

## CASE study

# Playing with trains

Mott McDonald is using The Model Railway as a tool for developing a complete 3D railway model, says David Chadwick

It's nice to see the English indulging in their greatest passion round here - watching the steam trains go by! We live close to the West Somerset Railway, and put up loads of enthusiasts when they come down for Gala Weekends. We even have one regular guest who brings his own diesel engine down from Lincolnshire to play around with!

I am sure that every single one of them, though, would be envious of Mark Eaden's job - investigating different design and modelling techniques to build 3D models of real live railway systems, so that his company can simulate train and passenger movements.

Mark is the Principal Engineer at Mott McDonald railways. His department's work - The Model Railway - won an award at the latest BE Inspired event in Charlotte. The project that it describes looks at the use of 3D design and modelling throughout all stages of a rail projects development, from feasibility to study to detailed design, to be used to explore and understand the functionality of the railway throughout the design process.

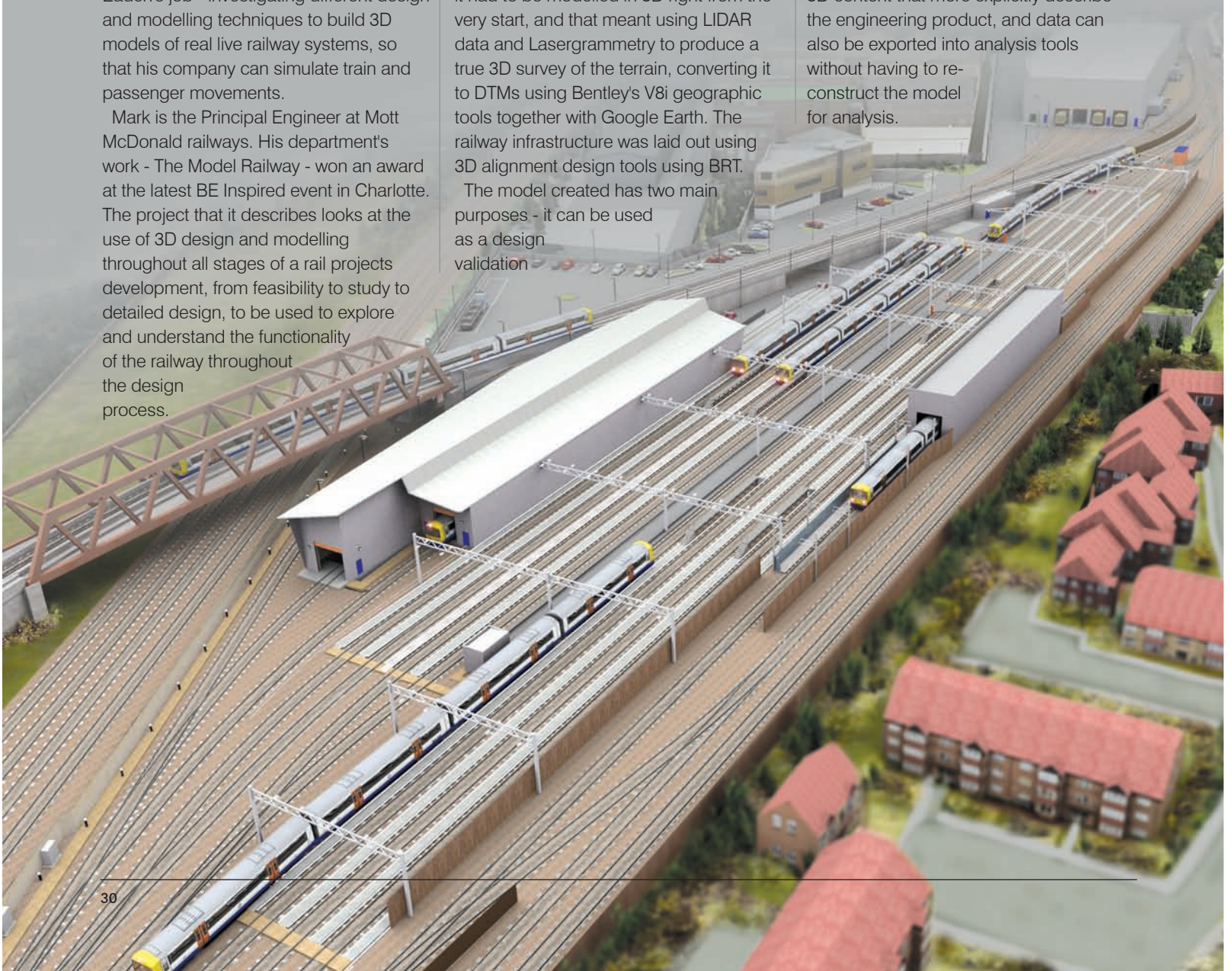
3D modelling is already being successfully used in the railway environment, but Mark and his believe that the model, comprising data from many sources, can be taken further - and be used for engineering analysis, signal sighting, public consultations, noise analysis and lighting assessments, to name but a few.

So where do you start? To get maximum value out of the model, Mark decided that it had to be modelled in 3D right from the very start, and that meant using LIDAR data and Lasergrammetry to produce a true 3D survey of the terrain, converting it to DTMs using Bentley's V8i geographic tools together with Google Earth. The railway infrastructure was laid out using 3D alignment design tools using BRT.

The model created has two main purposes - it can be used as a design validation

tool, looking at the relationships between different parts of the railway infrastructure - for instance between the railway itself and the signal scheme or overhead line design - and it is also used with visualisation tools for interdisciplinary design review. Mark said that it enabled them to resolve design differences with far less acrimony than ever before.

3D PDFs can also be used as output and presentation material with embedded 3D content that more explicitly describe the engineering product, and data can also be exported into analysis tools without having to re-construct the model for analysis.



And, of course, the model has to be produced and managed over the whole lifetime of the project, providing a primary source of data that can be used effectively by all involved parties. Using a 3D model doesn't entirely preclude the use of other design formats, and Mark sees occasions when schematic diagrams can be used alongside the model, although it would still be advisable that such data also be held in geophysical format, intrinsically linked, so that changes in one are reflected in the other.

### THE PHYSICAL INFRASTRUCTURE

Exploring relationships between different parts of the railway infrastructure comes nowhere near expressing how much infrastructure can actually be involved. It would be fair to say that nothing else matches it for complexity. Mark outlined all of the factors and elements that had to be considered for inclusion within the model.

First of all, you have the survey, outlined above, that builds the topography of the area and looks at existing infrastructure and ground conditions - you don't want to build a railway through a swamp! That's followed by the alignment of the track itself, its junctions with existing systems, and the design of the track, with cuttings, embankments and drainage systems.

If the railway is largely electrified, the model has to include delivery systems - conductor rails or overhead lines and gantries, the supporting infrastructure, and the bonding requirements. Electricity also has to be laid on to run the signalling structure - an acutely important part of the rail system, laying out signalling configurations, aspect positions (can the driver see them easily when travelling at speed, in any weather condition?), their supporting infrastructure and schematics.

There is always a large civil engineering element that covers bridges, tunnels and earthworks beyond that catered for with track alignment tools. Building infrastructure can be anything from signal boxes at railway crossings to the design or refurbishment of stations and termini. And then you throw in any other outstanding utilities and civil engineering bits and pieces to compete the model, such as lighting, car park design and

security systems.

The development of the model allows any or all aspects of the above to be developed, maintained in a single model, shared and updated between all collaborating partners.

### VISUALISATIONS

But that's just one part of the model - it's creation and development. Because the model can be delivered within all 3D environments it can be used in many ways. By utilising the latest visualisation tools it can be used for interdisciplinary reviews, where realistic and accurate models are used to increase understanding of the different elements of the model.

It can also be used for signal sighting, using animations that can mimic the view from the drivers cab as the model engine moves along the entire track. Visualisations can also be used to study the human factor, or involvement with the railway, ranging from appreciation to the ergonomics of the design.

Engineering simulations (using FE Analysis from LUSAS in most cases) cover a wide range of subjects, from power simulations, linked with electricity delivery systems, to multi-train or volume traffic simulations. Besides standard environmental assessments, probably required for rail design as much as building design today, the model data can be used for noise and vibration predictive modelling (Noise CandA). And we can go even further in our study of the human factor, by looking at the predicted movement of crowds through stations at rush hours.

Health and Safety aspects of rail construction in complex stations must also include ventilation simulations, as well as covering worst case scenarios, such as the outbreak and control of a fire, or perhaps even a potential terrorist attack. Lighting studies look at a range of conditions, from station and track lighting requirements to screen glare affecting the driver's vision.

The model can be used for operational planning, to configure the project planning model and to track the construction itself. It can also be used to keep a record of

assets and as a basis for setting up, maintaining and tracking maintenance.

### LESSONS LEARNED

Bearing in mind the reason behind the development of the Model Railway, it is interesting to look at Mark's later evaluation of the process. The two most interesting points were the intransigence of the 2D world view and the struggle they had getting around people's prejudices and misconceptions - although he admitted that using Microstation helped them eventually win most of the arguments. The second is that it is too easy to be seduced by the 'sexiness' of working in 3D, where they were sometimes guilty of allowing themselves to get carried away with an inappropriate level of detail, not commensurate with the phase of design activities.

As the focus moved away from drawing production to engineering model production, it raised the question of identifying the right resource for the task - to balance modelling skills with engineering knowledge. Mark explained that 3D modelling requires engineering decisions from an engineering qualified modeller, or one who understands where to get the information he needs.

3D modelling also requires discipline. 'Sales Pitch' visualisations needn't be totally accurate, but engineering models require absolute precision. Indiscipline leads to re-work.

Finally, transfer of data between different design and analysis packages sometimes caused problems. These included noise and vibration analysis in tramway design exported in FE Analysis and noise contouring software. To alleviate this, base models have to be constructed in precise and specific manners.

### IN CONCLUSION

Mark admits that he and his team are relying on learning from their mistakes to make improvements later on. They are also a bit frustrated, as technology isn't quite keeping up with their ambitions. It's getting closer, especially with rendering and processing animation data in real time, but it's not quite there yet!

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