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Developing and Comparing a range of Simulation Methods to Predict the Handling Balance of the MCR Race Car

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Introduction

Considering the similarity of the vehicles on track and the extent to which modifications are restricted by regulations, a vehicles suspension set-up is often considered the make or break of a team's racing season [1]. More efficient uses of time and money are always of interest. Teams, such as UWTSD's MSportEng, need quick and reliable ways to test and validate their suspension setup.

Project Aims

- Create and evaluate a Simulation model.
- Compare simulations across a range of software options.

This would give the team access to a simulation for evaluating setup and potential component changes, as well as ensuring the best software for the team's uses is chosen.

Methodology

- A **quarter-car** model was created in each piece of simulation software
- **SOLIDWORKS**' built in Motion Analysis tool made use of a CAD model that had already been created and verified.
- The **Simulink** assembly was created using blocks from the SimScape library to represent system components.
- **Adams/Car** uses a template-based approach to model the vehicle for use with pre-defined, or customised driving manoeuvres.
- Testing on a 1-Cos(x) bump was conducted.

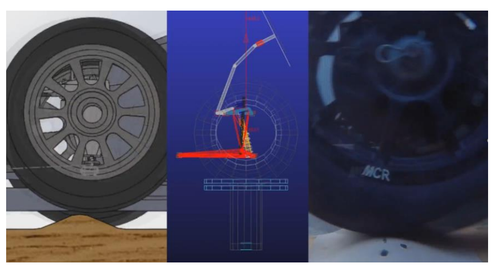
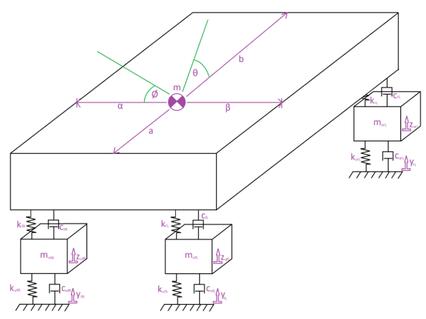


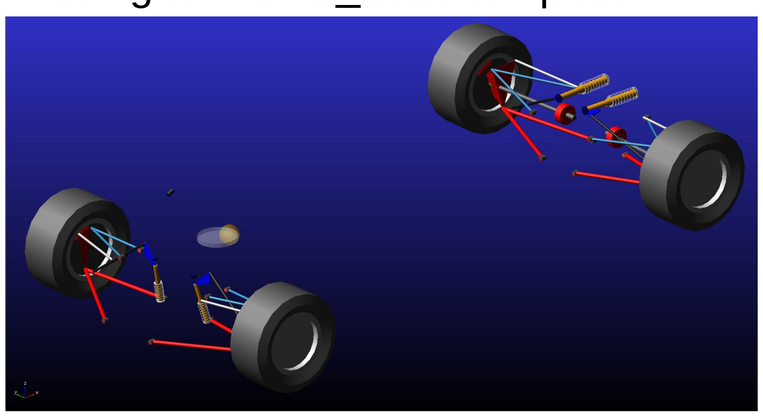
Figure 1: Cos Bump Testing

- A full vehicle model was created in Simulink and Adams.
- The Simulink model was created using a 7 Degree of Freedom Simulation model.



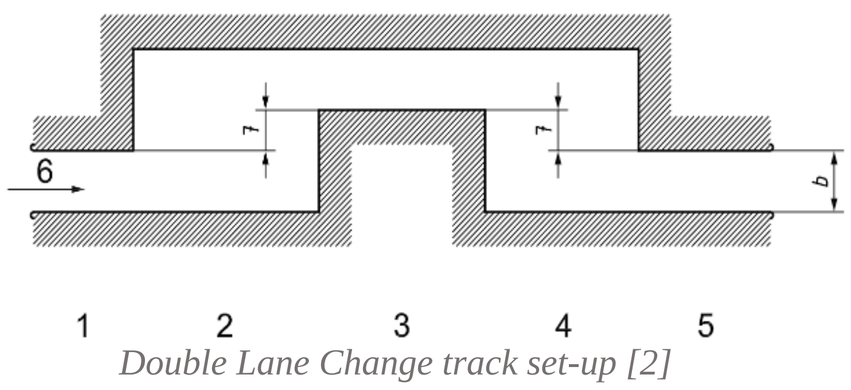
7 DoF model visualisation

- The Adams model was created using an FSAE_2018 template.



Adams/Car assembly on shaker rig

- Double lane change testing was conducted to evaluate weight transfer under varying suspension set-ups in each simulation.



Double Lane Change track set-up [2]

Results

- The lack of a driver model in SOLIDWORKS and Simulink makes results from complex manoeuvres un-reliable.
- The SimScape library being used in Simulink could not calculate rotational inertia.
- The Simulink 7DoF model only accounts for elastic weight transfer.
- Adams/Car produces the most versatile, precise and useful simulation.

Conclusions

SOLIDWORKS:
- CAD modelling and simulation in one package.
- No opportunity to account for component stiffness [3].
- No driver model.

This is useful for simple suspension analyses, such as bump steer or motion ratio analysis.

Simulink:
- Based on first principles.
- Easy to use interface.
- Automatically captures results that are likely to be necessary.
- Geometric and steer induced weight transfer are not calculated.
- No driver model.

The simulation is good for investigating elastic weight transfer in simple scenarios.

Adams
- Geometry-based approach.
- Simple to adapt to most vehicles.
- Stiffness can be considered during simulations [4].
- All data that Adams is capable of recording is automatically saved.
- Calculates all areas of weight transfer.
- Online support is limited.

Adams/Car is suitable for track simulations and ISO standard tests and can be used for component stress analysis or driver training.

References

[1] ISO3888-2, B. (2011) 'ISO 3888-2 - Passenger cars — Test track for a severe lane-change manoeuvre Part 2 : Obstacle avoidance'

[2] Morse, P. (2016) Race Car Tuning with Driver-in-the-Loop Simulators. Available at: https://www.ansiblemotion.com/automotive-driver-in-the-loop-simulation-articles/race-car-tuning-with-driver-in-the-loop-simulators (Accessed: 18 April 2020)

[3] "SOLIDWORKS Help," 2018. [Online]. Available: https://help.solidworks.com/2018/english/solidworks/motionstudies/hidd_dve_sim_springs.htm. [Accessed: 19-Apr-2020].

[4] "Welcome to Adams/Car."

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