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Engineering Problem

Engineering Design

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Table of Contents

1	Introduction	2
2	Specification	3
3	Time planning.....	3
4	Initial designs	4
5	Research.....	6
6	CAD Model	7
7	Technical Drawings.....	8
8	Justification	8
9	Conclusion.....	9
10	References.....	10

1 Introduction

The purpose of this paper is to address an engineering issue raised by an automotive original equipment manufacturer (OEM). This issue involves the redesign and implementation of a solution for the anodization tank. To design and develop an effective solution, several factors must be considered, including the initial designs, safety measures, and the operational functionality of the implemented design. Additionally, key legislation relevant to the new system must be reviewed, along with considerations for time planning, material selection, and the creation of a CAD model to demonstrate that the final product can operate as intended. Each of these elements plays a crucial role in ensuring the success and compliance of the redesigned anodization tank.

2 Specification

The final design for the anodization tank must adhere to a specific set of guidelines set by the line manager. They require that the design be operable by only one person, which means that some form of mechanical assistance must be incorporated to enable a single person to move the lid with ease. The new lid design must also prioritize safety, so all relevant safety features and considerations must be thoroughly explored. While modifications can be made to the existing lid to facilitate a new installation, the overall dimensions of the lid must remain unchanged. Additionally, there should be adequate clearance above the tank when the lid is removed, allowing the material being anodized to be easily dropped into and lifted directly out of the tank.

3 Time planning

Time planning is crucial for this project as it will help track progress and ensure that the manufacturer stays on schedule. The project must be completed as soon as possible, as the health and safety officer has classified the issue as a "major risk to staff." Given this urgency, a time plan has been developed, giving a total of 6 weeks for the design to progress from initial research to full implementation and operation. According to estimates for similar projects, the typical timeframe for a project of this size ranges from 1 to 8 weeks (Global Trade Specialists, 2025). Given that this is an addition to an already existing product, the 6-week timeline is considered feasible.

Four days will be assigned for the initial research, as this is a quick process. For the development of initial design ideas, one week will be dedicated to using the research gathered in the first four days to generate three different, effective potential solutions.

One week will then be allotted to the CAD process to ensure the design engineer has enough time to carefully create the desired product with as much detail as possible. This detailed CAD model will be required to manufacture the physical part needed to solve the issue.

Three days will be allocated for the manufacturing of the first prototype, ensuring it is ready for testing. Two weeks will then be set aside for testing the prototype, with this period also allowing for any necessary modifications to be implemented.

The final week will be dedicated to the implementation of the final design, assuming no additional issues arise during the testing process. Below is a time plan chart outlining the total time allocated to complete this project (Figure 1).

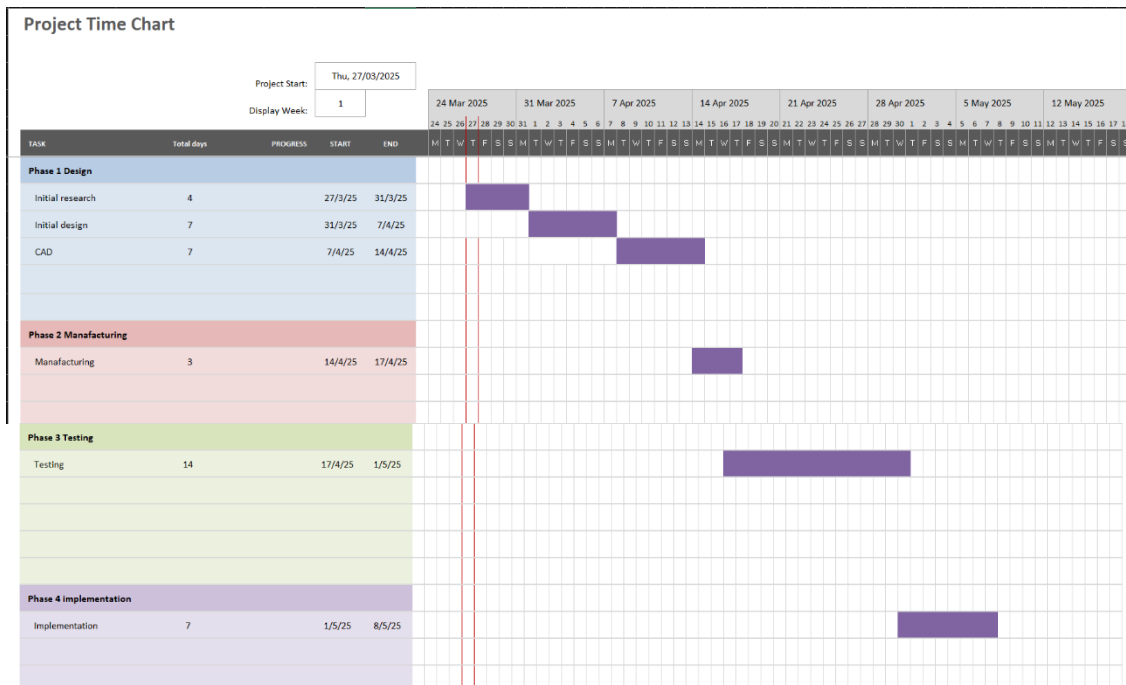


Figure 1

4 Initial designs

Design 1 (Figure 2) incorporates a locking gas strut system to assist the user in lifting the weight of the lid from the tank. The gas struts can be purchased, and custom-designed brackets will be created to retro-fit them to the existing tank and lid. This design meets the requirement for the tank to be operable by one person only. The gas struts will be positioned to allow the lid to open fully to 90 degrees, and the locking mechanism will ensure the lid stays in the upright position while the tank is in use. Using struts and brackets eliminates the need for modifications to the lid's size or design, requiring only holes to be drilled for mounting the brackets. This approach should be quick to create and implement. Additionally, the availability of pre-tested gas struts will speed up the testing phase, as they are already designed and proven to function effectively.

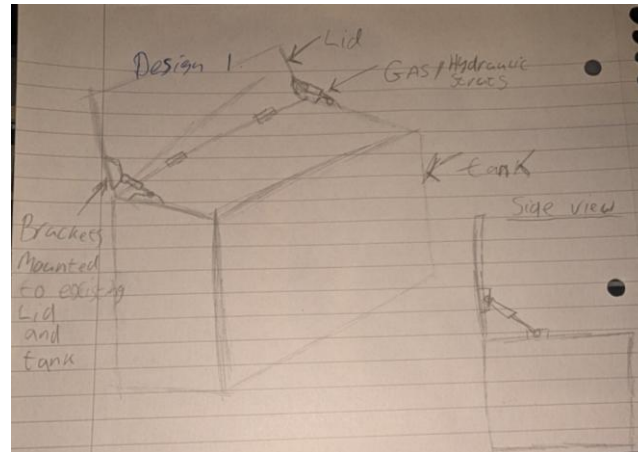


Figure 2

Design 2 (Figure 3) utilizes a gear and chain system operated by turning a handle attached to the main gear, similar to the pedal mechanism of a bike. While this design is slightly more complex than the previous one, it remains relatively simple to install. The use of two gears reduces the strain required to lift the lid, which is the primary objective of the solution. This design also incorporates an arm that locks the gear in place when the lid is fully open. Although this design could be effective, it may introduce potential issues due to the chain mechanism. For instance, there is a risk of clothing becoming caught in the chain, so a chain guard would need to be included to ensure user safety.

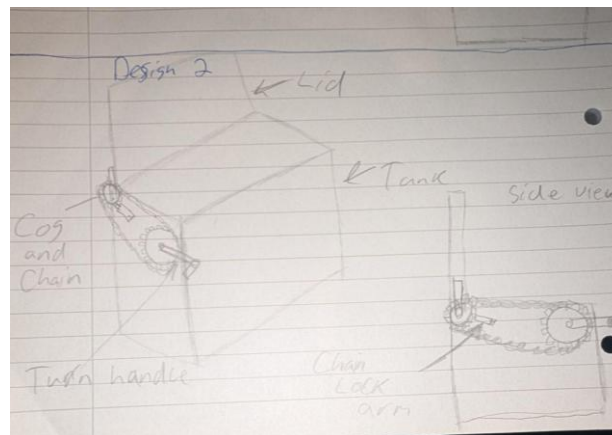


Figure 3

Design 3 (Figure 4) employs a self-designed rail system to push and tilt the lid toward the back of the tank. Two curved rails at the back will guide the lid behind the tank, making it easier to move the lid by pushing rather than lifting, as in the original design. However, a downside to this design is the space required for the lid to move backward. The area behind the tank will need to be kept clear at all times of objects and pedestrians, which could pose a potential health and safety risk.

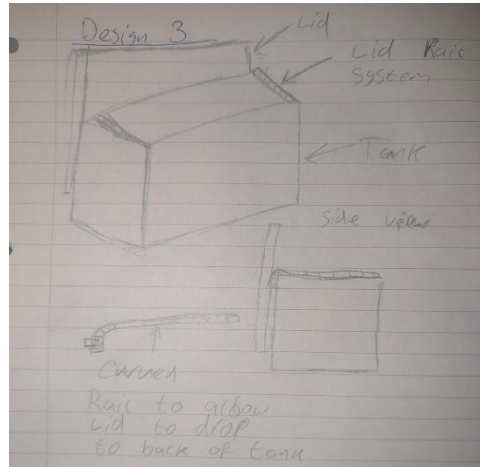


Figure 4

5 Research

Upon conducting research, it appears that gas struts are the optimal choice for the task at hand due to their strength, reliability, and wide availability in the market. SGS Engineering offers adjustable gas struts that are perfectly suited for this project, with the ability to lift up to 1200 N of force (SGS Engineering, 2025), which should be more than adequate for assisting in the lifting of the lid.

Gas struts have a broad range of applications in industrial settings, particularly in heavy-duty uses. For example, in the defence sector, they are commonly employed to lift heavy doors and hatches on armoured vehicles. They are also widely used in aerospace for landing gear systems, where their durability and reliability are essential (Albert Jagger, 2025).

For the construction of the brackets to secure the gas struts, aluminium will be chosen. Aluminium is a highly abundant metal in the manufacturing industry, known for its excellent properties. It is more ductile than other metals, making it less likely to crack when bent into tight radii. Aluminium is also cost-effective, easy to CNC machine, and resistant to rust, which significantly extends its lifespan (ASM, 2022). Additionally, its lightweight nature reduces the overall weight of the assembly, making installation easier. Its resistance to corrosion, combined with its durability, ensures that the brackets will provide long-term functionality and reliability. Overall, aluminium is an ideal material for the fabrication of the brackets, offering a balance of performance, cost-efficiency, and ease of maintenance.

6 CAD Model

Figures 5 through 10 below showcase the final CAD designs, which demonstrate how the completed assembly will appear. As seen in these models, the previously mentioned brackets and struts have been securely fastened in place using M10x1.5 bolts. Additionally, the struts are firmly attached to the tank body with M10x1.5 nuts and connected to the lid using an M10x1.5 bolt.

The CAD model confirms that the design is fully functional, allowing the lid to open and close to a full 90 degrees without any mechanical interference. Furthermore, the bottom bracket is strategically positioned above the 400mm fluid level line, ensuring that it remains outside the anodizing solution, preventing potential corrosion or operational issues.

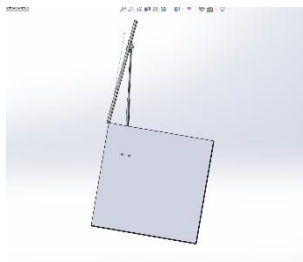


Figure 5

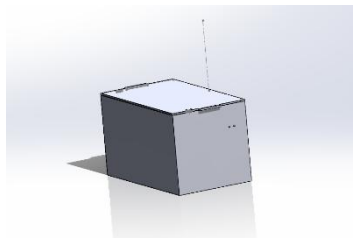


Figure 7

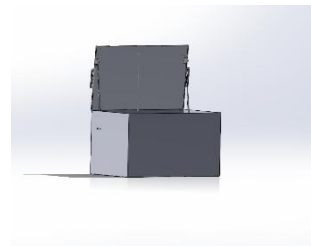


Figure 6

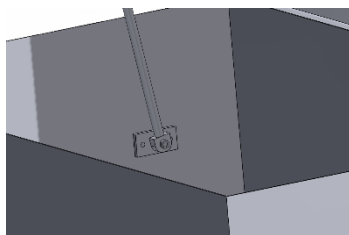


Figure 10

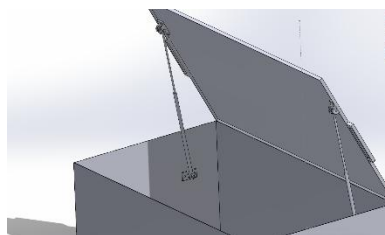


Figure 9

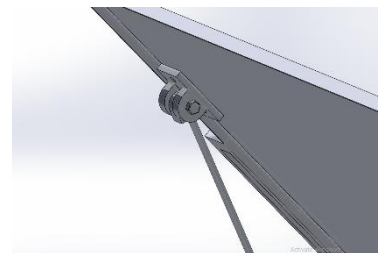


Figure 8

7 Technical Drawings

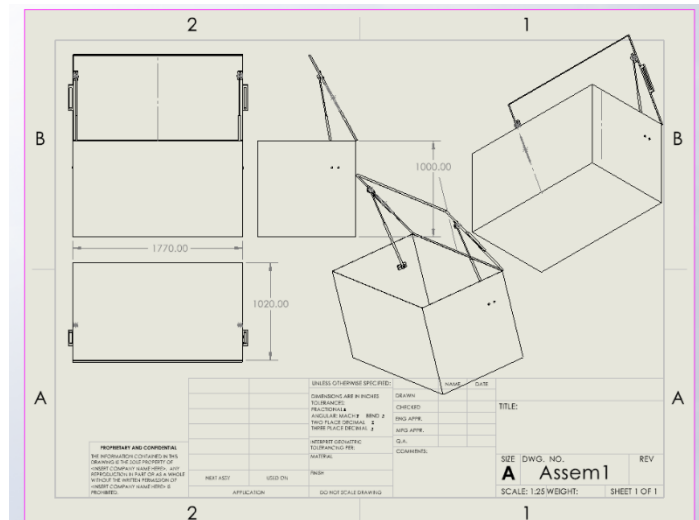


Figure 11

The technical drawing above (Figure 11) provides a comprehensive illustration of how the design has been carefully kept within the required dimensions. It offers valuable insight into how the individual components are precisely assembled to form the final structure. Additionally, the drawing presents a detailed view of the mechanism, clearly showcasing how each part interacts to ensure smooth and efficient operation. By analyzing this technical representation, one can gain a thorough understanding of the design's functionality, structural integrity, and overall performance.

8 Justification

Design Sketch 1 was chosen for the final design due to its simplicity and ease of implementation into an already existing system. Only mounting holes are required to fit this design to the lids, making the integration process straightforward. The ability to purchase gas struts not only accelerates production time but also reduces costs, as they are readily available and proven to work effectively. This design meets all the established criteria, such as allowing the lid to open vertically and out of the way, ensuring that materials needing anodization can be easily dropped in from above.

Additionally, the use of gas struts eliminates the lifting risk associated with previous designs, thanks to their lifting capacity and proven success in real-world applications.

9 Conclusion

To conclude, the selected design successfully meets all the criteria set by the manufacturer to address the health and safety concerns of the tank lid. The CAD designs, complete with detailed technical drawings, are now ready for manufacturing should a real-world scenario require them. Three design options were explored before arriving at the final choice, with careful consideration of complexity, safety, and time constraints. Ultimately, this design provides a balance of functionality, ease of implementation, and cost-effectiveness, making it the best solution for the issue at hand.

10 References

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