Lessons on Leadership and Learning from Motorsport

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The organisational culture found within professional sport is often put forward as an example for industry to look towards on how to improve its own performance. The history of safety within motorsport offers similarly important lessons on safety culture which are applicable in the Chemical and Process Industry, or indeed any industry.

This case study focuses on the introduction of the halo device into a number of prominent open wheel racing series, such as Formula 1 (F1), where it has been mandatory since 2018 (1). The halo device, so named because it consists of a bar surrounding the driver, acts to protect their head and neck from the impact of other cars, barriers, and debris such as loose tyres. It's introduction, which was at first controversial but has since been embraced by teams and fans alike (2), offers lessons on the role that leadership, learning and specific cultural context's play in creating a positive or negative safety culture.

By studying fatal accidents within three major open wheel racing series (Formula 1, Formula 2/GP2/Formula 3000 and IndyCar) between 1995 and 2019 it became clear that safety has improved over time. However, this also brought the few remaining areas of vulnerability into sharper focus and it has been apparent for some time that the exposed head and neck of driver's was a threat to their safety. Seven out of eight deaths in those series during this time frame resulted from injuries to the head of the driver which may have been prevented had their cars incorporated a halo device.

The opposition and reaction to this move also offers lessons on the topics of leadership, learning and unique cultural circumstances. A number of influential figures within F1, teams themselves and many fans opposed the decision to introduce to halo to F1 on various grounds, including its impact on the aesthetics of an F1 car. This opposition would be considered unusual when compared to our own industry, where it's hard to imagine a circumstance in which aesthetics could trump safety. However, it demonstrates that, whilst many factors are constants in influencing safety culture, each situation is unique and may carry unique challenges.

This opposition was successful in delaying the halo's introduction by a year however the governing body for F1, the FIA, eventually overruled the teams and mandated its use for the 2018 season. The halo was slowly accepted as part of F1, and the other series in which it was introduced, and has already been credited with saving the lives of numerous drivers. Most notably that of Romain Grosjean at the 2020 Bahrain Grand Prix. The willingness of the FIA to make an unpopular decision which could have harmed their sports appeal in order to improve safety is an excellent example of how leadership is essential in forging a positive safety culture.

These findings serve as a reminder that in order to create a positive safety culture we must be willing, to make unpopular decisions, and to face up to uncomfortable truths in order to learn the necessary lessons.

Keywords: Safety and Loss Prevention, Human Factors, Safety Culture, Leadership, Learning, Motorsport

Introduction

Human Factors

Historically the approach to preventing and investigating accidents has focused on technical failures and even when human error did play a role it may have simply been dismissed as carelessness and not symptomatic of a wider organisational problem which must be addressed. This approach neglects to consider how process and organisational factors may create a vulnerability to human error. However, as time has passed and our understanding of accidents and why they occur has improved this dismissive approach has become less prevalent as the inevitability of human error has been acknowledged (3). Even when the utmost care is being exercised, errors are still possible and it is unrealistic to expect such a level of care to be exercised at all times even though we may aspire to it.

Given the inevitability of human error it is unsurprising that human error plays at least some part in up to 80% of safety incidents in the process industry (4). If we wish to address this, then it becomes necessary investigate why and how humans make errors so we can implement measures which will either reduce the likelihood of them occurring or mitigate their consequences. There are many reasons why humans may commit errors, they may be a result of inadequate or flawed procedures, poorly designed control interfaces, or due to fatigue from excessive work. These reasons can be broadly categorized into Organisational. Environmental and Job factors (4). This research will be focused on organisational factors.

Organisational factors include things such as management systems, resources, communication & cooperation, and safety culture within an organisation. The organisation could be an individual plant, an entire company or more uniquely in this case, a sport (4) Specifically, we will focus on the concept of Safety Culture and within that the topics of leadership and learning.

Safety Culture

The concept of safety culture was first proposed by the International Atomic Energy Agency (IAEA) in the aftermath of the Chernobyl nuclear accident in 1986. The subsequent investigation determined that, as well as design faults, a poor attitude towards safety was pervasive within the plant and contributed to the incident directly (5). Since being introduced as a concept the recognition of its importance has grown and is now seen as a vital part of an organisation's safe operation

The definition originally proposed by the IAEA has been followed by numerous others in literature published since (6). These definitions vary significantly which has been a subject of criticism in some reviews (7). However, the issues of leadership and learning that will be discussed in this papet are commonly found throughout a variety of these definitions, a strong indicator of their importance regarding safe operation.

Leadership

The actions taken by those in senior positions or leadership roles are a vital component of an organisation's safety culture and safety performance. Not just due to the direct implications of their actions but also the signal this sends to others. Virtually every organisation will claim to value health and safety as one of their highest, if not their highest, priority. This may be true of some, but there have been many examples where these commitments have simply been empty words. Ultimately it will be the actions taken by leaders that demonstrate to subordinates their true priorities. (8). They will take note of this and, in order to protect their jobs, future employment prospects and to avoid causing conflict they will likely behave accordingly to satisfy their superiors.

In some cases, it is also necessary for leaders to challenge the attitudes and existing culture within an organisation. Motorsport is a good example of thus where a culture that to some extent covets danger exists (9). Effective leadership must be willing to challenge such attitudes.

Learning

Even in organisations or industries with good safety records and a positive safety culture, accidents or near misses can still occur. The reaction to these is an important factor in creating whatever safety culture may exist. These incidents should be treated opportunities to learn about vulnerabilities so they can be addressed to prevent future accidents (8). But the investigative process and implementation of potential recommendations requires the allocation of time and resources and may even expose uncomfortable truths. If proper investigations are not carried out and lessons are not learned then not only will vulnerabilities persist but it will be a clear indicator to stakeholders that safety is not a top priority within the organisation

Safety in Motorsport

The history of motorsport has seen almost constant evolution with regard to safety. From a time when drivers raced without seatbelts or helmets, taking in risks which would seem unthinkable by modern standards, to now when drivers can walk away from high-speed collisions and fireballs with minor injuries or even non at all. This transformation has been the result of many small steps taken over long period of time. Many prompted after fatal accidents exposed weaknesses and drew calls for action. The changes have seen every aspect of racing changed: barriers have gone from hay bales to advanced purpose built TECPRO and SAFER systems: personal protective equipment has moved on from goggles and overalls to ever more advanced helmets, fire-retardant clothing and HANS devices: cars themselves offer vastly greater protection than previously. The list could go on to include, marshal training, emergency medical response teams, track design and the rules of racing.

It may be very easy to look to these advancements and conclude that safety has been given its due consideration but many of these changes, which now feel second nature and are taken for granted, were controversial in their infancy. The HANS device saw much criticism from drivers and even seatbelts saw opposition (1). The same sentiment could easily be applied to our own industries. Much has changed any many lessons have been learned, but we mustn't allow complacency to creep in. As this paper will discuss, more can always be done to improve safety.

Note that the halo devices introduced into Formula 1 and Formula 2 are virtually identical and meet the same design criteria (10). The halo type device used in IndyCar, referred to as the "aeroscreen", has a similar design but with the addition of a clear plastic screen in addition to the halo type structure to protect drivers from smaller debris (11). Whilst the name differs between series the principle is the same and both designs will be refereed to as the halo throughout this paper for simplicity.

Note that whilst Formula 2, Formula 3000 and GP2 are distinct series they each filled the role as the primary feeder series for Formula 1 and largely did not run concurrently. For the period in question: F3000 ran from 1984-2004, GP2 ran from 2005-2016 and Formula 2 is the current series beginning in 2017.

Methodology

Sample Selection

The concepts of culture, leadership and learning as they relate to safety are typically observed in niche areas or industries which many are unfamiliar with. Motorsport's popularity offers a uniquely accessible example of the concepts tackled in this paper due to its popularity and it's inherent hazards. This particularly applies to the racing series selected here as, Formula 1, IndyCar, and Formula 2, are the world's most prominent open-wheel and open-cockpit racing series (12), with the exception of Formula E which was not included as it has only been held since 2014 (13).

The popularity of these series also results in them receiving the most coverage and attention. This made the research and data collection more effective as well as creating a unique culture regarding how the attention of fans influenced safety. Other popular racing series, such as NASCAR, the World Endurance Championship and the World Rally Championship were not included as these are not open-cockpit series and thus the introduction of the halo was not relevant.

The timeframe of 1995-2019 was selected as this offered a large enough sample size of incidents to establish trends and conclusions, as well as covering the timeframe after Ayrton Senna's death which was considered a catalyst for major changes in safety in Formula 1, as well as other series (14). This period has often been cited as a new era in safety for this reason

making it an appropriate period for study. The period was stopped at 2019 as by this point the halo was mandatory in all relevant series. (11)

Research

Official reports on the fatal accidents as well as news articles were researched to establish which fatal accidents had occurred in this timeframe, the nature of these accidents and likely causes of deaths as well as the reaction of participants, governing bodies, and fans. Reactions to the accidents themselves, as well as any proposed changes intended to address vulnerabilities exposed by these accidents were studied

As the focus was on safety systems intended to protect the driver non-driver deaths, such as those of marshals, were not included in the findings but accidents during testing were included.

Cases in which the drivers head suffered a direct impact

Results

Table 1 shows each fatal accident in the relevant series since 1995, and also includes a judgement of whether the halo may have changed the outcome had it been installed.

Driver	Date	Location	Series	Halo Relevance
Marco Campos	October 15, 1995,	Circuit de Nevers Magny-Cours	Formula 3000	Yes
Jeff Krosnoff	July 14, 1996	Toronto Road Course	IndyCar	Possibly
Paul Dana	March 26, 2006	Homestead-Miami Speedway	IndyCar	No
Henry Surtees	July 19, 2009	Brands Hatch	Formula 2	Yes
Dan Wheldon	October 16, 2011	Las Vegas Motor Speedway	IndyCar	Yes
Maria De Villota	18 August, 2011	Duxford Aerodrome	Formula 1	Yes
Jules Bianchi	October 5, 2014	Suzuka Circuit	Formula 1	Possibly
Justin Wilson	August 24, 2015	Pocono Raceway	IndyCar	Yes

Table 1: Fatal Accidents

Note: The date given is the date of the accident. Some drivers died at a later date due to injuries sustained during the accident.

Marco Campos

Campos collided with the rear of another car which caused his car to rise into the air and flip before landing on top of a concrete retaining wall which his head struck directly. with only his helmet offering protection the impact proved fatal. The direct impact to his head may have been prevented had his car been fitted with a halo device (15)(16).

Jeff Krosnoff

Krosnoff struck the rear of a car which pulled out ahead of him when attempting an overtake. This launched his car into the air at high-speed causing it to penetrate the catch fencing and strike a tree. His car disintegrated and he died from severe head and chest injuries. It isn't entirely clear that if a halo had been present Krosnoff would have survived as he suffered numerous other injuries to the rest of his body, but it would have offered some additional protection and greater structural integrity. Gary Arvin, a marshal, was also killed by debris during the accident (17)(18).

Paul Dana

Dana struck another car which was stationary on the track after a spin. His own car may have struck debris immediately beforehand causing a puncture and preventing effective braking resulting in a high-speed collision. His head was not struck directly by any debris and it is unlikely that a halo would have changed the outcome (19).

Henry Surtees

Surtees' head was struck directly by a loose tire from another car which had lost control and collided with the barrier. With only his helmet for protection the impact ultimately proved fatal and almost certainly would have been prevented had his car been fitted with a halo device (20)(21).

Dan Wheldon

Wheldon was involved in a multi car collision which launched his car hundreds of feet through the air and into the circuits catch fencing. His helmet is believed to have directly struck a post which formed part of the fencing causing his death. A halo device would likely have prevented this direct contact and may have saved his life although investigations attributed numerous factors which played a role in his death (22).

Maria De Villota

De Villota was taking part in a testing session with the Marussia F1 team when she collided with a truck whilst returning to the pits. The nose of her car passed under the truck causing her helmet to impact the truck directly. She suffered severe head injuries but survived the initial accident before dying fourteen months later from a heart attack. Doctor's findings suggest the heart attack was a direct result of her neurological injuries. The injuries she sustained would almost certainly have been prevented by a halo device which would have born the brunt of the impact with the truck instead of her helmet (23).

Jules Bianchi

Bianchi lost control in wet conditions and his car slid until it impacted a crane which was on track retrieving another car. Due to the high ground clearance of the crane his car's nose slide underneath the crane causing his helmet to suffer a direct impact. Bianchi did survive the initial crash but entered a coma and died nine months later. Whilst a halo would have offered additional protection it may not have saved Bianchi as the forces involved in the crash were so great that it likely would have also failed (24)(25).

Justin Wilson

Wilson was killed when a large piece of debris from another accident ahead of him on the track struck his helmet which offered insufficient protection and resulted in a fatal head injury. Similarly to Henry Surtees, the halo would likely have deflected this debris and saved his life (26)(27).

Discussion

Out of eight fatal accidents since 1995, five of these would likely have been prevented by a halo. The impact a halo would have had in another two is unclear, nevertheless these two drew attention to the lack of protection for the driver's head. The remaining fatality is unlikely to have been prevented or mitigated by a halo. Given these findings it is clear that the vulnerability of the head was a major weak point in the protection of drivers. Whilst later accidents such as Wilson's and Bianchi's appear to have resulted in corrective action with the introduction of the halo, there should have been adequate warning from previous accidents for action to have been taken earlier.

Some of these accidents bear striking similarities further emphasising the failure to learn:

- De Villota & Bianchi: Maria de Villota's crash during F1 testing in 2012, which contributed to her eventual death in 2013, and the first death of a driver due to injuries sustained during an F1 race since 1994 when Jules Bianchi died nine months after crashing into a recovery vehicle during the 2014 Japanese Grand Prix. The circumstances of Bianchi's death bore striking similarities to Villota's. Both drivers suffered serious head injuries after losing control of their cars and impacting a vehicle in a manner which meant the low nose of their car passed under the larger vehicle, and their head sustained a direct impact with little other than their helmet to offer protection. Despite the fact Villota's accident exposed this vulnerability so clearly only minor changes were made to the helmet and cockpit design to improve safety. Whilst a halo may not have saved Bianchi's life, other measures, such as stricter regulations on service vehicles accessing active racetracks may have made a difference. Both accidents also occurred in F1 and thus the governing body should have been acutely aware of this problem.
- Surtees & Wilson: Both drivers' were killed by debris from other accidents entering their cockpit and causing fatal head injuries. They did occur in different racing series, however Henry Surtees' death received widespread coverage due in part due to his father, John Surtees, being a former F1 world champion and the governing bodies of IndyCar will almost certainly have been aware

These cases offer a clear example of the importance of learning with regards to safety. Some vulnerabilities may initially go unnoticed but there are often near misses or less serious accidents which provide warning. However, in these cases even the most severe accidents, driver fatalities, were not learned from and action was only taken after further loss-of-life. These cases demonstrate that once a vulnerability has been exposed it must be addressed as if not, it is only a matter of time before a reoccurrence. Accidents, even those which tragically result in the loss-of-life, are an opportunity to save lives in the future which cannot be passed up.

Whilst there are many commonalities and lessons which can be learned between industries, many have unique challenges which must be accounted for. Motorsport is a good example of this where the attention of fans and demand for entertaining races are additional pressures on top of the usual aims of an industry and just as pressure on costs/profits have compromised safety before so have the demands of fans been at odds with safety in Motorsport. The halo is a prime example of this where its aesthetics was a controversial issue (2) during its introduction, a notion which would seem bizarre in most other industries where aesthetics would never be discussed on the same level of priority as safety.

It is competing demands such as these that make effective leadership essential. Leadership is about more than direct actions taken to enforce existing rules and procedures. It must also challenge problematic views and set a clear hierarchy of priorities

for all others to see, a hierarchy where safety is at the top regardless of other pressures. Leaders are also responsible for taking a longer-term view on issues rather than being guided by short term reward. This allows them to see through false dilemma's which pit safety against other competing factors and recognise that neglecting safety is not a sustainable approach and will eventually lead to tragedy. Tragedies which are often far more costly than the steps which could have been taken to prevent them. It is this kind of bold leadership which was lacking in the series in question for too long. The halo was a virtually inevitable step to improve safety. Just looking within F1, if Bianchi's death had not led to action, then eventually a future accident, such as Grosjean's would have. It was simply a question of when it would be introduced. At last, in 2018 F1 did show bold leadership and, despite protests from fans and prominent figures (2) within the sport, mandated the halo be installed in all cars.

Since the introduction of the halo though its presence has been embraced by fans, drivers and officials alike as it proved its worth in a number of high-profile accidents. Most recently a collision between Lewis Hamilton and Max Verstappen at the Italian Grand Prix saw one of Verstappen's tire's resting slightly on Hamilton's helmet, but mostly on his halo, preventing more serious injury and seeing widespread praise of the device (28). It has also been credited with saving the life of Charles Leclerc during the 2018 Belgian Grand Prix (2). The most prominent example however was that of Roman Grosjean at the 2020 Bahrain Grand Prix where the halo protected Grosjean's head from what would otherwise have almost certainly been a fatal collision and allowed an escape which was described by many as miraculous (29). The change of heart amongst many within these sports are further reminders of the benefits if bold adership which is willing to look into the long term.

Conclusion

In the period after Ayrton Senna's death from 1995-2019, where many advances improved the safety of drivers in open-wheel and open-cockpit motorsport, the drivers head remained a vulnerable with little other than a helmet for protection. This vulnerability was a key factor in a majority of driver deaths in this period within the series of Formula 1, Formula 2/F3000/GP2, and IndyCar. Despite serious accidents and even fatalities, inadequate action was taken resulting in further loss-of-life.

The failure to learn lessons and lack of bolder leadership at an earlier stage are reminders that facing up to uncomfortable truths and a willingness to make what may be perceived at the time an unpopular or controversial decisions are necessary parts of creating a positive safety culture and preventing future accidents.

References

1. Stuart, Greg. 1950 vs 2020: Cars, drivers, safety and pit stops – how F1 has changed in 70 years. *formula 1.* [Online] 2020. https://www.formula1.com/en/latest/article.1950-vs-2020-cars-drivers-safety-and-pitstops-how-f1-has-changed-in-70-years.62ITx6LlIY3qgzTctXgz1j.html.

2. Richards, Giles. Charles Leclerc pays tribute to halo after walking away from Belgian GP crash. *TheGuardian.* [Online] August 27, 2018. https://www.theguardian.com/sport/2018/aug/27/charles-leclerc-thanks-halo-belgian-grand-prix-crash-fernando-alonso.

3. Petrie, George. Major accident hazards in the gas industry. *Chartered Institute of Ergonomics abd Human Factors.* [Online] April 2015. https://www.ergonomics.org.uk/Public/Resources/Articles/Major_accident_hazards_in_the_gas_industry.aspx.

4. Reducing error and Influencing Behaviour. *HSE.* [Online] 1999. https://www.hse.gov.uk/pubns/priced/hsg48.pdf.

5. *HOW TO MEASURE THE SAFETY CULTURE OF ORGANIZATIONS.* Halaj, Martin. Prague : s.n., 2017.

6. IAEA. safety and security culture. *iaea.* [Online] https://www.iaea.org/topics/safety-and-security-culture.

7. Cooper, Dominic. Navigating The Safety Culture: A Review if the Evidence. *Behavioural Safety.* [Online] July 22, 2016. http://www.behavioural-safety.com/articles/safety_culture_review.pdf#:~:text=Guldenmund%20proposes%20that%20the%20safety%20culture%20construct%20has,granted%20as%20the%20basis%20for%20argument%20or%20action..

8. Michael S Wright, Philip Brabazon, Alison Tipping, Medha Talwalkar. Development of a Business Excellence Model. *HSE.* [Online] 1999. https://www.hse.gov.uk/research/nuclear/safetycult.pdf..

9. Walthert, Matthew. Formula 1 and the Relationship Between Death, Danger, Safety and Popularity. *Bleacher Report.* [Online] https://bleacherreport.com/articles/1888781-formula-1-and-the-relationship-between-death-danger-safety-and-popularity.

10. autosport. How the halo protection device passed its first major test in F2. *autosport.* [Online] May 17, 2018. https://www.autosport.com/formula2/news/how-the-halo-protection-device-passed-its-first-major-test-in-f2-5319477/5319477/.

11. Benyon, Jack. IndyCar aeroscreen can withstand more force than F1 halo - Red Bull. *autosport.* [Online] October 4, 2019. https://www.autosport.com/indycar/news/indycar-aeroscreen-can-withstand-more-force-than-f1-halo-red-bull-4987872/4987872/.

12. Zhang, Benjamin. 3 Of The World's Biggest Car Races Are Coming Up — Here's What You Need To Know. *businessinsider.* [Online] May 26, 2014. https://www.businessinsider.com/here-is-the-difference-between-4-major-racing-series-2014-

5?r=US&IR=T#:~:text=%20Formula%20One%20is%20an%20international%20racing%20series,the%20cars%20must%20conform%20to%2C%20change%20every%20year..

13. FIA. History of Formula E. *fiaformulae.* [Online] https://www.fiaformulae.com/en/discover/history.

14. Williams, Richard. Why Formula One should improve safety without removing risk. *theguardian.* [Online] October 10, 2014. https://www.theguardian.com/sport/blog/2014/oct/10/formula-one-safety-risk.

15. Arron, Simon. Obituary. *motorsportmagazine.* [Online] https://www.motorsportmagazine.com/archive/article/november-1995/8/obituary.

16. Brazilian driver dies after collision. *Independent* . [Online] October 17, 1995. https://www.independent.co.uk/sport/brazilian-driver-dies-after-collision-1578252.html#/comments.

17. Associated Press. 2 Deaths Mar Molson-Indy. *Pittsburgh Gazette.* [Online] July 15, 1996.

18. Harris, Mike. Driver and Track Worker Killed. *apnews.* [Online] July 15, 1996. https://apnews.com/article/9b329fa5357767c33982164d504a61cb.

19. Associated Press. Driver Paul Dana Dies in Crash. *foxnews.* [Online] March 26, 2006. https://www.foxnews.com/story/driver-paul-dana-dies-in-crash.

20. Hamilton, Maurice. John Surtees mourns son after death in freak Brands Hatch accident. *theguardian.* [Online] July 20, 2009. https://www.theguardian.com/sport/2009/jul/20/henry-surtees-death-formula-two.

21. Noble, Jonathan. Henry Surtees dies after F2 crash. *autosport.* [Online] July 19, 2009. https://www.autosport.com/general/news/henry-surtees-dies-after-f2-crash-4430656/4430656/.

22. CBS. Dan Wheldon suffered "non-survivable" injury. *cbsnews.* [Online] December 15, 2011. https://www.cbsnews.com/news/dan-wheldon-suffered-non-survivable-injury/.

23. BBC. Maria De Villota death linked to 2012 crash injuries, family told. *bbc.* [Online] October 12, 2013. https://www.bbc.co.uk/sport/formula1/24505702.

24. Bernson, Andrew. Jules Bianchi: Key findings from FIA's crash report. *bbc.* [Online] December 3, 2014. https://www.bbc.co.uk/sport/formula1/30320914.

25. BBC. Jules Bianchi: F1 driver dies from Suzuka crash injuries. *bbc.* [Online] July 18, 2015. https://www.bbc.co.uk/sport/formula1/33578770.

26. —. Justin Wilson: British IndyCar driver dies after crash. *bbc.* [Online] August 25, 2015. https://www.bbc.co.uk/sport/motorsport/34037413.

27. Phipps, Claire. Justin Wilson, IndyCar driver, dies of head injuries from Pocono crash. *theguardian.* [Online] August 25, 2015. https://www.theguardian.com/sport/2015/aug/25/justin-wilson-indycar-driver-dies-of-head-injuries-sustained-in-race.

28. Emons, Michael. Italian Grand Prix: Lewis Hamilton says 'halo' safety system saved his life in crash. *bbc.* [Online] September 12, 2021. https://www.bbc.co.uk/sport/formula1/58539315?at_medium=RSS&at_campaign=KARANGA.

29. Atwood, James. Formula 1 Halo devices: Grosjean crash proves they're here to stay. *autocar.* [Online] November 30, 2020. https://www.autocar.co.uk/car-news/motorsport-news/formula-1-halo-devices-grosjean-crash-proves-theyre-here-stay.