
Is Heavy Civil Construction Ready
to cross the 4D model technology chasm?
SYNCHRO™ 4D

Rich Humphrey, vice president,
construction products at Bentley Systems

Get the latest on 4D construction with one of our experts

We recently sat down with Rich Humphrey, vice president, construction products at Bentley Systems to discuss his thoughts on 4D construction modeling, why it's important for civil projects, and where he sees the industry moving in the future.

Q: What is 4D construction modeling?

A: Before we can define the term "4D construction modeling," we need to understand what 4D modeling means. The concept of 4D modeling refers to the addition of a time dimension to the 3D CAD model. Now, teams can analyze the sequence of events on a timeline and visualize the completion of construction tasks. Planners and engineers have been developing 4D models for some time for the preconstruction phase of a project. Now, construction firms are looking for ways to leverage these 4D models for downstream construction workflows, leading to the term 4D construction modeling. The bottom line is that developing a construction model from a design BIM model to drive 4D workflows results in projects that are more likely to be completed on time and profitable.

Q: What does 4D construction digital twins mean?

A: When we say digital twins, we mean 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. Typically, a digital twin can be continuously updated from multiple sources, including sensors and continuous surveying, to represent its near real-time status, working condition, or position.

4D construction digital twins are when the information coming from multiple sources is construction-based. It begins with a design model and evolves as additional engineering data is added, further detailing construction model objects.

The construction digital twin can be extended to include additional construction data—such

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as work break-down structures, material cost codes, and project schedules — to add even more information.

Additionally, the construction digital twin can be further updated with real-time data from the field, such as data from mobile apps, drones, or IoT sensor feeds. For example, if items are RFID-tracked or tagged when they arrive on the job site, that data can be continuously updated in the digital twin, creating a live and evergreen representation.

Q: What is the difference between 4D construction for civil works and for buildings?

A: Over the years, we’ve seen a lot of building construction projects implement 4D digital construction methodologies. However, we haven’t seen a lot of civil projects implementing 4D modeling until recently. The reason has always been because, unlike building design software, civil design authoring applications have not delivered constructible components for these types of projects. Building design models are delivered with a high degree of componentization and related engineering information. For example, a building model includes objects like doors, windows, walls, and pipes that are very discreet and can be directly connected to a construction schedule. Civil models are not componentized in this way and, therefore, require secondary processing steps that turn model objects into constructible components. For example, a 25-mile civil roadway or corridor model is often one long object unless split by a bridge or interchange. This type of model object is not a constructible component because it does not represent how that 25 miles of road surface, aggregate, barrier wall, and curbing will be constructed. As a result, it cannot be directly connected to time or cost. This situation has been a dilemma for the last decade and has required construction firms to rebuild their models into many model objects within the design authoring applications. It is an obstacle to adoption because it requires a high degree of knowledge of complex design modeling solutions.

In today’s new normal, the construction industry needs to prioritize critical infrastructure – and most of that infrastructure is civil. Roads, highways, bridges – they are all critical. And SYNCHRO 4D, our 4D construction modeling application, makes it possible for civil construction teams to break up projects into those constructible components.

Q: What is the future of the heavy civil construction industry going to look like?

A: 4D digital construction technology is constantly being upleveled, and what is possible now has changed so much from what was possible when I first started in this industry over 25 years ago. As I look at what's in the works and being developed, here are five trends that I'm excited for:

1) Model-based scheduling and simulation: A 4D model allows planners and construction staff to visualize construction sequencing, including staging the placement of equipment and managing material storage and site access. The enhanced view helps identify errors in the plan and optimize the path of construction. It is also a better way of communicating the plan to the rest of the construction team, building virtually first rather than finding mistakes in the field.

2) Model-based quantity take-offs and estimating: A model that incorporates quantity calculations and cost codes can be linked to model objects. The situation allows for more accurate estimates, enables rapid iteration if designs change, and permits cost to be part of the optimized project plan. Employing this practice ensures that organizations can win more projects and make them profitable.

3) Artificial and mixed reality, model-based field inspection, and progress tracking: A georeferenced construction model can be brought into the field using web and mobile applications to provide data access, as well as to capture data in the field with the 3D model as context. In this situation, field staff collect data about the correctly constructed asset because they use the virtual representation of this object as a reference.

4) Project management tasks enhanced by the model:
Even typical project administration tasks—such as the management of submittal, issues, requests for information, change orders, and observations—can be improved by delivering a more real-world context when creating and accessing these tasks. There are often thousands of documents, photos, and forms managed during the construction process, and project teams spend significant time trying find them to do their jobs.

This data could be more easily accessed and applied directly into a 4D construction model, as the user interface allows team members to integrate the information needed based on their view in a 3D model space. They can also include the time range in the 4D construction sequence. These additions are powerful new ways to more efficiently access and collaborate on every project management tasks.

5) 5D and nD models: 5D is 4D plus cost and could transform how we do planning, just like 4D did when everything was in 3D. This concept can be extended to nD, which refers to the additional dimensions that represent other types of information added to the model context.

Engineers, construction managers, and contractors have leveraged 4D construction modeling to drive significant value in workflows that once involved risk and inefficiencies during the construction phase of a project. We've already seen this success in the building construction industry. Now, the time has come for heavy civil to reap the benefits too.

If you'd like to learn more about 4D construction modeling, check out Bentley's SYNCHRO 4D.

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