Motorsport to Automotive
Suspension Geometry Design

Suspension geometry design is an important aspect of vehicle design. While there are a number of tools to aid in this endeavor, many of them produce very good results but can be very time consuming to implement.

What we'll be discussing in this paper is a method to short circuit this process using the motorsport simulation package ChassisSim. ChassisSim has a number of different suspension geometry options that are easy to implement. In particular, we'll discuss how ChassisSim was used as a proof of concept study to design a double wishbone suspension for a time attack car. As will be seen, the process was seamless.

The ChassisSim Suspension Geometry Interface

The ChassisSim suspension geometry interface is shown below:

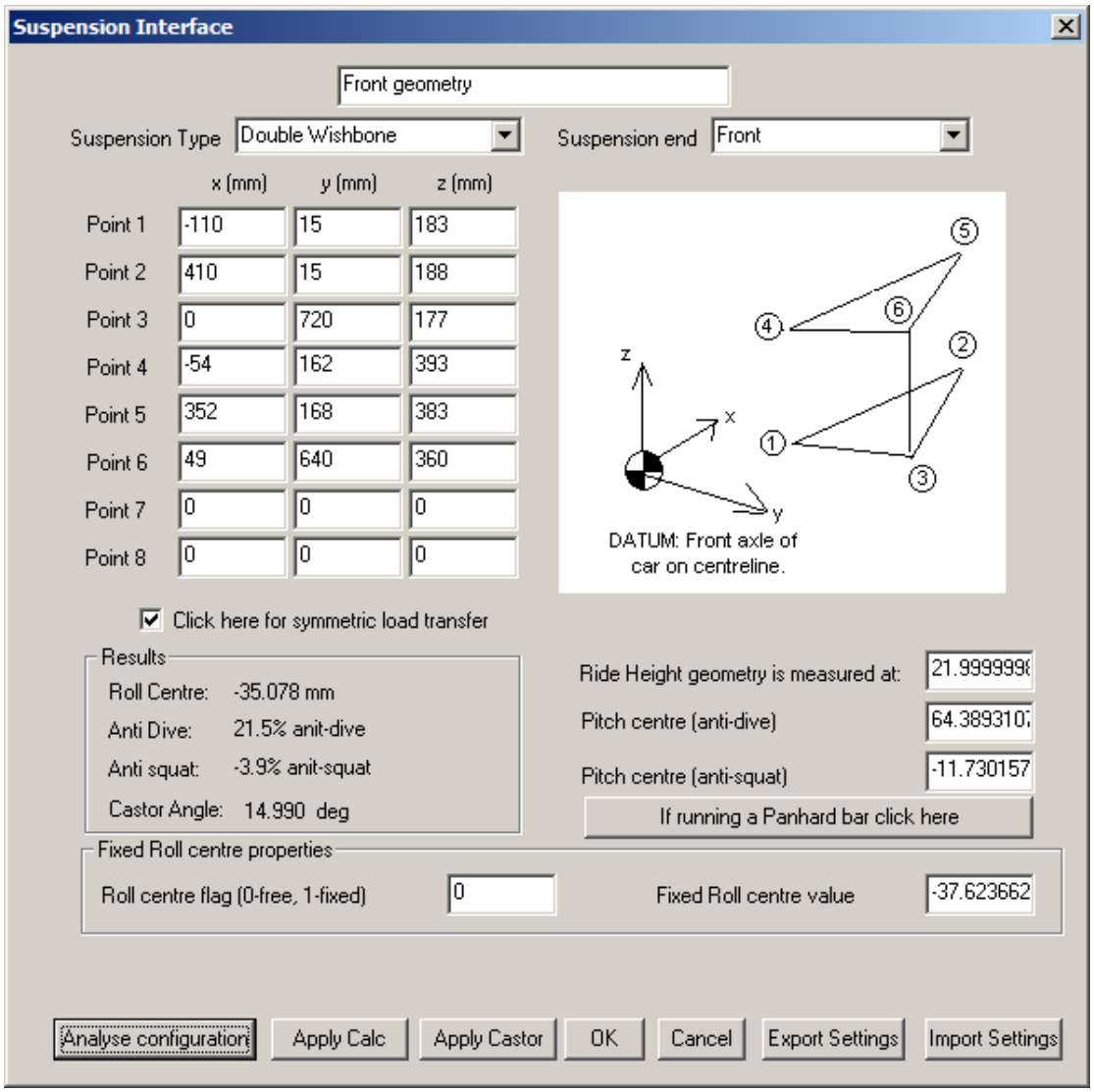

Fig - 1 - ChassisSim suspension Geometry interface

As can be seen, specifying a suspension geometry is a very straightforward process. To select a geometry you can select from a number of different options. These include live axles, double wishbones and McPherson struts. Once the geometry type has been selected, you simply enter the points in the X,Y,Z coordinates as indicated by the graphic. You also have the option to sanity check what you have just done by pressing Analyse Configuration. To apply your changes, press on Apply Calc and then press OK. You also have the option to export and import this configuration as an Ascii text file. This is facilitated using the Export Settings and Import Settings tabs, respectively.

As can be seen, this can be done in minutes as opposed to hours, making this perfectly suited for rapid prototyping and proof of concept.

Designing a Double Wishbone Suspension

The ChassisSim suspension geometry interface was the major tool used in a double wishbone suspension geometry proof of concept design for a time attack car. A time attack car is a heavily modified road car designed to achieve the minimum lap time for a given circuit. An illustration is given below:

Fig - 2: Time attack car

However, the techniques we are about to discuss are just as applicable for a road car.

This particular project scoped converting a MacPherson to a double wishbone suspension using the ChassisSim lap time simulation module. Here is the methodology that was used:

- The geometry was entered using the dialog box in Fig-1
- A lap time simulation was run.
- The returned cambers and roll center locations were reviewed in data.

One of the great things about the lap time simulation is that it returns a multitude of variables. In particular, it returns front and rear force based roll center and the cambers.

For this analysis we were concentrating on improving the stability of the roll centers and minimizing the camber loss. The comparison between the final design and the initial design is shown below:

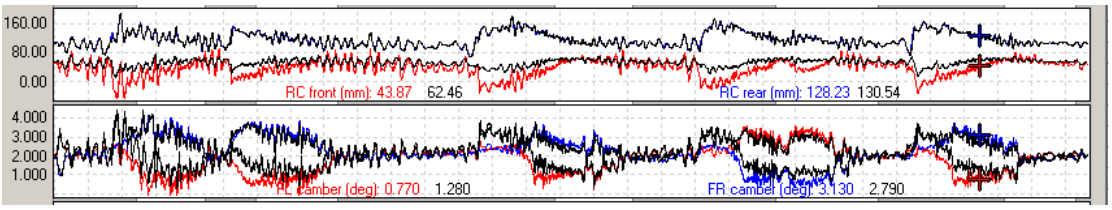

Fig - 3 - Comparison between initial and final design.

The baseline suspension geometry is coloured. The proposed design is black. The first trace is the roll center height. The lower of the two traces in the first plot is the front, which was the subject of the conversion. As can be seen, the front roll center height is much more stable. The second trace is the cambers and the results are much improved, particularly in terms of camber loss from the inside tire. It should also be added that this was an afternoon's work as opposed to weeks.

Conclusion

What has been shown here is a very effective and time efficient way of designing a suspension geometry configuration. The methodology was to use the lap time simulation to investigate what the roll centers and cambers would be for a given configuration. The advantage of using the lap time simulation is that, because it is being driven at the edge, you get to see what it is doing throughout the whole maneuvering envelope. To further short circuit the process you can even use one of ChassisSim pre-loaded tracks.

The other thing this brings to the party is that it can be done quickly. As seen in Fig – 1, a suspension geometry type and coordinates can be entered and sanity checked in minutes as opposed to hours. The configurations can also be saved to an Ascii text file, making this ideal to be used for proof of concept design.

The techniques discussed here, while applied to race cars, are readily applicable to their road car going cousins.

This combination of logged data and the ability to change configurations quickly makes ChassisSim a valuable addition to the vehicle dynamics department of any road car company.