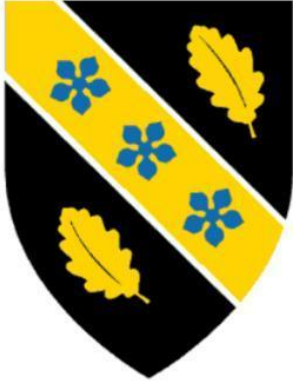


University of Wales Trinity Saint David

Wales Institute of Science & Art



Prifysgol Cymru
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Engineering Skills Report

Engineering Skills (ACHA4022A)

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1. Introduction

This report will detail a few challenges faced by the engineering world, namely Health and Safety in Engineering, some problems associated with Security in automotive engineering when faced with the growing interconnectivity of vehicles, the Engineer's role in society and how they can ensure sustainability, some common problem solving approaches, and a personal experience and reflection on an example of teamworking in the industry.

2. Health and Safety and Risk Assessments

Making considerations for Health and Safety in an engineering environment should be considered paramount. Every area in engineering has some kind of risk involved, especially in the motorsport sector. From the racetrack to the workshop and even the design office, there is the potential for injury or otherwise loss.

One recent activity with inherent risk recently undertaken as University has been machining parts in the machine shop, on both the lathe and the milling machine. To deal with the hazards inherent in this activity, a number of precautions are taken to ensure student safety.

One of these measures is the presence of supervision for students. Before they undertake any work, it is checked that they are suitably dressed, prepared and briefed on what is to happen. While they undertake any work on the machines, they are watched to ensure that nothing dangerous is done by the student.

Another measure is the wearing of PPE, Personal Protective Equipment. For this activity Safety Boots, Dust Coats and Impact resistant goggles are worn so that in the case of any accident the student should suffer lesser or no harm.

According to the UK Government (UK Government) in the Health and Safety at Work Act, PPE should be provided where needed, as well as made sure that it fits, is in reasonable condition and the user knows how it protects them. It is included that PPE should not be the first 'line of defence' when approaching safety, and that removing the hazard is far more effective than simply providing protective equipment. This is what the supervision aims to do – avoid an accident before you are relying on equipment to save you. The provision of PPE comes with the caveat that the user needs to both use it and use it effectively. Sometimes it will not fit properly or at all, which can cause people to not use it (Walker 2023).

Some of the risks present in the workshop are as follows, as a Risk Assessment table.

<u>Hazard</u>	<u>Consequences</u>	<u>Control Measures</u>	<u>What more could be done</u>
Trips, Slips and Falls	Minor (potentially serious) injuries	Workshop kept clean, no cables trailing across floor	Fluid spillage kits installed near machines
Flying debris from machining processes	Potentially serious injuries, especially to the eyes	Instruction on proper use of machines. Eye protection provided as PPE.	Machine-encompassing guards installed to prevent all debris reaching users.
Falling objects	Crushing injuries, especially to feet and legs	Safety boots worn as PPE, proper storage of heavy items	Guides on safe stacking for boxes and other items given
Electrical shock	Serious or life threatening electrocution	Machines properly maintained, user briefing	Electricity rated rescue poles to pull those trapped away from electrical sources
Fire	Minor to serious burn injury	Proper briefing, machine maintenance, fire extinguishers present, escape routes marked	Fire blankets installed near ignition sources

3. Security Risks

Modern vehicles face a variety of new threats that older vehicles do not. The addition of evermore computer systems into vehicles is designed to aid the driver – making the ride more comfortable and less stressful, but it also potentially opens the door for security risks.

There are different four types of risks identified by (Saulaiman, Kozlovsky et al. 2025). These are Safety, Financial, Operational and Privacy.

Safety is harm of some kind to a person, usually the one operating or passenger in a vehicle.

Financial risks are those which would cause a monetary loss for the manufacturer.

Operational risks are those which would affect the operation of the vehicle.

Privacy risks are those which might expose private or sensitive data to an attacker.

All of these have potentially severe consequences and need to be guarded against adequately to prevent them happening. One way of assessing which risks would need the most attention is by using a Risk Matrix, where the likelihood of a risk occurring and the impact of it occurring at weighed up to give a final score.

In the following Risk Matrix, feasibility and impact are rated on a score between 1 and 5, and then multiplied to give an overall risk score. The higher the risk score, the more thought and effort should be put into dealing with the risk.

<u>Risk</u>	<u>Feasibility</u>	<u>Impact</u>	<u>Risk Score</u>
Loss of driver control due to attack	1	5	5
Breach of personal information due to attack	2	2	4
Attack on self-driving systems	4	5	20
Theft through digital attack	3	4	12
Cyber attack on factory/distribution	3	4	12

The highest scoring risk in this brief table is the risk of an attack on a self-driving system. An example of this kind of attack would be a blinding attack on a vehicle camera – if a self-driving system is using this camera to determine its position on the road, the sudden loss of this could cause it to impact another vehicle, building, infrastructure or pedestrian (Monteuuis, Boudguiga et al. 2018).

One potential solution to this is using multiple, redundant systems for vehicle positioning. If the vehicle is using a camera to determine road conditions, the use of a radar or LiDAR (Light Detection and Ranging) system in tandem with the camera could prevent a single method of attack from causing severe disruption.

4. Engineers' Role in Society

Engineers hold a critical role in society – almost everything that you use daily has been designed by or had some impact on by an engineer. For this reason, engineers are held to high standards, such as the requirements met to be called a Chartered Engineer in the UK.

Being an engineer is not simply about making a product or solving a problem but doing so sustainably. Sustainability is the idea that what we do can be carried forwards into the future, so that we might be able to survive as a species and preserve our world for future generations.

Engineers often belong to a governing body, which will publish a set of rules or a code of conduct. One such is the Institution of Mechanical Engineers, or IMechE. In their code of conduct they specifically say “We should engage responsibly with the environment”. They clarify this means that they recognise the importance of environmental factors, comply with legislature, take into account the needs of the environment, and finally balance what is needed currently with what future generations might need. (Institution of Mechanical Engineers 2021)

Another institute that publishes a code of conduct is the Institution of Engineering and Technology. Their set of rules states “members shall take all reasonable steps to avoid waste of natural resources [&] damage to the environment”. This is a very broad statement which covers off most all of their responsibility to the environment as engineers. (The Institution of Engineering and Technology 2024)

In terms of Motorcycle Engineering specifically, these codes of conduct can be seen in a few ways. Whether on a racetrack or road everything should be considered. For example, materials should not be extremely energy-intensive to produce and should be recyclable after their life cycle. Emissions should be regulated to lower their impact on climate change, and the effects of using fossil fuels and oils should be assessed.

5. Problem Solving

When working on an engineering project, teams will often come upon problems that need to be solved. There are a variety of effective methodologies that can be used to overcome these problems, for example the Six Sigma method.

The Six Sigma method of problem solving involves breaking the problem solving down into multiple stages – Define, Measure, Analyse, Improve and Control. This can be broken down as follows:

1. Define – ensure that everyone knows exactly what the problem is. What are requirements and goals? If this is defined everyone is working towards the same problem.
2. Measure – establish measurable outcomes and find out what you are currently doing that might be wrong.
3. Analyse – Figure out what the cause of the problem is and how it is affecting you.
4. Improve – work on the problem using the information you have gathered to improve it.
5. Control – monitor and assess over time how your solution is working and decide if it needs further improvement.

(Sproull 2018)

In an engineering environment there could be a problem where a powertrain isn't making expected power, for example. The team involved could use this approach to try and overcome this.

A common problem with problem solving techniques is that the system often devolves into 'fire-fighting', where a large amount of problems are tasked to a team, and the engineers are rushed

to solve them. Problems are then solved badly, and need to be re-approached, wasting time and resources. This can be seen in Figure 1.

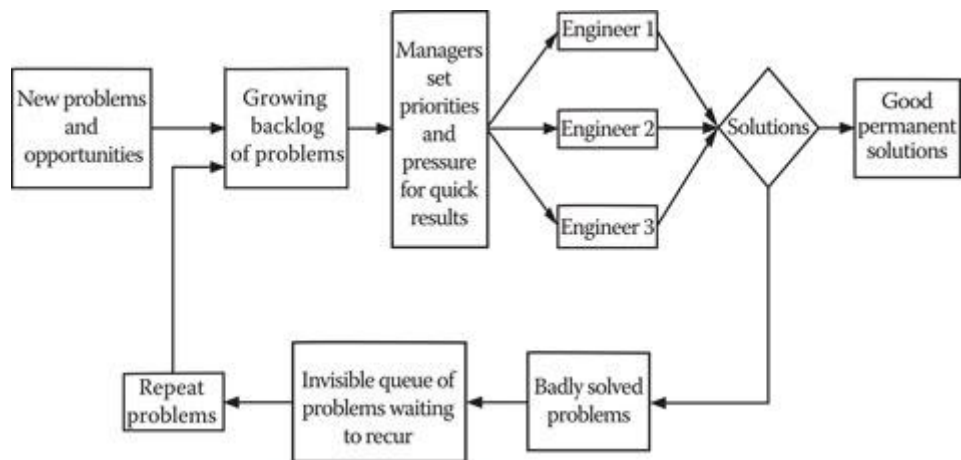


Figure 1 - Firefighting Flow Diagram

This should be avoided, and a model such as Figure 2 should be adopted instead. There is less pressure on the engineers to deliver, and solutions are better thought out and therefore do not have to be re-assessed.

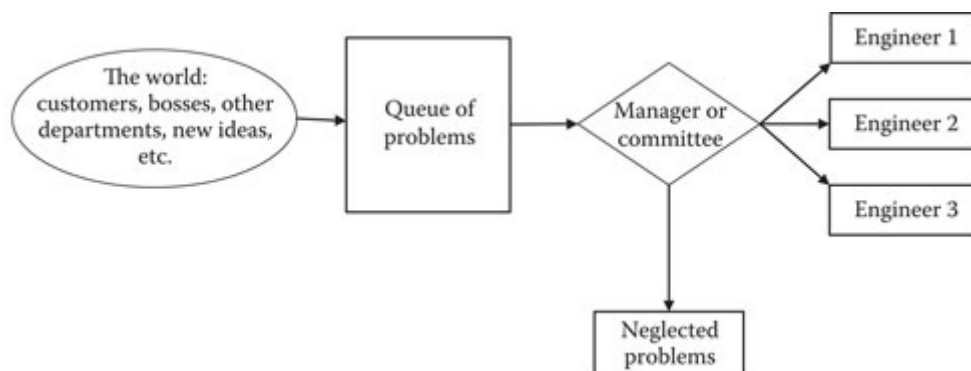


Figure 2 - Improved process Flow Diagram

6. Team Structure

I have previously been a part of several teams. One recent example of this was managing a motorcycle racing team in the Freetech Endurance championship, racing 125cc motorbikes for up to 8-hour races through a season.

In this year I assumed the role of Team Captain, having a variety of people undertake both engineering work at home and trackside work to achieve our goals. The structure of the team was fluid – the team brought completely different members to each event, with the only constant member being myself.

Away from races, at home, there were only a few people who would work on the bike and preparing for a race. This usually consisted of Luke – an experienced and competent mechanic – and Kenzie – who knew less specifically about bikes but was eager to learn. I would leave them be for most tasks and mostly give them authority on large technical decisions due to Luke's expertise. This worked well for the most part, work was done and to a high standard at that. Sometimes, decisions went one of two ways, either I would make the executive call (and it often go wrong) or simply leave it to Luke. In hindsight this could have been better if I had made a more measured approach and attempted to better understand the reasoning either way.

While at races I would be the only authority on the technical side of racing and made all the calls.

One problem with this was where I was slow to assign set roles. When something went wrong - a crash for example - I would hurriedly start repairing the bike myself and not effectively assign tasks to others. Not everyone knew what their roles should be, and we were slow to react to problems. Alongside this, there were also problems with riders where they would crash and lose confidence in themselves, which would lead to slower lap times, or in the worst case, them not racing at all.

As detailed by (Cobb 2012), there are more effective strategies for team organisation. This can be where people are assigned “task roles”, where they undertake specific tasks (such as repairing crash damage), or “people roles”, where they focus on keeping the team working effectively (mentoring and supporting bruised riders).

As an example of an effective team structure, Figure 3 shows a diagram of a Formula Student team, where everyone is divided into different roles.

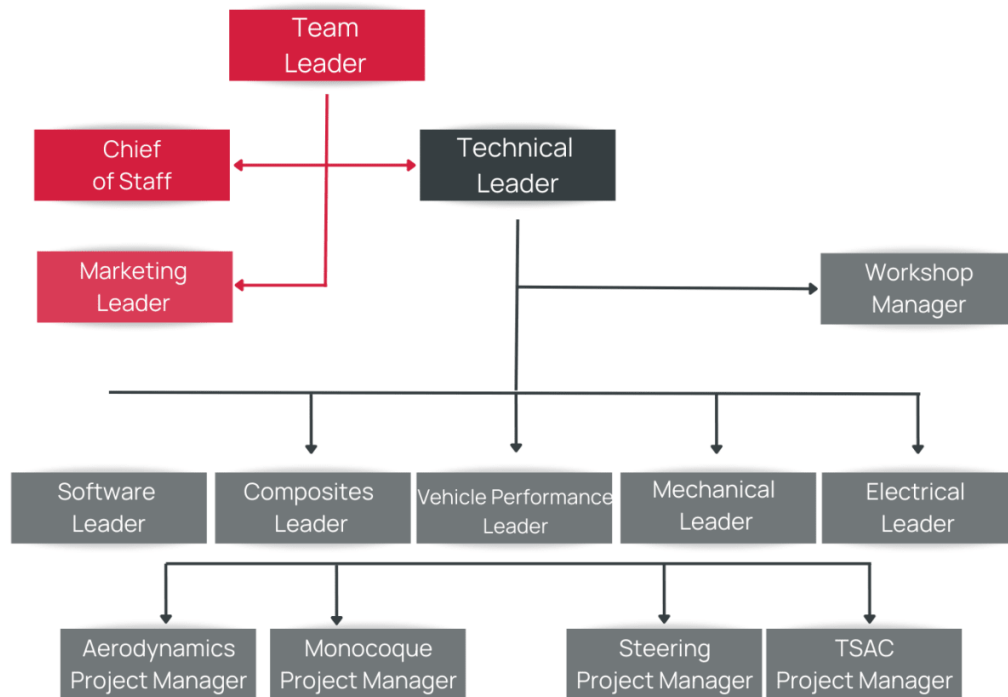


Figure 3 - (PWR Racing Team, 2024)

7. Conclusion

This report has discussed a few key areas that the Engineering Industry as a whole has to consider, from the legislation related to Health and Safety, modern problems with vehicle interconnectivity, sustainability and the role of the engineer, problem solving techniques, and team structure.

All of these are vitally important to the development of any engineer, and ensuring their competence in the subject matter will allow them to keep their skills sharp and adapt with the modern world.

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