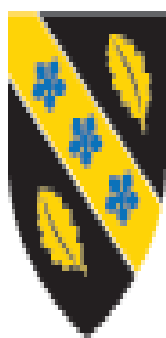


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Evolution of Aerodynamics in Motorsport

Academic Skills (ACHA4005)

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1. Introduction

This report investigates the evolution and development of aerodynamics in motorsport and the change of its importance throughout its time. A simple way to understand aerodynamics is that “Aerodynamics is the science that studies objects moving through air” (Steven De Groote, 2009). However, it is much more important than that in modern motorsport as this report will show. Aerodynamics can be used to create downforce which can improve cornering speeds and prevents cars from taking off at high speeds. This makes it an integral part of modern racing as improvements in aerodynamics can be worth seconds on track lap time, especially in motorsport such as F1 and WEC where cars can easily reach upwards of 200mph.

2. Aerodynamic Basics

There are two key parts that make up for the majority of motorsport aerodynamics, drag and downforce. Both components apply to all vehicles which have different effects on how fast a car is and how well it handles through corners.

2.1. Drag

Drag is the aerodynamic force that causes resistance in the opposite direction to the object traveling towards it. In the case of motorsport, as a car drives in a straight line air will cause resistance that will slow the car from reaching its highest possible speed. Aerodynamic cars are more efficient at reducing drag enabling them to reach and travel at higher speeds. Drag can be measured using the drag coefficient which expresses the ratio of the drag force to the force produced by the dynamic pressure times the area.

2.2. Downforce

The other important component is downforce. Downforce is typically generated on a car using wings like ones found on almost every modern motorsport vehicle. The way this works is as a car gains speed air flow over the wings of the car cause the air to push the car into the ground which prevents it from taking off and allows it to carry more speed through corners. Downforce also applies stability to a car at high speeds as it will remain planted to the track.

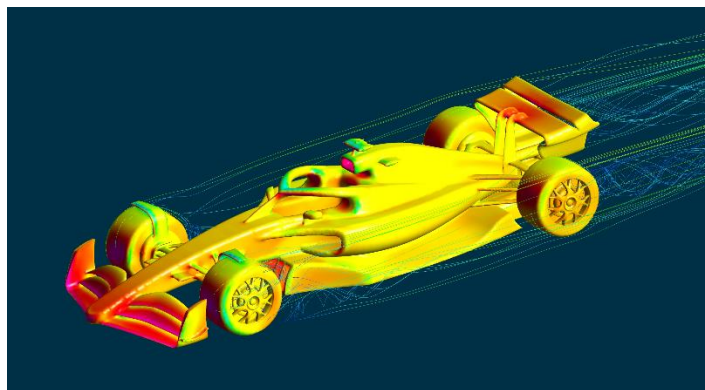


Image 1

3. Development of Aerodynamics over time

Over time there have been drastic changes to the use of aerodynamics within motorsport as major developments and discoveries have been made, many of these developments have been taken directly from motorsport in commercial vehicles to improve various aspects such as handling and fuel economy.

3.1. Early Motorsport (1950s):

In early racing aerodynamics was almost non-existent, the cars at the time heavily relied on having large powerful engines for their speed, most cars had large amounts of drag and little to no downforce. This made them a lot slower at cornering as they would tend to slide through corners and break a lot earlier as they were heavy, the lack of aerodynamics also made it much harder for them to accelerate out of corners as they weren't as aerodynamically efficient.

3.2. First major aerodynamic developments (1960s):

In 1968 the Lotus F1 team run by Colin Chapman had the idea of using a wing as they, "cleverly understood that if a normal wing could make an airplane fly, an inverted wing should create a similar force, but in the other direction. The negative lift should be capable to increase tire grip." (René Fagnan, 2018). This was first implemented on the Lotus 49B at the Monaco Grand Prix in 1968, the car would go on to win the race which is unsurprising as in modern Formula 1 Monaco is considered to be a high downforce track. This demonstrated how much more effective aerodynamics can make a car, this led to all other formula 1 teams developing wings for their own cars only 2 races later and permanently changing motorsport.



Image 2

3.3. Further developments (1970s – 1990s)

In the 70s aerodynamics became a much bigger part of motorsport especially in F1 where teams were starting to make adjustments not just to wings to add downforce but changing the body shapes of the cars to reduce drag and increase downforce. The bodies became wider, flatter and lowered a lot closer to the ground to direct airflow over the car instead of under which would keep the car more planted to the track. Soon after the concept of ground effect was discovered, Ground effect is "When a liquid (air in the case of F1 cars) is constantly passed through a funnel, the speed at which this fluid comes out of the thinner end is greater than that of, the wider end. The pressure is reduced and makes the output speed higher. This, applied to an F1 car, brings the car's floor closer to the asphalt to "throttle" the passage of air, creating less pressure than what is outside and making the air circulate faster. As the air passes faster under the car than over the top, a large downforce is created, causing the car to stick to the track and go faster." (Louis Pretorius, 2022). The more simple explanation is that air is funnelled over the car due to its shape and it pushes the car closer to the road. This was a huge aerodynamic advancement as it was an extremely effective way to generate downforce. However, this was banned in 1983 due to the dangerous crashes occurring when cars flipped upside down.

3.4. Modern Aerodynamics

There have been many new developments in the past few years of aerodynamics through F1, some of the most notable include X- wings which were additional winglets on the sides of the cars cockpit that were used on high downforce tracks such as Monaco to gain an edge in performance. A more recent example of aerodynamic innovation is the F-duct which was used first by McLaren to improve straight line speed of a car. This was achieved by redirecting air flow over the rear wing of the car when the driver covered the vent using their leg, (as shown in Image 3). A huge part of modern racing in F1 is DRS (Drag Reduction System), the use of DRS is to improve overtaking on the straights of a circuit by reducing drag on the car allowing it to reach a higher top speed. This is only allowed if a car following is within 1 second of the car in front and can improve top speed by a significant amount. It works by opening a flap on the rear wing of the car allowing for less air resistance, it is activated using a button on the steering wheel. Arguably the most useful development for modern day aerodynamics is the advanced wind tunnels that are used to test how air flows over a car. "Tests are conducted using scale models of the cars in a wind tunnel fitted with a "rolling road". Computers are used to mathematically simulate the flow of air around and through the cars and to model vehicle behaviour on the track."(Willem Toet).



Image 3

4. Conclusion

Throughout the course of motorsport there has been drastic changes and developments in aerodynamic research that have benefited or improved the design of modern vehicles in and out of sport. F1 cars are a great example of the change over the years as the shape and design of the modern cars is completely different to the original ones, they are much more detailed and precise in comparison with multiple components making a modern wing compared to old cars that used a simple sheet of metal. With the current rate of progression in development and technology being used in motorsport and the recent change in regulations in F1 its hard to say what the next big aerodynamic development will be that revolutionises the industry. Especially as ground effect has been re-introduced and needs to be developed further to prevent porpoising and achieve closer racing before regulations change again in 2026.



Image 4

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