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Importance of driving simulation in the development of the car and the driver.

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1. Introduction

This report will look at understanding the connection between driver and car development that the role of the driving simulator plays with focuses on Car Development, Driver Development, Synergy between Driver and Car, Simulation as a safety tool, virtual race strategy and real-time adjustments. Driving simulation is a growing technological advance applied to the development of the race and the driver. This report aims to understand this area in further detail to conclude why the use of a simulator proves to be beneficial in the overall development of the driver and the car.

2. Research Background

The use of driving simulators within the world of motorsport has significantly increased over the past few decades. Initially used as an additional tool, they have now become an essential part in race preparation, driver training and car development. The first concept of using a simulator in motorsport began in the 1980s when the complexity of race car design increased which demanded a more sophisticated way of testing and driver training methods. Early driving simulators were basic and often limited to arcade-style systems with minimal realism. Even with the limitations, the simulators introduced the concept of virtual racing environments and provided a clear foundation for future advancements.

As the progression of computing power improved in the late 1990s, driving simulators saw a significant jump in realism and functionality. The technology used in simulation became more accurate, which then saw a huge investment by top-tier motorsport teams such as F1. With the enhancements in the graphics and vehicle dynamics modelling, simulators could now recreate track conditions with greater precision, including providing details about tyre wear, fuel consumption and aerodynamics.

This period also marked the beginning of partnerships between racing teams and simulation technology providers. Motorsport organisations, especially F1 teams like Ferrari and McLaren, began to develop their own proprietary simulators to give drivers an edge on race day. These systems allow drivers to practise on upcoming race tracks and provided engineers with valuable data for car setup (Lloyd, 2024).

By the turn of the century, simulators became a central tool to motorsport training and race strategy. F1 teams were now using simulators to not only train drivers but to also optimise car design and performance. The enhancement of data-capturing simulators allowed engineers to experiment with car setups, identify any potential improvements, as well as allowing them to test any setup adjustments virtually before spending the money and manufacturing the upgrade to apply on track.

The use of simulators also became a detrimental tool for rookie drivers, who could learn new track layouts and improve their driving technique before the race. By the 2010s, lower-tier racing teams adopted simulators and implemented them into

training as simulators became more accessible and affordable. Simulators provided the teams with a cost-effective and efficient way of preparing for different tracks, weather conditions and race strategies.

The modern high-fidelity simulators are equipped with motion platforms and DITL (driver in the loop) systems which became standard in professional racing shown in Figure 1. (Gitlin , 2018). DITL simulators provided drivers with an immersive experience which allows them to have a prior interaction with the cars virtual controls and feel real-time feedback based on the simulator's response to their decisions and actions.

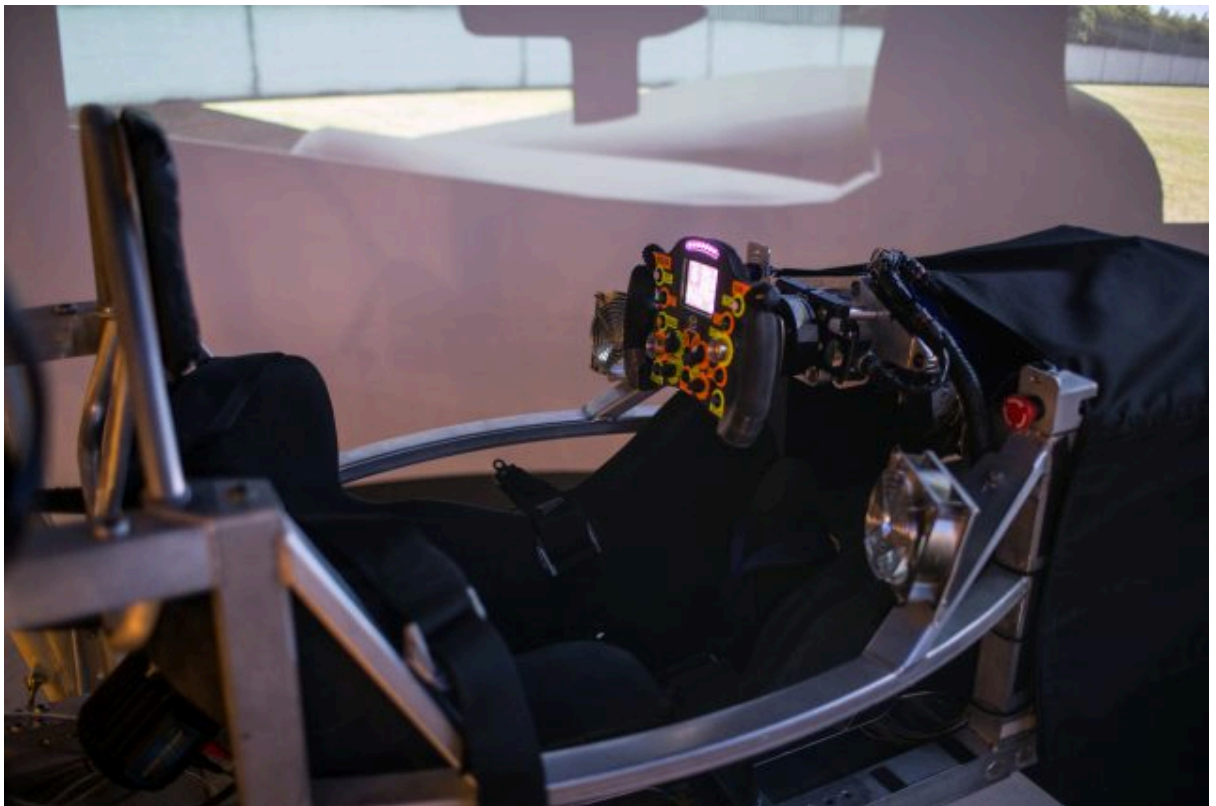


Figure 1: Driver-in-the-loop simulator (Gitlin , 2018)

The customisability of modern day simulators, allows teams to simulate a wide range of conditions, from tire degradation to specific race strategies that they may want to implement into future races. This also facilitates continuous driver development by providing instant feedback on a driver's technique, braking points and cornering.

3. Discussion

4.1 Overview

Driving simulation in the world of motorsport combines the use of hardware and software to replicate real-world track conditions. Modern Simulators used by Formula One teams could include a dynamic platform that mirrors (to an extent) the motion and g-forces that are experienced by the driver whilst in the car, but are replicated within a controlled setting. This is then combined with modern software to recreate accurate models of tracks, car behaviour as well as environmental conditions. The key areas that the engineers can look at are motion platforms: which provides feedback on areas like braking, acceleration and cornering forces, vehicle models: where engineers are able to understand the areas of the car such as tire behaviour, aerodynamics, suspension etc The data collected would then provide the teams with information on areas that need upgrading. In terms of driver development, the use of a simulator allows drivers to gain an understanding of any steering wheel upgrades as well as pedals or new tracks.

4.2 Car Development

The use of simulations allows engineers to set different setups and upgrades that they are wanting to bring to a race weekend for example aero packages, suspension settings and tire compounds in various track conditions without the expense and time of real-world testing, this helps to optimise performance before taking the car on track. Furthermore, with constant upgrades being brought to races and being worked on, the use of the simulator further allows the teams to see whether the upgrades bring the tools/drivability that the teams are lacking and further create load in areas they need.

Due to the nature of motorsport, it being fast paced, ensuring that the car is able to act accordingly is highly important. Race-car manufacturers Dallara Automobili found that the use of simulators helped to shorten product-development time as well as cost of testing and have found other advantages of the simulator in car development. 'Besides saving time and money, there are other advantages of simulator training for drivers. For example, training in the simulator lets Dallara optimise the car settings prior to a race, resulting in fewer training laps to reach the best settings. Race tactics can be discussed, prepared, and practised while using the simulator. Simulators are available at all times, unlike tracks which are bound by

time limitations.’¹ In motorsport the main aim for teams is to win races while conforming to a set of regulations. When regulation changes occur, development of the current car goes on the backburner slightly while the teams start thinking into the future instead of the present. The simulator is a beneficial tool for teams to have especially during times of regulation changes, as this allows teams to quickly modify the setup of the car between a Friday and Saturday of a race weekend prior to parc ferme.

4.3 Driver Development

The use of a simulator when a young driver is learning a new track could be crucial to the performance outcome. Allowing track familiarisation, allows the driver to gain confidence on tracks that they will be driving on throughout the race season.

Formula one grade simulators regularly incorporate motion platforms with six degrees of freedom, which is designed to mimic the movements on track. This allows drivers to provide close to spot-on feedback and further improve their performance as well as help the team to find and create sufficient upgrades.² Simulators are equipped with data analytic software that captures every aspect of the car and driver’s performance which helps engineers provide feedback to drivers to improve skill areas.

Grey (2023) wrote ‘Reaction time is critical in racing, where split seconds can mean the difference between winning and losing. Simulators allow drivers to practise their reaction times in different driving scenarios.’

It’s the thousandth of a second that can impact the outcome of a race. This further shows the importance of a racing simulator in the modern environment of motorsport racing and as time progresses simulators will be further prevalent in driver training and car development.

¹ ‘Simulator improves race-car performance’ (2013) *Machine Design*, 85(1), p. 24. Available at: <https://research-ebSCO-com.ezproxy.uwtsd.ac.uk/linkprocessor/plink?id=42e18ca8-097e-3dbb-9fbf-939417aec612> (Accessed: 16 November 2024).

² *Why do formula 1 teams need simulators* (no date a) *Motorsport Engineer*. Available at: <https://motorsportengineer.net/why-do-formula-1-teams-need-simulators/> (Accessed: 16 November 2024).

4. Conclusion

In conclusion, Driving simulation technology has transformed both vehicle development and driver training by offering safe, cost-effective and an efficient alternative. In vehicle development, simulators enable engineers to optimise safety, performance and driver experience. For driver training, simulators allow individuals to improve skills and prepare for challenging scenarios in a risk-free environment. As technology within motorsport advances, simulators are going to become an integral part in the automotive industry as well as the motorsport industry.

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