Need to Rethink Your Bridge Inspections?

Digital Twins Can Help

One of the challenges facing transportation agencies today is how to conduct accurate, timely and safe bridge inspections. Maintaining bridges is important to ensure public safety, and bridge owners and engineers need to perform regular inspections to determine the structural integrity of bridges so they can plan for maintenance, rehabilitation and replacement of those bridges.

Traditional visual inspections that take place onsite are labor intensive, can require expensive equipment, often require lane closures that create inconvenience for travelers, may present safety risks, and can be inaccurate and error prone.

National bridge inspection standards in the United States require additional data inputs and add another layer of complexity. And in today's COVID-19 environment, maintaining social distancing, and ensuring safety for employees and the public can present additional challenges.

Some of Bentley's most innovative users are reimagining inspections through the lens of digital twins. A digital twin is a digital representation of a physical asset, process or system as well as the engineering information that allows us to understand and model its performance. A digital twin can combine data from continuous surveys, photogrammetry, LiDAR and sensors as well as track changes to assets on a timeline, enabling owners to view the digital representation of the infrastructure asset and related real-world conditions over time.

As DOTs and agencies are being pressed to show the most effective use of their limited funding, taking advantage of digital twins can provide for safer, less expensive, and more timely and accurate inspections. Digital twins allow owners to track historical changes and understand information—such as the exact size of cracking, corrosion or section loss—rather than trying to determine this information by looking at pictures taken over time.

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The Stone Arch Bridge in Minneapolis is shown in several technology environments: ContextCapture (top left), from a UAV (top right), through Microsoft HoloLens 2 (bottom left) and as a reality mesh (bottom right).

We have seen transportation agencies, such as Minnesota DOT, use unmanned aerial vehicles (UAVs) to assist with their inspections and achieve savings of as much as 40 percent with these methods. Because bridges have such a long lifecycle, often up to 75 to 100 years, it is important to track change to the structures over time. These DOTs have found that by deploying UAVs and having a digital twin, they were able to see the change over time and have a holistic view of the bridge, including seeing past inspections laid on top of the current data, which can improve efficiency and help predict the future.

There is great opportunity for agencies to use UAVs to complement and augment standard and in-field inspections. The data from these inspections can be reviewed quickly and easily from anywhere, whether in the office or a remote location. When engineers review timelapse comparisons of detailed changes, they can annotate specific areas of concern and designate anything that needs to be specifically reviewed in the field. Field crews can see all the inspector notes right on the structure, which is more visual, more accurate and more efficient.

Taking advantage of digital twins allows inspectors to immerse themselves in the model of a bridge structure without being physically onsite. Inspectors conduct inspections using the digital twin of the asset, along with immersive inspection capabilities in Microsoft HoloLens. Inspectors can conduct significant parts of the inspection while in the office, reducing the time required in the field, which makes the overall inspection quicker, more efficient, safer and less costly.

A digital twin provides flexibility, as you can conduct more in-depth inspections without having to schedule expensive equipment and labor for that purpose. Applying digital twins over many large, complex or signature bridges can lead to significant savings, while increasing safety and providing richer visualization is the ultimate goal. And by conducting inspections using the digital twin of the asset, along with immersive inspection capabilities in Microsoft HoloLens 2, bridge inspectors can conduct up to 90 percent of the inspection while in the office. This practice reduces time in the field, making the overall inspection faster, more efficient, safer and less expensive.

One of the biggest advancements we see is a reality mesh, the visualization for a digital twin that gives yet another dimension to our understanding of the infrastructure and surrounding topography. A reality mesh is a 3D model of real-world conditions that contains large amounts of triangles and image data. Each digital component can be automatically recognized and/or geospatially referenced, providing users with an intuitive and immersive way to navigate, find, view and query their asset information. They can use reality meshes in many engineering, maintenance or GIS workflows to provide precise real-world digital context for design, construction and operations decisions. The photos, videos and data captured by UAVs can be used to produce a high-resolution reality mesh of a bridge. When this reality mesh is combined with other relevant data, it provides a great digital twin representation. And using reality meshes for inspections can significantly decrease the amount of time inspectors have to be on and around structures in the field.

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Utilizing digital twins and technology—including UAVs—to collect, process, store and analyze large amounts of data can reduce costs and increase quality of inspections. The immersive inspection capabilities in Microsoft HoloLens can reduce the time required in the field, while making inspections more efficient, safer and less costly. The technology can improve safety for inspectors and the public at large, and help preserve bridge infrastructure into the future.

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