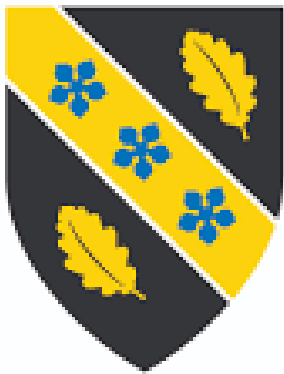


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THE EVOLUTION OF AN F1 CHASSIS

Academic Skills (ACHA4005)

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1. Introduction

This report will be discussing the evolution of an F1 chassis throughout the years, beginning with its original design in the 1950s before looking at how the science and technology behind it has evolved since leaving us with the up-to-date designs today. This report will also have a brief discussion on how it is made, the advantages of the modern-day design and how the FIA regulates the production quality of each individual chassis.

2. Research/background

The chassis is an integral part of any car, with its main roles being to support the vehicle and its various components. This will include the suspension, drivetrain gearbox and more.

When Formula 1 was introduced the car's chassis were built from steel or aluminium sheets that were shaped and welded together to form a shell around where the driver would sit. (Parker, 2024)

Towards the latter stages of the 1950s and going into the early 60's the use of sheet metal frames was slowly being replaced by space frame chassis. These were made from tubular steel that had been welded into a lattice shape. This offered the chassis much more rigidity and a better strength to weight ratio. (Parker, 2024)

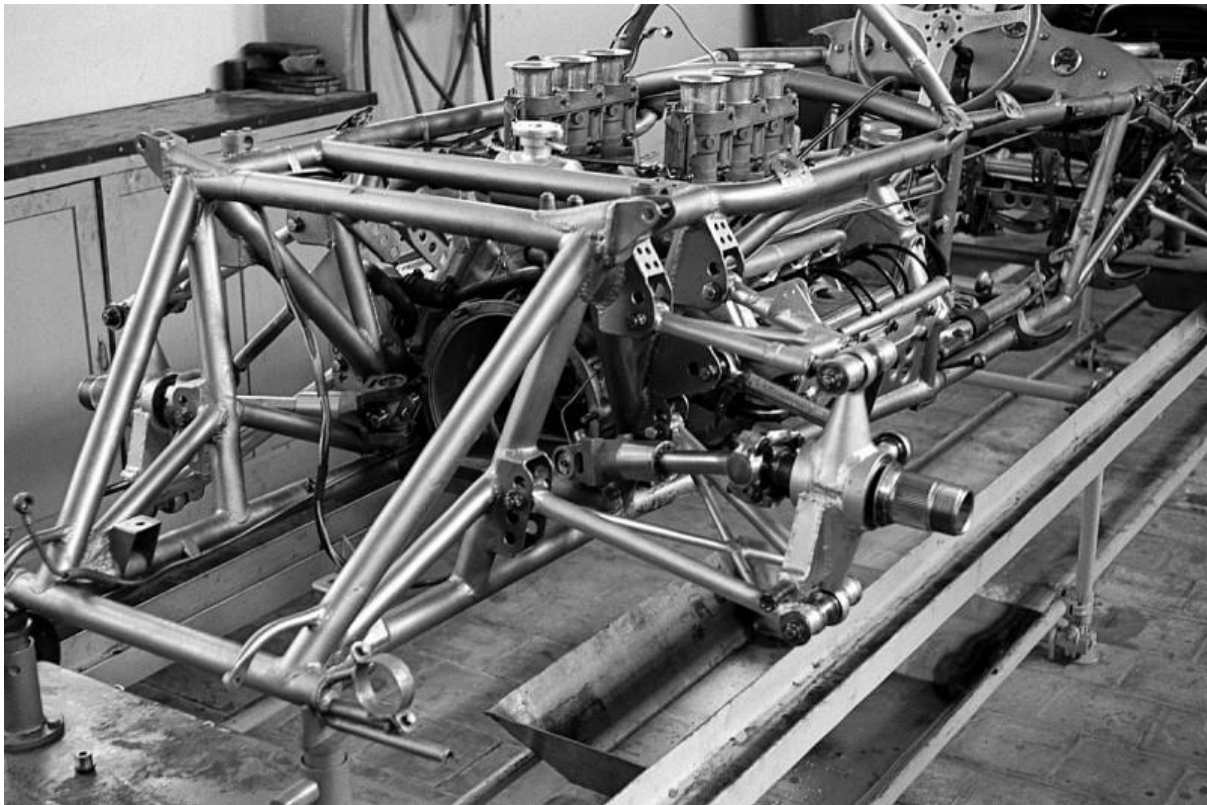


Figure 1- Tubular Steel Chassis

This was the case until 1962 when the Lotus 25 was released.



Figure 2- Lotus 25 (1962)

Colin Chapman designer and team boss designed the very first version of the monocoque chassis. Which was the first fully stressed chassis to appear in Formula 1. This design carried all the suspension loads, with the rear suspension being attached directly to the chassis, while the front suspension was attached to a subframe which was bolted onto the monocoque design. This design also had the engine sat at the rear directly behind the driver. (Rendle, 2024)



Figure 3- Picture of the Lotus 25 chassis

The car was built out of L72 aluminium alloy which was formed into box sections which were then built and riveted around the driver's seat, with fuel boxes being placed on both sides of the internal area of the frame to take up the wasted space. This design was nicknamed 'the bathtub' as it was so compact that it looked like the drivers were lying down instead of the traditional sitting position. (F1

Technical, n.d.) This design made the car stiffer and increased torsional rigidity while also providing a lighter structure. From here teams followed Chapman's lead and began their own research into this new design. (Partridge, 2022)

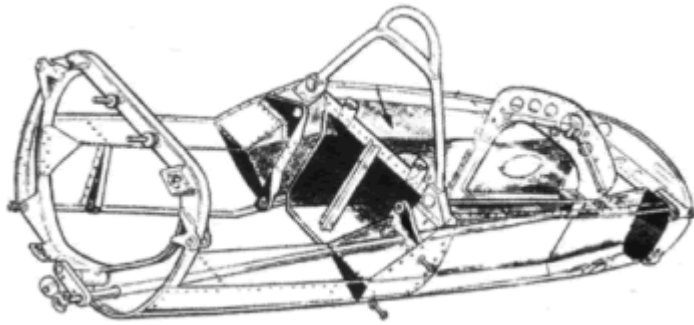


Figure 4- Drawing of the Lotus 25 chassis

This led to the teams beginning to investigate the use of composite materials to build their chassis. The first team to race with composites was the 1965 McLaren M2A, which was built using panels of Mallite. Mallite was made up of a core and outer shell. The core is an end grade balsa wood while the shell was layered sheets of aluminium. This design however was not picked up and continued with McLaren as they decided to go in a different direction. (Formula 1 Dictionary, n.d.)

Composites did not make another appearance until 1981 when McLaren designed the first car to compete with a carbon fibre safety cell, this was the first time carbon fibre had been seen on the vehicles, a change that would last for a long time. At this time Lotus were also working on their own carbon fibre composite using a carbon and Kevlar epoxy resin in place of the pre bonded aluminium skins. (Partridge, 2022)

It wasn't until 1983 when head engineer at McLaren John Barnard designed the first moulded carbon fibre chassis that was used on the McLaren MP4/1.



Figure 5- McLaren MP4/1

This design consisted of a layer of honeycomb aluminium that had been encased within these carbon fibre skins. Up to 12 layers of this skin had been used along with an epoxy resin and this design turned out to be 2 times stronger than steel but 5 times lighter. While also increasing the chassis torsional rigidity a significant amount. (Khabiri, 2015)



Figure 6 - Chassis of the McLaren MP4/1

This design has since become a staple in the motorsports industry due to its strength to weight ratio, and protective capabilities, with currently 60-70 percent of the structural weight on an F1 car being made from carbon fibre. (Autosport, 2022)

3. Discussion

3.1 How a Carbon Fibre Monocoque chassis is made

The carbon fibre monocoque is the chassis design that is still used to this day and has become a mandated rule by the FIA. Today all the chassis used in F1 are hand made using a carbon fibre composite material.

Carbon fibre is typically made from polymer molecules that have been bonded by carbon atoms. This is then woven into fabrics, with the strength coming from the higher number of fibres in a compacted area. These weaves come in many different designs but the most common are the plain weave, twill weave and harness satin weave. These each have different strengths and weaknesses so their use will be varied depending on design.

From here these weaves are layered on top of each other in varying directions depending on the anticipated loads in the differing areas of the chassis. Between these layers will sit an aluminium honeycomb to further add to the structural strength. This will then be placed into an autoclave where it will be heated in negative pressure. This will cause the shell to harden and give it its desired properties. (Formula 1 Dictionary, n.d.)

3.2 The properties and advantages of Carbon Fibre

The chassis is a critical part of the car's performance today and must be able to withstand many forces so that it can maintain structural integrity and provide the driver with consistent performance when dealing with the varying mechanical and aerodynamic loads from the drivetrain, steering and nature of the track. In more recent times the aerodynamic loads have overtaken the mechanical loads so when the chassis is designed the aerodynamicists often take the lead on shape to design the fastest car on the grid. (Rendle, 2024)

The carbon fibre monocoque chassis has the highest strength to weight ratios compared to other materials such as aluminium or steel. While also having an extremely high heat tolerance, high torsional rigidity, and the ability to absorb high amounts of energy when there is an impact. The only downside to using a carbon fibre chassis is that it is very expensive for the teams to produce, which can put the smaller teams at a disadvantage as they will have less money to spend elsewhere on the car.

3.3 F.I.A's rules and regulation

Before 1985 teams were allowed free reign on their car's safety however due to the level of accidents and fatalities and the negative press that came along with these incidents, the FIA took the decision to

begin regulating the overall car build to improve driver safety. They decided to create new regulations stating that crash testing was to be carried out on all chassis before the car was allowed to compete. Over the years these tests have become increasingly more stringent, and there are now multiple strict requirements that these chassis must meet before they are deemed race ready. (Formula 1 Dictionary, n.d.)

A leading example of these changes was the new regulation to further protect the drivers' legs within the chassis. To do this the FIA imposed a rule that the first layer inside the cockpit must be made from a carbon fibre/Kevlar composite to further increase the strength and rigidity of that specific area.

The regulations continued to develop until we get to the current specifications of the 2024 season. The information regarding the chassis for 2024 can be found in the technical regulations under Article 12. This consists of the general requirements and definitions, the survival cell specifications, the roll structures, cockpit specifications and cockpit padding. Before moving on to Article 13 which talks in detail about the safety structures and homologation. This list talks in detail about all the tests that the safety structures of the cars must go through it includes, the general principles, the survival cell frontal impact test and survival cell load tests, which further includes.

The fuel tank side test

Wheel contact side test

Floor test

Cockpit floor test

Cockpit rim test

Cockpit side tests 1 and 2

The nose push off test

Engine separation test

Forward survival cell test

More information on these tests can be found on the FIA technical regulations document which can be found in the reference list below. (Federation Internationale de l'Automobile, 2024)

4. Conclusion

In conclusion the chassis of a Formula 1 car has changed quite drastically over the years, from originally being made from sheet metals moulded into a cockpit to nowadays being a nearly indestructible carbon fibre 'survival cell' whose design is heavily influenced by regulations set out by the FIA for driver safety and the teams aerodynamicists who try and make the car as competitive as possible, while staying as close to the minimum weight regulations as possible.

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