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Engineering Technical Report

Workshop and Practice (ACHA4011)

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Definitions and abbreviations

PPE = Personal Protective Equipment

Swarf = Material, in the form of shavings, turnings, chips, or powder, that is removed from a workpiece during a machining operation. (Atkins & Escudier, 2013)]

UKCA = the conformity marking used for products being placed on the market in Great Britain (UK Government, 2021)

CE = the conformity marking for products being traded within the European Economic Area (European Commission, 2021)

Direct current = A unidirectional current of substantially constant value. (Butterfield & Szymanski, 2018)

Alternating current = An electric current whose direction in the circuit is periodically reversed with a frequency, f , independent of the circuit constants. (Butterfield & Szymanski, 2018)

IMechE = Institution of Mechanical Engineers

1 Introduction

This report will consist of research into the risks involved when using drills in an engineering workshop along with the various safety legislation and PPE required to reduce those risks. Subsequently an analysis will be conducted on the various organisations that publish a code of conduct for engineers and how engineers are required to follow these to create a more sustainable future in motorsport. Followed up by research into the issues that engineers in industry face and what problem solving this entails. Continuing with an examination of diverse team structures employed in the karting industry, including an analysis of their advantages and disadvantages. Finishing off with a personal development plan, with an overview of different career and personal goals for the next 10 years and how they will be achieved.

1.1 Aims

- Research the different health & safety and PPE legislations in the UK.
- Conduct research into the sustainability and environmental issue within motorsport and how engineers are required to follow codes of conduct to fix these issues.
- Consider the issues engineers face when designing products and how they overcome them.
- Discuss the different types of team structures and which ones work best within the go-karting industry.
- Produce a personal development plan.

1.2 Objectives

- Create an understanding of the health and safety requirements within an engineering workshop along with the problems engineers face up against the environmental impacts of motorsport. As well as how engineers go about solving problems when designing products.

2 Health & Safety with Risk Assessments

A common tool in any workshop is the drill. In the motorsport workshop within the university the pillar drill is the most commonly used. Being a power tool, it can be dangerous to use and therefore comes with safety risks that can be reduced in part with the implementation of PPE and training to protect those using the drills.



Figure 1 - Pillar drill (Sealey, 2023)

Undertaking tasks that require the use of drills can be dangerous and prone to injury. There are multiple risks that can be involved from injuries to the cause of fires. These can be down to the miss use of the machine, poor maintenance, and lack of cautiousness from the user.

2.1 Means to reduce risks.

To reduce any risks involved in using such machines, the understanding of the health & safety guidelines and the use of PPE are vital. These can include wearing eye protection whenever in close proximity of a machine, keeping hands and face away from all moving parts and clamping down the workpiece before operating the machine (University of Wales Trinity Saint David, 2023).

2.1.1 Health and safety legislations

When it comes to using tools within a professional workshop there are different legislations put in place by the UK government that employers must follow to ensure the safety and wellbeing of those using the equipment (UK Government, 2023). These legislations include regular inspection and maintenance of power tools, such as abrasive wheels, drills, and sanders, to avoiding potential accidents and injuries (Health and Safety training Limited, 2023). On top of regular safety checks tools should have correct safety features, such as safety guards to stop limbs, hands, clothing, or hair getting entrapped (Health and Safety training Limited, 2023).

In the UK and GB electrical appliance require certain certification marked with either the European standard, CE, or the new GB standard UKCA. Any tool between 50 and 1000 Volts for alternating current and 75 to 1500 volts for direct current must be marked with these certifications (UK Government, 2023). This is also required for electrical equipment that is intended to be used in a workshop environment, with pillar drills being between 230V for single phase and 650V for three phase drills they must have these certifications.

2.1.2 Required PPE

PPE is a vital way of keeping workers safe when using machinery. It is the employer's duty to provide PPE if it is required by a risk matrix for the specified task. (Health and Safety Executive , 2022).

When using a pillar drill in the university workshop it is required that the user is wearing steel toe cap boots, protective clothing such as overalls or a dust coat. On top of this Safety glasses must be worn to protect from swarf and particles being projected (Univeristy of Wales Trinity Saint David, 2023). However, it is prohibited to wear gloves to protect hands as these could get trapped in moving parts and cause injurie, instead it is required that barrier cream is applied beforehand and washed off afterwards. (University of Wales Trinity Saint David, 2023).

2.2 Risk assessment and risk assessment matrix

Table 1 – Pillar drill risk assessment

Hazard	Consequence Major = 5 High = 4 Moderate = 3 Low = 2 Insignificant = 1	Likelihood Certain = 5 Very likely = 4 Likely = 3 Unlikely = 2 Highly unlikely = 1	Risk = consequence x likelihood Substantial = 15-25 Moderate = 8-12 Low = 1-6	Residual risk	Implementations to reduce risks
Entrapment	5	2	10	Injuries such as amputation if limbs are pulled in. Ripped out hair. Minor or major cuts to fingers and hands.	Ensure that all clothing is suitable for use around the machine and that hair is tied back or concealed by headwear. Check for emergency stops allowing to cut off the machine. Drill must have a safety guard on it.

Cuts and injuries	4	3	12	Cuts to fingers, hands, and forearms. caused by misuse of tools and causing swarf to be created during the drilling of metals.	Correct training on drills to teach how not to produce swarf when drilling metals and stone. Keep hands and face away from moving parts.
Fire risk. Due to the overheating of either the drill or work piece.	5	1	5	Burns to the user. Danger to other workshop uses if fire spreads.	Correct training, fire safety equipment and signage.
Injuries to eyes.	5	2	10	Swarf and particles projected into the users' eyes, causing injuries.	Wear protective safety glasses and make sure the guard is down during the drilling process.
Electrocution from damaged wires or switches.	5	2	10	Electrocutions to the user, causing injuries or death.	Check that the drill is in perfect working order and is not damaged before use. Ensure all cables are out of the way of the drill and not at risk of damage.
Projection of drill bit or material.	5	4	20	Injuries to user such as cuts and bruising caused by improper clamping of workpiece or broken drill bits.	Clamp all workpieces do drill bed before use and check for damage to the drill such as broken drill bits.

Table 2 - Risk matrix

	Severity of Incident					
	RISK MATRIX	1 - Insignificant	2 - Low	3 - Moderate	4 - High	5 - Major
Probability of Occurrence	5 - Certain	5	10	15	20	25
	4 - Very Likely	4	8	12	16	20
	3 - Likely	3	6	9	12	15
	2 - Unlikely	2	4	6	8	10
	1 - Highly Unlikely	1	2	3	4	5

Substantial / Intolerable Risk (15 - 25)	Work must stop until suitable control measures have been implemented. Additional resource / cost likely required.
Moderate Risk (8 - 12)	Further consideration to be given to reduce risk. Additional resource / cost potentially required.
Low / Acceptable Risk (1-6)	No or limited further risk reduction measures required. Monitor existing controls. Additional resource / cost unlikely to be required.

3 Engineers Role in Society

Engineers have a vital role in our society, they are at the for front of development and are a defining factor in technological advancements. Throughout human history engineers have had to overcome multiple problems and create varying solutions. Today the main issue at hand is climate change and the push to become more sustainable is growing. Engineers are the leaders in solving these problems and creating a more sustainable future.

3.1 Sustainability in motorsport

Within motorsport there is a big push towards sustainability, multiple different racing series are developing different ways of overcoming these environmental challenges and reducing their carbon footprint. This can be proven through the fact that new series are starting up purely with environmental awareness in mind such as Formula E and Extreme E, both being electric racing series travelling round the world in a more sustainable and greener manor. These technologies being developed within motorsport and ideologies will in future help to produce more sustainable vehicles within the public sector.

3.2 Chattered engineers roles in improving sustainability

Chartered Engineers are held to a high standard through a code of conduct produced by the Engineering Council and the Royal Academy of Engineering. The Statement of Ethical principles produced in 2005 and then updated in 2017, states that it is the duty of engineers to protect, and where possible improve the quality of built and natural environments. On top of this they must maximise the public good and minimise both actual and potential adverse for their own and succeeding generations. All while taking due account of the limited availability of natural resources. (Engineering Council & Royal Academy of Engineering, 2017).

Along with these two organisations, IMechE have produced their own code of conduct supporting the one produced by the Engineering Council and the Royal Academy of Engineering. This code of conduct states that it is the duty of Mechanical engineers to promote sustainability. They must recognise the importance of environmental factors, comply with obligations of environmental protection and to balance the needs of the present generation with the ones of futures generations (Institution of Mechanical Engineers , 2021).

4 Problem Solving

Engineers face issues with all aspects of designing and producing products. These problems can be particularly difficult and generally will need to be sorted within both time and financial constraints. These problems can have more than one solution and it is the engineer's duty to use the most effective one. (Shaw, 2001)

4.1 Types of problem solving

There are various options when it comes to types of problem solving, a commonly used one is brainstorming. This is generally a group problem-solving method where teams come together to put forward ideas and solutions for the problem at hand (Bonnardel & Didier, 2020). Another frequently used method is Root cause analysis, the idea here being to determine the cause of the issue to then identify the best solutions available (Okes, 2019). Another good example of a method of problem solving is Triz which originated in the Soviet Union and is the theory of inventive problem solving (Sheu, Chiu, & Cayard, 2020).

4.2 The use of root cause analysis

When creating a product for a client, engineers are given various specifications and requirements they must abide by to achieve the correct design of the product. These requirements are generally set with a cost of production on mind, trying to help reduce the costs of designing the product by allowing the engineers to create the least amount of prototypes before putting it into production.

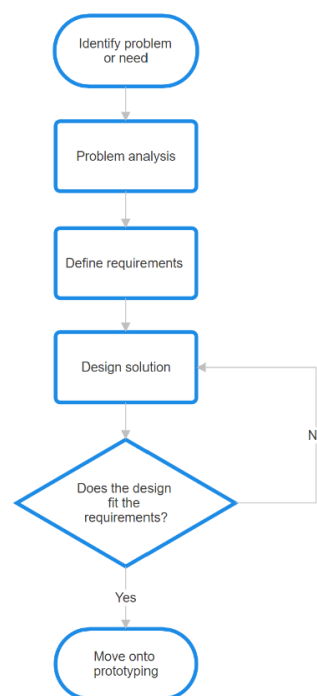


Figure 2 - Design process flow diagram

After the initial design has been agreed it is then put into production prototyping. This is where the product will be produced and tested to check it meets all the requirements without running into issues or failing. This phase allows for engineers to understand where the design can be enhanced and if there are any floors that could mean the product would need to go back to the design phase or can simply be modified.

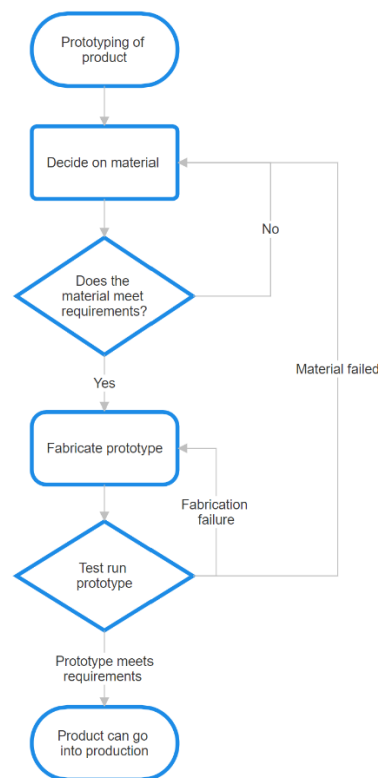


Figure 3 - Prototyping flow diagram

Once the product has been put into production, the engineers must confirm that there are no issues during the process and that the product can be commercialised. After the product has been commercialised, issue may still appear. The product could be unsafe, due to failure that was not initially considered or tested during prototyping. The means of solving and fixing these problems could possibly go as far as redesigning the product or just making a slight change. If the product does make the market and issues arise after that, it needs to be considered whether it would need to be recalled or if it is still safe to leave on market and make changes for future versions.

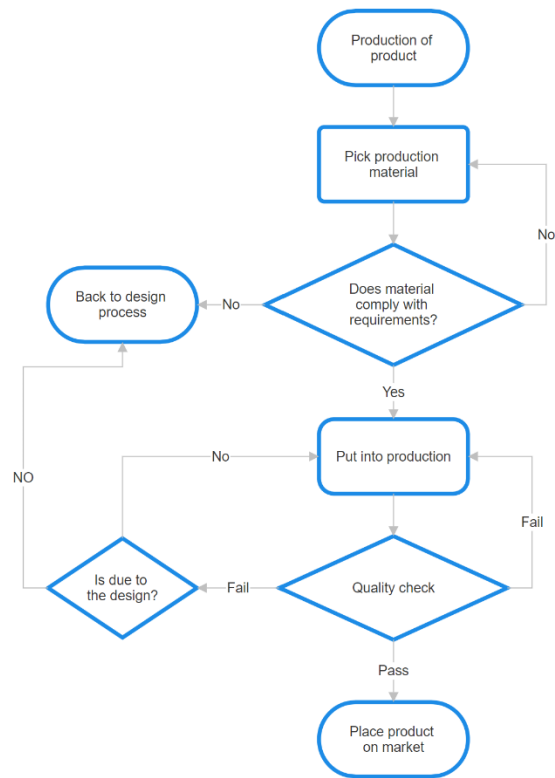


Figure 4 - Production flow diagram

5 Team Structure

5.1 The matrix team structure

I have had the chance to work in multiple different team environments in the past. All using the matrix team structure. A matrix organisation structure is where teams report to multiple leaders (Asana, 2023). The most recent being with Club100, a UK based go-kart company running multiple karting series around the UK including the British University Karting Championship.

The matrix structure works very well in this environment as it allows for effective communication between the team members running the events and ensures that each race meeting runs as smoothly as possible. In the hierarchy of the team, we have the event manager who governs the events with the help of the head mechanic, track clerk and race control all while keeping communication links between him and the observers. The track clerk and race control keep a close link between them and the observers as this is how they run the races and ensure that all penalties are applied correctly and consistently. Along with this, race control informs the head mechanic in the pitlane of stop-go penalties and other incidents that he then communicates to the pitlane team mechanics who stop drivers for penalties, repair crash damage and run pit stops during endurance racing.

The only exception to the matrix structure in this instance are the marshals who do not communicate back to anyone but instead are governed by race control and the track clerk while being overseen by the events manager with the observers communicating during incidents.

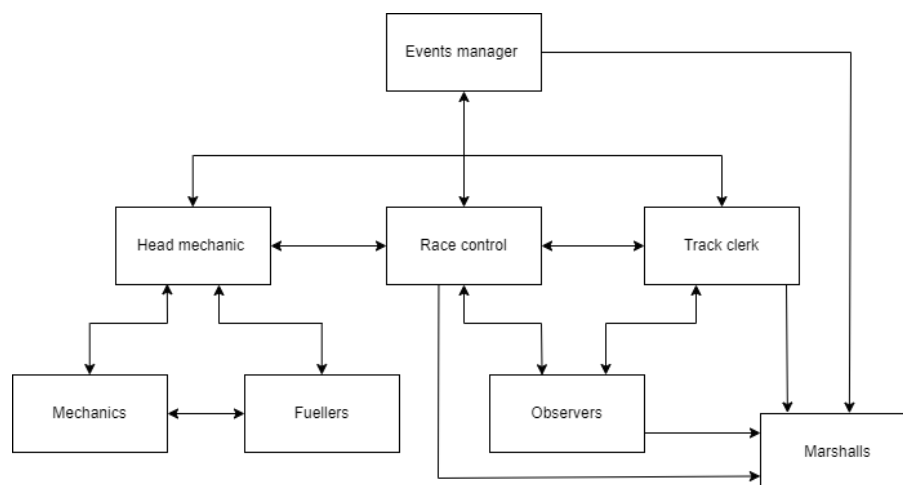


Figure 5 - Club100 matrix team structure diagram

There are pros and cons in all team structures. When it comes to the matrix organisation within Club100 it is very well suited but there are still some points that could be improved on.

Pros:

- It is a very efficient way of working in a team, with everyone being able to communicate with one and other without going through a manager.
- This communication can enhance problem solving, specifically in stressful situations such as crashes.
- Good use of resources as team members are assigned to their centre of expertise and therefore can be more efficient.

Cons:

- Can lead to miss understandings due to communication overload coming from multiple team members.
- In this instance it is harder to integrate the team as a new member due to everyone already having learnt how to work alongside each other.
- Unclear leadership caused by the track clerk and event manager giving contradicting information to the observers.
-

5.2 Other possible team structures

There are multiple types of team structures that suit different industries. The most common being hierarchical, functional and matrix. Having proved that the matrix team structure works very well in providing the best working team when it comes to running karting events. It is not necessarily the only possible structure.

The second team structure that stands out over the matrix organisation is the functional structure. It works in the same way where we would have an events manager governing the event but the difference being that not all groups would communicate with each other and the team members lower down in the hierarchy would not have as much if not no communication with the events manager or the other members above them. However, each team would communicate between themselves and with their proprietary managers.

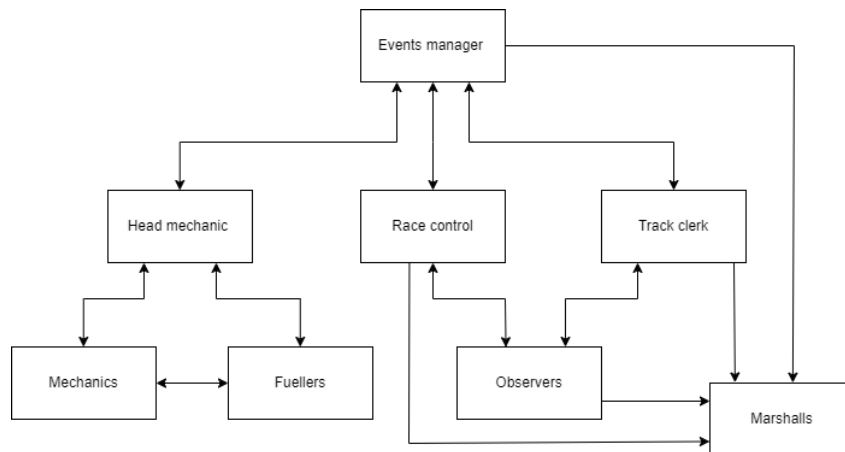


Figure 6 - Club100 functional team structure diagram

As we can see in figure 2, this would not necessarily work as it is vital that both the head mechanic and track clerk communicate directly with race control. Whereas here they would have to go through the events manager, this possibly creating a lot of confusion along with time wasting and overloading the events manager when trying to pass on information from race control to the pitlane for example.

6 Personal Development Plan

Degree – Motorsport Engineering

Previous Qualifications –

Brevet d’Initiation a l’Aeronautique, French certificate of introduction to aviation.

Baccalaureat en science d’ingenieur, French baccalaureate in engineering science.

Full driver’s license.

3.5 tonnes trailer driving course.

Foundation Year in Motorsport Engineering – certificate of higher education in Science, Technology, Engineering and Mathematics with Distinction.

Previous Experience –

Mountain bike mechanic

Bartender in charge of till and stock.

Various landscaping and basic carpentry jobs along with garden maintenance.

Waiting, cleaning and kitchen work in a ski chalet.

Ski coaching as a senior member of a ski club in the Alps.

Club100 - Karting observer relaying penalties to race control along with small mechanic jobs.

Long Term Goals (5 to 10 years)

- Complete my BASI level 4.
- Pursue my career in the Formula 1 industry.
- Create a stable income for myself and family members.
- Allow myself the funds and time to continue traveling.
- Purchase my own property.

Short Term Goals (0 to 5 years)

- Obtain a placement Year in industry allowing me to gain experience and create contacts.
- Have a better understanding of my career goals and find a specific path that interests me.
- Complete my Motorsport Engineering degree.
- Build up my savings.
- Start my BASI ski instructors' qualifications.
- Pursue qualifications in mountain bike instructing.
- Build up the funds to go travelling to Canada and South America.
- Once graduating from university start my career on my desired path, hoping to be Formula 1.

Goal	Objective	Resources Required	Measurement	Target Date
Obtain my BASI level 1 ski instructor's course.	Complete the weeks training required for the BASI level 1.	- Funds - Time - Ski equipment	Gaining a certificate	January 2023
Placement year within an F1 team.	Work with the careers advisers to obtain a placement year between year 2 and 3 of university in the Formula 1 industry.	- Strong CV - Application opportunities - Industry contacts	Gaining experience.	September 2026
Graduate from my motorsport engineering degree.	Obtain a first in my bachelors of motorsport engineering.	- Decent work ethic and organisation - Strong understanding of the studied subjects.	Graduation.	July 2027
Build up my personal savings.	Start building up a savings account with object of using it towards a big life project in the future.	- Good budgeting - An income - Limit outgoings	Money saving.	July 2025
Complete the next BASI ski instructor's qualifications.	Work towards completing my BASI level 2 and level 3.	- Funding - Time	Qualifying as an instructor	April 2026

Travel and visit Canada and south America.	Spend some time abroad discovering countries that appeal to me. This would be completed during my time at university in the summer brake periods.	- Savings - Good planning skills. - Basic language knowledge for the desired countries to visit.	Travelling. Learning new cultures.	August 2026
Pursue my BASI level 4	After completing the previous BASI levels. Complete the level 4 to become a fully qualified ski instructor worldwide.	- Physical training - Spend a winter season in France ski training. - Funding - Ski equipment	Qualified ski instructor	April 2028
Begin an engineering career in Formula 1	Start my post graduate career in the Formula 1 industry.	- Bachelors in motorsport engineering - Work experience - Strong CV - Interview opportunities	Employed	December 2028

7 Conclusion

Health and safety are very important when it comes to protecting engineers and technicians within a workshop environment, the government legislations, and the requirements for the use of PPE ensure that the employer can produce a safe environment for they employees when using machinery and tools. Along with this the various codes of conducts studied in this report help engineers to build a more sustainable future within motorsport. This can also be implemented when designing products and overcoming problems, engineering teams can be pushed to pick more sustainable materials. Depending on the environment different types of teams work better for different applications, as shown the matrix team structure is a very good example for use within the motorsport industry, allowing for good communication within a team.

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