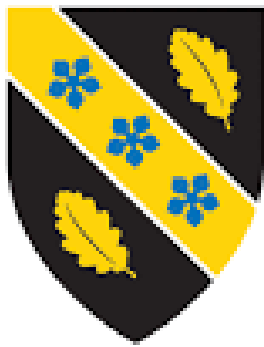


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Introduction to Engineering

Engineering Skills (ACHA4022A)

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Abbreviations

The following abbreviations are used in this report:

- HSE Health and Safety Executive
- PPE Personal Protective Equipment
- SWL Safe Working Load
- AV's Autonomous Vehicles
- FAV's Fully Autonomous Vehicles
- ADAS Advanced Driver Assisted Systems
- AI Artificial Intelligence
- LiDAR Light Imaging Detection and Ranging
- IMechE Institution of Mechanical Engineers
- CAD Computer Aided Design

1 Introduction

This report will look at the core skills an Engineer must have. From health and safety to innovating and designing the skills are what allows them to find the solutions when issues arise. It enables them to be at the forefront, on the verge of the unknown.

2 Health & Safety with Risk Assessments

2.1 Health & Safety Legislation

During the Winter it is standard practice for the engine to be taken out of car forty of the MCR UWTSD race team. To safely carry out this task it is essential to follow the legislation regulated by Health and Safety Executive (HSE). In the HSE (n.d.) guidelines it states that 30% of injuries are caused by lifting or moving bulky loads and that mechanical aids are available for specific activities. An engine is too heavy to safely lift alone. For these types of tasks engine cranes or alternative lifting hoists are used. The use of these devices does not automatically prevent injuries or accidents. Accidents are more likely to occur if the technician does not have the right training and is not familiar with the technology. Training should be provided, and the crane operator must be physically strong enough to safely control the equipment (Allan, 2012). Physical capability should be considered when lifting manually and is less of a consideration when lifting mechanically. However, it is still important to be aware of the capability of the person carrying out the task. In the same way that a person has a limit to how much they can lift, so does the hoist. A Safe Working Load (SWL) must be clearly labelled on the equipment. Exceeding the SWL can vastly increase the risk to the technician. Repeated stress being applied to a component can lead to fatigue failure. The most common type of failure in engineering. Regular testing of equipment is to be carried out, and records are to be kept. This ensures that the equipment stays up to date with the most recent health and safety legislation and prevents the likelihood of fatigue failure occurring.

2.2 Hierarchy of Controls

In the hierarchy of controls below, it lays out five different methods of reducing the risk. From least to most effective (bottom to top).

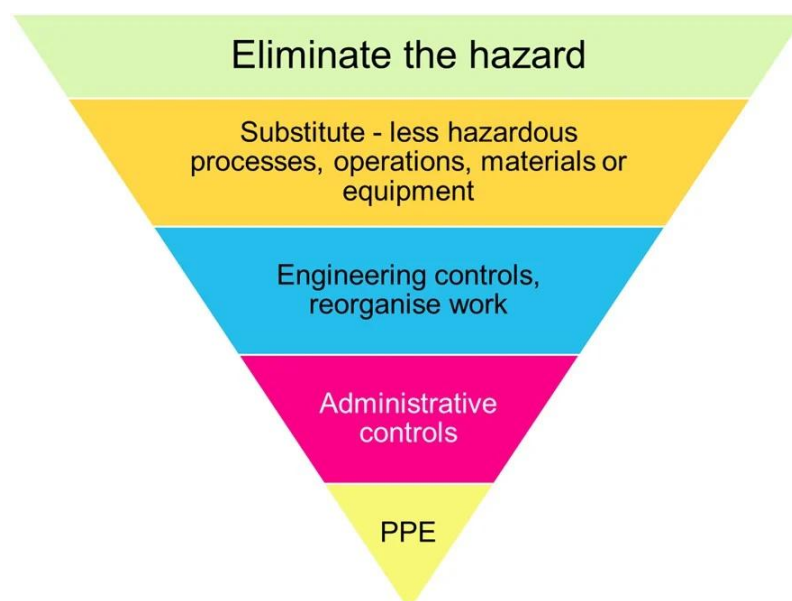


Figure 1: Hierarchy of Controls (Leathley, 2025)

PPE is used to add a layer of protection that then enables the technician to continue safely. Steel toe cap boots are universally accepted as a minimum layer that should be present during all workshops. In the case of removing an engine, overalls or protective clothing must be worn to stop oils and harmful chemicals coming in contact with skin. Administrative controls look at how technicians work. Engineering controls look to remove the technician from the hazard. This is particularly useful when there are limited options on how to reduce risks. Alternatively, in some cases, the hazard can be removed or replaced.

2.3 Risk Assessment

Hazards	Who may be harmed?	What prevention is already in place (PPE)?	Further action needed to prevent the risk	Who Needs to implement this action?	When is the action needed?
Failure of the hoist	Technician	Ensure suitable joints are used and their SWL is labelled	Regular testing of Equipment's	Regulatory body	Annually
Hoist may topple over	Technician and people working near by	The legs are secured with heavy duty pins	Individuals may need assist when moving the hoist	At the Technicians discretion	Before operation
The engine may swing while suspended	Technician	The operator holds the engine while moving the crane	Provide training on safe operation	Employer	Every two years
Oils, Greases, or chemical splashes	Anyone who is near the engine during removal	PPE is used in the form of protective clothing	Disposable gloves must be worn when exposed for prolonged periods of time or handling substantial amounts of grease or oil	The employer must provide disposable PPE	They should be bought regularly depending on demand

Table 1: Risk Assessment

The Template used is Provided by HSE.

3 Security Risk Matrix

3.1 Autonomous Vehicles

As the automotive industry becomes more autonomous there are security risks that present a challenge for engineers to overcome. Autonomous vehicles (AV's) have various levels of autonomy. Most modern vehicles are level 1 or 2 where basic vehicle functions are assisted or have the capability to be assisted. The highest level is fully autonomous, known as FAV's. Lower levels use advanced driver assisted systems (ADAS) to provide a small level of autonomy. FAV's have either utilised existing ADAS or have developed it to the point that it can function independently. FAV's use complex computing systems or artificial intelligence (AI) to drive the vehicle taking data from light imaging detection and ranging (LiDAR) and radar.

3.2 Threats to Autonomous vehicles

3.2.1 Digital Threats

Cyber-attacks can lead to the compromising of AV's sensors which could have disastrous consequences such as, death and severe accidents because of improper driving decisions. Hackers can tamper with the LiDAR and radar sensors to cause the computer to incorrectly read road signs and not recognise vehicles or people on the road. They can also mess with the camera systems to present phantom objects. (Giannaros et al., 2023).

FAV's use ADAS like cruise control and steer-by-wire to move the vehicle. If a cyber-attack enables a hacker to gain controls of these systems, the consequences could be devastating. The AI would no longer be in control, and the passengers would be at the mercy of the hacker. This is more reason cyber security around AV's and FAV's is imperative.

3.2.2 Physical Security Threats

Physical damage to sensors or cameras can adversely affect the vehicle's ability to make choices effectively. If the camera lens crack, then the visibility could be obscured. As cars age the wear on vehicles may present issues that are currently unnoticed. Due to the fact that autonomous vehicles are still quite new technology, it is hard to determine the lifespan of parts. If these parts fail often then it not only presents a danger to the public but also is a huge risk for the manufacturer.

Poor weather conditions can adversely affect the operation of sensors and cameras. In thick fog visibility is reduced and LiDAR and radar cannot effectively scan the environment. Moisture in the fog creates noise in the LiDAR system because it measures the time lazars take to bounce off objects and return. The fog scatters and absorbs these lazars. Mud and dirt can also cover sensors and cameras preventing them from working.

3.3 Security Risk Matrix

	Insignificant	Minor	Moderate	Significant	Severe
Rare					
Unlikely			Damage to sensors and camera		
Possible				Cyber attack where hacker tampers with the sensors	Cyber attack where hacker gains control of vehicle
Likely		Poor Weather Conditions			
Certain					

Table 2: security risk matrix

3.4 Response to an Attack

If a cyber-attack occurs and the vehicle is compromised, then the sensors and computing would be disconnected from the servers to halt any further attacks. In addition to this there may be backup sensors and a backup computer system that can be used.

4 Engineers Role in Society

4.1 Code of Conduct

4.1.1 IMechE

In the Institution of Mechanical Engineers (IMechE) code of conduct it states that Members are to “act with care and competence”. They shall not work professionally outside of their understanding and must continue to maintain and develop their knowledge. They are to “act with integrity and in a reliable and trustworthy manner”. This means that they are to be open and honest with the practices and methods they use. As well as the conduct for personal characteristics, engineers have a role to play in preventing climate change and becoming sustainable. Where there is bad practice and improper conduct members must call it out, upholding the reputation of the institution. (IMECHE, 2021).

4.1.2 Ferrari Group

The code talks heavily about their responsibility to the environment and sustainability, committing uphold international standards. They value human rights providing an “environment in which values are fostered and **ethical conduct** encouraged”. Similarly to the IMechE they ask employees to challenge and report violations of the code. This affirms the value to be integral and act with responsibility. Ferrari want to preserve the “traditions and identity” of the organisation. (Ferrari, 2023).

4.2 Discussion

From the codes summarised above it is clear that engineers have a vital role to play in society. What that looks like is individuals that are: responsible, integral, defend human rights (treating everyone equally), protect the environment and look towards a future built on respect and honour. However, they are not bound by the codes as a form of silence but are allowed freedom of speech. The codes of conduct are a way of keeping the values that formed and made the company successful. Ferrari is a perfect example of this. Enzo Ferrari the founder of the company is still acknowledged today for the culture and legacy he left. Engineers should be forward looking, ready and equipped for the future. That future will be shaped by global engineers as the world utilises the problem-solving and innovating abilities that they possess (Chan and Fishbein, 2009).

5 Problem Solving

In industry development is constant. This means being on the verge of the unknown. There won't always be a straightforward answer. Problem solving is an imperative skill that many careers require (Subramaniam and Khair Noordin, 2020). Being able to think outside the standard processes enables the engineer to find solutions and improve the product. Issues found in development can be difficult to solve. It could just be the technology isn't available, or it could be that there is a mistake that has gone unnoticed.

5.1 Flow Diagrams

Flow diagrams are a good tool used to diagnose where a mistake or issue may have occurred.

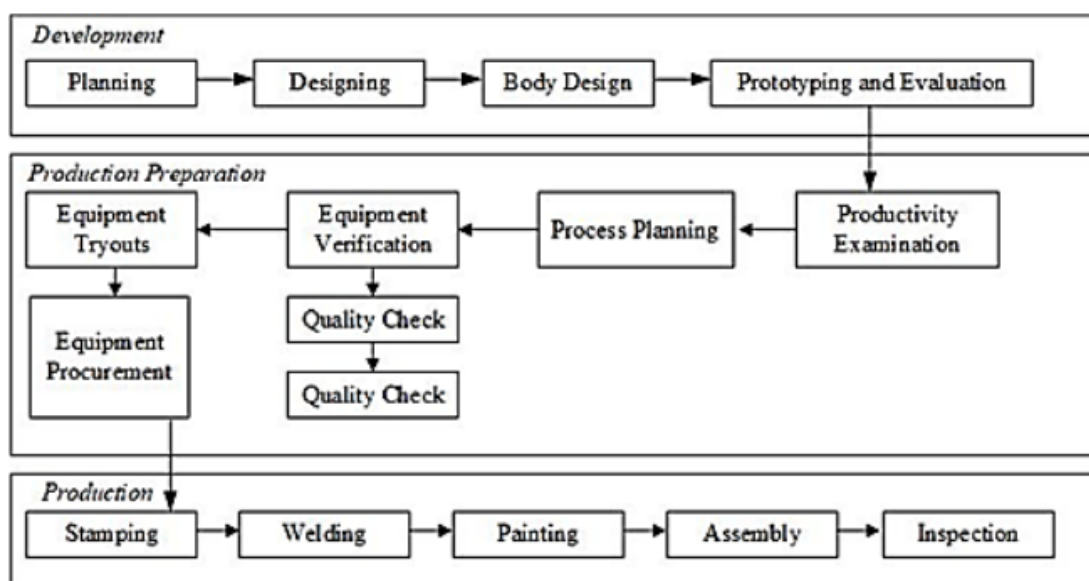


Figure 2 : Existing Automotive Manufacturing Process (Jadoon et al., 2020)

Figure 2 shows the process for automobile manufacture. The development stage is relatively straight forward, however if there is an issue then changes may be needed. Having a good understanding of the existing structures is vital. Flow diagrams can be used to look at the process and then be reorganised to improve the areas with issues. An engineer can create individual diagrams for the specific parts of the process which is useful because each part of development will be different, requiring different interventions. For example, designing will be different from prototyping and evaluation because the issue will be different. Designing may be an issue found on the computer aided design software (CAD), as with prototyping the issue may be that certain parts don't function as intended. Both require different solutions, but the skills needed to find them are the same.

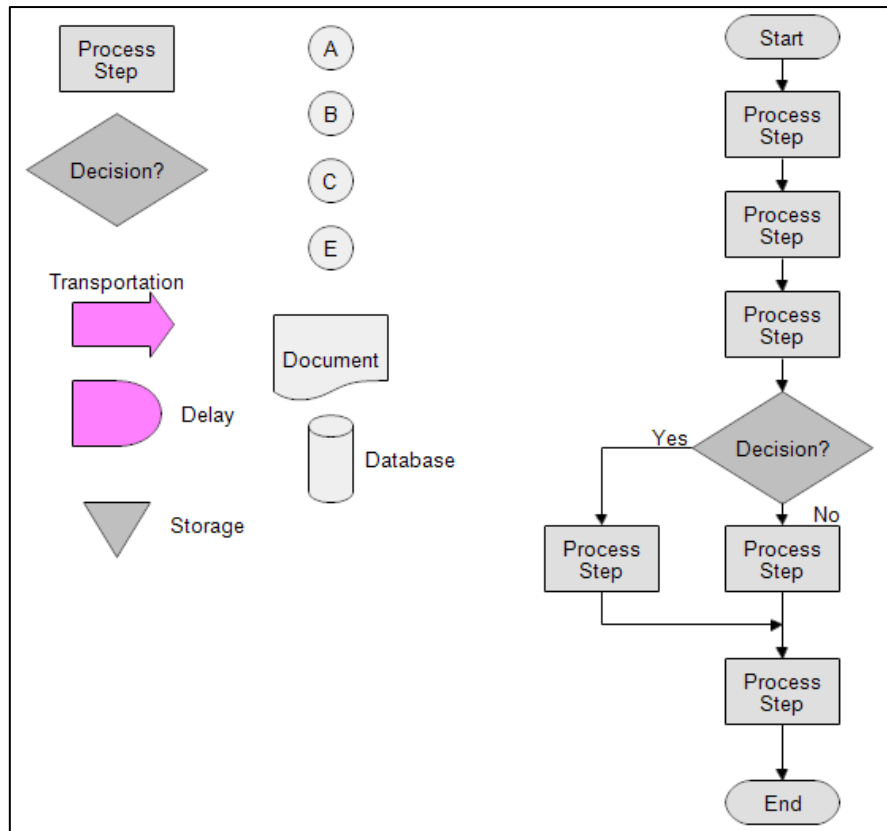


Figure 3: Process Flow Diagram Template (RFFlow, n.d.)

Figure three is a template that can be used to create a flow diagram. The decision step is one of the most important pieces of the diagram because this enables the engineer to step outside of the process. Good problem solving is all about being able to make the right decisions when stuck. Some of the options available when there is an issue is that they can either restart the process, fix the failure or redesign the next step. In any case the decision step is where the solutions will be found.

6 Team Structure

6.1 Personal review

While on foundation year we had to work in groups. My group consisted of four people in the first semester and three people in the second semester. I did find that there was a reluctance to take on the organisation aspect to the assignment. Everyone wanted to do the design work and the *easy stuff*. The way the group worked had aspects that were efficient and effective. I worked with someone quite closely and were able to keep the consistency up. Peers are able to share knowledge with each other because they tend to have a similar level of knowledge and experience (Zhuge, 2002). I think the negative aspect to the team structure was that we lost contact with two people because they were *working separately* or so we thought. When we did get back in contact with them after three or four weeks it turned out they hadn't done the work they said they would. The advice I got was that they be given some work to do even though the report was eighty percent complete. This changed the structure of the group massively.

6.2 Discussion & Research

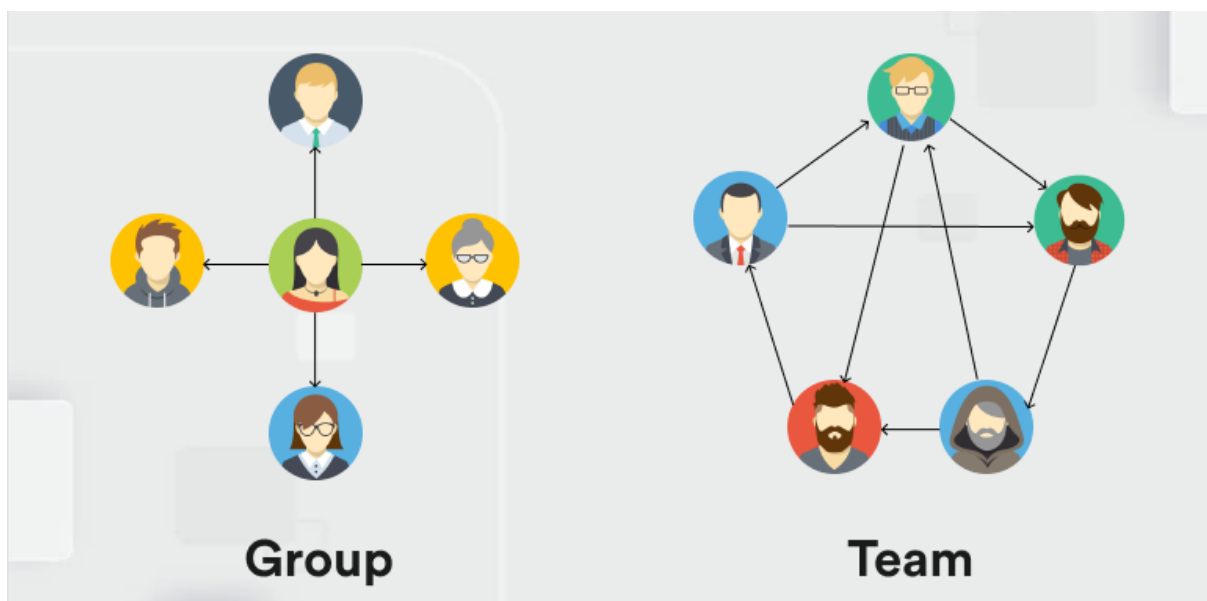


Figure 4 : Group Vs Team Structure (Belyh, 2022)

Figure four shows the different ways groups can be structured. Both, however, have short comings. I like the layout of the team rather than the layout of the group because it enables cross communication rather than having a manager overlooking different departments. However, the problem with the layout of the team is that if work is held up in 1 department it vastly affects the timescale of the project.

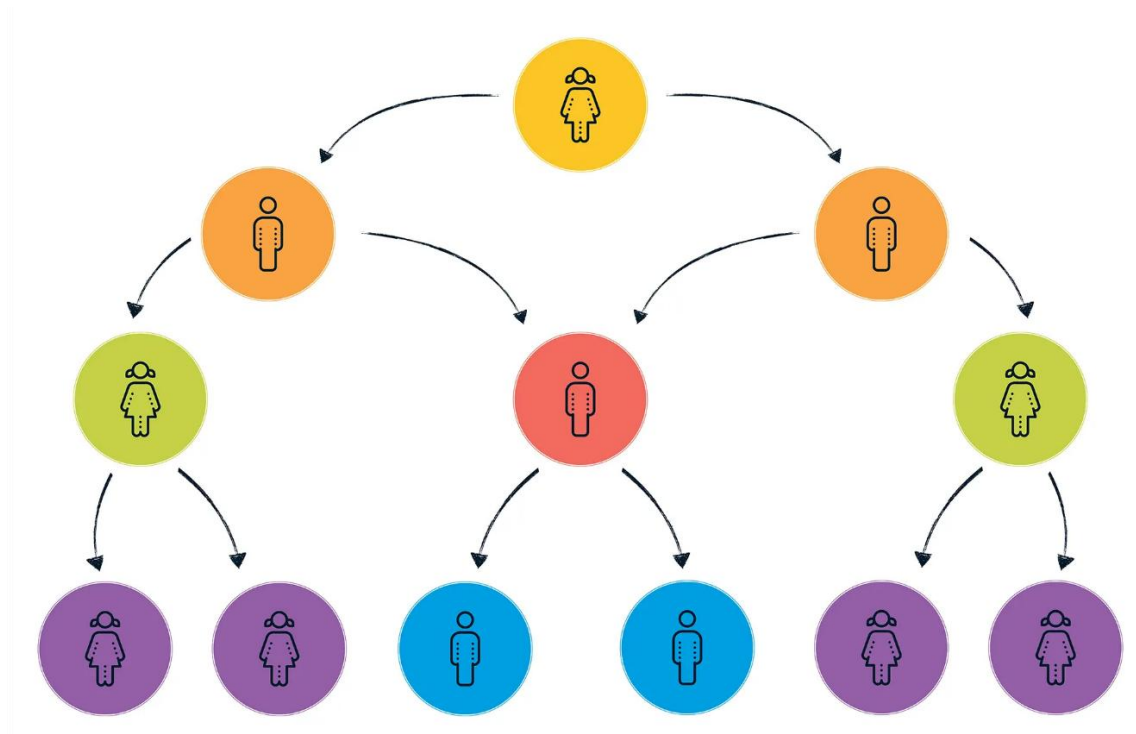


Figure 5 : Hierarchical Organizational Structure (F.Dieffenbacher, 2023)

Many organisations use a pyramid structure as shown in figure five. I think it is a good way of managing employees. If my group had implemented something similar to this structure while also keeping the team layout from figure four then we might not have lost contact with members of the group. The problem with this level of management is that members may feel like they don't really have much choice in what they work on.

6.3 Future Improvements

After we lost contact the structure became like the group shown in figure four but the project was the person in the centre of the structure. If I was part of another group I would definitely make more effort to maintain contact with everyone, having regular group meetings and reviewing the work that everyone has done. Something my group also struggled with was recording minutes when we did have a meeting so I would look to sort that out.

7 Conclusions

In conclusion, the skills an engineer must have are pivotal to the work they do. If an engineer doesn't have the skills required, then as covered under section 4.1 they must work to bring their abilities up to standard. From ensuring the safety and security to developing and innovating, engineers shape the world. The problems that presents are, as discussed in section five, able to be solved. This may require teamwork or personal innovation. Either way, one's ability to step back and look at the wider picture is a core skill that helps them prevent threats, provide safety and innovate through solutions.

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