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The Impact of Aerodynamics in Motorcycle Grand Prix Racing

Academic Skills (ACHA400)

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1. Introduction

This Paper researches and reviews the impact of aerodynamics (aero) within Motorcycle Grand Prix racing, looking at how it can improve motorcycle performance and lap times.

It will give a history on aerodynamics in Motorcycle Racing discussing how Aero has evolved in Motorcycle Grand Prix racing looking at the recent developments from Ducati Factory Racing team for the modern era.

2. Background and Historical Information

Aerodynamics In motorcycle Racing has come full circle within modern Motorcycle Grand Prix Racing, aero has not been a major part of GP racing for a long time, however this is not the first time we have seen it within the sport.

2.1 Aerodynamics in early Motorcycle racing

Organised GP motorcycle racing has been around since 1949 when the International Motorcycling Federation Championship was officially established (FIM MotoGP,2023).

However it did not take long for Aerodynamics to come into play, this is shown by the introduction of the appropriately named dustbin fairings such as that seen on Bob McIntyre's 1957 Gilera (Shown in Figure 1), aerodynamics had come into play at this point to make the bikes more streamlined to increase top speed and acceleration by reducing drag in the hope of reducing lap times to win Races.



Figure 1- Bob McIntyre 1957 Gilera 500 'Dustbin' (Snelling, 2017)

2.2 The receding of aero from early Motorcycle racing

The Aero phase did not last very long, as previously mentioned the purpose was to improve acceleration and top speed, this was because it was the easiest way to speed up the already established motorcycles, as machining technology, R&D, computing and materials engineering were nowhere near as advanced as they are today.

As a result of these limitations both power output and the ability to sustain high power were limited, so putting time into making the bikes move through the air more efficiently was another path to improve performance.

Other attempts at Aerodynamics were made as the bikes got faster and more powerful such as the attempts made by Privateer Roger Freeth by putting wings on his modified TZ 750 Yamaha in 1977.(González-Arcos and Gamez-Montero, 2023)

Technology grew in other departments such as chassis Development, tyres, engine materials, braking and even engine types seeing competition two stroke engines make their move into racing, with this vast range of improvements developing rapidly, the limitations had moved significantly further with motorcycle aerodynamics taking a step back for roughly another 40 years.

2.3 The issue in the modern era

The modern generation of Grand Prix racing motorcycles has returned to the aerodynamic problem due to very similar situation, power limitations, however now due to making so much power they are struggling to transfer the power through the tyre, causing loss of traction meaning they're losing drive reducing acceleration, the other significant long standing issue this grip and power increase causes is wheelies, as a result of a wheelie the bikes front wheel raises leaving the ground increasing their frontal area therefore creating more drag resistance slowing the bike down , the only way to reduce this is to reduce power to lower the front or feather the rear brake meaning the bike is not accelerating as hard or at all, the impact of the front wheel on the ground can also be dangerous and create more drag, lapping quicker means needing to reduce wheelie and grip issues in which aerodynamics now play a large role. (Oxley, 2023)

3. Discussing today's issues

This report has established two main roles of aerodynamics within motorcycle racing, firstly using aerodynamics to improve efficiency of how the vehicle cuts through the air, the term efficiency is referring to how much we can reduce the energy used to overcome the force of the air against the motorcycle (opposing its direction of travel), meaning more energy can be used to propel the motorcycle to a greater speed.

Increasing drive is the other aerodynamic purpose that has arisen from the research conducted, and this is the current problem, that the motorcycles are needing aerodynamic input to keep the motorcycles close to their optimum performance pitch angle allowing more power to be transferred as we now do not need to reduce the transfer of force through the tyre to decrease or stop wheelie, this also has a link to the other concept as this also keeps the frontal area to a minimum for longer.

3.1 The Streamlining Approach

The ideology of this approach is to produce a motorcycle shape that is the most efficient creating the least aerodynamic resistance (drag), this is usually done by reducing frontal area and trying to encourage the air to flow smoothly around and away from the vehicle, and around the rider, the rider of a motorcycle is essentially a large air brake which is why in a modern race you can see the rider increase their frontal area whilst under braking however we do not want this under acceleration or sustained speeds, this approach can be seen in the image in figure 1 showing Gilera's attempt at this in 1957 with their dustbin fairing attempt.

Gilera steering in this direction showed that streamlining was an effective aero approach to racing at the time, because within its second year the Gilera 500cc Dustbin managed to do the first ever 100 Mph lap of the Isle of Man TT in 1957. (Lucien C. Ducret, Accessed 2024)

This evidence shows that streamlining can improve GP motorcycle racing with that improvement alone however there are still variables such as the rider, as the year previous it was not Bob McIntyre onboard the motorcycle, the Gilera was also in its second year of this design however there is no indication of any major development between the years however this cannot be ruled out.

In the Journal Aerodynamic Drag and Downforce of a Competition Motorcycle, Katz (2022), investigates the effects of different Aerodynamic packages using 1/16th and full-scale wind tunnel testing assessing the loads transferred through the vehicle to the ground.

The journal makes a primary comparison of a traditional modern shaped motorcycle compared to the same motorcycle but with a more streamlined enclosure this is akin to Gilera's dustbin idea in the mid 50's, the article draws on the fact that streamlining a vehicle can give an improved overall top speed of the motorcycle, which is what was seen with the 1957 Gilera 500 breaking the 100mph lap so these are supportive of each other as concepts and research.

3.2 The modern Approach

The modern approach is different, the desired characteristic wanted is downforce, reducing wheelie allowing the bike to drive harder but also for corner grip using ground effect on the sides.

You can see in figure 2 the early modern-era aero shown by Ducati in 2016 with just simple 'winglets' on the front fairing trying to encourage the front wheel to stay on the floor or low under acceleration to accelerate harder for longer.

Figure 3 and figure 2 shows how the complexity has changed over 8 years.



Figure 2 - Ducati Gp16 Aero (Ducati Corse, Accessed 11/2024)



Figure 3 - Ducati Gp 24 Aero (Ducati Corse, 2024)

3.3 Lap time Comparison

Table 1 shows the best factory Ducati Qualifying time of the first race of the championship at Losail Qatar over 4 Different years, 2015 is relevant but predates the Aero intense era, 2016 is the first time we saw attention paid to downforce, 2018 is a developed package but also allows for development with the new tyre and 2024 is the most modern package.

Table 1- Ducati Factory Qualifying times Qatar - (FIM MotoGP, 2024)

Aero Package	Best Lap Time	Rider	Difference (s)	Tyre Manufacturer
2015	1: 54.113	A. Dovizioso	-	Bridgestone
2016	1: 54.693	A. Iannone	+0.580	Michelin
2018	1: 54.074	A. Dovizioso	- 0.039	Michelin
2024	1: 50. 875	E. Bastianini	- 3.283	Michelin

The data shown in table 1 displays an expected trend that lap times decrease as the aerodynamics develop, however there is an unexpected outlier, in 2016 the lap time didn't improve even though this is the first large aerodynamic development however the tyre supplier changed to Michelin in 2016 although the same type of tyre it was a fresh start on a little understood and tested tyre so this could've made a significant step backwards among other issues. (Mitchell, 2017)

Factors to consider when looking at the validity of the trend in table 1 are, tyre development, engine development, the 2016 electronics change, riders, introduction of ground effect and ride height devices, although these alone aren't making the big difference it is a combination of all of this.(Mitchell, 2017)

Two of these developments are specifically for wheelie reduction via a dynamic chassis geometry and downforce, these contributions to reduce wheelie show that it can and does equate to a faster lap time which is suggested by Mat Oxley (2023) in 'MotoGP 2023: the real aero war starts now', Showing that aero has been successful in its main purpose of improving lap times by reducing wheelie and increasing grip has been achieved.(González-Arcos and Gamez-Montero, 2023)

4. Conclusions

Reviewing this information shows one major takeaway that is, aerodynamics within motorcycle racing has a large impact, that can be used to improve performance of a racing motorcycle but also solve problems, this has been seen throughout history since the start of Motorcycles Grand Prix's (González-Arcos and Gamez-Montero, 2023; Lucien C. Ducret, Accessed 2024).

The streamlining approach can be shown and justified through the improved Gilera with the success at the 1957 IoM TT, also supported in 2022 using modern technology and assessment techniques showing streamlining alone can improve top speed of a racing motorcycle. (Katz, 2022; Lucien C. Ducret, Accessed 2024)

Increasing the downforce using aero has also been shown to successfully improve the performance of a racing motorcycle, with the concept being that reducing wheelie should result in an improvement in lap times, the data shown in table 1 presents a general trend to support this with the largest difference being the complex aero of 2024 being 3.283 seconds faster than not having aero in 2015.(FIM MotoGP, 2024; González-Arcos and Gamez-Montero, 2023; Oxley, 2023)

There are other factors that are contributing towards these improvements however they are hard to isolate from the data due to the secure nature of the industry, a way to improve this would be to use more manufacturers to see if the same trend appears, but also use a wider selection of sessions and tracks, furthermore firsthand research would be the best option with strict controlled variables.

Aerodynamics will play a crucial role in future GP racing due to forthcoming regulation changes reducing size limitations meaning that manufactures will need to rethink and get creative with designs moving forward, however we could also see a decline as engine capacity is going to be reduced meaning potentially less power reducing the Issue. (FIM MotoGP, 2024)

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