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The Development of Aerodynamics in Formula 1

Academic skills (ACHA4005)

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1. Introduction

This report is going to discuss all the major improvements and developments to aerodynamics within Formula One, the report will investigate the history of aerodynamics within Formula One and see how the engineers are still able to develop their cars even under strict FIA regulations. To do this research I need to use credible sources. to ensure that the sources are credible I will compare much of the research to other credible sources. The report will also discuss many issues engineers face while trying to develop the aerodynamics of their car.

2. Research and Background

2.1 What is aerodynamics?

The reason aerodynamics is so important when developing a Formula One car is because it can improve the cars speed. It improves speed by allowing air to pass over the car at a much quicker rate due to the shape of the car. This generates an increased amount of downforce allowing the car to gain incredible amounts of speed. Aerodynamics are one of the most important developments for F1 teams as it can give them an edge against other teams. Teams are given strict wind tunnel time each year to develop their car. Originally, the cars were designed for just power and had a round shape to their chassis.



Figure 1- First Formula One car (Fowler, 2014)

(Fagan, 2018) Aerodynamics were originally described as a 'black art' due to the lack of 'sophisticated wind tunnels'. That was until 1968 and the first major development – the wing.

2.2 First Major Development

The first major development to aerodynamics within Formula One was the addition of wings in the front of the car in 1968. The wings first featured on Graham Hills Lotus 49B at the Monaco grand prix in 1968 (Fagan, 2018). These wings were designed and fitted by a man named Colin Chapman. James Elson with Motorsportmagazine.com also stated that this was the first feature of wings in F1 and Colin Chapmans role in the introduction of the wings. Hill went on to win the Monaco grand prix by 6 tenths. This made everyone in the pitlane add wings to their vehicle and started to develop aerodynamics in many ways. The idea was if a plane wing was able to lift the plane up, then if the reverse the wing it should push the car down – causing downforce.



Figure 2- Graham Hill in the Lotus 49. 1968 (Motorsport, 2018)

2.3 1968-Present Day

Since the introduction of wings in 1968 there have been several aerodynamic developments within formula one. In 1977 lotus introduced side skirts. Side skirts were a major development as they 'help seal the gap between the cars floor and the track' (Howson, 2024). This created a ground-effect tunnel and lotus were the first to use and master this technology. This was proven when they went on to win the 1978 season. The early 2000s saw teams and engineers master aerodynamics. the exhaust diffuser was one of the major developments as this harnessed exhaust fumes and created more downforce (Proud, 2023). This innovation caused the design of the cars to change to what we are more familiar with today. During this time, teams had state-of-the-art wind tunnels and continuously developed the aerodynamics to create as much downforce as possible. One of the other developments was DRS which was introduced in 2011. DRS (Drag Reduction System) is used to create straight line speed by opening a gap on its rear wing allowing for a higher speed on straights and for overtakes (Braybrook, 2024).



Figure 3- The development of Formula 1 Cars since 1970 (msr, 2014)

3. Discussion

3.1 Regulation changes

Regulations are being added year after year to help keep teams on a level playing field and to also allow for more exciting races. The new regulations for the 2026 season decrease the cars weight by 30kg. This new rule has cut downforce by 30% and drag by 55%. The FIA's aim with these regulations is to improve racing and not just reliant on the car but more the driver. The 2026 season is a major development for aerodynamics as they are adding 'moveable front and rear wings'. These new moveable wings allow for more intense and closer racing (Barretto, 2024). There is also a new 'z and x mode'. X mode allows for a 'low drag configuration' that changes the angle of the flaps for improved straight-line racing. And Z mode which is similar to DRS but allows for greater cornering speed by opening up a wing flap (Barretto, 2024). This will increase downforce. Many of these changes are massive developments for aerodynamics as allowing a driver to control their wing angle while racing really shows how far aerodynamics has come since its introduction to Formula One in 1968. These changes have been controversial however as many people have tested out the new aerodynamic regulations on hyper-realistic electronic simulators and experienced many issues. For example, there has been many issues with spinning out on straights and not reaching maximum speed on the high downforce corners (Noble, 2024). This could be a problem for the FIA as the new regulations are some of the biggest changes in F1 history with a completely new chassis being required, costing the teams

millions of pounds to build and develop. The FIA are now trying to promote more closer racing, but this is difficult to do as there is a major dirty air problem within formula one which means trailing cars stuck in dirty air are unable to gain speed compared to cars driving in clean air.

3.2 Wind Tunnel's

Since Wind tunnels were first used in F1 they have become an important technology for teams to use as it allows teams to find out how aerodynamic their vehicles are. They are able to find the best angle for wings which can give the cars the best downforce and least drag for top speed. the Ferrari team principle described wind tunnels as 'game changing' for the 2026 season and having as much time within the wind tunnel could be crucial as F1 ATR decides how much time each team gets in the wind tunnel (Noble, 2024). The more a team uses the wind tunnel the more they are able to understand and develop the aerodynamics for maximum downforce. In 2023 McLaren developed a new state-of-the-art wind tunnel allowing them to test full scale cars. Much of the wind tunnel information is kept quiet though to not allow teams to copy their design. Wind tunnels are being developed to an incredible standard ready for the 2026 F1 season after the regulation changes and many teams invest millions of pounds into it to try and have the best aerodynamics in the world.

3.3 The dirty air problem

Another major issue for aerodynamics and F1 is the dirty air issue. 'Dirty air is boiling, twisting vortices being generated by winged machines'. This has been a problem within formula one since they have been able to track any aerodynamic data. This dirty air causes 'unpredictable handling snaps' which does not allow a trailing car to make any ground on the car they are (Kalinauckas, 2024). This can cause a 50% decrease in downforce meaning it is nearly impossible to make any time on the car ahead. There are some positives to this. Dirty air helps the car in front cool down. This is beneficial as in hot countries where they often race, cars can overheat and shut off. This can cause teams to be out of a race (Gustafsson, 2023). There are also many negatives to dirty air. One negative of dirty air is that 'it can cause spins as the turbulence disrupts the downforce of the car'. This has caused many crashes before and even cost many drivers from winning races. The most recent occurrence of this is Oscar Piastri at the Dutch grand prix. This resulted in him losing pole position and having to wait even longer for his first win in the McLaren.

4. Conclusions

In conclusion, there have been many developments to aerodynamics in formula one ranging all the way back to 1968. From wings which did not allow any change in angles to drivers being able to control flaps on their wings for what best suits them. With new regulations comes new problems and the team has engineers that will work tirelessly to have the fastest car on the track ready for 2026. The development of aerodynamics is one of the most critical for motorsport as aerodynamics is one of the few ways to make the car faster while staying within the regulations. The report discussed how dirty air affected cars, the new FIA regulations and how wind tunnels affect the development of aerodynamics in formula one and how there are positives and negatives to all these issues. Teams must work within the strict FIA rules and often overspend trying to stay in the budget trying to reach the new regulations.

5. References

Barretto, L., 2024. *Formula 1*. [Online]

Available at: <https://www.formula1.com/en/latest/article/explained-2026-aerodynamic-regulations-fia-x-mode-z-mode-.26c1CtOzCmN3GfLMywrgb2>

[Accessed 15 11 2024].

Barretto, L., 2024. *Formula One*. [Online]

Available at: <https://www.formula1.com/en/latest/article/explained-2026-aerodynamic-regulations-fia-x-mode-z-mode-.26c1CtOzCmN3GfLMywrgb2>

[Accessed 15 11 2024].

Braybrook, R., 2024. *Autosport*. [Online]

Available at: <https://www.autosport.com/f1/news/what-is-drs-f1-how-does-it-work/10307184/>

[Accessed 24 11 2024].

Fagan, R., 2018. *Motorsport Magazine*. [Online]

Available at: <https://www.motorsportmagazine.com/articles/single-seaters/f1/colin-chapman-formula-1s-greatest-innovator/>

[Accessed 15 11 2024].

Fagan, R., 2018. *Motorsport.com*. [Online]

Available at: <https://au.motorsport.com/f1/news/1968-first-wings-f1-1000902/1389077/>

[Accessed 15 11 2024].

Fowler, R., 2014. *Formula One Retro*. [Online]

Available at: https://www.motorsportretro.com/wp-content/uploads/2014/04/tumblr_mz17j7ehdu1qapwfro1_1280.jpg

[Accessed 15 11 2024].

Gustafsson, A., 2023. *Formulapedia*. [Online]

Available at: <https://formulapedia.com/clean-and-dirty-air-in-f1/>

[Accessed 15 11 2024].

Howson, G., 2024. *Motorsport Illustrated*. [Online]

Available at: <https://www.motorsportillustrated.com/blog/the-evolution-of-formula-1>

[Accessed 15 11 2024].

Kalinauckas, A., 2024. *Autosport.com*. [Online]

Available at: <https://www.autosport.com/f1/news/analysis-does-f1-have-a-dirty-air-problem/10584169/>

[Accessed 15 11 2024].

Motorsport, 2018. *Motorsport.com*. [Online]

Available at: <https://au.motorsport.com/f1/news/1968-first-wings-f1-1000902/1389077/>

[Accessed 15 11 2024].

msr, 2014. *Motorsport Retro*. [Online]

Available at: <https://www.motorsportretro.com/2014/03/f1-champion-cars/>

[Accessed 24 11 2024].

Noble, J., 2024. *Autosport.com*. [Online]

Available at: <https://www.autosport.com/f1/news/why-ferrari-thinks-f1s-wind-tunnel-rules-could-be-game-changer-for-2026/10671997/>

[Accessed 15 11 2024].

Noble, J., 2024. *Motorsport.com*. [Online]

Available at: <https://www.motorsport.com/f1/news/f1s-2026-active-aero-plan-set-for-change-after-alarming-simulator-findings/10596682/>

[Accessed 15 11 2024].

Proud, T., 2023. *Formula1News*. [Online]

Available at: <https://formula1news.co.uk/the-evolution-of-formula-1-technology-from-past-to-present/>

[Accessed 24 11 2024].

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