Motorsport to Automotive
Tuning Dampers on a Road Car

The software package ChassisSim has been extensively used in Motorsport Applications. This has spanned Formula as diverse as LMP1,LMP2, IndyCar, DTM , GP2 and V8 Supercars. The thing that allows ChassisSim to go into areas that its contemporaries can't is its transient multibody vehicle dynamic model that has been optimised for automotive applications.

However, what is truly exciting is that all the techniques that have been used in the motorsport community can be applied to a road car. This is due to ChassisSim multibody vehicle dynamic core and its ability to reverse engineer tire models from data.

In this case study we will focus on applying ChassisSim to tune dampers of a road car. In particular we'll talk about using the lap time simulation to tune the dampers of a vintage Porsche 911 car and how the shaker rig toolbox was used to tune the dampers on a GT car.

Adjusting Dampers Using ChassisSim

The damper interface with ChassisSim is shown below

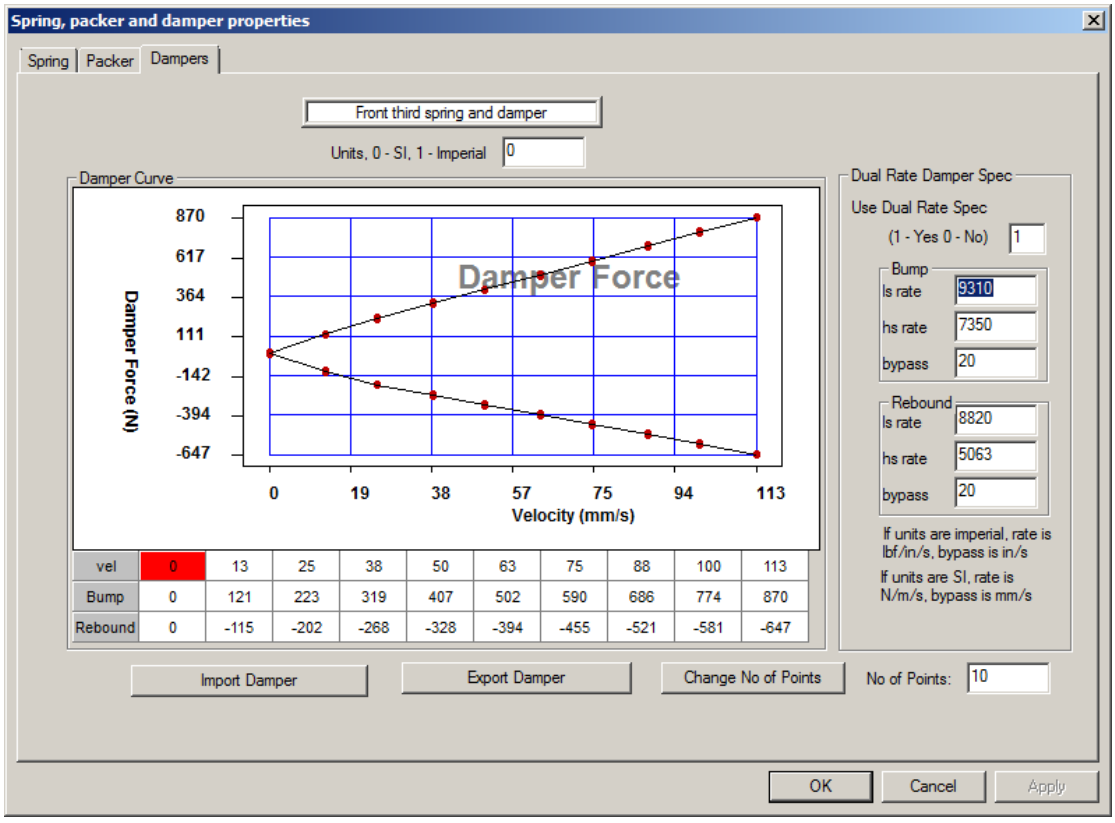

Fig - 1: Damper interface of ChassisSim

The damper model in ChassisSim is a peak force vs peak velocity graph of the damper. This curve can be produced by damper dyno such as Roehrig which is extensively used in motorsport. They are also very cost effective.

You can fill in the damper table by importing the results or using a dual rate damper model. What this means in plain English is that you can specify a damper very quickly and more importantly change it very quickly.

As we are about to see, the results of this approach will speak for themselves.

Tuning Dampers Using the Lap Time Simulation

The lap time simulation feature can be used to predict maximum performance of the vehicle around an open and a closed circuit. The results can also be exported to a variety of different data analysis packages. An example of this is shown below:

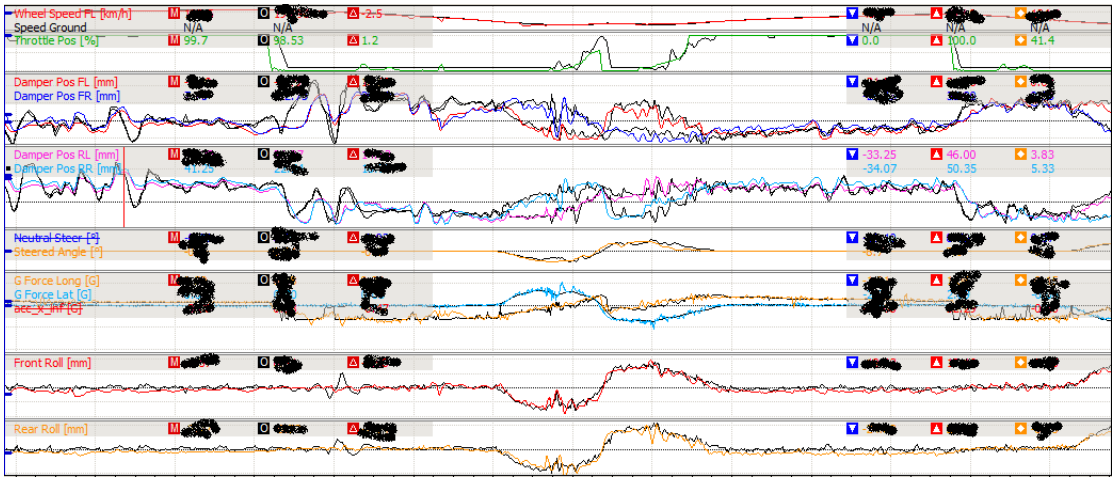

Fig - 2 - ChassisSim lap time simulation results.

Actual data is coloured. Simulated data is black. Note the second and third data traces. These are the front and rear damper movements, respectively. Due to ChassisSim multibody numerical engine, every lap time simulation is the equivalent of doing a damper replay.

What all this means is that the lap time simulation component of ChassisSim is a very effective tool in assessing what settings to apply to your dampers. A case in point was using damper histograms and the lap time simulation to asses the damper settings for a vintage Porsche 911.

An example of the damper histogram output is shown below:

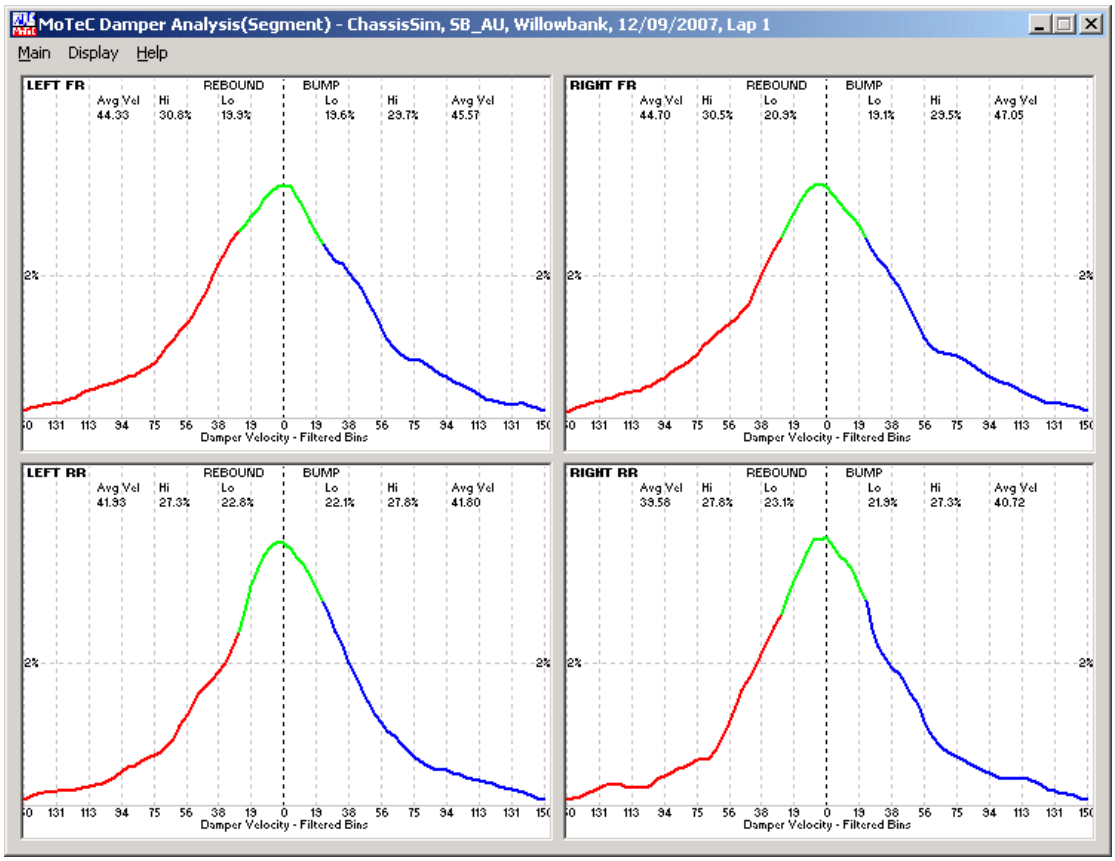

Fig - 3: Damper Histogram output from Simulated Data

The only necessary steps were to run the laptime simulation component and adjust the dampers in the simulated model to achieve the desired characteristics. When this was applied to the car in question it was 4s a lap faster than the base settings. This illustrates the resonant power in the lap time simulation component of ChassisSim.

Using the Shaker Rig Toolbox to Tune Dampers

The ChassisSim shaker rig toolbox allows the user to predict the frequency response of the vehicle by applying a constant velocity swept sine input. It can illustrate amplitude and angle response. It also returns contact patch load variation which is an excellent measure of the mechanical grip of the car.

This has been used and validated in formulas as diverse as IndyCar, V8 Supercars and GT Racing. The method used is very straightforward:

- Choose the input velocity and speed to simulate.
- Play with springs and overall damping to minimise load variation.
- Play with the damper settings to tune the desired shape of the curve for driver feel.

This toolbox played a critical role in the Maranello Motorsport victory at the Bathurst 12 hour in 2014 on a Ferrari GT3 car. One should note this particular car isn't that far removed from its road going cousins. An example of the output of the shaker rig toolbox is shown below:

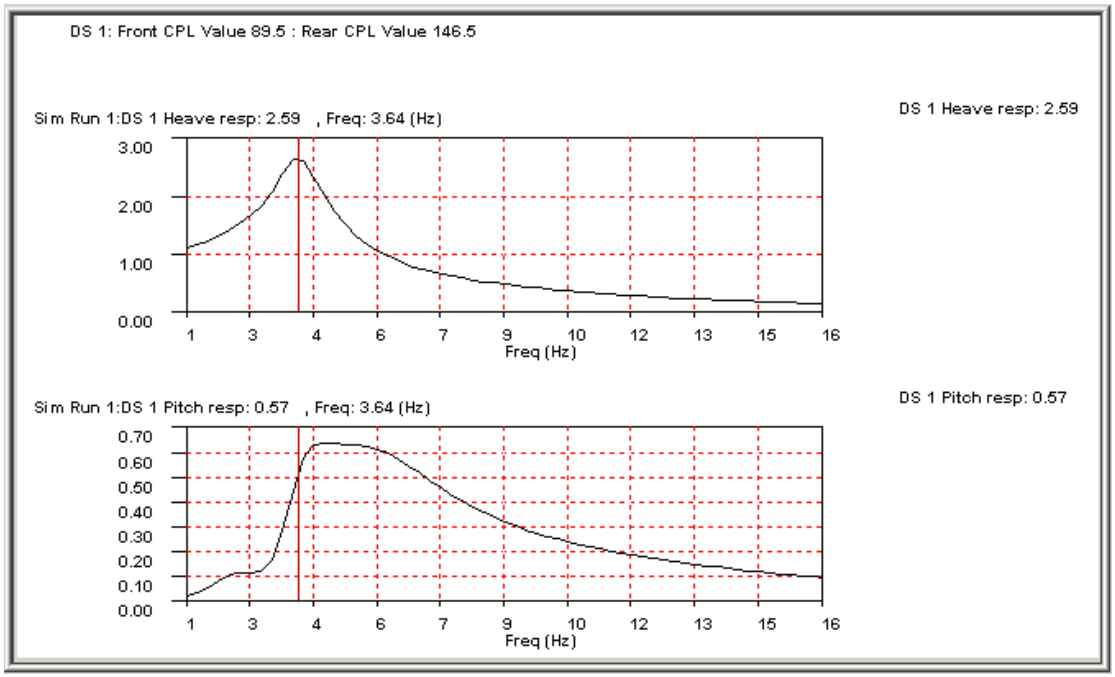

Fig - 4: Results of the Shaker rig toolbox

Observations and Conclusion

Everything that we have discussed here used motorsport techniques applied to road cars.

The first case study we discussed, the vintage Porsche 911 (a 71 model to be exact), was a street legal road car. The use of the lap time simulation component to produce damper histograms produced a lap time that was 4s a lap faster. This means the car had extra grip to the road and better handling, and ChassisSim played a critical role in making this happen.

The second case study was a GT3 race car, which is effectively a road car running racing tires, and a racing engine. The techniques we applied to this car, such as maximizing the mechanical grip and tuning the frequency response, aided in the race win and are identical to what you would do to improve the ride response and handling on a road car.

In closing, these techniques are completely applicable to a road car in addition to high performance race vehicles. Not only is ChassisSim straight forward to use, but what we have discussed here has been applied in anger and achieved results. You have nothing to lose.