

# The use of Simulation in Race Car setup analysis, F3000 Case Study.

## Introduction

Simulation is an ideal tool to explore the setup parameters for any given circuit. The reasons for this are,

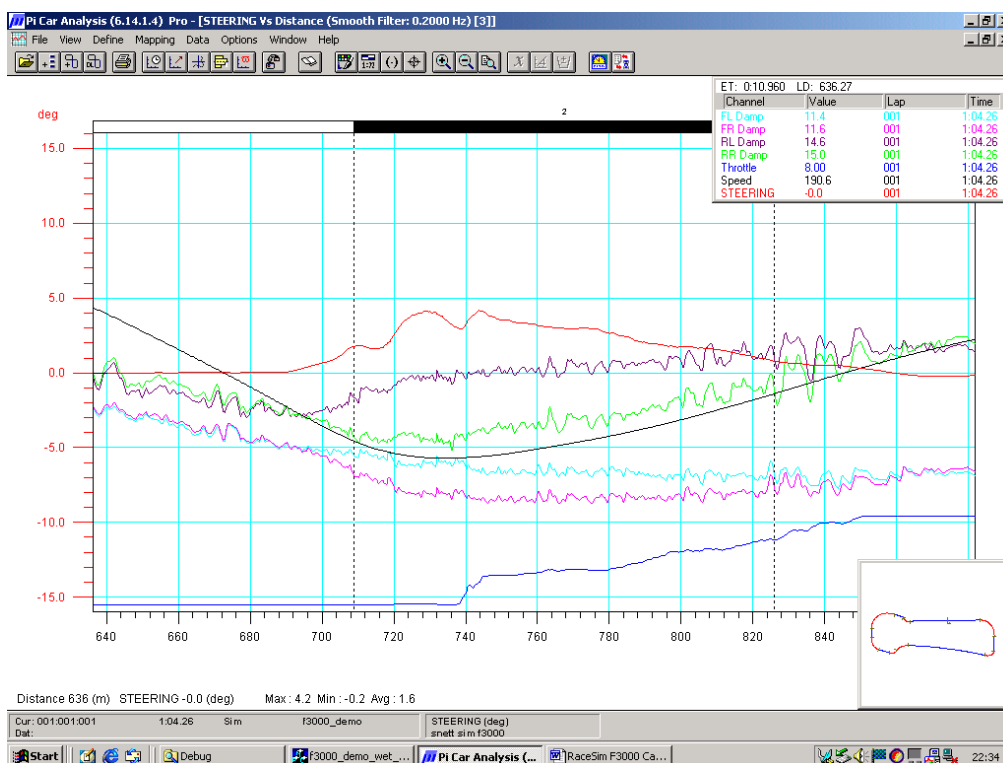
- Excessive testing is either not allowed, and/or is too costly and labour intensive.
- With simulation the engineer can investigate as many setups as possible. This allows the engineer to know what combinations will or will not work before arriving at the race track.

This presentation simulates the use of the simulation package, **ChassisSim™** - in analysing the effect a rear bar change on a F3000 Car in wet conditions.

**ChassisSim™** - is used to compare the 'before' and 'after' results. These are then compared to what was seen in practice.

## Simulation Results and discussion.

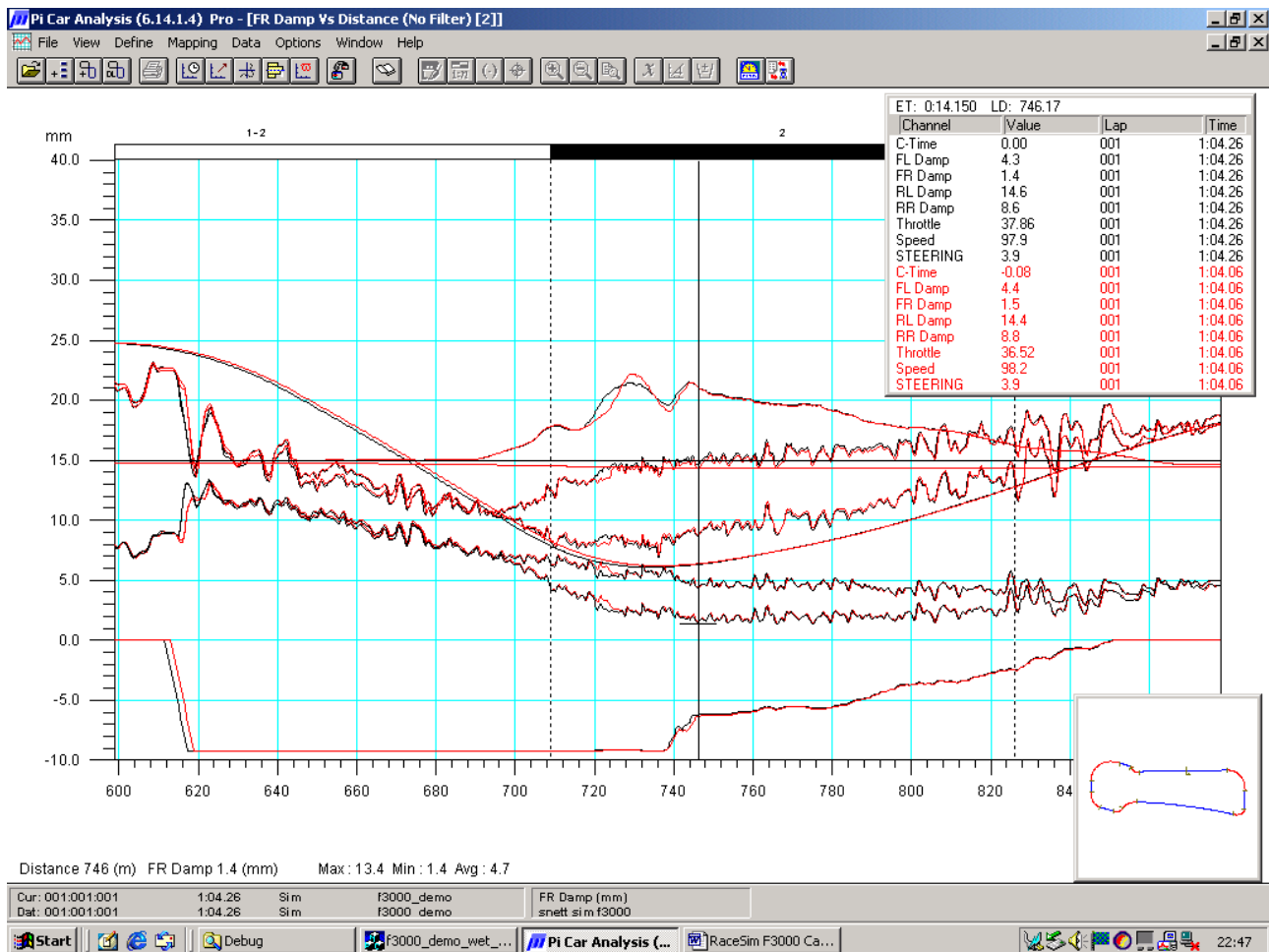
The base setup was simulated and the results are shown in Fig-1. This base setup had the rear bar disconnected. Driver feedback revealed that this setup yielded inconsistent handling. Typically, there was understeer on the entry and oversteer at the M/C of low speed corners. An example of the simulated output of a low speed corner is shown in Fig-1.



**Fig-1: Base wet setup in a low speed corner.**

As can be seen from Fig-1, the simulation reproduces the characteristics reported by the driver. From the steering trace it appears the car is inconsistent on turn in, then as the car progresses to the mid corner understeer is followed by oversteer. During this time it is obvious the car is not being supported adequately at the rear. From the damper traces it is clear that the car is squatting on the outside rear tyre. This transfers load diagonally across the car, inducing the understeer. However, as the car takes a set, some residual grip at the front activates, inducing oversteer. While the testing data is not available, this is exactly what was noted on the race car.

Clearly the challenge here is too offer more support at the rear. On the track during testing the rear bar was reattached. This was simulated and the results are shown in Fig-2.

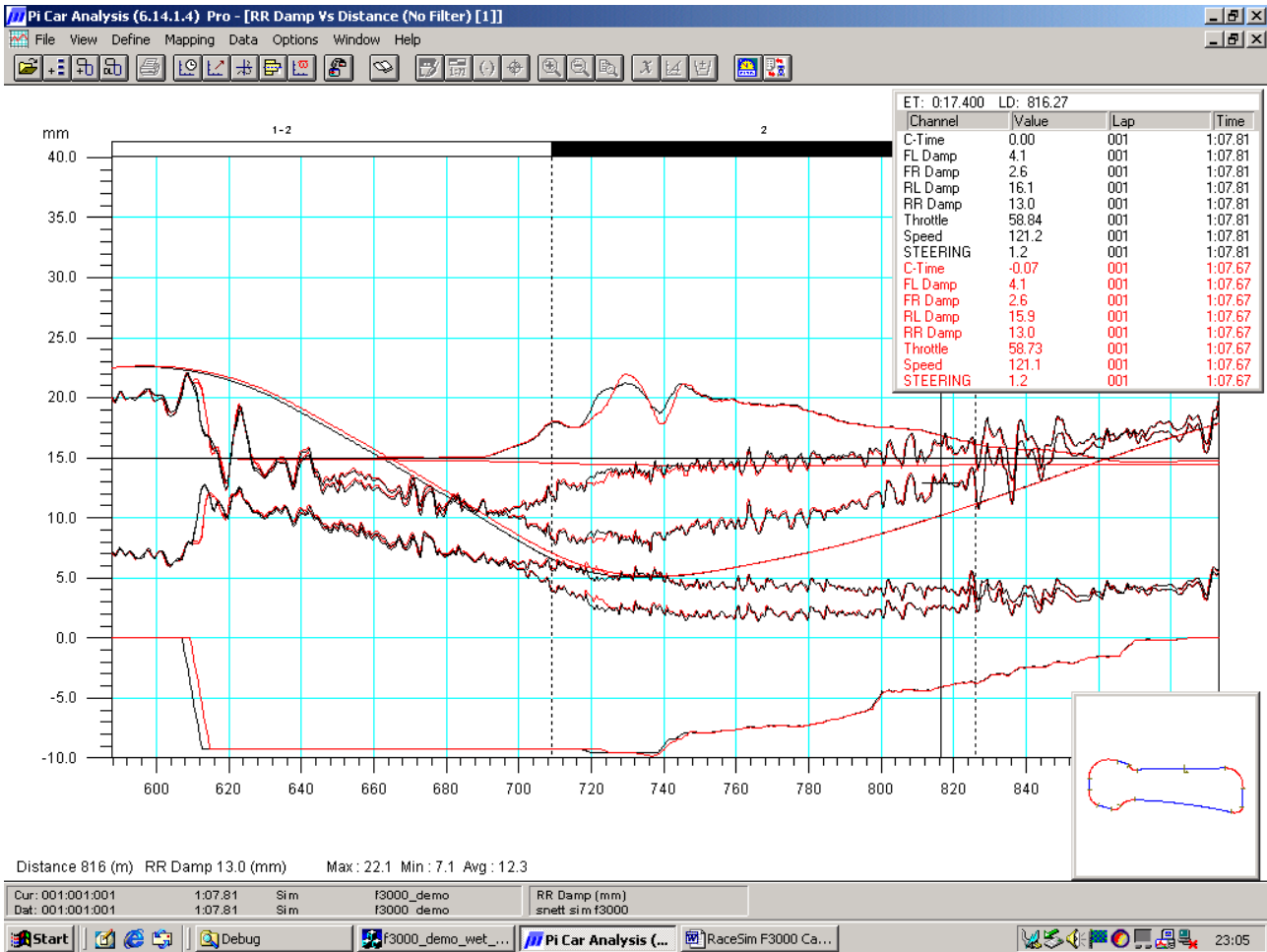


**Fig-2: A comparison of Base Setup (Black) to Rear bar reconnected (Red) in a low speed corner.**

While the change has been small, its effects have been profound. As can be seen from comparing the rear damper traces, the car's tendency to squat on the outside rear has been reduced. Consequently, as is seen in comparing the steering trace, the tendency to understeer at the mid corner section has been reduced. Furthermore, this has allowed the simulation to drive the car harder into the corner. While the tendency has been to increase oversteer, this change has led to an improvement of time of 0.08s for this corner.

*N.B. All these trends where replicated on the actual target vehicle. This includes the oversteer response.*

The simulation comparison was re run for very wet conditions. The results are shown in Fig-3



**Fig-3: A comparison of Base Setup (Black) to Rear bar reconnected (Red) in a low speed corner for very wet conditions.**

As can be seen the car's characteristics have been reproduced for these low grip conditions. The trends seen in Fig-2 have been successfully reproduced. In this case, these have been reproduced in grip conditions of 1.1g to 1.2g. This indicates that the simulator is offering a high level of sensitivity.



## **Conclusion**

A comparison has been presented for a setup change for a F3000 Car in wet conditions. During testing it was found that stiffening the rear bar had a positive influence on the consistency and grip of the car.

This was simulated for a variety of conditions. These conditions were both wet and very wet. In both cases the simulation reproduced the characteristics of the race car. On both the simulation and the target vehicle, increasing the rear bar stiffness improved the load transfer at the rear of the car.

The fact the simulation worked for both wet and very wet conditions shows the simulation has reproduced the characteristic of the target vehicle. Consequently, the simulation can be used to compare setups.