

Liverpool Lime Street Remodelling

Stages 2 & 2A - October 2017

Fully Logical Linked 4D Train Moves Programme



Background to LLS

Liverpool Lime Street is a main terminus station serving the city of Liverpool (UK) and a branch of the West Coast Main Line Service from London Euston, as well as for TransPenine Express trains. Opened in 1836, it is the oldest grand terminus mainline station still in use in the world.

Due to the ageing track, changes in standards, signals, rail usage and technology a £340m investment programme has already commenced, with the main bulk of the works taking place over 23 days in October 2017 and subsequent stages with completion in Summer of 2018.

The Liverpool Lime Street Remodelling project is being delivered by the Network Rail IP Signalling organisation as part of a number of projects in the Liverpool area to upgrade existing assets and improve transportation links.

Stages 2A and 2B are part of a 23-day blockade, with the first 9 days being a total blockade of all lines between Edge Hill station and Liverpool Lime Street (2Km), and a limited passenger shuttle service being provided between the two stations during Stage 2B.

The main aim of stage 2A is to deliver a significant quantity of Track and Civils works prior to the main blockade. These blockades work will reduce the work required in the final blockade (Summer 2018) and lessen the complexity of site integration.

The main contractors involved:

- **Buckingham Group** – Civils delivery partner
- **S&C Alliance (AmeySersa / Network Rail)** – Track & OLE delivery partner
- **Siemens Rail Automation** – Signalling, Control systems, Telecoms & Electrical & Plant (E&P) delivery partner
- **Network Rail Station Management** – NR Station Operations team at Liverpool Lime Street
- **Network Rail IP Central**

The Opportunity

Due to Liverpool Lime Street location, it's bottleneck terminus layout and track construction hewn out of hard sandstone the pressures on getting works completed on time, while this major network terminus continues to function, is high. Tight working spaces and short total site blockade, before a shuttle service commences, requires effective coordination of all contractors and stakeholders.

In order to achieve this coordination on such a critical piece of city infrastructure Network Rail commissioned the expertise of project management firm Specialist Project Integration (SPI) to deliver Engineering Integration, VR Modelling, BIM and 4D Integrated Planning using their Real 4D™ process. SPI selected Synchro as the technology platform and partnered with Metisplan to provide planning support. Together the companies developed a virtual construction site using information sourced from a Primavera P6 schedule and face to face workshops with planners and construction managers.

The Liverpool Lime Street Remodelling Programme is currently ongoing (as of August 2017), however the benefits and outcome of early Real4D™ are already being seen through the S&C Track Renewal Programme highlighted below.

Overall Project Aims and Outcomes

- Improved Coordination of Contractor Work Programmes through a Centralised Planning Programme
- 4D visualisation of contractor programmes with emphasis on S&C and OLE works
- Workspace Clash Detection
- Early Identification and Management of Risks and Opportunities

Outcomes (project ongoing)

- Centralised Primavera P6 EPPM, Standardised Activity ID, Properly Coordinated and Logically Linked Contractor Programmes
- A visual understanding of S&C track works allow other contractors to work around these
- 25 Potential Clashes/Programme Issues and Risks Identified in S&C Train Movement Programme

Why 4D?

One of the roles of a 4D planner, as with any planner, is to be successful networker - who can easily talk and mix with all trades and stakeholders to understand what needs to be achieved, by who, by when and how and then be able to communicate this "successfully" to all parties and reach agreement from all.

To communicate "successfully" a Gantt chart probably isn't the tool most people would say is the easiest to read by all stakeholders.

In Rail, there are many groups of niche specialist areas with their own terminology and ideas of what needs to take place to deliver their work packages potentially using different planning software.

They say, "a picture paints a thousand words", so to be able to place a 3D Model (picture) "on the front end" of a contractor's programme is a planner's dream come true – A tool that "successfully" communicates a programme to all stakeholders without a need to understand all the terminology.

Why Synchro Software?

Synchro Software is a fully featured planning software in its own right and 4D simulation software that makes it an industry leader in 4D visualisation. Early engagement of Synchro in the planning process has allowed changes and validation of each change to be made where it is cheap and cost effective to change – during the planning process.

Tools used

- **Synchro 4D**
- **Primavera P6 EPPM**
- **Bentley MicroStation**
- **ProjectWise V8i**
- **SPI VRAM**

Real4D™ Benefits

- Workspace Clash Detection
- Programme Logic and Validation
- Help planners to develop better plans
- Highlighted gaps in the blockade – Opportunities or De-Risk
- Identified Risk Areas – time allocated for a move
- Early engagement where changes are cheap to make
- Better site logistics and understanding
- 4D Model can be used for Site Introduction, Safety and Subcontractor Briefings

Using Synchro has allowed SPI to use its Real 4D™ tools to create a fully 4D train movement programme using 3D paths for each train entering, moving within and egressing the complex and tight bottleneck of Liverpool Lime Street Station (UK).

Early Engagement

By holding preliminary meetings and phone calls with all contractor planners the main issue for all was where are S&C trains at any one time on site, how long is each train consist (for every move), when are they moving and what route will they be taking. Once they knew this then they could manage their programmes around the larger train and S&C plant moves.

During these meetings, the 4D process was explained and agreement from all planners on what would be needed for a coordinated programme that would feed into a 4D model.

S&C Train Programme

The S&C train movement programme was in a very detailed and advanced stage of completion due to the fact the trains consist need to be known in order to work out if they can fit on site and are also governed by the need to book a slot to access and egress the blockade over a fully operational national network rail system. This also meant that the order of works and routes into and around the site were unlikely to change and so a fully linked train movement programme using 3D paths could be used.

Version 6 of the S&C programme, was split into 11 stages/areas of work that totalled 650 activities, of which, 310 activities were to do with train moves.

However, even with this excellent level of detail S&C train movement programme goes into a single activity could require a further 3 – 5 unique train moves, which resulted in 474 train 3D paths created and train carriages attached.

Simplification – LOD required

It is important to understand audience and level of detail required. Is it for constructability or for wowing clients and stakeholders with fully rendered and realistic models. In this instance it was for coordination and information on the location of work areas each contractor had planned, in particular S&C track and OLE works, so Civils and Signalling can work around and support these activities.

The detail of the trains was more about getting the length of each trains consist correct and so block shapes with correct buffer to buffer lengths were used. A standard 4m width was applied to all blocks, some were made higher than others depending on type and colours were also used differentiate between the different wagons, cranes and locos used.

Videos

To understand and visualise each train and its movements within the S&C programme and communicate this quickly to all contractors and 3D modellers, the 4D planner videoed each train move using the Post It notes he had observed S&C using in their planning sessions and sharing them on Dropbox. This meant that contractors were given a rough idea of movements and train consists and understanding into the S&C programme before the 4D model was completed and baselined.

S&C 4D Stats

- 310 - Train movement videos
- 474 - Centre lines created by modellers based for track moves
- 474 - 4D Paths created & shortened by 4d Planner to correct start & finish %
- 474 - Train moves calculated
- 39 - Train consists simulated
- 652 - Unique instances of Locos, Wagons, Kirow Cranes, ITC, Autohoppers, Tilters
- 409m - Longest train entering site
- 45 - Unique models used
- 25 - Potential clashes/programme issues & risks identified

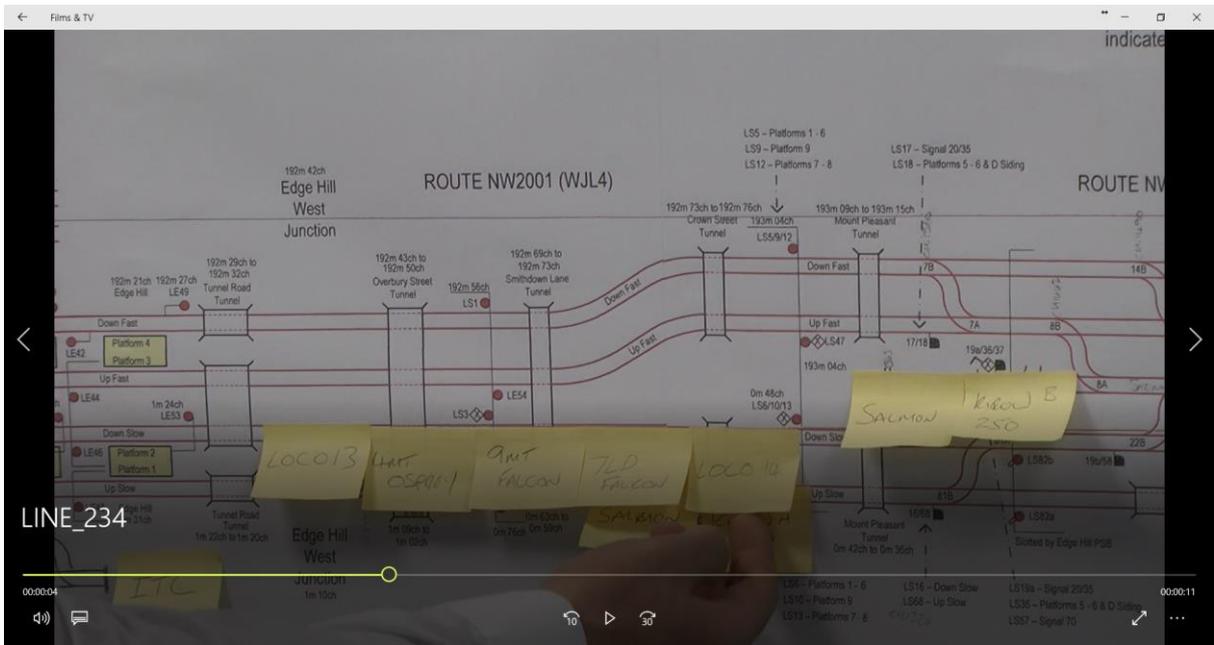


Figure 1 Screenshot of videos depicting train consist and movement planning used by S&C - track and post it notes not to scale

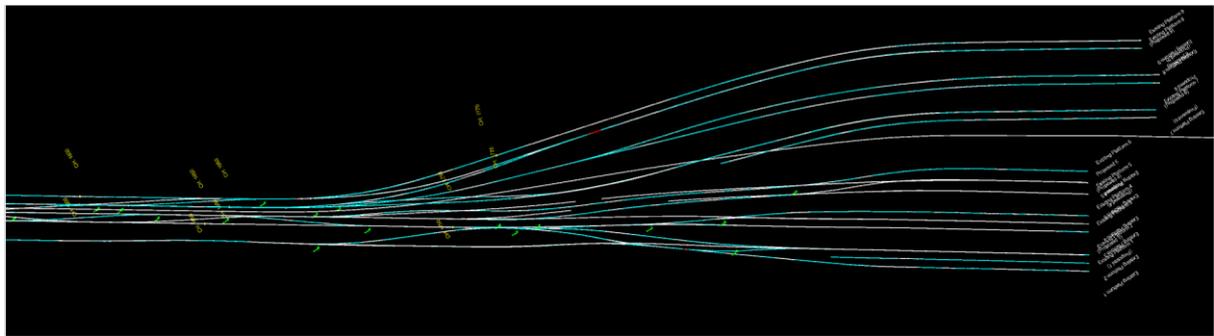


Figure 2 Centre Lines Used in the Creation of 4D paths - along all points, track, shunt neck and platforms

Real 4D™ Benefits

Workspace Clash Detection and Programme Ongoing Validation

On the whole the issues were mainly with how logic had been applied in the programme, rather than length of trains and routes taken. The 4D process did highlighted a few obsolete or forgotten train moves that were necessary to make way for longer trains accessing or egressing site.

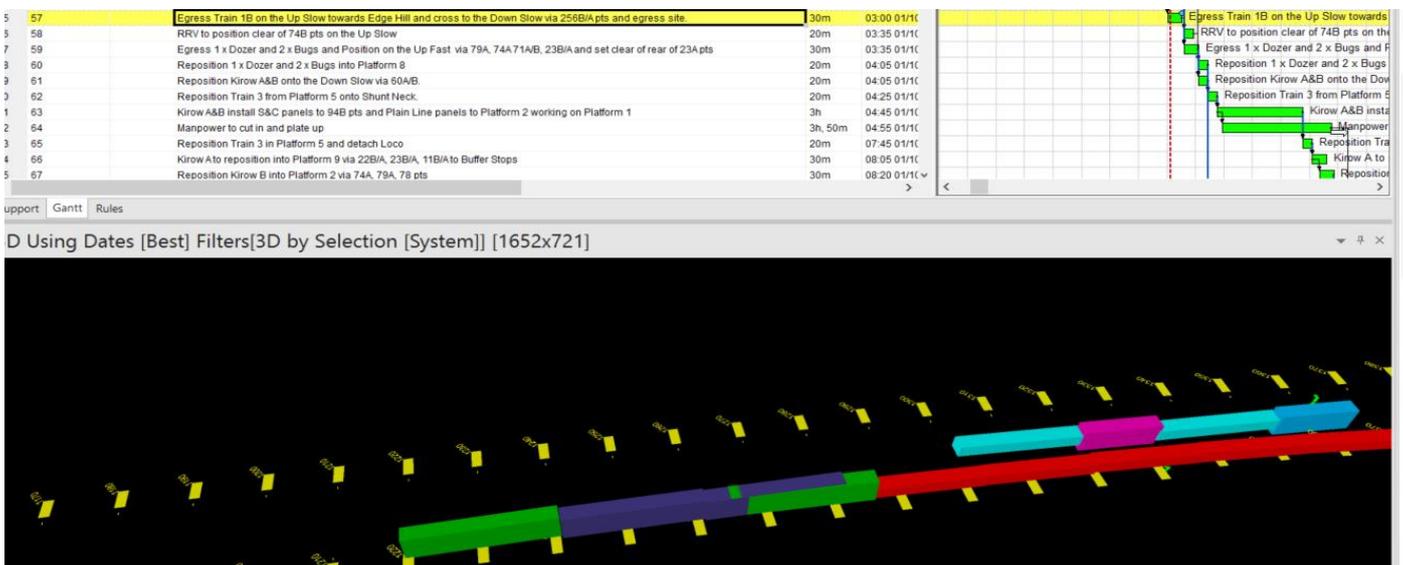


Figure 3 Stationary Train, set to move later in programme blocking way of larger egressing train

All train moves on site are strictly controlled and unlikely to have caused a 'clash' of trains, however 4D did highlight areas where Start to Start logic links had been a number of time that in effect hid the amount float available for two trains to make a set of points – in reality they had 10minutes to clear the points and not 30 minutes. (Figure 4)

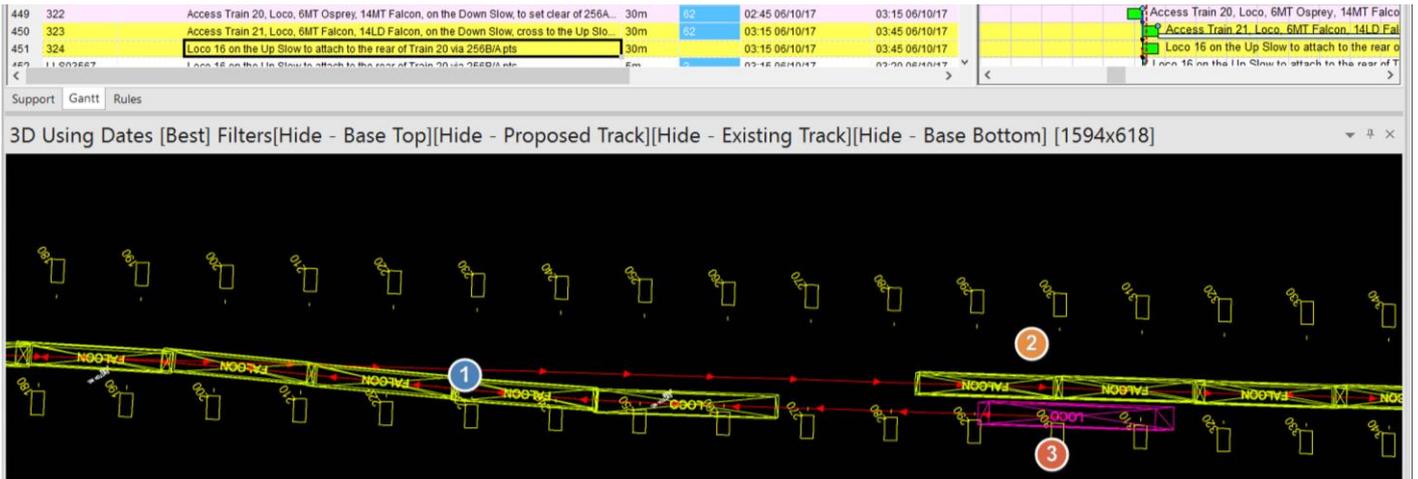


Figure 4 Example of one train move not being able to make a set of points before another train coming through - based on Average Speed derived from Distance required (4d Path Length) and Duration given (Hours/Mins)

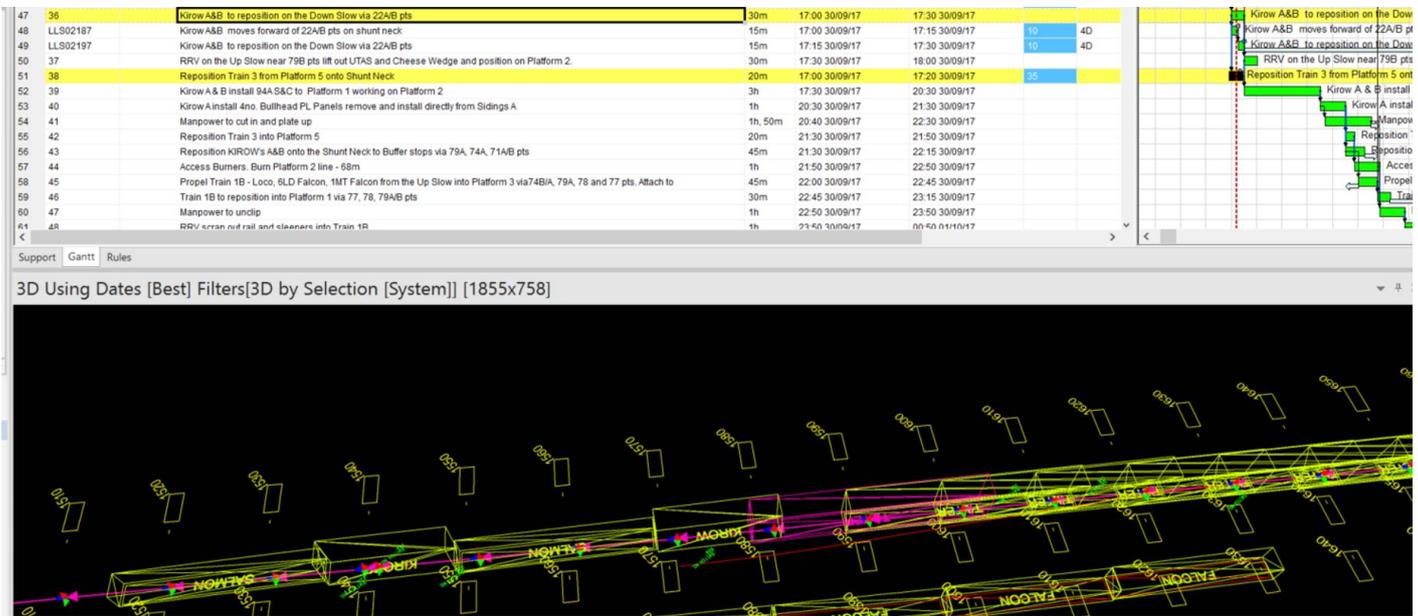


Figure 5 Example of Start to Start logic used in train moves - needed to be broken down a Finish to Start used

With a fully logically linked 3D path programme of train movements planners from all sides have been able to see what they had been asking for in the initial project planner meetings – knowing where the trains are, how long they are, what routes are they taking and how long will they be in a particular location for.

A “work space” can for example be put around trackside work gangs or particular objects where work is taking place and a clash detection report produced highlighting any “Clashes” not only within their own programme but others too.

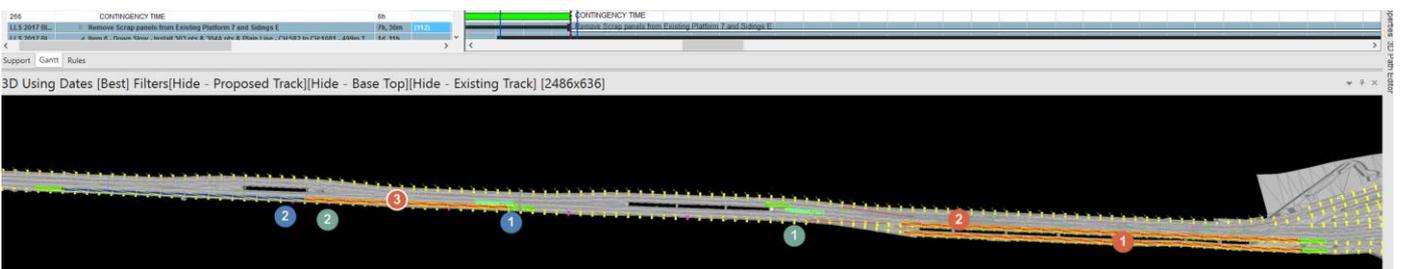


Figure 6 Length and Location of Trains During Stages – helped all planners work round S&C train moves

Another benefit of the 4D process has been resources (locos) linked to other activities on site that would be hard to spot in the text and Gantt chart without 4D highlighting the same object/resource being utilised at the same time.



Figure 7 Example of the same resource loco being used in 2 different activities with SS logic link. Reposition of Loco 5 needed to complete before egress of site could take place

Opportunities and Risks

During a blockade the Blockade Manager usually “blocks out” whole sections of track and platforms to allow for the priority works to be completed - in this case the S&C train moves, with the other contractors need to work around these. However, there are times where works can take place, say one end of a platform, where a train does not occupy the whole platform and is not “working”; or maybe a train requires a short stop or move next to another contractors work area before moving on. Using Synchro and Real4D™ tools SPI and Metisplan have been able to show these gaps in the programme that could be potentially utilised by the Blockade Manager to move works into as visually it can be seen where the train is, how long it is, duration it is in an area and the direction of travel through the site.

Site Introduction, Safety and Subcontractor Briefings

While this programme is still to take place the use of 4D model will be used to demonstrate the site layout and highlight train moves during site and shift briefings. Originally an animated PowerPoint, that was neither to scale, duration or sat contextually, was shown to workers and stakeholder prior to each shift. With a 4D model shift managers will be able to set up viewpoints, move around the model while trains are moving and highlight key areas workers will need to be aware of while on site.

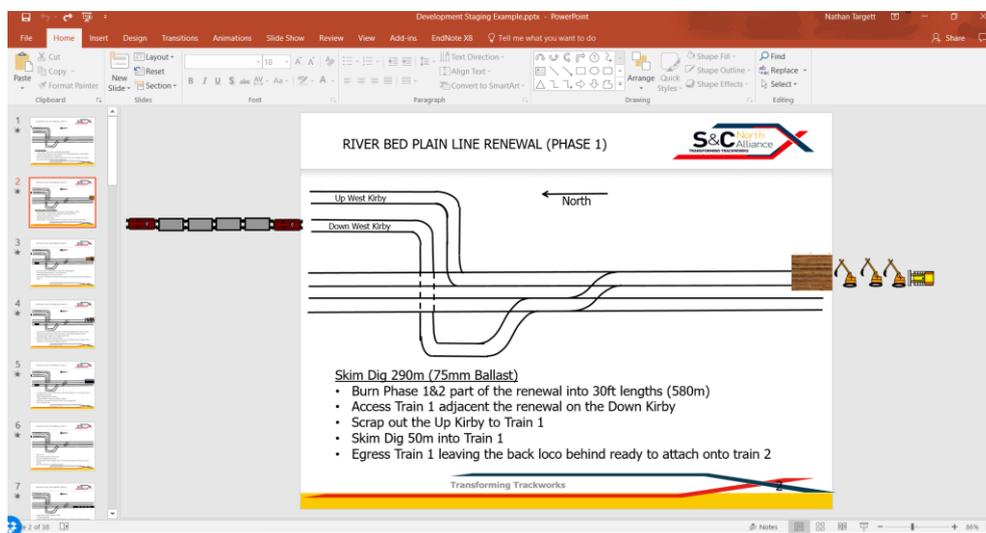


Figure 8 Example of a PowerPoint with Animations used by S&C to communicate broadly work sequencing to be carried out by shift teams

S&C have been using animated PowerPoint presentation for each phase of work they are on to demonstrate their programme to stakeholders and work gangs shift briefings. With 4D this will allow them to move back and forward on the timeline and move around the site to help with site briefings and safety.

Learning and Future Use

- Greatest Rewards Come with Even Earlier Engagement Starting Time

As with all 4D projects early and ongoing involvement is necessary. There is a certain amount of “catch up” required, especially with train moves, in preparing the model, assigning resources and attaching trains to 3D paths. Although 4D was brought in at contract award, it would have been beneficial to start at an even earlier tender validation stage.

- Setting Standards

Setting the planning standards and protocols as well as the baseline/proposed models and train moves is key even before works finally awarded. Once awarded then all contractors work at speed to flesh out their own approach to work in isolation due to the duration between award and works starting on site. With S&C train moves programme there is an opportunity to start the 4D process even earlier as these moves are unlikely to change a great deal due the need to booking slots for trains to arrive and leave on site.

- Getting the Right Level of Detail

Level of Detail is also key to get right. Who and what is the 4D programme for, does it need fully rendered real life graphics as you may want in a tender or to sell to a stakeholder/s or can a more cost effective basic model still get the point across to all parties.

- Getting the Right Support

Synchro advice and support throughout this project has been excellent. Nevertheless, SPI and Metisplan have been pushing the boundaries of what Synchro can presently do and have developed a number of tools and methodologies that hopefully one day will be incorporated into Synchro to make a Real4D™ train move programme a lot easier to do.

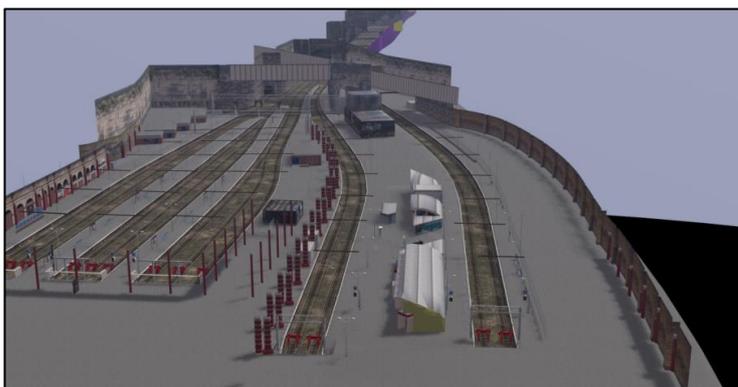


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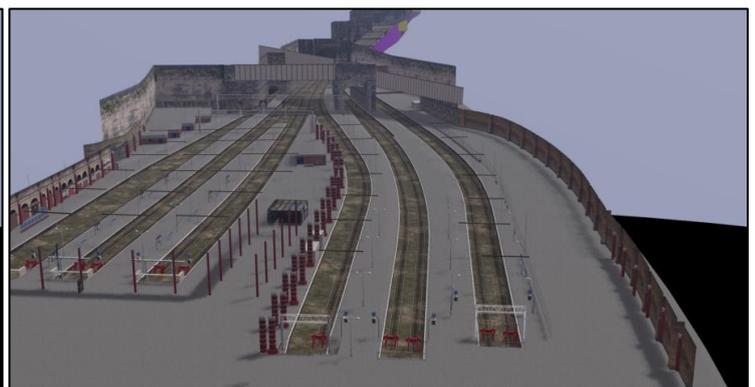


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Real4D™



Before



After