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Technical Report

Introduction to Automotive Engineering (ACHA4009)

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Chapter 1 – introduction

This technical report will evaluate the Red Bull RB8 and how topics covered during the semester such as aerodynamics, materials, and data analysis, have influenced the design and production of this Formula 1 championship winning car from 2012. The RB8 has been chosen for this technical report as it was a highly engineered race car with various amounts of components which impacted the design of the vehicle, this makes it a great example to talk about when evaluating the different topics that have been discussed throughout the semester. The RB8 was produced by Red Bull Racing in 2012 to compete for the Formula 1 world championship which they had won in the previous 2 years. In 2012 the RB8 won a total of 8 races and gathered 14 podiums between the 2 drivers of Sebastian Vettel and Mark Webber (Red Bull Racing , 2023), their total amount of points at the end of the season was 460, this was 60 more than Ferrari that finished 2nd in the constructors championship.

Chapter 2 – impact of the topics

2.1 – Aerodynamics

Aerodynamics played a massive role in the development of the RB8, from the flexible front wing to the DRS activated rear wing. Red Bull in its more recent years has been known for its unique and outlandish designs when it comes to aerodynamics partly down to their head of aerodynamics Adrian Newey. In 2012 Red Bull made a new design in aerodynamics to compensate for the loss of the double diffuser they used in previous years. Red Bull and Adrian Newey made an aerodynamic design which would rearrange the rear exhaust system to redirect air to the direction of where the tyres would compress at the rear of the car (Figure 1). This would generate more downforce in the exit of low-speed corners.

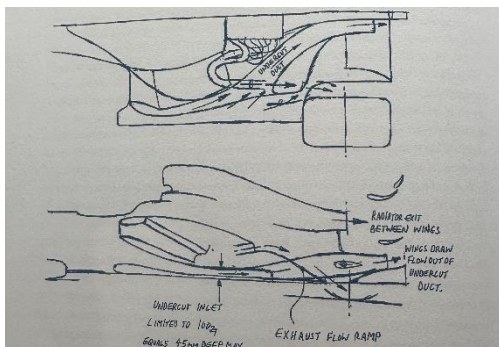


Figure 1: sketch of the exhaust with its ramp down to the rear squish area and undercut duct beneath it. (Newey, 2017)

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A detailed view of a Honda engine, likely a VTEC model, showing the intake manifold and valve train components. The engine is shown from a side-on perspective, highlighting the intake manifold and the valve train mechanism. The engine is illuminated with a warm, golden light, emphasizing its metallic surfaces and complex internal components. The background is a neutral, light gray, providing a clean backdrop for the engine.

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it possible for Red Bull to run more aggressive strategy in races, which meant that they could run longer stints on the same set of tyres during the race. Overall, the RS27 engine was an extraordinarily strong package that led Red Bull and Sebastian Vettel to win both constructors and drivers world championships.

2.3 – Hybrid systems

Hybrid systems were introduced into Formula 1 in 2009 with the implementation of KERS (Formula 1, 2022). KERS is the kinetic energy recovery system used to gather lost energy when a car is braking, this energy is stored and then used under acceleration later in the race (Racecar Engineering , 2023)(Figure 4).

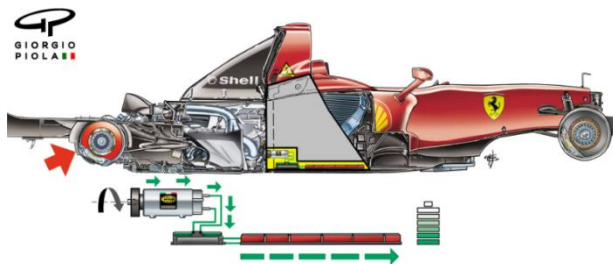


Figure 4: visual representation of KERS working under braking. (Formula 1 , 2017)

The KERS hybrid system was implemented into the RS27 engine that was produced by Renault for Red Bull in the 2012 season. The hybrid system was partially effective due to its small and lightweight design, this eliminated the impact on the cars overall weight and handling during a race weekend. The hybrid system allowed the cars to maximise its performance on the track partially in the straights and while overtaking. Since the implementation of the original KERS, hybrid systems have changed a lot in the more recent years. From 2014 onwards all Formula 1 engines have been turbocharged V6 engines with an electric motor and energy recovery system (Figure 5) , this is a huge change compared to the RB8 which solely relied on a combustion engine for



Figure 5:Hybrid Turbo V6 Engine (Josheph, 2014)

power. The new hybrid systems bring advantages like increased power output and reduced emissions which Formula 1 is pushing for with their Net Zero plan. Net Zero 2030 is a plan made by the FIA and Formula 1 to reduce the emissions created in Formula 1 races by using more sustainable technology and resources such as the hybrid engine (Formula 1 , 2022).

2.4 – Data Analysis

Data analysis would have been a key component during the design and development stage of the RB8. Compared to the previous year regulations had changed and major parts of the car that led to Red Bulls success had to be changed and redesigned. One of these key components was the double diffuser. The double diffuser was an aerodynamic technique that used airflow that passed under the car to create downforce (Somerfield & Piola, 2020). In 2012 Red Bull used Data gathered from the previous year to construct their new Exhaust-Blown Diffuser design. Data collected seemed to show that with the exhaust blowing into the double diffuser design there was more downforces being generated on the exit of low-speed corners (Newey, 2017). This led to the Red Bull and Adrian Newey creating the new Exhaust-Blown diffuser from the Data they had gathered in the previous year. Data is used extensively in Formula 1 and would have made a huge contribution to the design and development of the RB8. On car sensors, Aero rakes (Figure 6), telemetry, and simulation all play a role in the data analysis of the car while in development and throughout the Formula 1 season (Swinhoe, 2018).



Figure 6: Aero rakes being used to collect airflow data. (Formula 1 , 2023)

On car sensors would have been used during the 2012 season on the RB8 to collect real time data on various parts of the car's performance, these would include acceleration, speed, tyre wear and fuel consumption. These key aspects would have contributed to the development to the car thought the season. In more recent years it has been seen for teams to be collecting even more data with Mercedes claiming they collect 45 terabytes of data per week

(Swinhoe, 2018). Since the RB8 there has been continuous technological advances with data analysis and without them Formula 1 would not be where it is today.

2.5 – Materials

Many materials are used in Formula 1 but not all of them have as great effects on the car as others. In 2012 Red Bull produced a design of the flexible front wing (Newey, 2017). This design used rubber in the front wing so while the RB8 was under high airflow load the wing would manipulate and flex to let air flow under the car (Groote, 2012)(Figure 7).



Figure 7: Red Bull RB8 Front Wing (Red Bull, 2012)

This design is one of very few in Formula 1 that shows that not all materials used to make a significant impact on a car's performance must be expensive. Other materials that were used in the design of the RB8 were Carbon fibre, Kevlar, Titanium and Ceramic composites. Carbon fibre was used to create the RB8's chassis. The carbon fibre material was used as it was lightweight and strong, these components are needed in a competitive Formula 1 chassis. Kevlar was used in the safety feature called HANS (Head and Neck support device) a lifesaving restraint linkage that supports the drivers head and neck (Dupont, 2012). Another material that the RB8 had used in its development was Ceramic composite to create the brake discs. Ceramic composite has high heat and wear resistance making it a perfect material to use for the brake discs (Gasch, et al., 2005). The RB8's suspension components were made from Titanium, which was because they were strong and lightweight components which were needed for the success of the design of the RB8. All these materials were crucial to the design and success of the RB8 making the car lightweight, strong, aerodynamic, and safe.

2.6 – Simulation

Simulation had a crucial role in the development stages of the RB8. Simulation was used to optimise various aspects such as aerodynamics, suspension, and tyre wear. Red Bull used and created computer simulations to evaluate the cars performance to help them design different options and make more Data-driven decisions on what design choices would improve the RB8's performance on track. CFD (computational fluid dynamics) (Femto Engineering, 2023)

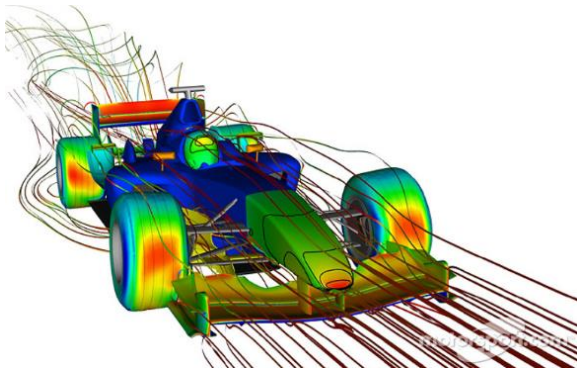


Figure 8: Computational Fluid Dynamics simulation on a Formula 1 car (Boxall-Legge, 2018)

simulations were also used in the development of the RB8 to examine the airflow around and underneath the car to improve the overall aerodynamics and downforce (Newey, 2017).

Red Bull use simulation throughout the Formula 1 season for different weather and track conditions, these simulations contributed to the success of the RB8 at every race weekend as many simulations are run to compensate for any situation during a race (Aston Martin F1, 2022).

Chapter 3 – Current state of the industry

In the current state of the Formula 1 industry in the past 30 years there has been a strong push for more safety. Safety increases can be seen with the new Halo design that is now implemented to every Formula 1 car. The Halo is a device that sits above the cockpit and the drivers head and is connected by 3 panels to the car.



Figure 9: Halo device seen on the 2023 McLaren.

The Halo is said to have given the drivers a 17% increase in chance of survival (Woodhouse, 2022), this percentage increase can be seen with there being far less driver injuries because of the Halo since its implementation. The current state of the automotive industry has also made its effect on Formula 1 industry with its new push for more sustainable fuels and technologies to be used in F1, this initiative is called Net Zero and pushed to reduce carbon emissions to 0% by 2030 in F1 (Formula 1, 2022).

Chapter 4 – Conclusion

Red Bulls RB8 was a brilliant work of engineering and made them a three-time constructors championship winning team at the time in 2012. From the aerodynamics of the flexible front wing to the Exhaust-blown diffuser, the RS 27 engine, and the KERS hybrid system the RB8 was made to perform. However, in the current automotive industry it would not be seen that way, The RB8 was an open throttle Fuel wasting car without the same standards that are held to a Formula 1 car today. The RB8 was a fitting Formula 1 car for 2012 but it would not be the same in 2023.

References

- Alpine, 2012. *Alpine Racing*. [Online]
Available at: <http://media.alpineracing.com/About-RS27.html>
[Accessed 17 April 2023].
- Aston Martin F1, 2022. *Aston Martin F1*. [Online]
Available at: <https://www.astonmartinf1.com/en-GB/news/feature/how-weather-influences-f1-race-strategy-presented-by-netapp>
[Accessed 18 April 2023].
- Boxall-Legge, J., 2018. *Motorsport.com*. [Online]
Available at: <https://www.motorsport.com/f1/news/fia-unrestricted-cfd-testing-explained/4315882/>
[Accessed 18 April 2023].
- Dupont, 2012. *Dupont*. [Online]
Available at: <https://www.dupont.co.uk/knowledge/automotive-industry.html>
[Accessed 18 April 2023].
- Femto Engineering, 2023. *Femto Engineering*. [Online]
Available at: <https://www.femto.eu/stories/what-is-cfd/>
[Accessed 18 April 2023].
- Formula 1, 2017. *Formula 1*. [Online]
Available at: <https://www.formula1.com/en/latest/article.re-writing-the-f1-rulebook-part-4-cleaner->

[cars-kers-and-return-of-slicks.1NUrjG83a6aE0QSuAkGK8.html](https://www.f1technical.net/development/20809/red-bull-rubber-nose-flexing-confirmed)

[Accessed 18 April 2023].

Formula 1, 2022. *Formula 1*. [Online]

Available at: <https://www.formula1.com/en/latest/article.f1-continues-push-to-hit-net-zero-carbon-by-2030-target.7fGtPCNCwOnMFFt9Ys1HAa.html>

[Accessed 17 April 2023].

Formula 1, 2023. *Formula 1*. [Online]

Available at: <https://www.formula1.com/en/latest/article.from-aero-rakes-to-flow-vis-5-key-terms-you-need-to-know-for-f1-pre-season.10Cdt2TOEZ1rR7pgQhnMux.html#:~:text=Aero%20rakes%20are%20broad%20scaffolding,or%20simulations%20back%20at%20base.>

[Accessed 18 April 2023].

Formula 1, 2022. *Formula 1*. [Online]

Available at: <https://www.formula1.com/en/latest/article.watch-a-brief-history-lesson-on-the-evolution-of-formula-1-engines.4CePUwEOAwNKVaDeWCeFnW.html#:~:text=We%20also%20go%20back%20to,most%20efficient%20power%20units%20on>

[Accessed 17 April 2023].

Gasch, M., Johnson, S. & Ellerby, D., 2005. *Handbook of Ceramic Composites*. Boston: Print ISBN.

Groote, S. D., 2012. *F1 technical*. [Online]

Available at: <https://www.f1technical.net/development/20809/red-bull-rubber-nose-flexing-confirmed>

[Accessed 18 April 2023].

Josheph, N., 2014. *Autoblog*. [Online]

Available at: https://www.autoblog.com/2014/01/22/renault-energy-f1-2014-power-unit-official/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAACexYn4iYQpvjW7z6Xw_Jfk_vq83ERi9p5QDuob5YhKlgGOTWmx5mxMvaG3hTgckYp4T9NRU3MsPRjePAzrKJ5NBbhtwAY

[Accessed 18 April 2023].

Newey, A., 2017. *How To Build A Car*. Dublin: HarperCollinsPublishers.

Racecar Engineering, 2023. *Racecar Engineering*. [Online]

Available at: <https://www.racecar-engineering.com/articles/the-basics-of-f1-kers/>

[Accessed 17 April 2023].

Reb Bull, 2012. *Oracle Red Bull Racing*. [Online]

Available at: <https://www.redbullracing.com/int-en>

[Accessed 18 April 2023].

Red Bull Racing, 2023. *Oracle Red Bull Racing*. [Online]

Available at: <https://www.redbullracing.com/int-en/cars/rb8/>

[Accessed 17 April 2023].

Renault Group, 2012. *Renault Group*. [Online]

Available at: <https://www.renaultgroup.com/en/news-on-air/news/f1-new-rs27-engine-australian->

gp/

[Accessed 18 April 2023].

Somerfield, M. & Piola, G., 2020. *Autosport*. [Online]

Available at: <https://www.autosport.com/f1/news/banned-the-double-diffuser-that-triggered-an-f1-development-race-4982556/4982556/>

[Accessed 18 April 2023].

Swinhoe, D., 2018. *IDG connect*. [Online]

Available at: <https://www.idgconnect.com/article/3582953/how-formula-1-evolved-into-a-data-first-sport-on-wheels.html>

[Accessed 18 April 2023].

Woodhouse, J., 2022. *Planetsport*. [Online]

Available at: <https://www.planetsport.com/motorsport/news/all-you-need-to-know-halo-about-f1-halo>

[Accessed 18 April 2023].