

Analysis and significance of Pembrey Test results

Basic Definitions

$$\text{Overall Steering Ratio} = \frac{\text{Steering Wheel Angle}}{\text{Road Wheel Angle}}$$

So

$$\text{Road Wheel Angle} = \frac{\text{Steering Wheel Angle}}{\text{Overall Steering Ratio}}$$

Neutral Steer

The SAE defines neutral steer as :

A vehicle is neutral steer at a given trim if the ratio of the steering wheel angle to the overall steering ratio [ie the actual steered wheel angle] equates to the Ackerman steering angle for a given radius of turn.

Ackerman Steering

Ackerman steering angle δ (*delta*) is the geometric steered wheel angle required for a car of wheelbase L to track round a turn of radius R at low speeds where the external forces due to accelerations are negligible so $\delta = L / R$ for small angles.

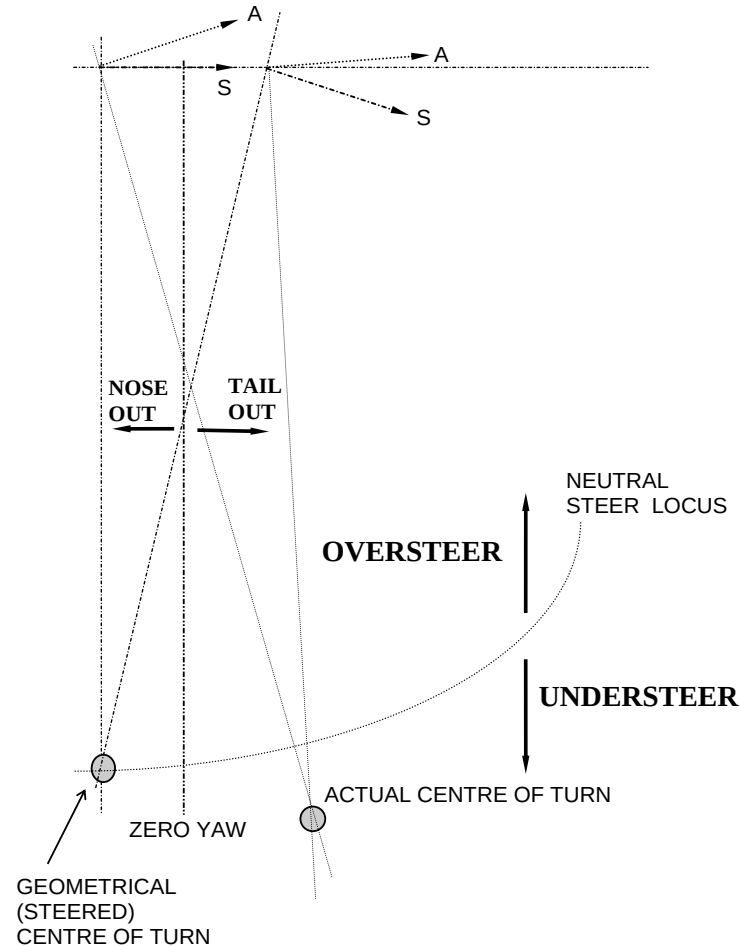
Understeer

A vehicle is understeer at a given trim if the ratio of the steering wheel angle to the overall steering ratio is greater than the Ackerman steering angle for a given radius of turn

Oversteer

A vehicle is oversteer at a given trim if the ratio of the steering wheel angle to the overall steering ratio is less than the Ackerman steering angle for a given radius of turn

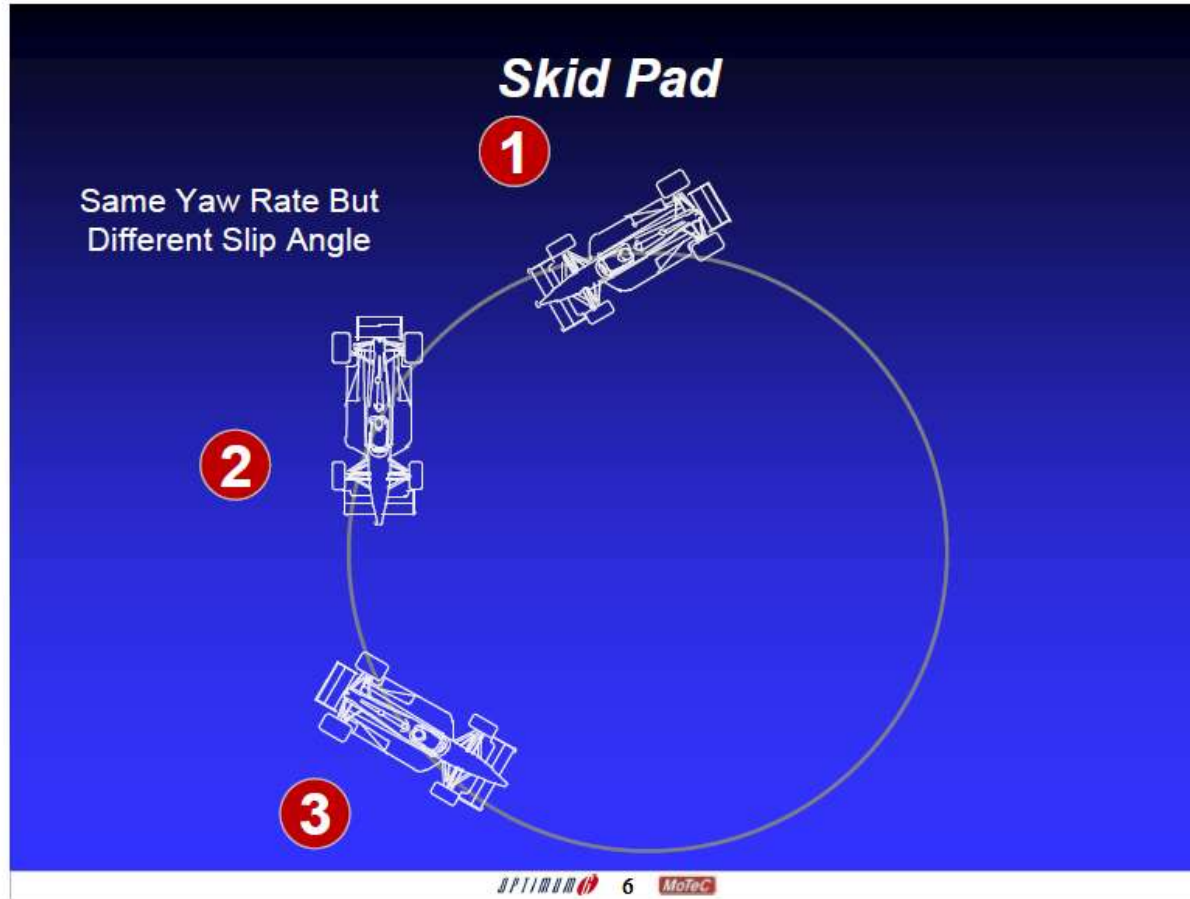
Geometrical method of demonstrating oversteer and understeer



If the centre of turn is closer to the car than the neutral steer locus the car will be oversteer and if it is beyond the locus it is understeer .

So the car shown is understeer with tail out attitude.

Tail out cornering on the skid pad



Assignment aim

The aim of the assignment is to demonstrate the change in vehicle behaviour produced by the change in parameter that you are adjusting - tyre pressure, damper setting or axle load.

Having got the data from the track test you need to demonstrate how, as the parameter changes, the level of understeer changes.

Example analysis

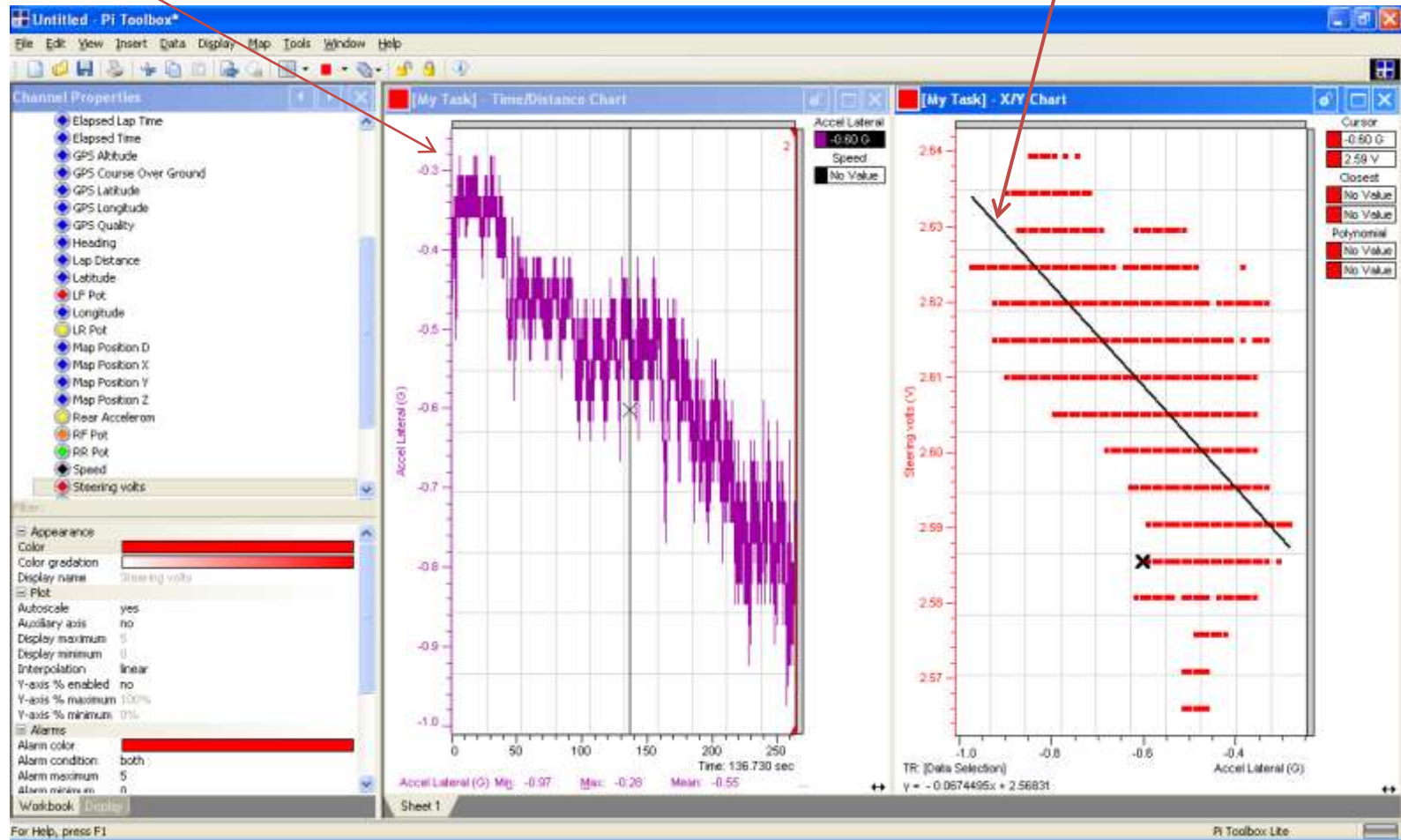
You need to find some numerical value that demonstrates the handling balance at a particular lateral acceleration.

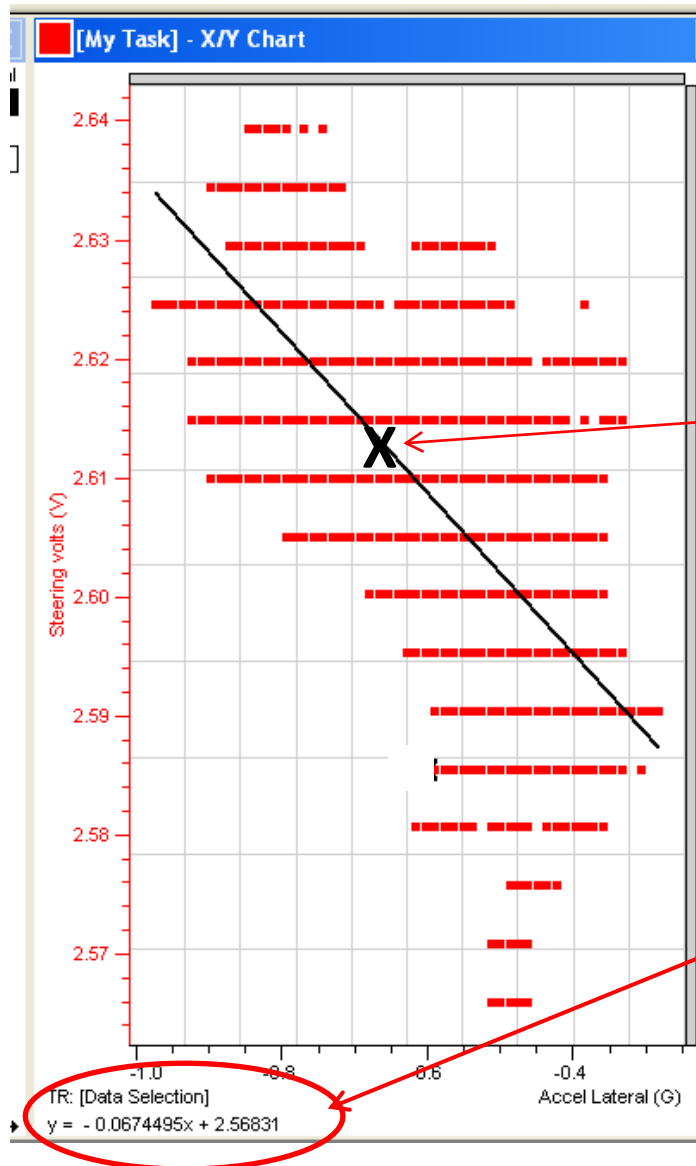
One of the easiest to determine might be the steering angle. If the parameter change is at the rear and steering angle goes up it means that the rear grip was improved by the change. If the steering angle goes down it means that the rear grip has reduced.

You can plot that value of steering angle against the parameter value to show a graph that demonstrates the effect of the parameter

Select a series of laps with a constant change of lat acc

Insert an XY plot in the work sheet and add a linear trendline



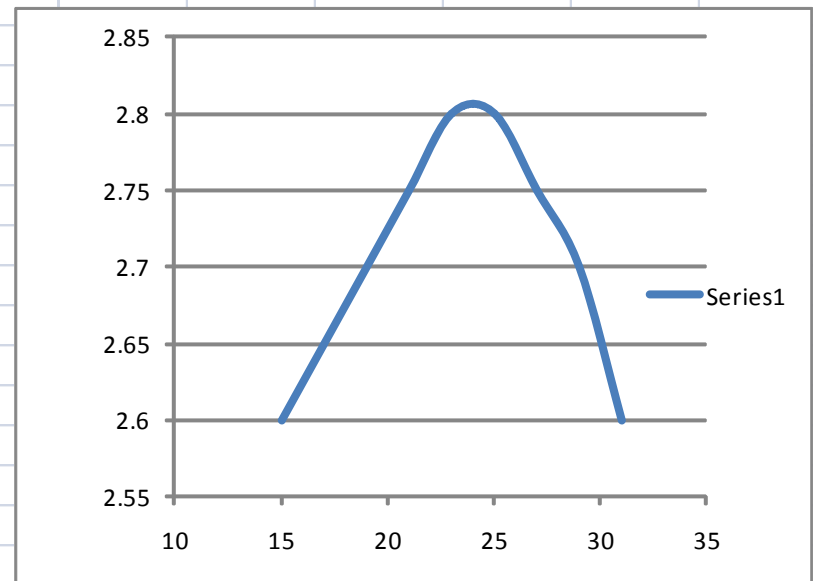


Find the value of the steering angle at a relatively high lateral acceleration so that the parameter has a significant impact on the handling balance. You can either do this by moving the cursor on the trendline to the chosen lateral acceleration and then noting the steering volts.

or
Put the lateral acceleration into the equation of the trendline

Repeat this exercise for each parameter value and then plot parameter value against steering volts. The example here might be for the effect of front tyre pressure with the peak steering voltage indicating the minimum steering angle and hence where maximum grip is occurring at around 25psi

Tyre Pressure	Steering Volts
15	2.6
17	2.65
19	2.7
21	2.75
23	2.8
25	2.8
27	2.75
29	2.7
31	2.6



Further work

Look at the value of the trendline for different polynomial orders to see if that shows the trend more accurately – for example as speed increases the balance may change and this would not be demonstrated by a 1st order trendline

Check that the trendline really does represent the trend of data points and is not just a mathematically accurate but irrelevant line