

University of Wales Trinity Saint David

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Harry Stark

2404901

Motorcycle Engineering

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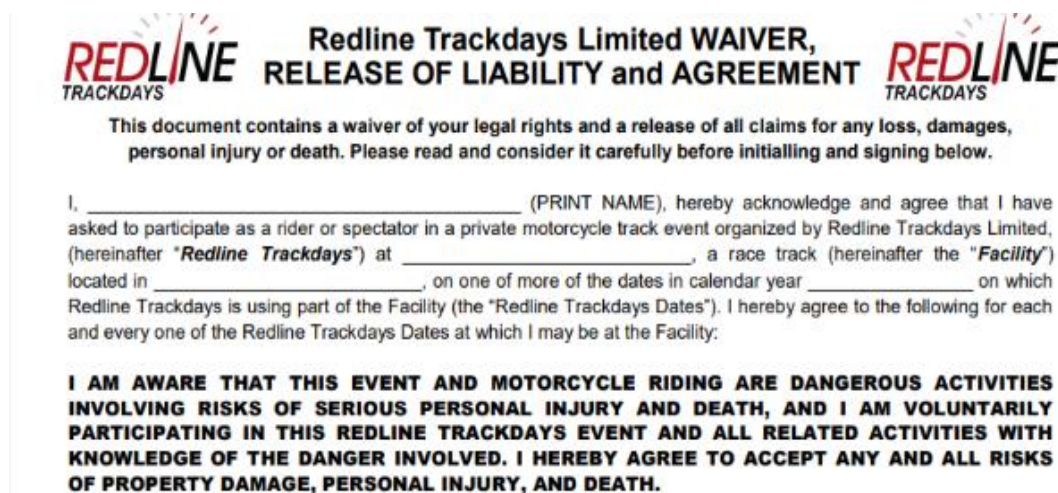
1. Introduction

This technical report will detail the importance of innovation and team-based cohesion whilst outlining the imperative use of Risk Assessments and Security matrixes. It will become apparent that cyber-security plays a massive role in society today. Especially considering new technologies like autonomous vehicles, which are targeted by hackers to exploit weaknesses within the network self-driving cars operate with. There are multiple ways risk in each industry is mitigated, Engineers, however, face unique project-based issues frequently. Therefore, it is vital that engineers have a few robust methods to analyze and break down a problem into comprehensible parts for a richer interpretation.

2. Health and Safety with Risk Assessment

Motorcycle racing has been notorious for its associated risks. An activity that is one of the most dangerous of all extreme sports is subject to the Health and Safety Act 1974. Similar to motorsport racing, this act helps ensure the safety of all those either working within the event or actively taking part in it. Organisers such as the ACU, are incredibly detailed in how they operate to safeguard participants. This is achieved via the use of in depth Risk Assessments and risk identifying methodologies ([ACU, 2025](#)).

Whereas the Health and Safety Act 1974 is geared more for events and organisations. The Road Traffic Act 1988, sections 12A – 12F for England and Wales, relates mainly to the legalities of holding a racing event on an otherwise public roadway([UK Government, 2012](#)). Acts like the Code of Practice in relation to motorcycle racing are mainly used for the roughly 5,000 off road sporting events in the UK ([ACU, 2025](#)). In terms of safety legislation, it is standard practice for organisers to ask participants to sign waivers to participate in events.



The image shows a waiver form for Redline Trackdays. At the top, the Redline Trackdays logo is on the left and right, with the title 'Redline Trackdays Limited WAIVER, RELEASE OF LIABILITY and AGREEMENT' in the center. Below the title, a paragraph states: 'This document contains a waiver of your legal rights and a release of all claims for any loss, damages, personal injury or death. Please read and consider it carefully before initialling and signing below.' The main body of the form contains a line for the participant's name: 'I, _____ (PRINT NAME), hereby acknowledge and agree that I have asked to participate as a rider or spectator in a private motorcycle track event organized by Redline Trackdays Limited, (hereinafter "Redline Trackdays") at _____, a race track (hereinafter the "Facility") located in _____, on one of more of the dates in calendar year _____ on which Redline Trackdays is using part of the Facility (the "Redline Trackdays Dates"). I hereby agree to the following for each and every one of the Redline Trackdays Dates at which I may be at the Facility:'. At the bottom, a bolded paragraph states: 'I AM AWARE THAT THIS EVENT AND MOTORCYCLE RIDING ARE DANGEROUS ACTIVITIES INVOLVING RISKS OF SERIOUS PERSONAL INJURY AND DEATH, AND I AM VOLUNTARILY PARTICIPATING IN THIS REDLINE TRACKDAYS EVENT AND ALL RELATED ACTIVITIES WITH KNOWLEDGE OF THE DANGER INVOLVED. I HEREBY AGREE TO ACCEPT ANY AND ALL RISKS OF PROPERTY DAMAGE, PERSONAL INJURY, AND DEATH.'

Figure 1, [Track Day Liability Waiver](#)

2. Health and Safety with Risk Assessment

Potential Hazard(s)	Individual(s) at risk/ related to risk	Actions in place before identification Of Hazard(s)	Actions in place after identification of Hazard(s)	Action(s) carried out by
Inadequate clothing protection , leading to serious personal injury.	Participants and potentially Organizers	Participants are recommended to wear normal track day attire such as, An EU certified helmet, leather racing suit and back protector with at least CE Level 1.	Participants are responsible for their own clothing protection as stipulated in Waiver. If clothing requirements are not met, participants can and will be removed from the event to ensure their own safety.	Participants (signed waiver declaration).
Racing Circuit is too wet, leading to crashes and collisions	Participants	Racing teams will be asked to bring a set of tires designed for wet conditions, commonly referred to as “slicks”.	The event will be cancelled if the conditions are deemed too dangerous.	Organizers.
Inadequate amount of Safety staff/ Inadequate training, leading to injured participants not receiving treatment when necessary.	Everyone	Marshall and safety staff are responsible for wearing high visibility clothing to ensure identification at all times.	Safety staff are to be hired from certified hiring agencies and/or have referenced experience.	Organizers.
Rider riding in pit lane when they should be pushing their motorcycles. Subsequently leading to collisions.	Participants	Riders are required to dismount to ensure safety of others.	Lap penalties of up to 5 minutes will be implemented for the offending team.	Organizers and Safety staff.

Figure 2, Risk Assessment

3. Security Risk Matrix

With the introduction of autonomous vehicles on the market ([Lu et al., 2025](#)), more challenges arise. Although present on public streets, the cyber security technology for self-driving vehicles is still in the developmental phase, even in 2025.

This means that cyber-attacks, such as false-positive obstacle readings forcing an autonomous vehicle to emergency brake in an otherwise unsafe place to do so, can be carried out at little to no risk posed towards the intruding party. Typically done by spoofing the vehicles LiDAR sensor, which is used to determine distance by using a laser sensor to create a 3D environment ([Cyberpath, 2025](#)). Even more troubling is that commercial fleets of cars can be targeted as their over-the-air update mechanisms can be compromised, subsequently granting full access. Another major defect relates to sophisticated firmware attacks via infotainment systems. Hackers can infiltrate by abusing network segmentation failures themselves, this essentially allows for a compromised non-critical system to affect a critical one by way of removing segmentation between the systems remotely.

Cyber security experts recommend using intrusion detection systems to mitigate some of these weaknesses ([Lippi et al., 2025](#)). IDS essentially acts as non-optional add-on for any system that deems it necessary to prevent threats from compromising a network. It forms a critical aspect of a layered defence strategy. For instance, with an IDS in place, zero-day threats are significantly reduced. This allows for proper network segmentation so that Hackers are unable to bypass typical endpoint security measures, anti-virus software and reactive patching. A common misconception within the autonomous vehicle sector is that cyber security concerns are negligible given that the user has a key and physical access to the vehicle.

3. Security Risk Matrix

Probability	Risk Matrix					
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
Severity						
		Negligible	Slight	Moderate	High	Very High

Figure 3, Risk Matrix

Probability	Definition		Value
	Frequent	Very high occurrence	5
	Occasional	Likely to occur	4
	Remote	An even chance of occurrence	3
	Improbable	Unlikely to occur	2
	Very improbable	Very low occurrence chance	1

Figure 4, Risk Matrix Probability

Severity	Very High	Very high occurrence	5
	High	Likely to occur	4
	Moderate	An even chance of occurrence	3
	Slight	Unlikely to occur	2
	Negligible	Very low occurrence chance	1

Figure 5, Risk Matrix Severity

Potential Hazard(s)	Risk Value Before adjustment	Risk Value After adjustment
Inadequate clothing protection, leading to serious personal injury.	15	9
Racing Circuit is too wet, leading to crashes and collisions.	16	8
Inadequate amount of Safety staff/ Inadequate training, leading to injured participants not receiving treatment when necessary.	10	5
Rider riding in pit lane when they should be pushing their motorcycles. Subsequently leading to collisions.	16	6

Figure 6, Risk Matrix Response

20 - 25	Severe	A Severe risk rating requires an immediate and detailed response outlined in the risk assessment. If severity CANNOT be mitigated, event cancellation/postponement is necessary.
15-19	High	A High-risk Rating requires immediate action to be. All Highly rated risks MUST be mitigated to at LEAST a medium-level risk rating.
6-14	Medium	A medium-level risk, if situated in the lower band (6-10) with a probability of no more than "Improbable - 2", is acceptable based on the nature of the motorcycle event.
1-5	Low	A low-risk rating is acceptable assuming that the outcome(s) from the controlled hazard are negligible.

Figure 7, Risk Rating

4. Engineers Role In Society

Reputable engineering is the backbone of any market that wants to make profit whilst maintaining good public relations ([Botha, 2014](#)). This doctrine applies greatly for Engineering, if mistakes are made at any point during the manufacturing process of a vehicle, the public will face the potentially dire consequences ([Rich, 2021](#)). The Ford Pinto, although remembered for its unique subcompact/hatchback style blend of manoeuvrability, was riddled with design and functionality problems([Shutt, 2024](#)). The primary issue being that the gas tank was placed behind the rear axle nut, essentially exposing it to a high likelihood of being punctured and causing a fire if rear-ended by another vehicle.

This exact reason is why high levels of scrutiny is now commonplace within the automotive industry. Two primary companies that deal with Code of conduct are NSPE ([National Society of Professional Engineers, 2019](#)) and IMechE ([Institution for Mechanical Engineering, 2017](#)). First parts of both Code's of Conduct state that the safety of the public is paramount, importantly followed by the notion to only perform services within the area of your own specified engineering competency.

Due to recent developments in our understanding of the knock-on effect motorcycles have to the environment, brands like BMW and Honda used to include soy-based wiring to meet manufacturing regulations. A common misconception is that this feature reduces the weight of the motorcycle, leading to a better performance. This feature backfired as time has played a massive factor in the recessive functionality of bio-degradable wiring. Almost every motorcycle with soy-based wiring has had to be repaired or maintained to an unrealistic standard compared to that of traditional plastic wiring protection. This has led to even more unrecyclable resources being used to circumvent the soy-based wiring, thus damaging the environment more in the long-term.

5. Problem Solving

Contrary to popular belief, An Engineers' role does not solely pertain to flashy monikers such as 'Formula One Racing Engineer' and 'NASA Curiosity Driver' ([NASA, 2020](#)). Most Engineers are more grounded in their roles and responsibilities, defining modern technologies through the development of robust research methods to ensure the 'Health and Safety' of the public and professionals on the racetrack. Engineers need to operate to the highest percentile of accuracy when determining a product's capacities ([Pannell, 2023](#)) whilst also maintaining regulatory safety standard for themselves ([OSHA, 2024](#)).

Interchangeably referred to as 'Safety Engineers' or 'Risk Management', this specific Engineering principle is renowned in Hazard Perception and Mitigation ([CLRN team, 2024](#)). For example, Formula One technicians and designers have created a new safety technology feature referred to as the Formula One Driver 'Halo'. According to ([Ono, 2023](#)), after the unveiling of the new safety feature post 2014 Grand Prix crash by Jules Bianchi ([Collins, 2014](#)), trends indicate that the 'Halo' is the most viable solution in terms of safety when considering the dangers of debris impacting the driver ([Monroe, 2021](#)).

Safety features such as the 'Halo' are prime examples of Engineers' being faced with a serious problem within a specified demographic of people such as Formula One Drivers. During the developmental cycle of this new safety feature, many other designs were considered, one of which was a cage around the F1 driver. This design did not work as the driver's view was obstructed by 3 metal supports for the protection cage. Thus leading to a more dangerous environment for the driver. Sometimes the only real way to know if an idea can be executed efficiently, is to try the idea in practice.

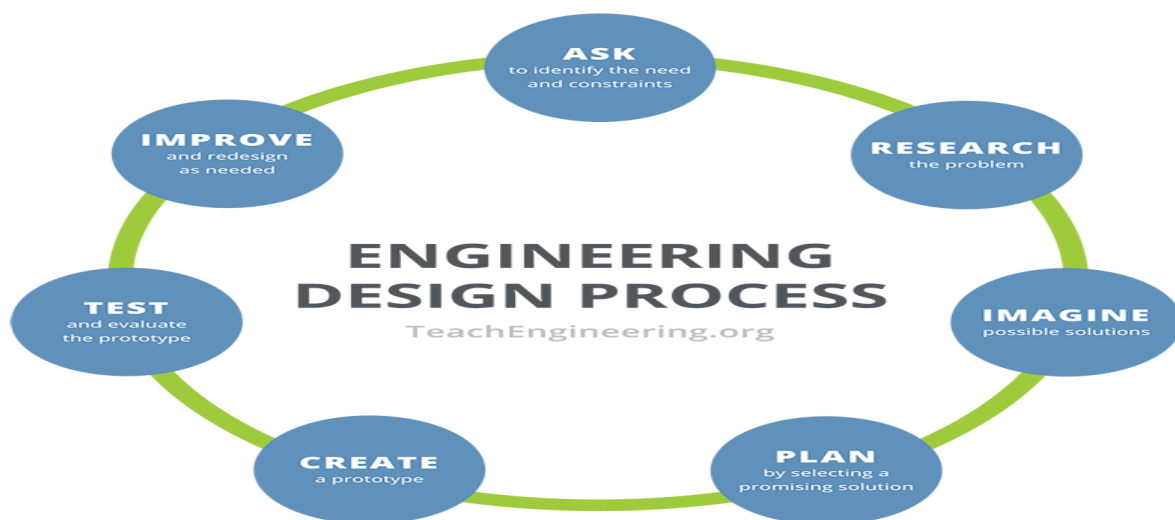


Figure 8, Problem solving Flow chart

6. Team Structure

During my time at University, I have been fortunate enough to participate in the 2024/2025 season on Freetech Endurance. Whilst very challenging in terms of my riding capabilities, my mechanical aptitude was expanded upon more thoroughly. Adjusting to each race circuit over the season, coupled with the sometimes-tumultuous weather, was truly a test of my Engineering skills and capacities. As novice track riders, with the exception to one teammate, the motorcycle we rode was badly damaged multiple times. Totalling somewhere between 8-10 crashes, with one crash being borderline catastrophic, it was a good example of our perseverance as a unit.

My specific role within the hierarchy of the team was to ensure the tires are warmed before each practice session. Although trivial to some, this role is vital if you enjoy having traction whilst on the circuit. As the heat allows the rubber from the tires to “stick” to the tarmac far easier than if they were cold. The team structure itself was quite Flat, meaning that everyone had the same level of responsibility but for different part of the motorcycle. This left Noah, our team lead, to organize the event side of things and timekeeping.

Unfortunately, during our final race event, I managed to crash on my 2nd lap (10 minutes into the first day...). This left me stranded in a reservation just off the 2nd hairpin. The right-hand side of the motorcycle was splayed across the floor missing both clutch lever and clutch shifter. Using my knowledge of motorcycles, I was able to rock the motorcycle out of gear so I could perform my walk of shame, back to the pit lane.

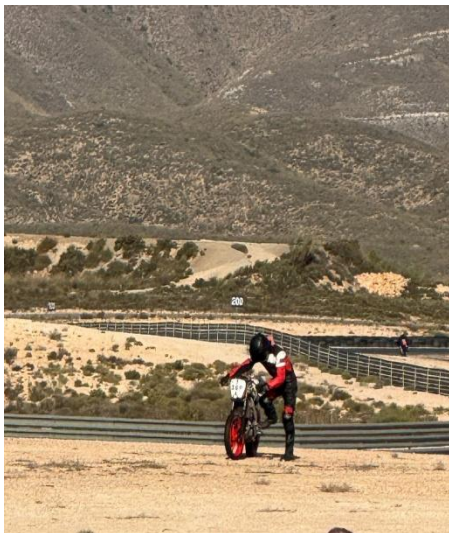


Figure 9, Crash



Figure 10, The motorcycle

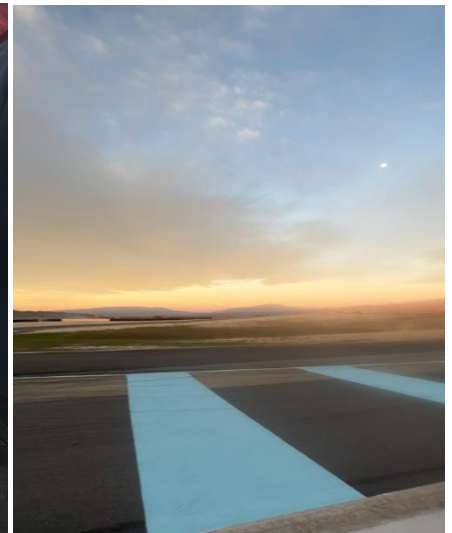


*Figure 11, The Race Circuit
(Andalucia)*

7. Conclusion

Being knowledgeable about different problem-solving strategies and inherent engineering responsibilities adds a significant level of competency within the engineering practice. This subsequently will lead to a more confident approach when tackling design-based issues whilst maintaining a responsive team-based cohesion throughout any project.

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