

Assignment 1

by Oliver Beck

FILE	3954_OLIVER_BECK_ASSIGNMENT_1_138915_1771978022.DOCX		
TIME SUBMITTED	16-DEC-2018 11:20PM (UTC+0000)	WORD COUNT	3895
SUBMISSION ID	97543577	CHARACTER COUNT	17548



Prifysgol Cymru

Y Drindod Dewi Sant

University of Wales

Trinity Saint David

University of Wales Trinity Saint

David

School of engineering

Motorsport Engineering

Race Engineering

Oliver Beck

P149901

Contents Page

1-Introduction

2-Test Session

2.1-Test Plan

2.2- Test Track and Simulator

3- Test Session 1

3.1-DS Analysis

3.2-TT Analysis

3.3-JY Analysis

3.4-Test Plan Assessment

4- Test Session 2

4.1-Driver Instructions

4.2-Session 2

4.3-DS Session 2 Analysis

4.4-TT Session 2 Analysis

4.5-JY Session 2 Analysis

4.6-Test Plan Assessment

5-Conclusion

List of Figures

Figure 1-Brans Hatch Layout

Figure 2-Driver Times

Figure 3-Brake Histogram

Figure 4-DS Steering Pct

Figure 5-DS G force Lat and Steering Pct

Figure 6-DS throttle Position

Figure 7-TT G force Lat and Steering Pct

Figure 8-TT Brake and Steering

Figure 9-TT Throttle Position

Figure 10-Lap Comparison

Figure 11-JY Overall

Figure 12- JY Brake Position

Figure 13-JY Lap Comparison

Figure 14-Session 2 Times

Figure 15-DS Brake Comparison

Figure 16-DS Session Comparison

Figure 17-TT Session Comparison

Figure 18-JY Session Comparison

1-Introduction

A driver's ability to maximise the performance of his car will rely on controlling his inputs, this is because each driver input will then have an effect on the cars output in terms of cornering forces, speed, breaking forces as well as other outputs. Throughout this report 3 different drivers will undergo a test plan on the simulator with all 3 drivers given the same plan, car and track. Each driver's data will then be analysed against one and others looking at where each driver can improve compared to the others using the Motec software, driver techniques such as throttle application, steering technique, braking technique and gear selection will all be analysed. The drivers will then be given feedback and placed back onto the simulator to see if the advice works and improves the drivers time.

2-Test Session 1

The test session will need to give adequate time for all three drivers to get a good amount of time on track to get used to the car and the track. The three different drivers that will be used range in various different levels of experience with driver 1 being Tim Tudor (TT) having experience in the sim used as well as real racing experience on track. Josh Youngs (JY) is driver 2 and has previously used the simulator that is being used in the test but has not used it in a year. Daniel Salatheil (DS) is driver 3, he has little race experience with the only racing done on a low-quality sim.

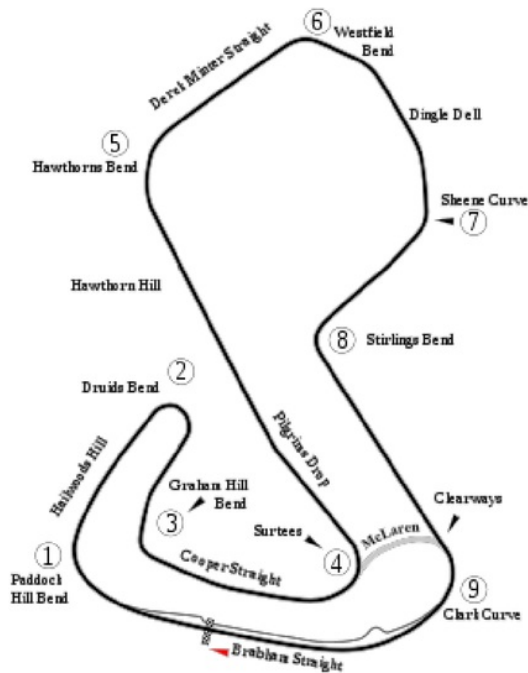
2.1-Test Plan

The test session will take an hour and a half as this is the only time possible for the sim. Each driver will be given a 25-minute spell in the simulator with the first 3 laps being given as warm up laps to allow the drivers to get used to the car and the track. All three drivers will be under the same circumstances as one and other as the car set up will be the same, this could have massive differences as a car set up can massively affect driver times. Other variables that have been controlled include the temperature in the room as this is the same for all three drivers as well as the light being the same, both of these factors can affect a drivers' concentration.

2.2-Test Track and Simulator

The track that will be used in the test is Brands Hatch and has been selected as it has a range of different straights and corners as shown in figure 1 below.

Figure 1



3-Test Session 1

The first driver selected was TT as he has had experience in the sim and on track so gave the less experienced drivers an opportunity to watch TT drive and get further knowledge of the track. During his stint TT completed 21 laps with his fastest being a 1:23:391. The next driver to go was JY this was again due to having a higher level of experience than DS in his time he completed 20 laps and had a time of 1:23:341 and the last driver to go was DS who completed 15 laps with his fastest being a 1:27:274. Below Figure 2 shows the full lap times and laps completed.

Figure 2

Driver	TT	JY	DS
Lap 1 (Out)	1:50:757	1:38:994	1:43:093
Lap 2	1:34:363	1:28:166	1:28:165
Lap 3	1:26:576	1:26:670	1:32:154
Lap 4	1:26:202	1:27:564	1:39:591
Lap 5	1:26:160	1:28:810	1:27:718
Lap 6	1:25:050	1:38:619	1:28:472
Lap 7	1:26:665	1:37:702	1:27:670
Lap 8	1:24:303	1:26:435	1:29:187
Lap 9	1:25:394	1:24:994	1:27:375
Lap 10	1:24:271	1:26:371	1:27:274
Lap 11	1:24:265	1:24:516	1:29:052
Lap 12	1:23:732	1:25:115	1:29:615
Lap 13	1:23:740	1:24:514	1:27:706
Lap 14	1:25:157	1:24:938	1:27:686
Lap 15	1:24:179	1:24:472	1:27:497
Lap 16	1:30:419	1:32:193	
Lap 17	1:23:981	1:36:193	
Lap 18	1:23:391	1:24:708	
Lap 19	1:24:183	1:25:933	
Lap 20	1:32:267	1:23:341	
Lap 21	1:24:257		

JY became the benchmark for the three drivers after achieving the fastest lap out of the three drivers, all three drivers have very different techniques in the way they approach the corners and straights with various different degrees of success. Figure 2 shows the lap times.

From these lap times shown in figure 2, it shows that TT is very consistent by having 8 laps within a second of his fastest lap this is a good quality in a driver as when on circuit driving this is needed because a poor lap can lose track position. TT has errors on lap 16 and 20 as these are 7 seconds slower than the others.

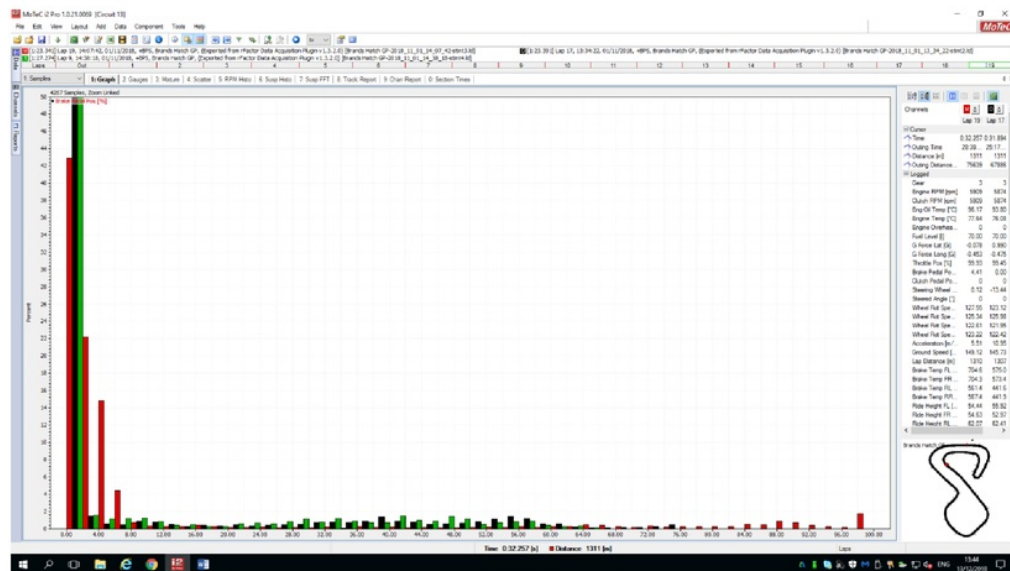
JY is very inconsistent and there is a big spread between each lap and doesn't have another lap within a second of his quickest lap, this shows that Josh is not racing to his potential as he is capable of the fastest lap of 1:23:341 but only delivering this once shows massive inconsistency. JY has errors on Lap 6 and 7

DS is the slowest driver out of the 3 drivers but does show consistency by having 6 laps within a second of his quickest lap, this will mean by eliminating a few errors could massively improve his times.

3.1-DS Analysis

In the driving of DS there are many weaknesses in comparison compared to the other two drivers. One distant difference is the braking used by the drivers, DS only uses a maximum brake pressure of 64.7% as shown in figure 3(Green line DS). This then translates to losing times in many corners including corner 3,4,5,6 and 7. A driver's ability to only use part of the brake may be down to not being able to reach the pedals fully, A driver should use the balls of his feet for the brake pedal as this is the strongest part of the foot as well as the most sensitive (Bentley, 1998). By only using a part of the brake will mean that the full force of the brake will not being applied meaning that the driver will have to stay on the brake longer to slow the car down to the speed needed to take the corner, this could result in breaking whilst in the corner meaning instability which results in vehicle instability (Racer, Rapid, 2016). A driver should aim to get on the brake with maximum pressure to use the maximum potential of break available to maintain straight-line speed for as long as possible (Fey, 1993)

Figure 3



DS steering has room for improvement as he tends to steer too hard into corners, this is shown in corner 1,3 and 5 as shown in figure 4 it can be seen that he steers much harder and then releases earlier than the other two drivers. DS often has to correct his steering every time this happens it will mean that the vehicle is becoming unstable (Racer, Rapid, 2016), a driver should have smooth steering as this will create stability in the vehicle meaning that the tyres will be in contact with the road for as long as possible allowing for more grip, it can be shown in figure 4 that DS does not reach the lateral G that either TT or JY does. DS oversteers in a series of different corners as shown in figure 5 it shows a sudden spike in a loss of grip as shown by losing lateral G (Law, 2000) this is also clear to see as is also accompanied by a Steering correction. Oversteer is when there is a loss of grip in the rear of the car, causing the front of the car to start to overtake to front of the car.

Figure 4

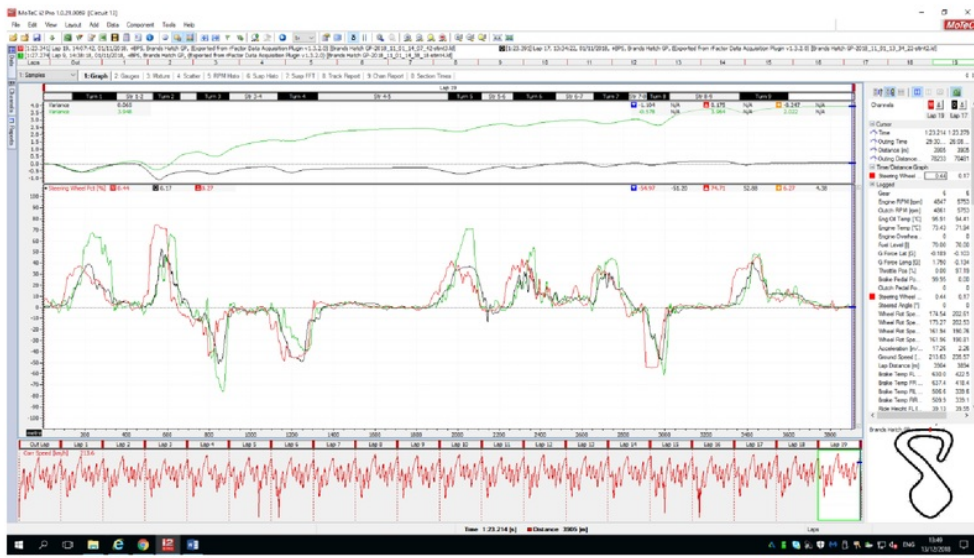
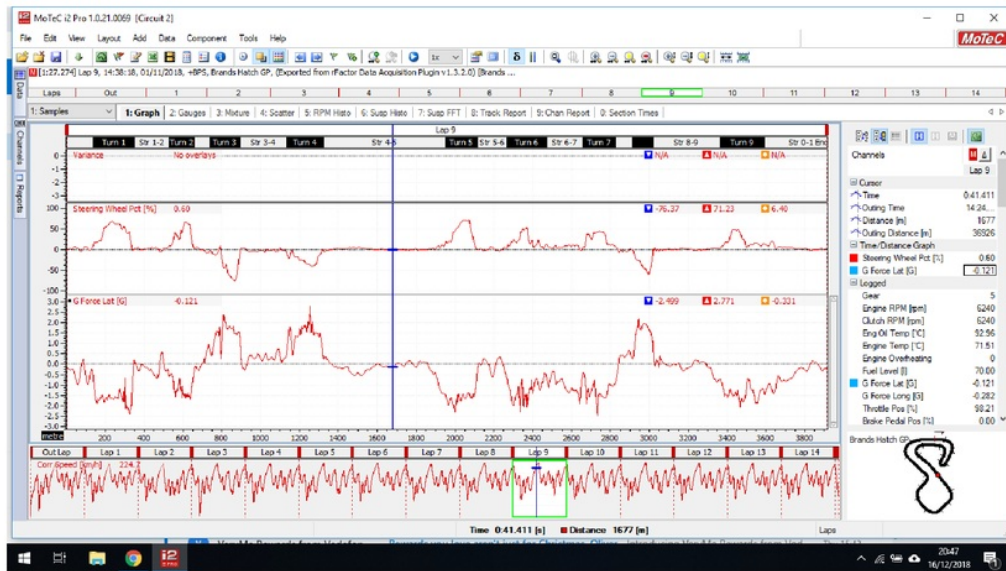
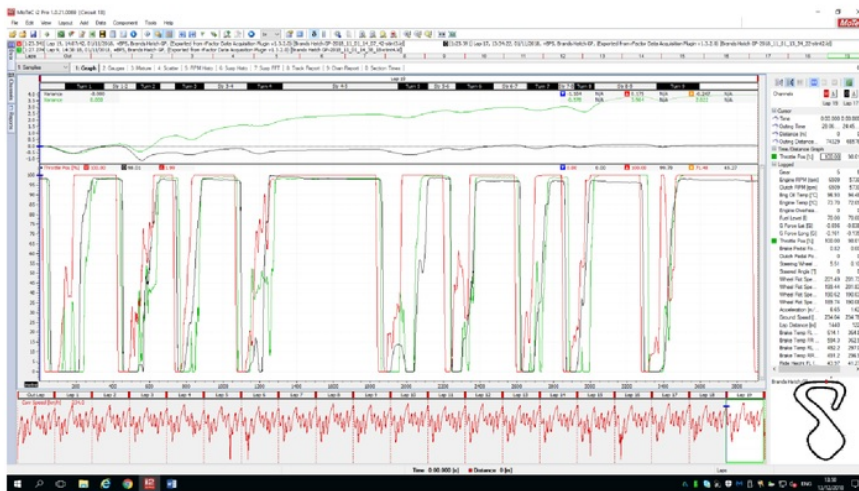


Figure 5



In corner 3 it is evident that DS is slow to get back onto the throttle whilst on the exit, it can be shown in figure 6 as he is very hesitant to get on the throttle it is time being lost, this will mean that accelerating is occurring slowly meaning time is lost over the other drivers at this point.

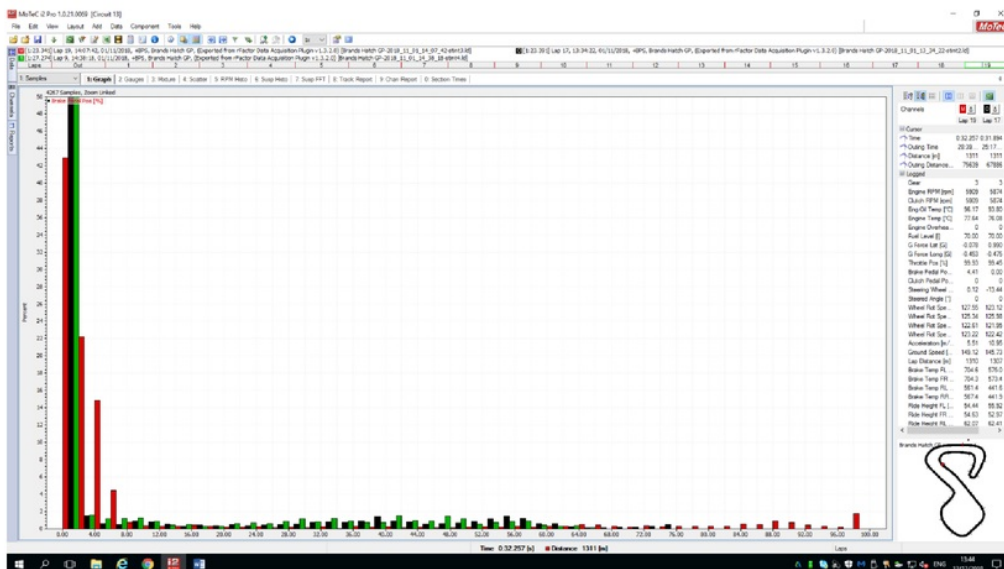
Figure 6



3.2-TT Analysis

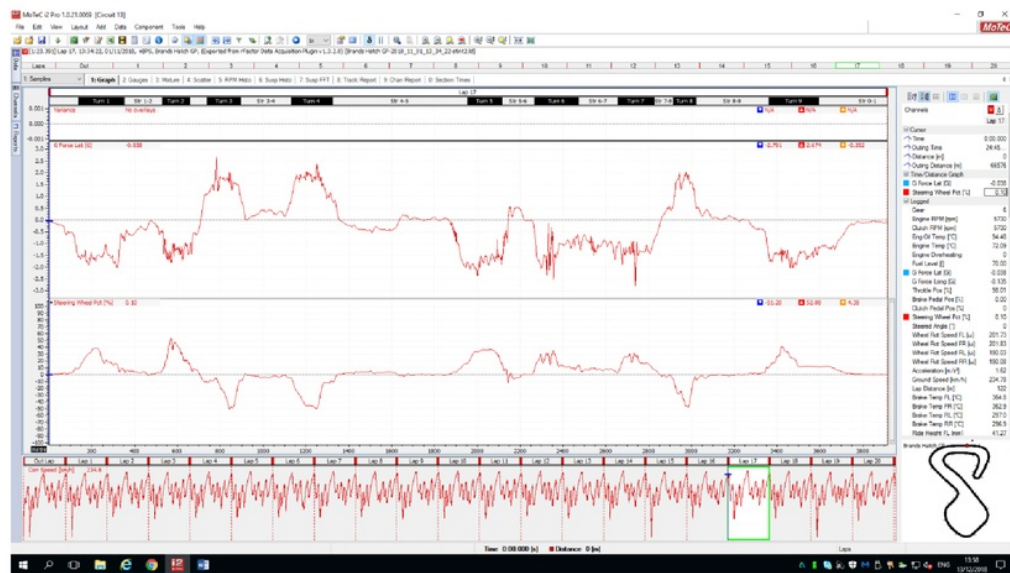
TT does not have any clear mistakes in his driving like DS but it is clear that he can improve in certain areas, this is clear to see as he is slower than JY as an overall as well as throwing away a 1.117 second lead over JY on their best laps compared. Although TT has better brake pressure than DS figure 3 shows that he is not at 100% this will then mean time is lost as the same reasons as said with DS in section 3.1.

Figure 3



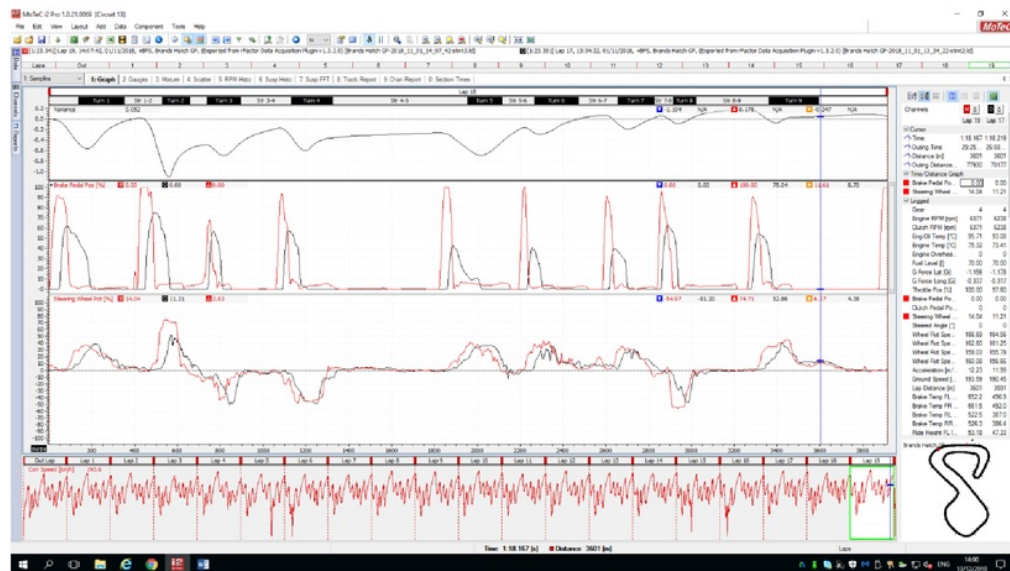
TT shows oversteer occurring during his exit of turn 7 as shown in figure 7 it shows a sudden spike in a loss of grip as shown by losing lateral G (Law, 2000) this is also clear to see as is also accompanied by a Steering correction. Oversteer is when there is a loss of grip in the rear of the car, causing the front of the car to start to overtake to front of the car. To correct this TT could correct this by reducing the entry speed into the corner and applying the brakes earlier before the corner.

Figure 7



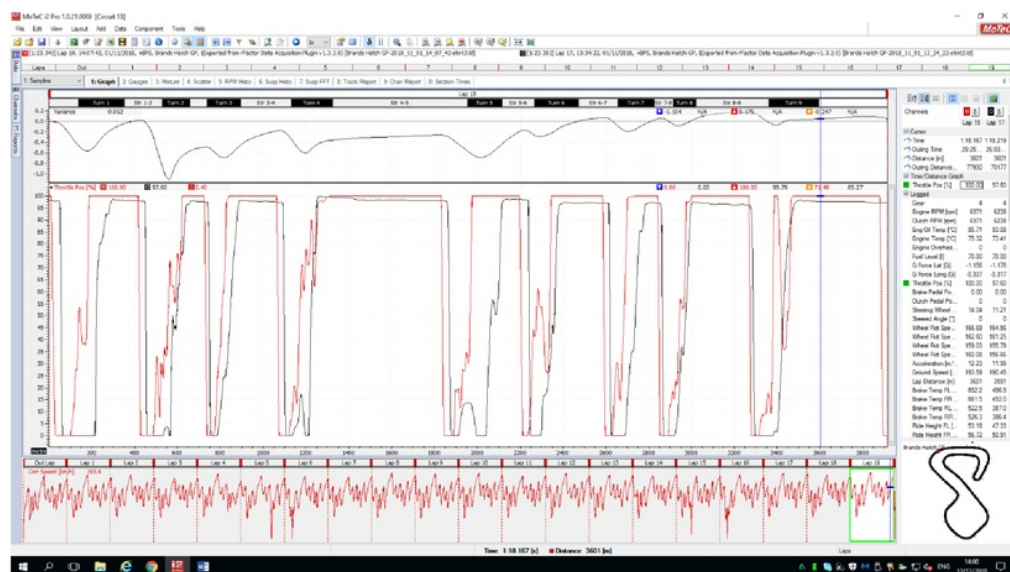
Whilst going into turn 3 TT brakes slightly later than JY causing too much speed to be carried into the corner meaning that he loses grip as shown in figure8 Breaking earlier will then allow for earlier turning which as shown by JY in figure 8 gives an advantage as it will then allow the driver to get on the throttle quicker this will then mean that speed starts to build quicker for the straight that's approaching (Velenis, 2008).

Figure 8



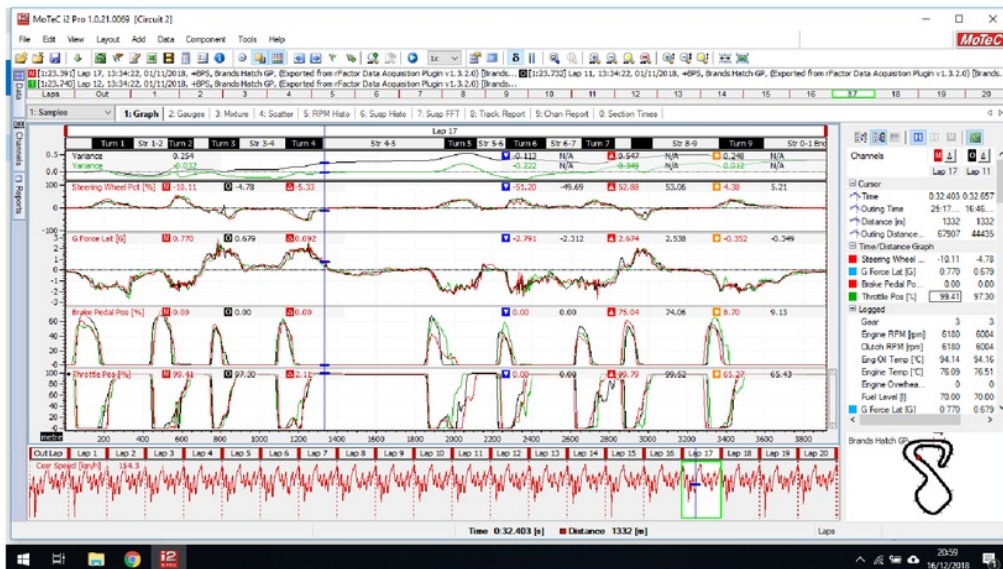
An area where TT lost time was in turn 5 as he was slow to get on the throttle as hesitation is shown this can be seen in figure 9 its clear to see that JY gets on the throttle quicker, whilst TT also has a correction in his throttle meaning that he comes off and goes back on this will cause a loss in time as the car is no longer accelerating (Motec, 2011).

Figure 9



TT shows very consistent lap times and below in figure 10 is a graph showing his 3 fastest laps overlaid on one and other it shows the small differences that he makes to go faster in lap 18. During lap 13 TT is actually faster until straight 4-5 this is because during turn 1 and 2 he is slightly quicker to get onto the brakes as well as getting onto the throttle (Velenis, 2008), this advantage is then lost by poor throttle application. Breaking harder on turn 6 has a poor throttle application as it is applied too early meaning that he pulls off and on a few times.

Figure 10

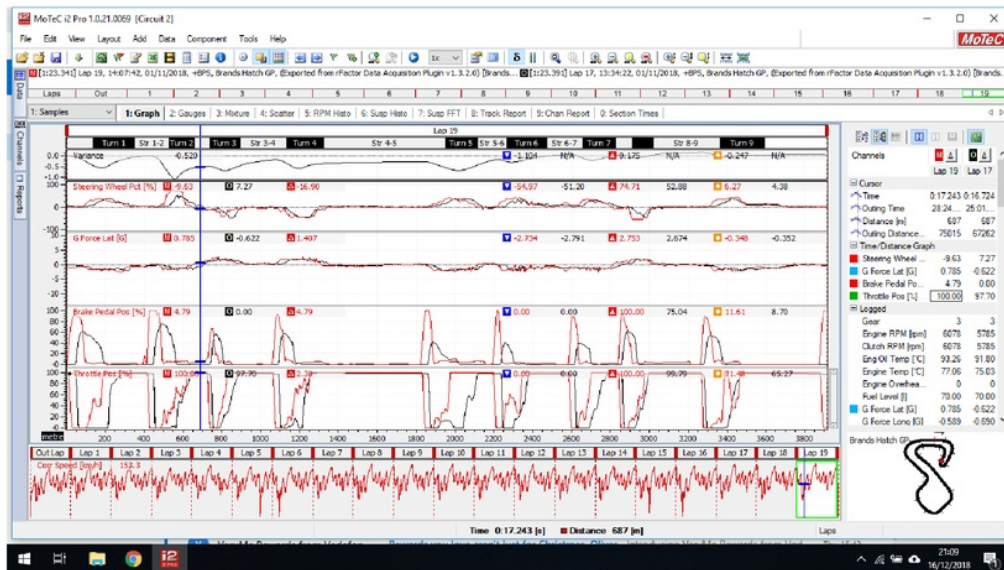


3.3-JY Analysis

JY sets the fastest lap during session 1 but still has flaws in his driving as at one point in the lap he is 1.117 seconds behind TT which would be hard to make up for during a real race because of being able to overtake a car is harder than going faster as it may cause a change of line. Throughout his lap JY doesn't show any signs of oversteer.

JY losses lots of time over TT in turn 2 as he takes a very hard line into the corner this causes the car to become unsettled causing oversteering as shown in figure 11. TT brakes later and softer with a smoother line this causes a 0.5 second advantage throughout the corner (Law, 2000).

Figure 11



JY spends the least amount of time at 0% brake pressure this is shown in figure 3, this will mean that there must be an error in his driving as he must be resting his foot on the brake pedal and this can be shown in figure 12 as these are positions where brake is not needed yet still applied.

Figure 3

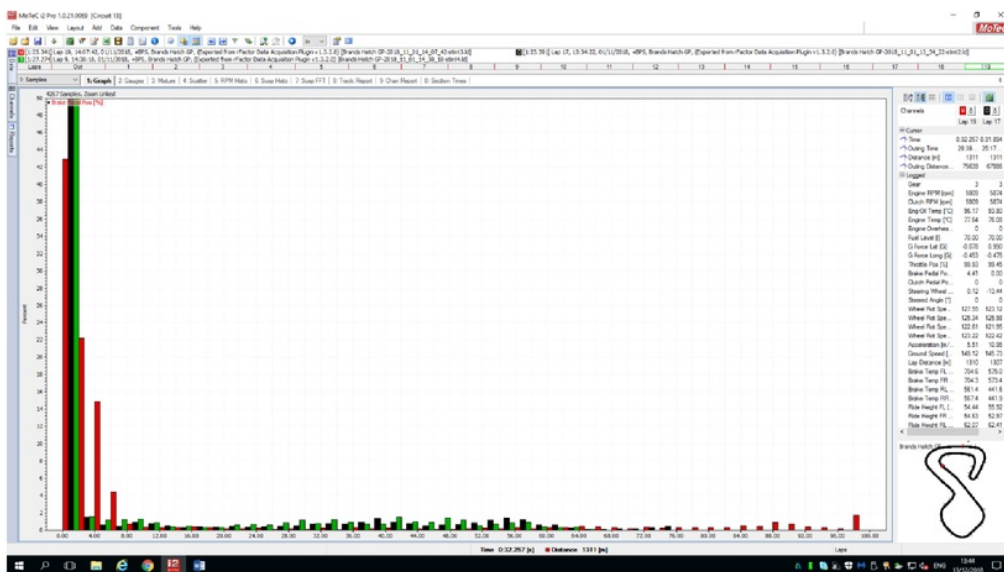
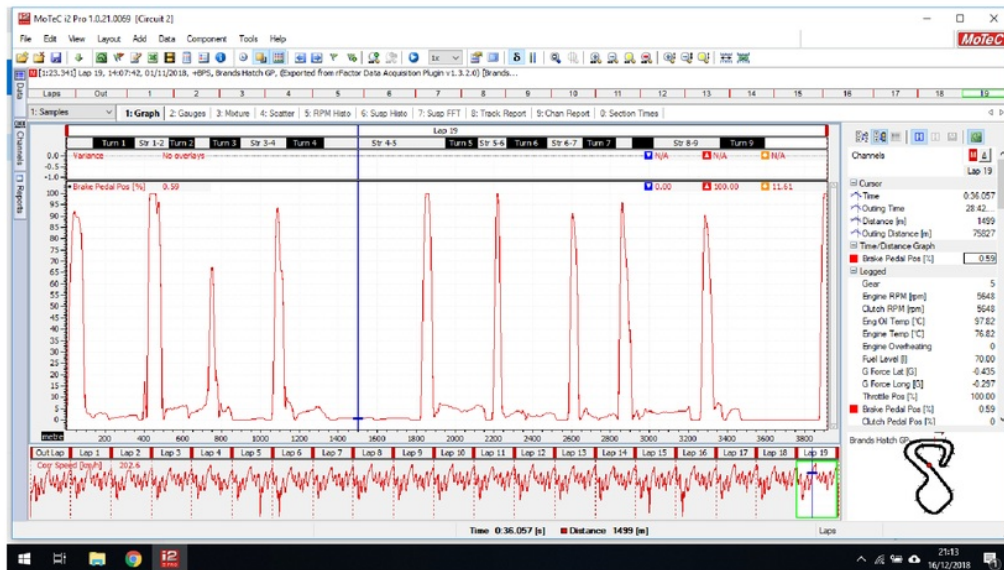
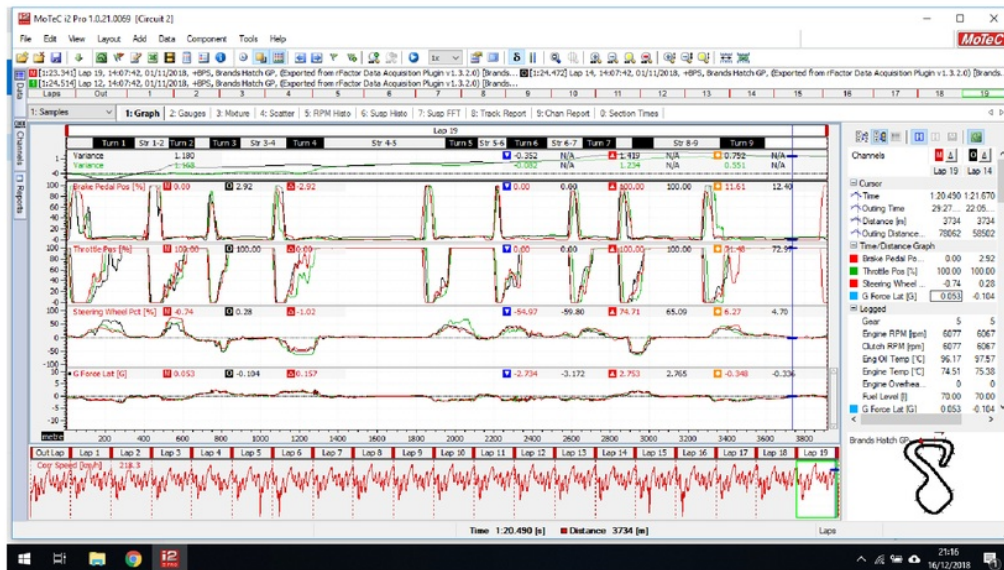


Figure 12



JY has a significantly faster lap than the rest of his laps so the key to improving him would be to add consistency, this will be done by looking at what he did differently on his fastest lap and why he is faster. Below figure 13 overlays his fastest 3 laps and there are some clear differences in both throttle application, brake pressure and steering. His line into Turn 1 is similar in 2 of his 3 fastest laps but on one steers harder into the corner this then creates a lack of grip meaning that a brake adjustment is needed as shown on the black line this creates a lack of speed and a poor line going into turn 2 which then creates a loss of 0.6 second loss once the corner is complete. During turn 5 on his fastest lap all 3 lines are similar but makes time up because he gets on the brake quicker meaning he is able to get on the throttle earlier and has a smooth throttle application where on the other 2 laps he is hesitant making adjustments. During turn 6 and 7 breaking points are similar as well as pressures with the lines into the corner also being similar he is just more confident with the throttle and sticks on it more confidently, using more available grip.

Figure 13



3.4-Test Session 1 Analysis

Although the test allowed all 3 drivers to have time in the simulator because of the time wasted changing drivers and setting up the simulator, it gave DS a disadvantage as he didn't get as many laps in. Both TT and JY hit there fastest laps towards the end of their stints this would suggest that given the time DS would be able to do the same, because if all session ended at lap 15 as DS session did then JY best time would be 1:24:472 and TT being 1:23:732.

4-Test Session 2

For session 2 there was some changes that needed to take place as errors occurred during the first session, reducing the amount of time in the car for each driver to ensure that they all get equal time in the car, this will mean that each driver will get 2 warm up laps and then 20-minute driving time. This will eliminate the bias of certain drivers getting more time than others. Although there is a small bias in session 2 as both DS and JY had access to the data between session 1 and 2 so were capable of seeing where they went wrong. The second session were under the same circumstances as the first with the same car and track being used.

4.1-Driver Instructions

The drivers will be given different types of instructions, this will be overall driver improvements and corner instructions. Driver instructions will also be given at different points in the session, this is because overloading a driver with instructions will cause a distraction as they will have too much to think about often causing the driver to struggle with the other parts of his lap.

TT instructions

Initial instructions

Brake harder to reach 100% brake pressure

During session instructions

-Apply the throttle harder on the exit of turn 5

-Brake earlier into turn 3

JY instructions

Initial instruction

-Make sure that foot is not resting on the brake pedal, this will be monitored by during the test and instructed if he is still doing so.

During session instructions

- Smoother throttle application.

DS instructions

Initial instructions

-Make sure to hit the brakes harder and reach 100% brake pressure

-Be gentler on the steering and make it smoother into the corners

During session instructions

-Adjust line for turn 2

-Turn 3- Adjust line, brake harder

-Throttle sooner on straights- wait for less steering %

4.2-Test session 2

Figure 14

Driver	TT	JY	DS
Lap 1 (Out)	1:34:561	1:35:150	1:39:460
Lap 2	1:34:913	1:26:294	1:28:930
Lap 3	1:24:017	1:24:344	1:26:673
Lap 4	1:23:704	1:23:376	1:27:151
Lap 5	1:24:267	1:25:559	1:27:382
Lap 6	1:23:764	1:23:204	1:26:660
Lap 7	1:23:614	1:23:946	1:27:273
Lap 8	1:24:030	1:22:767	1:34:333
Lap 9	1:24:469	1:29:701	1:27:070
Lap 10	1:23:939	1:24:066	1:25:940
Lap 11	1:23:502	1:22:875	1:27:592
Lap 12	1:23:538	1:23:218	1:28:411
Lap 13	1:24:259	1:23:992	1:26:226
Lap 14	1:31:945	1:25:791	1:25:232
Lap 15	1:25:396	2:05:179	1:26:965
Lap 16	1:23:521	1:24:602	1:25:273
Lap 17	1:23:448	1:24:713	1:25:238
Lap 18		1:23:479	1:26:396

During session 2 the drivers were still ranked as JY being the quickest with an improvement time of 1:22:767. TT was the second fastest driver with a time of 1:23:448 which was actually slower than the first session. DS was slowest but had an improved time from the first session with a time of 1:25:232.

TT shows great consistency throughout his session with the only laps on his stint that aren't within a second of his quickest being his warm up laps whilst he has an increase of 8 second in a lap indicating an error.

JY shows much greater consistency in session 2 compared to session 1 by having 6 laps within a second of his fastest lap. On lap 15 he has a 35 second increase that will indicate a spin or major error.

DS has a drop-in consistency by only having 3 laps within a second of his fastest lap, he has a far slower lap in lap 8 which will indicate a spin or error.

4.3-DS Session 2 Analysis

DS improves massively during session 2 this is bettering his fastest lap by 2 seconds, this is down to multiple different changes that he makes to his driving throughout session 2. Figure 15 shows that as an average DS has a harder braking pressure but is still not capable of hitting 100%, his increased braking sees advantages in corner 2,3 and 8 as he then can get onto throttle quicker. Turn 4 DS gets on the brakes later and harder producing an advantage over his previous fastest lap, on DS first session best he over steers in corner 4 as shown in figure 16 but this is corrected in session 2 providing a 0.5 seconds loss. During his turn 7 in session 2 DS over steers, this is shown by a spike in the lateral G but is quickly corrected by applying the brakes and a small steering correction. During turn 8 DS gets on the brakes harder into turn 8 but unlike session 1 he stays on them meaning he is able to get on the throttle much quicker.

Figure 15

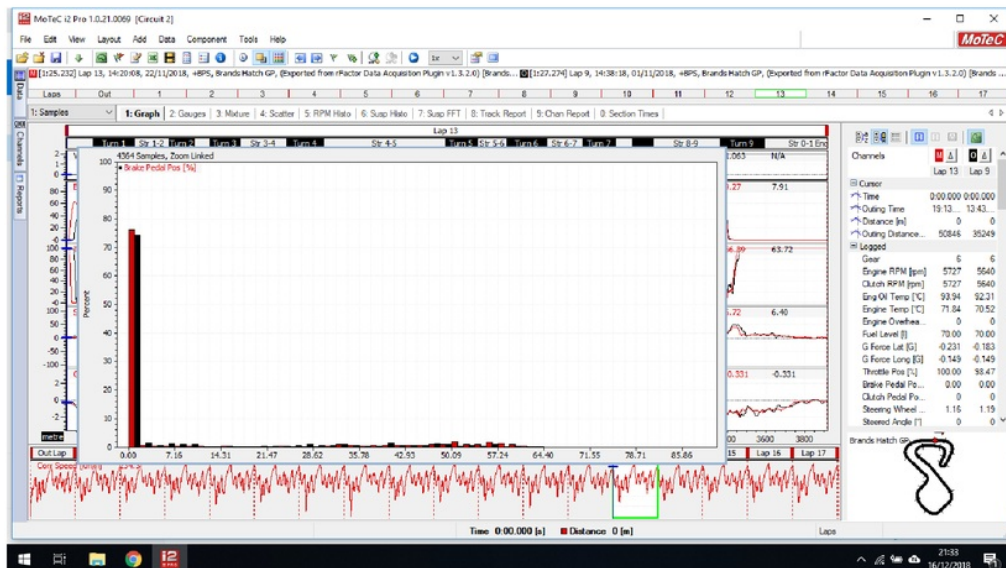
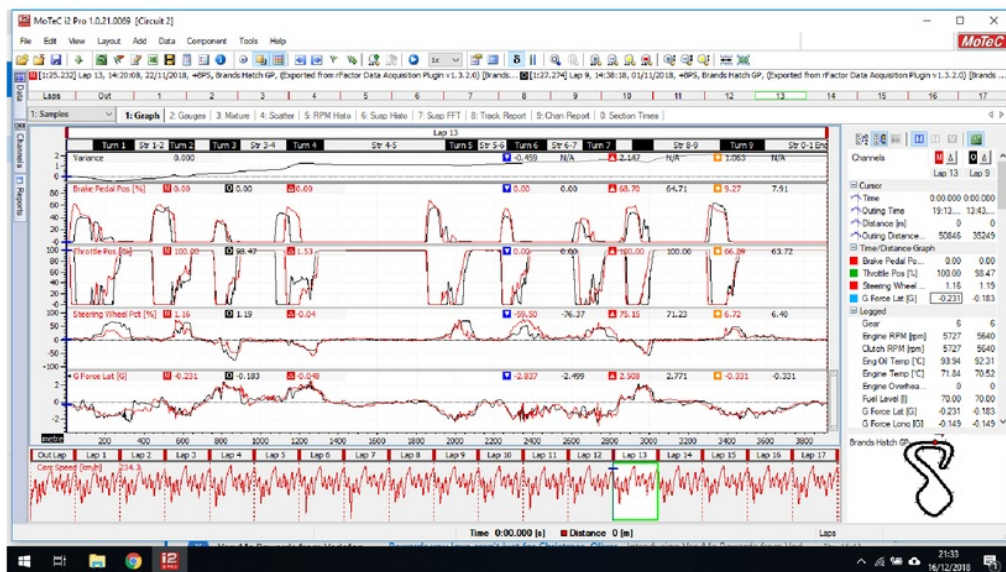


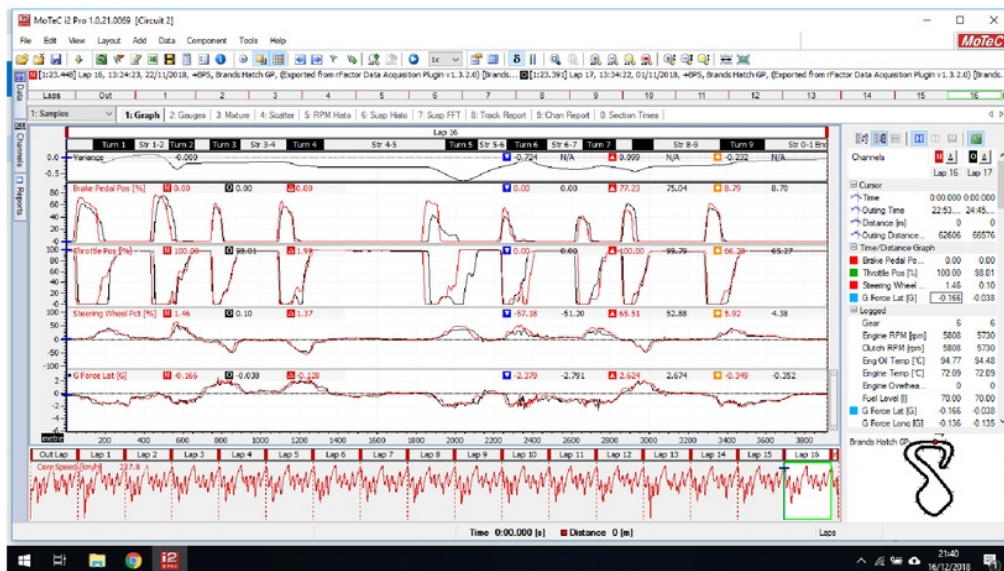
Figure 16



4.4-TT Session 2 Analysis

TT shows a slower lap time in the second session, although he is quicker in certain corners in the second session. TT applies the brakes both earlier and harder into turn 5 which boasts an advantage as he is then capable of then getting on the throttle quicker in the exit of the corner although he still maintains the same release in the throttle as in the first session, this may be by getting on the throttle later he may then be able to get on the throttle and stay on it. TT loses time in corner 2 and 3 as he brakes harder but for similar amount of time meaning that entry speed is lower into these corners then resulting in slower entry speeds.

Figure 17

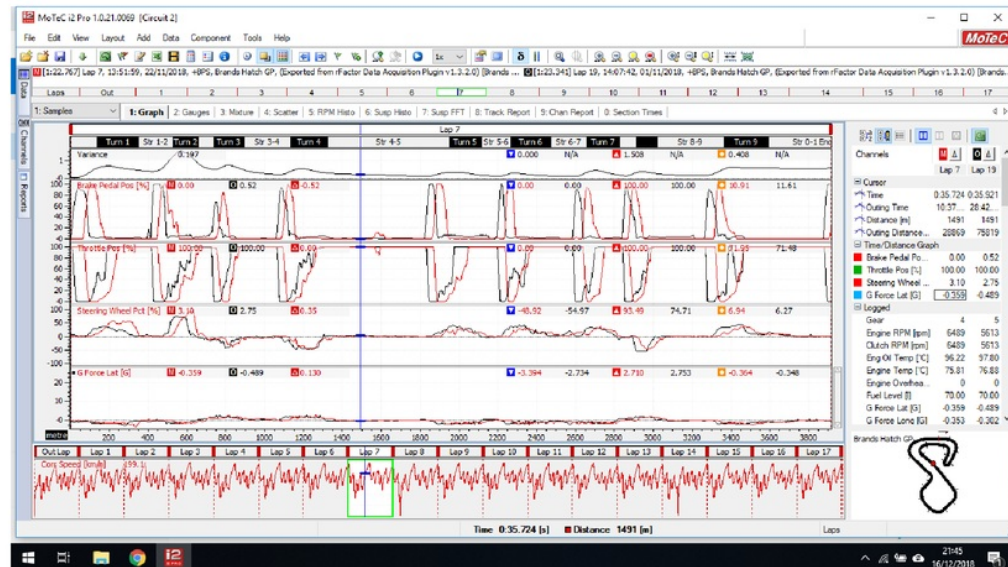


4.5-JY Session 2 Analysis

JY shows an improvement between each session with one very distinct difference between each session and this is the later braking into every corner

JY throttle application in session 2 is far more confident, this is a problem in the first session as he often hesitates although in session 2 this is not completely eliminated as shown in corner 2,4 and 5 as figure 18 shows. The smoother throttle results in a massive increase of speed into corner 9 that results in an 0.4 loss of time.

Figure 18



4.6-Session 2 Analysis

Session 2 was more successful than session 1 as it gave all 3 drivers a fair amount of lap times by taking into account the time that will be needed for changing drivers. The instructions were productive for DS and JY but didn't help TT this may be down to his experience in the car as he may be stuck in his ways then found it unnatural to change how he drives.

5-Conclusion

The test proved to be beneficial as all 3 drivers as it shows that they are capable of taking on knowledge and implementing the changes. The simulator allows for a mass of data to be taken with all data being correct, whereas often on a real race car data systems can go wrong, the simulator will allow the drivers to be fully analysed with their inputs then being assessed and seeing what it then causes as a result. Although simulators allow for drivers to drive safely without any risks or chance of danger it doesn't then give a real experience to the drivers as they are not having to forces applied onto them meaning that it is not as physically demanding. whilst taking away the risk of danger it may mean the drivers are more confident but then when put back on the track is lost causing a driver to be more conservative and become slower. The driver's ability whilst testing may differ if another car is selected for the test, a front wheel drive car may suit a different drivers style differently so by carrying out

this test in another vehicle may cause different drivers to have an advantage. The ability for a driver to be comfortable with his car allows for much more confidence in turn a much more successful lap, set up changes can be used to add this although it will take time to find the perfect set up for a driver it can be used to compliment a driver's style and to improve their skills. If the test was to be run again to develop a driver further it would be recommended that a series of different set ups are used as well as different tracks being used as a driver's ability should not solely be linked to a single track.

Bibliography

Bentley, R., 1998. *Professional Race Driving Techniques*. 1st ed. s.l.:Motorbooks .

Fey, B., 1993. *Data Power*. 1st ed. s.l.:s.n.

Law, H., 2000. *Development of an Expert System for the Analysis of Track Test Data*, s.l.: s.n.

Motec, 2011. [Online]

Available at:

[https://www.dropbox.com/sh/bpi7c5qgthvcq2e/AAB4iYLuzJhcQdPaxKJSYwCPa?dl=0&preview=i2+Data+Analysis+March2011+\(1\).pdf](https://www.dropbox.com/sh/bpi7c5qgthvcq2e/AAB4iYLuzJhcQdPaxKJSYwCPa?dl=0&preview=i2+Data+Analysis+March2011+(1).pdf)

[Accessed 2018].

Racer, Rapid, 2016. *Handling Diagnostics*. [Online]

Available at: <http://www.rapid-racer.com/handling-diagnostics.php>

[Accessed 2018].

Velenis, 2008. *Optimality Properties and Driver Input Parameterization for Trail-braking Cornering*, s.l.: s.n.