

Race Engineering Assignment - Iwan Thomas

by Iwan Thomas

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Driver Comparison Through Data Analysis
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2.0 Introduction

A track test has been conducted through the use of the simulator to compare three driver's driving techniques and performance. The track test was conducted using an Aston Martin GT1 car on Brands Hatch GP circuit. The three drivers will be critically analysed through the use of Motec. One benchmark driver and two comparison sets of data will be analysed. The drivers we chose were Tim as the benchmark driver and Josh and Dan as the comparison drivers. Inputs such as Throttle Position, Brake Pedal Position and Gear Selection will be analysed to in relation to the response of the vehicle along with lap and sector times to demonstrate the consistency of the driver. A test plan will be devised to ensure seamless testing whilst switching between drivers and relaying information to them. Suggestions will be made to each driver during the test, based on the live data to improve their driving performance, in theory, improving lap and sector times. These suggestions will be documented within the report and discussed whether they improved the driver's lap times. Results of the three drivers will be displayed in graph form and the graphs will be critically analysed. Research will be conducted to support the stated analysis in this report.

3.0 Methodology

The task given was to have three drivers racing the Brands Hatch GP track in an Aston Martin GP2 car in an hour and a half slot. A driver had to be selected to set a benchmark time. Two other drivers would race the same track and the same car, competing to beat the benchmark time. Whilst the driver's in the sim, live data on the computers must be monitored and any irregularities or mistakes recorded. The first session was held on 1st November 2018 where a 20 minute session was allocated to each driver. The drivers drove the tack and had three minutes to exit the vehicle and allow the next driver to start their session. During that 20 minutes, four minutes were allocated for warm up and the number of laps completed after this was down to driving ability. After the first session, the data must be analysed to provide the drivers with improvements ready for the second session.

The second session was held a week later on the 8th November 2018. The same car, same track and same timings were used. Each driver set out on their warm up laps and when the timer begins, instructional improvements must be relayed to the driver. This must be done not to disturb the driver or cause the driver to crash. Short, precise and concise instructions must be given to each of the drivers. Whilst each driver is working on these improvements, the live data can be analysed to see if the improvements are working (or not).

After the completion of the second session, the results recorded must be analysed and compared. There are many, many channels that can be analysed so the most important should be prioritised and analysed in the assignment.

4.0 Results Gathered

4.1 Dan Salathiel

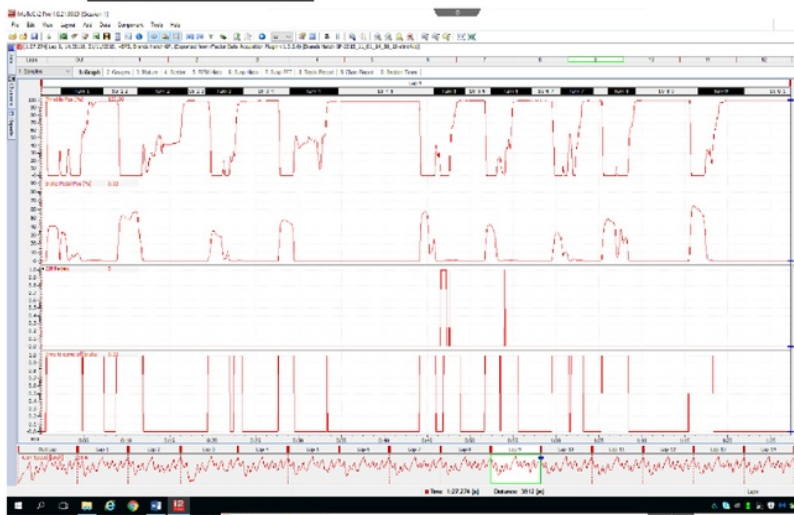


Figure 1: Brake application - Dan

Figure 2: Throttle application - Dan

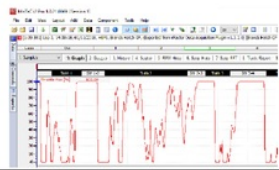
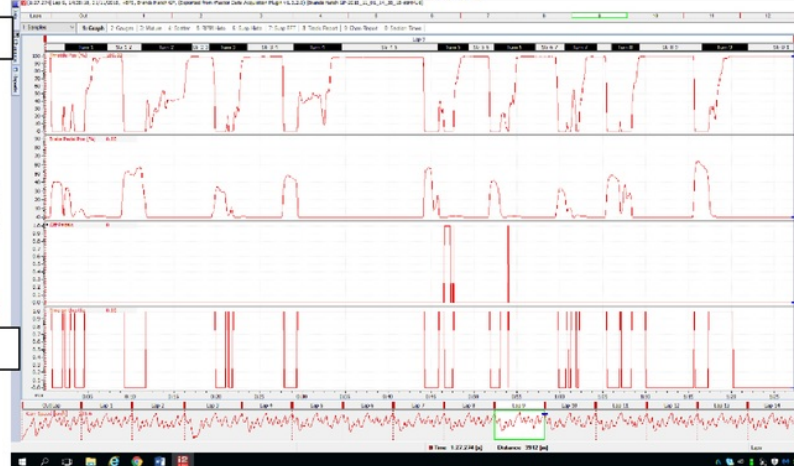


Figure 3: Throttle confidence - Dan



Dan spent 39 meters of his fastest lap off both pedals. “The movement from the throttle to brake pedal must be as fast as possible. Any time lost here isn’t huge, but it’s still time lost” (Driver61, n.d.). As seen in figure 1, Dan is only using 62% of the brake pressure causing him to brake for longer. The last graph in figure 1 shows the time he was on the brake for. The last graph in figure 2 shows the amount of time Dan is on the throttle in this lap. From looking at the graph, he isn’t very confident with his throttle application; a prime example of this is in figure 3. Dan also wasn’t merging the throttle and brake very well throughout his time on the track.



Figure 4: Yaw and steering angle - Dan



Figure 5: Corner speed oversteer - Dan

I have decided to use negative yaw rate to view this graph. As seen in area 1, Dan spun out on turn 2 due to oversteer, entering the corner too fast as seen in figure 5; enters at 127.4km/h as seen in area 3. Dan attempts to correct this by turning to no steering lock and then to full lock in the opposite direction, spinning out as a result. His steering over the course of turn 3 to turn 5 are near perfect; there's a possibility that more speed can be carried through these corners allowing Dan to set a quicker lap time. In area 2, Dan suffered from understeer. This was due to entering the corner too fast. Jamie green, a professional driver for Audi entered corner 5 at 105 km/h (Parries, n.d.) whereas Dan entered this corner at almost twice the speed, at 207 km/h.

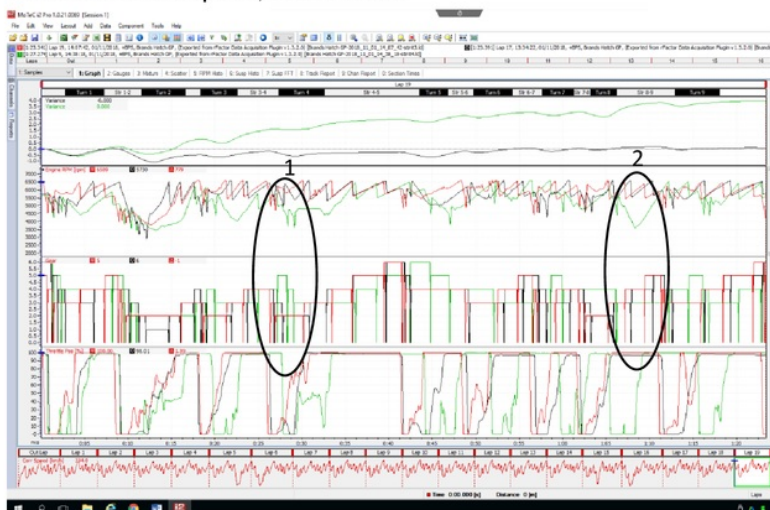


Figure 6: Corner speed understeer - Dan

Figure 7: Gearing - Dan



Figure 8: Gear changing - Dan

As seen in section 1, Dan's RPM bogged down as he needed to change gear; he was in gear 5 while the other drivers were in gear 2. "Gear changes should be evenly spaced through the braking zone and as always be as smooth as possible" (Driver61, n.d.) whereas he had quick changes. Dan would've been able to save time on this corner and turn at a faster speed if he'd chosen the correct gear.

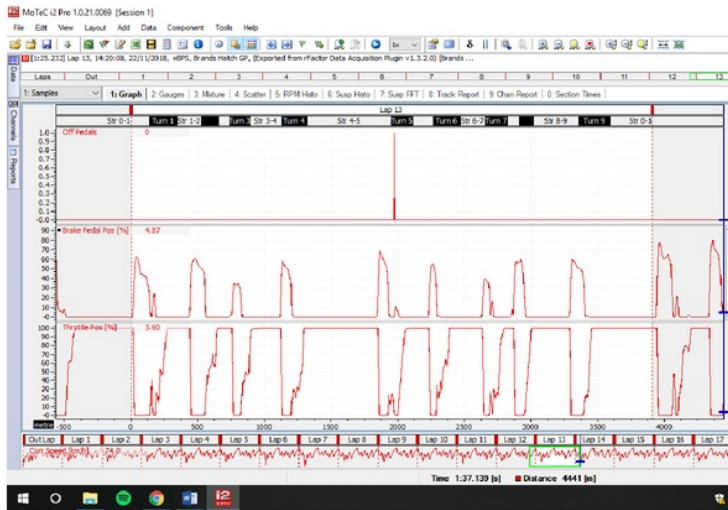


Figure 9: Braking after improvement - Dan

After improvements, Dan had 4 meters off both the pedals. This has saved him a time around the track. In the first session, Dan wasn't using the full potential of the brakes therefore one of the improvements was to stamp on the brake harder which has been understood as he now hit a maximum brake pressure of 78% instead of 62. This can be noticed as he's saved 2 seconds on his quickest lap. Dan still isn't as smooth as other drivers on the brake and accelerator, there's plenty of room for improvement

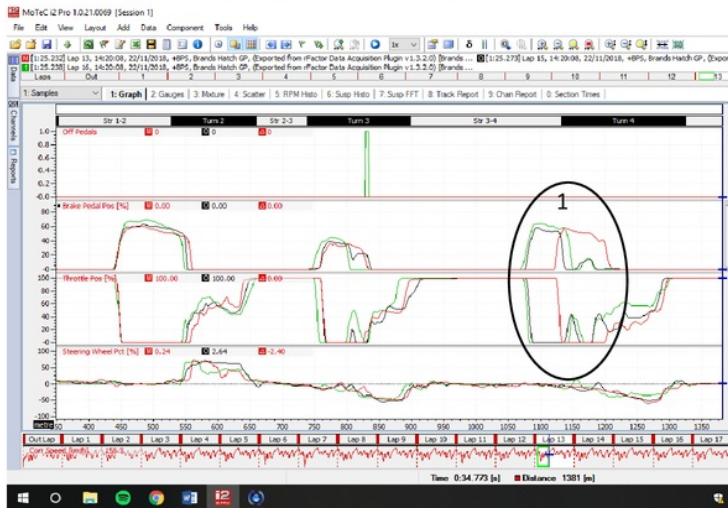


Figure 10: Turn 2 after improvement -

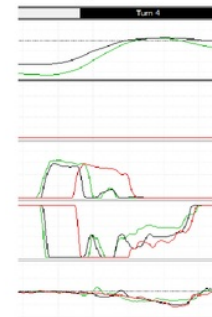


Figure 11: Losses due to late braking - Dan

The second improvement was to adjust the line for corner 2 as on the first session he kept spinning on this corner. As seen in figure 10, Dan didn't spin on this corner after the improvement was implemented. The three lines shown are three laps he completed. Even though Dan was the slowest driver, he is still a very consistent driver as seen in the three laps. In area 1, Dan braked very late for this corner causing a slight amount of time on the exit. Dan entered this corner too quick causing him to completely come off the throttle reducing his already quickest time. Dan lost a little time on his green lap due to coming off both pedals for 4 meters. It's very little but time could've been shed.



Figure 12: Brake lock-up
- Dan

Area 1, 2 and 3 demonstrate the main points where Dan's front right wheel has locked up on lap 3. The wheels locked up in area 1 due to a spin that occurred on turn 2 where he ended up rolling backwards. Area 2 lock up was due to Dan entering the corner at too much speed and had to slam on the brakes, locking up the inside wheel in order to bring him down to a suitable speed for this corner. And area 3 is likely to be due to a loss in concentration resulting in a loss of traction, applying the brakes too hard and locking up the inside wheel



Figure 13: Turn 7 and 8
- Dan

This graph displays three of Dan's quickest laps. As shown, Dan locks up on corner 7 and 8 all three times. Dan should change his line ever so slightly in order to turn the corner a little less sharply.

4.2 Josh Youngs

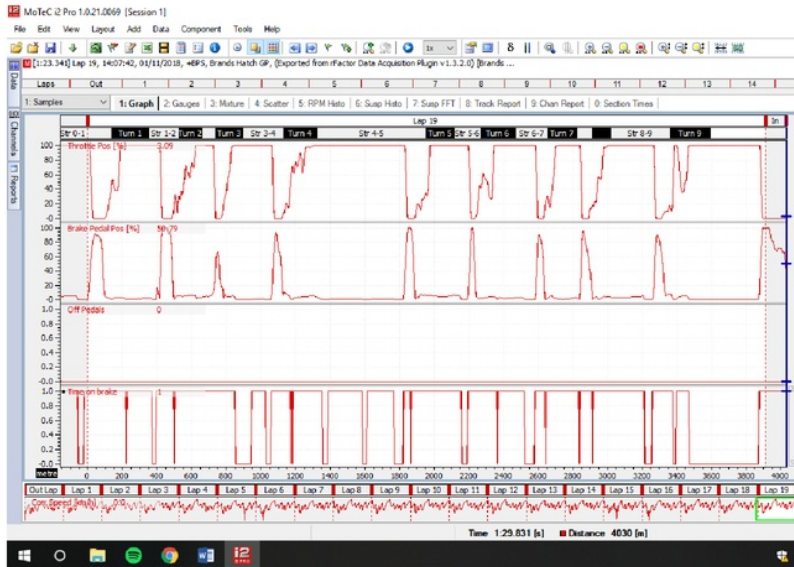


Figure 14: Brake application - Josh

Figure 15: Throttle application - Josh

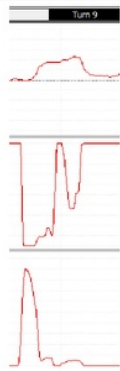


Figure 16: Steering correction - Josh

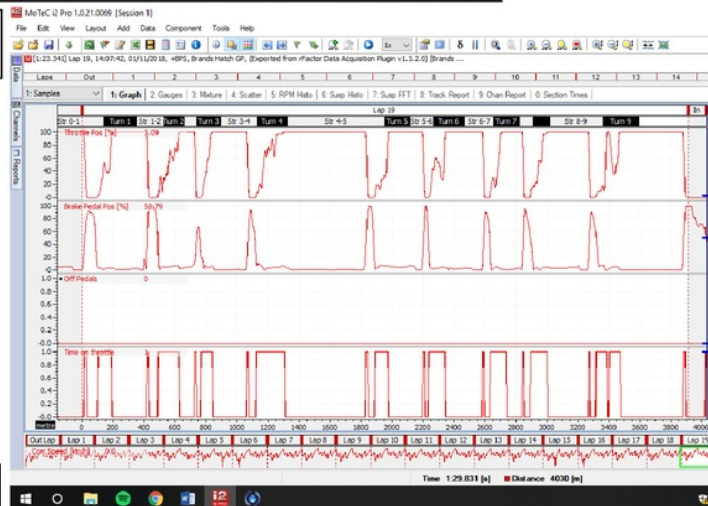


Figure 12, demonstrates Josh's brake application on his quickest lap. Josh ended up having no time off both pedals as he was resting his foot on the brake. Even though Josh was resting his foot on the brake, he ended up having the fastest lap time out of the three drivers. There is a possibility that time could be gained through keeping his foot off the brake pedal. Compared to Dan's throttle application, Josh is rather smooth with an exception for figure 14. Josh seems to lose concentration, losing traction half way through turn 9 causing him to come off the throttle slightly and adjust his steering whilst tapping the brake.

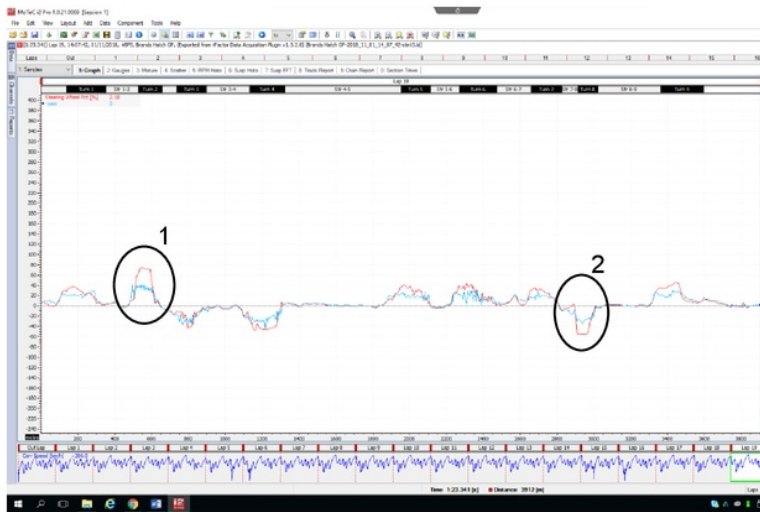


Figure 17: Yaw and steering angle - Josh

I have decided to use negative yaw rate again to view this graph. As seen in area 1, josh has completed a very smooth corner. This can be seen by a constant yaw and a smooth steering angle. Area 2 is the same, a relatively smooth corner. Josh's quickest lap was a very good lap in terms of steering. There is a possibility that he wasn't using the full potential of the car's grip around the track. Josh would have to enter these corners quicker to determine whether he's pushing the boundaries of the tyres grip.



Figure 18: Gearing - Josh

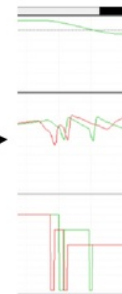


Figure 19: Gear selection - Josh

As seen in figure 17, Josh lost time to Tim due to the fact he changed down an extra gear 40 meters before Tim. Josh could've produced an even faster lap time if he'd stayed in fourth gear for a little longer. Due to Josh's quick gear change, his throttle application became unsettled. If he'd stayed in gear four, he would've produced a smoother curve, just like Tim's. Josh is using the full rev range of the car by changing gear at around 6500 RPM. This is making the most out of every gear the car has.

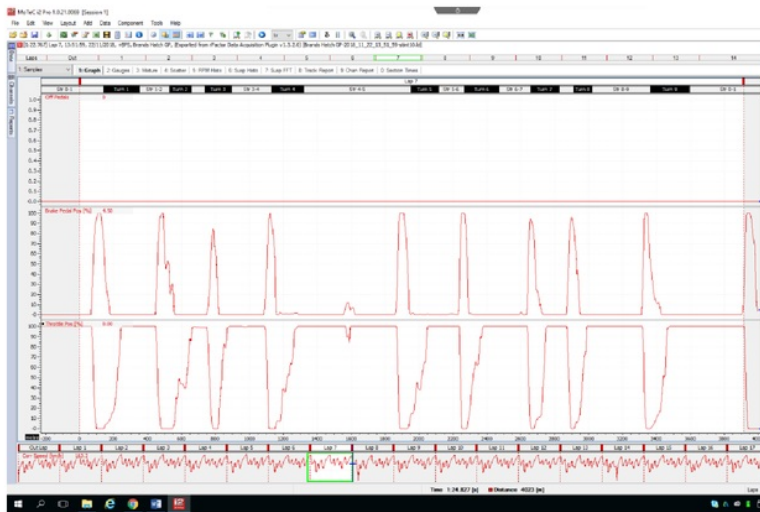


Figure 20: Braking after improvements - Josh

The main improvement told to Josh before entering the track was to stop resting his foot on the pedal. As seen in figure 18, Josh is no longer resting his foot on the brake and he's merging the throttle and brake extremely well. Even though Josh wasn't resting his foot, he still had zero meters off both pedals. Josh was still hitting 100% brake pressure for a very short amount of time, but this has clearly worked by looking at the lap times produced. Throughout the lap, Josh had very smooth throttle and brake application through acceleration and deceleration.

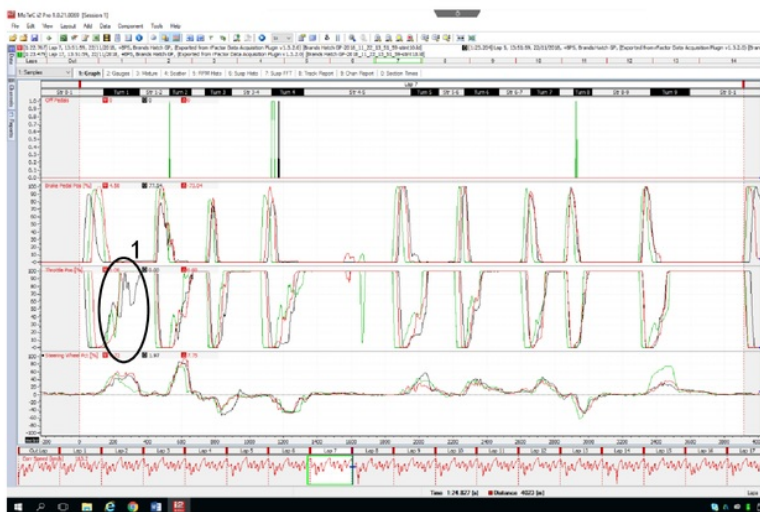


Figure 21: Throttle application after improvements - Josh

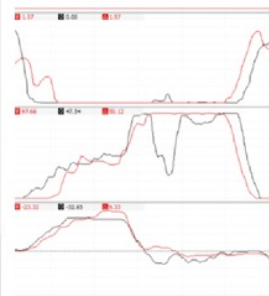


Figure 22: Throttle confidence- Josh

Figure 19 shows three of Josh's laps in session 2 of testing. As seen in area 1, Josh's throttle application wasn't as smooth as it could've been. The second improvement Josh was informed of was to become smoother on the throttle. As seen in figure 20, this is an example of where Josh wasn't smooth on the throttle and when he was told the improvement, how the throttle smoothness changed. The black line demonstrates the lap before improvements and the red line shows the throttle application after improvement. Through looking at the data, Josh was accelerating through the corners taking advantage of the maximum grip available. Josh is the only driver that did this.

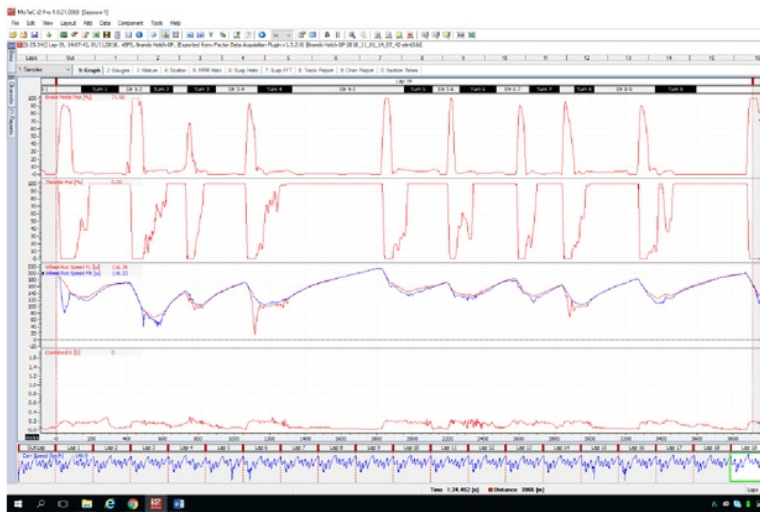


Figure 23: Brake lock-up - Josh

As seen in figure 23, Josh is locking up his wheels on the majority of corners, this is due to the 100% brake that he applies. The blue line demonstrates the front right wheel and the red line shows the lock-up of the front left. Braking at 100% has its advantages and disadvantages as demonstrated.

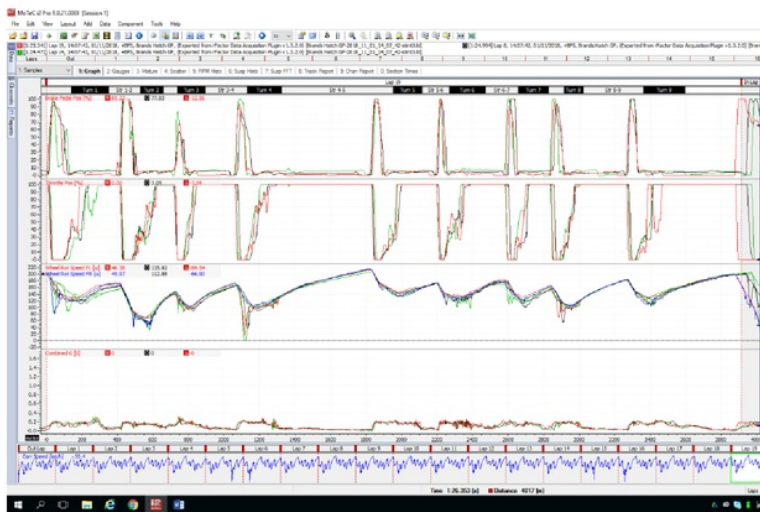


Figure 24: Braking fastest lap - Josh

The graphs above demonstrate three of Josh's fastest laps. Due to Josh's very hard braking, he locks up on the majority of corners. If he braked a little less aggressively, he would still achieve a very competitive time but would be locking up on every corner, increasing the risk of spinning out.

4.3 Tim Tudor

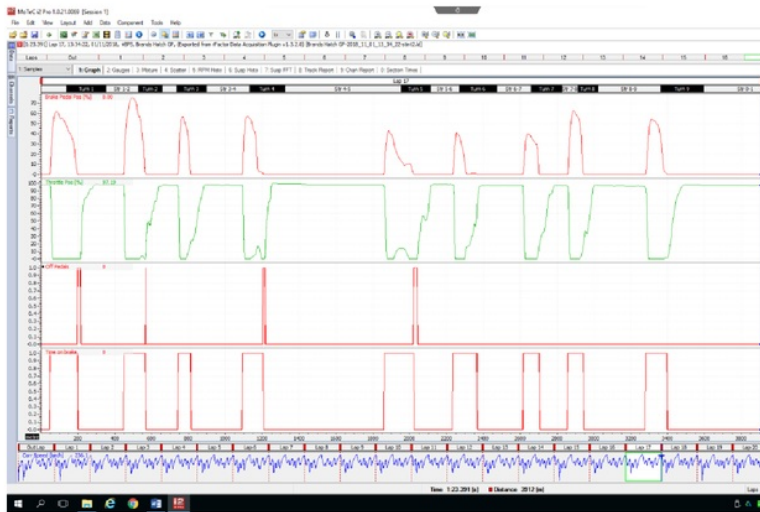
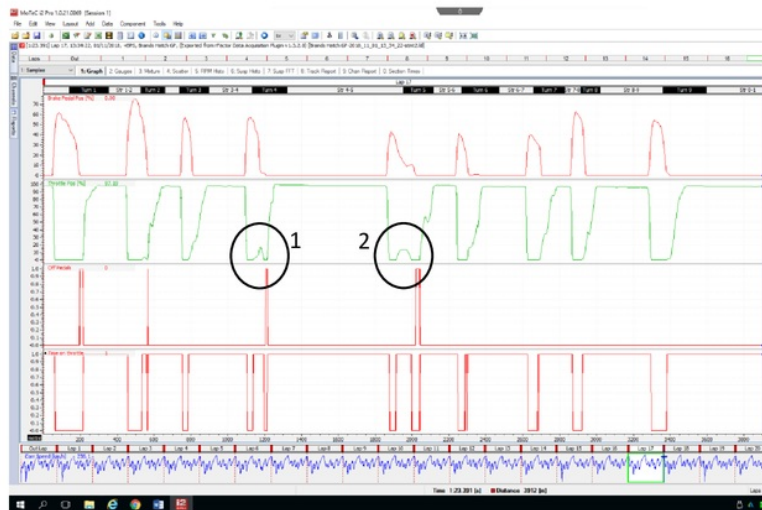


Figure 23: Brake application - Tim

Figure 24: Throttle application - Tim



As seen in figure 21, Tim has a very smooth throttle and brake application but spent 31 meters of the track off both the throttle and the brake. Tim tends to be off both pedals in the corners therefore meaning he's carrying too much speed into these corners. As seen in area 1 and 2 Tim had to use the throttle again as he braked too soon causing him to slow down too much before the corner. Through analysing the data Tim's lap isn't the quickest but it's definitely the smoothest driving out of the three drivers. Tim blends the throttle and accelerator very well on his quickest lap. "You must reduce brake pressure as you steer, and eventually come off them at the point at which 100% of available lateral grip is being exploited" (Williams, 2016).

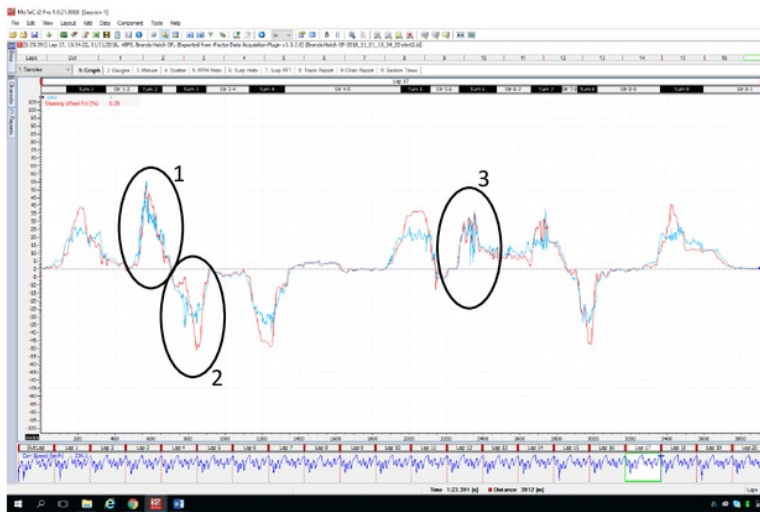


Figure 25: Yaw and steering angle - Tim

As seen in the graph above, this is Tim's steering angle plotted with yaw rate. Area 1 demonstrates a relatively smooth corner, using all the grip possible. In area 2, Tim hit peak yaw at the beginning of the corner; this is due to Tim sliding slightly. As seen just after peak yaw, he corrects his steering bringing the car back under control. The rest of the lap is smooth until area 3 where Tim's steering is rather erratic. This is due to almost losing control of the car; he saves it before spinning. Overall Tim is a very smooth driver, this is due to being a driver for a race team therefore having a lot more experience than Dan and Josh.



Figure 26: Gearing - Tim

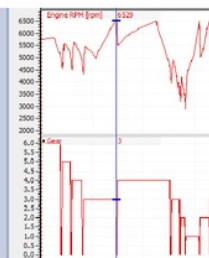


Figure 27: Gear changing - Tim

As seen in the graph above, Tim is using the full potential of the rev range. As seen in figure 24, Tim's gear changes are very similar to Josh's, changing at 6500 rpm, compared to Dan changing gear at 5800 RPM. Tim is a very quick and consistent driver with the majority of his laps less than a second slower than his quickest.

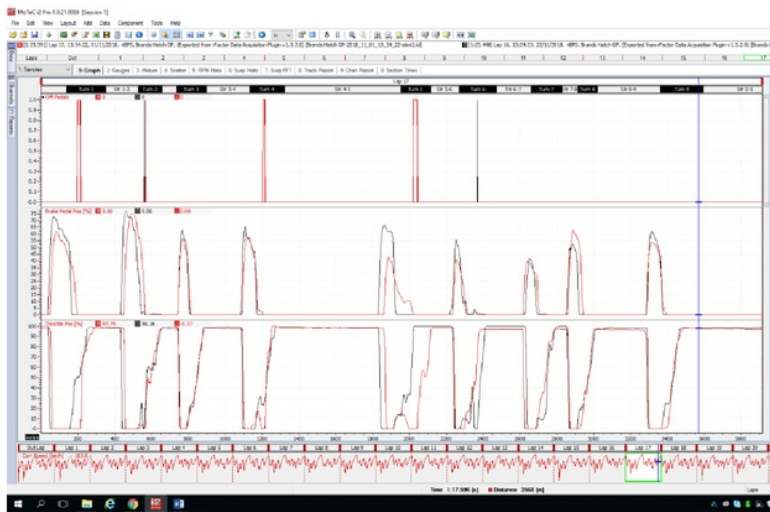


Figure 28: Throttle sooner improvement - Tim

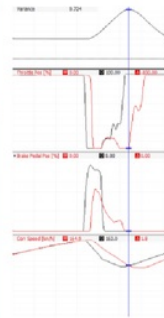


Figure 29: Consequence of improvement - Tim

The first improvement we told Tim to do was come on the throttle quicker out of turn 5. As you can see, the red line is session 1 and the black line is session 2 and he came on the throttle sooner. After analysing the data, it has been discovered that this improvement hasn't improved Tim's lap time; he's got slower, losing 0.7 seconds on this one corner alone. Tim did exactly as the improvement stated as seen in figure 27, but to get on the throttle sooner, he had to brake sooner too, causing him to enter the corner at a slower speed and possibly entering on the wrong line. Figure 28 demonstrates the correct racing line.

Figure 30: Racing line

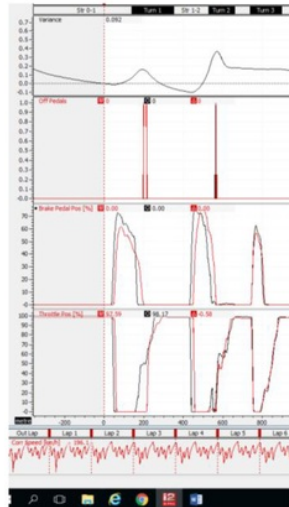
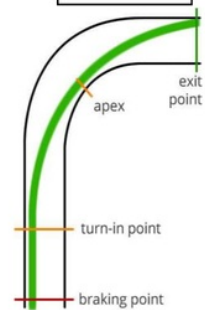


Figure 31: Brake sooner improvement - Tim

The second improvement Tim got advised was to get on brake earlier and harder entering turn 1 to set up a better line going into turn 2, getting on the throttle as soon as possible down the straight. As seen in the variance section of figure 29, he completed this improvement and gained time on the straight between turn 1 and 2



Figure 31: Brake lock-up
- Tim

Again, Tim is a very consistent, smooth driver. He doesn't lock up as hard as Josh and doesn't lock up as much as Dan does. This goes to show how a professional driver compares to Dan who has never been in the sim and Josh who has used it but not raced as much as Tim. Figure 31 shows that Tim mainly locks up his front right wheel. The high spikes in Combined G, as seen circled are where Tim has hit the apex curb bouncing the wheel upwards.

5.0 Conclusion

Reflecting back on session one, it could've run a lot smoother. The session went slightly over the hour and a half allocated but as a group, it was ensured that this did not happen in the second session. A Gantt chart was created with 25 minutes of driving but only one minute was allocated for the drivers to exit the vehicle and the next driver to get set up which was later realised this wasn't enough therefore increasing the change over time to three minutes and decreasing the driving time to 20 minutes. Other than the timing, it's believed that the first session ran smoothly and all the data required was gathered. Whilst analysing the results, it would've been ideal if a slightly longer track would've been used. This is due to then having less laps but more data for each lap. On the track selected, there were only 9 corners to analyse the results from.

The second session was completed within the allocated time slot with time to spare and there were no complications during testing. All the data was collected and collated successfully and distributed throughout the members in the group.

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