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Digital Twin Optimises High Speed Rail Timetable

Model-based engineering, optimisation methods and advanced simulation tools combine to maximise infrastructure utilisation and limit noise impact of HS2

As more high speed rail projects are created to meet growing needs for mobility, the tensions between transport benefits and local environmental impacts inevitably rise. The benefits of greater transport capacity and faster journey times are offset by the disruption caused by the new infrastructure.

The UK's HS2 project is committed to address this through defined limits for these impacts using a range of criteria, such as permissible noise levels, and enshrining those limits in law to ensure they can be held to account.

But while such initiatives may reduce objections, they do cause significant obstacles for timetable schedules, which must balance the need to provide passenger capacity against permissible limits.

With the high cost of such infrastructure projects, the HS2 Innovation Team wanted to investigate how to maximise train throughput without exceeding the permissible noise levels.

To avoid expensive and time-consuming experimental studies, HS2 worked with CFMS to use digital engineering tools that have been developed in aerospace and other high value design sectors. Transferring these tools from other industries provided actionable insight to optimise the timetable schedule while checking that noise limits would not be exceeded.

Using a combination of model-based engineering, advanced simulation and high performance computing, the CFMS team built a software model and simulated different scenarios of different train volumes passing along the track.

CFMS specialists used a combination of noise models, geographic data and system constraints to create a digital twin of an 8km section of track in north west London, with 166 surrounding assessment locations. The digital twin enabled the direct assessment of results (DARN) noise levels to be calculated at each of the 166 assessment locations for this section. Then by using the digital twin to model different train volumes, CFMS experts optimised the frequency of trains using the track but not exceeding the noise level limits.

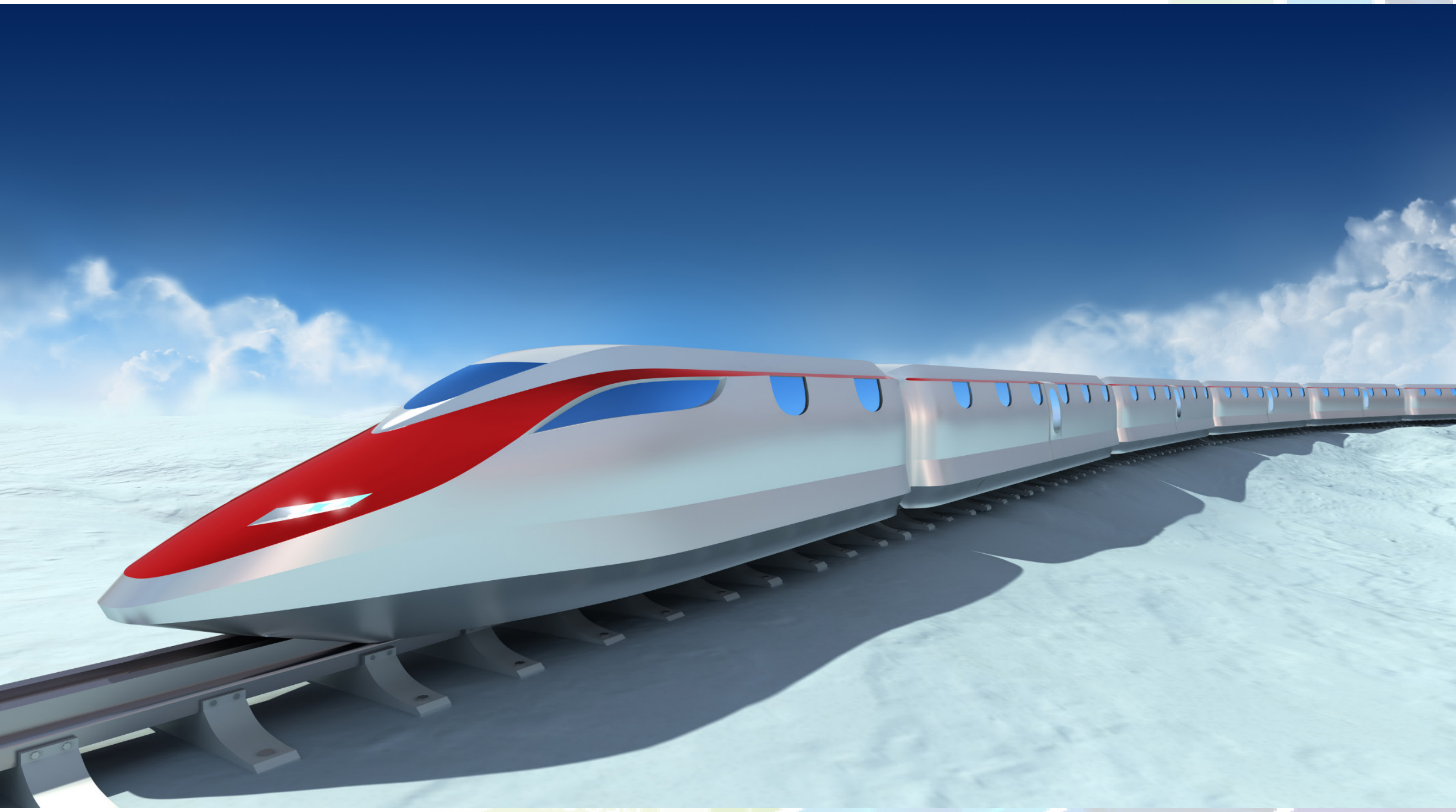
The CFMS team employed a range of methods to determine which assessment locations exceed noise limits with different train frequencies. Combined with an in-house framework for optimisation and sensitivity analysis, this gave HS2 planners an optimised throughput of trains and confidence the forecasts would prove to be accurate.

With a digital twin to model different scenarios, this approach can also be used to automatically optimise train throughput for a range of different starting situations, such as a train failure, extreme weather conditions or any other incident that could disrupt the regular timetable.

The project demonstrated how digital engineering methods can generate accurate models quickly to improve infrastructure projects. It eliminates uncertainties and overcomes preconceptions within project teams that could constrain the development of optimisation.

The project has shown how digital engineering can create more optimised solutions and the framework can be adapted to any 'throughput scheduling' problem, such as other transport systems, factory utilisation, or other network optimisation.

If you would like to learn more about how the latest digital engineering tools can benefit your projects, please contact CFMS for more information.



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