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Optimum Lap Testing Results

Introduction to Vehicle Engineering (ACHA4035)

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2.Introduction

In this report I will be looking at Improving a vehicles lap time around a circuit from the baseline lap. I have been given a list of factors I am allowed to change on the vehicle and have been assigned a budget system that will determine how many changes I can make. I will discuss what factors on the vehicle were changed to optimize performance, and by how much each modification effected the lap time, along with minimizing spending for other changes by using trial and error to determine what changes are the most effective. The report will also compare how the same setup is better suited to different circuits, one being long straights and fast flowing corners, the other being tighter, slower and more technical.

The vehicle being used is a Prototype vehicle specific for this report. It will be tested at two circuits, those being Silverstone and Monaco. These two circuits are drastically different in their layout which makes finding a setup that improves lap times through both circuits by a large amount quite challenging, as you don't want to sacrifice speed on Silverstone, and for Monaco it is essential that the vehicle is not lacking in its cornering ability.

3.Main body

I first started by setting some baseline laps around Silverstone. The car was in its completely stock format and did a time of 99.99s. as standard the car has 550hp and weighs 975Kg. this is already an incredible power to weight ratio meaning the car isn't slow, so changing other parts of the setup would possibly make more of a difference than modifying these two figures. I firstly wanted to improve the cars grip through the corners. Silverstone is a very fast track with many fast-sweeping corners. Using the budget constraints, I selected map C for aerodynamics and Map C for tires. This lowered the drag coefficient to 0.45 and raised the downforce coefficient to 1.7. and for tires raised the longitudinal friction to 0.85 and raised the lateral friction to 0.825. these changes lowered the lap time by 1.98s (98.01). This improvement is good but still left me a large amount of budget to make further changes. I decided to lower the weight of the vehicle from 975kg to 915. This change gave me a lap time of 96.71 which is 1.3s faster.

Weight plays a huge factor in how fast a vehicle can get round a circuit. Less weight = Less inertia which helps with cornering. Lowering the Weight of a vehicle also raises its

power to weight ratio. The power to weight ratio is the cars hp divided by its total weight. It shows how much weight the engine has to propel, Prestige imports.com.

Given the fact the weight was already reduced, I then raised the power of the vehicle, selecting map C which raised the power by 10% giving the vehicle 605HP. This change lowered the lap time again with a drop of 1.24s (95.47) further proving the importance of a good power to weight ratio, However this left me with no more available budget, So I decided to raise the mass of the vehicle back up to 945kg, changed the aerodynamics to Map D which gave figures of C.D 0.58, C.L 2.2, also changed the tires to set E which gave figures of 1.85 Lon MU and 1.85 LAT MU.

These changes did work and lowered the lap time even further, giving me a time of 94.18s which is 5.81s faster than the stock lap. Using the grippiest tire set made a considerable difference as tires are incredibly important in creating a fast lap time, tires are the last and ONLY point of contact to the tarmac, so it is Vitally important that they deliver the optimum amount of grip.

I also ran a stock lap on Monaco which was a 83.25, and using the last setup the lap time was reduced to 79.88, 3.37s quicker than the standard lap, which although not big of an improvement, is still a lot faster than the standard lap time.

The data shows clearly that different setups have different effects on different tracks and need to be prioritised on each accordingly. Monaco doesn't have many long straights, meaning the vehicle doesn't take advantage of the extra power when running a lap, whereas on Silverstone with its 4 Massive straights the vehicle can benefit from the extra top speed to improve its lap time.

After chopping almost 6s of the stock lap on Silverstone, I was quite happy with the results but decided to try on more setup. For this final setup I raised the weight to 975kg, and increased power to 660hp. Leaving tires and aerodynamics the same. These changes led to another drop-in lap time leaving me with my two fastest laps being a 93.49 at Silverstone and a 79.59 and Monaco.

This setup with brute power and as much tire grip as possible raised the cornering speeds during fast corners by a drastic amount. While not sacrificing speed in slower corners due to the added weight as shown on figure 1.

Round 1 Silverstone Circuit - Speed (1)

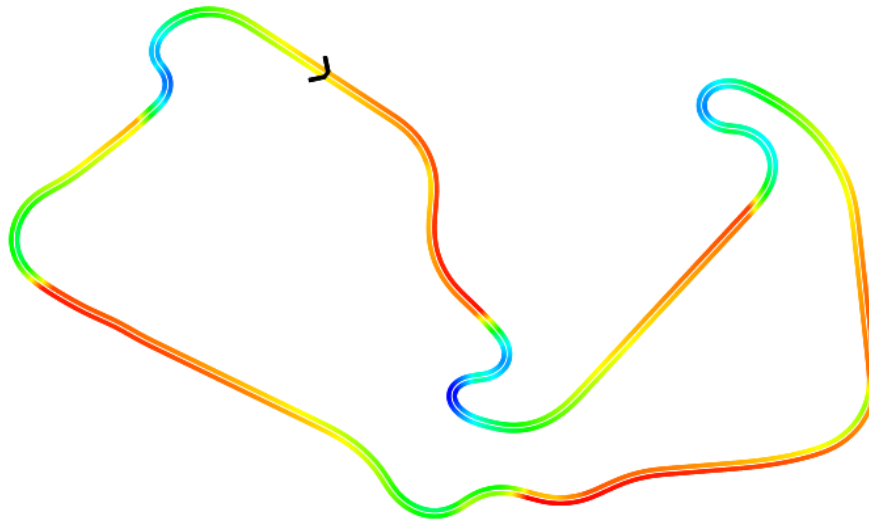


Figure 1.

Figure 1 shows the track map diagram, indicating the speed of the vehicle around Silverstone on both laps. These track maps are incredibly beneficial when setting up a vehicle as it shows exactly where speed is being gained around a circuit. Seeing this can help an engineer drastically improve a vehicle's lap time

The inner line shows the stock lap, and the outer showing the fastest. The diagram shows speed with blue being slowest and red being fastest, using this you can clearly see the major increase in speed through long corners and long straights. The stock setups lap time showed cornering speeds of 286kmh through Maggots, whereas the modified setup hit speeds of 308kph though the same corner. I was happy with this massive improvement in high-speed corners on Silverstone. The diagram also shows that the modified vehicle was braking later and getting on power sooner. This has a big effect on lap times as it maximises the amount of time that you can travel at an increased speed.

Round 2 Monaco - Speed (1)



Figure 2.

Figure 2 is the track map of Monaco also comparing the speed of the stock and fastest lap. It shows similarly that cornering speeds are increased, but only by a marginal amount, however the vehicle is noticeably later braking and hits higher speeds down both straights, and the long fast right-hand corner. However, I feel that this track being so different to Silverstone would benefit from its own setup that maximises faster speeds in tighter corners

4. Conclusion

The data shows that the improved setup made a major difference to the lap time at Silverstone, with the time dropping by 6.5s (99.99 -> 93.49) however at Monaco this improvement in lap time was not as drastic, with an improvement of 3.66s (83.25-> 79.59), Almost 50% less effective than the same setup on Silverstone. This is simply due to how different the two tracks are. With the vehicle being primarily tested at Silverstone, and the setup therefore prioritising this track, the setup was better suited to Long flowing corners and high-speed straights where the vehicle had a major advantage in top speed, and high-speed cornering ability due to the added downforce. At Monaco the car would have benefited massively from a setup that had Less weight and power, but as much aerodynamic grip as possible, the lower weight would decrease the inertia during corner entry and exit, which would allow the vehicle to corner faster around the circuit's tight bends. Improving Aerodynamic downforce would have had the same effect, providing a maximum amount of cornering speed.

This all shows that setting up a vehicle for multiple tracks can improve lap times across the board, however this can sacrifice performance gains on tracks with major differences, showing that vehicles would benefit more being setup on a track specific basis, with changes being made to gain maximum performance specific to the individual track.

5. References

- <https://www.prestigeimports.com/blog/understanding-the-power-to-weight-ratio-in-supercar-performance> October 30th 2024, By prestige imports