

# University of Wales Trinity Saint David

Wales Institute of Science and Art



**Prifysgol Cymru**

Y Drindod Dewi Sant

**University of Wales**

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Workshop and Practice

Engineering Technical Report

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# 1 Introduction

This report will give an overview of the subsequent topics:

Health and safety, including a risk assessment, this will detail the relevant health and safety legislation for an activity that a student can participate in during their first term at university. A relevant risk matrix will also be included in this section.

Engineers and their subsequent roles in society, this will explain some organisations that are similar to a worker's union in supporting their engineers, but also holding them to meet certain conditions and a high standard of professional conduct.

Problem solving, this will examine some of the issues engineers can face often and the steps they take and the options they can use to solve said problem. This will include a flow diagram to visualize the process taken to solve a problem.

A team structure and the impact this can have on an outcome for a project, this will be a personal account of an activity that the author has completed. This will then examine another team structure and compare the effectiveness of both layouts.

A Personal development plan (PDP), this is again a personal account of the authors own plans and aspirations.

## 1.1 Aims

The Aim of this report is to give the reader an overview of the expectations of an engineer and the problems they may face throughout their career.

This will also give the reader and understanding of the authors, experiences, and their aspirations to become a member of the engineering industry.

## 2 Health and Safety

Health and safety has quickly become a huge aspect of life for the employee, employer, and the government, as the responsibility of the safety of an individual has been placed upon the individual and the organisation, an emphasis has been placed on eliminating risks from the environment. To minimise this risk, assessments are made and then evaluated against the risk, versus reward of that activity.

The risk matrix is able to visualise the possibility of an accident or injury against the severity of an injury. During the risk assessment process, an action can be given a score of possibility and a score for severity of injury, these scores can then be placed against the matrix and then is given a simple view of the risk associated with the task.

| Risk Matrix |          | Severity   |        |           |           |           |
|-------------|----------|------------|--------|-----------|-----------|-----------|
|             |          | Negligible | Minor  | Moderate  | Major     | Severe    |
| Possibility | Certain  | Medium     | High   | Very High | Very High | Very High |
|             | Likely   | Medium     | High   | High      | Very High | Very High |
|             | Possible | Low        | Medium | High      | High      | Very High |
|             | Unlikely | Low        | Low    | Medium    | Medium    | High      |
|             | Rare     | Low        | Low    | Low       | Low       | Medium    |

*Table 1 shows a simple risk matrix.*

Tasks within an automotive workshop can often include lifting or moving heavy objects such as cylinder heads, engine blocks etc. With these objects having considerable amount of mass, when dropped they can cause injuries to an individual's legs and feet when dropped, because of this steel toe-capped shoes are required to protect the individual's extremities. As the responsibility of reducing harm is placed upon the organisation and the individual, it is a legal requirement for organisations to issue personal protective equipment (PPE) to employees, but often these are the cheapest they can find that meet the set requirements set by the UK government. As stated by the Health and Safety Executive, when PPE is deemed to be necessary by a risk assessment, the employer then has a duty to provide its staff with the required PPE free of charge. (Executive, 2022)

### 2.1 Responsibility on the individual

There is also a legal responsibility placed upon the employee to keep themselves away from risks, there is current guidance for an employee to carry no more than they can safely lift. The HSE has identified a difference between what a person is able to lift and what they can safely lift. Due to this there is a responsibility on themselves to understand their own physical limits. Because of the weight of an engine block, during the engine strip lectures an engine stand is used and then parts are placed into the supported engine. When lifting a cylinder head to attach it to the engine block, an individual must carry the head from the counter and then lift it onto the engine block, this will incur a risk of dropping the head. A cylinder head for the engines used in the workshop do not weigh a significant amount therefore the possibility of dropping it can be assumed to be rather unlikely but because of the height it can be dropped from the severity of injury can be assumed to be quite high, therefore we can give it a major severity score. From this we can see that it is still classed as low risk against the risk matrix. Using the risk matrix is a way of quickly visualising the risk associated with an activity.

### 3 Engineering Roles in Society

In the United Kingdom, the term engineer can be applied to numerous different job titles without the need to be registered and regulated. This has led to the creation of organisations that given an accreditation to engineers that employers can validate to guarantee they are employing an individual that is held to the same code of conduct to their existing staff. Upon joining these organisations, an individual is held to a code of conduct and must meet a set criterion, once these prerequisites are met, they are given the prefix 'Chartered' this can be put before their email handle or on Job applications to show that they have met the requirements that the organisation has set.

Both of the below organisations push their members to be more environmentally conscious and search for more sustainable pathways. The IMECHE hold numerous seminars throughout the year with some of these being aimed at sustainability and environmental issues.

#### 3.1 Institute of Mechanical Engineers (IMECHE)

The IMECHE is an institution that was formed in 1847 and holds itself to the value of "improving the world through engineering." This body continues to guide and improve the lives of engineers from all aspects of life, supporting aspiring engineers through college or University down to guiding engineers to their desired career path. To support the institutions finances, there is a yearly registration fee that can be paid by the employer directly, or through the individual themselves. The institution prides itself on their goals of inclusion, diversity, and sustainability and encourages its members to adhere to their standards.

#### 3.2 Engineering Council

The engineering council is similar to IMECHE but appreciates the different specialisms of the engineering industries, they include a similar accreditation scheme for engineers and again, hold these engineers to a strict code of conduct. The engineering council can also give their accreditation to smaller organisations under the engineering umbrella such as the Safety and Reliability Society (SaRS) this allows Engineers that are currently held under the society can now be included into the Engineering Council's membership. The smaller organisations must apply for a licence for their engineers to register with the Engineering Council. (Anon., 2020)

- 
- 1 **Contribute to building a sustainable society, present and future**
  - 2 **Apply professional and responsible judgement and take a leadership role on sustainability**
  - 3 **Do more than just comply with legislation and codes: be prepared to challenge the status quo**
  - 4 **Use resources efficiently and effectively**
  - 5 **Seek multiple views to solve sustainability challenges**
  - 6 **Manage risk to minimise adverse impact and maximise benefit to people and the environment**

*Figure 1 Shows the Engineering Council's code of conduct towards sustainability minimising environmental damage (Council, 2021)*

## 4 Problem Solving (With flow diagrams)

Due to the complex nature of today's society, problems can often arise at many different points of a product's lifecycle, whether that be during development or when the product has been placed within the market. Sometimes issues can be placed within the engineer's control, but can also be placed upon them, such as supply issues. Due to the nature of the issues that can arise, numerous different approaches to problem solving have been developed, Root Cause Analysis or RCA which identifies the initial cause of an issue faced by the engineering team and then applicable solutions could then be implemented to fix the issue. Within an engineering team, brainstorming can often be used successfully as it allows the team to discuss their ideas and then evaluate them based on the compatibility with the issue at hand.

### 4.1 Theory of Inventive Problem Solving (TRIZ)

TRIZ, is another problem ideology that focusses on summarising solutions and previous engineering problems systematically to look for overlapping similarities. (Gadd, 2011) TRIZ can allow an engineering team to use a previous solution to a problem and adjust it to suit a newer issue that has been found, this can increase productivity and save a business money. Developed in Russia, it is a completely different problem-solving ideology to what is commonly used in the United States, but over time has become more common across the globe as it allows problem solving in a creative manner.

### 4.2 Solving problems in development

Issues during development can often have a knock-on effect to the areas of the product's development. For example, if a component such as a rod bearing had a high chance of failure after a short amount of time, instead of designing, prototyping, and producing a new component, they would use a previously made component and adjust it to suit its new application. Instead of taking the time and resource to create a newer component, adjusting a common component would save time and money and be a more efficient way of solving an issue. Although this can be a simple and effective way of solving a current issue, if the component was to be more complex, it can have an effect on other components and cause further issues not originally intended, if we use a brake calliper as another example, the decision could be to use a brake calliper from another model of vehicle, but the clearance between the calliper and the wheel could become an issue if the calliper was not originally intended to be used with the wheel used causing the calliper to come into contact with the wheel incurring damage.

## 5 Team Structure

A good example of a team exercise is the Integrating project from foundation year, this included having a team of 4 people and designing a soap box racer. The initial team structure was us split up into 3 individuals and then a team manager. The team manger then dictated which section of the assignment each individual would complete. This layout was relatively simple and there were no immediate issues within the team, although a few issues could have arisen if the other team members weren't as enthused with not being team manager.

I was given control of the team's finances, this included costing up all the materials to suit the budgets for each variation of our soap box cars. As the three options we had were all separate and then would be compared against each other, there were three separate budgets and then the best value for money would be chosen and progressed into the second stage of our assignment. Costing and the financing became quite a downside of this team structure as all of the prior work (design, material selection, and all the considerations on how much material would be required) needed to be completed before my work could be done. Further to this, the time scale needed for all the prior work was given priority over the financing as it was viewed as a small part of the assignment, but it was initially research intensive gathering all the data needed to accurately cost up the materials used for each design.

### 5.1 Self-directed team structure

Without managers, this type of structure is entirely dependent on its own members to complete their own processes while giving them a feeling of ownership. This can often lead to the members covering entire cycles of work (product lines, lab work, design, and testing) (Notes, 2023). This type of structure would have benefited our assignment as each individual's work would have been their own responsibility making the marking scheme fairer for all parties involved. With this team structure there is no manager which can often lead to a team that doesn't have a dedicated member to gather feedback from as they are all equal members.

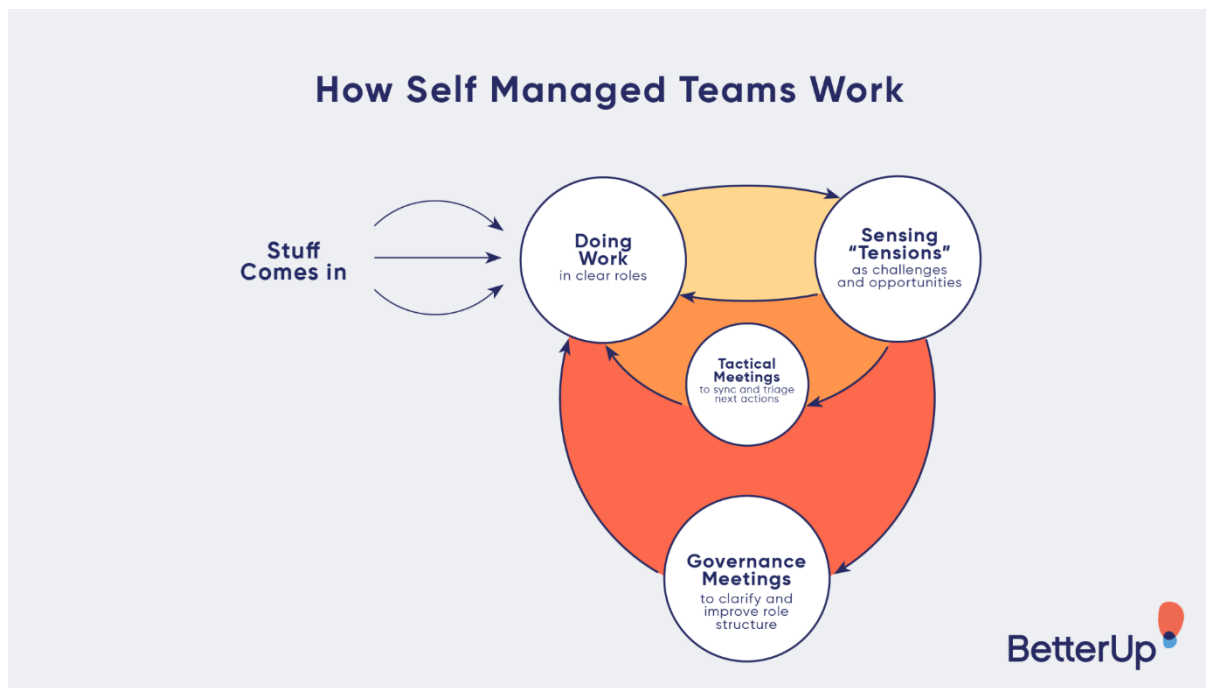


Figure 2 shows the process of given work for a self-directed work team. (Perry, 2021)

## 6 Personal Development Plan

| Long Term Goals (5 to 10 years)                                                                                                                                                                                                                                                                      |                                                                                                                                                   |                                                                                                                                                                                                                               |                                                                                             |                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| I aim to create and run a business specialising in manufacturing and re-manufacturing performance, repair, and maintenance parts for historic/nostalgic automotive and motorsport legends. These will focus of older BMW's but will include bespoke work for motorsport teams and enthusiasts alike. |                                                                                                                                                   |                                                                                                                                                                                                                               |                                                                                             |                                                                           |
| Short Term Goals (0 to 5 years)                                                                                                                                                                                                                                                                      |                                                                                                                                                   |                                                                                                                                                                                                                               |                                                                                             |                                                                           |
| My biggest short-term goal is to finish my degree with the best mark I can achieve and then gain some further industry experience to build on the work I was doing in the summer break.                                                                                                              |                                                                                                                                                   |                                                                                                                                                                                                                               |                                                                                             |                                                                           |
| Goal                                                                                                                                                                                                                                                                                                 | Objective                                                                                                                                         | Resources Required                                                                                                                                                                                                            | Measurement                                                                                 | Target Date                                                               |
| Create a collection of parts that can be sold to consumers to generate capital to expand my business.                                                                                                                                                                                                | Catalogue the common failure points of my car, re-design, and prototype these to develop an inventory of parts that can be manufactured and sold. | Time is the main resource that will be used to meet this goal.<br><br>Towards the end of the goal, money will be required as the manufacturing process will generally not be cheap due a lower volume of sales to begin with. | A minimum of 10 common failure points to be re-designed and ready to prototype.             | This goal is to be completed before the end of this academic year (23/24) |
| Begin using social media to market my process, show upcoming projects etc.                                                                                                                                                                                                                           | Finalise my website, this will serve as a blog to show potential customers what any upcoming projects are and what is already in development.     | Again, time is the main resource required to complete this goal.                                                                                                                                                              | Continue work on the website up to a point where I am happy with the initial look and feel. | This goal is to be finished by the end of the academic year (23/24)       |
| Tabel 2 shows the Author's personal development plan.                                                                                                                                                                                                                                                |                                                                                                                                                   |                                                                                                                                                                                                                               |                                                                                             |                                                                           |

## 7 Conclusion

### 7.1 Health and safety

We can see that although an individual has a responsibility to keep themselves safe, their employer also has a responsibility to minimise risks of injury and provide PPE free of charge, although the PPE issued is often of lower quality compared to what is available to a consumer, they will still meet the regulations set by HSE.

### 7.2 Engineering in society

This report has shown that the major engineering organisations hold their members to their codes of conduct, it is also shown that the two organisations written about are pushing for engineering to keep the environment and sustainability at the forefront of what they do.

### 7.3 Problem solving

Triz is used as another way of solving issues, originating in the 20<sup>th</sup> century Russia, it was a major engineering tool used by the Soviet Union as it focussed on solving issues as cost effective and quickly as possible.

### 7.4 Team structure

This report has detailed the authors personal experience within a team, noting the positives of the team structure used and then detailed another structure that could have been appropriate to use for the task that was set. Both structures have their own positives and negatives that can be utilised to their advantage based on the activity that the team has been set.

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