

Arcadis Solves a Significant Railway Bottleneck to Eliminate Slowdowns and Speed Passenger and Freight Travel

Creating a Digital Twin of One of the U.K.'s Busiest Junctions
Reduced Travel Disruptions to Less than Three Months

EVERYTHING SLOWED AT CARSTAIRS

The West Coast Main Line is one of the most important railways in the United Kingdom. It connects London and Glasgow, as well as to a branch line to Edinburgh. Not only is it the main rail route for passengers traveling between England and Scotland, but the West Coast Main Line is also a key link to the European mainland through its onward connections with the Channel Tunnel. Approximately 40% of all rail freight in the entire United Kingdom travels along the line, making it one of the busiest freight lines in Europe.

Over the years, the patchwork collection of 19th century rail lines has been replaced and modernized. Electrification and other enhancements brought rail speeds up to 110 miles per hour for most of the route. However, Carstairs Junction, a tiny village in southern Scotland, remained a stubborn bottleneck. The village is home to the junction between the Glasgow and Edinburgh routes.

Until recently, all rail traffic passed through Carstairs station, even though few passengers would get on or off at the village. As a result, rail traffic had to slow down to 40 miles per hour to safely navigate the junction, causing significant inconvenience to passengers and freight timetables.

MINIMIZING A CONSTRUCTION-RELATED RAIL SHUTDOWN

Though the solution seemed obvious—redesign the station and junction to remove the bottleneck—implementing it was a different matter. Such a sweeping overhaul would likely require that length of track to completely shut down, effectively stopping rail travel between three of the country's largest cities for a significant time. One option, which would involve only working on the project during weekends to minimize disruption, could cause the project to drag on for up to five years.

Rail owner-operator Network Rail grappled with the issue for decades, explained Chris Conroy, BIM manager with engineering, design, and management company Arcadis.

"In the last 20 years, it's been critical for Network Rail to find a way to upgrade the junction while keeping traffic open," Conroy said.

In 2019, Network Rail formed Rail Systems Alliance Scotland, a partnership between Network Rail, Arcadis, and rail infrastructure firm Babcock International, to undertake the rail renewal and maintenance program and to support additional rail enhancement projects throughout Scotland.

COORDINATING DESIGN AND CONSTRUCTION WITH A DIGITAL TWIN

After weighing up numerous options, the team settled on a GBP 157 million plan to install new tracks that would accommodate services without a specific stop at Carstairs Station and eliminate the need for non-stopping traffic to slow down. This package included fully upgrading the overhead line electrification (OLE) infrastructure through the junction, enabling the use of newer, more efficient train stock that emit 30% less carbon than current trains. Additional elements include improved signaling and upgrades to Carstairs Station itself to enhance the experience for arriving and departing passengers.

The most critical element of the package was that construction would only last 88 days with varying levels of rail closures, keeping the impact on rail traffic to a minimum. Meeting that deadline was vital, as the construction schedule would be well-communicated throughout the United Kingdom to warn passengers of service disruptions and potential delays to their journeys.

PROJECT SUMMARY ORGANIZATION

Arcadis

SOLUTION

Enterprise Engineering

LOCATION

Carstairs, Scotland, United Kingdom

PROJECT OBJECTIVES

- ◆ To separate traffic that does not stop at Carstairs Junction.
- ◆ To create a digital twin to communicate design intent, minimizing construction time and travel disruption.

PROJECT PLAYBOOK

AssetWise®, Bentley LumenRT™, Bentley View™, iTwin®, iTwin Capture, iTwin Platform, MicroStation®, OpenBuildings®, OpenRail™, OpenRoads™, Pointools™, ProjectWise®, STAAD®, SYNCHRO™

FAST FACTS

- ◆ Traffic on a main rail line had to slow from 110 miles per hour to 40 when passing through the junction at Carstairs.
- ◆ Separating traffic that does not stop at Carstairs Station into a separate line would free it from slowing down, though construction would cause major traffic disruptions throughout the country.
- ◆ Arcadis determined a digital twin would improve project development and minimize rail disruptions.

ROI

- ◆ Using Bentley applications helped them reduce the time needed to create 3D models by 35%.
- ◆ Reviewing the placement of every element with Bentley View helped them to detect and resolve 15,000 clashes.
- ◆ Using the digital twin as the basis of the project helped the teams deliver the project 14 days ahead of schedule while saving GBP 50 million.



“Bentley products enabled the digitalization of the design process and coordination with more ease, where project members can work remotely across the globe.”

– Santosh Kumar Chitti, Technical Discipline Lead, Arcadis

“If they had delayed construction even a day longer than planned, it could have resulted in negative media attention for Network Rail,” Conroy said.

Conroy and his colleagues realized that their development partners needed a design and construction schedule that was exceptionally accurate and easy to understand so that conflicts and misinterpretation, as well as the potential difficulties and delays in construction, could be kept to a minimum.

As a result, Arcadis decided to use Bentley applications and the iTwin Platform to create a unified digital twin incorporating all aspects of the project via digital versions of every asset, from the new track system to benches at the station. With the enhanced visualization provided by the digital twin, all stakeholders could fully understand and prepare for the challenges that they would face well before the first day of construction.

Arcadis created a reality mesh with ContextCapture, then used MicroStation, OpenBuildings, OpenRail, and OpenRoads to accurately design all assets. Not only did they create a digital twin of every project detail, but they also created animations with Bentley LumenRT to demonstrate spatial coordination of track formation, sleepers, signal foundations and other structures.

ELIMINATING THE BOTTLENECK IN LESS THAN THREE MONTHS

Using Bentley applications helped them reduce the time needed to create 3D models by 35%, ensuring the project remained within the schedule. Reviewing the placement of every element with Bentley View helped them to detect and resolve 15,000 clashes, along with any other necessary adjustments before construction.



Arcadis determined that creating a digital twin of the project would not only improve the development of the project, but it would also minimize rail disruptions.

Arcadis completed their design for the project, clearly demonstrating the shared vision for the new station and junction. With the design in hand well before the deadline, Network Rail and Babcock began construction.

The clear, accurate design greatly reduced the number of construction site errors that could have occurred using traditional and less accurate paper-based design methods. Additionally, the insight into the design intent sped understanding of the more complex details. Using the digital twin as the basis of the project helped the teams deliver the project 14 days ahead of schedule while saving GBP 50 million.

“We had had a lot less technical queries during the project,” Conroy said. “Because we had hands-on digital information, we were able to get through them very quickly.”

Due in part to the clarity of the digital twin, the major track blockade was successfully completed in 88 days, and passengers were not subjected to any more disruption than they were expecting. Now, trains that do not specifically stop at Carstairs station can proceed through the area at full speed, improving the travel time between three of the country's largest cities.

With the success of the digital approach for Carstairs, the Rail Systems Alliance Scotland is now adopting the use of digital twins for other projects within the area.

“We now know how digital twins can be used on different schemes, and have already been invited to support another major project in Scotland using the iTwin Platform,” Conroy said.



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