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**The development of the survival cell
within Formula One cars**

Academic skills (ACHA4005)

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Introduction

The purpose of this paper is to explore and analyse the development and implementation of the survival cell (better known as the tub) within Formula One racing. The intent is to show how the survival cell first started compared to how it is now and how the developments have improved safety.

Background / Contextual

The survival cell (the tub) is the central part of an F1 car, being where the driver is seated it is necessary for it to be nearly indestructible to prevent death or severe injury. It is currently being made of carbon fibre layers at 6mm thick with added layers of zylon at the back to increase the strength of the tub.

Discussion

The carbon fibre composite survival cell was first introduced in the 1980s in the McLaren MP4/1C. It was the first Formula 1 (F1) car to utilise a full carbon body (pirancomposites.com, february, 2024) and the only one of its kind for the time, compared to now where composites are an integral piece within the construction and manufacturing of all F1 cars. The survival cell has evolved overtime from being about 60 layers of carbon fibre to absorb the impact of the crash to now, where the carbon fibre is still 60 layers with a roll hoop behind the drivers head, the flanks of the survival cell “the tub” are protected by 6mm layers of carbon with Zylon, one of the materials used to make bullet proof vests (thepitcrewonline.net, august 2018). This addition to the flanks of the car make it so the tub is nearly impenetrable and protect the drivers spine to lower the risk of fatal or life altering injuries.

The beginning of a carbon fibre tub started in 1981 with McLaren and Lotus both working on a carbon fibre chassis / survival cell, however Lotus designer Colin Chapman was the first person to create the tub as a light casing made of metal over the tube frame that was classic of the time. (colinchapmanmuseum.com, 2024)



Figure 1 - a model of the chassis using a mannequin illustrating the form and function of the tub.

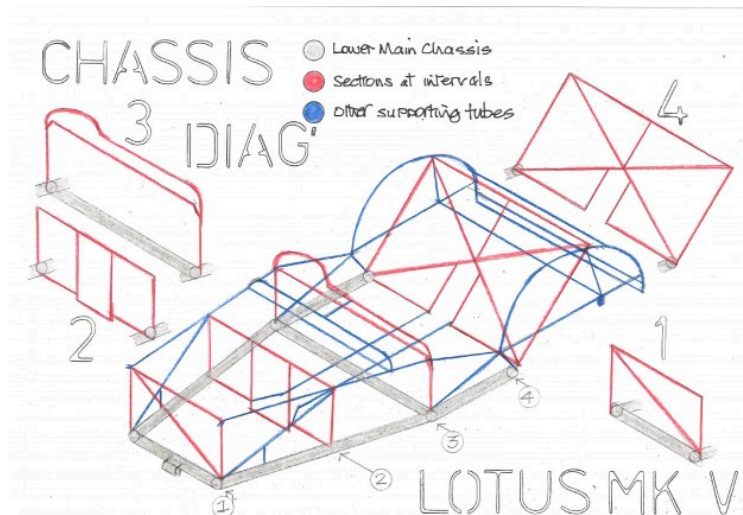


Figure 2 - Diagram displaying the 3D nature of the tubs new metal frame design.

McLaren was the first team to create cars with the carbon fibre survival cell for a Formula One race in 1981 at the same time Lotus was developing the same tub however were just using a method known as “cut and fold” where they replaced bonded aluminium with carbon fibre and kevlar epoxy, McLaren however did not do this, instead creating the tub with moulded carbon fibre and aluminium in a sandwich method. (Formula1-dictionary.net)



Figure 3 - The McLaren MP4/1C carbon fibre moulded tub.

McLaren first outsourced the building of their survival cell to Hercules Aerospace company in the United States instead of using their own facilities meanwhile Lotus opted to build their in-house with their own facilities.

McLaren used a method where sheets of carbon fibre would be wrapped around a mould where aluminium honeycomb would then be layer on top and finally more carbon fibre would be layered again, this a tub 3,5mm thick, there would often be up to 12 layers of this on top of each other.

After 1981 Williams also started using the honeycomb shell with its debut being the 1982 belgian grand prix. Other teams also adopted this over the years, especially after John Watson crashed during the 1981 Italian grand prix and was able to walk away unscathed.

In 1983 Gustav Brunner worked alongside Tim Wardrup to create a tub that also worked as the primary body work of the car, this made the car lighter, thinner and shorter than the previous ATS D3. (Formula1-dictionary.net)

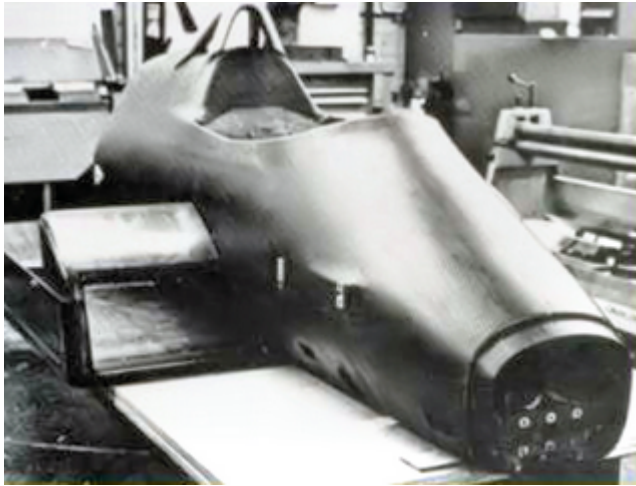


Figure 5 - New survival cell for the ATS DS6 from 1983.

Ferrari also adopted this design soon after due to the positive effects on the car. However other teams opted to use the new version of the tub other teams used but continued using separate bodywork.



Figure 4 - Ferraris first full carbon chassis.

In the 2000s the cars took on a less boxy, more complicated shape meaning that the shell was broken up into smaller sections and then sealed or bonded together to still create the impenetrable shell needed to protect the driver. 12 layers of carbon fibre mats are placed one over the other into a mould and depending on the load the part would encounter these were woven and placed together in different ways (F1chronicle.com, 2022). This was then heated in the autoclave to harden and become strong enough to protect the drivers in the event of an accident.

Over the years the FIA have introduced a number of tests for the survival shell and introduced new rules for the part itself. The FIA introduced crash tests to ensure that the tub would protect a driver in the even of a crash, these tests for the rear and sides of the survival

shell were made mandatory in 1985 with them getting tighter and tighter over the years to ensure driver safety. If the survival shell does not pass the test during preseason testing the car is not allowed to race. The FIA is also concerned about the shell's ability to withstand penetration, especially after Schumacher's crash in the 1990s where his leg was broken during the silverstone grand prix where a part of the front suspension had penetrated through into the shell. Due to this incident the FIA determined it is mandatory for the inside of the tub to be made of kevlar.

In order to ensure the driver is as comfortable as possible within the cramped tub the FIA mandated that there should be minimum dimensions for the tub to prevent injury.
(F1chronicle.com , 2022)

There have been more features added to the tub over the years including a fire suppression system that can be triggered by both drivers and marshals alongside a medical warning light that can tell the extraction team if the tub has suffered a significant impact that may mean the driver is injured and so extra care must be taken when getting the driver out.
(redbullracing.com, 2018)

Another safety piece that is inside the survival shell is a customised seat that is specifically moulded to the driver, this seat is specifically designed to bring the driver the most comfort alongside being safe, these seats can be extracted without having to cut straps or undo the harness within the car, thus acting as a backboard of sorts for the driver in the event of a crash.

Conclusions

Overall the survival cell has developed dramatically from its first inception, from a metal frame concept in the 1980s to a sophisticated highly regulated piece that has saved countless drivers lives and saved many more from injury in 44 years.

The survival cell is critical in Formula One, starting out in inception to increase efficiency and aerodynamics and now playing a critical role throughout Formula racing and the wider motorsport community.

References

1. pirancomposite (2024). *F1 Composites: Revolutionising Formula 1 Racing Technology*. [online] Piran Advanced Composites. Available at: <https://pirancomposites.com/news/f1-composites/> [Accessed 17 Nov. 2024].
2. Prentice, J. (2018). *Safety in Motorsport: the Monocoque*. [online] ThePitcrewOnline. Available at: <https://www.thepitcrewonline.net/2018/08/02/safety-in-motorsport-the-monocoque/> [Accessed 17 Nov. 2024].
3. The Colin Chapman archive (2024). *The Lotus Mk.VI: Six of the Best*. [online] Colinchapmanmuseum.co.uk. Available at: http://www.colinchapmanmuseum.co.uk/?page_id=2067 [Accessed 17 Nov. 2024].
4. formula1-dictionary (n.d.). *Monocoque*. [online] www.formula1-dictionary.net. Available at: https://www.formula1-dictionary.net/monocoque.html#index_top_page [Accessed 17 Nov. 2024].
5. f1chronicle (2022). *What Is A Monocoque? | F1 Chronicle*. [online] f1chronicle.com. Available at: <https://f1chronicle.com/what-is-a-monocoque/> [Accessed 17 Nov. 2024].
6. Redbullracing.com. (2018). *Bulls' Guide To: Car And Driver Safety*. [online] Available at: <https://www.redbullracing.com/int-en/bulls-guide-to-car-and-driver-safety> [Accessed 17 Nov. 2024].