

UWTSD

WISA



Motorcycle Winglets

Academic Skills (ACHA4005)

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1 Introduction

1.1 Justification

Motorcycle winglets are a recent innovation to motorcycle design, notably in motorcycle racing series such as MotoGP. Whilst controversial, the recent addition to winglets has proven effective to improving performance, providing greater downforce which improves lap time (Motorcycle Winglets - How Do They Work? | 2020). With other motorsport and vehicle disciplines, such as Formula 1 and supercars, having fully integrated wings into their design decades prior to any motorcycle brand had, it was only a matter of time before motorcycle engineers looked to bring in wings to help improve performance and become a staple of motorcycle design.

1.2 Aims

The main reason for winglets being developed and introduced into motorcycles, specifically motorcycle racing, were to improve and decrease certain aspects of riding a motorcycle. Some of these areas were reducing wheelie when opening the throttle, and improving stability under braking and through cornering.

1.3 Objectives

The objectives of introducing wings were so that manufacturers could gain a competitive advantage over rival brands. For example, Ducati were the main innovators of winglets, which helped give them a performance boost which ultimately helped them win their first race in six years in 2016 when Andrea Iannone took the chequered flag in that seasons Austrian Grand Prix. Most other manufacturers have responded to Ducati, but none have made as radical changes to motorcycling as them.

2 Background

The word “Winglet” initially comes from Formula 1, to describe the aerodynamic additions that are visible on Formula 1 cars. Wings were first seen in Formula 1 in 1968 (Wings & Ground Effects | Formula One Art & Genius, 2018).

Winglets in MotoGP can be seen as early as 2010 and 2011, where Ducati experimented with them in the hope they could improve their bikes turning to catch up with rivals Yamaha and Honda. However, winglets did not become properly introduced in MotoGP until 2015 (The Importance of “Winglets” in MotoGP - Box Repsol, 2023). In the late 2010’s, winglets were beginning to pop up on road bikes as well, such as the BMW S1000RR and the Ducati Panigale V4. Whilst there is no benefit to riding with winglets on public roads, manufacturers do this for homologation purposes, for example brands running in World Superbikes and British Superbikes (Wings on Wheels: Why the Latest Sports bikes Have Aerodynamic Winglets, 2020). As machines running in production based championships aren’t allowed to stray too far from the road going machine, manufacturers can add winglets to the road machine to try and gain an advantage on the track against their rivals.

When winglets began to become more mainstream in MotoGP, they were placed at the front and side of the fairings. This was so that there were improvements to stability under braking and to help improve aspects of cornering, such as corner speed. In the second half of the 2022 season, Ducati were the first to run what was known as the “Stegosaurus wing”. These were winglets placed on top of the tail of unit of the motorcycles, in attempts to clean airflow and further improve stability under braking.



Figure 1 - An example of front-end winglets on Honda's 2023 factory machine

3 Discussion

Circuit	Losail International Circuit	Circuito de Jerez	Mugello Circuit	TT Circuit Assen
Pole Position (2014)	01:54.507 Marc Marquez (Honda)	01:38.120 Marc Marquez (Honda)	01:47.270 Marc Marquez (Honda)	01:33.653 Aleix Espargaro (Yamaha)
Pole Position (2021)	01:52.772 Francesco Bagnaia (Ducati)	01:36.755 Fabio Quartararo (Yamaha)	01:45:187 Fabio Quartararo (Yamaha)	01:31.814 Maverick Vinales (Yamaha)

As seen in Table 1, pole position lap times on each of the four circuits have decreased exponentially since the introduction of wings, considering these are the best motorcycle racers in the world and finding even tenths of a second is difficult at this level without huge developments. On the two longer tracks Mugello Circuit and Losail International Circuit, which have a length of 5.245 kilometres and 5.419 kilometres respectively, nearly two seconds a lap has been gained after wings had been introduced and developed. On the two shorter tracks Circuito de Jerez and TT Circuit Assen, which have lengths of 4.428 kilometres and 4.555 kilometres respectively, around one and a half seconds have been found per lap. To put that into perspective, Marc Marquez's pole position time from the 2014 Spanish Grand Prix held at the Circuito de Jerez, would have placed him 21st on the grid for the 2021 Spanish Grand Prix, only beating two riders. This result is similar for the 2021 Italian Grand Prix, where again Marc Marquez's 2014 pole position lap time would place him 23rd and last on the 2021 grid.

This shows that there is a positive correlation between the introduction of wings and improvements in lap time, and the continued development of the winglets. This is also further proved by the fact that Marc Marquez is one of the best motorcycle racers of the last decade and a half, having claimed eight world championships between 2010 and 2019. However, wings do come with their disadvantages. The main problem is that they create drag, meaning that it reduces the top speed of the bike every so slightly. Also, wings only properly come into effect at speeds of over 60 miles per hour, effectively making them just added weight during slow speed sections of track.

There are other factors that have contributed to an improvement in lap times over the past decade. One of these is engine development. In 2012, MotoGP announced they would increase the engine

capacity from 800cc to 1000cc (MotoGP Flashback: First Season of 800cc | MotoGP | News | Crash, 2012.) With only having a couple years of development, the 2014 Yamaha M1 had 240 horsepower (MotoGP - Racing Information | Yamaha Motor Co., Ltd., 2014), whereas the 2021 Ducati had over 250 horsepower, so a slight increase. However, with only the small increase in power and engine development being sealed throughout the racing season, engines won't have the biggest impact on lap time as you can only develop a 1000cc prototype so much.

Another factor which has helped the development of MotoGP is the material used for the chassis. Most teams use aluminium chassis and have done for many years, but teams such as KTM and Aprilia are bringing in new ideas such as steel chassis and even carbon fibre chassis to try and improve the handling of the motorcycles. This innovation in chassis has not taken off as much as winglets but is still important to improvements in performance (KTM's Radical New MotoGP Chassis Shows the True Success of the European Marques, 2023).

One other factor that has improved performance in MotoGP is the introduction of the rear ride height device in late 2019. Whilst exiting corners onto long straights, the rider can lower the rear suspension of the bike which reduces the centre of gravity of the bike therefore making it more stable. This meant the bike would not wheelie and the rider would be able to get better drive onto straights. This also meant riders wouldn't have to worry about a wheelie off a race start (MotoGP Rear Ride Height Device Explained - 44Teeth, 2021). Although this innovation has been effective in dropping lap time, it does come with its downsides. The main one is the weight of the device, causing the bike to feel heavier and effects the handling of the machine. There have also been some cases of the device sticking on, causing riders to have limited control throughout corners.



Figure 2 - Ducati's rear ride height device in action

4 Conclusion

In conclusion, Winglets have been the most effective development in improving motorcycle performance over the last decade. With the amount of development this innovation has brought with every manufacturer resorting to adding it to their machines, it has changed the world of motorcycling. Many manufacturers have looked to add Winglets to their machines instead of investing in costly areas such as electronics, which makes many riders feel like they are no longer riding a bike and instead a computer is riding it for them. However, with MotoGP looking to make a major overhaul with regulations in 2027, there is a chance wings will be scrapped as engine size decreases down to 850cc (MotoGP Heading for 850cc Future? | MotoGP | News | Crash, 2023). With this possibly being the case, there would be a knock-on effect to the rest of the motorcycle engineering world, as road bikes would also potentially look to get rid of wings. Even if they were to go, winglets would go down as one of the best innovations in motorcycle design history.

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