Railway vehicle dynamics simulation platform

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BACKGROUND

- Post-processing not consistent even in the same site, each simulation engineer has his own program for post-processing.
- New SIMPACK 9 provides flexible substructuring and more powerful scripting language. They enable automatic and efficient model assembly.
- Some vehicle models only adjust parameters or just change a little in the structure. So we don’t need to establish a new vehicle model but only modify the original model from database.
- Result validation becomes more significant in the future, but is not included in SIMPACK yet.
How to be more efficient

1. Question
2. Vehicle model development
3. Prepare the parameters
4. Pre-processing
5. Simulation
6. Post-processing
7. Make report

VDSP
Sifang Co., Ltd. had a cooperation with Get Group about simulation platform project from 2012 to 2013. According to the needs of Sifang, Get Group created a practical solving scheme and its implementation to realize the simulation platform.
The VDSP includes two parts: one is simulation database, another is the platform.

**PART I:**
- vehicle database
- track and excitation database
- testing database
- criterion database

**PART II:**
- modeling
- analyze and post processing
  - simulation
  - post processing
  - confidence level
  - parameter
The programming language is QSA, which is available in SIMPACK Post. With this language it’s easy to create a flexible program.

```javascript
function GB5599(args) { // GB5599 function
    var OutFile = "Report.html";
    var Analyst = new String;
    ......
}
```
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SIMPACK QSA Workbench
Vehicle database

- According to Sifang, a tractor model / motor model have been set up in the vehicle database.
- Profile database includes Chinese wheel profiles and rail profiles such as: LM, LMA, Rail_50, Rail_60 and so on.
- Track excitation database: excitations such as AAR2～AAR6 track irregularity spectrum have been added.
• Linear critical speed analysis
• Non-linear critical speed analysis using “once integration method”;
• Non-linear critical speed analysis using “minus acceleration method”;
• Long straight track analysis;
• Curve passing performance analysis;
• Longitudinal dynamics analysis
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Post processing interface
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Curve and key data will be output automatically.

Acceleration Output
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#### Y/Q: Derailment Coefficient

**Left Diagram:**
- **Title:** Y/Q derailment coeff. wheel (left side)
- **Description:** The chart shows the derailment coefficient over time for the left wheel. The data is compared to the original dataset with spikes removed for tpxs calculation.
- **Graph Details:**
  - Y-axis: Y/Q derailment coeff. wheel
  - X-axis: Time in seconds
  - The graph displays a range of values from -0.5 to 0.2 for Y/Q derailment coeff. wheel.

**Right Diagram:**
- **Title:** Y/Q derailment coeff. wheel (right side)
- **Description:** The chart shows the derailment coefficient over time for the right wheel. The data is compared to the original dataset with spikes removed for tpxs calculation.
- **Graph Details:**
  - Y-axis: Y/Q derailment coeff. wheel
  - X-axis: Time in seconds
  - The graph displays a range of values from -0.5 to 0.5 for Y/Q derailment coeff. wheel.

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**Data Analysis:**
- **Left Side:**
  - Maximum Y/Q value: 0.48
  - Shows significant variations in derailment coefficient over time.

- **Right Side:**
  - Maximum Y/Q value: 0.38
  - Shows variations similar to the left side.

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**Notes:**
- In Simpack software, the derailment coefficient is calculated considering the derailment direction. Left derailment is indicated by a positive Y/Q value, while right derailment is indicated by a negative Y/Q value. This ensures a more accurate representation of derailment behaviors.

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**Simpack Result File Name:** E:/Simpack_start/tyz_script/vehicle1.sbr
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Post processing exports report in HTML format which can be read by MS Word

**车辆动力学性能分析报告**

本次分析是依据 GB5599-85 标准对**车辆的动力学性能进行分析。该车辆为**客车，试验线路为**线路。分析过程包括 1 个工况，对每个工况分别进行该车的动力学性能平稳性分析和稳定性分析。针对每种工况，在报告中分别给出该车的平稳性分析和稳定性分析的性能指标，并依据 GB5599-85 标准进行评价；报告的最后，以表格形式给出各个工况下该车辆动力学性能的平稳性分析和稳定性分析的综合数据结果。

工况 1：车辆试验速度为：72Km/h。
**车辆单变量 DS 分析报告**

2013-04-02

本报告是利用 Simpack V9.1 软件，完成该车辆动力学性能的参数化性能分析流程。本次分析为单变量的 DS 分析过程，定义一个设计变量，目标函数为该车辆的临界速度指标，即以该车辆在设计变量的不同取值下的车辆的临界速度为研究对象。报告中分别对设计变量、目标函数进行说明，并给出目标函数与设计变量的关系，视该设计变量的类型而定，如果是实数类的设计变量，除了给出目标函数与设计变量取值的关系曲线以外，还计算得到目标函数对设计变量的敏感程度；如果是其它类型的设计变量，包括：非线性参数、车轮踏面形状或轨道截面形状等类型，则只给出目标函数与分析过程的关系曲线。

设计变量:

本次单变量 DS 分析所考虑的设计变量的属性如下:

1. 名称：\_CB_mass
2. 单位：[kg]
3. 物理含义：车体质量（M）
4. 类型：实数类
5. 源文件：
Simulation result and test result comparison

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Simulation result and test result comparison

仿真实数据与试验数据的对应表

测试信号：Velocity
仿真数据
传感器名称：$S\_CAR$
选择分量：X

测试信号：Acc1Y
仿真数据
传感器名称：$S\_CAR\_Middle$
选择分量：Y

测试信号：Acc1Z
仿真数据
传感器名称：$S\_CAR\_Middle$
选择分量：Z

测试信号：Acc2Y
仿真数据
传感器名称：$S\_CAR\_Cabin$
选择分量：Y
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Simulation result and test result comparison

![Graph showing simulation and test results comparison](image-url)
Conclusion

- Quick modelling becomes reality through new SIMPACK 9. It helps us a lot in efficiently creating models.

- The VDSP can establish standards and process management to perform railway vehicle dynamics simulation.

- The VDSP extends SIMPACK’s functionality, enables the user to dealing the data more easily and can validate the simulation results.
thank you!