

UWTSD
WISA



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Evolution of aerodynamics in motorsport

Academic Skills, ACHA4005

Technical report writing

By Finlay Summers (2205013)

10, Oct, 2023

Contents

- Page 1, title page
- Page 2, contents page
- Page 3, Introduction and start of background information.
- Page 4, F1 cars from 1956 to 1970
- Page 5, the introduction of wings to 1970s F1 cars
- Page 6, The lotus 78 and ground effect
- Page 7, F1 cars from 1980s to 2000s
- Page 8, F1 cars from 2000s to modern day
- Page 9, Discussion and conclusion
- Page 10-11, Referencing

Introduction

In motorsport, there is a wide range of factors that contribute to a successful team, such as funding, engine performance, fitness of the driver, concentration, training, and importantly technology.

In this investigation, I will look at a wide range of sources discussing the evolution of aerodynamics in motorsport and what role it plays within race. Some would argue that aerodynamics in motorsport plays a substantial role motorsport, especially in Formula 1 as an example. The aim of this investigation is to see how technology and engineering have improved and developed aerodynamics over decades to become what it is today. My investigation will be oriented to Formula 1 (F1) as it has some of the world's best aerodynamics research and development (R&D) within the subject and it also has been well documented over the years with reliable sources to reference.

Background

Some of the first examples of aerodynamics within motorsport date back to the 1950s when F1 had its first race. At this time aerodynamics were very basic and teams didn't utilize them to much extent as shown in **Figure 1**. The car and driver in **Figure 1** is Nino Farina in his 1950 Great Britain race-winning Alfa Romeo. The cars at this time were merely just an engine with a seat behind it on wheels and the only

Figure 1 (tipo 58 “Alfetta”)



aerodynamics on the car was just some metal bodywork surrounding the engine in almost a tube-like shape. Racing at this time had a lot more focus on raw engine power and driver skill to win races as technology was not advanced enough to develop efficient and effective aerodynamics.

As F1 started to increase in popularity and development, so did the cars.

Figure 2 shows Fangio in his Lancia Ferrari D50 at the 1956 Monaco Grand Prix. This shows the first steps of design towards using aerodynamics to increase a car's speed and efficiency with side pods being implemented to reduce drag from the front wheel and to decrease air resistance on the back wheel. A small improvement to the aerodynamics of the car is that the driver seat is lower to the floor as well as the rear curvature of the car is risen up to almost the head height of the driver to create a smoother and more direct flow of air over the car to reduce drag. Aerodynamics at this stage in Formula was primarily for drag reduction but had not yet improved to any sort of downforce.

Figure 2 (Lancia Ferrari D50)



The next notable change to F1 car design was in 1963 when the cars were built very low to the ground with the engine being moved to the rear of the car. Shown in **Figure 3**. This allowed the front of the car to be thinner therefore reducing air resistance increasing speed and reducing drag.

Figure 3 (Brahbam BT3)



F1 cars remained relatively similar to the mid-60s up until the 1970s when cars changed drastically with the introduction of front and rear wings. Although basic, these wings were implemented to increase

Figure 4 (Brabham BT33)



downforce which allows faster cornering speed and much better handling as backed up by this writing: *"In 1970, the revolution of aerodynamic engineering began to take place. It started with the creation of wings, which meant more downforce for the cars. Essentially this meant they had more grip and could coast around corners much faster than previously."* This would be the start of a new era of F1. **Figure 4** shows The 1970 Brabham-Cosworth Formula 1 car. On this particular car, there are two small straight wings on either side of the nose of the car, with a large wing on the rear of the car. However, at this time, these wings would only have a single edge compared to today's modern F1 cars which have multiple edges on the wing itself. This indicates that the first research and development into downforce were taking place and this research and data gathered from this season would provide the foundations for teams to improve their cars for later years to come. This led to multiple varying car designs with different styles and wing shapes, as shown in **Figure 5, Figure 6 and Figure 7.**

Figure 5 (Brabham BT26A)



Figure 6 (Brabham BT34)



Figure 7
(Lotus 56B Pratt & Whitney)



Going through the early 70's some F1 teams leaned towards the design of integrating the front and rear wings into the car itself. This was done to create one single aerofoil for air to pass over instead of a separate wing however the downside of this meant that the car was heavier than the cars with separate wings.

The next car I going to talk about in my investigation revolutionized Formula 1 forever. The Lotus 78 shown in **Figure 8** was the first ever car to introduce the “ground effect” into F1. This passage from [Lotus 78: F1's first true ground effect car February 2020 - Motor Sport Magazine](#) talks about the significance of the discovery of using ground effect for downforce: *“At that time, while every F1 designer had studied in varying depth the effect of airflow around the sides and over the top of his car, few – apart from Gordon Murray of Brabham and McLaren – had tackled proper management of airflow beneath it. Indeed, even these exceptions had tried to stop much air flowing under their cars at all.”*

This passage shows that there had been research into aerodynamics however little R&D had taken place into studying the airflow underneath the car, and teams had previously purposely tried to mitigate the flow of air underneath the car instead of utilizing it therefore when the ground effect was first used in the Lotus 78, it made teams completely rethink their designs for years to come.

“Ground effect consists of reducing the space between the floor of an F1 car and the asphalt to create a low-pressure area under the car, thus increasing the speed with which the air circulates and creating a greater downforce, even higher than that generated by the wings.” as **Figure 8** shows.

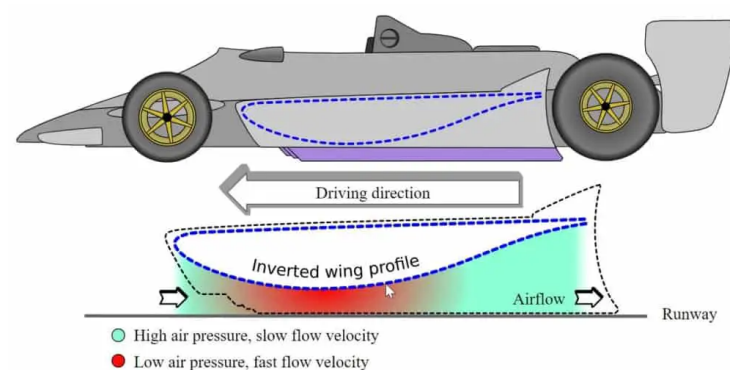
This description of ground effect explains the unprecedented advantage that ground effect gives to cars by giving them significantly more downforce compared to conventional F1 cars without using ground effect.

However since ground effect cars were so effective, cars were required to have flat floors as of 1983 therefore ending the ground effect era.

Figure 8 (Lotus 78)



Figure 9
(Diagram of ground effect)



Throughout the 1980's up until the late 1990s, the F1 car's were no longer allowed to use ground effect meaning they had to revert their designs back to traditional downforce methods as shown in **Figure 10**. Car's throughout this era were made significantly lighter to improve handling and power-to-weight ratio however aerodynamics over this period did not change drastically.

Figure 10 (Toleman TG183B)



Formula 1 cars from the 2000's up until the early 2010's shown in **Figure 11** and **Figure 12** had now started to implement multi-layered wings, having these extra layers on the wings greatly increased downforce helping with faster cornering speeds and increased handling. This era of F1 is when aerodynamics became one of the biggest factors in performance throughout F1 and all the race teams wanted to be the best and have the most advanced aerodynamics on the grid. This led to millions being spent on aerodynamics R&D with the use of wind tunnels and modern technology.

Figure 11 (McLaren MP4-24)



Figure 12 (McLaren MP4-25A)



Figure 13

Modern-day F1 cars have some of the most intricate aerodynamics of any machines built today. Every panel of bodywork has been custom-designed and tested to ensure it is as aerodynamic and efficient as possible. Due to F1 becoming so popular within the last decade, budgets and funding have hugely increased meaning teams are able to spend more on aerodynamic R&D leading to State-of-the-art technology being used within F1 to make cars as fast as they can be. Extensive testing and prototyping take place in wind tunnels to ensure the car is as aerodynamic as it can be to reduce air resistance and increase downforce as shown in **Figure 13**.

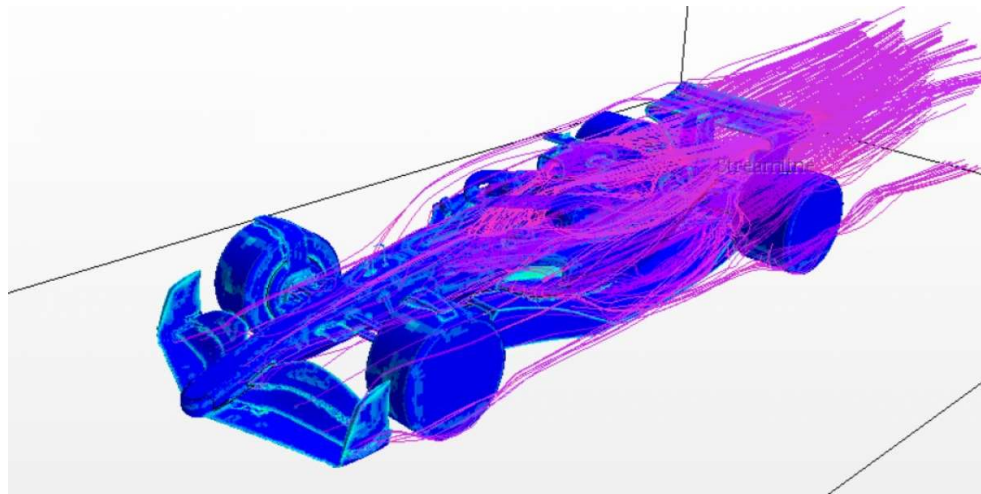


Figure 14



Discussion

The analysis of my findings shows the clear technological advancement that has taken place over decades of F1 racing and how teams have come up with solutions to increase their downforce and how to make their cars as fast around the track as they can go. Such as the Lotus 78 using ground effect to give the car a considerable amount more downforce than its competitors giving it an upper hand over the other cars. Technology has meant that in more recent years, teams are able to perfect their car using data analysis and testing.

Conclusion

In conclusion, the advancement of technology and popularity in F1 have played a huge role in the evolution of aerodynamics. The differences between the earliest F1 car in the 1950s, and the most modern F1 car to date are vast, with 1950s F1 cars being little more than an engine on wheels with little to no aerodynamics on the bodywork compared to modern-day F1 cars being intricately designed out of the lightweight materials to be as aerodynamic as possible.

Referencing (A-Z)

[F1 - The Official Home of Formula 1® Racing](#)

[History of F1 - 1970s - Aerodynamics play a major part in the series, as rivalries hot up \(sidepodcast.com\)](#) - published August 16th 2007

[Lotus 78: F1's first true ground effect car February 2020 - Motor Sport Magazine](#)

[What Is Ground Effect In F1? - One Stop Racing](#)

Figure 1 [\(pinterest.co.uk\)](#)

Figure 2 [\(pinterest.co.uk\)](#)

Figure 3 [ViaRETRO](#)

Figure 4 [\(silodrome.com\)](#)

Figure 5 [Brabham BT26A - F1technical.net](#)

Figure 6 [\(pinterest.co.uk\)](#)

Figure 7 [Lotus 56B - F1technical.net](#)

Figure 8 [\(pinterest.jp\)](#)

Figure 9 [\(presticebdt.com\)](#)

Figure 10 [GRR \(goodwood.com\)](#)

Figure 11 [GTPlanet](#)

Figure 12 [Carscoops](#)

Figure 13 [skillsire.com](https://www.skillsire.com)

Figure 14 [Alfa Romeo UK](https://www.alfaromeo.co.uk)