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1 Introduction

This technical report will cover a planned project, producing an Industrial Descender for use in industrial abseiling within the Construction Industry, from the viewpoint of a team leader of an engineering team. It will cover team roles and structures, both used and considered, taking care to utilise team members efficiently to ensure a successful project. It will also consider other roles outside of engineering involved in developing and manufacturing an Industrial Descender. While also looking at the planning needed for such a product while including the different impacts the process or product could have in today's world, such as ethical and environmental impacts.



Figure 1 - An example of descenders already available (Pearce, 2016)

In the United Kingdom, the most common cause of fatal injury, is falling from height (hse.gov.uk, 2022) so it is important to consider laws, and engineering protocols that need to be considered when producing a product. The team, during the duration of the project, must adhere to and meet the strict safety standards needed for the product to be manufactured in various areas around the globe.

The penultimate section of this essay will be looking into personal development and the plan included, in meeting the set of goals of the author and which cover both times spent at university and the continual professional development needed once in industry.

2 Engineering Team Structure

2.1 Adaptive Triad Structure

A Triad team structure is based upon a temporary team made up of multi-skilled personnel, in this case consisting of an engineering team, product team and a design team working together (Gent,2018).

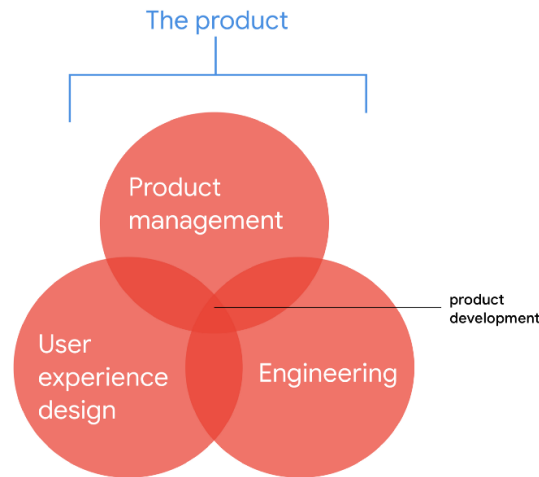


Figure 2 - A simple Triad (Eaton, 2018)

At the core of a triad structure is the ability to ease the decision-making process, due to all departments working closely, triads can also scale up through the development of the product and can be extended to include more teams, resulting in an adaptive triad. The nature of this project requires extra non-engineering teams to deal with the marketing to sell the product overseas, in addition to a legal team to deal with the legislation and industry standards that must be met at every stage of the project. An adaptive triad has advantages over a standard triad structure because it can reduce communication complexity, without hindering creativity and takes less effort to maintain compared to structure types more commonly seen in larger projects. The dynamic collaboration style of an adaptive triad, provides a continuous flow of information as the entire team is connected, whether this is via daily team meetings, shared online channels or even shared workspaces (Apostolos, 2022). The downside to this, especially as the team grows larger, is the potential to delay the decision-making process.

2.2 Team Roles within a Triad Structure

The design team will consist of CAD Engineers to build the model virtually, to specifications laid out by the engineering team. They will also take care to use the information gathered by the research team, to model a piece of equipment that will be ergonomically comfortable, helping it stand out from other products. The design team are responsible for the overall experience of the product for the consumer (Singh,2020). The design team will have a design leader who will oversee the entire design process and be the main focal point when communicating with the other teams.

The product development team will be responsible for achieving the vision of the product. A product manager will execute the planned strategy needed to achieve the objectives put in place. Ensuring the overall project runs smoothly, taking charge of prioritisation and road mapping to keep the

project on time. Singh (2020) states that, because of the overlapping activities, the product manager is usually the first to step on the toes of other teams, breaking the bond of the triad. To avoid this, the product manager must take care to find the most appropriate method to deal with communication issues.

The next team is the engineering team, made up of qualified engineers who will create the specifications for the build. The engineering team should take care to communicate with the design team to find out if the specification is plausible, especially early on in the project, before any prototypes are made. The team will have an engineer who specialises in materials and will choose materials that stay in the budget. The materials chosen, need to be tough enough to pass all testing and have a life cycle which is not affected by harsher climate and conditions. This team will also consist of a manufacturing engineer to make an efficient production method. At all times, the team should take care to communicate with the other departments before project altering decisions are made.

The advantage of the adaptive triad is the ability to have additional teams which can aid the project at different points. To make use of this, an additional team for research will be deployed. The need to obtain first-hand information and examination of competitors trends is vital in creating the specifications for the build, or else this product could cease to be competitive (Pugh, p56, 1990).

Another non engineering role involved would be a team of trained technicians, which would test the real-world use of the equipment. This project would only use qualified technicians of the highest standard, thus only using Industrial Rope Access Trade Association (IRATA) qualified rope access technicians (irata.org, 2022).

2.3 Other Team Structures Considered

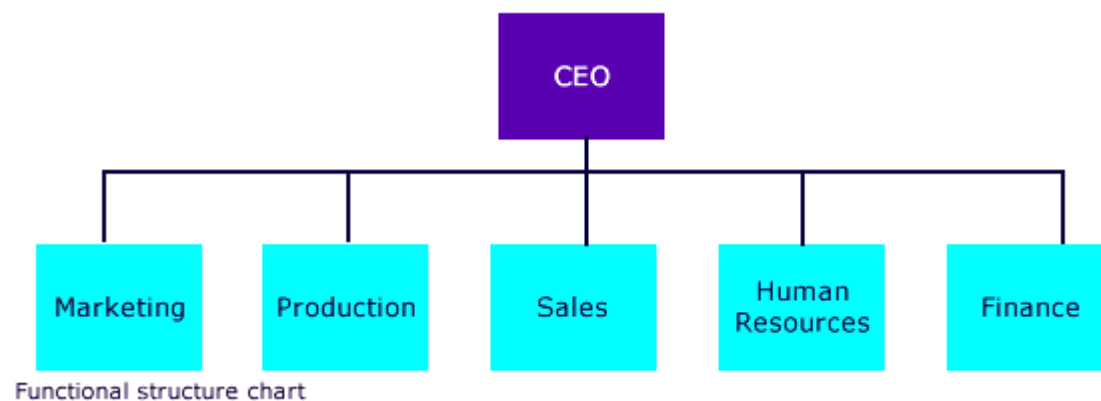


Figure 3 – An example of a Function Structure Chart (Olmstead, 2022)

A functional structure was considered because departments are split up by work specialisation, with each department having a leader. Due to the “top-down” structure of having one project leader and a leader per group, lower-level members of the team are not actively involved with decision making. This leads on to the challenge of the function structure, which is the lack of coordination between departments (Olmstead, 2022).

3 Product Development

3.1 Finding Product Ideas & Research

To make the product a worth while endeavour and to also be profitable. The research stage must look at functions already fulfilled by other products on the market, then go on to improve on them and create a superior product. Information gathering will include analysing trade publications, exploring patents and assessing catalogues of competitors. (Pahl et al, p63, 2007).

Pahl (2007) also goes on to say the most important factor in finding new product ideas is being client focused. Using a technique known as Quality Function Deployment (QFD) is one established method of identifying clients' needs and then turning them into products.

3.2 Product Planning

If the research stage of the project is successful, it can have considerable influence on the potential of the product. Careful planning can give the opportunity to the team, to design something that can meet industrial standards and laws in various parts of the world. If successful, the product can then be sold in different continents, without making variations of the same device. The product is not a standalone product, so the team must adhere to the standards of the ropes, harness, and carabiners of which it must be compatible.

3.3 Stages of Development

Designing a physical product comes with a separate set of issues when compared to other forms of product design, such as software. For a mechanical product, the design process must be followed as strictly as possible, to avoid making and re-making prototypes, using excessive man hours which will result in a much higher budget (alpineeng.com, 2022).

This project will follow the six-step engineering method set out by Lasser (2013)

1. Idea
2. Concept
3. Planning
4. Design
5. Development
6. Launch

This systematic six-step method was decided upon, as it will compliment the smaller size of the team and a clear system with minimal steps, helps the team know where and when objectives must be met. This system will benefit from the communication available with an adaptive triad structure.

3.4 Engineering Code of Conduct

The Engineering Council and Royal Academy of Engineers, state that the code of conduct is put together with four principles for ethical behaviour and decision making. These include *Honesty and Integrity*. Secondly, *Respect for life, law, the environment and public good*. The third principle is *Accuracy and Rigour*, and lastly, *Leadership and Communication*. Engineers will be expected to abide by this professional code of conduct. The engineering code of conduct is put into place to promote high standards of ethical conduct. This helps protect the public, engineers and uphold the engineering profession. Engineers are expected to act in accordance regardless of their role within the project (engc.org.uk, 2017).

4 Issues, Legislation & Standards

4.1 Issues

Even with in-depth planning, issues can always arise. With an engineering dependant project, which is set out in steps. If one step runs into problems, it can leave the next team waiting until the gridlock is resolved. To overcome this, the project manager can review the stages of the project regularly, making sure to keep development on track.

Another unforeseen circumstance that could halt design and development, is a pandemic on the scales seen in 2020 with COVID-19. Causing strong declines in industry, some of the hardest hit industries were, textiles and clothing, with a 28% drop, and automotive manufacturing with a drop of 16.2% (Zaichenko, 2021). Although a pandemic is a more extreme example, issues within businesses such as cutting the number of staff, supply chain issues and logistical problems could arise at any time due to an economic recession or political disputes.

4.2 Standards

An industrial descender must meet strict safety standards before it is sold and accepted in industry. According to the European standard, under the EN 12841 *Rope Adjustment System*, the device must go through rigorous testing. The static strength of the device is tested to 12kN (kilonewton). The locking capabilities of the device are then scrutinised before the testing of the device's minimum working strength. This consists of a 3kN weight held for 3 minutes, any more than 300mm slippage will cause the device to be deemed unsafe (Ricky, 2021).

Due to the descender not being a stand-alone product, it must also meet the standards of the equipment it is attached to. It must be compliant with the fall arrest harness standard, which falls under EN 813 2008 *Sit Harnesses* (sirsafety.com, 2022). It must also be compatible with low stretch rope which conforms with EN 1892 standards, so the descender must be compatible with type A rope with a diameter between 10mm and 11.5mm (abaris.co.uk, 2022).

Only once these standards are met, the descender is ready to be produced, once it is produced it is compulsory for the manufacturer to supply all relevant information to the consumer, as well as it being etched onto equipment. Etched information includes the EN 12841 number, max rated load and which anchor lines must be used (en-standard.eu, 2022).

4.3 Ethical Considerations

As with all rated safety equipment, the consumer must have the confidence that it will provide the level of safety it is advertised to do so. This means once the descender has passed its conformity tests, this standard must be maintained throughout the manufacturing run.

5 Personal Development Plan

In my career I would like to go down the route of data analysis, being involved in the role of a data engineer in motorsport. To aim for this goal, I acted upon my interest and got involved in race teams from foundation year, including a full season working in the Junior Supersport 400 in the BSB, which involved working closely with a data engineer. I plan to continue this throughout my time in university, moving up through the championships until I hit my goal of the WSBK.

6 Conclusion

To conclude, creating a successful product on any scale, planning and teamwork are the difference between a project being a success or failing. For a safety critical product such as a descender, the correct planning must be carried out to the highest of standards to be able to create an in-depth product plan, in which the device will adhere to all necessary industry standards, without the correct plan in place, the product will not succeed.

As with any engineering project, excellent communication between various teams, has the potential to avoid wasted resources and time. Good communication will lower the likelihood of repeating stages of the project, such as redesigns, or confusion amongst the teams, due to lack of coordination, resulting from poor communication.

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