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The development of aerodynamics in rallying

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1. Introduction:

Aerodynamics in rallying has changed dramatically over the years by having regulation changes to make the cars faster. Aerodynamics is an important factor in rallying due to the road changing with every corner being different. The FIA has changed the regulations of rallying to try and improve the performance level of the sport by adding aerodynamics in recent years, but in the 1990s, aerodynamics wasn't a big factor of the sport, but the sport itself was very competitive and at a high level of performance without the effect of aerodynamics. Which makes people think if aerodynamics in rallying the best option with the amount of time the teams spend on upgrading these packages on the car to upgrade the performance level. The development of wind tunnels has helped the teams upgrade certain parts of the car to increase the performance level.

2. Research/Background:

2.1 – Group B

Rallying between the years 1960-1980 was road cars modified with the safety requirements of rallying and aerodynamics wasn't a big factor in the sport at all. It was the 80s that aerodynamics was starting to get more popular with rallying with Group B era starting to develop standard road cars such as the Audi Quattro and Peugeot 205, adding front spillers and rear wings onto the cars. The MG Metro 6R4 was a car that changed dramatically from its standard road car into the Group B rally car with Formula 1 engineers helping to make the car more competitive. The 6R4 was the first car in the WRC to use a front wing and the rear wing was developed by British formula 1 engineers from Williams F1 Team. Because of the data and wind tunnel Williams F1 team had then knew that their front wing work well aerodynamically which they decided to use as the front of the Metro 6R4. Since they had engineering help from Williams F1 tea, the Metro 6R4 had the technology and the advice that they needed to improve the car by using the knowledge from a top Formula 1 team. They used aluminium as the material of both front and rear wings since it improved the handling of the car. (llluis555, 2016)



Figure 1- MG Metro 6r4 (<https://www.linkedin.com/pulse/mg-metro-6r4-pugnacious-powerful-daring-different-great-nick-wells>, Nick Wells. 2022)

The Metro 6R4 was a car that changed aerodynamics in rallying especially in Group B, but from 1986 to the early 2000s, rally cars competing in the WRC was mostly a standard road car but with the added safety features needed to correspond with the regulations set at that time.

Aerodynamics wasn't a big factor in the Group A era of rallying, but rally team still used wind tunnels to change small factors of the car to be faster and competitive. This era of rallying was more concentrated on the engine to make more power rather than aerodynamic.

2.2 – Aerodynamic change in regulations

Aerodynamics became a big factor in rallying again in the years 2010 to today by the changes in the regulations. The regulation changed in 2017 to make the cars more aerodynamically to improve the speed throughout the rallies, this was the most aerodynamic era in the history of WRC which left the manufacturers changed most of the body panels to reduce drag and make the air that's being broken through active the rear wing to make the car more stable in corners. Manufacturers that were competing in WRC (Ford, Toyota, Hyundai and Citroen) added lips to the front bumpers to make the air flow to the roof of the car and to the rear wing to improve the grip levels on the road. They also made changes to small details of the car such as the wing mirror to make the car faster and make airflow active the primary aerodynamics. By adding these small aerodynamic features, the manufacturers were trying to improve performance and maximise the performance of the cars.

2.3 Wind tunnels in rallying:

Rally teams over the years have used wind tunnels to look at certain parts of the car to improve for the season ahead. Some WRC teams have used a 1:1 scale of the car to know exactly the air flow of the car when rallying to show which sections need to be upgraded and changed. One example of a rally team using the wind tunnel is Mitsubishi in 2004 with their Lancer WRC.



Figure 2 - Mitsubishi Lancer 2004 in wind tunnel ([Transforming Rally Car Aerodynamics - The Mitsubishi Lancer WRC04](#), Lluís Vazquez Vilamajo, 2020)

This is an example of a scaled car in a wind tunnel with the engineers of the team using paint to show the air flow of the car at speed. The idea of putting a scale model of the full car is one that is heavily used to the WRC teams to show the whole cars air flow at different scenarios of the wind tunnel proses to show which sections need to be upgraded through the season. The rod that is located on the windscreen of the car is built to the modelled car to create and measure drag and air flow under conditions that will be experienced while rallying over the season. The use of the wind tunnel is a good factor of the sport in the aerodynamic department to develop and upgrade the package of the car to increase the level of performance and to get the best result at the end of the season (Vilamajo, 2020).

3. Discussion

By researching at different eras of rallying and the regulation changed throughout the history of rallying, aerodynamics has been a big factor towards improving the performance of the cars and making the championship more exciting. The regulation changes have been made throughout the years to make the cars perform better but has it made a change that they were hoping for.

3.1 – Comparing Average Speeds of different eras

By researching on certain eras of rallying and the regulation changes been made and comparing the same rally location in different years its shown that the speed of the cars hasn't changed a lot throughout the years. By comparing a stage from Rally Finland, Ouninpohja, times have been faster in recent years and a factor of that is because of the aerodynamics. The stage is a 33 km stage ran in the same direction in 2004 and 2024. Of course, the cars have been made more durable for jumps by improving the suspension to help the cars land better to keep the speed. But, throughout the years, the stage time has improved by around 30 seconds. The speed of the cars in 2004 completed the stage at an average speed of 127.8kph and in 2024 the speed has increased to 133kph, which shows that aerodynamics can help the speed difference due to the cars having a small horsepower difference.

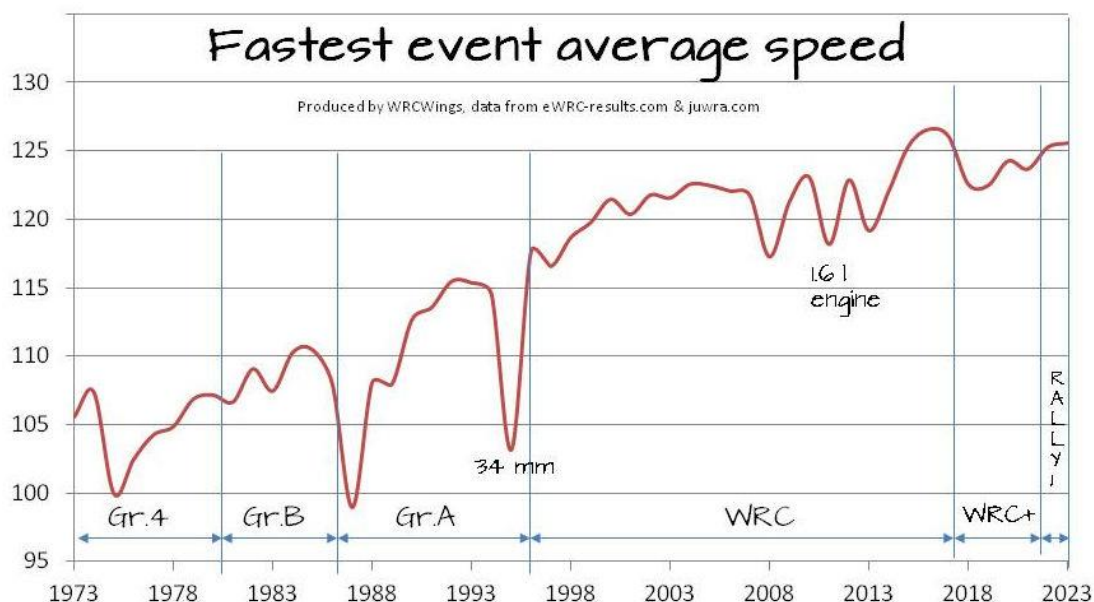


Figure 3 - Graph of average speed of fastest event in different eras and years (<https://www.wrcwings.tech/>, Illuis555, 2023)

By looking at the graph above, there is a clear difference of average speed from the start of WRC in 1973 and to 2024. The cars made a vast difference in speed in the group A era between the years 1988 and 1998 which is where aerodynamics wasn't a big factor to begin with. By comparing Group B rallying (1980 – 1986) to Group A rallying (1987-1998), there was a big drop of speed at the start of the group A era but as the teams started to develop the cars the speed increased without changed the aerodynamic package on the car, which implies that the aerodynamics of the Group B era wasn't effective to the performance of the cars to compared with the less aerodynamic chassis of the cars in Group A.



Figure 4 - Audi Quattro S1 (Group B)
(<https://www.thedrive.com>, James Gilboy, 2020)



Figure 5 – Subaru Impreza 1995 (Group A)
(<https://www.rallylegend.com/>, Press Release, 2023)

But as they changed the regulations at the start of 1998 the speed slightly increased from 1998 to 2007. When the FIA changed the rallying regulations in 2008, the aerodynamic package on the cars started to increase with including a rear wing to make the car more stable on the stages and make the air flow active the rear wing to improve traction and stability of the car. Between 2008 and 2013, the speed increased and decreased within the different years. When the WRC allowed the manufacturers to add more aerodynamic features for the 2015 season, the speed started to increase again fast and peaked at the big regulation change in 2018. After the 2018 season, cars started to decrease in speed but having the same aerodynamic packages on the cars which led the FIA to make the Rally1 cars have a hybrid powertrain to increase the horsepower when the battery charged and to boost the cars acceleration on slower corners.



Figure 6 – Ford Puma Rally 1
(Wikipedia, 2024)



Figure 7 – Ford Fiesta WRC+
(<https://www.wrcwings.tech/>,
Illuis555, 2020)

This graph shows that aerodynamic doesn't make such of an improvement in performance because of the 2 regulation changed in 1987 by banning the Group B era of rallying which was highly based on aerodynamics and engine power, and also banning the WRC+ era of 2017-2021 which was the most aerodynamically era of rallying to date, didn't improve the performance of the cars that the regulations tried to imply with the changes made.

4. Conclusion

In conclusion, aerodynamics in rallying has changed dramatically over the years with the changes made in the regulations. By researching about different eras of rallying with aerodynamics being an important factor in the research, the results I have discovered shows that aerodynamics doesn't make as much of a change as what the regulations set by the FIA implied. Which shows that the modern rally1 cars doesn't need as much aerodynamics to increase the performance level as intended by looking back as the performance level in the 1990s where aerodynamics wasn't a big factor compared to how much aero is on the car currently.

5. Reference Page

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2. [Transforming Rally Car Aerodynamics - The Mitsubishi Lancer WRC04](#) – Figure 2 – Lancer 2004 in wind tunnel.
3. [Stage results Neste Rally Finland 2004](#) – Stage time of Ouninpohja stage 2004.
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6. <https://www.thedrive.com/news/32165/this-audi-sport-quattro-clone-is-your-cheap-ticket-to-a-group-b-rally-experience> - Figure 4 - Audi Quattro S1
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8. https://en.wikipedia.org/wiki/Ford_Puma_Rally1 - Figure 6 - Ford Puma Rally1
9. <https://www.wrcwings.tech/2020/10/06/m-sport-evaluates-modifications-to-the-fiesta-wrcs-front-air-package/> - Figure 7 – Ford Fiesta WRC+