



# Romax Consultancy Services Provide Reliability Solutions for European Rail OEM

## Client

CAF MiiRA (Motion and Intelligence in Railways) designs, manufactures and maintains railway wheelsets and their components: wheels, axles, gearboxes, axle boxes etc. In addition to supplying a wide range of components, CAF MiiRA have a great deal of expertise in supply and repair of gear units and are the only wheels and axles manufacturer able to design and assemble the complete wheelset.

## Challenge

Ensuring reliability by preventing gear edge loading; improving noise, vibration and harshness (NVH) performance as much as possible; understanding the link between test data and simulation.

## Solution

Romax Technology consultancy services, a proven solutions provider for the rail industry, use a whole-system simulation approach to calculate gear micro geometry parameters which satisfy demanding reliability and NVH targets, and help to define a simulation strategy covering both the test and in-service arrangement.

## Benefits

Confident simulation for full understanding of system behaviour before production, leading to minimised operating costs, increased reliability, de-risked new designs, and improved client confidence and end-user satisfaction.

CAF MiiRA is a leading company in the design, manufacture and maintenance of railway wheelsets and their components. Currently, CAF MiiRA is the only manufacturer of wheels and axles capable of delivering the wheelset with a complete design: from the wheels, axles, axle boxes, and gearboxes.

Mikel Oyarbide, Gearboxes Projects Engineer at CAF MiiRA, explains: "CAF offers comprehensive global rail solutions which, in addition to the supply of trains, include viability studies, civil work, electrification, signalling, maintenance, and system operation. Thanks to these integrated projects based on concession or turnkey models, customers are offered a single, global, specific solution, which guarantees the integration and compatibility of all the systems. Our products can be tailored to suit the specific requirements of each customer, providing safety, comfort and satisfaction to millions of users throughout the world."

With durability a key industry priority, CAF MiiRA's gearbox engineering team have worked with Romax Technology on several projects to ensure optimum gear design for reliable performance and reduced noise. Typically, the systems are diesel electric drivetrains and Romax' involvement is on the mechanical sub-system.

*"Romax brought a lot of value to our design process, including Right First Time™ design and improving our understanding of our products, which in turn means that lead times can be achieved, and we save cost and test rig availability."*

**Mikel Oyarbide**

**Gearboxes Projects Engineer  
CAF MiiRA**

## Partnering with Romax for Reliability in Rail

CAF MiiRA boast a wide range of expertise on a variety of gearbox designs. However, the industry's changing requirements mean that new gearbox layouts are being commissioned all the time. In these cases, CAF MiiRA might partner with simulation experts to ensure the project is completed to their high standards.

Oyarbide comments that CAF MiiRA chose Romax for this because "Due to short delivery time demands, a Right First Time™ approach was necessary. The time required for a traditional 'test-error-correct-test' method was not acceptable. To get the initial design correct, we needed to analyse the complete gearbox and calculate the system deflections and gear contact misalignments. Before working with Romax, we used independent calculation methods for shafts and gears, then defined the best possible micro geometry, then tested, corrected if necessary, then tested again. Romax brought a lot of value to our design process, including Right First Time™ design and improving our understanding of our products, which in turn means that lead times can be achieved, and we save cost and test rig availability."

## Micro-Geometry Improvements for Reliability and NVH

CAF MiiRA sought Romax's help to improve the reliability and NVH performance of a one stage spur cannonbox locomotive transmission. The gear micro geometry was optimised using Romax analysis of system deflections and gear mesh misalignments, to improve the gear contact distribution and transmission error (resulting in durability and noise improvements).

"Thanks to Romax analysis, we could define the required gear corrections in the detailed design phase of the project. In the end, a contact patch test was performed in the test rig to verify the defined gear corrections," Oyarbide comments.

*"We can spend more time optimising during the design phase than previously, due to Right First Time™. We have a better control of the gearbox design and working conditions."*

**Mikel Oyarbide, Gearboxes Projects Engineer, CAF MiiRA**

CAF MiiRA then asked Romax to do a repeat project, this time for a new cannonbox configuration. Components were imported into Romax software from native CAD models using CAD Fusion. Romax performed micro geometry optimisation to meet stress targets, minimise transmission error (TE) and edge loading, using a genetic algorithm approach to prioritise particular targets for particular load cases and a sensitivity study to show which results were sensitive to manufacturing variance in which parameters. An optimised design was specified, however, when the gears were manufactured, the observed tooth contact patches on the test rig did not match the simulation prediction from Romax.

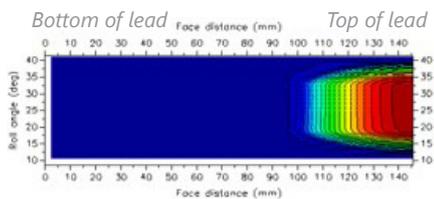
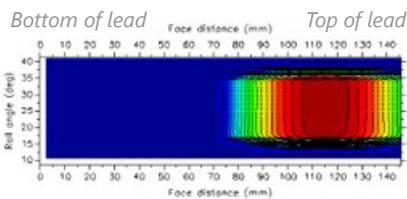
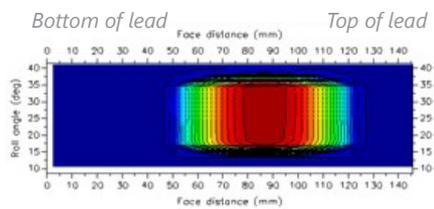
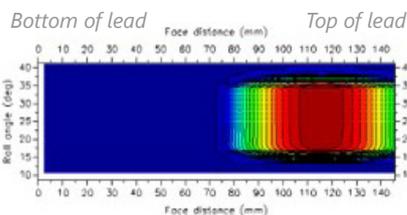
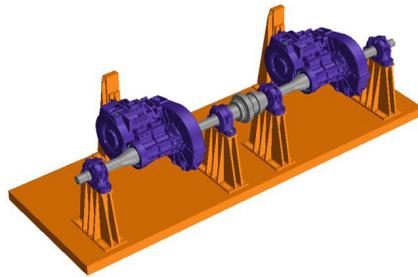
### Correlating Simulation and Testing

To investigate this issue, Romax tried to manipulate the existing model, varying parameters in an attempt to correlate with the test rig contact patterns. After no success, Romax checked the CAD model of the test rig. Here it became clear that the test rig conditions were different to those of the real-life train (and therefore those of the Romax simulation). There were differences in the system supports (the test rig did not have wheels, and had extra couplings) and the loads (the test rig did not include the carriage weight, so did not account for vertical loads). By contrast, the Romax simulation had accounted for the full working conditions of the train.

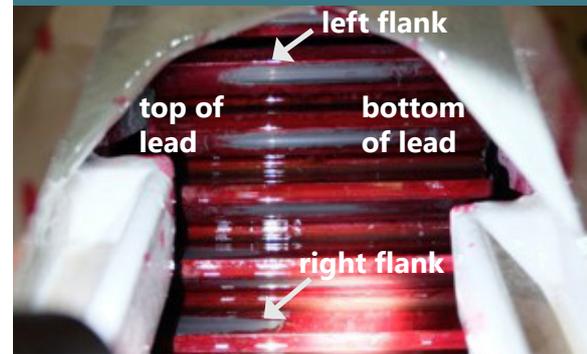
Once this had been established, Romax sought to prove their findings. They built another model in Romax software, using the same traction unit from the initial model, and imported the CAD test rig data. The results of this model correlated with CAF MiiRA's physical test rig.

*In-service Romax model and contact patches of pinion 1 (left then right flank), used for simulation of in-service train*

*Test-rig Romax model and contact patches of pinion 1 (left then right flank), used for correlation of test data*



- **Optimising for reliability by reducing gear edge loading and transmission error**
- **Using correlation and simulation for pre-production understanding of full system behaviour**
- **De-risking new designs**
- **Minimising operating costs**
- **Increasing reliability**



*Gear test data, which correlates well with test-rig Romax model*

The findings of this project therefore hold much significance for the future. CAF MiiRA have an improved method for simulating realistic load conditions in the train, and for correlating results obtained from test rigs. Such intelligent use of simulation and testing can lead to improved design processes, and subsequently more reliable, cheaper, and more efficient final products. Oyarbide comments: "It is very difficult to measure these gains, but they are definitely very important. Moreover, the possible delivery delays are minimised if everything is Right First Time™."

CAF MiiRA have a reliable process to use for future developments, ensuring knowledge of their system behaviour before manufacture through confident simulation. For future projects, if the test rig Romax model matches the actual test rig, then CAF MiiRA can be confident that the in-service Romax model will match the in-service train. "We can spend more time optimising during the design phase than previously, due to Right First Time™. We have a better control of the gearbox design and working conditions. At the moment we expect to continue collaborating with our high speed gearbox development together with Romax. For sure, there will be more projects in the future where we will also work together."

### To find out more

Contact us via [marketing@romaxtech.com](mailto:marketing@romaxtech.com) or visit [www.romaxtech.com](http://www.romaxtech.com) or [www.cafmiira.com](http://www.cafmiira.com)



Since the time of writing this case study, the Romax product offering has evolved. The features and benefits described here most clearly map onto our new products Enduro and Spectrum.