

University of Wales Trinity Saint David

Engineering Academic Discipline



Prifysgol Cymru

Y Drindod Dewi Sant

University of Wales

Trinity Saint David

Engineering Skills

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Reid Lupton - 2517853

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1. Introduction

1. Introduction

This technical report covers different aspects of engineering, such as:

- health and safety, where how different legislation and organisations have been implemented to reduce risk.
- cyber security, discussing the dangers of modern technology in the automotive industry.
- roles and responsibilities, in which Chartered Engineers are responsible for projects safety and job professionalism
- problem solving methods, options for investigating and methods to fix parts
- team structures, comparing different methods to set up teams of engineers

2. health and safety with risk assessment

1. Safety and legislation examples on lathes

Health and safety is critical within engineering. For example, during use of the lathes in the machine workshop at [UWTSD](#), parts were being fabricated to practice and learn skills, multiple safety requirements must be met. The legislation for using lathes in the UK are defined by HSE in [PUWER 1998](#). These define that the machine must be maintained to a safe condition and has regular inspections. This regulation will ensure that the lathes will be safe and functional to operate.

Other safety measures, such as the chuck guard, preventing operators from easily touching moving machinery. This drastically reduces the risk of potential injuries. Operators and bystanders must also wear eye protection while any machine is in use, to prevent swarf and debris entering eyes of the operator and bystanders.



Figure 1 -shows an example of a lathe chuck guard

(<https://www.weprofab.com/lathe-chuck-guard/>)

2. Risk assessment

Risk assessments are legally required in industry to formally identify and eliminate or reduce potential hazards and risks. This became legislation in 1999 in the [MHSWR](#) regulations. These must be completed before any other work to ensure safety of anyone who could be at any potential risk relating to the goal of the assessment. Risk assessments can be applied to many different industries, but most follow the same pattern and layout.

Risk assessments are documents that are constantly being updated to ensure all possibilities are considered and identified and have actions to prevent or reduce the risk.

Potential hazards	Those at risk and how	Actions already in place	Further action required	Action by
Swarf in eyes	The operator and bystanders.	Eye protection mandatory when any lathe is in use	Unsure swarf is cleared regularly	Lathe Operator and bystanders
Part ejecting from lathe	The operator and bystanders.	Do not stand in parallel to the part while lathe is in use	Ensure chuck is securely holding part	Lathe Operator and bystanders
Touching moving parts on the lathe	Bystanders and the operator	A chuck guard to be lowered when the lathe is spinning.	Ensure that the lathe has fully stopped before raising the guard	Lathe Operator

3 Security risk matrix

1. Security threats to autonomous functions in modern vehicles

Modern vehicles have many automatic features due to the rise of electronics with them. According to [cyber security specialists](#) modern cars have become significantly more vulnerable to cyber attacks due to their dependence on wireless features. This ranges from power windows to mostly autonomous driving. These all have their purpose and use but can also introduce threats to the security of the vehicle. For example most modern cars have their windows controlled by manual switches, however some have the capability to use external inputs as well. These can be from the key fob, apps and technicians. Each introduce a potential vulnerability and threat. If an unauthorised individual gained access to the app capable of operating features on vehicles, there is a large risk that this can allow them; to open the windows, fully unlocking the vehicle, and even starting it.



These systems such as key fobs have had secure connections due to rolling codes which have made physical attacks easier than electronic access. Modern vehicles on the other hand have more possibilities to attack as there are more potential attack vectors than ever before.

Figure 2 -An example of an app for a vehicle
(<https://news.mgmotor.eu/mg-ismart-smartphone-app-why-its-a-must-have/>)

2. Security risk matrix

likely		Risk assessment Matrix				
		5	4	3	2	1
Likelihood	5					
	4					
	3		4		3	
unlikely	2			1, 2	5	
	1					
		1	2	3	4	5
		Effect Low - high				

Threat number	autonomous functions	Threat	threat effect	likelihood
1	Central locking	Vehicle left unlocked	3	2
2	alarms and keyless ignition on cars	Vehicle can be stolen without	3	2
3	DDoS attacks	Vehicle inoperable or functions unavailable	4	3
4	GPS and trackers	Locate precise location and location history.	3	2
5	alarms and keyless ignition on motorcycles	Vehicle can be stolen without any suspicion of the theft (assuming no physical locks)	4	2

A risk matrix has no law requiring its use but it's a useful tool for employers to gauge risks and their impact easily, even without understanding the risk in detail. This is because the risk matrix utilises simple wording and, in most cases, intuitive colour coding. Allowing risks to have action taken to reduce or eliminate them.

4 Engineers role in society

1. Code for Chartered Engineers

Chartered engineers are engineers who have met specific high level requirements of skills in their discipline. These engineers are required to follow a specific code during their work. These are defined and published by the [engineering council](#) and [IMechE](#). According to the codes published by IMechE require Engineers to; keep up to date with current with their knowledge and skills, respect others and be trust worthy, engage in sustainability practices, contribute positively to the public.

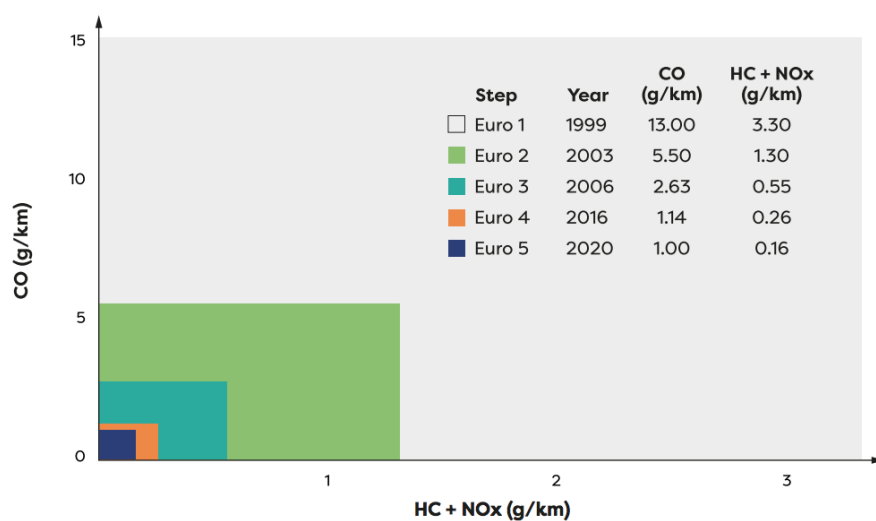
The Engineering council requires engineers to follow similar codes of conduct to IMechE, these codes are: knowledge to solve engineering problems within new technologies, responsibility for engineering systems, balancing the advantages and disadvantages of technical and socioeconomic factors, ability to develop other staff, effective communication skills.

2. sustainability and environmental issues within motorcycles

Keeping environmental and sustainable within motorcycles is a challenge due to many factors. Some of these factors are their high revving nature which creates significantly more pollution than lower revving engines. This is only worsened by owners typically modifying their vehicle with aftermarket exhausts to remove catalytic converters, a component in exhaust systems to reduce carbon pollution ([catalytic converters](#)), which drastically increases the pollution from the motorcycle.

This can be visualised in this graph showing the difference in old emissions requirements, (euro 1) where catalytic converters were not required or needed to pass emission tests. In contrast, modern motorcycles complex catalytic converters are essential to pass requirements

Development of European Motorcycle Legislated Emissions Limits



of euro 5.

Figure 3 – displaying the differences in all the different Euro emission requirements.
(<https://www.aecc.eu/legislation/motorcycles-and-mopeds/>)

5 Problem solving

1. engineers options for problem solving

Engineers have many options to solve problems they encounter when developing new products. One common method to solve problems is with Root Cause Analysis (RCA). This allows engineers to investigate parts post failure and conclude what caused the knock on effect failure. This allows engineers to understand the part more in depth and make critical decisions to resolve or mitigate the failure. Due to root cause analysis requiring the part failing before being an effective tool, it can be ineffective for a lot of the design process but cause some of the largest design changes.

Another example of problem solving is using the ‘Divide and conquer’ method. This allows engineers to break down large problems into smaller issues which are significantly easier to fix individually. This also requires a post-failure investigation and significant retesting of the part, for RCA be effective.

2. how these solved problems can be shown

Flow charts can be used to show how a problem was solved by displaying each step and decision made of the process. An example of this is in 2018 in MotoGP where Ducati created the ride height device. This allowed Ducati to lower their centre of mass meaning they could accelerate out of corners faster with less risk of unwanted wheelies. This allowed them to gain faster lap times and become one of the fastest bikes on the grid, with every other team copying and implementing their own ride height device.

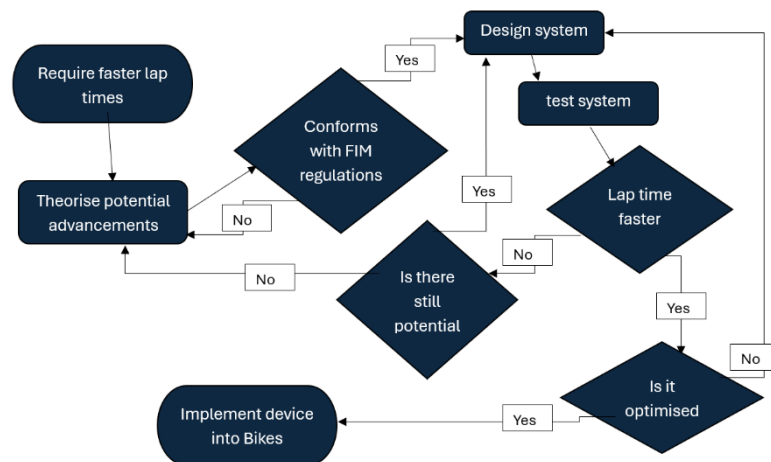


Figure 4- Displays a potential flow chart of a simplified engineering process for the ride height

6 Team structure

1. personal experience in working as a team

I have personal experience working in a team when I worked with my peers at Pembrey race circuit. It was a test day for new students at [UWTSD](#). I worked in multiple different positions to gain an understanding of what was needed for each position. One of the jobs I worked was the tires where I managed tire temperature with warmers and managed tire pressure. Another was where I had to check all the bolts and parts of the bike were still tight and in spec for the upcoming laps.

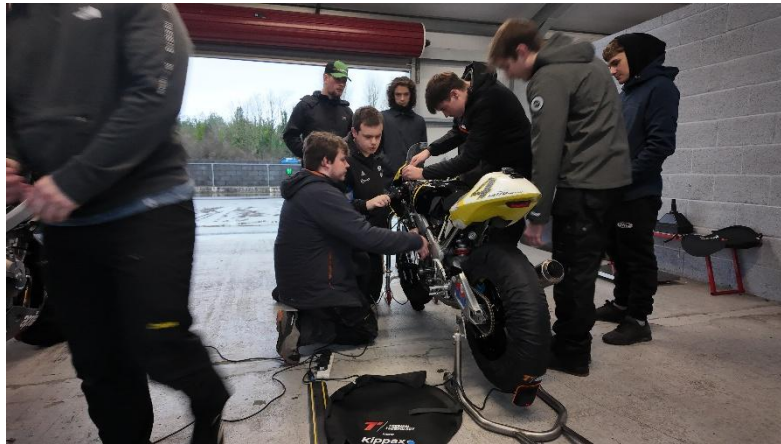


Figure 5- a photo I took of us working on the UWTSD race bike

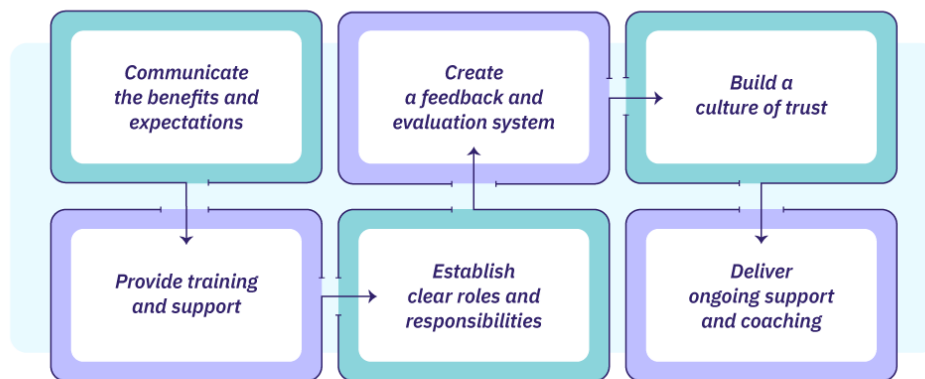
2. what type of team structure was used

The type of team used for this team was ‘functional teams’ where each person is specialised at one specific job and doesn’t help others. This was because helping other could allow mistakes and confusion occur which could be dangerous for the pit crew and the rider. This style of team makes it effective for fast turn around but requires effective team communication and timing. However after every test window, everyone swapped jobs to get a better understanding of what was available.

3. different types of team structure

There are many different types of team structure, for example of some: 'self-managed teams' and 'teams of teams'. Self managed teams are set up to where the work force maintain themselves for the work that is needed, often leading to faster efficiency. This would be advantageous for a pit crew as they require to work seamlessly together and fast. However this is difficult to set up and have run well.

How To Implement Self-Managed Teams



AIHR | ACADEMY TO INNOVATE HR

Figure 6- show the steps to implement self managed teams(What Are Self Managed Teams? Definition & Examples - AIHR)

Teams of teams are effective as pit crews as they are adaptive and motivate themselves, this allows for small groups of workers to work independently from other groups to complete tasks in different blocks to speed up effectiveness. However staff need to be effective at collaborating and communication.

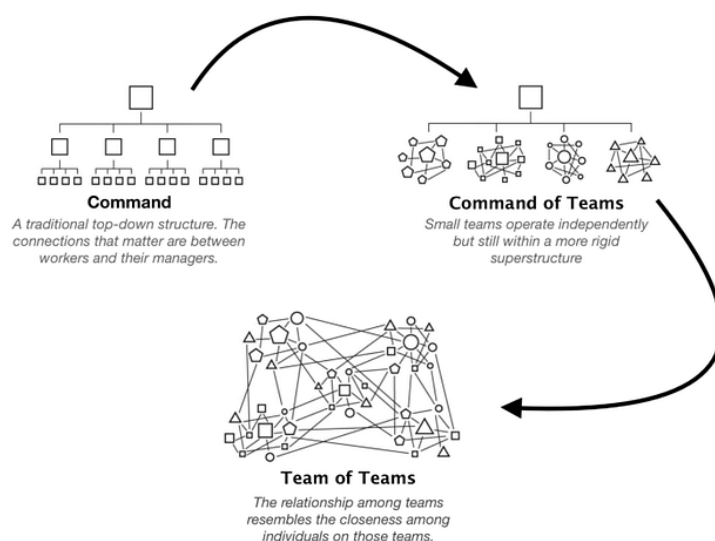


Figure 7- a visualisation of teams of teams
(<https://beaugordon.medium.com/key-takeaways-from-team-of-teams-by-general-stanley-mcchrysal-eac0b37520b9>)

7 Conclusion

1. conclusion

In conclusion, Engineering has a lot of responsibility regarding the safety, sustainability and environmental impact of products and designs. These problems can be solved with some of the discussed problem solving techniques and team variants, which each has benefits and drawbacks for everyone in the team and management. Cyber security on modern vehicles has to be considered when demoulding new products as they can cause detrimental safety and security issues. Chartered engineers are engineers who have reached a level of professionalism and competency, this shows their knowledge and skill set is high level. Safety in engineering spaces has advanced due to the [PUWER 1998](#) requiring employers and employees to ensure their safety in workspaces to prevent or reduce risks.

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