TRAILER STABILITY ASSIST IN SIMULATION

Nithin Ambady, Mark Foster, Krzysztof Kowalski

SCS Virtual Tools and Analysis

Introduction

TSA (Trailer Stability Assist) development in simulation allows the tuning of the system to be performed using CarMaker and other software tools, removing the requirement for physical trailer towing tests.

Drivers for capability:

- Elimination of associated risks to personnel, vehicles and test locations
- Programme costs reduced due to physical prototypes not being required

TSA – Sub Functions
Overview

- Trailer Probability Learning
  - Trailer Plug Detection
  - Maximum Velocity Analysis
  - Yaw Rate Damping Analysis
  - Constant Driving Analysis
  - Mass Analysis
- Sway Detection
- Sway Mitigation

Trailer Probability Learning – eg. Constant Run Analysis

Current Method:

- Physical Testing
- 1 of each engine variant vehicle required
- 1x 800kg trailer
- Trailer ballast
- Dummies and vehicle ballast
- Use of Proving Ground
- 1 Application Engineer
- 1-3 weeks work based on Timing
- Repeat with changes in engine calibration and prototype vehicle level.

Developed Method:

- Virtual Testing
- 1 of each engine variant vehicle model required:
  - Accurate engine model data
  - Accurate aerodynamic data
  - Correct gearbox data (ratios, inertias and shift limits)
  - Correct Torque Conveter data (ratios, inertias and shift limits)
  - Correct drive train data (Conveter fctors, look up logic, inertias & spring constant)
- 2x Trailer models required, min and max weights (800kg and 1800kg) (built from Trailer Builder tool)
- Const_Run_Result TestWare script
- Constant_Run_Result.m Script for post processing data and Report Generation.
- 1hr per engine variant

[ref: TSM in Simulation, Mark Foster, Sept 2013]

Vehicle Model Correlation

Trailer Probability Learning

Correlation Manoeuvres used:

Coast Downs in Neutral

60 kph, 80kph, 120kph

Constant Runs in Drive

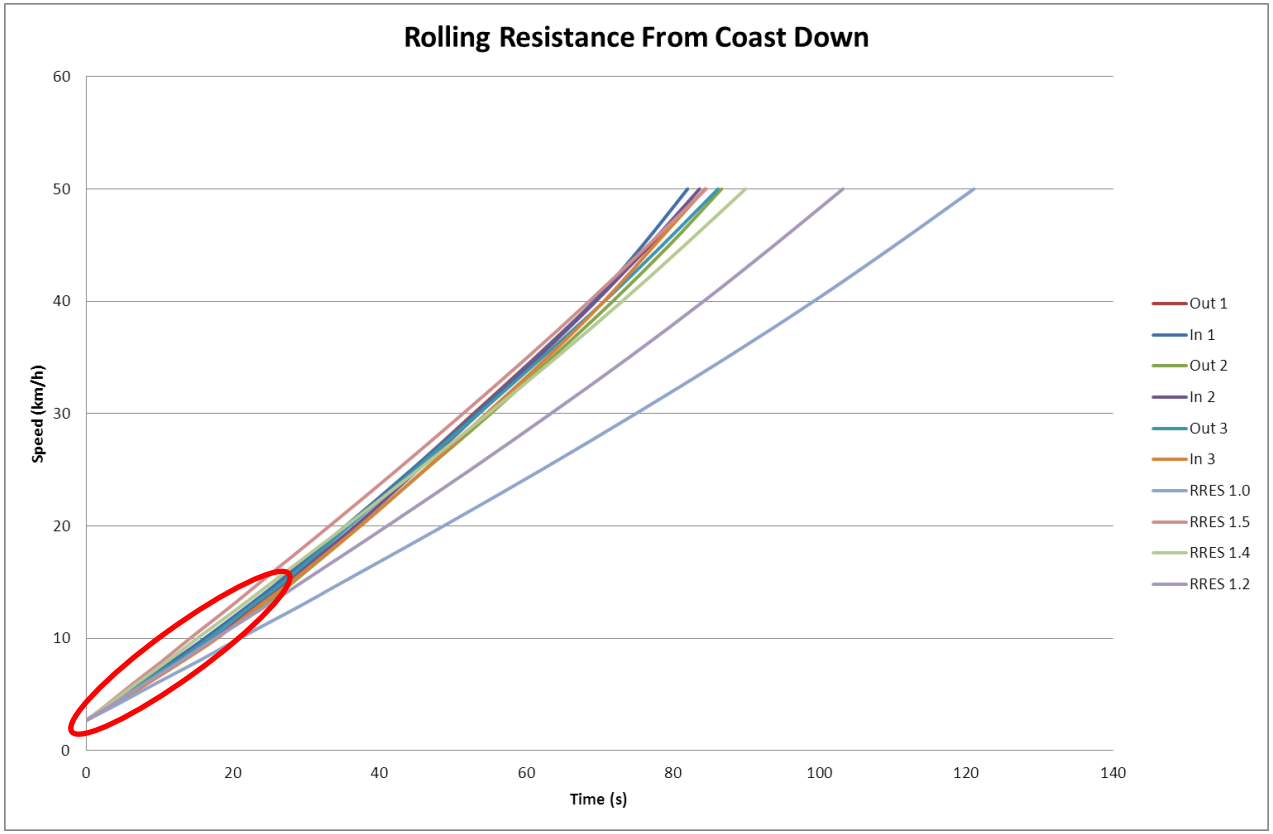
60 kph, 80 kph, 120 kph

Study:

1. Effects of Tyre Rolling Resistance
2. Effects of Aerodynamic Data
3. Effects of Wheel Bearing Friction

Constant Run Analysis- Vehicle Model Correlation

Effects of Tyre Rolling Resistance

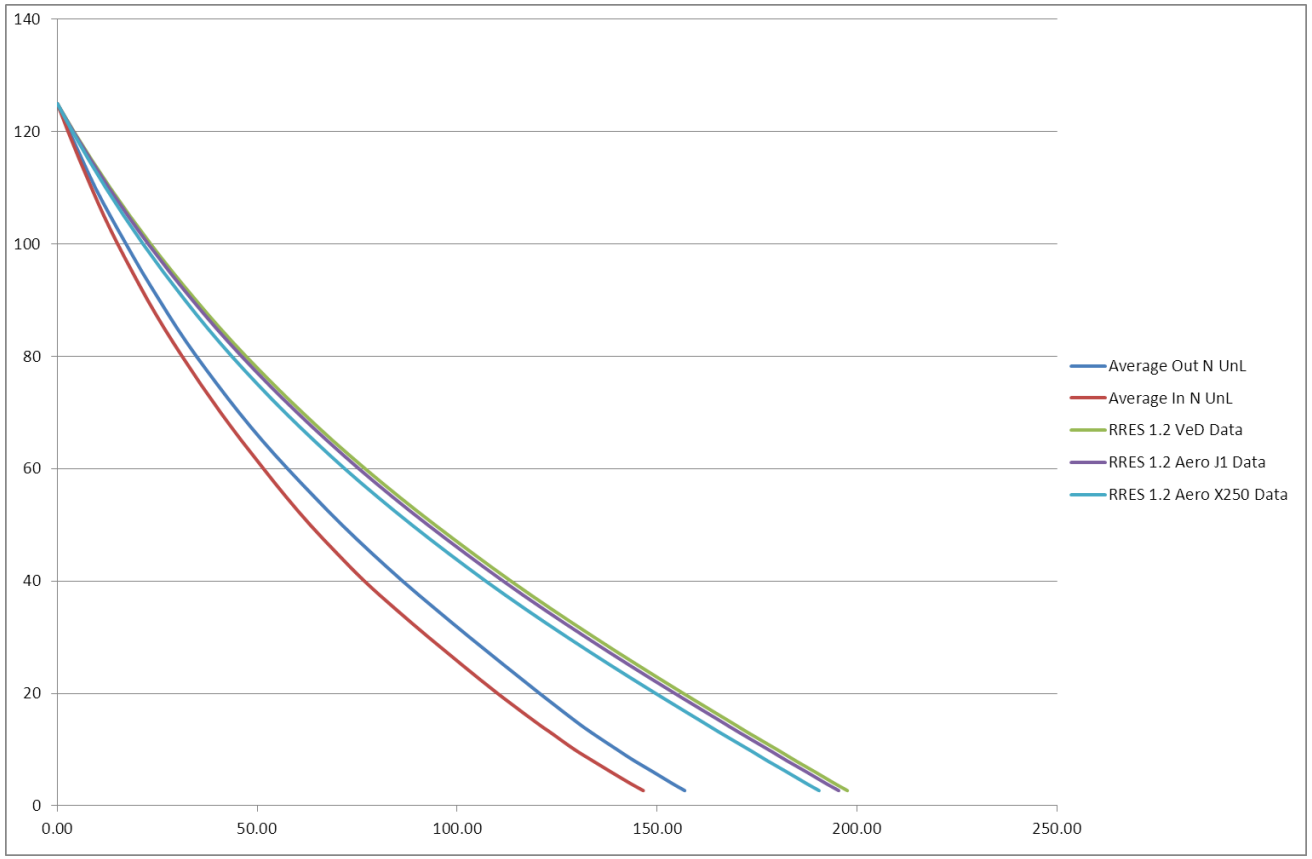


Looking at physical coast down data (in N) for the same vehicle changes were made to the LMY scaling factor for rolling resistance inside the tire model, this was done until the 0-15km/h range is matched.
Aerodynamics will not have an effect at this low speed. For this vehicle it is equivalent to 1.2.

[ref: TSM in Simulation, Mark Foster, Sept 2013]

Constant Run Analysis- Vehicle Model Correlation

Effects of Aerodynamic data

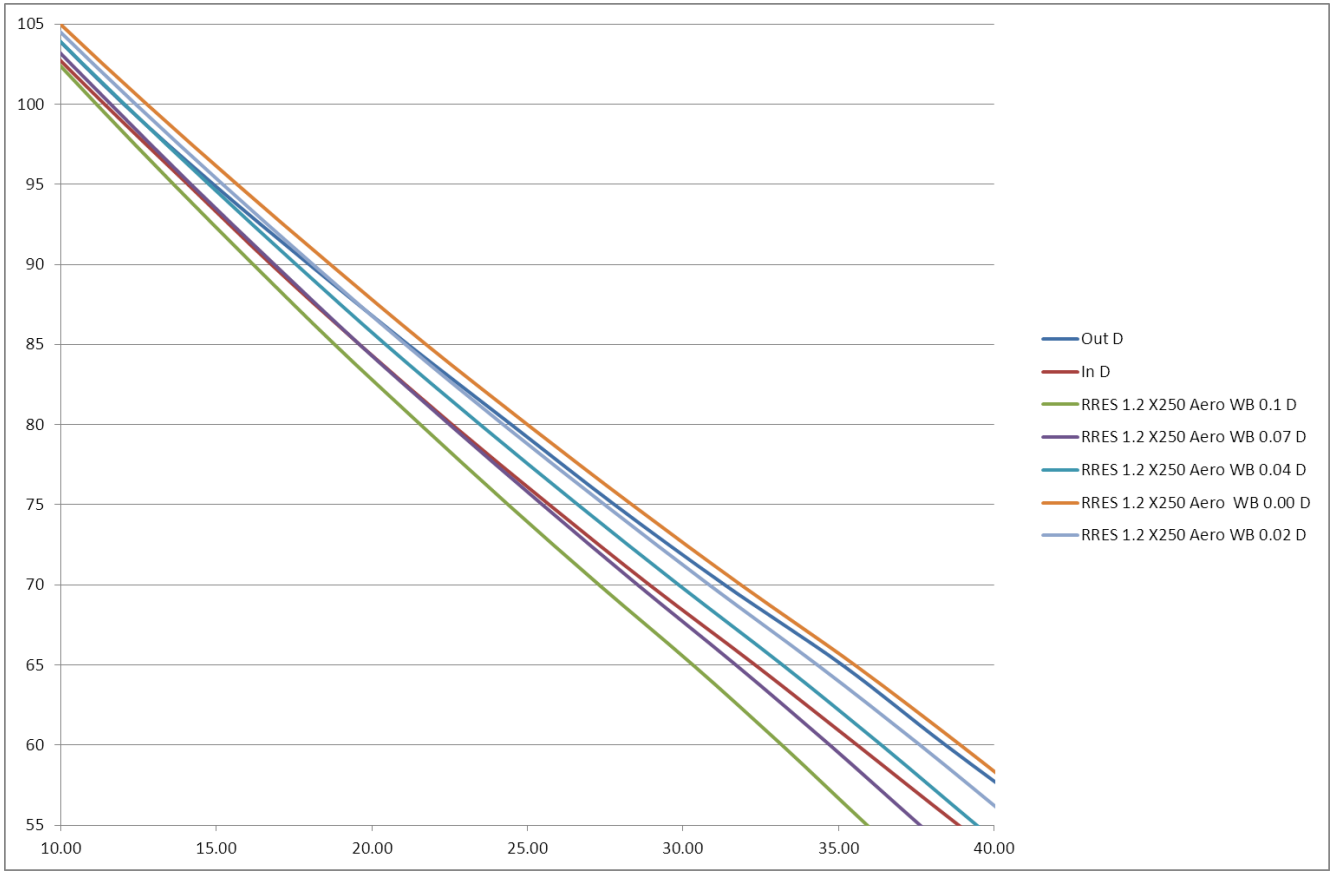


Once the tyre rolling resistance is confirmed it is important to use aerodynamic data which is as close as possible to the physical vehicle. Again this is compared in a coast down from 125km/h in N. Unfortunately no aerodynamic data exists for the M1 vehicles, as can be seen from the 3 sets of aerodynamic data we have, the X250 data is closest, however it can also be seen there is still a large difference in the coast down between the model and the physical vehicle.

[ref: TSM in Simulation, Mark Foster, Sept 2013]

Constant Run Analysis- Vehicle Model Correlation

Effects of Wheel Bearing Friction



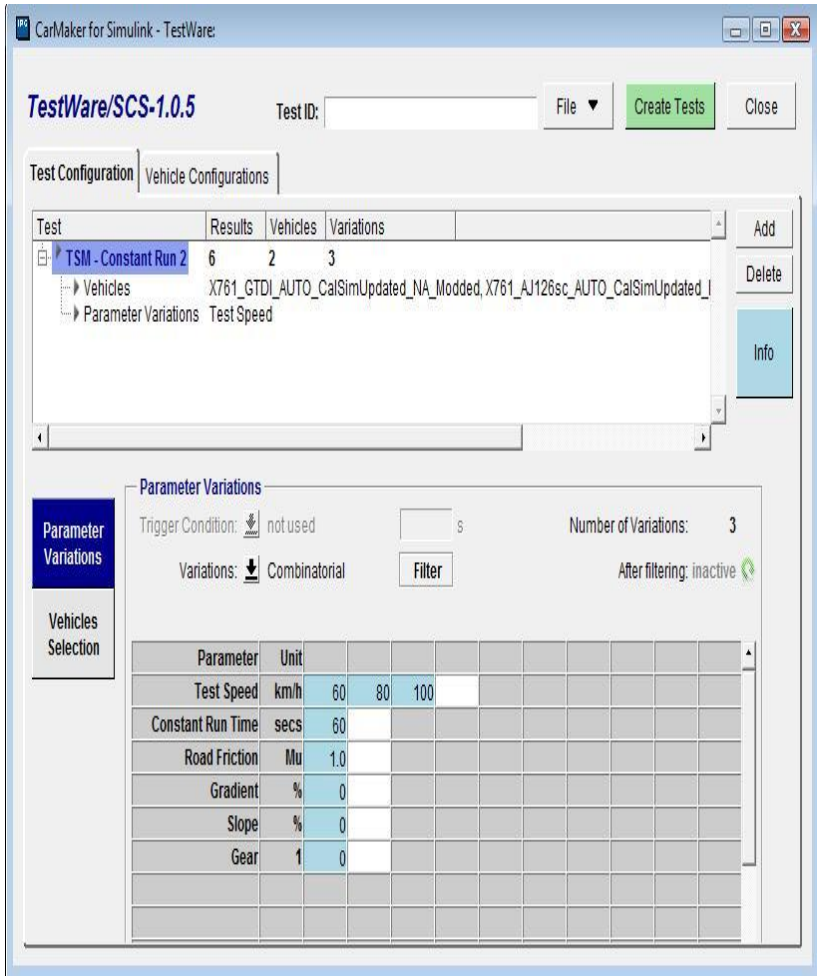
Once the rolling resistance and aerodynamic data has been chosen it is important to get the overall coast down to match. As the tests we want to perform with this correlated model are all in gear and between 60-100k, it is important to correlate the coast down in D. This will also include all of the drag from the drivetrain. As such the wheel bearing friction has been introduced to generate more drag on the vehicle to represent a similar level as seen in the vehicle. The friction coefficient chosen is 0.04.

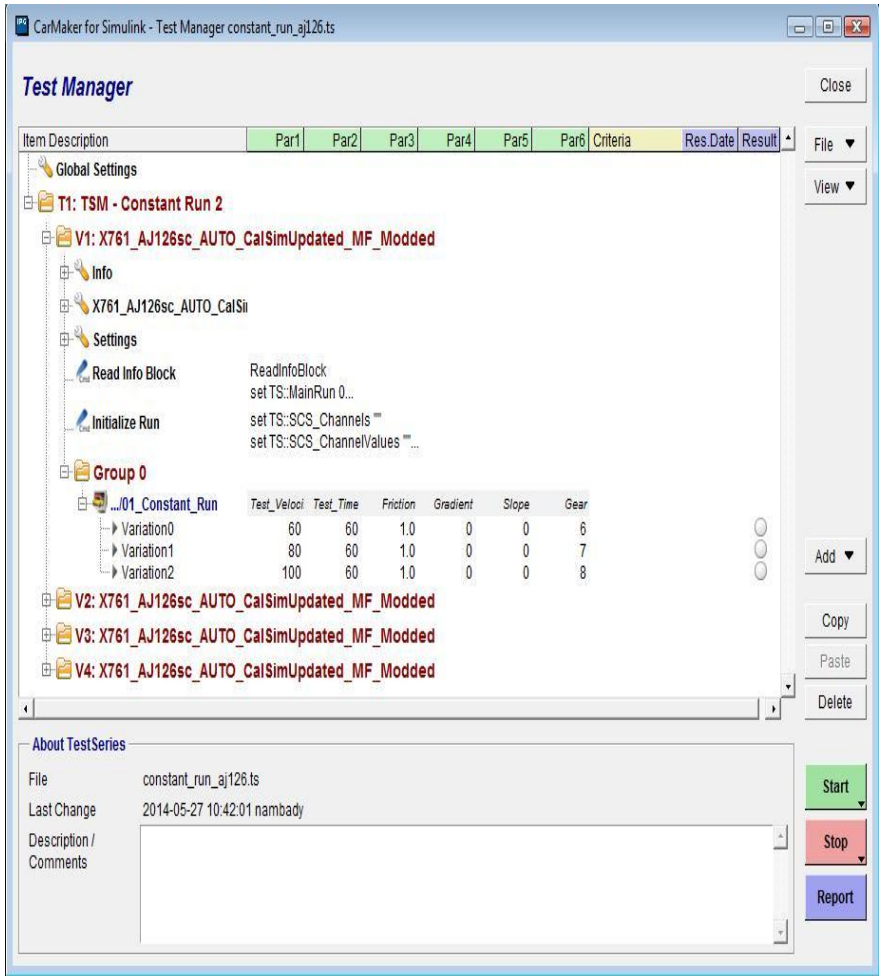
[ref: TSM in Simulation, Mark Foster, Sept 2013]

Tools and Methods

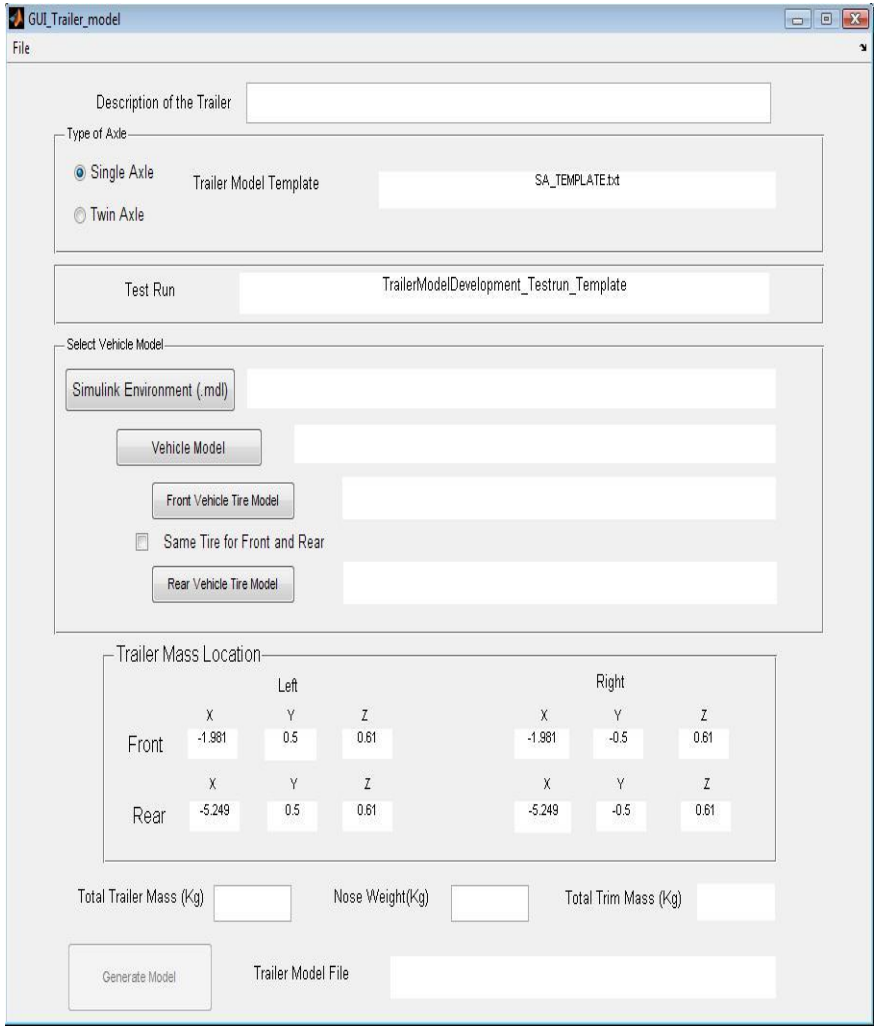
- Virtual Development of TSA using:
  - ❑ IPG Testware
  - ❑ IPG Test Manager
  - ❑ TestWare Builder GUI (Bespoke JLR)
  - ❑ Trailer Builder GUI (Bespoke JLR)
  - ❑ Matlab m-scripts in the CarMaker for Simulink Environment
    - ➢ Auto selection of Calibration files based on the vehicle selected
    - ➢ Post Process data files to generate parameters

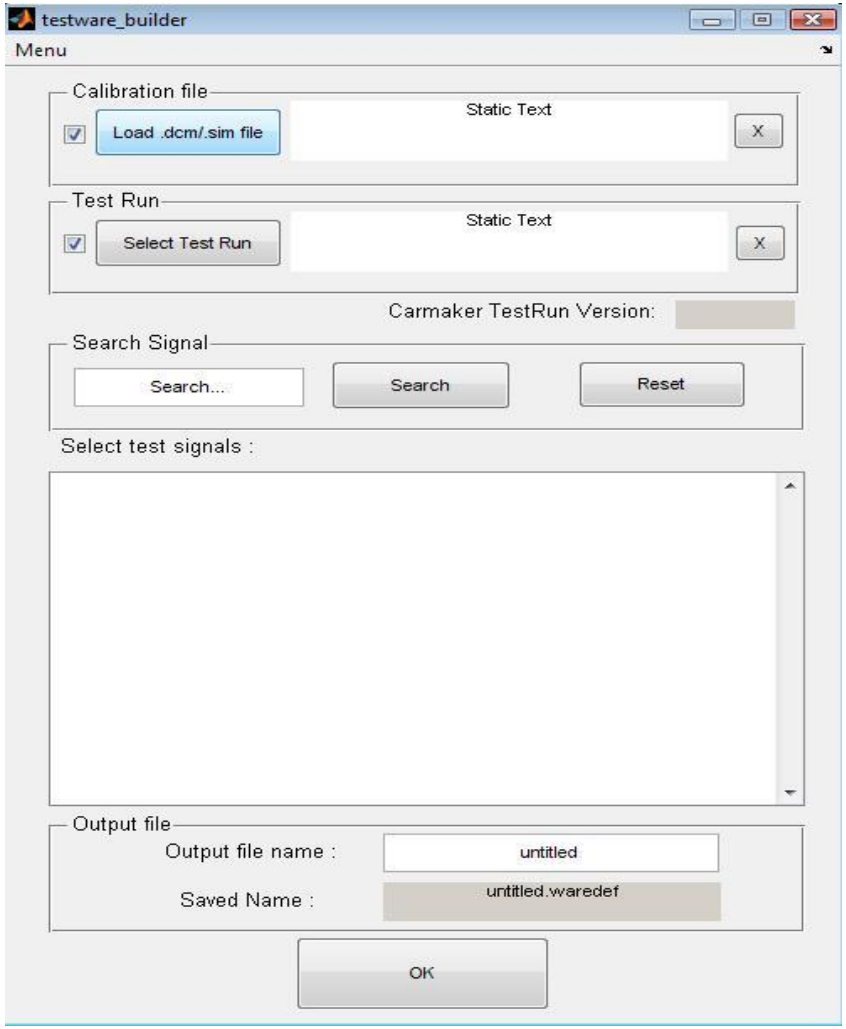
Tools and Methods
Test Suite Creation





Tools and Methods
Bespoke Tools





Conclusions

- It is possible to tune the function to a certain degree of confidence using just Simulation
- Few Hours than weeks of physical Testing
- Understand a broader range of Trailers, Test Speeds, Loading Conditions
- Elimination of associated risks to personnel, vehicles and test locations
- Programme costs reduced due to physical prototypes not being required

Nithin Ambady
(nambady@jaguarlandrover.com)

Mark Foster
(mfost103@jaguarlandrover.com)

Krzysztof Kowalski
(kkowalsk@jaguarlandrover.com)