How did the risks Mercedes took for the 2014 season define an era in Formula 1?

By Jamie Woodward 4B

Formula 1 (F1) is not just a sport about driving as fast as you can around a track. It is also about manufacturing the fastest car within the regulations. However, these rules are always changing, in part triggered by risks taken by the best engineers, designers, and manufacturers. As summed up by Adrian Newey “Every time we push the boundaries, we invite scrutiny, and the regulators respond by tightening the rules. It is a constant game of cat and mouse.” (Newey, 2019). “In Formula One, the challenge is not just to build a fast car, but to do so within the confines of the regulations, which are often a moving target.” (Newey, 2019) These technical innovations introduce many risks, especially considering the introduction of the cost cap in 2021 set at $135m; thus, if you invest a lot of your time and money into a concept and it fails, that can completely ruin your season. Technical risks are even more acute for smaller teams because a greater proportion of their finances are derived from their finishing position in the Constructors’ Championship.

Occasionally, technical risks can lead to step-changing performance improvements. Following the 2008 financial crisis, Honda felt compelled to leave F1, resulting in the sale of the teams’ assets to Ross Brawn for £1 (Brawn: The Impossible Formula 1 Story, 2017). Despite an impossibly small budget of £100m especially when compared to the over £350m budget of McLaren, Ferrari, and Toyota (The Autosport Forums, 2011), Brawn found a loophole in the regulations which allowed them to create a double diffuser (which accelerates the air beneath the car reducing the pressure [Bernoulli's Law] increasing downforce – Brawn took this further by starting the diffuser around the board at the bottom of the car increasing the amount of downforce created even more than with a single diffuser). This led to Brawn winning 6 of the first 7 races of the 2009 season. Naturally, other teams copied this innovation meaning that Brawn’s advantage was short-lived but still resulted in one of the most legendary stories in modern F1.

The Formula 1 search for technical loopholes in the regulations is best summed up by “Newey saw a loophole in the new regulations and, in the best traditions of aerodynamics, exploited it to the full” (www.autosport.com, n.d.). The innovations that Brawn made were outlawed by the 2010 regulation changes, meaning that when Mercedes acquired the team, they had to find new areas to exploit.

In 2014, F1 completely overhauled the technical regulations around the engine changing it from a 2.4l V8 engine to a 1.6l V6 engine (FIA, 2011). One of the most significant changes was the addition of the turbo through the Motor Generator Unit – Heat (MGU-H) and Motor

Generator Unit – Kinetic (MGU-K). Mercedes had a head start on this due to their early development into the kinetic energy recovery system (KERS) in 2009, which was the foundation of the new turbo and the Brixworth factory was already prepared for it. This condensed the development time and effectively let them create another iteration of the engine versus its rivals (THE RACE, 2020). For this season Mercedes took the approach of creating 3 different engine designs, one for reliability, one for performance and one as the "race variant". This allowed them to focus on each area without compromising on the others. In July of 2013 they were far behind schedule. Mercedes changed the priority from winning the championship to just being ready in Australia (the first race of the season); staff agreed to do an extra 10 hours of work a week and non-essential tasks were ceased. The 3-engine strategy led to the most uncertain start of a season Mercedes had experienced so far, as it was slightly over-ambitious given the limited design and manufacture time available. If they did not finish the engine in time, it would not only compromise their season but also expose them to reputational risk especially as they were contractually bound to supply engines to Williams, McLaren, and Force India by October 2013. This further increased the risk of trying to design 3 engines at once.

The triple engine plan arose from the introduction of a performance group comprising of senior members from each department that would help centralise the goals of all the areas of development. The first product of this group was the 2013 car which was overall the second-best car ahead of Ferrari but behind Red Bull (Formula 1® - The Official F1® Website, 2024). In 2014, the results of this performance group included the split turbo charger and a steering system that moved backwards and forwards (The Race, 2020). The split turbo charger was comprised of a compressor and a turbine, located at the rear of the engine; the exhaust fumes power the turbine and the compressor, generating excess heat. The super-heated, compressed air could not be fed directly into the engine and had to be cooled in a radiator located in the sidepods of the car. Mercedes' innovation was moving the compressor in front of the engine and connecting it to the turbine via a shaft running through the middle of the engine, resulting in a multitude of benefits: the compressor was cooler as a result of being nearer to the air inlet, the air was travelling through shorter pipe work thus reducing the turbo lag, and therefore reduced utilisation of the Energy Recovery System (ERS). The reduced cooling requirements allowed for smaller sidepods (The Race, 2020), thus improving aerodynamic efficiency. Additionally, the rear of the engine was cooler, so the gearbox could be situated underneath the engine, improving balance and weight distribution (Reddit.com, 2019). Ferrari was only able to achieve this feat 3 years later in 2017.

In F1 there is a continual balance to be struck between developing the current car in order to gain or retain and advantage or get a head start on the following year's car. For Mercedes the dilemma was two-fold, whether they had sufficient advantage over Red Bull to win the Championship, and whether their car was sufficiently reliable to avoid DNF. Mercedes opted to focus on the reliability of their car. These concerns meant that the focus was to make parts for the 2014 car. The performance group produced an improvement in December which did not require an all-new cylinder head. This could provide a decent performance increase with a slight change. However, they required more funding from the Mercedes Company in Stuttgart, luckily this request was accepted. Mercedes struck gold again in February in Bahrain at preseason testing where they produced a performance improvement that Andy Cowell, Engineering director, described as “one of the biggest I’ve ever seen.”

The fuel load changed from 160kg in 2013 to 110kg in 2014 and the fuel flow rate was limited to 100kg/h and strictly monitors the rate. As a result of the limited amount of fuel available on the cars and the ban on refuelling in 2010, F1 teams had to run a mix of fuel and air. In order to make the fuel last longer, the amount of the air in the fuel mix (running lean). However, this can lead to incomplete combustion which leads to unburned fuel in the engine which almost always results in loss of power. The innovation Mercedes made was adding a smaller chamber near the spark plug which ignites the fuel called the pre-chamber. When the fuel is injected, it creates a richer area of fuel, so the fuel ignites every time. The smaller chamber led them to having the ability to spread the reaction over a larger area of the outer chamber and run the fuel leaner. It created more power as more reactions were happening per second. This process is called Turbulent Jet Injection (TJI). Running the fuel very lean while having complete combustion, allowed Mercedes to use less fuel, push for longer and run lighter than other teams. As a result, they were getting 1000hp with 1/3 of the fuel of previous regulations (www.youtube.com, n.d.).

Unlike Red Bull, which was focused on the present and near future, Mercedes always focused on the long-term horizon. Red Bull continued to develop the car right until the end of the season, whereas Mercedes switched focus to the next year’s car around halfway through the year. Team members who later joined the Mercedes team from Red Bull confirmed that they were worried about the performance of the W04 (Mercedes’ 2013 car) and therefore continued to work until the season’s end (Brawn and Parr, 2017).

2022 saw the introduction of the new regulations including a cap to the budget, relating to the development and construction of the car. Mercedes pioneered the radical “zero sidepod” concept where there is a larger amount of exposed floor that could create

downforce, instead of the more conventional sidepod that accelerated air underneath the car. As a result of winning the 2021 Constructors' Championship, Mercedes received the lowest allocation of wind tunnel testing time, making them more reliant on CFD (computational fluid dynamics) to refine the aerodynamics of the car. Unfortunately, these simulations did not predict the porpoising problems that became apparent during pre-season testing in Barcelona. This meant that they had to run their car with increased ride height to prevent the porpoising, reducing their downforce and therefore increasing tyre wear in the corners.

One of the reasons for Mercedes' success was their culture, which encouraged taking risks without fear of the consequences for failure. Without this, many of the innovative designs, such as the split turbo would have never been imagined or created. This principle is applicable to both industry and education; as Harvard Business School reports, there are many ways to fail well by ensuring the organization learns from the failure and implements change as a result "While we tend to lump all kinds of failures together, experiencing them all as negative experiences in life or in business, Edmondson contends that some failures are smarter than others because they help us identify a path toward eventual success." (Harvard Business School, 2023). It is the post-failure analysis through rigorous review that is key to continual improvement, but for greater societal impact. It is important to share the lessons to avoid repetition of mistakes (Birkinshaw and Haas, 2016). If we were to apply this in a school context, pupils should be encouraged to undertake projects to extend themselves and analyse why they fail so the lessons can be taken forward into other endeavours. It was by creating a culture that embraced learning, agility, and team partnership that allowed Mercedes to create the most dominant era in F1 history.

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