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Contents

1. Introduction.....	iii
1.1. Interpretation of Client Brief	iii
2. Key Legislations	iv
3. Specification	v
4. Production Time Plan	vi
5. Research	vii
5.1. Materials	vii
5.2. Mechanisms for Design Choices	vii
5.3. Costs	viii
6. Initial Designs	ix
7. Final Design (CAD)	xii
8. Manufacturing Process	xvii
8.1. Justification of Design choices	xvii
9. Conclusion	xviii
10. Further Work	xix
11. References.....	xx
Table 1 Specification Table (F. Flye, 2025)	v
Figure 4-1 Time Plan of producing the product (F. Flye, 2025).....	vi
Figure 5-1 Tank lid design (PF, 2011)	vii
Figure 6-1 Design 1, Consisting of a pull sheet Lid (F. Flye, 2025)	ix
Figure 6-2 Design 2, Consists of a Lid operated by Torsion Spring hinges (F. Flye, 2025)	x
Figure 6-3 Design 3, Consists of a hatch operated by a wheel system and snap technology (F. Flye, 2025)	xi
Figure 7-1 Design of Track Chute (F. Flye, 2025).....	xii
Figure 7-2 Design of Pull sheet which acts as the lid (F. Flye, 2025)	xiii
Figure 7-3 Design of M8x12mm Hex Bolt (F. Flye, 2025)	xiv
Figure 7-4 Assembly Technical Drawing (F. Flye, 2025)	xv
Figure 7-5 CAD Model of Tank Assembly (F. Flye, 2025)	xvi
Figure 7-6 Final Design Drawing and Annotations (F. Flye, 2025)	xvi

1. Introduction

This report consists of the understanding of the client brief and the design and manufacturing process behind the developed ideas. Within this report the key legislations that are applicable to the process of anodising will be uncovered to help understand what parameters there are when constructing the designs for the new lid. Furthermore, a time plan will be constructed to convey the period of time that producing the product will take meeting the required specifications that are set.

Additionally, three initial designs will be created to produce concepts for the finalized design, which will produce a 3-D Computer aided design and along with it fully annotated and dimensioned technical drawings of the assembly. Finally, the report covers the manufacturing process of the components implanted into the design to create a clear view of how the overall design was produced.

1.1. Interpretation of Client Brief

The client brief conveys that the Anodising tank lid needs to be modified to ensure safety when operating and that the lid can be operated by a single person. This has to be achieved without changing the overall dimensions and material of the anodising tank however alterations can be made to every other aspect of the tank. On the other hand, the tank lid can be altered by any means necessary with no constraints. Furthermore, there must also be enough clearance above the tank to enable the metal plate to be lowered and raised out of the tank, this can be achieved in a multitude of ways given the constraints of the brief.

2. Key Legislations

Within the process of Anodising many legislations become applicable as there is a lot of risk when working with hazardous liquids and heavy objects. The legislation '(Health and Safety at work act 1974)' states that the employer has to ensure the health, safety and welfare of their workers' this is a key legislation due to the fact that employee's will be handling the chemicals and operating the anodising tanks. Additionally, another key legislation is '(Control of substances hazardous to health, 2002)' which states that employers have to control and assess the risks that are applicable to the handling of hazardous sustenance's' this is applicable to this brief as the operators have to handle sulphuric acid within close vicinities, so correct PPE would have to be given and extra safety measures would have to be implanted into the design of the tanks.

Therefore, COMAH regulations are also applicable as '(Control of Major Accident Hazards, 1999)' state that all necessary measure is taken to prevent major accidents involving hazardous substances' this is associated with both the design if the tank and lid and how they are operated which the employer should conduct thorough risk assessments.

3. Specification

Specification	Requirements
Design	The lid must be modified or completely redesigned to enable safe operation
Lid material	The lid material may either stay the same, however with a redesign to counteract the weight of the stainless steel or a complete change of material that still shares the qualities of stainless steel.
Tank design	Tank dimensions cannot be altered that being 1770mm x 1020mm however modifications can be made either altering the thickness, adding components
Operation handling	The lid needs to be designed to enable safe operation via a single person of any calliper
Accessibility	The lid needs to allow for overhead clearance as aluminium sheets need to be lowered and raised without interference.
Safety Features	There must be safety precautions implemented into the design if the design already does not see fit. Those following the regulations set in place for health and safety, control of hazardous substances and manual handling.
Environmental Factors	Environmental factors need to be taken into consideration when modifying both the lid and the tank using sustainable materials and possibly ecofriendly materials that can be widely sourced.
Manufacturing Process	Many factors must be taken into account, cost effectiveness, availability of materials and parts, and reliability of said materials.

Table 1 Specification Table (F. Flye, 2025)

4. Production Time Plan

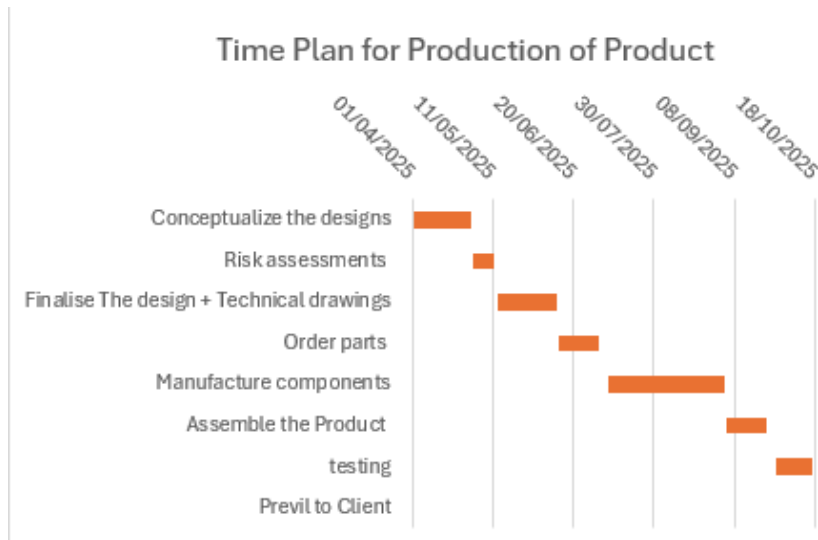


Figure 4-1 Time Plan of producing the product (F. Flye, 2025)

5. Research

5.1. Materials

In terms of materials a variation was covered, however two seemed to display qualities that suited the design thoroughly for this task. Both Aluminium and High-Density Polyethylene are excellent thermal insulators and have high resistance to corrosion. Aluminium is an ideal for corrosive applications as it has the ability to create a protective oxide layer naturally '(Shane, 2024)', which causes them to have a higher resistance to corrosion. However, HDPE is an excellent corrosion resistant material as it has a 'robust structure with a non-polar molecular composition and a high crystallinity (Huilin, 2025)' due to its structure this causes the material to have high durability to within degradation.

HDPE is a much better thermal insulator as it can 'tolerate a vast range of temperatures without degrading (Sharma, 2024)' due to its high thermal stability it demonstrates its ability withstand high temperatures which is perfect for this application.

5.2. Mechanisms for Design Choices

While conducting research many alternative methods to creating a easily operable tank lid arose, one gather from an article by '(Sun, Wang, Pan, Zeng, Hu, Qi, Long, Xu, 2024)' stated that the designed a lid using hinges and a stainless steel pull cord' this produced the idea to use torsion spring hinges as they would give more leverage to the operator making the lift of the lid substantially easier. This is done through the fact that torsion springs 'store the energy when rotated so they maintain pressure between surfaces that use angular movement (Lesjöfors, 2024)' this constant pressure would hold the lid in a corrected a safe position while the tank is in operation.



Figure 5-1 Tank lid design (PF, 2011)

In addition to this another mechanism found in figure 5-1 uses two separated stainless-steel panels that fold and snap together when closed, which utilized holes within the closed lid to ensure that there was no pressure build up when the tank isn't in use.

In this figure it is operated via either 'hydraulics or electromechanically powered actuators (PF Editorial Team, 2011)' which improves the functionality of the tank however vastly increasing the cost of the components. However, this can be hand operated if a handle or arm was connected to the central point of the lid as shown in design 3.

5.3. Costs

In terms of material cost, considering that the lid will be converted to HDPE according to '(Vision Plastics, 2025) a 2000mm x 1000mm x 20mm is £227.30' which for high quality, high-density polyethylene is the lowest figure available on the current market with other ranging around '£460 sourced from (Direct Plastics, 2025)'. This is a better competitive price than Aluminium, as 'Aluminium costs £2.23 per kg as of current market stated by (Markets Insider, 2025)' so with the same Dimensions for the sheet the value would be around £240.84 as the density of 'Aluminium is 2700kg/m³ according to (WorldMaterials, 2025)' so to calculate the weight of the sheet the formula would be $Weight = volume (L \times W \times T) \times Density$ therefore the weight would be 108kg so multiple this by 2.23 and £240.84 is the value received. On the other hand for the Stainless steel plating (A4) the cost for a 1730mm x 960mm x 10mm sheet would cost around £366.88 as the density of Stainless steel is around '8000kg/m³ (World Materials, 2025)' and the current market is '£2.76 per kg (Mike, 2025)' so the weight of the sheet would be 132.86kg.

As for the fasteners that will be used a bag of 50 M8x12mm Stainless Steel (A4) Hex Bolts cost '£22.61 found within (RS PRO, 2025)' the use of A4 Stainless Steel is required as A2 Stainless steel can only resist diluted sulphuric acid at about '5% maximum at room temperature (British Stainless-steel Association, 2025)' where A4 withstands higher levels of sulphuric acid without degrading.

6. Initial Designs

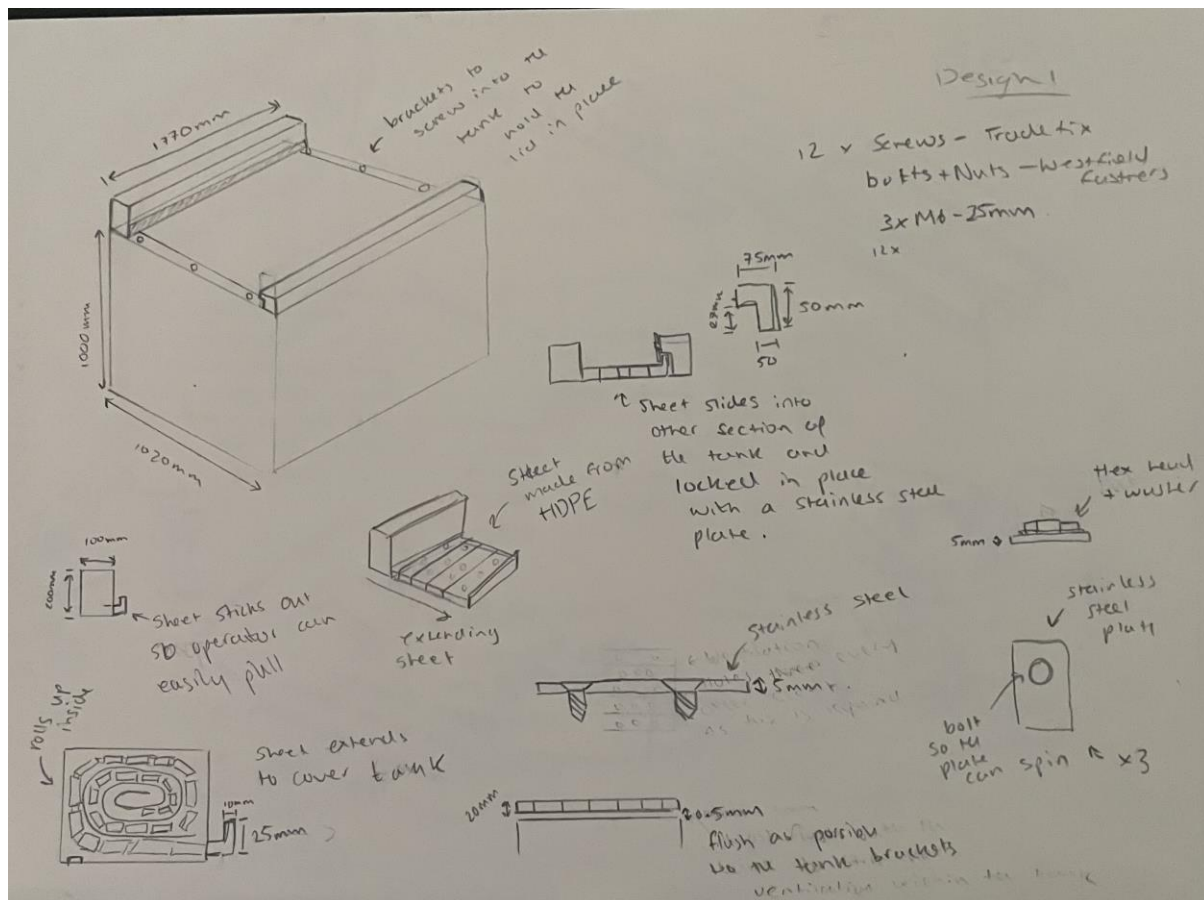


Figure 6-1 Design 1, Consisting of a pull sheet Lid (F. Flye, 2025)

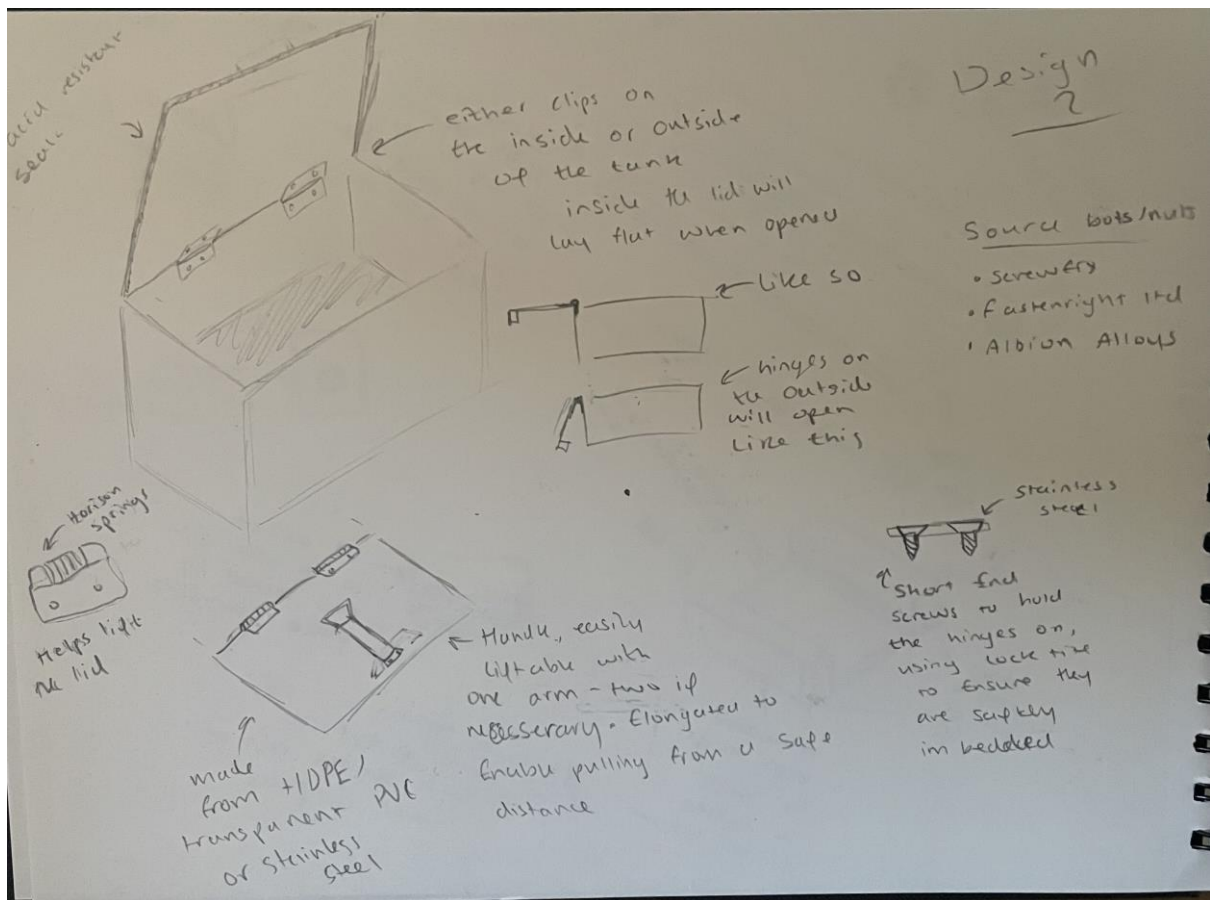


Figure 6-2 Design 2, Consists of a Lid operated by Torsion Spring hinges (F. Flye, 2025)

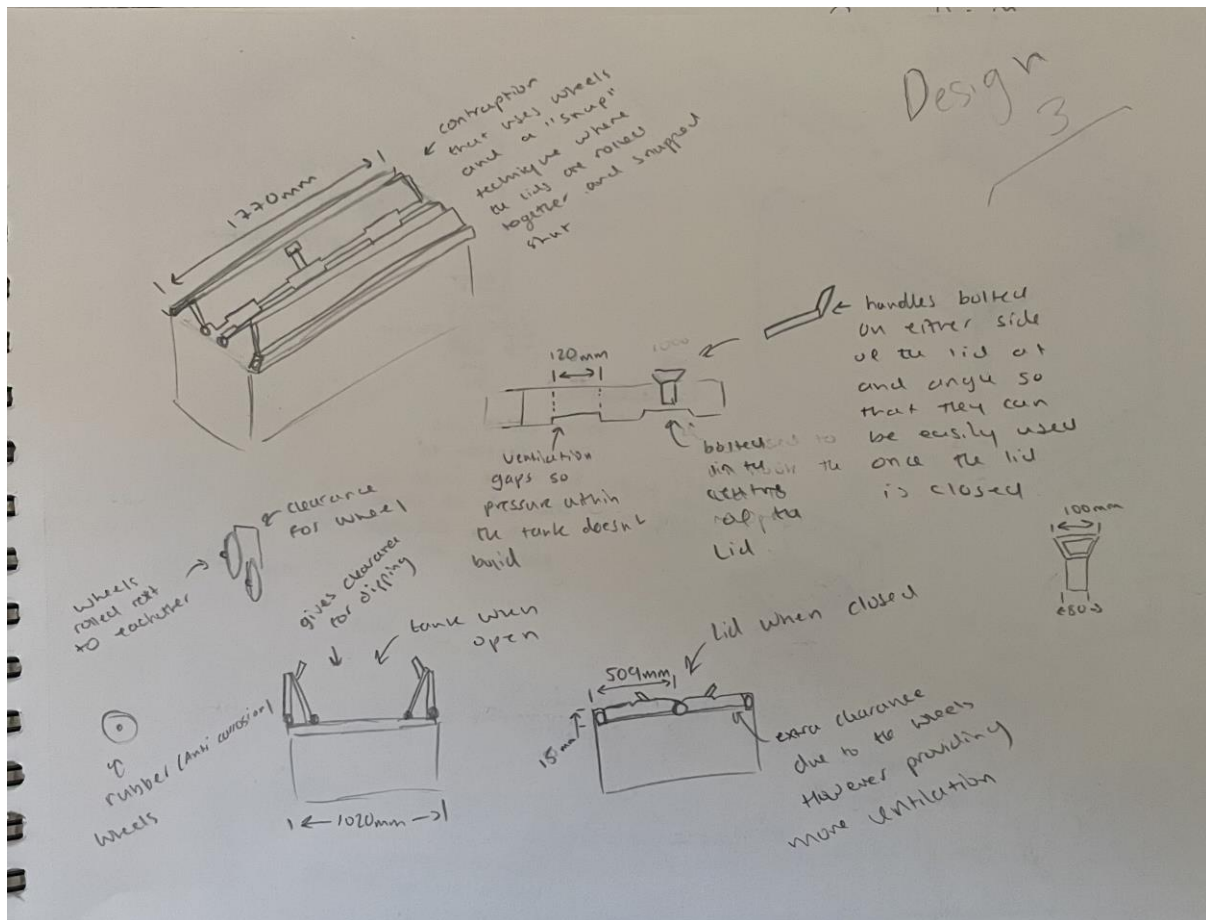


Figure 6-3 Design 3, Consists of a hatch operated by a wheel system and snap technology (F. Flye, 2025)

7. Final Design (CAD)

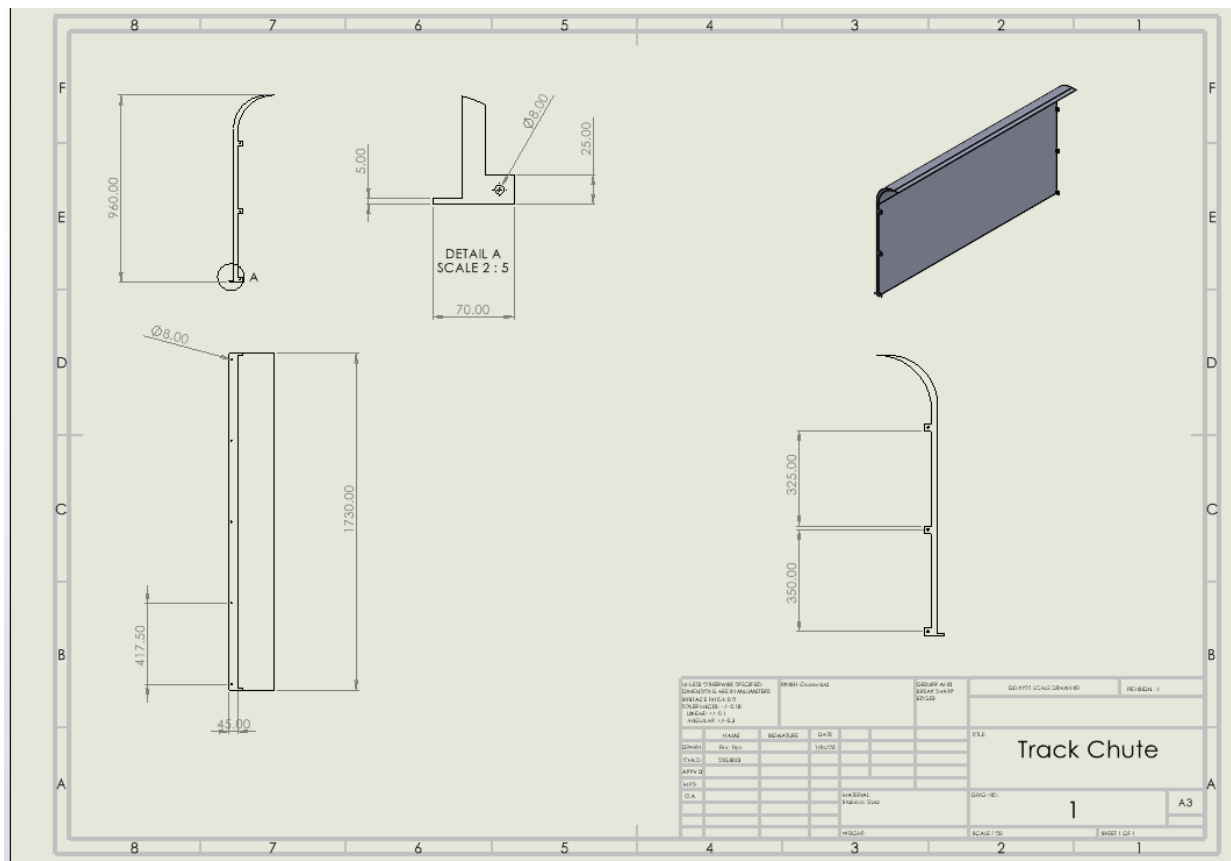


Figure 7-1 Design of Track Chute (F. Flye, 2025)

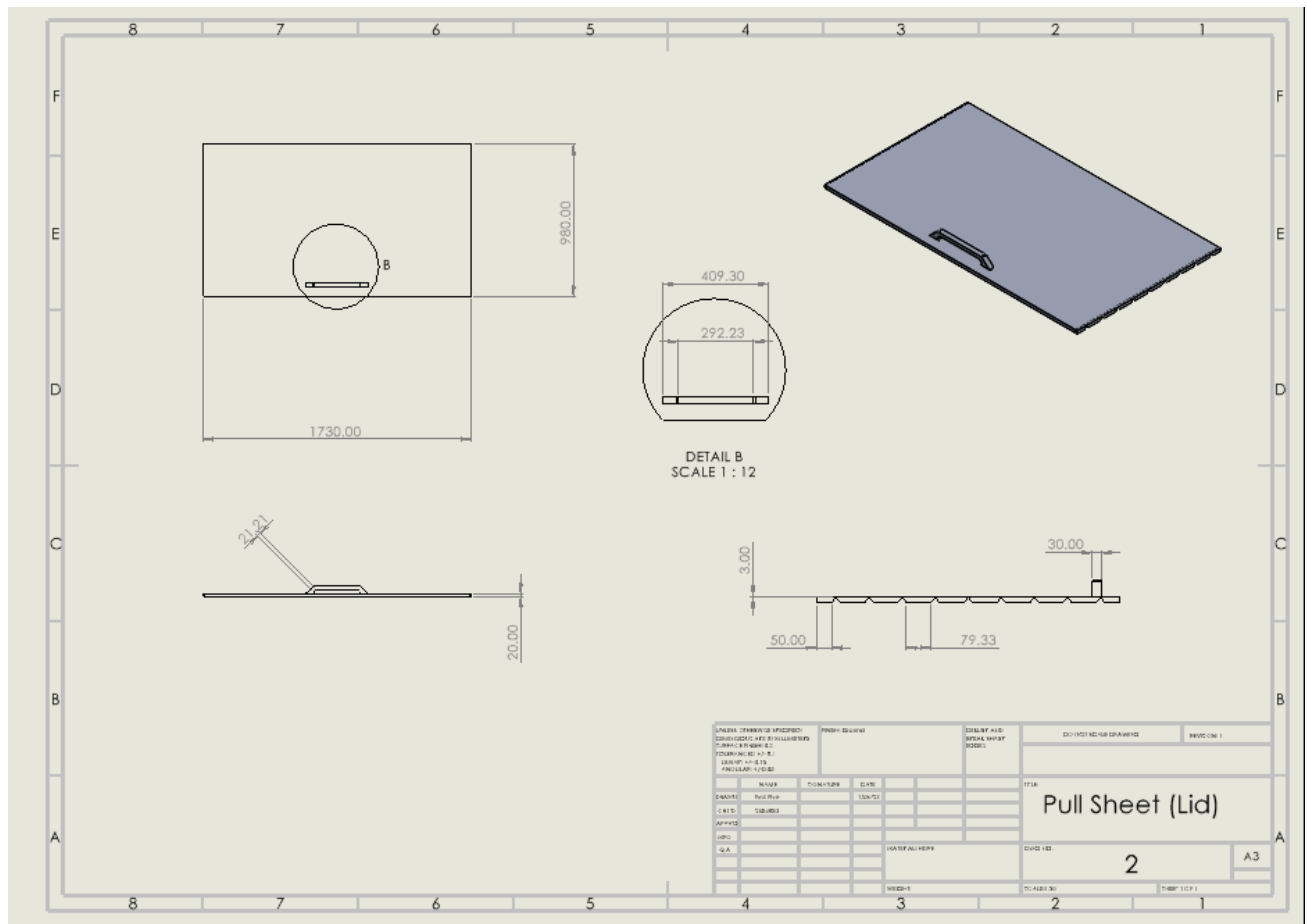


Figure 7-2 Design of Pull sheet which acts as the lid (F. Flye, 2025)

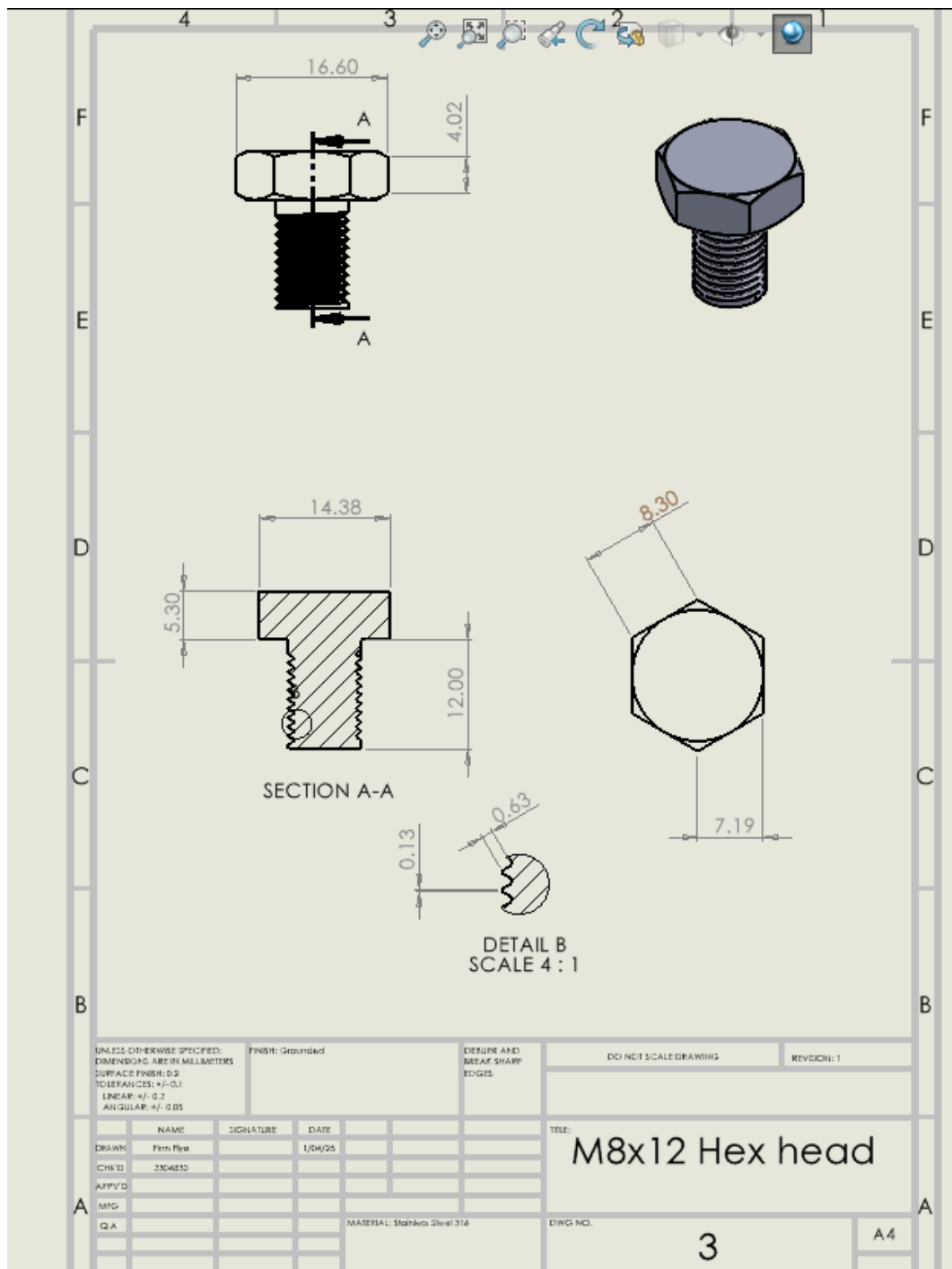


Figure 7-3 Design of M8x12mm Hex Bolt (F. Flye, 2025)



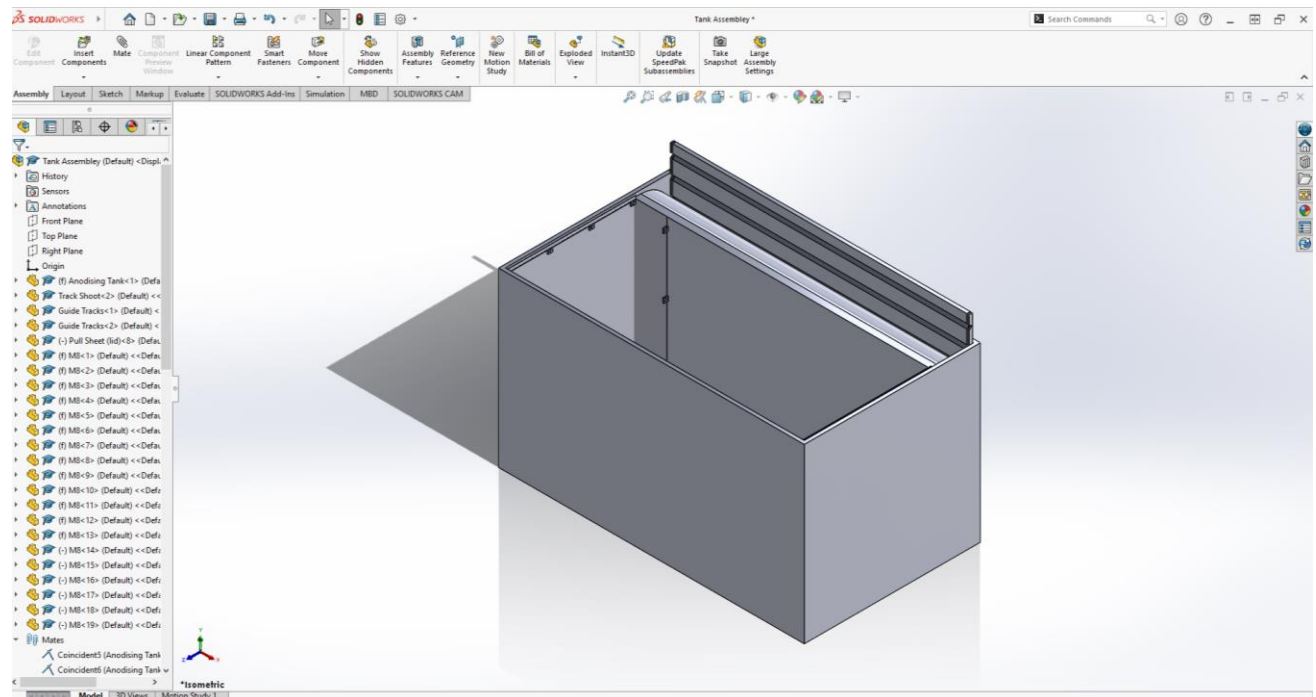


Figure 7-5 CAD Model of Tank Assembly (F. Flye, 2025)

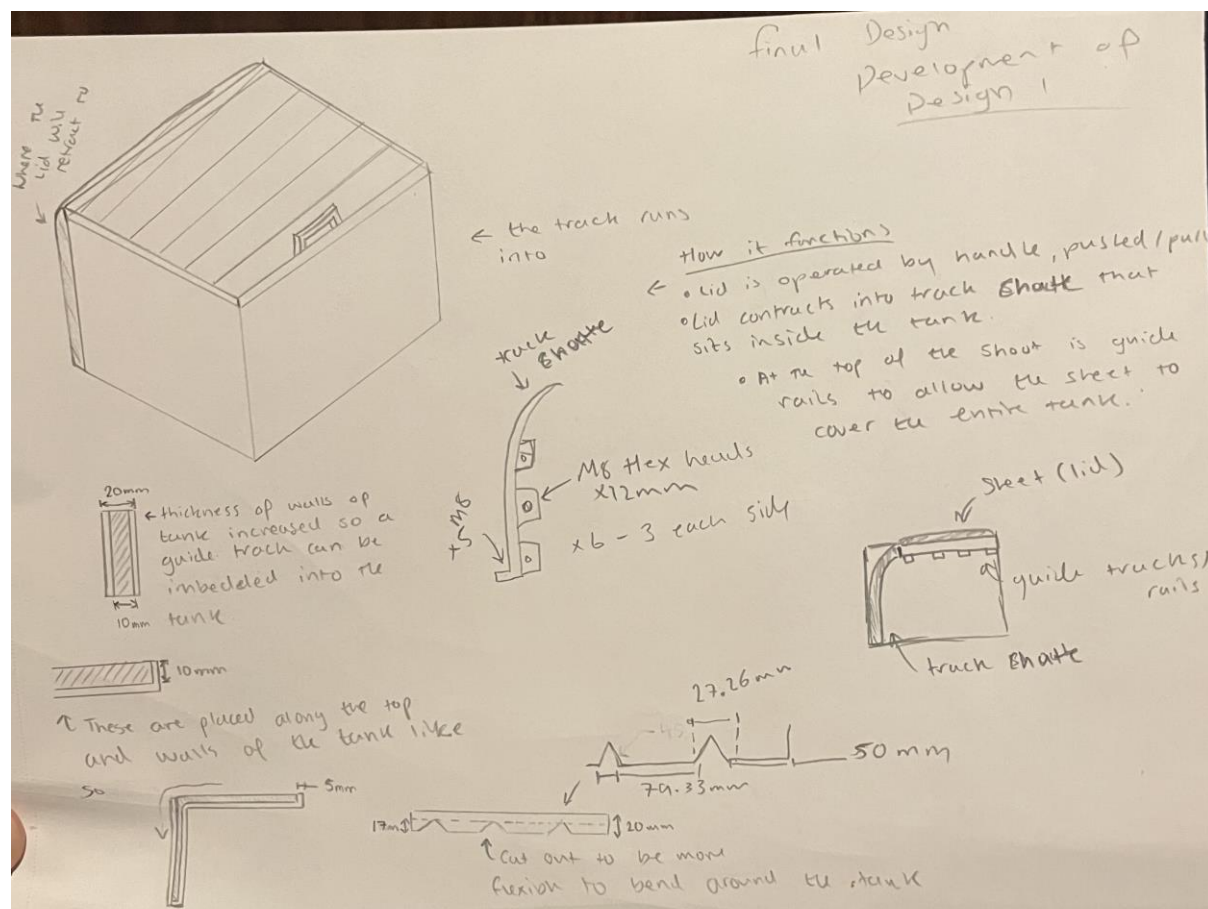


Figure 7-6 Final Design Drawing and Annotations (F. Flye, 2025)

8. Manufacturing Process

As a starting point, after the consideration of the CAD model designed above the materials and costs should be considered and then using those ideas to produce a prototype of the design. Using CNC Milling machines to help hone the sheets and guide tracks to the correct measurements in preparation for assembly as these machines used 'three different axis to have high dimensional accuracy and ultra-precision in terms of tolerances (Qin, 2013)'. These can be used to create the surface finish as each component is grounded. Through the Choice of CNC machines, the CAD model will have to be converted into g-codes as this is the system that CNC machines understand.

Following the execution of the dimensions of the sheets and guide tracks. The tank should be altered to accommodate the fasteners that will be implanted into the components using handheld drills with precision. Thereafter, the components and tank can be assembled together using handheld tools such as impact guns, rachets, spanners and torque wrenches to ensure the components are securely fastened.

Finally, the product should be tested and quality checked to ensure after all the processes that it is to the standard specification and that it can perform well under constant use.

8.1. Justification of Design choices

The design entails a variety of features, with regards to the client brief must have operational safety to minimize the potential for accidents to occur, the change to the original design enables anyone of any calliper to safely operate the lid via guide tracks to push and pull the lid rather than lift. Which reduces the chance of bodily strain and damages following the regulations of the health and safety at work act. Due to the lid having to meet the regulations of COSHH the lid material was altered to a lightweight High-Density Polyethylene (HDPE) as it has the 'properties of high durability and resistance to material degradation (Nguyen, Mwiseneza, Mohammed, Cousin, Robert, Benmokrane, 2021)' in this case that would convey that it has a high resistance to corrosion, which is a by-product of using sulphuric acid.

Additionally, this design is a simplistic design to accommodate easier manufacturing and operations of the tank within the workplace. Through this simplistic design comes its relatively cost effectiveness as each complete design cost of £602.77. With the design being financially beneficial it can be produced on a larger scale thus reducing the cost even further as the materials and parts can be bought in larger quantities for discounted prices.

9. Conclusion

In conclusion the CAD model meets the required specifications, demonstrating safe operation as the lid is lightweight as easily moveable due to the guide tracks that it follows in and out of the tank. This is plausible due to the alteration of the lid to a HDPE sheet that was indented equally over its width, so that it could bend following the curve of the Track Chute. Additionally, this didn't alter the clearance above the tank so the Aluminium sheet can still be lowered and raised without any implications. Furthermore, the tank was followed to the constraint set and was only modified to accommodate for the fasteners applied to the components.

The overall cost of the assembly of the tank and lid was relatively low at a figure of £602.77 not considering the cost of manual labour and electricity, which meets the specifications set out for this task while using readily available materials that can be purchase in mass quantities.

10. Further Work

To further optimize the design produced alterations can be made to the Stainless-steel track chute reducing the width to allow for more overhead clearance when the tank is in use.

Alternatively, the design could be made above the tank and displaced to the side, thus the sheet would be pulled straight across the tank, which would remove all implications that could be caused to the clearance. In addition to this alternative materials could have been chosen that may have been more ecofriendly and sustainable to those chosen so that the tank can meet every specification set out while reducing the effect on the environment.

Moreover, had the chance arisen prototypes could have been made to test the functionality prior to the actual design to gather further information and possible improvements to the current design. Finally, a more in-depth investigation into the cost of the parts and materials could have been conducted to understand the full feasibility of the production of the design at a much larger scale.

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