminate repetitive and rote tasks for today's engineers. Dynamo for Civil 3D allows you to build scripts and routines that aid in processing anything from common tasks to the most complex of design workflows. Wouter Bulens, the BIM Manager at Belgium's TUC Rail says that adopting BIM using Dynamo for Civil 3D has eliminated repetitive tasks for the company by automating them.

Using such design automation, engineers can complete tasks in minutes that would otherwise take hours. This is good news for the AEC industry as it needs such efficiency gains to do more with less.



## Cloud collaboration

BIM is taking 2D models to more easily visualized 3D ones. Autodesk BIM 360 Design is taking 3D to the cloud, enabling real-time design collaboration and project data management.

BIM 360 Design allows multiple stakeholders across different disciplines and in geographically dispersed locations to access and sign off on design projects all while working with a single source of truth – virtually anytime and anywhere. Since everyone now understands their piece of the puzzle, it's easier to collaborate and get a handle on project timelines.

This cloud-based solution is bringing a new level of connection, efficiency, and integration to even the largest teams and the most complex infrastructure projects.

## Virtual reality

Increasingly useful in making the sales pitch to external entities, BIM delivers 3D models that are easier for external stakeholders to visualize. The BIM models can be uploaded into virtual reality headsets and viewers can “walk around” the new infrastructure for an immersive experience to gauge what the final asset will look like. Such easier visualization allows for a more straightforward sign-off on projects.



In addition to virtual reality applications, companies are using BIM in other ways. Virgin Hyperloop One, a transportation pioneer, uses BIM through a suite of Autodesk infrastructure solutions, including Civil 3D, BIM 360 and more. The company is redefining high-speed rail, working on delivering people to destinations at speeds of up to 670 miles per hour. Virgin Hyperloop One uses BIM for optimization of transportation routes and improving its digital engineering and construction workflows.



## Build

- Digitization of construction
- Advanced work packaging
- 3D laser scanning and drone technology



### Digitization of construction

Digitization during construction helps connect construction project managers and other stakeholders in real time. Jamie Waller, Assistant Director of Construction at the Tennessee Department of Transportation, remembers the old days of project design and construction. Designs had to be routed to a print shop for production, copies of which would be delivered to all stakeholders. Any changes to the original would kick start the whole process again, wasting time and money.

“Construction projects would get put on hold because of these delays,” Waller said.

The solution: virtual design and construction to aid every aspect of construction, starting with digitizing the design and construction process. TDOT uses PlanGrid, an Autodesk company, to get all stakeholders on the same page during the construction process.



## Advanced work packaging

At the foundational level, technology can help with advanced work packaging (AWP), where AEC professionals dissect project scope to manageable work packages.

“It starts with the initial planning and continues through detailed design, construction execution, and it provides a framework for a productive and progressive construction process,” says Kris Landry, with the construction team at Autodesk.

The advantage of AWP: It gets design and construction teams together well before the RFP release.

## 3D laser scanning and drone technology

Photogrammetry, which uses 360-degree photography as surveying and mapping tools, and 3D laser scanning tools help construction managers measure what’s unfolding on the ground against design. Immediate feedback prevents costly and cascading time delays. Drone and UAV technologies are similarly pressed into service for asset surveys especially in remote and inaccessible locations.





## Operations and Maintenance

- Building Information Modeling
- Mobile field services
- Artificial intelligence and machine learning

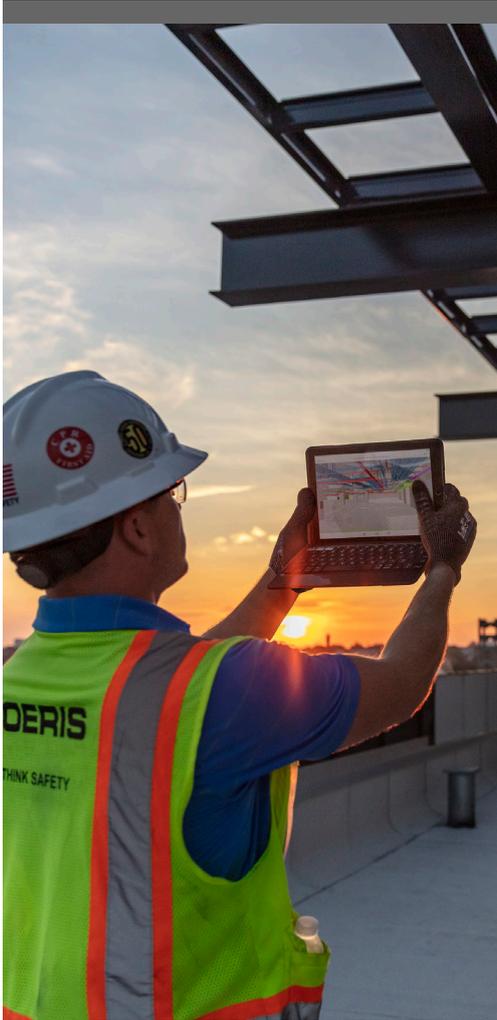


### Building Information Modeling

There's a growing clamor for operations and maintenance (O&M) to be integrated into the infrastructure project along with design and construction components. AEC professionals use BIM's next-generation technology to operate and maintain some of the world's busiest transportation infrastructure.

BIM's digital models can be integrated with asset management software systems so that the same 3D model can be of use further down the line.

London's Heathrow Airport uses such a system for thorough O&M, even for small but critical components such as Airfield Ground Lighting (AGL). The BIM model stores all information about each of these lights at the airport and contract maintenance crews use the related maps generated from that data to service these units.



## Mobile field services

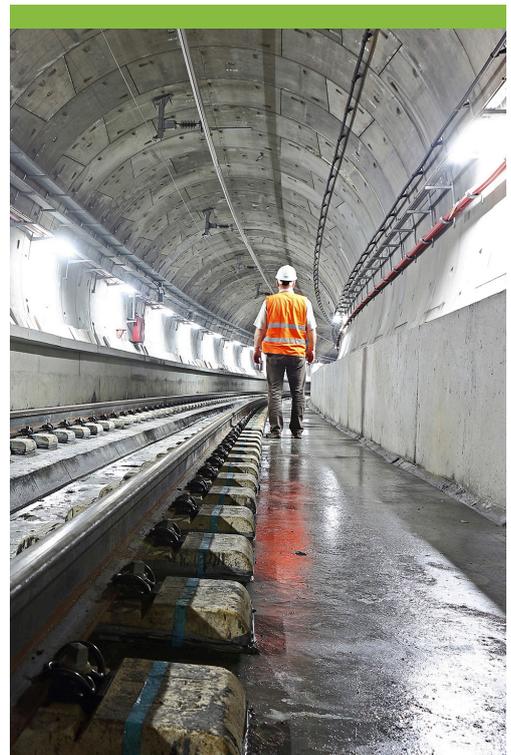
Integrating data into a central source of truth is key, says Nigel Stroud, who leads the information management for Heathrow Airport's expansion team. Field service workers access data about assets on their mobile devices – data that feeds from the central BIM models.

“So our engineers now are armed with mobile devices, which will show them the work orders that they've got to respond to. If there is a fault in a toilet or the lights have gone out in a terminal building, and the field service worker doesn't know where the problem is, [he or she] can click on the maintenance system in the mobile device. That will then route to a map that shows where the asset is located,” Stroud said. This makes for more efficient operations and maintenance.

## Artificial intelligence and machine learning

Infrastructure maintenance is also made more efficient through laser-scanning existing structures and comparing the images against designed equivalents. Artificial intelligence and machine learning algorithms conduct this compare-and-contrast quickly and efficiently, and flag anomalies for repair.

Networks of pipes, too, are addressed in a similar manner. Given dwindling infrastructure budgets, repairs, if any are needed, can be targeted much more efficiently.





## Digitization for a Better Future

Infrastructure projects large and small need to register significant time and money savings if they're to meet the needs of the future.

BIM's ability to bring all stakeholders on the same page through all stages of the infrastructure project delivers greater transparency along with monetary and time savings.

Equally important, these capabilities ensure that design, build, and operations and maintenance data don't get bogged down in information silos.

Technology that eases infrastructure project management strengthens every aspect – so gains achieved in one automatically cascade on to the other. The bottom line: better project management leads to better infrastructure tomorrow – something we all need.

As Wouter Bulens says: “Keep in mind that you're not connecting data, you're not connecting software. You're connecting designers to create one product, one design. You're connecting people.”

## The Numbers

The world population is predicted to grow to nearly



**10 billion**  
by 2050

with almost 70%  
living in cities.<sup>1</sup>

Infrastructure dollars needed to satisfy global demands will reach



**\$94 trillion**

by 2040.<sup>1</sup> There's a \$15 trillion investment gap.<sup>2</sup>

<sup>1</sup> United Nations, Department of Economic and Social Affairs. <https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html>

<sup>2</sup> Global Infrastructure Hub <https://outlook.gihub.org/>

