Technology Trends, and Industry Vision for Innovation in BIM for Infrastructure

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At Autodesk, our vision is to help people imagine, design, and create a better world.

We have a unique perspective on technology that helps people imagine, design, and create a better world, because we serve many industries, including MFG, Buildings, Infrastructure, and M&E... this enables us to see the convergence of all these industries in a unique way.
One reason why it is important to be looking at technology trends and innovation is due to the fact that the transportation industry as a whole can be characterized as complex, costly to maintain and crumbling. We all know about the ASCE report cards that continue to report low grades for our roads and bridges.

You hear about this a lot in the news, but what you don’t always hear about is all of the innovation that’s happening in the industry that is addressing our problem. At the core of some of this innovation is Building Information Modeling, or BIM.
BIM has been around for about a decade now in other industries, and close to 50 percent of new projects are using BIM processes at some level. Civil Infrastructure owners and consulting firms have been moving cautiously toward adoption of this new way of working as are contractors and other stakeholders that also stand to benefit.

The question many people ask is What is BIM and how is it different from 3D modeling? It’s not a product, it’s not a service, it can simply be described as a “A collaborative process, driven by the creation and exchange of relevant digital information through the entire life-cycle of a built asset.

Core to the process is the connection of intelligent, structured data to digital models, which is really how it differs from basic 3D modeling, which many in the industry see as a stepping stone.
We are currently working with governments and AEC firms around the world providing services and products to enable them to adapt to meeting existing and emerging BIM requirements.

This is a snapshot of some of the BIM for Infra activity happening WW. You’ll note some comes in the form of a mandates – red and blue - and some are guidelines that are evolving - purple.
You can see from the map that BIM for Infra adoption is rapidly accelerating around the globe.

Much of the expansion can be attributed to owner requirements and, increasing government mandates. This chart illustrates the value of BIM as reported by a recent survey of owners in the UK where mandates are well established.
Technology trends

HIGH DEFINITION SURVEYING

DIGITAL COLLABORATION

MACHINE LEARNING

ADVANCED ANALYTICS & IoT

INDUSTRIALISATION OF CONSTRUCTION
Technology trends

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- DIGITAL COLLABORATION
- INDUSTRIALIZATION OF CONSTRUCTION
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Growing use of laser scanning and the benefits to using point clouds and other reality capture data to build existing conditions models that help inform decisions.

We are in a partnership with the City of Paris on a project to enhance the visitors journey at the Eiffel Tower. This is all part of a competitive tender process the City of Paris launched earlier this year which requires the use of BIM. This tender process was open to architects and engineers from around the world.

As part of the project, Autodesk, with the help of survey company Gexpertise and WSP, created a digital 3D model of the existing Eiffel Tower site

• **2.4 square km** - **342 GB of point cloud data used to build elements of the model including terrain, buildings, statues and city furniture**
• *Cumulative point cloud contains 10.3 billion points and covers 0.93 square km*
This is one resulting view of the model.
While 3D models of Paris and of the Eiffel Tower site have been created, this is the FIRST time that the Eiffel Tower site digitally represented with this level of accuracy with added intelligence so the city can keep track of important features such as how much green space is added, how visitors will travel from nearby metro stops and measure impacts of potential road closures and building reuse. A model where structured information is connected to the digital model simply did not exist before.

In total 8,200 trees and 1,000 buildings were modeled and categorized – because this was important to the city. 
In addition, 3 bridges, 25 statues, 100’s lighting fixtures, 100's benches and park fixtures were also included in the model

This model will be used by the 4 design team finalists so they can develop, visualize and communicate their designs
While not a transportation project, the work we did to virtualize the Glen Canyon Dam is another great example of using reality capture to connect the physical to the digital world.

This is a project where the US Bureau of Reclamation engaged with Autodesk to capture, model and virtualize the Glen Canyon Dam and its facilities, inside and outside.

The Glen Canyon Dam, it impounds Lake Powell, the second largest reservoir in the country.

Their goal is to Create a virtual facility for O&M, Security, and Outreach/Education purposes.
Because of the growing use of reality capture data, we’re prioritizing new ways to extract information from point clouds. We’ve incorporated Machine Learning into our design software to automate the costly process of extracting information from point clouds.

This includes
Thinning the cloud down to the pertinent data
• Classifies and identifies similar features – such as signs, trees and other road furniture
• And is automating the extraction of bare earth, point features, and linear features such as edge of pavement, top and bottom of curb and centerline.
Technology trends

- High Definition Surveying
- Digital Collaboration
- Industrialization of Construction
- Advanced Analytics & IoT
- Machine Learning
Lots of new ways to digitally collaborate. This project was completed by a joint venture between two AEC firms, Ramboll and Sweco on a Railway project in Norway.

They were planning a 35 km double track railway where it was required to use a solution that enabled rapid modeling and optimization. The other requirement was a solution that provided a way to clearly communicate to obtain environmental and community approvals.

They made use of various types of data including GIS data so they could identify areas to avoid and also were able to use integrated analysis capabilities identify areas with significant cultural and environmental restraints and also to consider flood risk.
With support from new Digital Collaboration methods, Ramboll Sweco team was able to fast-track this Norwegian railway high speed rail extension.

The high points here were:
- Their ability to more affectively communicate design intent and issues with over 120 stakeholders to help drive design approvals by utilizing extensive overlays of project critical constraints and proposed design models.
- They used InfraWorks as the common data environment for the entire project team enabling a rigorous schedule of project reviews every 14 days—a process the team called Integrated Concurrent Engineering or ICE.
- And, lastly, the project was able to recognize a 20% time savings with help from this Connected BIM process in the planning and approval phase of the project.
An example from the Sichuan Communication Surveying & Design Institute who implemented a new digital collaboration processes to help:

• Cut design time and costs by a third
• One key factors cited was their usage of cloud-based simulation and analytics to evaluate factors such as traffic and drainage to more quickly iterate on design options to help meet aggressive sustainability project goals.
• And, again, we see that customers are finding great value in bringing together multi-disciplinary designs from core authoring design tools for simulation, collaboration, and the mobility of data that the cloud provides.

SCSD even created a web enabled mobile terminal (as they called it) to review design alternatives and constraints in the field.
Virtual Reality, or VR, is another way we see innovation in digital collaboration

- Here we see an excellent use case of VR for the rail Authority - Bane NOR in Norway
- Project involved increasing capacity of an existing rail line with a parallel 7.8KM tunnel along with upgrades to the existing stations and facilities.
- A consulting firm in Norconsult carried out the design for this project.
- Focus is on their use of VR to increase project understanding by stakeholders and accelerate the approvals process.
BIM+GIS Integration

This is an example of a proof of concept we build with Esri that illustrates the power of bringing the two worlds together.
Technology trends

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A lot of innovation in Industrialized construction is happening with building construction, but here ICA Construction brought digitization to construction in a big way by completing this bridge project in Mexico City utilizing extensive BIM and pre-fabrication workflows.

This is a great example of BIM where a large portion of the individual components were ultimately prefabricated based on the model data, offsite. Then mobile devices were used to scan and track where all the components are in the process and to better anticipate where and when they need to be delivered to the site.

You can see they also merged the design models with scanned models of the built environment to choreograph the erection activities to identify and eliminate any potential issues beforehand.

Excellent example of bringing digital infrastructure to an infrastructure construction project
Technology trends

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The bridge shown here is part of a story about MX3D, a startup and Autodesk partner based in Amsterdam. MX3D has been working with robotically produced metal 3D Printing for a number of years now and they decided to build a bridge in this fashion in order to demonstrate the capabilities of this radically new technology.

CREDIT: MX3D
MX3D and Autodesk collaborate to instrument the MX3D bridge, with the goal of collecting data that could be used to begin generating engineering knowledge of the sort we need to power our tools and scale metal 3DP. To do this, we made a prototype using a catwalk bridge that exists in our start up incubation space in SFO called Pier 9.
Occupancy = n

We began collecting the data from sensors in early in 2017. We are using that data and machine learning techniques to see if we can get the bridge to count the number of people on it at any moment in time. We may also teach it to distinguish between a person walking on it and a dog, or a person walking on it and a machine next to it starting up, and so on. We are learning that a set of simple sensors can, with the help of ML, make a really smart thing.
Here’s the bridge we’re going to replace with the MX3D bridge. We are planning to make this our second prototype by placing sensors on this bridge, too. This will let us test data capture for engineering and IoT purposes, and test the exact sensors we intend to use on the final bridge, plus find out what issues we face with power and connectivity at this site. CREDIT: Author
Beyond IoT, advanced analytics are also key to better decision making and more resilient infrastructure.

Example here shows flood simulation analysis in Paris... we partnered with a company called Hydronia to model flooding within a context model created in our software InfraWorks.
We also have the capability to perform traffic simulation in context of the design providing real time feedback on design options in a more understandable way.
And moving from macro simulation to microsimulation – we are finding the need to understand the movement of people – going beyond simply counting cars and thinking of LOS as a true measure of our infrastructure systems.

Here we see another example from the Bane NOR project in the Netherlands we showed earlier. Here they use mobility simulation to evaluation different emergency evacuation scenarios for the rail station.

This same sort of microsimulation could be used to evaluate park n ride locations, bus stop feasibility or even event management, such as planning for how to park cars for large events like PGA golf tournaments or something similar.
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This is a form of generative design we are exploring that is intended to help optimize grading.

Here we are seeing where generative design can help tedious and time consuming tasks like detailed grading around bridges or other structures.

The idea is to let the engineer set the constraints that need to be met or desired outcomes and let the cloud compute the best options to be evaluated...
Last example here of machine learning and AI that is a glimpse into the future of all construction sites. Here a startup company called SMART VID and AEC firm Skanska asked, “why can’t we use technology from Autonomous vehicle AI” to drive safety on the job site?
Advancements in high definition survey, digital collaboration, industrialization of construction, IoT and Advanced Analytics and Machine Learning are all making this a very interesting time to be in the industry.