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1 Introduction and interpretation of the client brief

The proposed design aims to address the issue of the two person operated lid by redesigning and creating a new lid that can be operated by a single person. The current design poses a risk of potential injury and strain due to its design, this new design operated by a single person will aim to reduce the risk of injury by making the use of the lid much easier.

The new lid design must comply with health and safety regulations to assist in reducing the risk of injury in the workplace. The redesigning process will consider essential factors such as material, heat and corrosion resistance, weight reduction, durability and ensuring it is compatible with the anodization tank.

2 Key legislation considerations

2.1 The UK Health and Safety at work act 1974

This legislation requires that companies and employers consider and enforce the required health and safety requirements and rules to ensure employee safety and welfare. The new design incorporating single person operation of the tank must consider and mitigate the safety risks and risk of potential injury to ensure safe usage of the product in work environments. (Legislation.gov.uk, 2025.)

2.2 Manual handling operations regulations 1992

This regulation mandates that employers must aim to minimise the risks when employees operate machinery and, in this case, the chemical processing tank. There are many factors to consider, especially due to the tank's usage, including different chemicals that could harm human skin. The current design of the lid requires two people to operate, so the new design must allow for one person to operate. This means the new design must consider the health and safety risks of one person operation, such as strain improper lifting posture, or increased risk of accidents due to difficulty in handling the lid alone. (hse.gov.uk, 2025.)

3 Specification

This specification highlights the design requirements for the modified design of the anodisation tank lid that enables one person to open the lid instead of two, while complying with health and safety regulations.

Specification Category	Requirements
General design	The lid must be redesigned to be operated by a single person without injury or strain.
Tank compatibility	The must be fit on to the current design of the tank and must be compatible with the dimensions, which must remain unchanged.
Tank dimensions	1770mm x 1020mm x 800mm
Lid material	The material must be corrosion resistant and resistant to 30% sulphuric acid and 25°C. Lightweight alternative to stainless steel.
Lid weight reduction	The new lid design must be lighter than the current 5mm stainless steel lid while maintaining its durability and corrosion and heat resistance.
Ease of operation	Must be easy to operate with minimal force by one person. This can be achieved by using a hinge or hydraulic arm.
Handling and ergonomics	The lid must have an ergonomic and easy to operate handle or mechanism to reduce strain when in use by a single person.
Clearance and accessibility	The design cannot obstruct or change the design of the tank, only the lid can be modified.
Safety features	The modified design of the tank lid must prevent injuries and strain while one person can operate it. The new design must comply with The UK Health and Safety at work act 1974 and the Manual handling operations regulations 1992.
Manufacturing	The manufacturing process must be cost effective by using widely available materials that are cheap to buy in bulk and easy to work with to reduce costs further.
Environmental considerations	The lid will be made using sustainable materials where possible and the manufacturing process will minimise waste.

Figure 1 Jones R, 2025. Specification table. Unpublished.

4 Time plan for producing the product

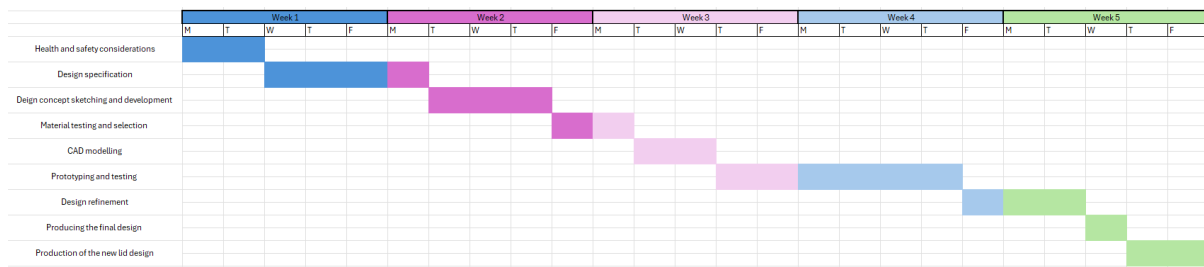


Figure 2 Jones R, 2025. Gantt chart of the time plan. Unpublished.

5 Research

5.1 Materials

The new lid for the tank must be resistant to 30% sulphuric acid and 25°C. There are a few materials that can withstand these conditions. Polypropylene is a semi-rigid thermoplastic with good chemical resistance. This plastic is tough with good heat resistance and is used in a wide variety of areas such as food packaging, bottles, pallets, plastic storage boxes, batteries, car bumpers and more, proving its versatility. Polypropylene is a relatively cheap material to buy in bulk, meaning it would be ideal for producing a product in the hundreds. The average price for polypropylene as a raw material as of March 2025 is around US\$1.51/kg in Europe, converting to £1.17/kg. (Business Analytiq, 2025.) the new design for the lid must be lightweight enough for one person to operate it. The density of polypropylene is between 0.895 and 0.920 grams per cubic centimetre (K.D. Fedderson, 2024), making the lid sections very lightweight while maintaining the strength and chemical resistance of the material. Polypropylene can be permanently in use up to temperatures of 100°C ((K.D. Fedderson, 2024), making it much more resistant than the 25°C needed for the new lid. A downside to polypropylene is that because it's a thermoplastic, although the fact that it is one of the stronger plastics, its still more vulnerable to external damage than some other materials such as stainless steel or aluminium.

Stainless steel is a very versatile material used in many products such as lamp posts, chemical tanks, saucepans, and much more. Depending on the grade, stainless steel has a high temperature resistance, being able to constantly operate up to temperatures of 1150°C, with some steels even being able to withstand temperatures up to 1500°C, making it an excellent material for working in heat. (Metal supermarkets, 10/12/2024.) Stainless steel has excellent corrosion resistance, meaning it can handle the 30% sulphuric acid, making it a decent choice. Stainless steel is very easy to work with, and decently cheap too, coming it at approximately US\$1.01/kg to US\$1.68/kg (Melbourne Scrap, 2024), depending on the grade, converting to £0.78/kg and £1.30/kg, making it a very cheap raw material. These factors make stainless steel a very viable options for use as the new tank lids material. A downside of stainless steel is that it's quite heavy, weighing around 8.03 grams per cubic centimetre (N Spira, 16/11/2021), but this can vary slightly depending on the grade. This weight makes it almost ten times as dense as polypropylene. This could cause some difficulty when one person tries to open the lid, as it required in the specification.

Aluminium has good thermal resistance, beginning to lose its strength at approximately 660.3°C (Clinton Aluminum, 2023), making it suitable for the lid as it can withstand temperatures much higher than the required 25°C. The heat resistance for aluminium alloy is approximately 400°C, depending on the grade. (A Shyam, S Bahl, 2023.) Pure aluminium is rarely used in products as its cheaper to use aluminium alloys, while maintaining most of the useful properties. As of 1/4/2025, the price of raw aluminium is approximately £2559 per ton (LME, 2025), equalling £2.56/kg, making it significantly more expensive than the other two materials when buying in bulk. Aluminium has an average density of approximately 2.7 grams per cubic centimetre, ranging between 2.64 grams per cubic centimetre and 2.81 grams per cubic centimetre (Thyssenkrupp, 2023.). This makes it relatively lightweight, suitable enough for the new lid. Aluminium is a very easy material to cast and machined, making it a desirable option for the tank lid. Although aluminium has these desirable properties, it is quite a soft material and not often strong enough for commercial and industry uses, meaning it would have to be an alloy of some sort to account for the strength of the material.

Overall, the polypropylene seems to be the best option for the lid design as it has excellent corrosion and heat resistance, is very lightweight, inexpensive to buy, and relatively easy to work with. It's a lightweight material, meaning operation by a single person will be much easier than a heavier material such as stainless steel at almost ten times the density.

5.2 Researching existing Lid designs

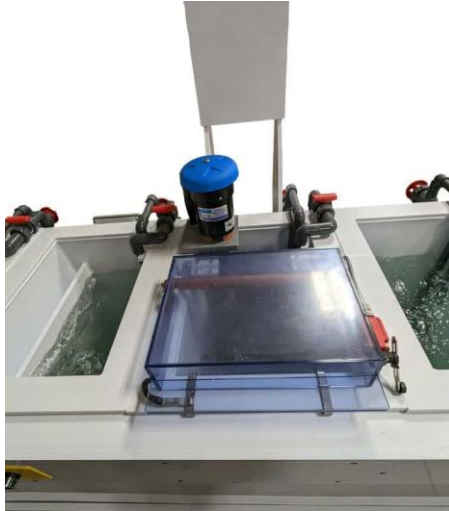


Figure 1 Titanium anodizing tank, BestTechnology

The image shows a small plastic lid on an anodisation tank. While this design suits the tank in the image, the tank that is in the specification is much larger, so while the plastic is lightweight, the current design for the lid may make it awkward for one person to lift up to 90 degrees.

While this lid is easy to design and manufacture, it seems too simple and similar to the original lid. This design won't be easy for one person to operate by themselves.

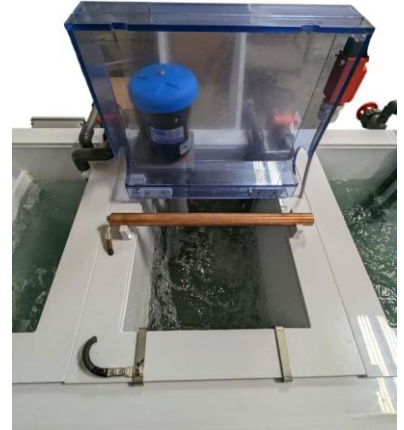


Figure 2 Titanium anodizing tank with copper anode bar, BestTechnology

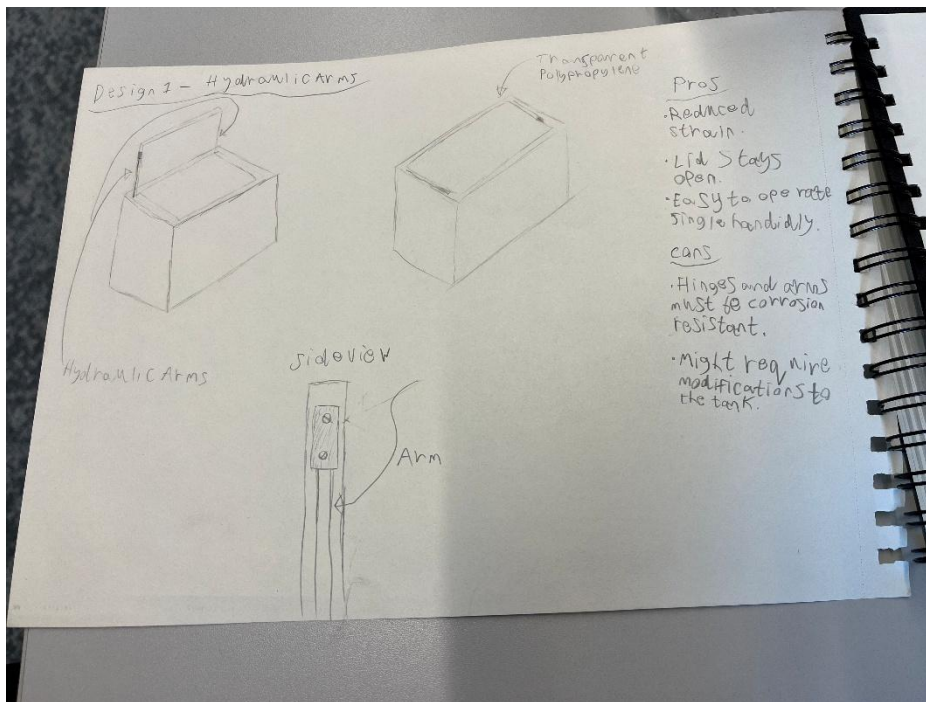


Figure 3 Image showing the folding mechanism of an anodization tank, Products Finishing. 2011.

This image shows a folding lid of an anodisation tank that can be opened in two halves. The lid is made of metal panels, likely stainless steel or aluminium, and has a hinge running along the centre length of each section. This hinge allows the lid to fold open on both sides, making it easy to access the tank while keeping the heat in when in operation when the lid is closed. The sliding-folding feature of the lid allows easy operation by one person, following the specification.

This design is quite unique and could potentially serve well as the new design of the tank lid.

6 Annotated sketches of multiple design concepts



This first design shows a lid that is equipped with hydraulic arms, similar to a car boot, on the sides, allowing for assisted lifting and they can hold the lid at whatever angle is needed when operating the tank. The assisted lifting from the hydraulic arms will reduce the risk of injury or strain when in use and will allow for one person to easily open and close the lid in a similar way to a car boot.

Figure 4 R Jones, hand sketched design with annotations of first lid design, 2025. Unpublished

The hydraulic arms would be attached to the side of the lid and the sides of the tank. The arms will allow for the lid to be lifted with minimal effort and will stay at whatever position the operator wants to open it to.

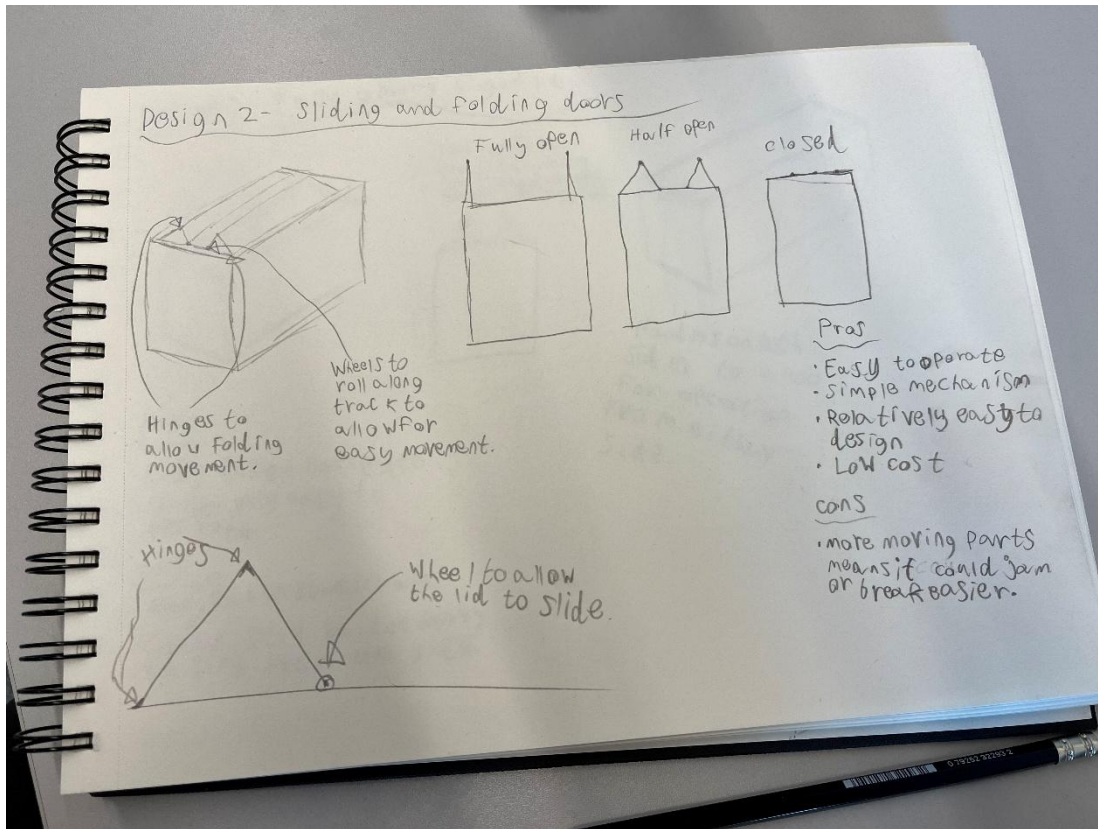
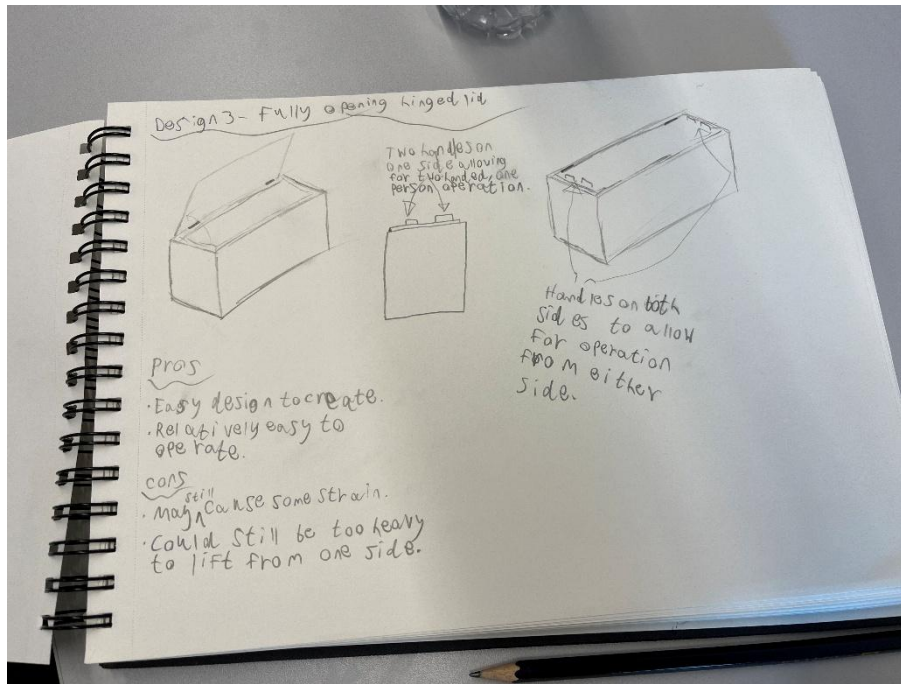


Figure 5 R Jones, Second design showing foldable lid. 2025. Unpublished

The second design is a folding lid design, inspired by the folding lid on a previous page. This design makes it much easier to operate single handedly. A downside of this design is because there are more moving parts, it could jam or become damaged easier.



This design is a simple folding lid design, similar to the original, but with two handles on either side so the user can lift the lid from either side. This design is easy and cheap to create, but could still come with the same issues of potential strain or injury.

Figure 6 R Jones, Third design showing an opening lid design. 2025. Unpublished

7 CAD models of the final design

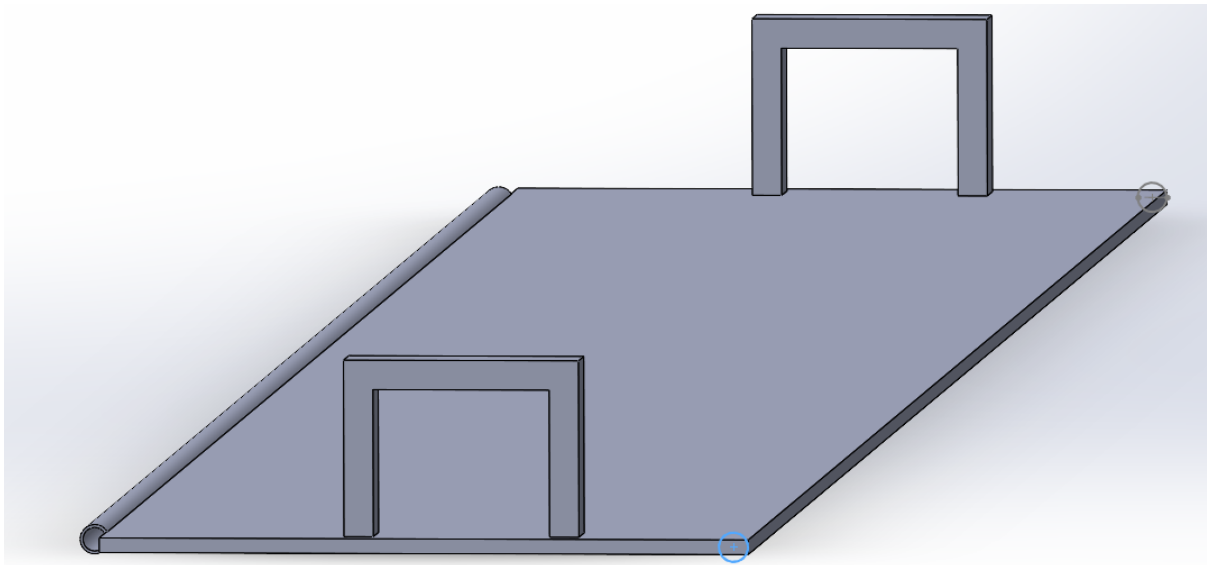


Figure 7 Middle lid section. R Jones. 2025. Unpublished.

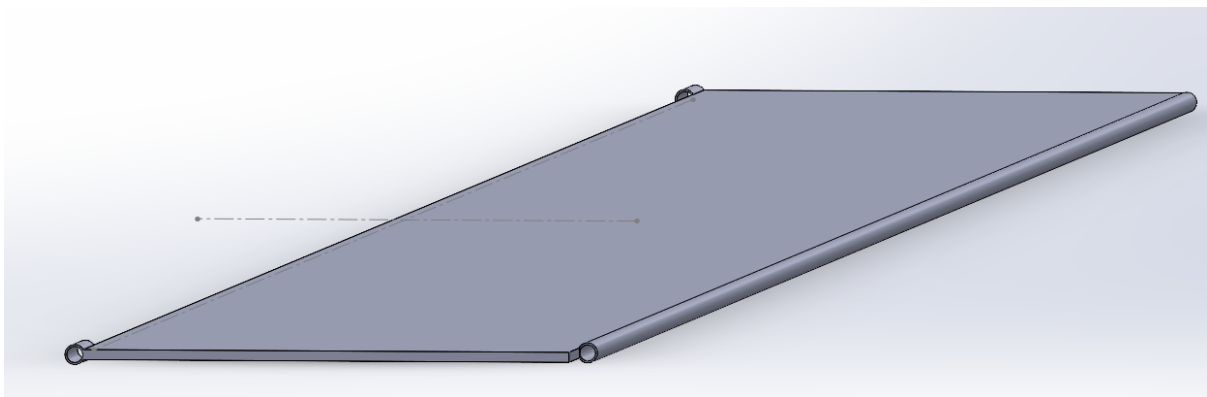


Figure 8 Lid section. R Jones. 2025. Unpublished

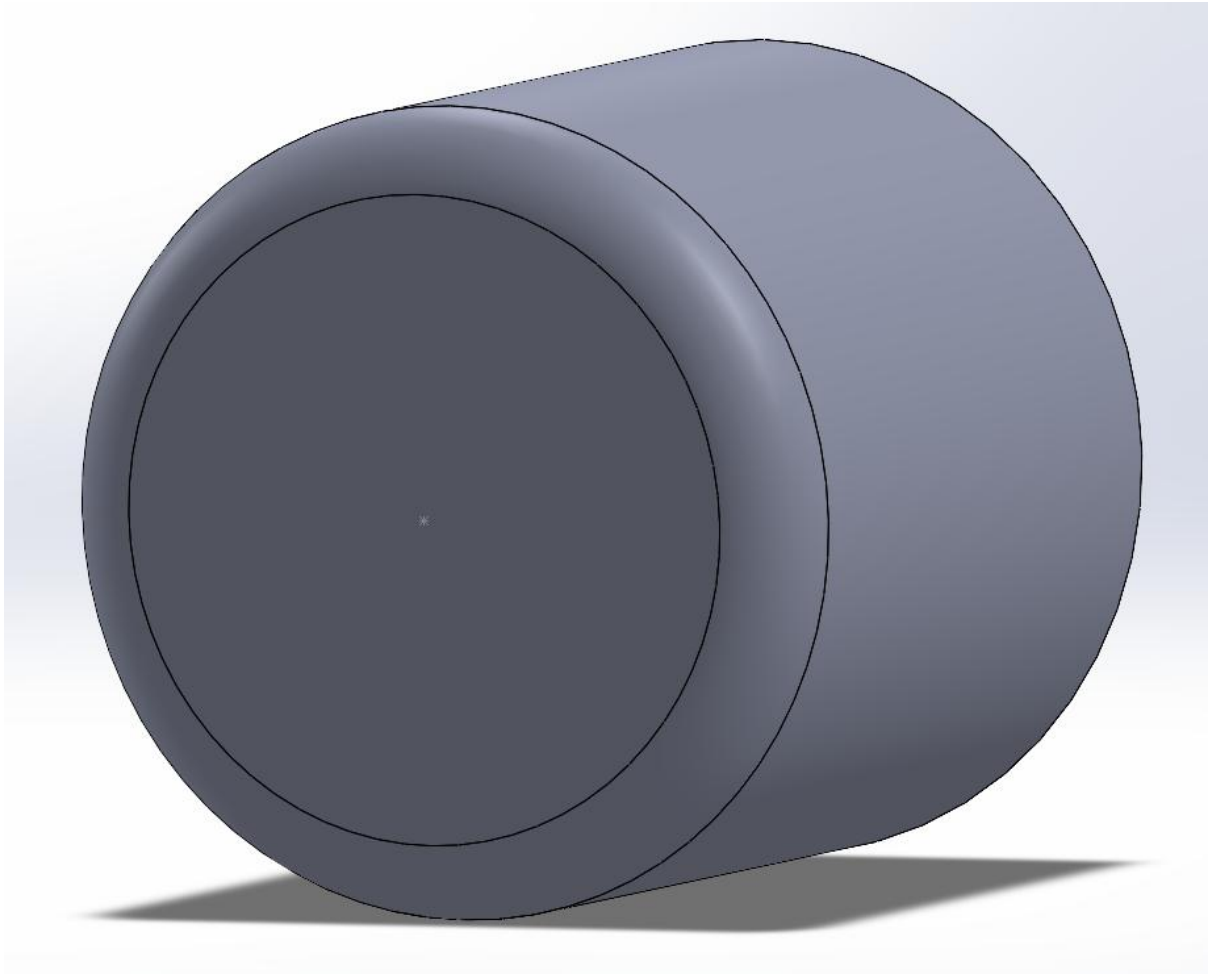


Figure 9 Model of wheel allowing for smooth movement of lid. R Jones. 2025. Unpublished

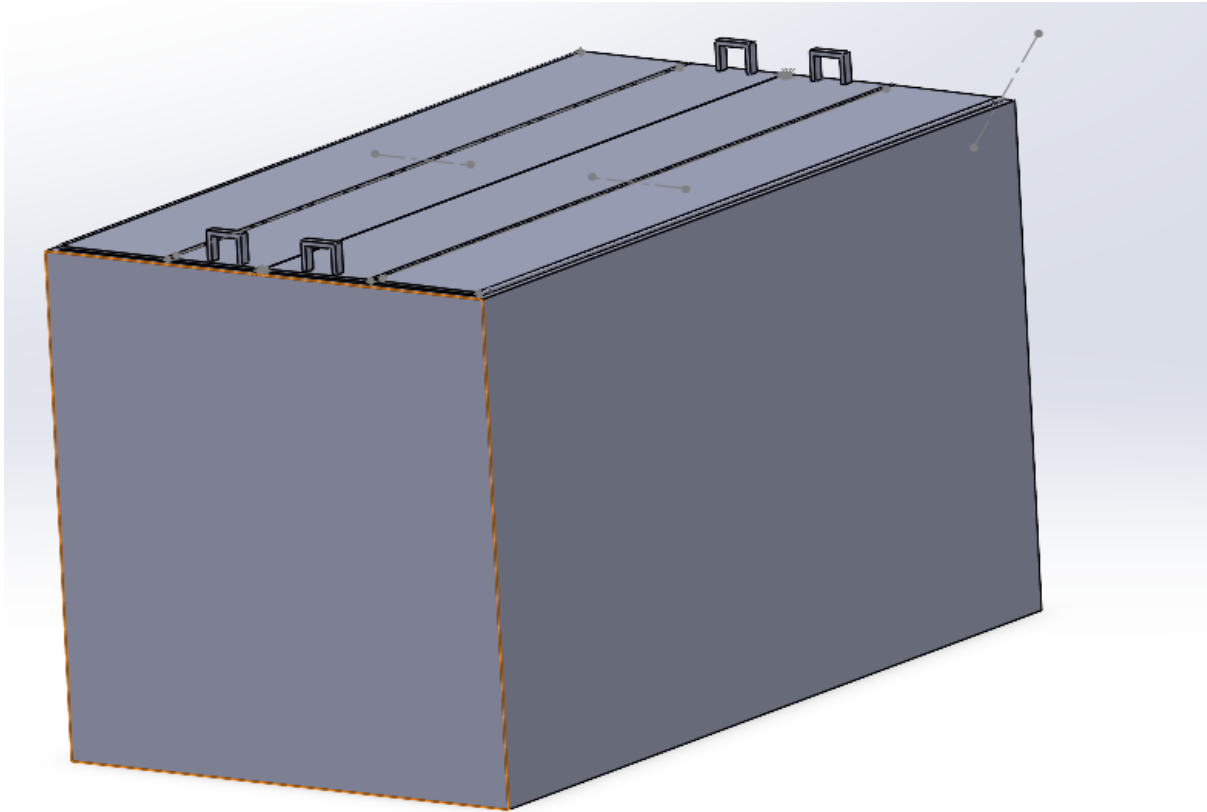


Figure 10 Assembled final design of tank with new lid design. R Jones. 2025. Unpublished

8 Fully dimensioned technical drawings (BS8888), with material choices and tolerances

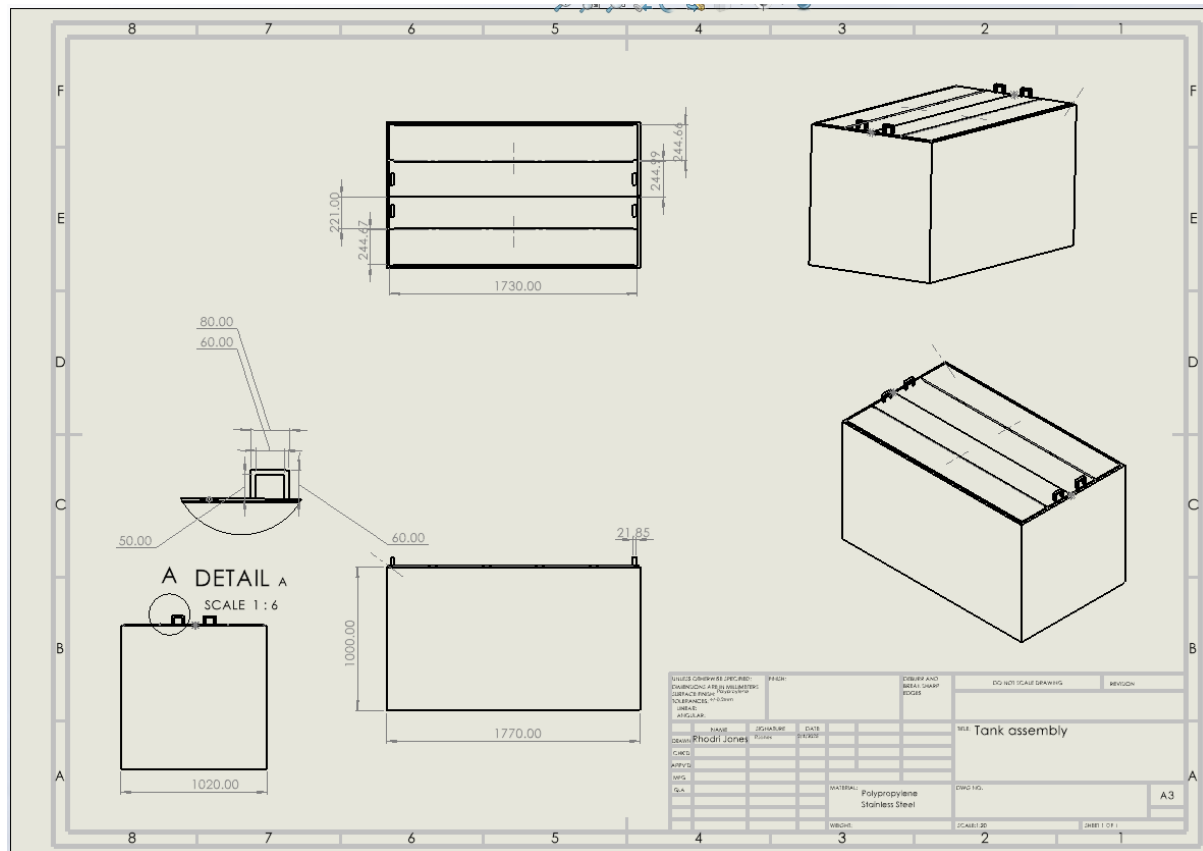


Figure 11 R Jones, Technical drawing of Complete tank with new lid design. 2025. Unpublished

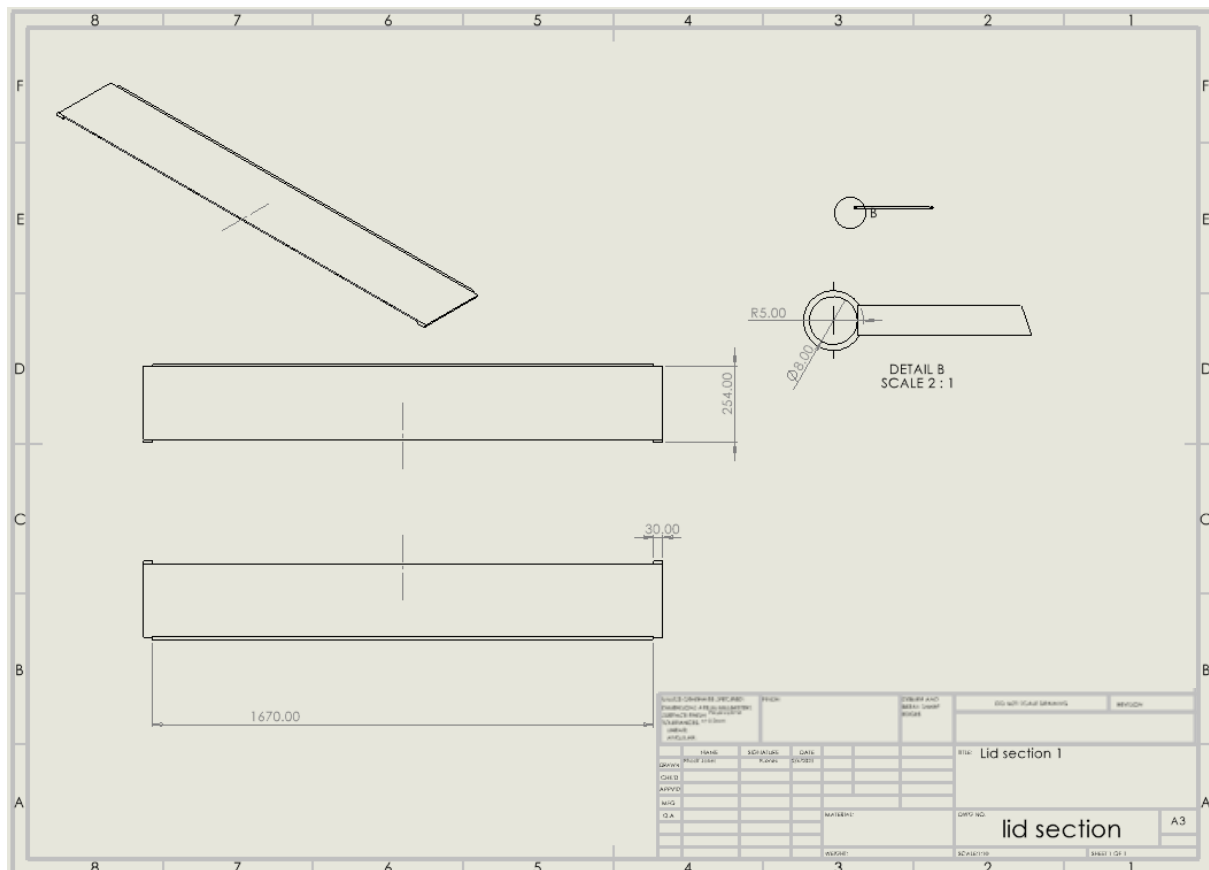


Figure 12 R Jones, Technical drawing of Lid Section 1. 2025. Unpublished

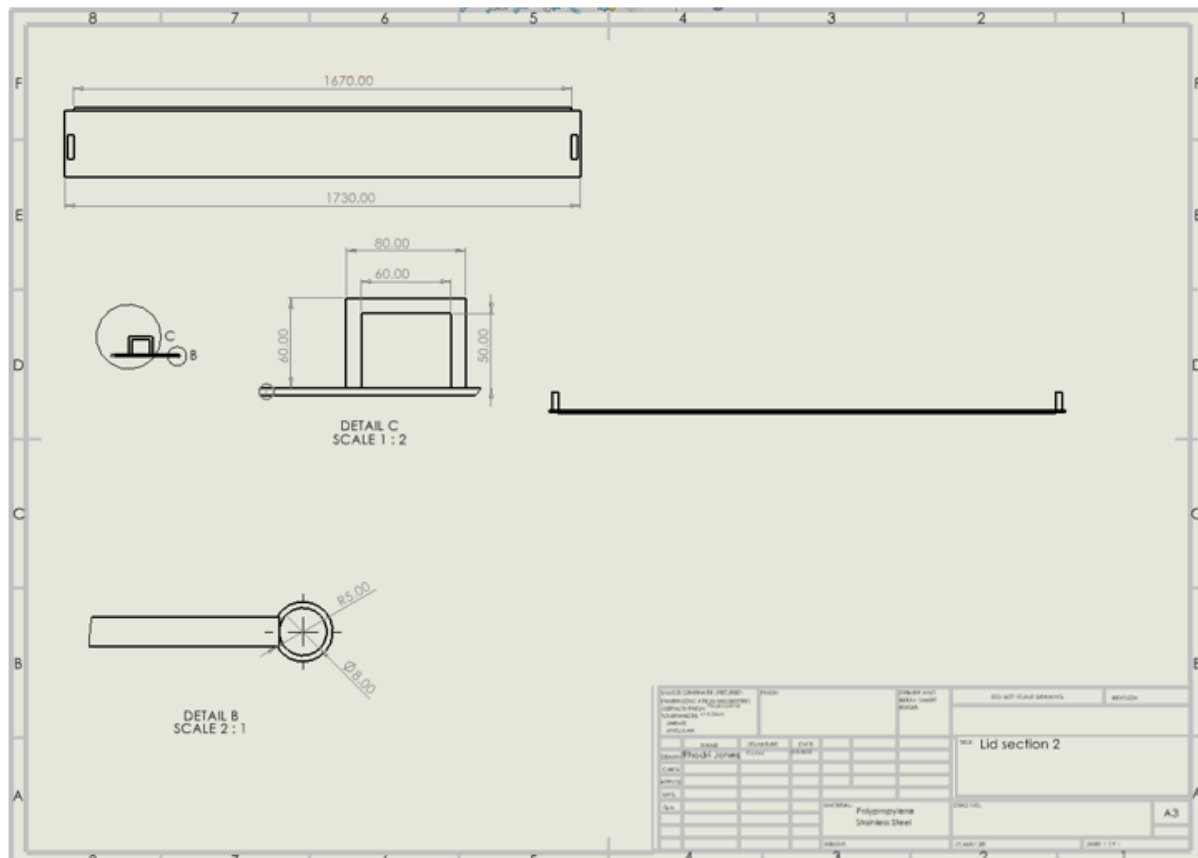


Figure 13 R Jones. Technical drawing of second section of the tank lid. 2025. Unpublished.



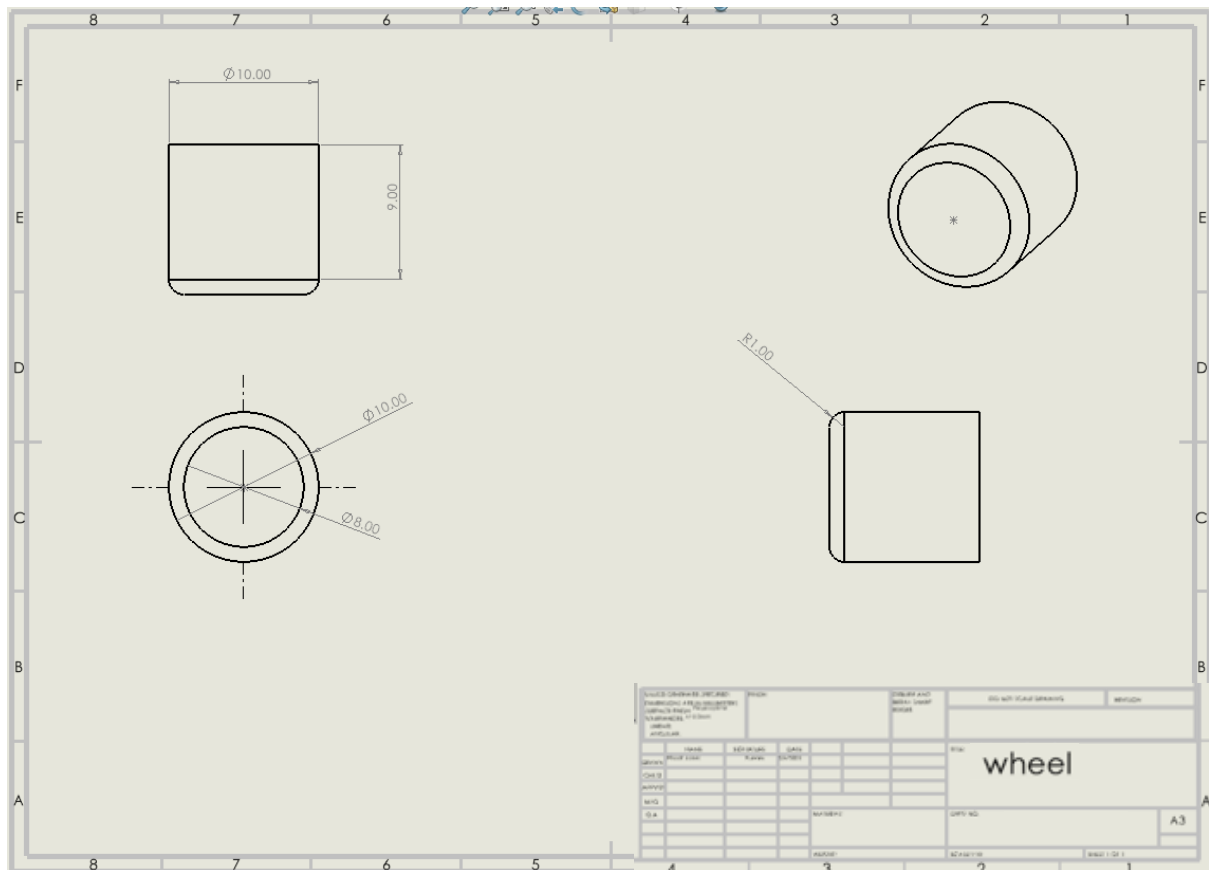


Figure 15 R Jones. Technical drawing showing the wheel on each side of the lid to allow it to roll. 2025. Unpublished.

9 Manufacturing processes for each component

The wheels will be made of polypropylene using injection moulding to ensure each wheel is the same. The wheel will be made of polypropylene due to its strength and chemical resistance.

The hinge bar will be made of stainless steel due to it being a major stress point of the lid. The stainless steel will be cut using a bandsaw machine. This will ensure the accuracy needed for the vital component in the lid.

The polypropylene lid sections and handles will be manufactured with a laser cutter to ensure the accuracy needed. Laser cutting will also be a very quick method of manufacturing these pieces.

10 Justification for design process and choices

The second design, the foldable lid, seemed like the optimal option due to its mechanism not requiring much effort to operate, and because its split into two sections, the weight needed to be lifted is halved. The material chosen is polypropylene due to its low cost, corrosion resistance and lightweight. These benefits make it ideal for its use as an anodization tank lid that will be produced in the low hundreds. Polypropylene is quite a strong thermoplastic, but its obviously not as strong as stainless steel or aluminium, so this downside could be counteracted by reinforcing the plastic lid sections with thin bars of stainless steel diagonally across each section to ensure its integrity. Polypropylene is stable at the required temperature of 25°C, and has a high resistance to 30% sulphuric acid, meaning it can easily withstand the conditions of the tank.

The folding design allows for the tank to be stored in a much smaller space because the lid doesn't open outwards beyond the space that the tank takes up, making it ideal for smaller workshops. The current lid design requires room for it to be placed down, creating a hazard and taking up a lot of room due to its size. This folding design eliminates these issues and any health and safety issues that come with removing and placing down the current lid.

The folding design also allows for the operator to partially open the lid for monitoring or maintenance without going through the process of opening the entire lid. This design will allow for one person operation, so monitoring the anodization process will be easier due to it being foldable and much easier to open and close than the current lid design.

There is a reduced risk of strain and injury as the lid simply is pushed and folded back as opposed to two people manually lifting the current lid and placing it down, potentially causing muscle strain, back injuries and injuries from dropping the lid. The wheels on either side allow for smooth movement when opening and closing the lid.

11 Conclusion and further work

The folding lid design for the anodization tank allows for safer and more efficient operation compared to the original design by adopting the folding mechanism. The new design allows for single-person operation, reducing the risk of injury and strain that could be caused by the current, two-person lid. The choice of polypropylene as the new material ensures a lightweight design, aiding the single person operation, while maintaining sufficient durability. Polypropylene is a very corrosion resistant and cheap material, making it ideal for this application.

The design successfully meets the outlined health and safety regulations of the UK Health and Safety at Work Act 1974 and the manual Handling Operations Regulations 1992. The design improves the operating experience and greatly reduces risk of injury and ensures worker safety.

While the current design meets the key requirements and specification, additional changes could be made to improve its performance and durability.

One change that could be made it to test different methods of reinforcing the polypropylene lid such as putting thin steel bars diagonally to reinforce its structure. This will improve its durability without increasing its weight by a significant amount.

The CAD model is not a 1 to 1 reflection of the intended design as one of the lid sections is shorter to account for the hinges, this was done only in the CAD modelling and will not be the final design. Each section of the tanks lid will be equal size to ensure easier manufacturing and repairs.

Another change that could be made is using something to assist further in opening the tank lid, such as gas struts or an electrically operated mechanism to open the lid automatically.

12 References

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