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**An investigation into engineering team structures and
industry standards**

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1 Introduction

This report aims to outline the role of a lead engineer in an engineering team tasked with designing a product and how this role would need to be planned and carried out over the course of a product development cycle, including a look at how the engineering team fits into the overall development team structure and how good communication is maintained between sub-teams. An overview of relevant concepts such as professional codes of conduct, industry standards and consideration for environmental issues will be included, as well as how this relates to the selected product.

The product selected for this report is a sustainable note pad targeted at students.

2 Research

2.1 Team Structure

The team structure is one of the most important aspects of a project as it ensures every team member knows what is expected of them, and which areas of the project they are responsible for.

It is important for team members to work effectively together in all aspects of engineering to achieve full contribution from all team members (Takai and Esterman, 2017).

In addition to this, ensuring the team has good communication and can work efficiently together will help mitigate the risks of miscommunication that could cause mistakes or delays to the product cycle.

When considering team structures there are two widely accepted systems known as centralised and decentralised, with a third known as hybrid that is a combination of concepts from both.

Hameri, A (2002) describes the differences between centralised and decentralised in the following ways. Centralized team structures function as one unit with one person in full control of the project, enabling good coordination between team members as all decisions come from the same place. This also promotes good control for the project leader. Decentralised team structure consists of multiple autonomous teams under individual managers that can independently make decisions without the project leader. However, a project leader will usually oversee the sub-teams as a whole and provide the overall direction of the product. This usually leads to more disorganisation and miscommunication in large teams however decentralised teams give specialists more control over their individual areas.

Therefore, centralised structures work well for large teams but may be detrimental to the project due to specialists having less control over their areas but coordination between sub-teams is less of an issue. Decentralized structures work well for small teams, allowing specialists the freedom to innovate in their respective areas, and the small size of the team ensures that the problems associated with communication and coordination are mitigated.

Hybrid team structures are commonly used by modern multinational corporations where the development of a product is completed by many sub-teams who themselves fit into a rigid centralised structure. These sub-teams can make smaller decisions related to their specific area to minimise the micromanagement required from the project leader. As these sub-teams are usually in

different geographical locations, reducing the time and resources that might be wasted can have a significant impact of the economic efficiency of team of this scale. However, the project leader in a Hybrid structure retains executive control of the project to ensure that no resources are wasted in a situation where different sub-teams may pursue ideas in different design directions, which can lead to wasted resources if the results produced are not compatible.

In relation to the development of the notepad, a hybrid team is unwarranted due to the relative size of the team. A decentralised structure fits the project best as this will encourage innovation and creativity as specialists have autonomous control of their individual areas and the small size of the team will minimise the potential for miscommunication and disorganisation. The proposed team structure is shown below (Figure 1) with the arrows representing lines of communication.

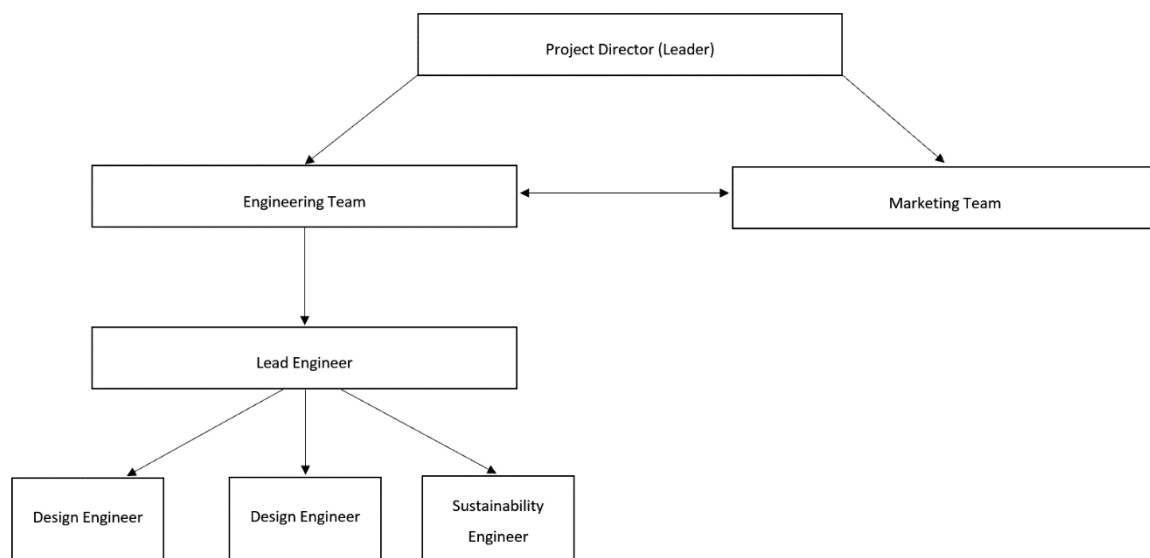


Figure 1 - Team Structure

The team will be split into two sub-teams with a project director overseeing the project. The engineering team and the marketing team will need to maintain consistent communication to ensure the product meets the criteria specified by the director and the individual team leaders to produce a well-rounded product. Each team leader has autonomy over their individual areas and are expected to collect feedback from their specialists and communicate this with the other sub-team to decide what is best for the product. Project manager responsibilities will include providing overall direction for product development and goals. Any disputes between sub-teams will be settled by the project director after relevant arguments have been reviewed from both departments.

2.2 Engineering Code of Conduct

It is vitally important that all engineers are held to the same standard as engineering affects all aspects of society for example cars, buildings, and infrastructure. If standards of quality were not maintained, it would risk the lives of members of the public, and consumers may be placed in danger. It is also important to maintain a good level of trust as engineers are trusted to maintain a high standard of quality as well and ensuring their work is not detrimental to society or the environment at large. Having a defined code of conduct ensure all products and services created meet these standards across all disciplines.

British engineers are overseen by the Engineering Council who operate under a royal charter and aim to maintain internationally recognised standards of professional compliance. This royal charter, granted by the UK monarch, defines the objectives of the Engineering Council, and grants them the authority to pass Byelaws. Leading to the creation of the United Kingdom Standard for Professional Engineering Compliance (UK-SPEC) as detail by The Institute of Mechanical Engineers - IMechE (2013).

The UK-SPEC places emphasis the following concepts:

- Good knowledge and understanding of engineering principles, processes, systems, and products
- Responsibility, Management and Leadership
- Communication and interpersonal skills
- Professional commitment to codes of conduct, safe work environments and sustainable development

First published in 2003, the UK-SPEC incorporates the knowledge and understanding of industry professionals from a wide range of engineering disciplines, it is kept under constant review with the most recent edition published in 2013 and the latest edition set to be published on 31/12/21. The UK-SPEC provide an independent assessment of an engineer's skills and competence and is a key aspect in the evidence required to progress through the IMechE's charter process. In order to obtain EngTech certification, the first step towards being chartered, another assessment must take place, the certificate of Continued Professional Development provided by CPD services. This is important to prove the engineer in question is up to date on the latest developments in science and technology to ensure that they are always at the forefront of their respective fields and represents their continued commitment to the profession.

To ensure that all team members meet these standards it will be required that all team members obtain an IMechE registration of EngTech or higher.

3 Methodology

When creating a product/service it is important to select a target audience and conduct market research, this provides data to make sure that the product is performing to consumer expectations and provides value to the customer. The target audience for the notepad is eco-conscious students.

Consumer surveys are useful tools when gathering this data, surveys are useful to gauge what characteristics are desirable to a consumer and to outline what expectation the consumer had for the product. In relation to the notepad this would include inquiries into preferred paper thickness, preference of paper colour and how important sustainability is to the consumer when making decisions about a product. When collecting data in this way the larger the data set the more accurate the resulting information therefore it is important to survey as many people as possible. This poses a problem for the economic efficiency of the project, as it may be costly to produce and distribute these surveys as well as leading to unnecessary emissions and damage to the environment resulting from paper production and transportation.

As explored by Shannon *et al.*, (2003), problems like this may be solved through the use of electronic surveys which enable a cost effective alternative, grant access to a larger range of people and help make the project more sustainable.

Avoidance of problems that may arise of the course of a project is a key part of good planning procedure, it is important to focus on maintaining effective communication and a clear team structure. Gantt charts are a useful tool for this as they show timelines and deadlines for all tasks as well as dependencies between tasks.

As described by Kumar, P (2005), Gantt charts can maintain effective scheduling and ensure that all team members understand the progress of different areas of the project as Gantt charts give a easy to read graphical representation of the progress of the project. The relevant leader can assign personnel and resources in the team where they are most needed based on the progress of simultaneous tasks shown on the Gantt chart.

Shown below (Figure 2) is an example of a Gantt chart.

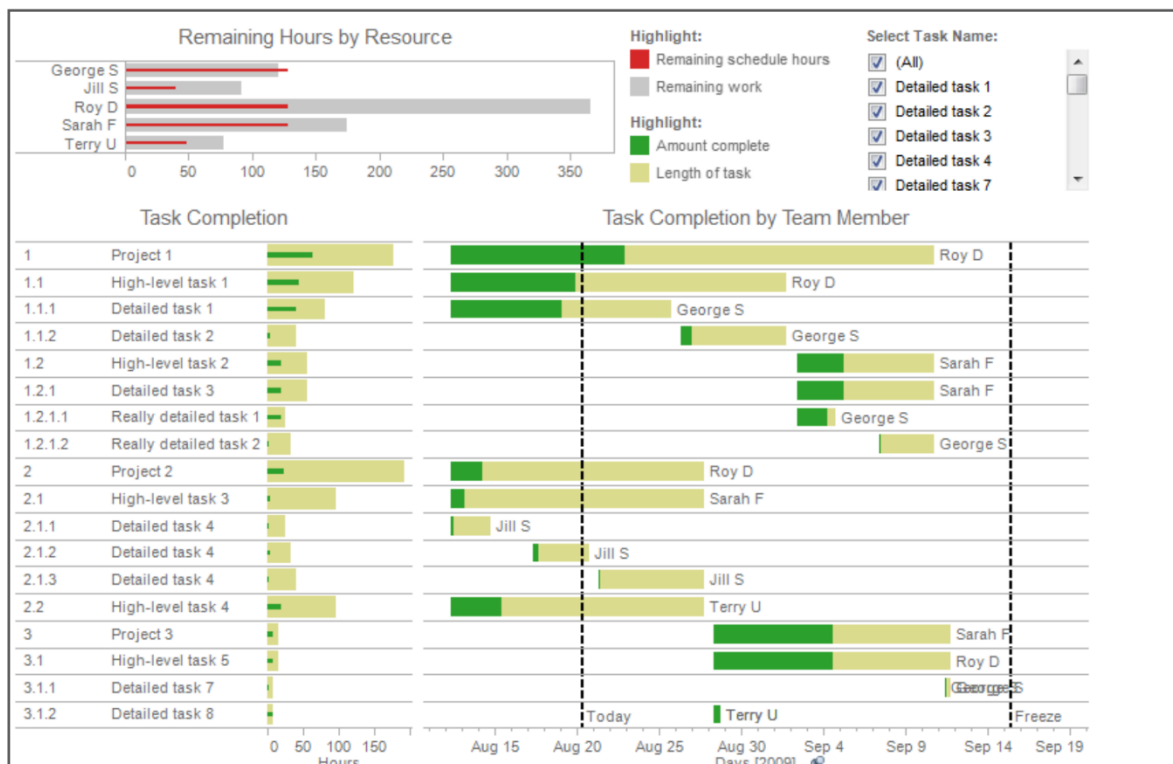


Figure 2 - Example of a Gantt chart (Hom, Perez and Williams, 2014)

Regular weekly or monthly meetings are an essential edition to Gantt charts to enable team members to easily communicate the progress of their areas. Meetings also facilitate the discussion of problems before they occur to help prevent them. Problems that do occur can be more easily dealt with and all-affected team members can be easily notified of possible delays.

4 Discussion

In Engineering it is expected that all aspects of a design including the ethical implications of the project are thoroughly considered. This is vital as engineers are responsible for considering the implications of the project on the wider world, for example emissions involved in production, exploitation of workers in developing nations, damage to local eco-systems, and the product's impact on society more broadly. Health and safety of the working involved in any process therefore risk assessment must be carried out wherever there is the potential for danger and the risks mitigated. Safety must be held in the highest regards as the environment that engineers work in can be dangerous, as a result it is vitally important that all team members are aware of the current regulations for health and safety in the workplace (Wikeley, 1989).

To maintain and uphold engineering standards many countries around the world have a code of ethics. The modern British code of ethics was established in 2005 when the Royal Academy of Engineering and the Engineering Council published a report titled *"Statement of Ethical Principles for the Engineering Professional"*. This document describes four fundamental principles as detailed below (Engineering Council and Royal Academy of Engineering, 2014):

- Honesty and integrity
- Respect for the law, human life, and the environment
- Accuracy and rigour
- Leadership and communication

When developing any product, legislation related to the design and manufacture must be respected. These regulations are put in place to ensure that expected standards are maintained across an industry and to prevent harmful business practices. A focus of these types of regulations is the protection of worker rights to a safe environment, the protection of the natural environment and ensuring all projects are ethical. In the case of the notepad, the used of elemental chlorine as bleach in paper production was outlawed in 2004 requiring all paper to be elemental chlorine free (ECF). This is because the use of chlorine releases dioxins (Nitrogen dioxide, sulphur dioxide, carbon dioxide etc.) into the food chain through waste water pollution as shown by Solomon (1996) in his paper.

In the case of the notepad, it would be beneficial to leave the paper completely unbleached, from accessibility, environmental, and economic perspectives. The off-white appearance would show the

product's commitment to sustainability and make it more attractive to the target market. In addition to this the colour would make the product easier to use for those who suffer from dyslexia, as described by Mortimore (2013), making the product more inclusive, a key consideration in any product. To further attract the target audience the aluminium bindings can be sourced from recycled material and remain unpainted to allow the product to be marketed as made from fully recycled materials. The health and safety risks associated with this project are low as all materials can be sourced post-manufacturing.

5 Conclusion

Overall, the principles discussed in this report outline how effective communication and maintaining an adaptive project plan can help mitigate the risks of problems occurring throughout the product design cycle. In addition to this, selecting a target audience and maximising the appeal to that audience is a reliable way to ensure a successful product. A focus on sustainability is increasingly important in modern society and as such sourcing of materials, emissions produced, and waste products are a key aspect of any design.

Regarding my own professional development, I intend to work in motorsport where the aspects of effective teamwork, communication, good project planning, respect for safety and the environment play an important role. To compliment my career, I intend to achieve CEng chartership with the IMechE, and will need to achieve EngTech certification first. To accomplish this, I need to prove I meet the UK-SPEC standards and achieve CPD certification.

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