

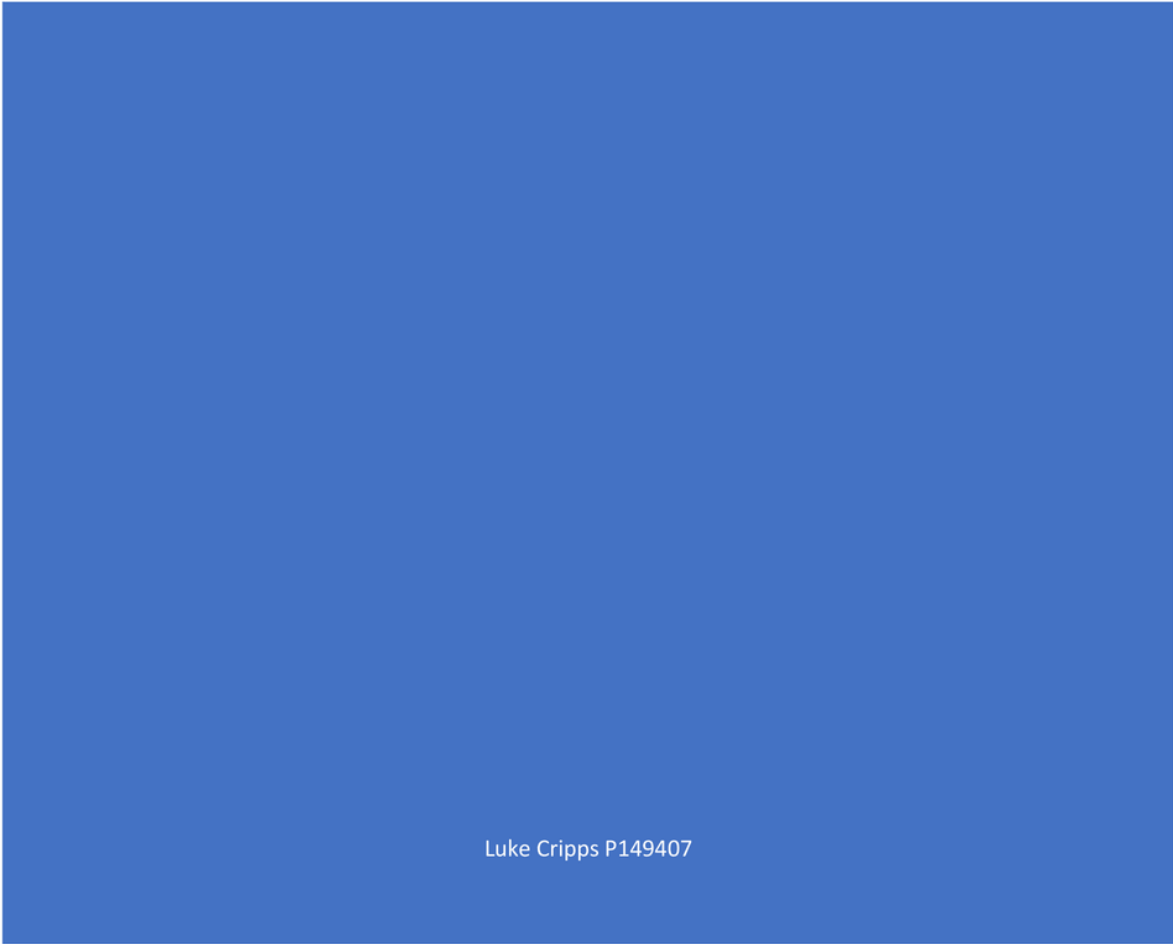
driver comparison through data analysis

by Luke Cripps

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DRIVER COMPARISON THROUGH DATA ANALYSIS



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Contents

Introduction	2
Research	2
Methodology	2
Analysis	3
Conclusion	11
Evaluation	11
Bibliography	12

Introduction

The aim of this assignment is to critically analyse driving styles of three different drivers, through the assessment of data gathered through testing using a racing simulator. The main parameters that need to be looked at from the gathered data include steering input, braking technique, throttle application and gear selection. Each one of these driver attributes will influence the overall performance of vehicle and therefore the lap time achieved.

Research

Driver analysis is key in the motorsport industry, with its usefulness being invaluable to teams racing in motorsport series like formula one, and formula E. Without software to carry out data acquisition, the racing series mentioned would not be able to make the leaps in performance that has occurred in the years gone by, as explained by Guido Lopez, 2009.

When planning to carry out tests for driver analysis, comparable to Wm. C. Mitchell, 2000, the way in which the test is carried out needs to be carefully choreographed, so all team members know the roles that they have been allocated, as well as knowing when each driver is to go out on to the track to perform the timed run, that would have been already discussed with the driver. Planning out the tests means that no time is wasted, which is valuable in the motorsport industry.

In the automotive industry, tests are being carried out, similar to Bing Zhu, 2017, where different drivers will be tested for a scenario, to see if the responses provided by the drivers are all the same, or if a portion of the group have a different method of driving through the differing scenarios. These tests can be carried out on people from all different backgrounds, as J C Campelo, 2006 has already done so.

Methodology

In order to gather the data needed for the investigation, tests using the racing simulator need to be planned and carried out. The circuit used for the tests needs to be decided and the vehicle being used needs to be allocated. The circuit chosen for the test was the Silverstone GP circuit, and the vehicle allocated was formula GP2 car. The circuit chosen for the testing provides both fast and slow corners to be analysed, as well as long straights and quick changes in directions for the drivers to be tested.

For the testing to be carried out effectively and efficiently, test plans need to be devised and carried out with precision. For the first test session, driver A would go for five timed laps, with one out-lap, then consequently, driver B and C would follow the same procedure. Once driver C has completed their laps, the sequence would start again with driver A and end with driver C. For the second test, for the first runs of the drivers, the same procedure is followed. Once the drivers have completed their first runs, they would be given an improvement to implement into their second run. At the same time as the drivers completing their runs, using the screens in the adjacent room, team members would be

watching the movements of the driver and noting if there was anything noticeable that would appear on the data.

Analysis

The first step into identifying the areas for improvement for the drivers in the second session is to analyse their laps during the first session. When looking at the figures below, red lines are driver A, black lines are driver B and green lines represent driver C. The first driver to look analyse would be driver C. During the first run, the driver was lifting through turn one, when compared to the other drivers. This action was not occurring during each lap of the run for the driver, but it did impact the drivers lap time. The diagram below shows this action taking place.



Figure 1 - Driver C lifting off the throttle through turn one

When braking into turn six, the braking position was not consistent over the five laps, although this is mainly due to the driver's inexperience around the circuit, as shown in the diagram below.

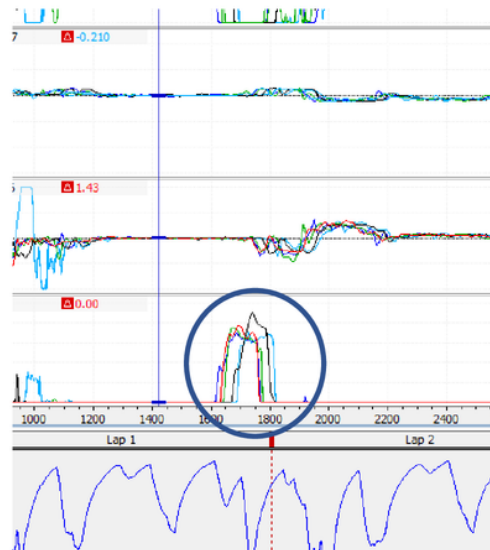


Figure 2 - Driver C's varying braking positions into turn six

On the entry into turn nine, the driver would lift off the throttle, resulting in reduced cornering speed, meaning a loss in lap time. When comparing with the other drivers, the throttle would stay at one hundred percentage. This action does not occur on the fastest lap of the driver; however, it does happen on a portion of the other laps, meaning it would result in an overall improvement.

Turn fourteen, the driver is braking to late, not using enough force, as well as not hitting the throttle early enough on the exit of the turn. Also, turn fifteen, the driver is taking to long to achieve full throttle on the exit of the corner. When compared to the other drivers, driver C losses time in both corners. The diagram below illustrates this loss in time.



Figure 3 - Driver C braking and accelerating tendencies in turns fourteen and fifteen

In the second run for driver C, lifting off the throttle through turn one was still occurring, consistently over the five-lap run. Both other drivers did not lift through the corner, where driver C lost time. The braking into turn six was not consistent once again. Lifting through turn nine once again. Braking into turn fourteen has gone from braking to late to braking to early. The issues the driver was having in turn fifteen are still apparent.

Now looking at driver B. On the exit of turn three, the driver should apply the throttle earlier, as when comparing with driver A, the throttle is applied at one hundred percent very quickly before coming off for the entry into turn four. Although the overall lap time of the driver compared to driver A is similar, time could have been gained by applying the improvement, as the diagram below illustrates.



Figure 4 - Driver B acceleration through turn three

Turn six, on the exit of the corner, one hundred percent throttle should not be used, as this is making the driver use the brake into corner seven. When compared to driver A, the throttle is not being used at its maximum, entering turn seven from the exit of turn six, meaning that driver A is carrying more momentum into the turn, letting the vehicle do the work instead of forcing the vehicle around the corner. This action can be seen in the diagram below.

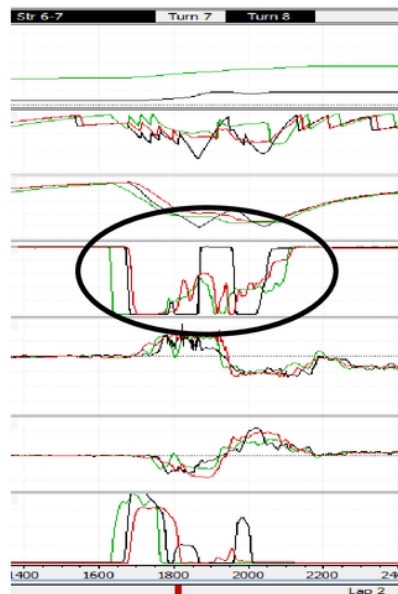


Figure 5 - Driver B acceleration through turn six

Turn eight, the driver is lifting off the throttle too much through the corner. This occurs each lap of the first run. When comparing driver B with driver A, driver B could gain time by not lifting off through the corner as much, as seen in the diagram below.

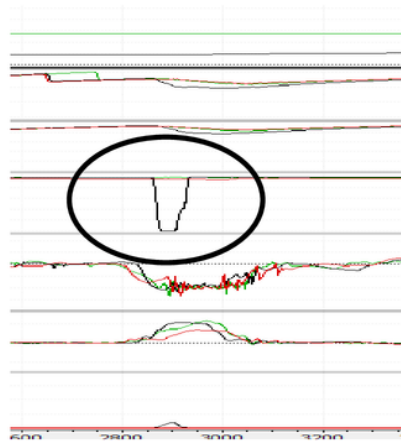


Figure 6 - Driver B throttle position through turn eight

Turns nine through thirteen. The driver is losing time through this section against driver A. The driver should apply less force to the brake pedal when entering turn eleven, while still braking at the same point, as well as not applying full throttle on the exit of the corner. This is causing the driver to brake into turn twelve, losing speed on the exit. Whereas driver A is still applying the brakes into turn twelve, then knowing that the vehicle has slowed sufficiently to go through the corner, starts to apply the throttle, without having to use the brakes again. This can be seen in the diagram below.

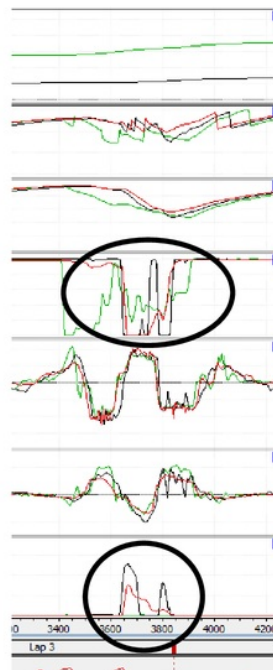


Figure 7 - Driver B throttle and braking position through turns nine to thirteen

In the second run, on the exit of turn fifteen, driver B tries to apply full throttle, but must ease of and reapply through turn sixteen. This happens consistently over the five laps. The diagram below shows this reaction happening.



Figure 8 - Driver B acceleration through turn fifteen

Moving onto the first runs of the second test. Firstly, looking at driver C, the driver is braking too early into turn six, compared to the other drivers, as well as lifting through turn eight, but not lifting off completely. Additionally, through both turn thirteen and fourteen, the driver is taking too long to achieve full throttle compared to the other drivers, which is costing time. Driver A brakes too early into turn fifteen, when comparing with both other drivers. This is costing the driver time entering the corner, which should be improved on.

As well as comparing the times of the drivers against one another, the drivers need to be compared against themselves. There may be some improvements that could be identified between the laps of the individual drivers between the runs of the different sessions. From the analysis of the first session, and the first runs of the drivers in the second session, and the consequent analysis of the drivers against themselves, the following improvements have been identified:

Driver A	Driver B	Driver C
Use second gear for turn three	Use second gear for turn three	Use third gear for turn seven
Brake later into turn fifteen	Brake later into turn six	Ease off the brake through turn fifteen
	Use first gear for turn fifteen	

Table 1 - Improvements for the drivers

For the first improvement for driver A, a couple of laps were needed for the improvement to be properly implemented, but once the driver was comfortable, the lap time improved. Additionally, for the second improvement, the driver was able to implement it straight away. However, time would be gained on the entry to the corner but would be lost on the exit. The two diagrams below show the improvement in lap time for driver A.

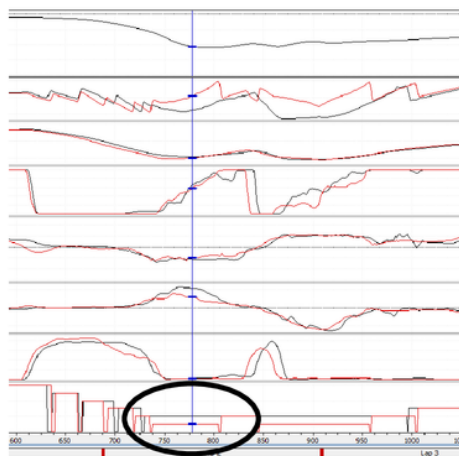


Figure 9 - Driver A improvement one

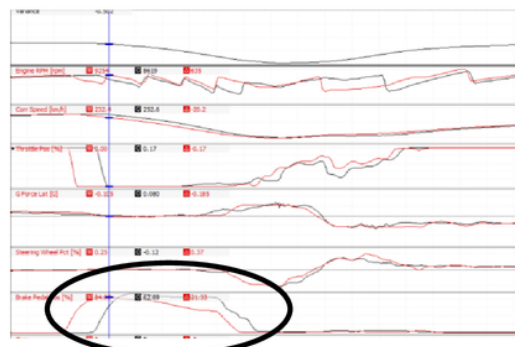


Figure 10 - Driver A improvement two

For driver B, improvement one does improve the lap time of the driver. The driver took a few laps before the improvement could be implemented successfully. For the second improvement, the driver was able to implement the action straight away, improving the lap time. On the other hand, the driver was unable to implement the third improvement. The improvement in lap time for the first two actions can be seen below.

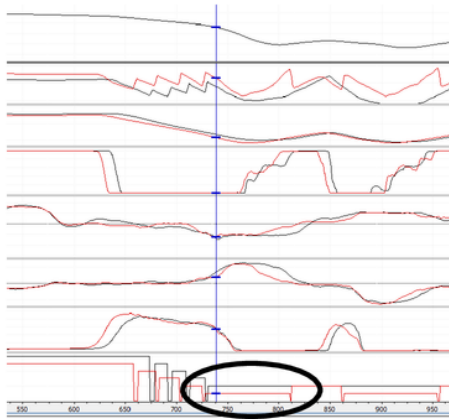


Figure 11 - Driver B improvement one

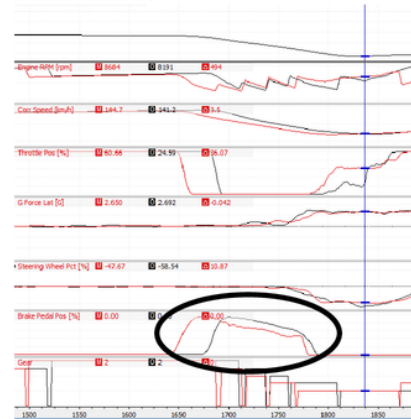


Figure 12 - Driver B improvement two

For driver C, the first improvement improves the overall lap time for driver for half the laps, but the other laps, the proposed improvement did not improve the lap time. This was not the fault of the driver however; team communication was the problem for proposed improvement. For the second improvement, the overall lap time would improve, but the gains in lap time going into the corner result in losses on the way out. The two diagrams below show the effect on lap time of the two improvements.

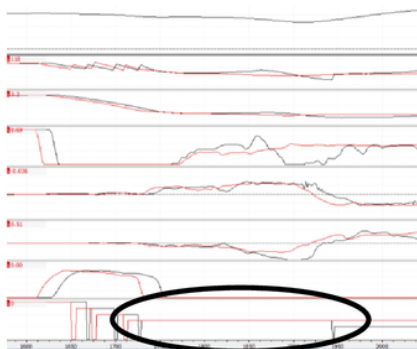


Figure 13 - Driver C improvement one

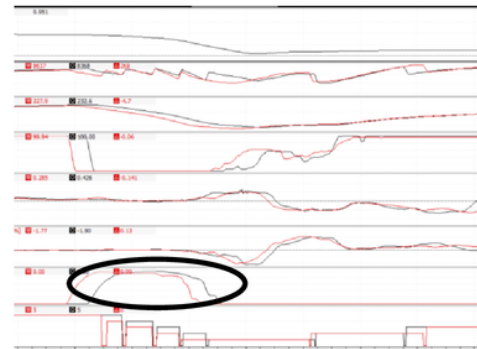


Figure 14 - Driver C improvement two

As well as looking at the data for the lap time comparison, how the drivers use the throttle and the brake can affect the lap times greatly. The following charts show the difference between how the drivers use the throttle and the brake.

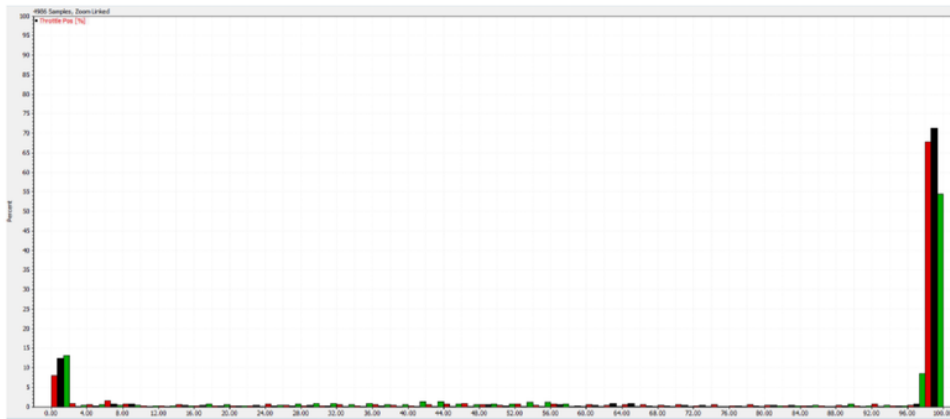


Figure 15 - A histogram showing the relationship between throttle percentage and time

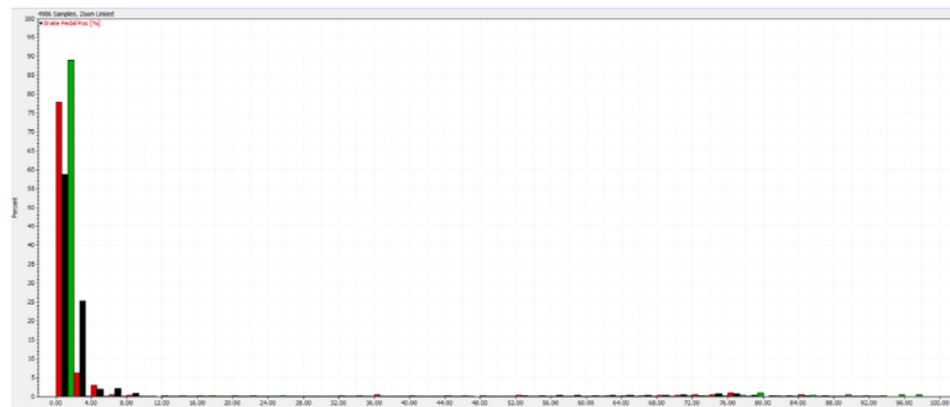


Figure 16 - A histogram showing the relationship between braking percentage and time

Looking at the graphs, driver B is using one hundred percent throttle over a lap for longer when compared to the other drivers. Whereas for the brake percentage graph, driver C uses more of the maximum available braking power when compared to the other drivers.

Additionally, gravitational forces in the lateral and longitudinal directions can be plotted against each other to show how the drivers are using the available grip of the vehicle used for the testing.

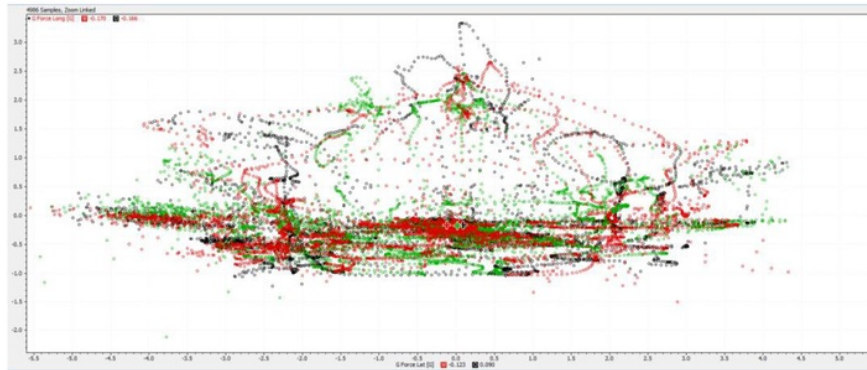


Figure 9 - A scatter graph showing the relationship between gravitational force in the longitudinal direction and the lateral direction

Looking at the diagram, drivers A and B are able to use more of the available grip of the vehicle when compared to driver C, as more of the points for the drivers are around the outside of the circle. This is due to the inexperience of the driver.

Conclusion

Looking at the data provided from the tests, driver A was able to produce the best lap time, while being able to use more of the available grip that the vehicle was providing. Driver C was able to use the brakes at their optimum performance more compared to the other drivers but suffered from lack of experience. Driver B was able to spend more time using one hundred percent throttle compared with the other drivers, however driver A spent the least time at zero percent throttle. Drivers A and B were able to take the improvements given to them and put them into action with a better degree of success than driver C.

Evaluation

After completing the testing, a few areas of improvement were noted:

- The team needed to be more planned and prepared for the second test day.
- Although team roles were decided prior to starting the second test, some team members did not stick to task, one of the reasons for driver C not showing the rate of improvement compared to driver A and B.
- After the drivers came out of testing the seconds runs, with the improvements given to them, feedback needed to be taken to acknowledge if the driver felt that the improvement had worked.

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