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The Spectrum Bogie

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The Spectrum Bogie

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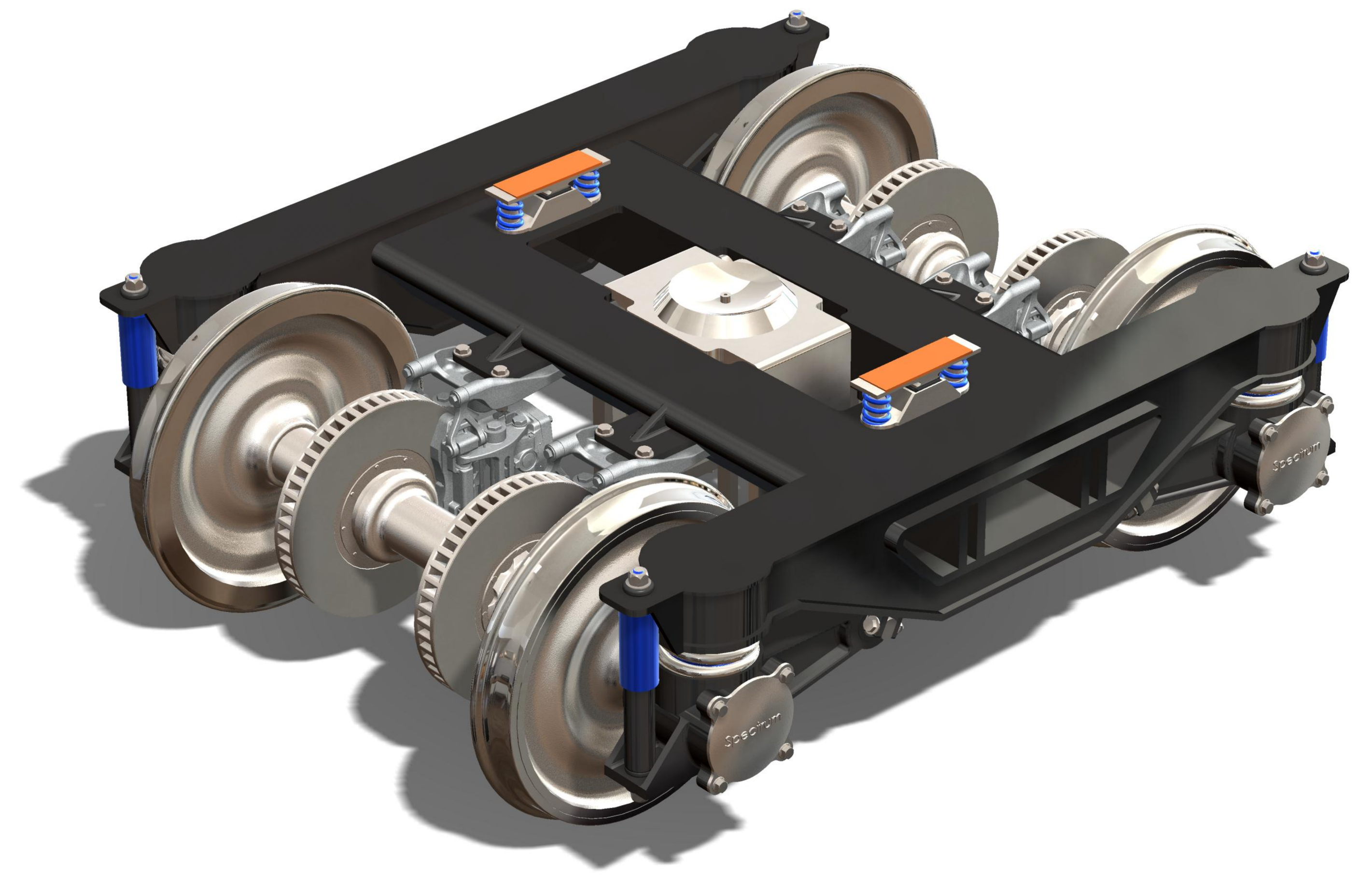
Problem definition:

- The Spectrum train aimed to exploit the Low Density High Value (LDHV) goods market for containerised loads
- High speed (up to 160 km/h) was necessary to integrate with passenger services, with potentially lower axle load, fragile cargo, and an articulated wagon design
- An optimised running gear design was required

Final Bogie Design:



Aim:

Produce a novel bogie concept with:

- High speed stability
- Good ride quality
- Safe running (compliant with Standards)
- High curving performance (low track damage)

Process:

- Review of existing bogie designs and identify an appropriate base concept
- Determine initial values for suspension component parameters (lengths, stiffnesses, damping rates etc.)
- Construct a mathematical vehicle model (in Vampire) to optimise those parameters for the required performance
- Implement an iterative optimisation process with dynamic simulations to achieve the aims
- Produce a CAD model of the viable bogie concept

Base Concept:

- A review of existing bogie designs led to a chosen base concept
  - Trailing arm primary suspension
  - Coil sprung
  - Viscous damped
- UIC secondary suspension
  - Standard centre bowl and side-bearer arrangement
- Axle mounted disc brakes
  - Required to operate alongside passenger stock
  - Dictated external axle boxes

Initial Parameters:

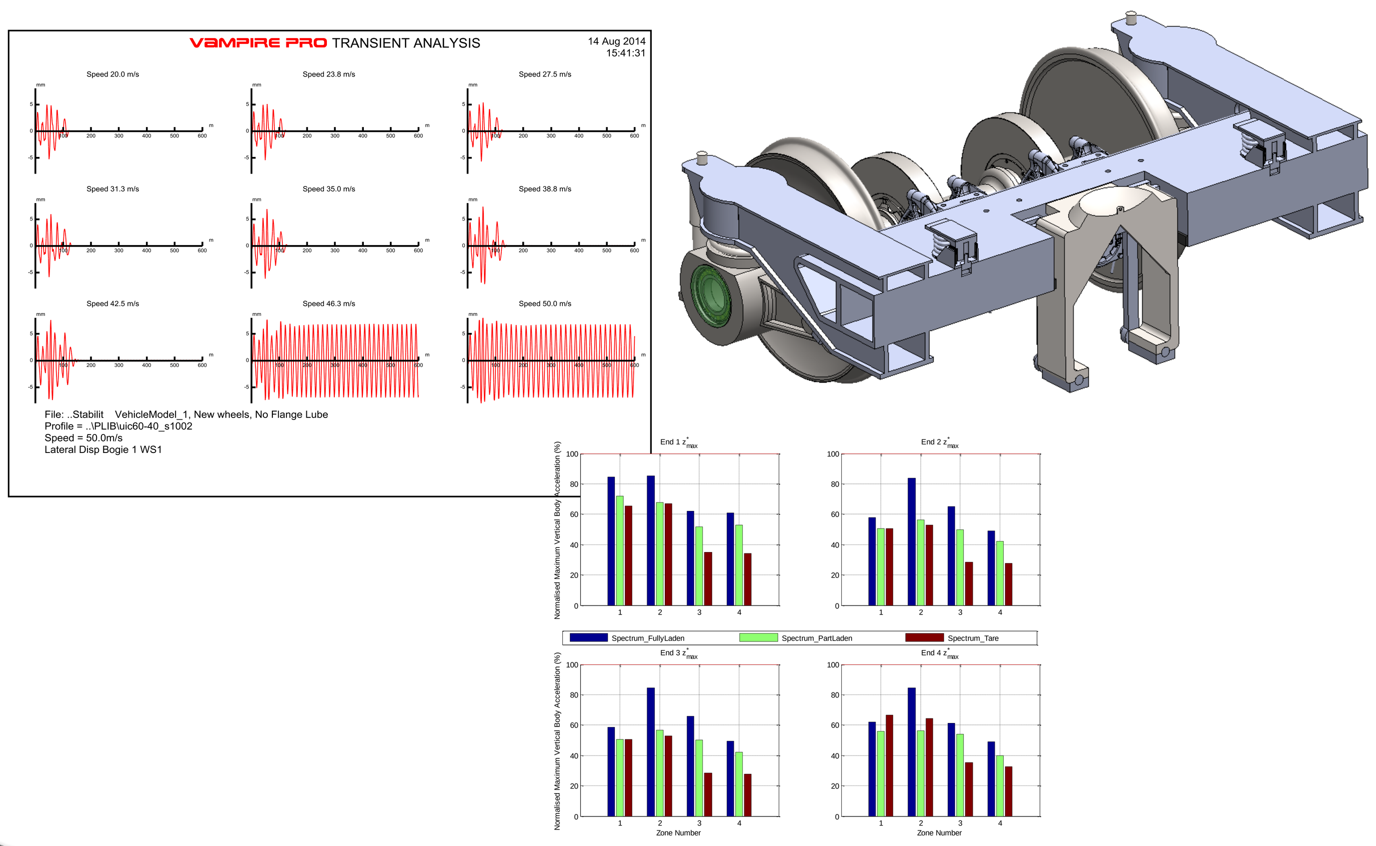
- Initial parameters can be determined a number of ways:
  - Calculation from fundamental principles $\omega_n = \sqrt{\frac{k}{m}}$
  - Application of accepted vehicle design principles
  - Engineering judgement/application of experience
  - Derivation: for example the trailing arm bush parameters were determined by calculating their influence on primary yaw stiffness 'KY'

$$KY_{TBY} = \frac{(Y_{TB}\theta)^2}{2} . K_{TBY} \qquad KY_{TBX} = Y_{TB}^2 . K_{TBX}$$

» *K – Stiffness in given direction*
» *Θ – Wheelset yaw angle*
» *Y_{TB} – Trailing arm bush semi-spacing*
» *$_{TB(X,Y)}$ – Trailing arm bush longitudinal and lateral directions*

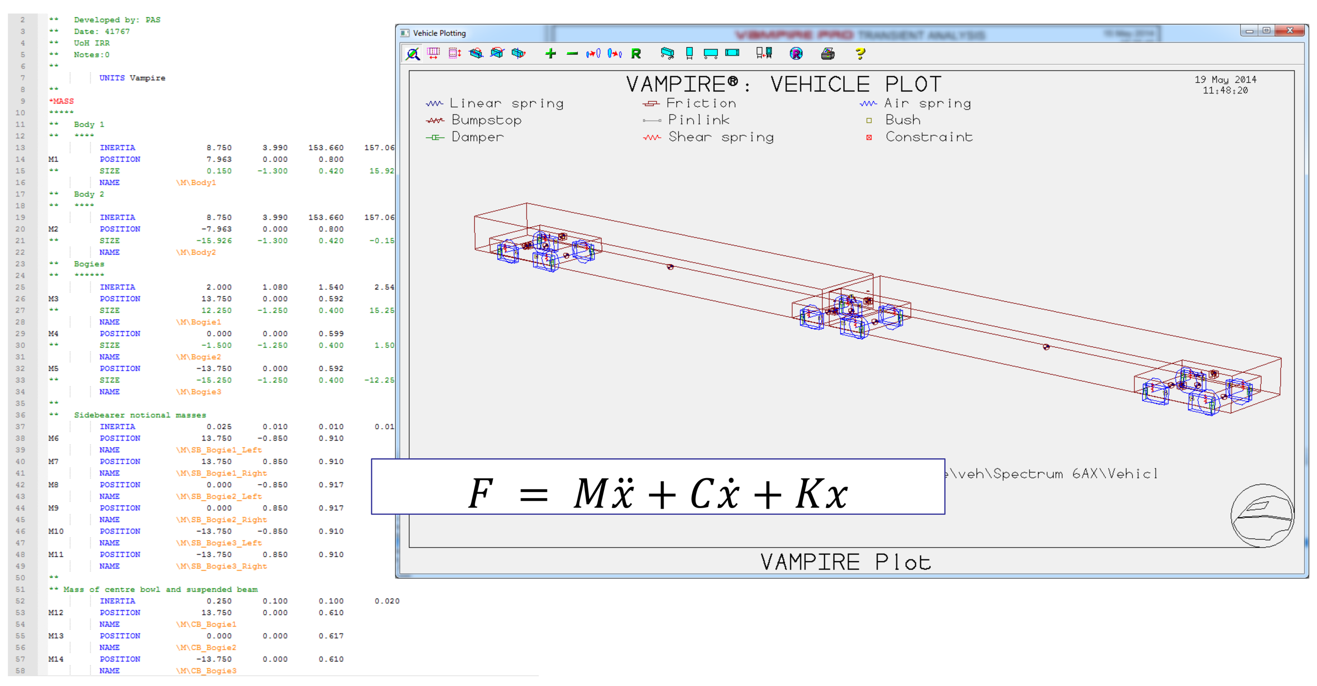
Analysis and optimisation:

- The vehicle parameters were used to create a Vampire multi-body dynamics model



Mathematical Vehicle Model:

- The vehicle parameters were used to create a Vampire multi-body dynamics model



What was achieved?

- A novel bogie concept was developed - featuring conventional/proven suspension components and technologies, but in a novel arrangement and application. Swing links were introduced to the UIC secondary suspension to improve lateral ride and stability.
- Improved dynamic performance with reductions of between 8% and 16% in Variable Usage Charge compared to a conventional Y-series container vehicle (calculated with Network Rail's Variable Track Access Charge Calculator)

Inspiring tomorrow's professionals

The Spectrum project received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 266192.

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