DIGITAL TWINS ADVANCE SUSTAINABLE INFRASTRUCTURE

Enabling a lifecycle perspective to embrace decarbonization, resilience and social equity from the beginning of projects

The following Q&A builds upon a conversation in June 2020 about digital twins with Tom Coleman, Vice President of Visualization and Data Intelligence, WSP USA.

Figure 1 - The shaded part of the rendering above represents an isometric view of 3D objects embedded with data—applied in the development of a digital twin.

When we first spoke about WSP's work with digital twins, you noted that digital twins were an indispensable tool for infrastructure planning and design. How would you characterize progress since that time?

Tom Coleman: Cloud architecture, especially over the past two years with changes in work practices, has provided the opportunity to align everything we do as a company with a Future Ready®[1] mindset.

Today, we have greater understanding about what digital delivery encompasses and what steps we should be taking now to implement a digital twin solution for bridges, highways, transport, and building projects. This greater understanding has enabled us to apply digital twins to more projects, such as in the IBR [Interstate Bridge Replacement] program.[2] The IBR digital twin includes 56 bridges—54 landside bridges[3] and two Columbia River Crossing bridges—on about five miles [8.0 kilometres] of Interstate 5 [I-5], the main north-south interstate highway on the West Coast in the United States, stretching from the border with Canada all the way through California to the border with Mexico.

The Interstate Bridge across the Columbia River is a critical connection between Oregon and Washington states on I-5, supporting local jobs and providing a trade route for regional, national and international economies. The Washington and Oregon State Departments of Transportation seek to replace the aging interstate bridges with a modern, seismically resilient multimodal structure, or possibly structures, to provide improved mobility for people, goods and services.

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[1] Future Ready® is WSPs global innovation program that seeks to better understand the key trends in climate change, society, technology, and resources and how they are impacting our world, locally and globally. Future Ready® is a registered trademark of WSP Global Inc. in Canada and New Zealand. WSP Future Ready (logo)® is a registered trademark of WSP Global Inc. in Europe, Australia and in the United Kingdom.

[2] WSP is the prime general engineering consultant for the IBR project.

[3] The 54 landside bridges in the IBR program include a variety of elevated structures carrying a road, path, light rail transit or railroad.

How can a digital twin bridge vast distances to address project requirements?

Tom Coleman: Digital twins are elevating collaborative capabilities as they provide an immersive and integrated visualization of previously siloed information, which may relate to a vast distance between project team members such as with the IBR project. Building collaboration is essential to meeting the objectives of our clients—two state DOTs, Washington and Oregon—plus many federal, state, regional and local partners. A digital twin base gives project team managers the awareness that enables them to communicate the vision of what can be done during the start-up of a project and to scope, mobilize and deliver digital solutions effectively.

The digital twin incorporates reality data from drones, mobile LiDAR [light detection and ranging] and aerial mapping. Once we have the reality data specific to projects, we can easily build a 3D model to create a digital twin that enables early consideration of multiple project aspects. For example, now with digital twins, we have been able to immediately consider sustainability aspects such as how to reduce carbon emissions in the design of the project and the cost reductions or increases associated with those changes. We can model sustainability into our design workflow directly and make adjustments—corrective actions—based on what the model tells us. With the addition of machine learning, we can create a dynamic model that can simulate and predict how infrastructure assets and transport networks will perform in real life.

The elements of a digital twin are reviewed and updated throughout the project lifecycle until decommissioning of the infrastructure asset.

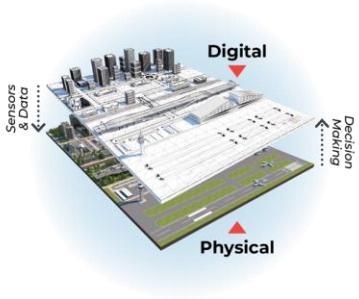

Figure 2 - Elements of a digital twin - A digital twin is a virtual replica of an asset that incorporates associated real-time data during operation of that asset. It provides an immersive and integrated visualization of previously siloed information and enables use of modern digital analysis techniques, such as condition-based monitoring and predictive analysis, to plan for the continued functioning of infrastructure.

Can you expand upon how digital twins are advancing effective work environments?

Tom Coleman: Digital Twins provide a scalable, timely and effective transition from planning into design and the construction phase and then to maintenance and operations. A common data environment [CDA] aligns information systems—including CAD, GIS, 3D BIM, public outreach data, project controls, design information, traffic and sensor data, asset data and other related information—to manage a digital twin, which shows the project team the physical and functional characteristics of the whole project. In this way, the CDA enables more effective work environments and upfront project development to support sustainability pillars. We can test, validate and alter the performance characteristics of what we design to meet the different sustainability pillars we need to address such as carbon reduction. Ultimately, in the long run, we see this collaboration extending across the entire supply chain—toward even more open, evergreen infrastructure digital twins—where carbon calculation and optimization are

intrinsic to and transparent in all stages of the infrastructure project lifecycle.

So, you are saying that collaborative work and digital twins are mutually reinforcing?

Tom Coleman: Yes. Before digital twins, we had one path of information and transferred that information from a person or group of people to another person or group. Now, with digital twins, we can converse across disciplines, such as design and asset management; we can assess different characteristics early in the project at the concept design stage and enable timely modifications and updates throughout a project's lifecycle.

Also today, we can use IoT and artificial intelligence [AI] to add data to visualizations and make decisions across departments; we can put ourselves inside of the virtual model of a city, for example, and interact with it—a process now called the metaverse; we can better relate the design to the context of the world around us We can test and validate elements of infrastructure—bridges, roadways, transit, and buildings—before construction;. we can create dynamic models that simulate and predict how these assets will perform in real-life contexts.

Three-dimension reality models provide the basis for visualizing, collaboratively managing, and monitoring changes to infrastructure during the project and when the asset is in operation.

What benefits can digital twins bring to client organizations across infrastructure sectors over the long term?

Tom Coleman: Digital twins allow us to be more informed and take a systems approach to our projects, which expands our universe of understanding about the environments in which we live and work.

With this systems approach, digital twins enable understanding of how elements of infrastructure interact before investing. For example, through linking visualization to actionable data we can determine how to make a bridge stable in a seismic area or understand how a floodgate responds on a bridge under certain circumstances, especially important as the world increasingly deals with climate change impacts.

The need to mitigate risk and build resilience is common to all infrastructure projects, and we can do that with digital twins.

Concerning sustainability, in addition to building resilience and supporting decarbonization, how can digital twins advance social equity?

Tom Coleman: A digital twin provides a platform to evaluate factors that support social equity. For example, in order to address the underlying factors that impact accessibility in transportation, a 3D view can be evaluated with AI to identify and fill gaps in transport services. All kinds of valuable data can be generated from the project models to promote increased transparency and understanding of infrastructure planning, design, maintenance and operational issues with project stakeholders.

The digital twin perspective also allows early consideration of the short- and long-term impacts of infrastructure-related decisions on human health and wellbeing as we now have the capability to apply the results of economic, social and environmental impact studies in projects well before construction.

In terms of supporting and advancing sustainability, it is worth repeating that digital twins can inform the entire lifecycle of a project

from concept to design, into construction and through operation. Sensors, IoT and real-time data enable the analysis of essential considerations and the ability to simulate potential impacts of decisions, which is game-changing for advancing sustainability outcomes including social equity.

To read the first Q&A on digital twins with Tom Coleman, continue here. To read about digital twins in water management, continue here.

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