

# **Safety at the Forefront of Racing**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Car crashes are undesirable. Car crashes at upwards of 100 miles per hour are way less desirable. In fact, from 2011 to 2015, “NASCAR race cars experienced a crash rate 134 times larger than passenger vehicles per mile... for the same five years passenger vehicle occupants experienced a 9.3 times larger injury rate, which includes injuries to driver and passenger vehicle occupants” (Patalak et al., 2020, p. 6). Since the deaths of Ayrton Senna in 1994 and Dale Earnhardt in 2001, Formula One and NASCAR, two of the world’s top racing series, have made tremendous steps forward in safety methods to prevent further deaths from occurring. Bruno Latour’s actor-network theory states that technologies are developed through the relationships and connections between humans and nonhumans (1992). Safety improvements in racing have been created through the mutual discussions and interactions between many actors, including drivers, fans, racing teams, governing bodies for the sport, track layouts, and even weather conditions. Analyzing the changes that have been made in racing over the past 20 years will illuminate the vast progress which has been made. Every safety device has its purpose in protecting the driver in the vehicle, but many are implemented with backlash from certain actors. In almost every case, the governing body for the racing series had to use their authority to enact a change to the previous design. You’d think safety should be something all parties agree on. Yet, the actors disagree on almost all technologies that have been implemented, illustrating the importance of having a governing body to attest to safety.

## **Formula One**

Formula One (F1) is an open-wheeled racing series that travels around the globe, visiting five different continents during its 23-race season (Formula 1, n.d.). 20 drivers representing 10 teams race around circuits, exceeding 200 miles per hour. Fans, numbering 6.15 million in total, attended a grand prix in 2023 (Gassman, 2023). F1 has made a variety of adjustments to remain

the premier open-wheel racing series around the world, most notably improving the safety of drivers, fans, and personnel involved in race weekends.

Bruno Latour's actor-network theory states that "sociotechnical systems are developed through negotiations between people, institutions, and organizations" (1992). The theory illustrates how the different actors in a scenario, human and nonhuman, affect each other's actions and shape how technologies are developed. In F1, human actors include drivers, fans, the International Automobile Federation (FIA), and racing teams. Nonhuman actors are the cars, track design, and weather conditions. The dynamics between human and nonhuman actors in F1 will be analyzed to illustrate the effects of increasing safety in the sport.

In 1994, three-time Formula One world champion Ayrton Senna crashed into the wall on the seventh lap of the San Marino Grand Prix, killing him (Williams, 2010). The governing body for world motorsport, the FIA, has since implemented a variety of changes to the track so a crash like Senna's does not occur again. The track map of the 1994 San Marino Grand Prix is shown in Figure 1, where Senna's car continued straight when he was attempting to turn left at the flat-out Tamburello. A current picture of the circuit is shown in Figure 2. Since Senna's fatal accident, the track layout has been altered, adding chicanes at the once high-speed corners, forcing cars to slow down. Figure 2 shows a current image of the Tamburello, Villeneuve, and Tosa corners with the corresponding turn numbers from Figure 1. Not only have chicanes, two turns in quick succession in opposite directions, been added, but large gravel runoff areas have been added to slow the car down significantly if it goes off track. While cars that come to rest in the gravel pit are stuck, forcing the driver to retire from the race, this safety mechanism has provided much needed security for drivers in the event of an accident.

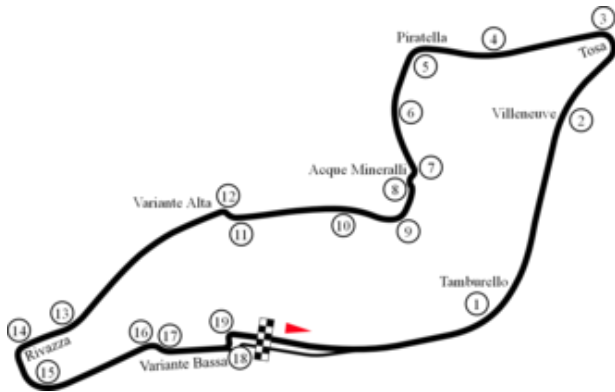


Figure 1 (left): 1994 San Marino Grand Prix Track Layout (Wikipedia, 2024a)  
 Figure 2 (right): Current Imola Track Layout, numbers added for clarity (Scuderia Ferrari Club, 2020)

Adjusting to the changes in track layout takes time, especially for drivers who have raced thousands of laps at a circuit. Surprisingly, drivers took the lead to initiate changes through a new Grand Prix Drivers’ Association, adding chicanes and other features to slow cars down through the highest-speed corners (Youson, 2019). Track design changes are not easy, as the FIA receives backlash from fans if they interfere with historic corners. The added safety means that tracks are slower and safer, drawing criticism from drivers and fans who believe cars should be pushed to their limits, regardless of the negative consequences. Disputes between the actors in F1 always end with one result: the FIA making changes to minimize the risk of danger, regardless of whether some drivers and fans disagree wholeheartedly.

Along with changes to track layouts, the FIA has also adjusted the car to protect drivers. Wheel tethers, which prevent the wheels of a car from flying off during collisions, were introduced in 1999 (Duxbury, 2021). While Senna’s cause of death could have been any one of three injuries, a rebounding wheel hitting him in the head almost surely was the fatal blow (Palmer, 2021). Elizabeth Blackstock writes that wheel tethers don’t seem to be reliably working (Blackstock, 2020). However, even she states that “the tethers at least absorb some of the worst

forces” and have saved plenty of lives in the process, which can still be considered a safety improvement.

In 2003, the Head and Neck Support (HANS) device was introduced to the cockpit of the car. It functions by “keeping the driver’s head and neck in line with the rest of his or her body, reducing the risk of serious head and neck injuries” (F1 Chronicle, 2019). Tethers prevent movement of the head and neck during impact, and the collar distributes the forces of an impact across the driver’s shoulders, reducing stress on the head and neck. Through a series of tests, it was shown that neck tension, neck shear, and total neck load were reduced by 81, 72, and 78 percent, respectively (Sherman, 2012). Invented by Dr. Bob Hubbard, the HANS device is now required in almost all racing organizations, and its effectiveness has reduced the risk of fatal or serious head and neck injuries by 88% (F1 Chronicle, 2019).

The latest change to the cars was the halo, which debuted in 2018. This device surrounds the driver and is “designed to withstand 15 times the static load of a Formula 1 car and a 20kg (44lbs) wheel travelling at 225kph (140mph)” (Ono, 2023). Drivers initially had mixed reactions to the halo being introduced, as Lewis Hamilton, widely regarded as the greatest F1 driver of all time, stated “I understand safety is a huge issue and something we have to work towards, but this is not the one” and Max Verstappen said “It’s not just the looks, I don’t think it is necessary” (Andrei, 2022). However, the device has proved useful in many scenarios, shown in Figures 3, 4, and 5. Figure 3 shows Fernando Alonso’s McLaren landing on Charles Leclerc’s Sauber with an estimated 56 kilonewtons, more than 5000 kilograms of force (Smith, 2018). In Figure 4, Verstappen’s car lands on Hamilton’s in a scary crash at Monza. Following the race, Hamilton said the halo saved his neck, the opposite to what he said three years prior (Andrei, 2022). Most recently, in Figure 5, Zhou Guanyu was flipped, skidded across a gravel pit, then catapulted over

the barriers at Silverstone before coming to rest. The halo saved him from being crushed while upside down, a testament to the advancements made in the sport.



*Figure 3: Fernando Alonso lands on top of Charles Leclerc (Smith, 2018)*



*Figure 4: Lewis Hamilton collides with Max Verstappen (Llewellyn, 2021)*



*Figure 5: Guanyu Zhou slides upside down (Erozden, 2022)*

Although many drivers and fans thought the halo was impractical, that did not stop the FIA from approving the change. In the end, even Verstappen and Hamilton, two of the halo's most outspoken critics, realized that it saved their lives. The science supports the decision, and even though some might still disagree with the decisions made by the FIA, the truth remains: the advancements made by F1 inside the car have, as described, saved many lives over the years since Ayrton Senna's death.

Finally, F1 has introduced changes to the pit lane and fan experience to protect more than just the drivers. In 2000, Michael Schumacher won the Italian Grand Prix at Monza. He was driving back to the pits when fans started to make their way onto the track. Shown in Figure 6 is the mob of fans he had to navigate through to get back to pit road. Not only was the situation dangerous for the fans who were putting their lives at risk, but it put Schumacher in a bad spot where he could face unfair punishment if he hit someone. Schumacher famously said, "the celebration at the end was for not killing anyone" (Bhattacharjee, 2022).



Figure 6: Schumacher Avoiding Fans on Track (TheRealLuke1337, 2023)

Since that incident, F1 is now keeping fans well off the track in grandstands. Grandstands not only keep the fans off the track, but they also sit behind fences to eliminate the possibility of fans being hit by flying debris from the track. The current Monza track map, with grandstands shaded, is shown in Figure 7. The track boasts a capacity of 137,000, so plenty of fans can pack into the stands safely (Red Bull, 2022). Upon the conclusion of the race, once all cars are back in the pits, fans can enter the main straightaway of the circuit to watch the podium ceremony, as shown in Figure 8.

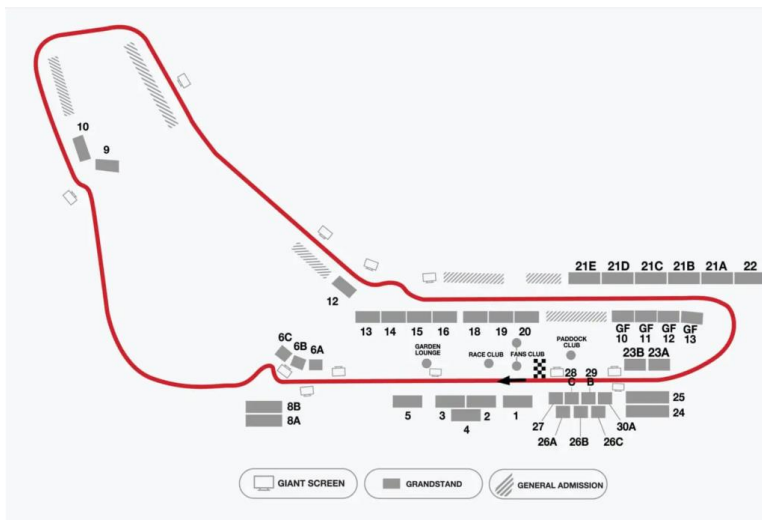


Figure 7: Monza Track and Grandstand Layout (GPGT, n.d.)





*Figure 8: Fans attend a postrace podium celebration (Walthert, 2013)*

Lastly, Formula One has implemented a pit lane speed limit of 80 km/h at all tracks, keeping the crew safe (Duxbury, 2021). In the past, there was no limit, and drivers would race down the pits, only feet away from crew members. This posed an incredibly risky situation and was amended to make sure no crew lose their lives in a preventable accident. While there was never much disagreement on how the safety of fans and crew members in the pits should be handled, the FIA enacted well-defined rules which have since remained.

Following the 2023 Qatar Grand Prix, Martin Brundle, a former driver turned reporter for F1, emphasized that he thought F1's decision to carry out the race was the right decision, even though there was a massive debate considering the incredibly hot and humid conditions (Saeed, 2023). I believe the mindset that drivers are athletes and should be able to suffer through treacherous conditions is a poor one. Sacrificing the safety of drivers, many of whom reported they were throwing up or on the verge of passing out in the car, should not occur simply to finish a race. Luckily, nothing catastrophic occurred, but I believe that in the future, a more cautious approach should be taken to protect all actors involved.

When looking at the changes made in F1 through the lens of actor-network theory, there are many actors involved, including drivers, fans, crew members, and the FIA. Changes to the tracks provide difficulty for drivers, who must relearn how to drive corners at high speed. Yet, many of them agree with the changes so none of their competitors have a fatal crash. Additionally, fans and crew members do not want to see their drivers in danger, so typically, all parties agree on how to proceed following fatal crashes. Unlike the changes to the track, the drivers and FIA disagree with new regulations in the cars. Verstappen and Hamilton were both outspoken adversaries to implementing the halo, as both thought it was unnecessary and would block their vision. Yet, even with several of the top drivers speaking out against the change, the FIA mandated the device, understanding that the greater safety of the sport was more important than the opinions of a few drivers. In the end, once Verstappen and Hamilton had a close call at Monza, their opinions changed, with Hamilton realizing that his life could've been in danger if not for the FIA's rules regarding the halo. Finally, fans always want to witness the race's action from as close as possible. However, the FIA makes sure that safety is the top priority, relocating fans to safe areas of the track to view the race from.

This analysis confirms that the FIA typically gets the final say in decision-making, regardless of what other's opinions are. This has historically resulted in developments to reduce injuries and deaths to drivers. Actor-network theory assumes that all actors hold equal power, yet this analysis shows that one actor, the FIA, holds significantly more power than any other. Furthermore, the other human actors in the scenario seem to hold power over nonhuman actors, as drivers and fans who have strong opinions about modifications to the sport put pressure on the FIA to make the decision that makes them happy. This exposes actor-network theory to critiques, as it does not represent this scenario well. The rules and regulations within F1 are strict and can

cause tension between the FIA, drivers, teams, and fans. However, these dynamics have continued to shape the design of the sport, making it clear that F1 is one of the top racing disciplines in the world.

## **NASCAR**

On February 15, 1948, at the Daytona Beach road course, the first National Association for Stock Car Auto Racing (NASCAR) race was run (NASCAR, n.d.). In the past 76 years, the sport has evolved in many ways, most notably in the tracks and their layouts, the design of the cars, and the rules surrounding the cars. While rule changes sometimes don't go over too well between drivers, fans, and NASCAR, each of these evolutions has contributed greatly to the improvement of safety over the years in NASCAR.

The 2001 Daytona 500 should have been a great day for Dale Earnhardt and his team's cars. On the final lap of the race, Earnhardt was running in third place behind two of his own team's cars, driven by Michael Waltrip and his son, Dale Earnhardt Jr. (Bradley, 2021). In the final corner of the race, Earnhardt's car got loose before sliding up the track, clipping Kenny Schrader. Earnhardt's car went head-first into the concrete wall, subjecting him to g-forces with a magnitude between 48 and 68 (Sologic, n.d.). Earnhardt was pronounced dead at the medical center after the race of a basilar skull fracture, an injury that had killed three other drivers in the eight months prior to the incident (Bradley, 2021). February 18, 2001 has since been known as NASCAR's darkest day, marking the last time a driver has died in a NASCAR-sponsored competition.

One of NASCAR's primary focuses following the death of Earnhardt was improvements to on-track safety. Steel and Foam Energy Reduction (SAFER) Barriers were created to

distribute the impact load of a car crashing into the wall significantly better than concrete walls, lessening the chance of injury to drivers. These barriers were installed at many tracks in 2002 following Earnhardt's death, and further coverage was installed at most tracks in 2015 (American Galvanizers Association, 2015). The barrier has been shown to reduce impact loads and vehicle decelerations by 30-80%. This improvement has prevented many drivers from suffering injuries since its debut. In 2008, the SAFER Barrier was patented, marking its impact on the sport (Faller et al., 2008).

Additionally, catchfences have been improved by making the chain-link mesh stronger, adding more reinforcement poles, and creating better links between the poles and mesh (Leslie-Pelecky, 2015). This has provided more safety for the fans, with less possibility of injury, as cars and debris do not fly into the stands as easily. In crashes where cars become airborne, typically at the highest-speed tracks, catchfences are extremely important for safety purposes. Austin Dillon, who was involved in a huge crash at the 2015 Coke Zero 400, pictured in Figure 9, stated after the race that "it's pretty impressive to see how far we've come after learning from other wrecks... The catchfence did its job. It kicked things back into the track where we needed to" (Ryan, 2015). Dillon's wreck shows how much care has gone into protecting drivers and fans at NASCAR's tracks.



*Figure 9: Austin Dillon's car flies into the catchfence at Daytona (Newsome, 2015)*

In 2003, the free pass rule was instituted (Crossman, 2021). The free pass allows the first driver who is one lap down from the leader to gain that lap back if a caution is thrown. Prior to 2003, drivers would continue to race back to the start-finish line attempting to pass the leader and get back on the lead lap before having to slow down for the caution. This was incredibly dangerous, and as seen through Dale Jarrett's crash in 2003 at New Hampshire, cars racing back to the caution flag can be especially threatening to the driver of the wrecked car on track, who is left helpless while cars fly past (George, 2021). Following Jarrett's crash, NASCAR made the change to the free pass rule, creating a safer racing environment.

Finally, NASCAR's safety team partnered with the American Medical Response (AMR) to increase on-track capabilities, which included adding a physician to the chase vehicle, which rushes to wrecked cars to check if drivers are seriously injured (Crossman, 2021). In serious crashes, this improved system helps medical professionals arrive at the car faster, giving the drivers a better chance of survival from potentially life-threatening injuries.

NASCAR has also greatly improved the safety of drivers in their cars. The primary mechanism introduced to stop incidents like Earnhardt's from occurring was the HANS device,

which has since been implemented in almost all top racing series around the world (NASCAR 101, n.d.). Mark Martin, a NASCAR driver alongside Earnhardt, said of the HANS device, “I would not wear one for anything. I’ll just keep my fingers crossed and take my chances” (NASCAR 101, n.d.). Brett Bodine, who began wearing the HANS device prior to Earnhardt’s wreck, was called names and questioned about his motives (Ingram, 2023). Even Earnhardt himself stated “Tie kerosene rags around your ankles so ants don’t crawl up and eat your candy ass” prior to the 2001 Daytona 500. Earnhardt’s words came back to haunt him later that weekend.

Current NASCAR drivers use a nine-point harness system for their seat belt (Crossman, 2021). Each belt is placed strategically around the driver to catch them in a variety of collisions, spreading the load out across their body to avoid severe damage to any specific area. The car itself has also seen improvements. The roll cage, designed with thick tubing, protects the driver in rollover crashes (Nice, 2001). The front and rear of the car is meant to crush slightly to help absorb impact. In addition, the front of the car is designed such that the engine is pushed out the bottom of the car, rather than into the cockpit, in a head-on collision.

The newest car model, the Next Gen car, has provided improvements to a variety of features. The car has new front and rear bumpers, which allow for better pushing at superspeedways and less chance of an accident (Taranto, 2022). Also, the front clip of the car was improved, increasing the amount of crush it is capable of withstanding during a crash. This reduces the acceleration the driver is exposed to during a frontal impact (Crandall, 2023). The safety upgrades inside the cars have contributed to overall driver safety in NASCAR since the 2001 Daytona 500.

Finally, NASCAR has changed the allowed racing packages at certain tracks to prevent dangerous speeds (Ramalingam, 2023). Joshua Lipowski, a NASCAR blogger for The Daily Downforce, writes “Adding more horsepower could vastly improve the racing product at many race tracks, particularly at short tracks. Many drivers and fans have been pulling for more horsepower” (Lipowski, 2023). Later in the blog post, he mentions that more horsepower would increase the speed of the cars and put the total horsepower closer to that of Formula One. While many fans and drivers want to see the highest speeds possible, I believe that NASCAR’s decision to keep the horsepower lower is the better decision for a few reasons. First, even the biggest tracks on the NASCAR circuit are smaller than that of F1. Therefore, the horsepower between the two series should not be compared. While the speed of the cars might increase with more horsepower, that does not mean the racing quality will improve, and the safety of the drivers would also be more at risk. Even though many might prefer having higher horsepower, I stand with NASCAR’s decision to keep the current horsepower configuration.

When looking at the changes made by NASCAR through the lens of actor-network theory, the human actors include drivers, fans, NASCAR, crew members, and nonhuman actors are the cars, weather, and type of track. On-track improvements, like SAFER barriers, catchfences, the free pass, and AMR safety team, were all implemented (Crossman, 2021). The scientific data behind these changes, along with the concrete evidence from being used in races, helped to make sure all parties agreed on their implementation. Many drivers, including Earnhardt, pushed back on increased safety in cars because more safety implied that a driver was weak and not meant for the sport (Ingram, 2023). Because NASCAR did not want to make the drivers and fans mad, they did not require the safety upgrades to be made. Not surprisingly, death can change a group’s decision-making about safety, as drivers began wearing the HANS

following Earnhardt's death until it was mandated 8 months later (NASCAR 101, n.d.). Finally, there are split opinions on the horsepower dilemma, which is still being debated (Ramalingam, 2023). Some drivers, fans, and crew members want faster cars, since they believe their driver is best equipped to win at higher speeds. However, others are unsure of how safe increasing speed could be and if it will increase the quality of racing. NASCAR currently has the stance that safety is the highest priority, and I expect that they will hold firm to that philosophy when making the final decision about horsepower.

With this analysis, it holds that NASCAR makes changes to increase safety in the sport. However, NASCAR is influenced by outside parties, like drivers and fans, more than F1 is. The dynamics between drivers, fans, NASCAR, crew members, and nonhuman factors all make NASCAR the premiere racing series in the U.S., and it has no intention of losing that status in years to come.

## **Conclusion**

Deaths in motorsport occurred quite frequently before the turn of the 21st century, yet adaptations to human and nonhuman factors at racetracks have limited serious injuries and deaths significantly in the past 20 years. Increased safety regulations are implemented by the FIA and NASCAR, the respective governing organizations in the disciplines analyzed above. While these organizations face controversy from time to time due to their decisions, it is apparent that they almost always choose to improve safety. F1 has only had one death since 1994, and NASCAR has remained death-free since 2001, illustrating the improved protection (Formula 1 Wiki, 2023; Wikipedia, 2024b). A safe environment for drivers, fans, and teams will provide more security from potential controversies in the sport, allowing for greater fan retention in years to come. This research provides many details about the current status of safety in racing, and it



begs the questions “how will F1 and NASCAR continue to make fans happy through the constant adaptations in the sport?” and “will F1 and NASCAR ever reach a point where the governing bodies have to surrender some power to the other actors?”, both of which can be answered in future research.

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