

University of Wales Trinity Saint David

Wales Institute of Science & Art



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

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Jeremi Gumapos

2305861

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1 Introduction

Tasked to research and write a report on a chosen technical topic. The report is to be written clearly and effectively describing ideas and concepts relevant to the subject and referencing appropriate resources to support the research. The chosen subject is Motorsport Engineering.

2 Motorsport Engineering

2.1 Evolution of Aerodynamics in Motorsport

The development of aerodynamics in motorsport has improved over time starting from 1920's automotive design to present-day aerodynamic developments.

The first car to be aerodynamic or streamlined was called the Rumpler Drop, also called the Rumpler Tropfenwagen. The designer of this car was an Austrian Engineer named Edmund Rumpler designed in 1921. During this era, there was no foundation of how cars should be designed to be aerodynamic, therefore there was a ton of room for designs, innovations, and experimentation. Figure 1 shows the design of the Rumpler Tropfenwagen. (Blackstock, 2022)



Figure 1 Rumpler Tropfenwagen, 1921 (Blackstock, 2022)

As time went on, in the 1930s, aero became a larger part of car design and was influenced by aeronautics. In the early 1930s, Austrian engineer Paul Jaray who also designed zeppelins helped design a car with Hans Ledwinka, Erich Ledwinka, and Erich Überlackner called "Tatra T77". It was the first car to be aerodynamically tested thanks to Paul Jaray's connections at Luftschiffbau Zeppelin. The Tatra T77 was tested in a wind tunnel facility. Figure 2 shows the Tatra T77. (Branch, 2023)



Figure 2 Tatra T77 1934 (Branch, 2023)

Though aerodynamics isn't simply about the car versus the wind, cars can also take advantage of wind by downforce. Downforce is the increased vertical downward force onto the tires of the car for better tractions, especially through corners.

Wings were first introduced in the 1960s in the world of racing, installed high above the back of the car with the wing being upside down. Rear wings create low pressure below and high pressure above the wing creating a downforce on the rear of the car. (AUSBODYWORKS, 2019)

Lotus was the first team to install rear wings on an F1 car in the 1968 Monaco Grand Prix. Lotus had to balance the car and, therefore, added small wings in front. (Fagnan, 2018)

In the 1970s, Formula 1 teams began to experiment with aerodynamics that could affect the ground effects of the car. There were no regulations for ground effect at that time, therefore, allowed cars to be wide and have large wings. They also added low skirts that ran along the side of the car, creating an effective seal under the car creating low pressure while encountering high pressure on top of the car. This resulted in a suction increasing the traction of the car. An example of this is the Lotus 78 designed by Colin Chapman and Peter Wright. (Hunter, 2023). Figure 3 shows the design of the side skirt.



Figure 3 Low skirts of the Lotus 78 (Classic Lotus Team, 2021)



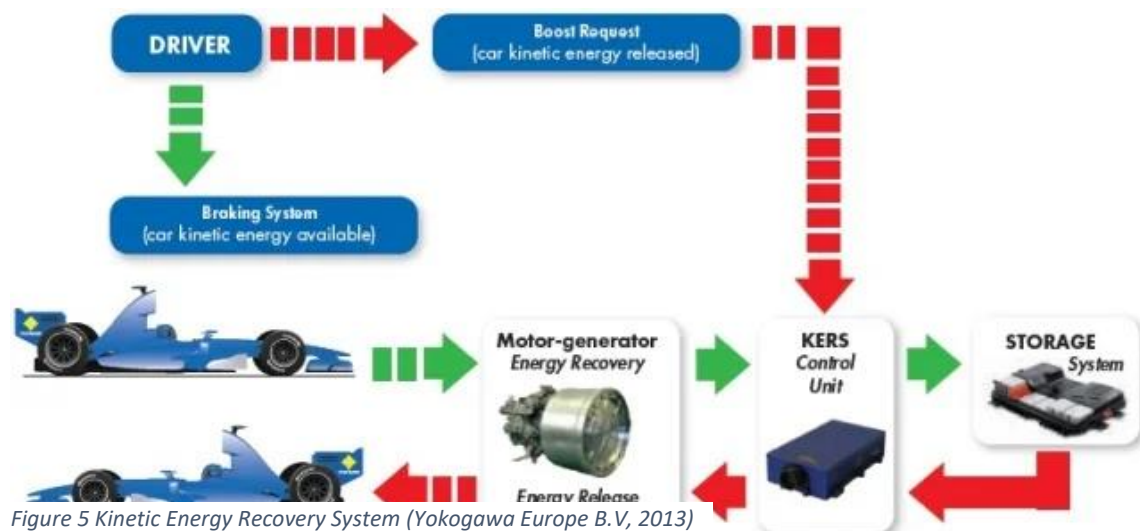
Figure 4 Fan on the back of Brabham BT46B (Smith, 2021)

Another notable example of the use of ground effect during the 1970s was the Brabham BT46B designed by Gordon Murray and Ralph Bellamy. This featured a fan behind the car allowing the car to have a much lower pressure under the car effectively creating more downforce. (Hunter, 2023).

As teams from F1 pushed the boundary of ground effect aerodynamics, The FIA began to impose much stricter rules on the design of the cars, banning the use of low skirts, and fans and having cars to have flat bottoms. This ended the utility of the ground effect in F1, and teams turned to other aerodynamic solutions to create downforce. (Hunter, 2023).

2.2 Implementation of Hybrid Technology in Different Motorsport Series

In 2009, the Kinetic Energy Recovery System (KERS) was introduced in F1 to direct F1 engineering to develop greener technology. KERS is a way of storing kinetic energy that is lost by braking to enter a corner. This creates a waste energy in the form of heat from the friction of the brake pads. That waste energy is stored in a Motor Generator Unit-Kinetic (MGU-K) where it is then utilised by the system which the driver can use later to recover. When the energy is expended, the power created is merged with the engine's output by an electric motor generally located at the front end of the crankshaft. FIA regulates the power output of the motor. In the early system, the power is capped at 60kW (around 80bhp). Later, the limit was raised to 120kW (nearly 160bhp) in 2014 due to the use of a weaker 1.6-litre V6 engine which replaced the older engine 2.4-litre V8. (Abidi, 2022). Figure 5 shows the Kinetic Energy Recovery System.



In the World Rally Championship 2022, Schaeffler subsidiary Compact Dynamics provided all manufacturers in WRC with an innovative hybrid system. The hybrid system is a small design that combines a motor-generator, control unit and a battery with 3.9wKh capacity which weighs altogether just 87Kg. The driver has an addition of 100kW extra boost on top of the 286kW (385bhp) of the internal combustion engine.

The system can recharge through the recuperation of braking energy during the stages. (Schaeffler AG, 2022). Figure 6 shows the Hybrid System.

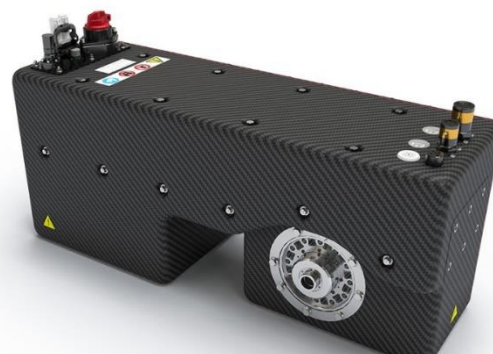


Figure 6 Hybrid System by Schaeffler (Schaeffler AG, 2022)

2.3 How data acquisition and data analysis contributes to on-track performance

Many teams and manufacturers in the motorsport industry collect huge volumes of real-time data on and off the track during racing competitions in large volumes. These data contain the car and the car engine data that guide the drivers and the engineers to understand the vehicle in a dynamic environment. The data collected data from the vehicle during a race helps racing teams make vital decisions when reading the behaviour of the vehicle. Engineers have different ways of collecting data. An example would be collecting data from vibration, heat monitoring and other different sensors transmitting live data to a data logger. (LightningChart, 2023).

In Motorsports, every second in every lap counts. Drivers are given decisions by their engineers based on millions of data points that were transmitted from the car to the teams' transmitter. The visual data is displayed on the racing engineers' dashboard and whether a decision is made and communicated to the driver. Data can also be used against rivals. Race engineers can keep track of their driver and their rivals' driver. This allows the team to formulate a strategy on a real-time analysis. (LightningChart, 2023).



Figure 7 LightningChart Test Logger (LightningChart, 2023)

Regarding real-time analysis and performance, engineers rely on high-performance charting controls and data loggers to render live data smoothly. Performance can be affected by the drivers themselves but, miscommunication of data can happen between the driver and their team. High performance is key to being ahead. (LightningChart, 2023). Figure 7 shows a test logger.

2.4 Use of Carbon Fibre in Motorsport

Carbon fibre is used in motorsport because of how lightweight the material is. It contributes to the weight-to-power ratio of a car. An ideal car in motorsport must be lightweight and powerful to allow quick acceleration and reach top speed at a faster rate while also being nimble going through corners. In motorsport, Carbon fibre gives an advantage to get more performance out of the car. Even if the car has enough horsepower to counter the weight of the car, it would only be great going in straights, but it would be terrible through corners. That's why carbon fibre is used. (SMITEAM, 2019).

Another factor why carbon fibre is used is because of its durability and strength. The drivers must trust their vehicles and go through multiple laps without parts breaking. Racing puts a lot of strain on the vehicle, that's why carbon fibre is utilised because it is very durable. Strength also comes into play, the faster the car is going more pressure is applied to the material for downforce. Every ounce of weight matters in motorsport. (SMITEAM, 2019).



Figure 8 Carbon fibre on an F1 car (Sutton, 2022)

Carbon fibre has a low heat conductivity compared to other materials used, therefore engineers would only have to monitor the heat coming from the car parts and the heat won't alter the integrity of the carbon fibre. It also has a low thermal expansion meaning that the carbon fibre won't expand or weaken from the heat. On top of all the elements that it is exposed to, it is the perfect material to be used for motorsport from other materials due to its lightweight and material properties. (SMITEAM, 2019).

3 Conclusion

Overall, motorsport has evolved and improved over time. From the early concept and design of aerodynamics in the 1930s from using aeronautics to using the ground effect in the 1970s with designs that place high pressure on top of the vehicle to take corners at higher speed. The implementation of hybrid technology in motorsport to counter the problems of the environment. Introducing greener technology and allowing to use of heat energy to gain performance. Data acquisition and data analysis help engineers understand the behaviour of the vehicle in racing conditions and create decisions for the drivers to make in real-time. The use of carbon fibre and favoured more than other materials due to its lightweight and high durable properties making it the best option for motorsport.

4 References

- Abidi, Y. (2022, December 19). *How does KERS System in F1 Cars Work?* Retrieved from MAKEUSEOF: <https://www.makeuseof.com/how-the-kers-system-in-f1-works/>
- AUSBODYWORKS. (2019, July 14). *What is a Spoiler on a Car and what does it do?* Retrieved from AUSBODYWORKS: <https://www.ausbodyworks.com.au/blogs/articles/whats-the-point-of-a-rear-spoiler>
- Blackstock, E. (2022, March 16). *This Is The Rumpler Drop, The World's First Streamlined Car.* Retrieved from JALOPNIK: <https://jalopnik.com/this-is-the-rumpler-drop-the-worlds-first-streamlined-1848661136>
- Branch, B. (2023, March 3). *The Remarkably Futuristic Tatra T77 from 1934.* Retrieved from SILODROME: <https://silodrome.com/tatra-t77-car/>
- Classic Lotus Team. (2021). *Secrets of the Lotus 79 Skirts.* Retrieved from ClassicLotusTeam: <https://classicteamlotus.co.uk/en/news/posts/2021/secrets-of-the-lotus-79-skirts/>
- Fagnan, R. (2018, January 31). *The First Appearance of Wings on Formula 1 Cars.* Retrieved from Motorsport.com: <https://au.motorsport.com/f1/news/1968-first-wings-f1-1000902/1389077/>
- Hunter, J. D. (2023, January 17). *The Original Ground Effect F1 Era.* Retrieved from WHEELSPORTS: <https://wheelsports.co/the-original-ground-effect-f1-era/>
- LightningChart. (2023, October 12). *Motorsport Analytics for Accelerating Performance on Car Racing Competitions.* Retrieved from LightningChart: <https://lightningchart.com/blog/motorsports-analytics/>
- Schaeffler AG. (2022, January 20). *Hybrid System from Schaeffler Subsidiary Compact Dynamics Revolutionizes World Rally Championship.* Retrieved from SCHAEFFLER: <https://www.schaeffler.com/en/media/press-releases/press-releases-detail.jsp?id=87764289>
- SMITEAM. (2019, September 25). *Why Carbon Fiber Car Parts are the #1 Choice in Auto Racing.* Retrieved from SMICOMPOSITES: <https://www.smicomposites.com/why-carbon-fiber-car-parts-are-the-1-choice-in-auto-racing/>

Smith, D. (2021, November 9). *SPECIAL: Won and done - the Brabham BT46B 'Fan Car'*. Retrieved from RACER: <https://racer.com/2021/11/09/special-won-and-done-the-brabham-bt46b-fan-car/>

Sutton, M. (2022, July 2). *How carbon fibre technology is shaping F1's new era*. Retrieved from Motorsport.com: <https://www.motorsport.com/f1/news/how-carbon-fibre-technology-is-shaping-f1s-new-era/10386218/>

Yokogawa Europe B.V. (2013, July 3). *Kinetic Energy Recovery System for the Automotive Industry*. Retrieved from AZOMaterials: <https://www.azom.com/article.aspx?ArticleID=9503>