

Driver comparison through Data Analysis

by Daniel Salathiel

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1.0 Introduction:

Track testing using a driver in a loop simulator is a widely used tool for motorsport teams to develop the cars setup and devise key training programs for their drivers (Bottiglieri, 2018). These techniques help to improve the driver's performance, utilising a software program such as Motec I2 Pro. These systems gather data via sensors and driver inputs, then stores the data for further analysis. Once the data is stored, a race engineer can open the data in a dedicated software such as Motec I2 Pro, to further discuss improvements with the driver based on the previous session (Bottiglieri, 2018).

Throughout the report key performance indicators will be looked at and critically analysed to help develop the driver, this will be measured in the improvement of lap times and the consistency. From the data collected and live data streaming of the two other drivers', improvements can be suggested to the driver to help improve their performance based on the variance in time. These improvements can be obtained through analysing different data channels the data collection software provide, to help gain an understanding of how the driver compares to the other drivers data collected, and the difference in key performance indicator channels.

The driver inputs effect the dynamics of the car drastically in motorsport. The longitudinal G's show the effect of the drivers braking on the chassis, and also any consequences of the driver's actions can be seen through the recorded cornering speed and lateral G graphs. Adapted from (The Driver, 2018). From this information suitable improvements will be suggested to the drivers, and the results from these will be looked at to see if the performance has improved over the course of their second session as a result.

2.0 Literature review:

2.1- rFactor Racing Simulator:

rFactor is a racing simulation package from image space Incorporated. It provides a realistic racing simulation with the latest vehicle and race customisations with an extended sense of realism. The software and hardware provide 15 degrees of freedom using an advanced physics engine, advanced tyre modelling, complex aerodynamics and realistic responses to driver inputs. The data can be stored and formatted to be used in conjunction with a data analysis software. Adapted from (rFactor, 2018)

2.2 Track selection:

The track selected for this report is Brands hatch GP circuit as displayed below with the relevant corner indicators. (Frontier, 2018) This circuit was selected due to its complexity over a moderate lap time, meaning more data sets could be collected in the allocated time slots of an hour and a half.

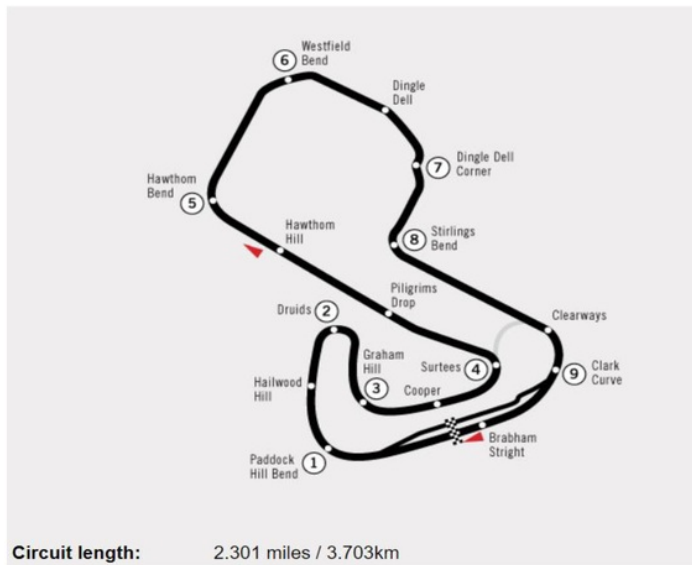


Figure 1: Brands Hatch GP circuit, (Frontier, 2018).

The corner numbers will add reference to the data analysis in the Motec software in this report.

3.0 Methodology:

The test session was limited to one hour thirty for sessions one and two. A test plan for the sessions allowed for a more efficient process. Each driver was allocated a time slot. To reduce the confusion when analysing the data; driver A, driver B and driver C will be allocated to the drivers depending on their running order. For consistency, the drivers allocated letter will stay consistent throughout session one and two.

The sessions consist of a warm up session and a timed session. For the first session a 4-minute warm up session was allocated to each driver, this is to allow for the driver to acclimatise themselves with the handling characteristics of the car. This warm up session also allows for the driver to carry out sighting laps and get a feel for the track. Once the warm up session has been completed the driver will enter the timing phase of the testing.

During the timing sessions the drivers' data will be collected and processed by the rFactors software. Along side this live data can be noted, to help give a clearer understanding of the data when it comes to analysis on the Motec Pro i2 software. A 25- minute session as been allocated to each driver to avoid exceeding the assigned time slots for the simulator sessions. The timed sessions will allow for the driver's key performance indicators to be recorded using the various input channels on the simulator. These performance indicators will be the bench mark for the drivers, allowing for comparison between the different drivers and timings to allow for improvements to be suggested for the second session.

Before the second session is carried out the data from session one is analysed to gain vital information on the drivers' key performance characteristics. From the analysis an improvement program will be noted for each driver in relation to the datum, and the comparison of the driver's data against each other. This information will be delivered to the drivers during session two, with the goal of improving their overall times and performance. The information will be processed and delivered in a manner deemed not too overwhelming for the driver, as feeding complex instructions to the driver would lead to a hindrance in their performance as discussed with each driver (Buddy Fey, 1993).

Once the feedback has been delivered based on the noted improvements and live data noted during the session, the data will be analysed through the Motec software to see if the improvements advised have improved the performance and efficiency of the drivers during their timed sessions.

4.0 Analysis of rFactor data using Motec Pro I2 software:

To analyse the performance of the three drivers, the data collected from session 1 will be analysed to give an understanding of the individual drivers' characteristics. The Drivers lap will be used as a bench mark. From the datum key performance indicators can be looked at to see how the other two drivers can improve upon their performance, and how the bench mark driver can improve their lap times by looking at points where the other drivers gained time.

Driver A session 1 and 2 best times (1) 1:23:390 (2) 1:23:488

Driver B session 1 and 2 best times: (1) 1:23:210 (2) 1:22:767

Driver C session 1 and 2 best times: (1) 1:27:274 (2) 1:25:232

4.1 Driver analysis through comparison:

The data collected for the driver's best laps are to be compared, this will lead to feed back for the drivers based on the key performance indicators in relation to what the other drivers are doing that could benefit their lap times. The red data lines indicate Driver B as they set the quickest time, the black line indicates driver A the second quickest and driver C is indicated by the green line.



Figure 2: Turn 2 data comparison, (Daniel Salathiel, 2018).

The data shown above in figure 2 shows the comparison of the performance indicators for the drivers braking and throttle applications. Driver B's data shows that they are braking earlier than driver A and C. This means that they can get on the throttle sooner while on the apex of the corner, meaning they are carrying greater speed through turn 2 indicated by the cornering speed, shown in figure 5 below. Driver B carries 79.1km more speed over the slower driver C.

Channels			
	Lap 7	Lap 17	Lap 9
Cursor			
Time	0:12.292	0:13.970	0:14.633
Outing Time	10:14....	24:59....	13:58....
Distance [m]	601	601	601
Outing Distance...	26178	67177	35850
Time/Distance Graph			
Corr Speed [km/h]	157.5	80.3	78.2
Throttle Pos [%]	99.78	60.46	41.36
Brake Pedal Po...	2.09	0.00	0.00
Steering Wheel ...	12.42	40.74	52.20
Gear	3	1	2
G Force Lat [G]	-1.048	-1.232	-1.413
G Force Long [G]	-0.543	-0.511	-0.102
Logged			
Gear	3	1	2
Engine RPM [rpm]	6270	5408	3783
Clutch RPM [rpm]	6270	5408	3783
Eng Oil Temp [°C]	96.50	89.99	87.17
Engine Temp [°C]	77.31	74.18	71.72
Engine Overhea...	0	0	0
Fuel Level [l]	70.00	70.00	70.00
G Force Lat [G]	-1.048	-1.232	-1.413
G Force Long [G]	-0.543	-0.511	-0.102
Throttle Pos [%]	99.78	60.46	41.36
Brake Pedal Po...	2.09	0.00	0.00

Both figures show a difference in line through the corner by driver B when compare to the two other drivers. Driver B uses a wider line turning in 42M earlier, meaning the driver is reaching the apex sooner as shown by the difference in steering percentage in figure 3 to the left, indicated by the red box. (Buddy Fey, 1993).

Regarding the line taken, the ideal line in a real-world situation required the driver to turn into the corner later as displayed by drivers A and C. Turning in towards the apex opens up the exit creating a more direct, straighter exit from the corner (Driver61.com). This is dependent on driving style, the line taken by Driver B shows greater advantage, so will be used as performance enhancement advice for the other two drivers.

Figure 3: Steering percentage data for Turn 2, (Daniel Salathiel, 2018).

Going into turn 3 driver B gained even more time over driver A and C by increasing their commitment and utilising the key performance indicators in a different manner to gain positive results. The driver applied the brakes later and harder than the other two drivers meaning they carried greater cornering speed. This can be seen by the data shown in Figure 6 below.

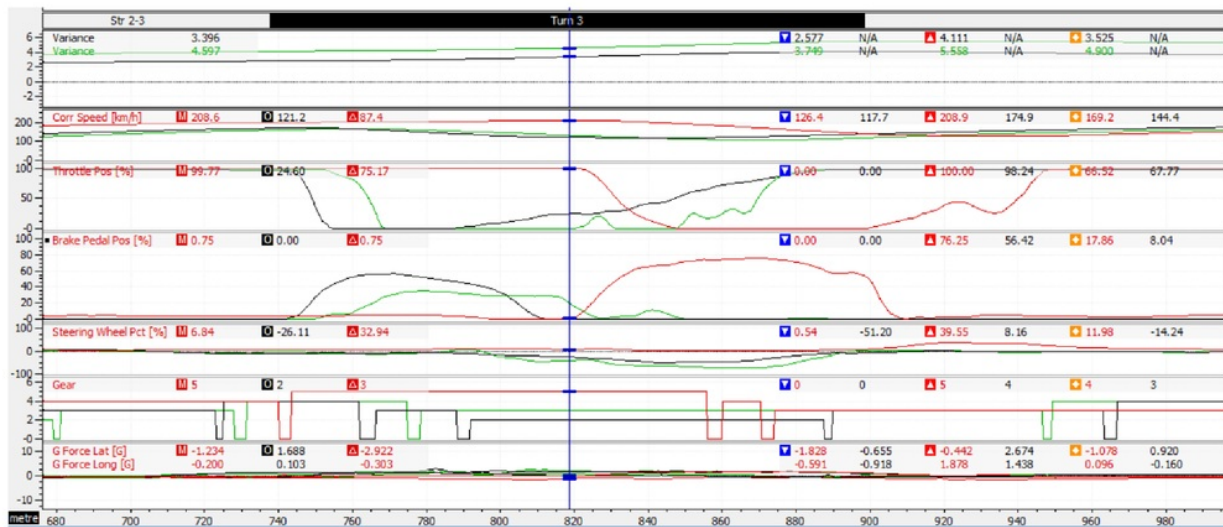


Figure 4: Turn 3 Driver data analysis, (Daniel Salathiel, 2018).

The data shows that driver B is braking 75M later than driver A and 57M later than driver B, carrying 88.3 Km/h more speed through the turn. The lateral G force for driver B shows that they are maximising the cornering grip of the car. The exiting speed for all three of the drivers is very similar. This means Driver B maintains the time advantage but hasn't gained a disadvantage through doing this. This shows that driver A and C can brake later into turn 3 and keep throttle application to gain performance and maximising more of the available grip.

This is the driver's confidence in pushing the car to the limit of grip. Begin to break traction, you're only exceeding the limit by one or two percent and not 10 percent. If you overshoot by 10 percent, it may be that you can't make it around the corner and end up having an accident as stated by (Driver 61.com).

The sectors where the most time can be gained in regard to the datum is sector 1 and 2 of the track. During the second sector Driver A and C gained time back reducing the advantage driver B gained during sector 1. Looking at the data for this section will allow for recommendations for improvements of driver B's performance, but also the two other drivers to help them gain an even greater advantage.

Through the analysis of sector three, the datum showed that driver B lost time through Turn 7. Upon analysis the data showed that the driver braked earlier and a lot harder than the other two drivers leading to a decrease in cornering speed and lateral G force. The throttle percentage also shows that, the driver realised that they had lost too much momentum entering the corner and re-applied the throttle on the entry to the corner. This may be due to corner 7 being a blind apex corner, which means that Driver B and driver C will for the next session will be advised to keep commitment through the corner to gain a performance advantage. The braking point for Driver A will be used as an example. All the points above can be seen in figure 5 below:

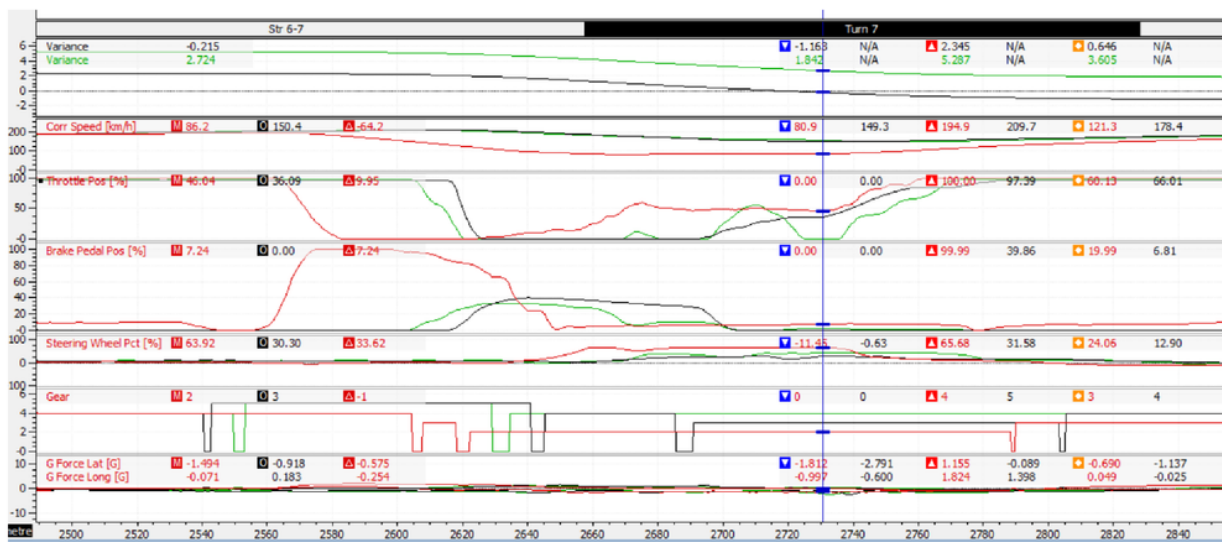


Figure 5: Turn 7 data comparison, (Daniel Salathiel, 2018).

4.2- Driver comparison through Histograms:

4.2.1- Brake percentage Histogram:

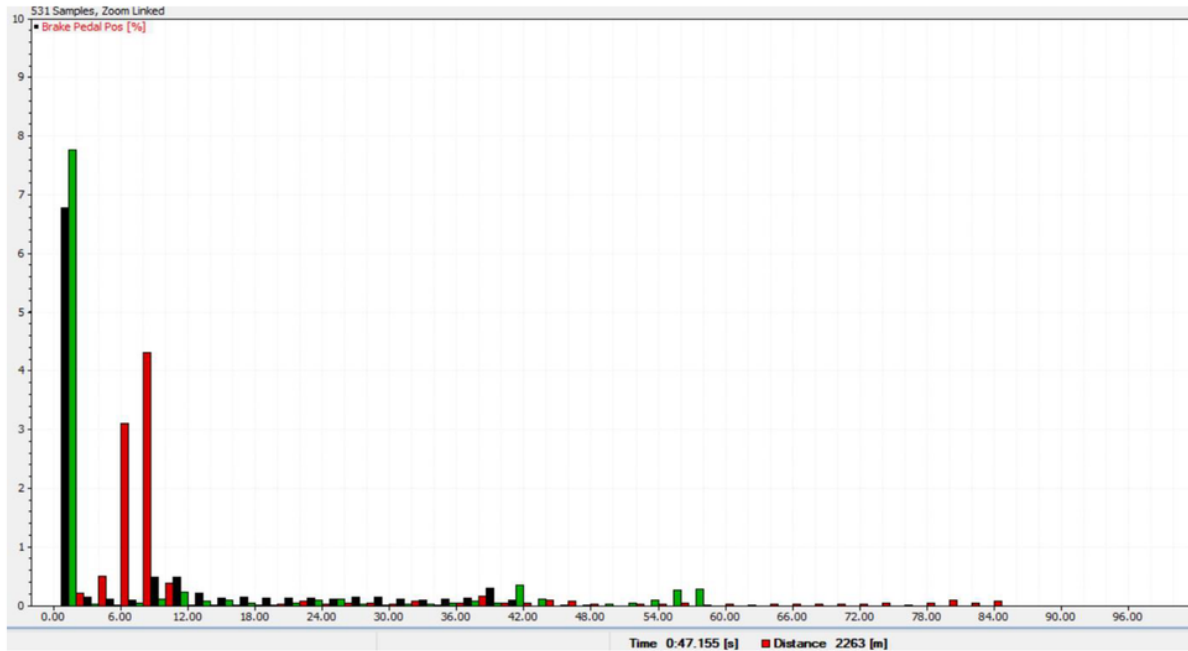


Figure 6: Session 1 Braking percentage histogram, (Daniel Salathiel, 2018).

The histogram shows that both driver A in black and C in green were consistently hitting the 0% percent braking margin, meaning they were fully disengaging the brakes and using the full momentum of the car. The histogram shows the noted parasitic braking caused by Driver B shown in red, resting their foot on the brake pedal. On the other hand, this driver was achieving the highest braking percentage, meaning they were using the longitudinal grip available to them most effectively out of the three drivers. Based on this analysis Driver B is advised to reduce the pressure of their left foot on the brake pedal when off the brakes, and Drivers A and C are advised to maximise the braking effort under braking conditions when entering the corner to make the most use out of the braking grip available. Driver C is at 0% percent braking for longer, there they need to brake earlier for the corners and more effectively.

4.2.2- Throttle Percentage Histogram:

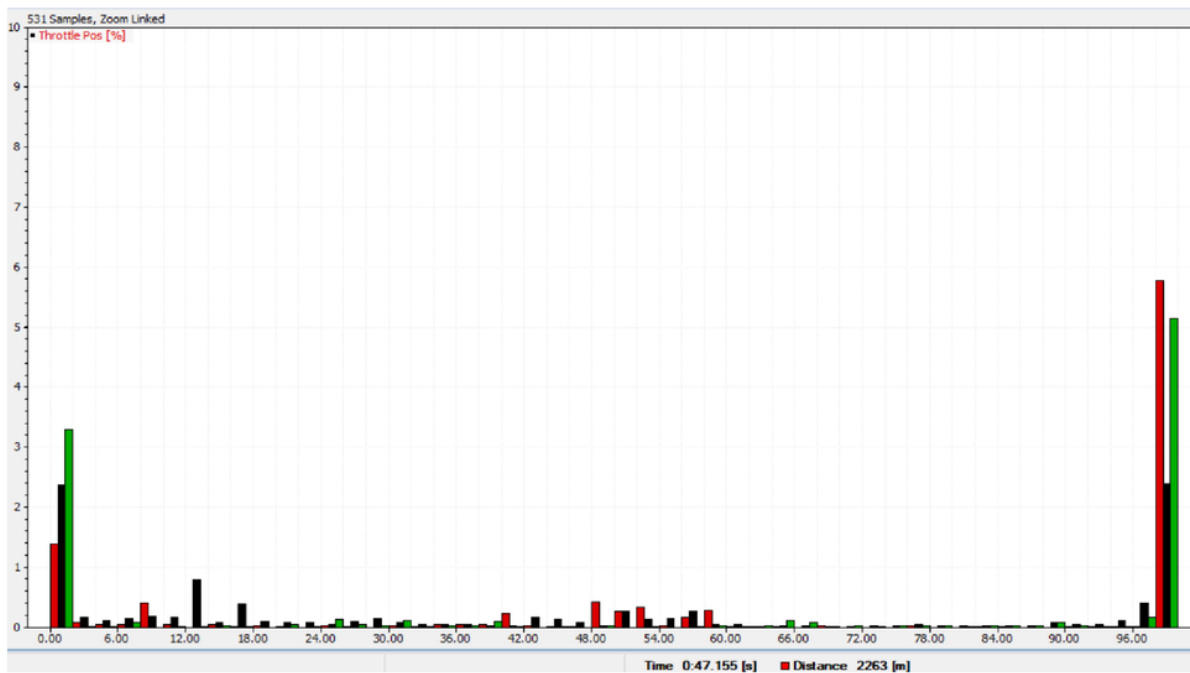


Figure 7: Session 1 Throttle Percentage histogram, (Daniel Salathiel, 2018).

The histogram shown in the figure above shows the drivers throttle percentages at a given time. Upon analysis driver C is shown to be at 0% throttle the longest and the second longest at 100%. This means that the driver is applying the throttle consistently, with limited partial throttle application. When compared to Driver A shown in black and driver B in red, the data shows that the two drivers are at partial throttle. In this case the partial throttle application aids their performance during the session, which is reflected in their faster times overall.

4.3 Driver A individual analysis:

Driver A set the second quickest lap of session 1, with a time of 1.23.390. The driver's performance throughout the session showed consistency in relation to lap times. The characteristics of the drivers' key performance indicators are smooth and shows a more conservative approach when compared to the other drivers. One such performance indicator is the brake and throttle application shown in figure 2 below for their quickest time.

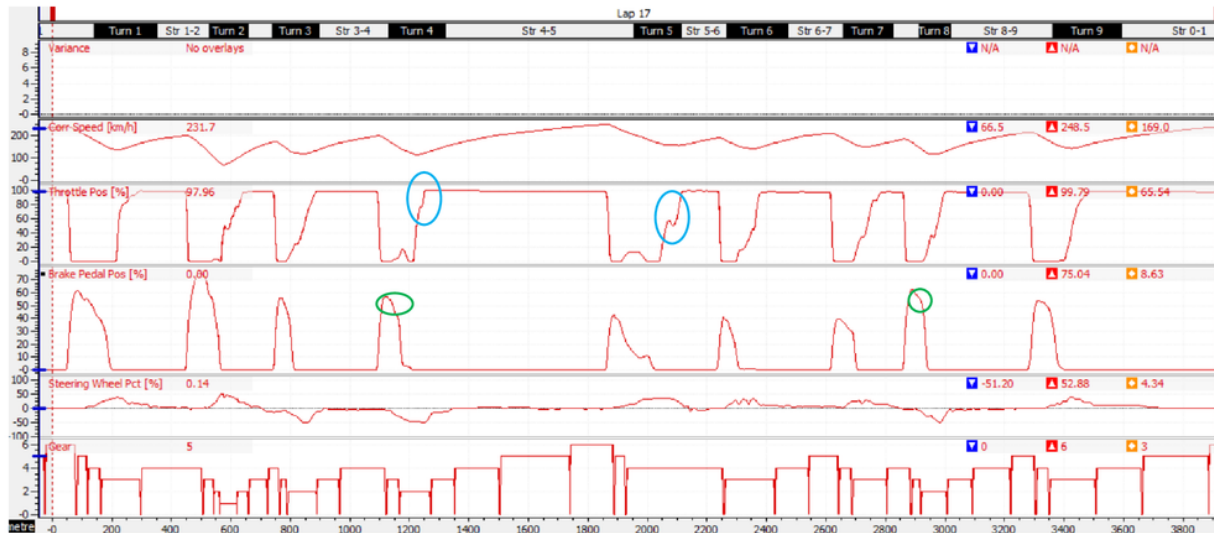


Figure 6: Driver A motec data for fastest lap, (Daniel Salathiel, 2018).

The figure shows that the driver bleeds off the brakes when entering the corner carrying good cornering speed, the throttle application shows hesitation throughout most of the lap. This is shown by the circled throttle position data in figure 2. This may be due to a confidence element where the driver is ensuring there is sufficient grip available to apply full throttle. In this case an improvement can be suggested to the driver based on three performance indicators: brake, throttle and steering position. The improvement would be maintaining cornering speed and wait until the steering percentage is reduced before applying the throttle to prevent destabilise the car, and then apply 100% throttle and commit to reduce the need to lift off due to loss of grip (Buddy Fey, 1993). It has been noted that this may be due to the driver still learning the full capabilities of the car.

The data shown on lap 19, shows the driver spin out on turn 2, shown in figure 9 below. Upon analysis, the cornering speed when compared to two other laps carried out by the same driver showed a much lower speed. The braking percentage shows that the brakes were applied for 6m longer reducing the overall cornering speed, this may have caused the cars cornering downforce to reduce causing the car to lose lateral grip. This is shown by the increase in lateral G force, indicating oversteer of the vehicle under braking and the increase in steering percentage as counter steer into the slide. (Katz. J. 2006).

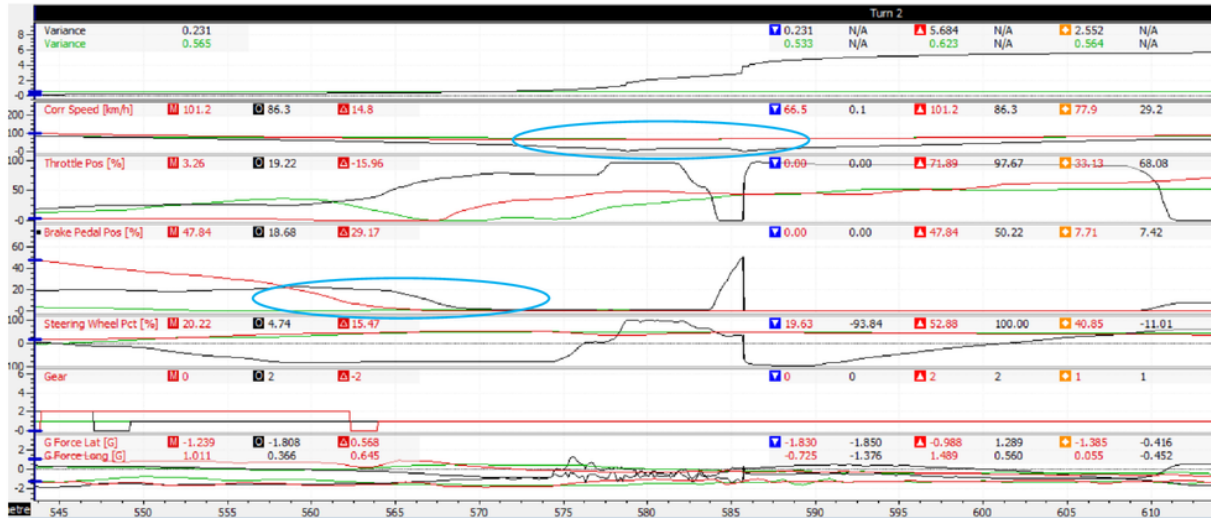


Figure 9: Driver A spin analysis (Daniel Salathiel, 2018).

4.3.1 Improvement suggestions for driver A:

- Turn 2- Maintain speed into entry to ensure no loss of downforce.
- Turn 5- Reach **100% throttle** quicker
- Turn 8- **Brake earlier** and get to **100% throttle** quicker
- Gained time during the last straight/ corner.
- Turn 1- Brake earlier and to get the line you want for apex.
- Wait to apply throttle at less steering angle and keep it on.

4.4- Driver B Individual analysis and Improvement suggestions:

Driver B's strongest sector was sector 1. Setting the quickest time for session 1 with a 1:22:767. The data shows that driver B showed consistency with holding cornering speed through this sector by aggressive late braking.

Through the data analysis it was noted that the driver lost time throughout the sessions lap times due to them resting their foot on the brake, meaning that for the duration of their laps, the brake was partially engaged. This can be seen in the figure below.

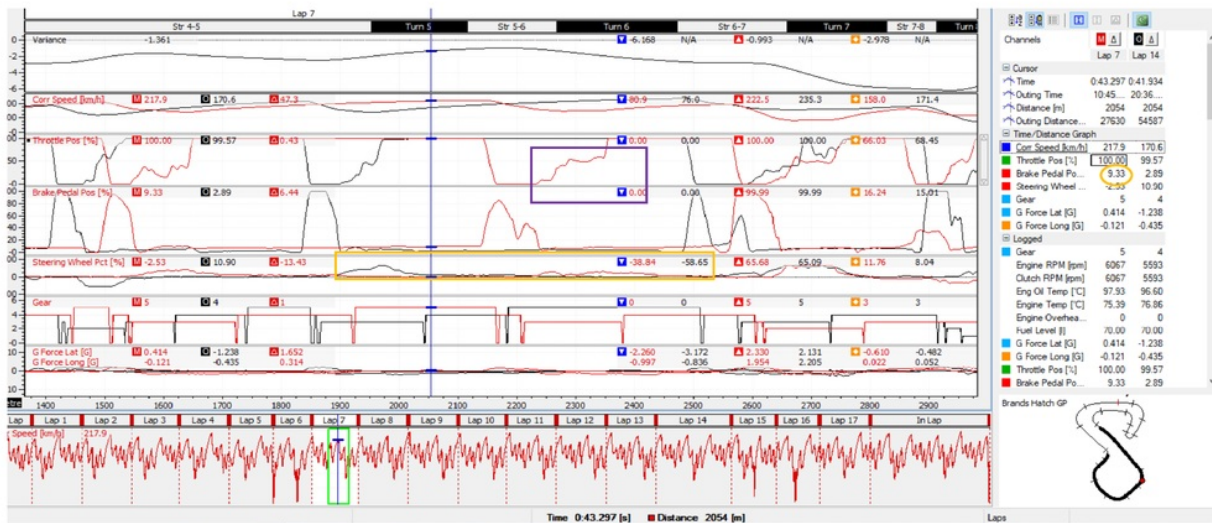


Figure 10: Driver B data analysis, (Daniel Salathiel, 2018).

The yellow boxes display that at some points driver B was applying up to 9% brake, this would lead to a considerable effect on performance over the duration of a session, This can be seen in the histogram below. Advice would be given from the observation of this key performance indicator for session 2.

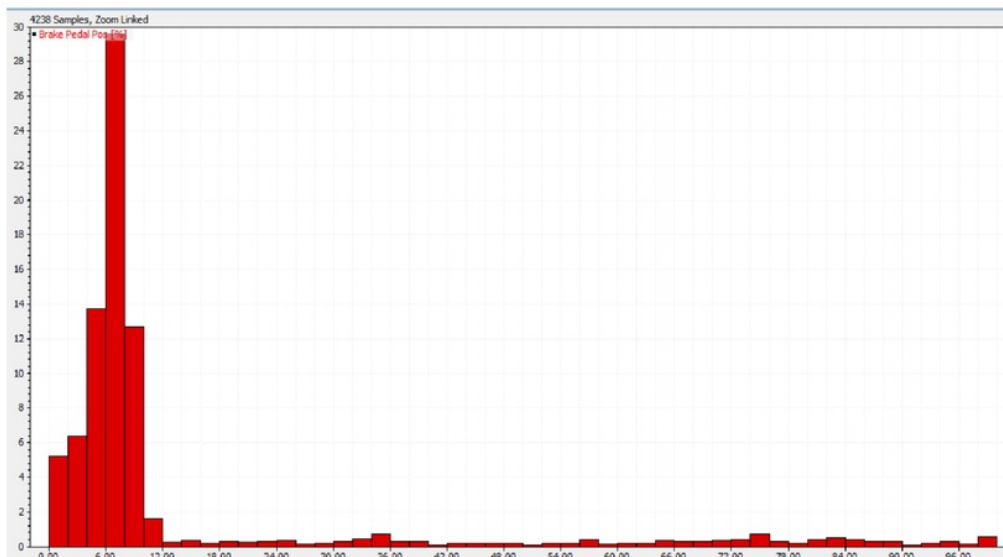


Figure 11:
Driver B
Brake
percentage
data
Histogram,
(Daniel
Salathiel,
2018).

The purple boxes indicate the throttle application of the driver. The data shows an erratic application of the throttle, meaning the car is becoming unsettled and reducing the cornering speeds. This can also be seen in the steering percentage highlighted, showing that the throttle application is being applied while under heavy cornering. The steering data also shows corrections to counter this (Buddy Fey, 1993). As shown in figure 12 below.

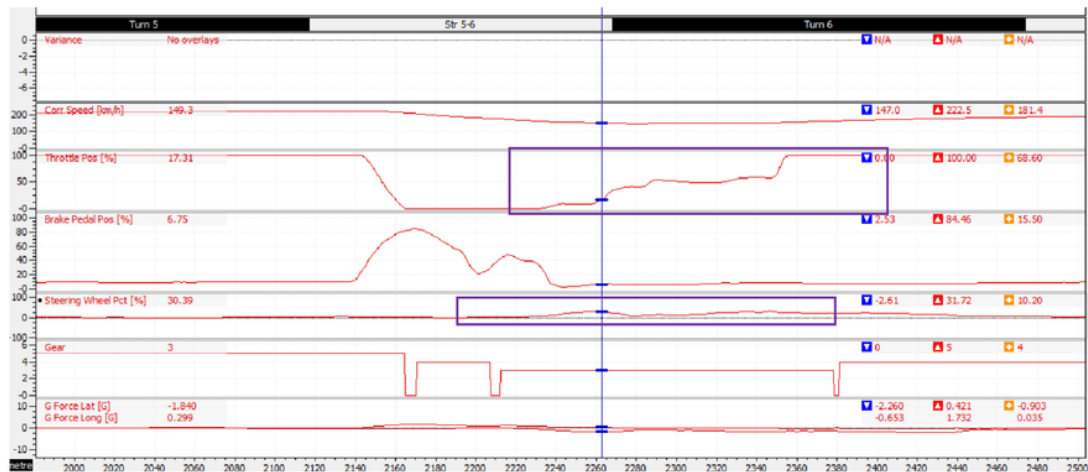


Figure 12: Driver B Throttle and steering analysis, (Daniel Salathiel, 2018).

4.4.1- Improvement suggestions for Driver B:

- **Turn slower** into turns.
- **Brake softer**
- **Throttle later** and stick on it.
- **Balance** throttle and brakes through corners
- **Resting foot on brake** through last straight
- Last corner/ straight- parasitic braking... resting foot brake.
- **Turn 5-** Apex wide... try to get closer to the curb.
- **Sector 1-** Smoother throttle application.

4.5- Driver C individual analysis:

The driver's strongest sector was sector 2, setting a lap time of 1:27:274. Upon Analysis of driver C's data, it was apparent that the driver was struggling to reach an efficient braking percentage through out the session. This can be seen through the analysis of the histogram in 13 figure 14 below.

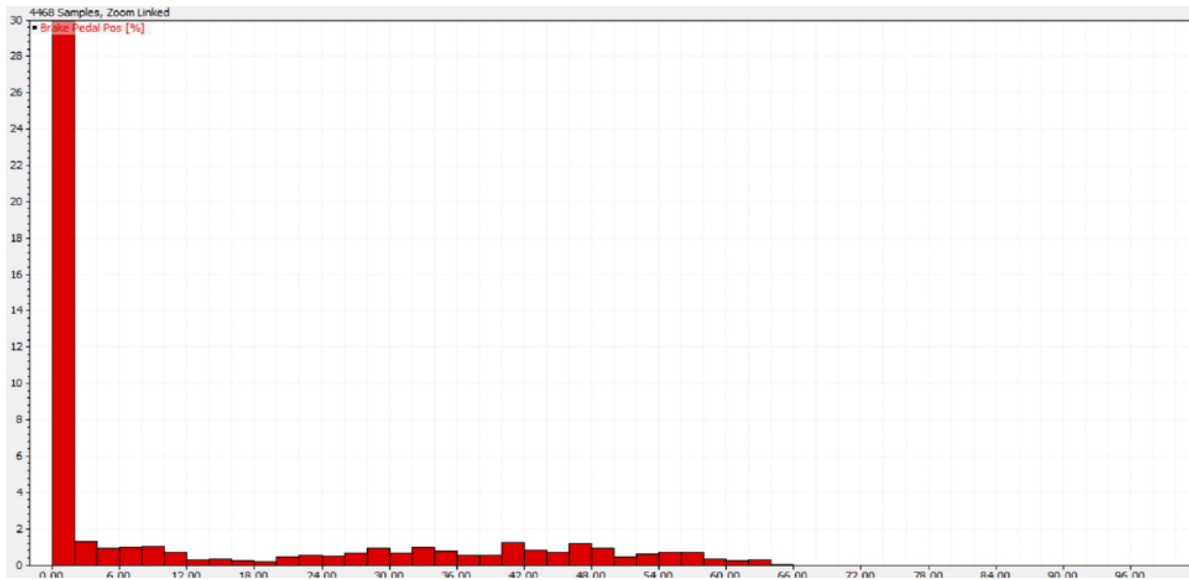


Figure 13: Driver C braking data histogram session 1, (Daniel salathiel, 2018).

Looking at the data for the quickest lap of driver C. The data shows that the driver has an aggressive driving style shown by the high lateral G forces being displayed. This can also be seen in the cornering speeds, the data for the cornering speeds show high momentum being carried, which is reflected in the drivers steering inputs. In the figure 14 (Buddy Fey, 1993), it can be noted that there are high steering percentages being used, indicating more lock is required due to excessive cornering speed being carried. It has been noted that this may reflect the braking percentages being lower than required, after discussions with the driver the advice was given to wear a sturdier shoe for the next session to try and gain as much braking performance as possible. Another factor that might influence this is the seating position of the driver. During the next session precautions must be carried out based on these issues to rectify them and increase the performance of the driver.

Another key performance indicator that shows room for improvement is the throttle application. The driver shows hesitation when applying the throttle exiting the corner. This is due to the driver destabilising the car by applying too much throttle percentage at a high steering percentage. Thus causing the car to become unsettled and lose traction, meaning the driver is counteracting the loss of grip by coming back off the throttle as displayed in figure 14.

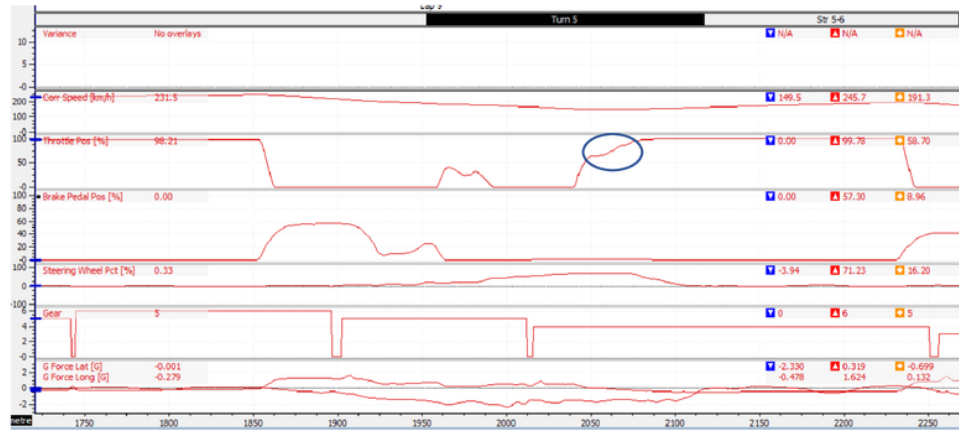


Figure 14: Driver C throttle application analysis, (Daniel, Salathiel, 2018).

4.5.1- Improvement Suggestions for Driver C:

- **Reduce cornering speed-** To reduce steering angles
- **Harder braking-** wear better shows
- **Earlier** on the brakes- higher %
- Adjust line for **turn 2**
- Turn 3- **Adjust line**, brake harder
- **Throttle sooner** on straights- wait for less steering %

5.0 Session 2 Analysis:

5.1. Driver A session 2 analysis:

The first set of advice was given to the driver during lap 4 based on sessions data and the current live data being seen. The driver was told to apply the throttle quicker but apply it smoothly to maximise grip and exit speed when coming out of turn 5. The data for the corner on lap 4 and lap 5 can be seen in the figure below.

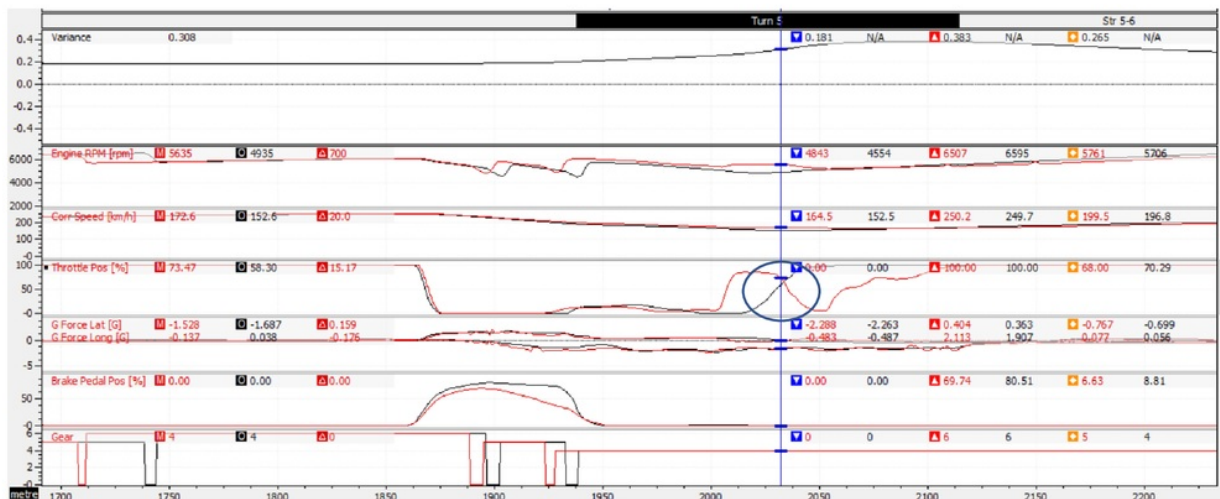


Figure 15: Driver A Lap 4 and 5, turn 5 data analysis, (Daniel Salathiel, 2018).

The data shows that after the advice was given, on Turn 5 the throttle was applied in a smoother manner displayed by the black line in the circled area above. This resulted in a higher lateral G force of -0.159 being displayed, meaning the driver was closer to peak G force on this high-speed corner. A product of an assertive driver and a balanced chassis according to (The Driver, 2018). This improvement in performance can be seen in the overall speed advantage shown further down the straight, resulting in an increase in speed on lap 5 of 7.9 Km/h shown in figure 16 below. The advice given aided in the lap time for lap 5 being decreased by 1.497 seconds.

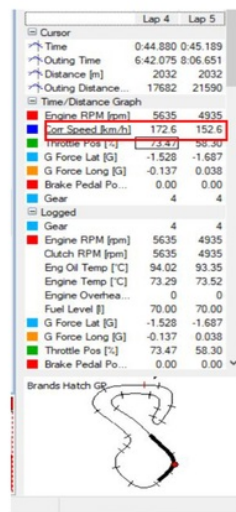


Figure 16: Driver A corrected speed laps 4 and 5, (Daniel Salathiel, 2018).

The second part of advice was delivered to the driver on lap 14 of the timed session. The driver was instructed to brake earlier on Turn 8. This is due to symptoms such as lateral G peaking at mid corner or later and the inability to apply the throttle at the exit of the corner efficiently due to carrying too much speed (The Driver, 2018). This advice was to allow the driver to reach the apex of the corner sooner and accelerate out of the corner more effectively. The driver was seen to build upon this performance indicator on the following two laps as seen below.

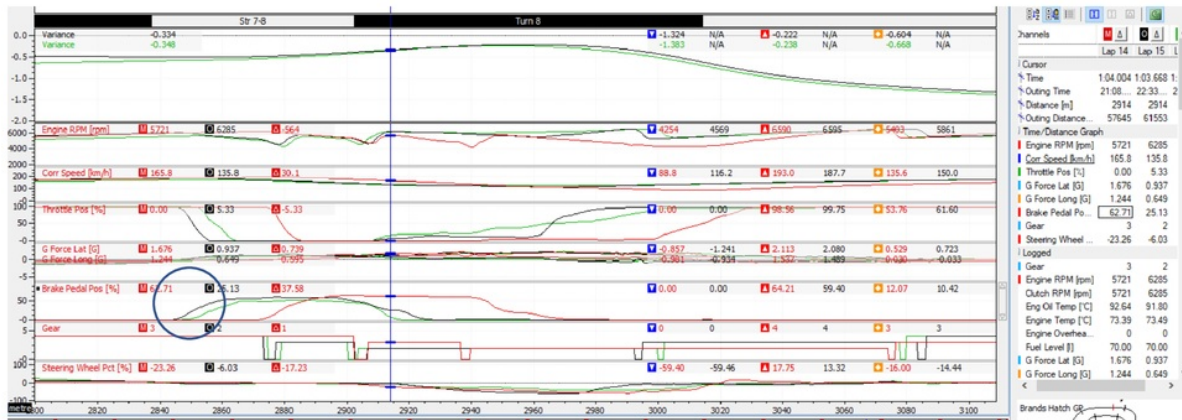


Figure 17: Drive A session 2 throttle application, (Daniel Salathiel, 2018).

The black and green line show the brake being applied a lot sooner than the red line which was the lap the advice was given on. This allowed the driver to start to steer into the corner 28m sooner as shown by the steering percentage data. This also meant that the lateral G peaked sooner indicating the driver was able to reach the apex sooner.

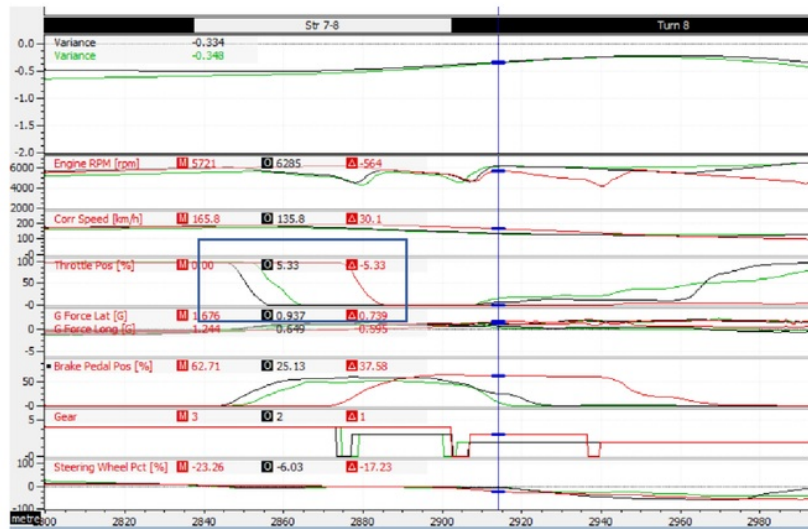


Figure 18: Driver A, Session 2 turn 8 lap 14/15/16 acceleration percentage data, (Daniel Salathiel, 2018).

This allowed them to apply the throttle sooner reaching a higher exit speed of 135.4 km/h when compared to lap 14 which was 90.2 Km/h.

5.2 Driver B session 2 data analysis:

During session 2 driver B received the first set of instructions on lap 1, regarding the issue noted in session 1 for the parasitic braking. The data below shows the driver resting their foot on the brake during the outing lap, the driver was made aware of this issue towards the end of this lap and can be seen to rectify it after sector 1 of the track.

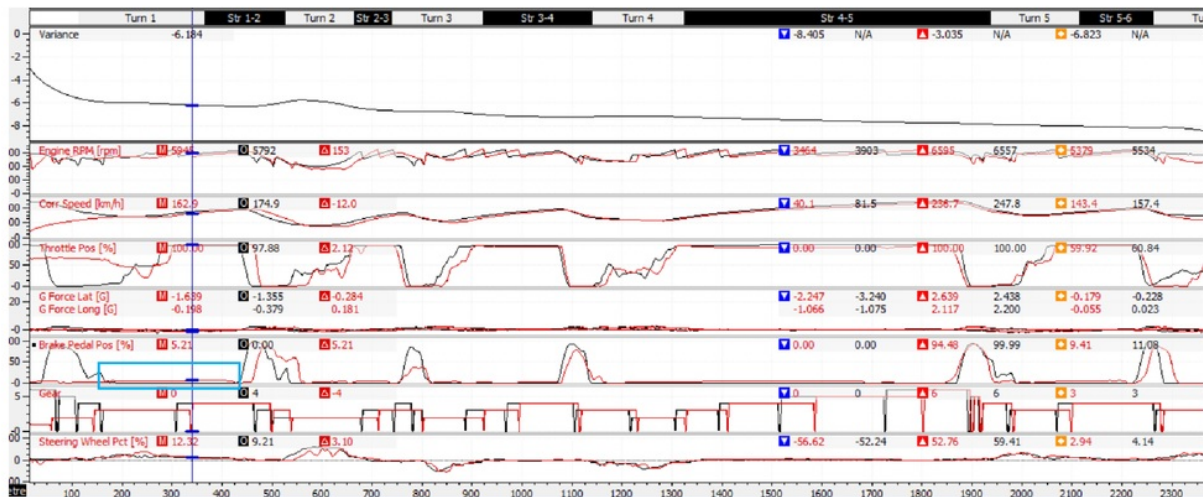


Figure 19: Driver B session 2 Brake percentage analysis , (Daniel Salathiel, 2018).

The braking data shows a parasitic braking percentage of 5.21 percent which is caused by the driver not fully lifting their foot off the brake pedal when its not needed. This can be seen in the blue box in the figure above and the figure below indicated by the blue line on the data and the braking data.

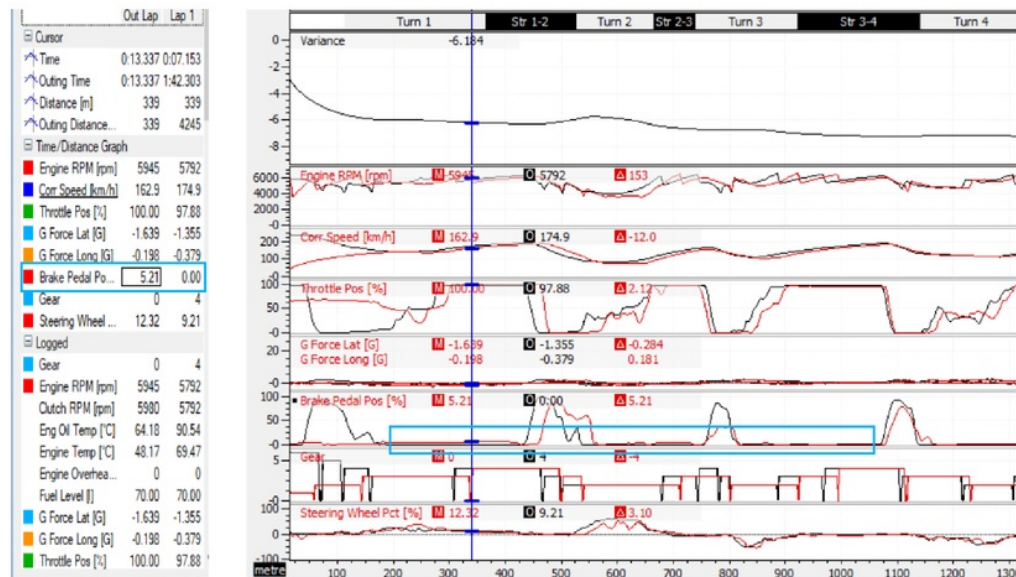


Figure 20: Braking data for parasitic percentages in lap 1, (Daniel Salathiel, 2018).

The black line indicates the following lap from when the driver was told about the issue. It can be noted that the driver is no longer resting their foot and has 0% braking. This resulted in 12 Km/h over the same sector being gained along the straights helping increase the drivers performance.

The second key performance indicator that was targeted next was the braking points for each lap. This was given on lap 4. The driver was instructed to brake later but with the same effort to reduce the need to lift off and re-apply due to over braking for the corner and correction. The data in the figure below shows the black line for lap 5 is much smoother and the driver braking later into the corner by 22m at 98 percent.

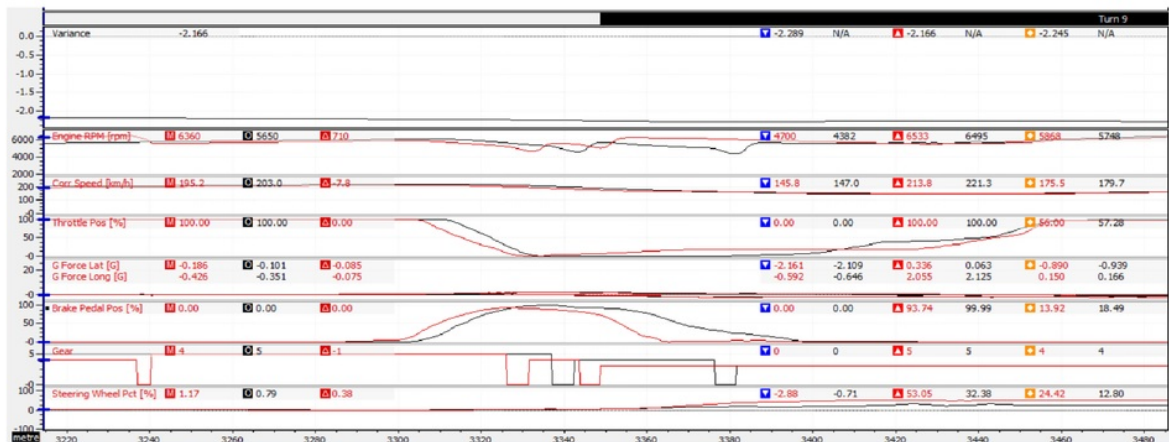


Figure 21: Driver B session 2 turn 9 later braking data, (Daniel Salathiel, 2018).

The driver maintained the same cornering speed, but the later braking allowed the driver over the course of the lap to make up a further 2.355 seconds by gaining the confidence to brake later into the corners throughout the whole lap.

The same issue was noted for turn 8, where the driver broke earlier than needed and suffered the same outcome analysed for driver A in session one (section 4.1). The moment can be seen in the figure below (the red line of data) through the steering correction and throttle correction. Based on the analysis of this data as it happened, the driver was instructed to maintain speed into the corner by later braking to ensure enough longitudinal G to maintain downforce.

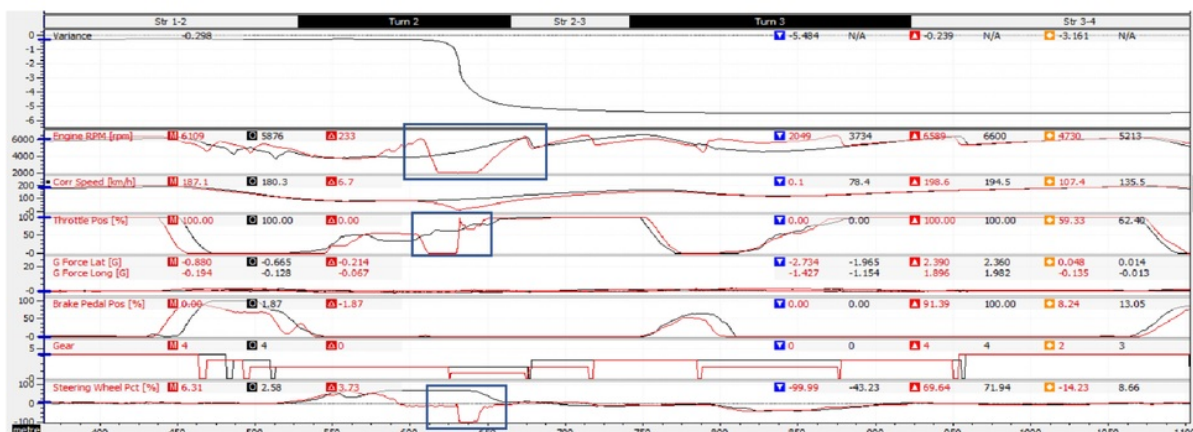


Figure 22: Driver B session 2, turn 2 data analysis, (Daniel Salathiel, 2018).

5.3 Driver C session 2 data analysis:

Driver C showed the greatest improvement during session 2. The driver based upon the analysis of session 1 decreased their quickest lap time by 2.042 seconds. The drivers seating position and foot wear was analysed and changed ready for session 2 to allow the driver to maximise their braking effort. The analysis allowed the driver to achieve a greater braking percentage. The first set of performance advice was delivered during lap 2, where the driver achieved a maximum percentage of 89.44% as shown in the figure below. Indicated by the red bars on the histogram. The driver was advised to brake later and harder into the corner, due to the driver braking at the same points as session 1, but with a much higher percentage. Improvement can be seen on the 3rd lap, where the driver is seen to achieve a much higher percentage. In figure 24 for the black line data, the driver can be seen to brake later into the corners displayed by the highlighted blue box. Helping the driver decrease their time for lap 3 by 2.257 seconds.

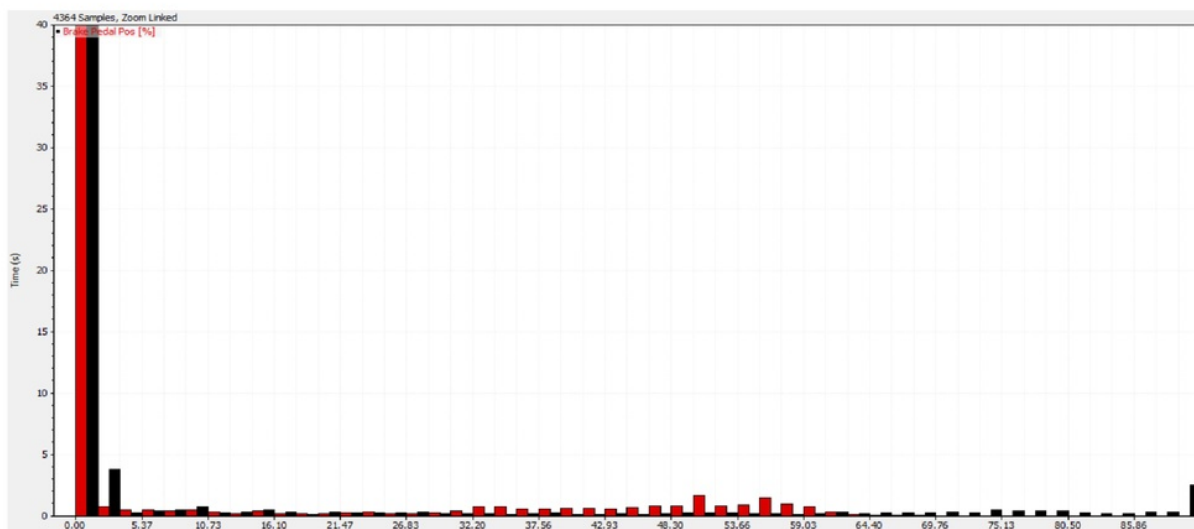


Figure 23: Driver C session 2 Brake percentage Histogram, (Daniel Salathiel, 2018).

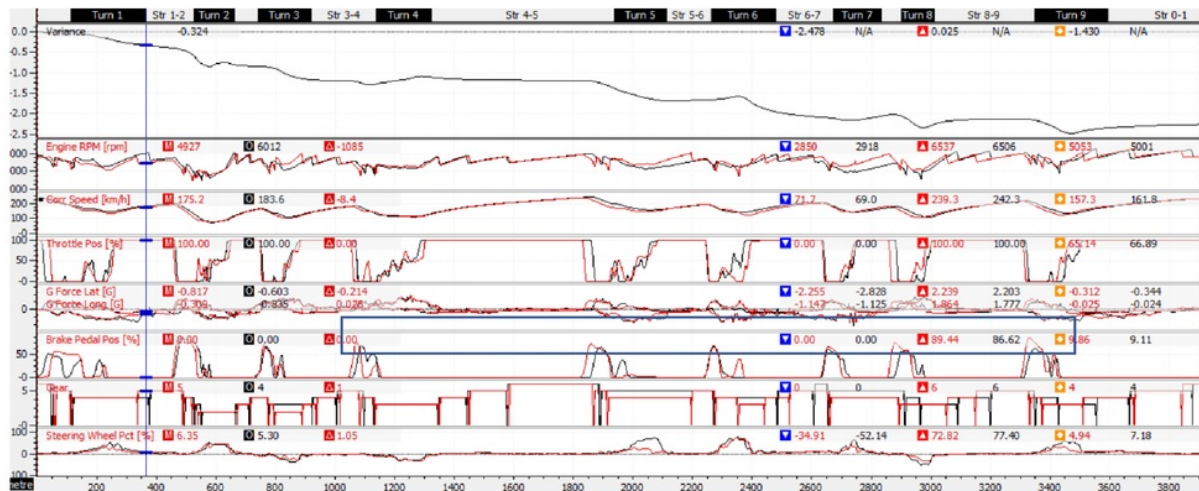


Figure 24: Driver C session 2 Later braking analysis, (Daniel Salathiel, 2018).

The second performance advice was given during lap 7. The driver was told to brake earlier for turn 2, to reduce their entry speed to prevent the car from running wide and off line. This can be seen in the lateral G force peaking mid corner (Buddy Fey, 1993). The improvement can be seen 3 laps later where the driver reaches peak G force before the apex of the corner, and can be seen to brake 15 meters earlier, 26% percent higher braking position achieving the correct speed shown by the lateral G force of lap 8 and 9.

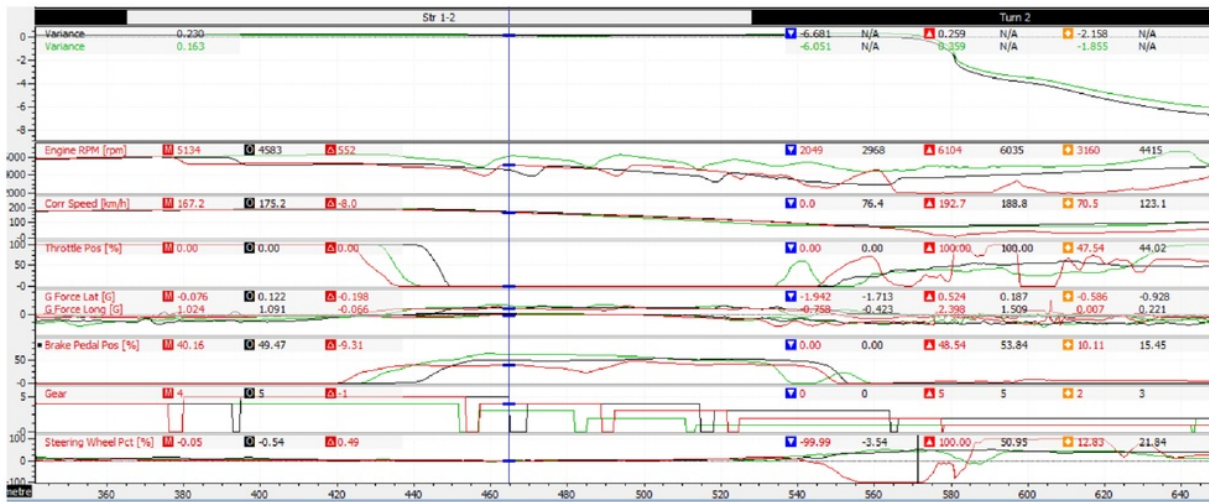


Figure 25: Driver C session 2 laps 7/8/9 data analysis, (Daniel Salathiel, 2018).

Further advice was given to the driver to change down to gear 2 quicker on lap 8. The driver was changing gear too slowly meaning the reduction in speed was reduced, due to the engine braking being reduced (Howstuffworks.com, 2018). The key performance indicators that were analysed helped reduce the drivers lap time on lap 9 by 1.13 seconds.

6.0 Conclusion:

The key performance indicators allowed for constructive advice to be delivered to the drivers. From this the drivers were able to build upon their performance and gain knowledge on how to use different approaches to reduce their lap times. Drivers A and C managed to improve their lap times during session 2 based on the analysis of the data from the first session. Driver A increased their consistency even though they set a slightly slower time, but acted upon the information given to them, showing results in sector timings.

All three drivers showed different experience and driving styles which was reflected in their data. But all were able to achieve a cleaner, smoother lap regarding the key performance indicators, data and balancing the chassis of the car to improve overall.

In conclusion the data was collected efficiently using team planning, and the data was thoroughly analysed for the second session to give the drivers the best chance at improving. The information gathered and delivered to the drivers gave tangible results in terms of not only decreasing their times and increasing their consistency, but visible changes in the driver input data. This means that each driver took on board the information being given to them and was able to use it to improve their driving.

Bibliography:

- Bottiglieri, M. (2018). *DATA ACQUISITION TO ANALYSE THE DRIVER AND HIS RACE CAR*. [online] Available at: https://www.researchgate.net/publication/266011043_VEHICLE_DATA_ACQUISITION_AND_ANALYSIS_FOR_DETECTION_OF_THE_DRIVER'S_DROWSINESS [Accessed Nov. 2018].
- Buddy. Fey, (1993). *Data power: Using Racecar Data Aquisition*. Memphis, Tenn.: Towery.
- Daniel. Salathiel, (2018) Driver comparison through data analysis
- Driver 61. (2018). *How to Drive the Perfect Racing Line - Fast Through Apex & Exit*. [online] Available at: <https://driver61.com/uni/racing-line/> [Accessed Nov. 2018].
- Frontier, S. (2018). *F3 Brands Hatch, 18-19 June | Jazeman*. [online] Jazeman.com. Available at: <http://www.jazeman.com/race/formula-3-18-19-june/> [Accessed Dec. 2018].
- HowStuffWorks. (2018). *How Engine Brakes Work*. [online] Available at: <https://auto.howstuffworks.com/auto-parts/brakes/brake-types/engine-brakes.htm> [Accessed Dec. 2018].
- Rfactor.net. (2018). *rFactor Simulations*. [online] Available at: <http://www.rfactor.net/> [Accessed Dec. 2018].
- store.steampowered.com. (2018). *rFactor on Steam*. [online] Available at: <https://store.steampowered.com/app/339790/rFactor/> [Accessed Dec. 2018].