SAMSUNG

Product Proposal Specification Report

Heat Pump for Domestic Markets

Materials and Processes 2 - 3DD 2046
Product Design Year 2
UoN SoTA 2015

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Contents

3.0 Design Specification

3.1 Design Specification Factors.

3.1.1 Formulating Design Specification:

The semiotics of the external casing, remote, and remote interface are particularly significant to the user. The semiotics of these parts appeal to the 'Professional Rewards' sector of the Mosaic Consumer Classification report of 2009. This provides a market size of 8.23% of households in the UK [26.4 million households in the UK as of 2013]. On top of this 5% or 1.32 million households are already catered for, therefore the total market size in the UK alone is 2.06 million households. The redesign of the heat pump will open up a new market sector for domestic renewable energy and move the current products from a red ocean market to blue ocean.

The product appeals to this collection of people for multiple reasons; 70% savings on bills, the product pays for itself in two years, it is retrofit and is can be used on multiple wall thicknesses, it actively monitors expenditure accurately, lowers carbon footprint incase of future legislation regarding personal carbon credits, it's a long term investment, the integrated system reflects the users behavior and used learnt information to aid them, finally the fundamental new asset is about positive behavioral change and aiding the user to reflect on there habits of use and bill management.

The home remote makes the users life easier by being transportable, easily charged and by using a simple interface that everyone understands. As well as this the mobile app (available on the App Store and Android) sends reminders to the user about how much money they could save if they turned the heating down. As well as the ability to turn the heating off from anywhere in the world if they have left it on.

The environment and context of the visible parts of the heat pump have been taken into account to please the user. The external casing design conforms perfectly to the brief, the result is a surreal yet understated product; simplicity is the key. The material selection, perforated aluminum distorts the products surroundings helping it to blend in but also enhancing its presence.

The assembly of parts allows easy access for all users, the resident, installer, maintenance/ product engineer and the decommissioning team. The design of the conduit, bracket and chassis allow this buy using standard drill bit sizes and tension bolts. The simplicity of the assembly allow the product to be installed within 24hours. All of the parts a durable and are expected to have a life span of up to 15-years.

The internal parts consist of proven technology. This technology is in ready supply with minimal development required, therefore there is a decreased cost and investment risks factor. Ease of manufacture is incorporated into the design to assist in reducing these risks. The manufacturing techniques used utilise existing moulds and materials as well as this the use of cold manufacturing reduces the carbon footprint of the product. The technology also possesses as 5-year warranty.

3.1.2 Enterprise Inventory Fit:

Samsung EHS principals have been adhered to in order to confirm relevant innovation.
The design of both semiotic parts [external casing and remote] combined the design culture

of both sides of the company. The innovation process has taken into account Samsung's overall business objectives as well as new criteria influenced by the user. Samsung EHS has provided the main foundation for the design and components as well as new deigns for the conduit, bracket and chassis.

Samsung already possesses the expertise to produce the new product type. Even though the company is opening up a new market sector there is a relatively low enterprise risk.

3.1.3 Cost Factors:

In reference to 1.1 sub section 1.1.1 the size of the potential market must be taken into consideration. Out of the 2.06 million the aim for the first year of sales is between 5-10%. This means producing between 103,000 and 206,000 units in 12 months. In order for supply to meet demand 150,000 units will be produced, this large scale system will manufacture 5o units an hour. All of the costs have been estimated and are presented below; these have been used to produce estimations for Pc and Pt.

Marketing, sales and support costs [Cmkt]: £1,500,000 (5% of annual product sales)
Material costs [Cmat]: £4,683,000
Manufacture and Assembly costs [Cma]: £180,000
Disassembly and end-of-life processing costs [Cde]: £400,000
Anticipated total quantity [Qat]: 150,000 units.
Development Costs [Cdev]: £180,000

Pc + Pt. = [(Cdev + Cmkt)/ Qat] + Cmat + Cma + Cde

Pc + Pt. = £5,263,011.20

The Pc value of £2.6million from the first 150,000 units sold will be reintegrated back into the company to compensate for; manufacturers tooling costs, material, cost to market, distribution, advertising, marketing to sellers and overheads.

The cost of the heat pump to the consumer can be reduced by the RHI scheme and through assisted purchasing. In the future the technology could be developed to produce a micro generation of energy that the user could sell back to the grid.

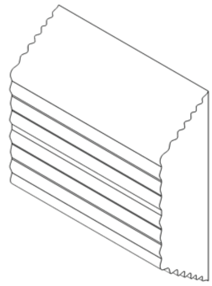
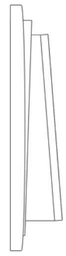
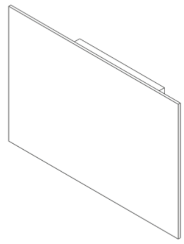
There will inevitably be competition between Samsung and rival companies. Depending on cost of production more could be allocated to the manufactures in order to stop competitors offering higher sums of money. On the consumer scale in an attempt to beat the rivals the product can be altered to make it more desirable, increased product guarantees, introducing buy back schemes will help to keep customers in the supply chain.

3.2 Concept Proposals.

3.2.1 Concept Proposal Description:

During the concept proposal stage three concepts for each part of the assembly were draw up. The brief and sections 3.1.1 are used for the criteria to evaluate the concepts. The concept proposal matrixes of each part are presented below [ratings from 1-5, 1 being the worst and 5 being the best].

3.2.1.1 External Casing:

			
Casing name:	Ripple	Discs	Screen
Material:	Perforated aluminum with external sealant.	Sheet copper.	Sheet stainless steel.
Fixing:	Simple hooking action through loops at the top of the casing and onto the chassis.	Bolted to the wall over the internal components.	Sliding motion over the top of the internals fixed with four scews.
Enterprise:			
Samsung brand culture.	3	2	4
Global market relevance.	4	3	4
Exploits existing Samsung experties.	5	4	4
ROI (Return on Investment).	5	3	5
Market:			
Customisable opportunity.	5	5	4
Distinct differential.	5	5	4
User:			
Suits life style.	5	1	4
Appropriate for context.	5	1	4
Ease of installation.	5	2	5
Ease of assembly on site.	5	3	5
Technology:			
Ease of manufacture.	5	4	5
Cost of investment tooling. (1 - high)	5	2	4
Total:	57	35	52

Evaluation of each concept:

Ripple: This concept does conform to the brief and shows signs of the surreal yet understated form the user wanted. The possible alterations include; extending the ripple effect further to reduce the amount of level material and increasing the presents of Samsung brand culture. Despite this the new design has to connect with the underlying brand culture of Samsung EHS. As well as the semiotics appealing to the user the use of aluminum reduces the carbon footprint of the product. Refer to section 3.1.1, Technology.

Screen: Although this concept has a better brand culture the form its self doesn't show much innovation. The concept draws inspiration from Samsung TVs. There are various alterations that can aid the design, these include; adding a texture to the front face replicating the back of a Samsung TV, increasing the size of the face to provide the illusion that it is floating.

Discs: The Disc concept is very appealing despite its very low score in the concept evaluation matrix. The notion of using copper immediately increases the casings aesthetics, however it is not a partially sustainable material. One of the alterations that could be made would be to the material as sustainability is key within this design proposal.

In conclusion to this particular concept proposal evaluation it has been decided that the ripple concept will be developed further. The alterations will be amended to produce a final product proposal.

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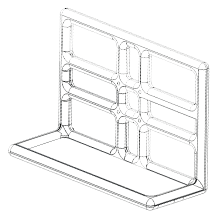
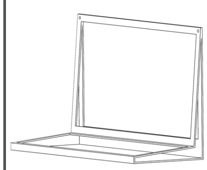
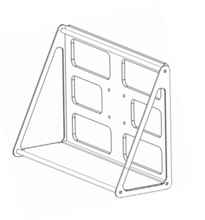
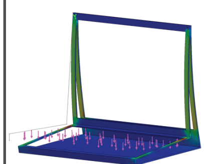
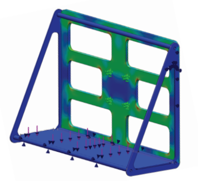
3.2.1.2 Chassis:

			
Chassis name:	Tubing	Minimal	Sheet
Material:	Aluminum tubing.	Sheet stainless steel.	Sheet Aluminum.
Fixing:	Four bolts in the centre passed through the wall.	Four small bolts in each of the corners.	Four bolts in the centre passed through the wall.
Market:			
Customisable opportunity.	2	2	5
Distinct differential.	3	1	5
User:			
Appropriate for context.	3	2	4
Ease of installation.	5	5	5
Ease of assembly on site.	5	5	5
Technology:			
Ease of manufacture.	1	5	5
Cost of investment tooling. (1 - high)	3	4	3
Part preformance. (Static Stress)			
Total:	22	24	32

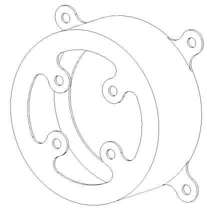
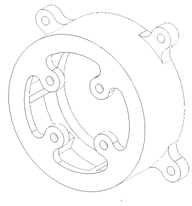
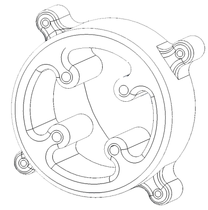
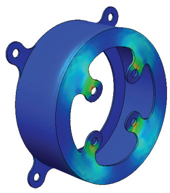
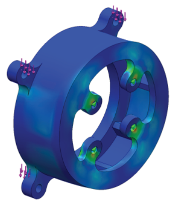
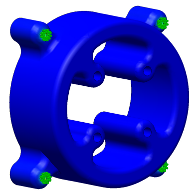
Evaluation of each concept:

The three chassis presented above all have their advantages and disadvantages. However the most effective would be the concept on the far right. It offers a high strength to weight ratio as well as this it is not a particularly expensive chassis to produce. The middle chassis is nowhere near strong enough and the first is over engineered costing more money and taking more time.

In conclusion to these findings the chassis further FEA testing carried out will show the strength of this chassis and where its weaknesses are.

Possible improvements could include the addition of thinner sheet thicknesses in order to reduce material or instead of using method that use up excessive energy and materials simply use bolts to connect the parts together, this will aid reduce the overall carbon foot print of the product.

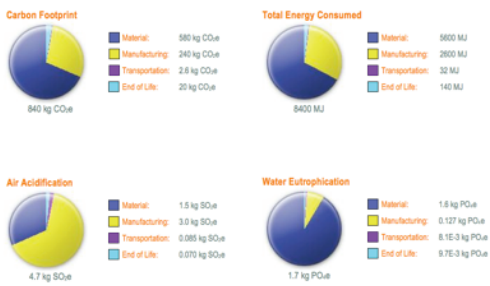
3.2.1.2 Bracket:

			
Bracket name:	Dev-1	Dev-2	Dev-3
Material:	Sheet Aluminum.	Galvanised steel.	Cast stainless steel.
Fixing:	Four bolts in the centre passed through the wall.	Four bolts in the centre passed through the wall.	Four bolts in the centre passed through the wall.
User:			
Appropriate for context.	0	2	5
Ease of installation.	5	5	5
Ease of assembly on site.	5	5	5
Technology:			
Ease of manufacture.	5	4	3
Cost of investment tooling. (1 - high)	2	3	4
Part preformance. (Static Stress)	0	4	5
			
Total:	17	23	27

Evaluation of each concept:

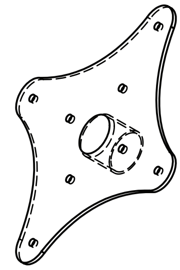
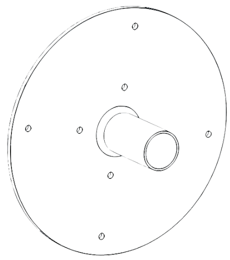
This concept evaluation matrix shows the development of the bracket. Through out the process there is a clear progression of success in altering the shape and material of the design.

There is a need to alter the design of the bracket by sacrificing strength for a reduced environmental impact. As the sustainability report below suggests the largest factor in the brackets carbon foot print, total energy consumption and water eutrophication is the material its self. Changing the form could dramatically reduce these numbers. Another major factor is where the bracket is manufactured; figure one is based on data that takes into consideration the fact that it was manufactured in Asia. If the bracket was to be manufactured within Europe this would mean an 11% decrease in its carbon footprint from 840 kg CO2e to 750 kg CO2e (a 90 kg CO2e decrease).



In conclusion to this particular concept proposal evaluation it has been decided that dispite the Dev-3 concept being The reduction of material will be completed and further FEA testing will follow.

3.2.1.3 Conduit:

		
Conduit name:	Cut-out	Circle
Material:	Aluminum tubing.	Sheet stainless steel.
Fixing:	Four bolts in the centre passed through the wall.	Four small bolts in each of the corners.
Market:		
Customisable opportunity.	2	2
Distinct differential.	3	1
User:		
Appropriate for context.	4	2
Ease of installation.	5	5
Ease of assembly on site.	5	5
Technology:		
Ease of manufacture.	5	5
Cost of investment tooling. (1 - high)	2	4
Total:	26	24

Evaluation of each concept:

This concept evaluation matrix shows the form of two conduit concepts. Through out the process there is a clear progression of success in altering the shape and material of the design.

They two conduit concepts are not too different however it is the sight changes that can make all the difference. The reduction in material could save Samsung a large amount of money and be better for the environment, because of these factors the second conduit will be developed further or used in the final design.

In the event of the bracket not being used in the final design the cut out conduit will double as the bracket. However as stated in 3.2.1.2 this depends on the assembly FEA testing phase.

3.3 Design Development.

3.3.1 Prototype Design: There is a huge importance for the production of a physical or virtual prototype. Within this project a virtual Solidworks model has bee produced that is perfectly represents the final product. This has also prompted the use of standards that the final product must conform to.

3.3.2 Proposal Evaluation FEA, LCA: There are many lifecycle considerations and end-of-life processes that need to be addressed. The lifecycle is a products use in respect to its impact on the environment, user, technology and market. There are many factors that affect the lifecycle of the product. These include: minimal material usage, reduction in energy during the manufacturing stages (cold forming processes to produce the parts), where the product is manufactured, how efficient the technology is and how easy it would be to upgrade the heat pump, easy access to the internals of maintenance. At the end of all this the end-of-life strategy must be analysied, The heat pump has been built to last 15 years, at the end of this 80% is intended to be recycled with the other 20% heading to landfills. The introduction of a by back scheme could massively improve this number.

3.3.3 User Evaluation: In order to ensure that the final product is complete an evaluation was carried out. The virtual prototype and technical aspects of the project have been evaluated against the brief above in the concept evaluation matrixes. However these factors have been checked through out the project to ensure that the project is conforming to the sealed designing brief.

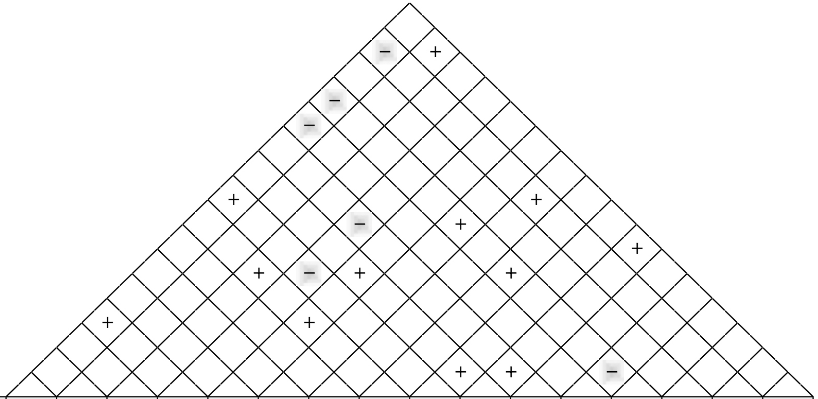
3.4 QFD Evaluation:

3.4.1 House of quality: The evaluation table is presented over leaf.

Correlations	
Positive	+
Negative	−
No Correlation	

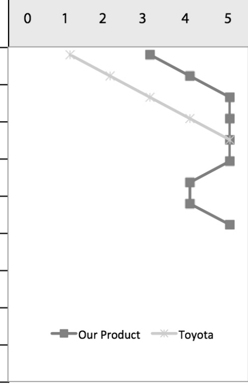
Relationships	
Strong	●
Moderate	○
Weak	▽

Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼



Row	Weight Chart	Relative Weight	Importance	Maximum Relationship	Customer Requirements (Explicit and Implicit) / Functional Requirements	Weight	Produce…. units	Efficency	Minimal Material Usage	Life Span of 15 years	80% of Recyled/Reused Materials	5 hour Installation Period	70% Energy Savings	Strength	Material	Semiotics	Material Thickness	Carbon Footprint	Ease of Maintenance	Ease of Insallation	Ease of Manufacture	Our Product	Toyota	Row #
					Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
					Direction of Improvement	◇	◇	▲	▼	▲	▲	▲	◇	◇	◇	▲	▲	▲	◇	▲	◇			
1	|||||	10%	3	9	Samsung Brand Culture.					●	●	○	●	○		●		○				3	3	1
2	|||||	10%	3	9	Global Market Relevance.		○			●								●				4	4	2
3	|||||	10%	4	9	Exploits Existing Samsung Experties.	●	●	●		○		●	●			●						5	2	3
4	|||||	10%	4	9	Weather Proof.							○			●				●	○	○	5	5	4
5	||||||||||	20%	5	9	Sustainability.		○	●	●	○			●		●		●					5	2	5
6	|||||	10%	5	3	ROI (Return on Investment).		○															5	3	6
7	|||||	10%	5	9	Surreal Yet Understated.											●						4	3	7
8	|||||	10%	5	9	Warranty.									●								4	2	8
9	|||||	10%	4	9	Cost.		●								●							5	3	9
					Target	45kg	150000 units	Further research	Reduce by 3kg	Material finishes increasing life span	What about the other 20%	Cost?	Advertisment	FEA testing	Finishes and strength	Renders	5mm max.	300kgCO2e	Yearly checks	User experience map	Depends on many factors			

Competitive Assesment



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3.5 Proposal Definition:

3.5.1 Definition Phase: The external casing is a surreal yet understated product; simplicity is the key. The material selection, perforated aluminum distorts the products surroundings helping it to blend in but also enhancing its presence.

The semiotics of these parts appeal to the 'Professional Rewards' sector of the Mosaic Consumer Classification report of 2009. This provides a market size of 8.23% of households in the UK [26.4 million households in the UK as of 2013]. On top of this 5% or 1.32 million households are already catered for, therefore the total market size in the UK alone is 2.06 million households.

The product saves the user up to 70% on bills, the product pays for itself in two years, it is retrofit and is can be used on multiple wall thicknesses, it actively monitors expenditure accurately, lowers carbon footprint incase of future legislation regarding personal carbon credits, it's a long term investment, the integrated system reflects the users behavior and used learnt information to aid them, finally the fundamental new asset is about positive behavioral change and aiding the user to reflect on there habits of use and bill management.

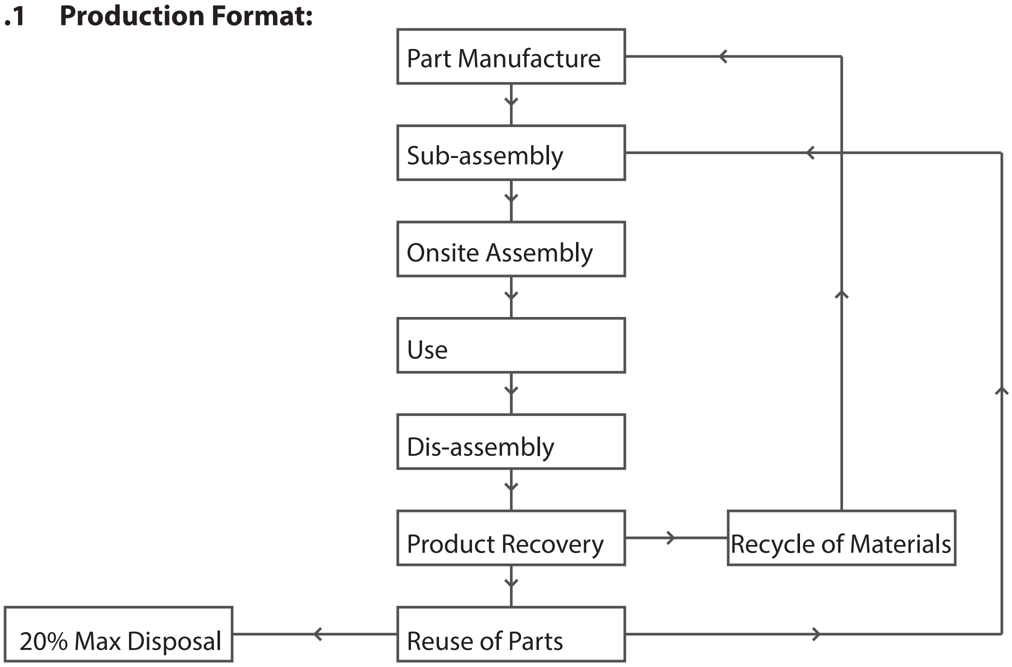
The assembly of parts allows easy access for all users, the resident, installer, maintenance/ product engineer and the decommissioning team. The design of the conduit, bracket and chassis allow this buy using standard drill bit sizes and tension bolts. The simplicity of the assembly allows the product to be installed within 5hours. All of the parts a durable and are expected to have a life span of up to 15-years.

3.5.2 Realisation Phase: There is no need for any new tooling keeping the ROI (Returnon investment) very low. The outer casing uses the same tooling as standard corrugated metal. However the corrugated aluminum cannot be purchased ready manufactured as the perforations and embossing need to completed prior to assembly.

4.0 Production Specification.

4.1 Manufacturing Strategy:

4.1.1 Production Format:



4.1.2 JIT strategy: In Order to reduce cost contributing towards Samsung's expenses a JIT strategy will be put in place. The system will include only purchasing the quantity of materials and parts needed for one weeks production, 2,500. Only when 80% of the materials have been used will the next order be made. However this requires the sourcing of an efficient and reliable supplier.

4.1.3 Manufacturing Costs: For manufacture and assembly costs a sum of £180,000 has been set aside. This includes the manufacture of: parts, assembly, sub-assembly, product/system testing and subcontractors for packaging and storing.

4.1.4 Manufacturing Documentation: All of the manufacturing documentation will be presented in sections 4.2 and 4.3 in the form of GA drawings, assembly specification/process, as well as FEA tests and materials.

4.2 Product Assembly.

4.2.1 GA Drawing: All of the general assembly drawing will be presented within section 4.3.1 in the form of part/component drawings.

4.2.2 Assembly Specification: All parts within the assembly will anodized post sub-assembly ensuring a durable long lasting product. The only acceptation to this is the outer casing, which will be polished to a shine. Despite early indications of a bracket this has been removed from the assembly due to unnecessary material and cost. As for tolerances the virtual model takes 0.2mm of manufacture variants into consideration.

4.2.3 Onsite Assembly Process:

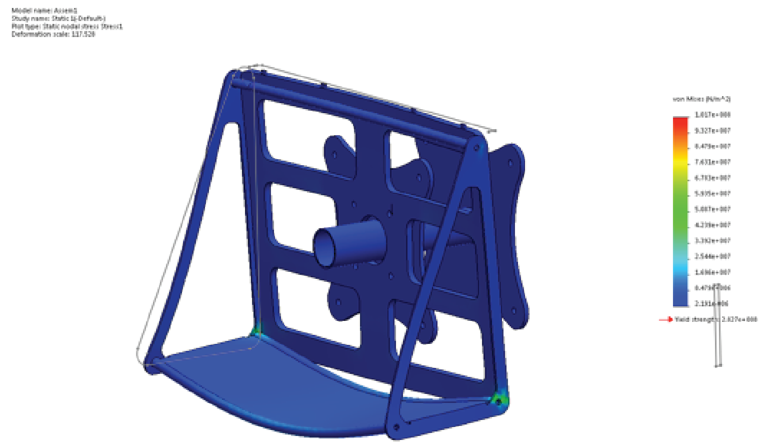
4.2.3.1 Conduit: The assembly of the conduit requires the use of a standards 80mm diamond tipped drill bit for the onsite assembly process. Once the hole has been drilled the long tubed conduit section is passed through the wall on the inside.

4.2.3.2 Chassis: There are four guidance holes for the chassis to be attached to the outer, short-tubed conduit with the four bolts included. Once attached, the combination of the chassis and outer conduit must be slid over the protruding tube from internal conduit, and then bolted.

4.2.3.3 Casing: The external casing uses a very simple method to connect to the chassis. There are four oval protrusions on top of the chassis and four holes on the framework of the casing. These are simple slotted together, in addition to this there a four small screws in each corner to ensure the casing is as close to the wall as possible. In order to finish the assembly a silicone seal is applied around the edges to waterproof the heat pump.

Refer to section 4.2.9 to see a diagramatic version of the events within section 4.2.3.3.

4.2.4 Assembly Performance – FEA:



The performance of the assembly (both conduits and chassis) shows an overall yield strength of 2.827e+008. Meaning it is twice as strong as necessary when a force of 80kg is applied directly on the loading area for the heat pump internals. In relation to section 3.2.1.2 the FEA study above shows that the bracket isn't needed. The FEAs for the bracket can be found in the appendix of this report.

4.2.5 Assembly Costs: In relation to section 3.1.3 and 4.1.2 the assembly costs are a fraction set aside for the manufacture and assembly costs. Taking the onsite assembly into consideration, the assembly time on site is an expected 5 hours.

£15.00 hour for the instillation team means a cost of £150 for the two workers per instillation however this up to the consumer to pay for this amenity.

4.2.6 Disassembly: The disassembly process only takes a fraction of the time and the price for this would half of the installation fee, at £75.

4.2.7 LCA Considerations:

4.2.7.1 Casing:

Weight: 8925.41g
Electricity consumption: 0.715 kWh/lbs
Natural Gas consumption: 2900 BTU/lbs
Built to last: 15 years.
Carbon footprint: 120kg CO2e

4.2.7.2 Chassis:

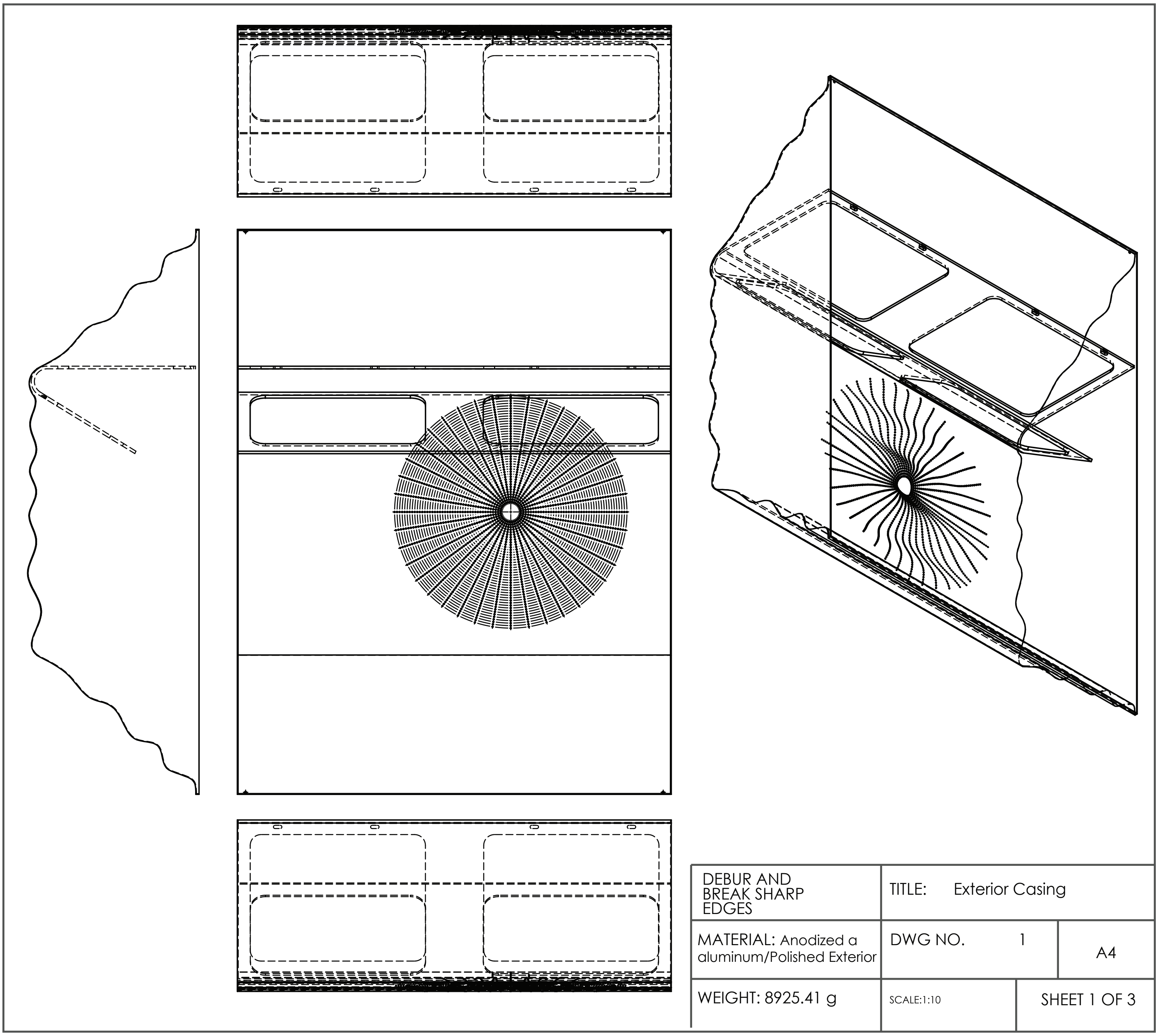
Weight: 7433.54g
Electricity consumption: 0.715 kWh/lbs
Natural Gas consumption: 2900 BTU/lbs
Built to last: 15 years.
Carbon footprint: 100kg CO2e

4.2.7.3 Internal and External Conduit:

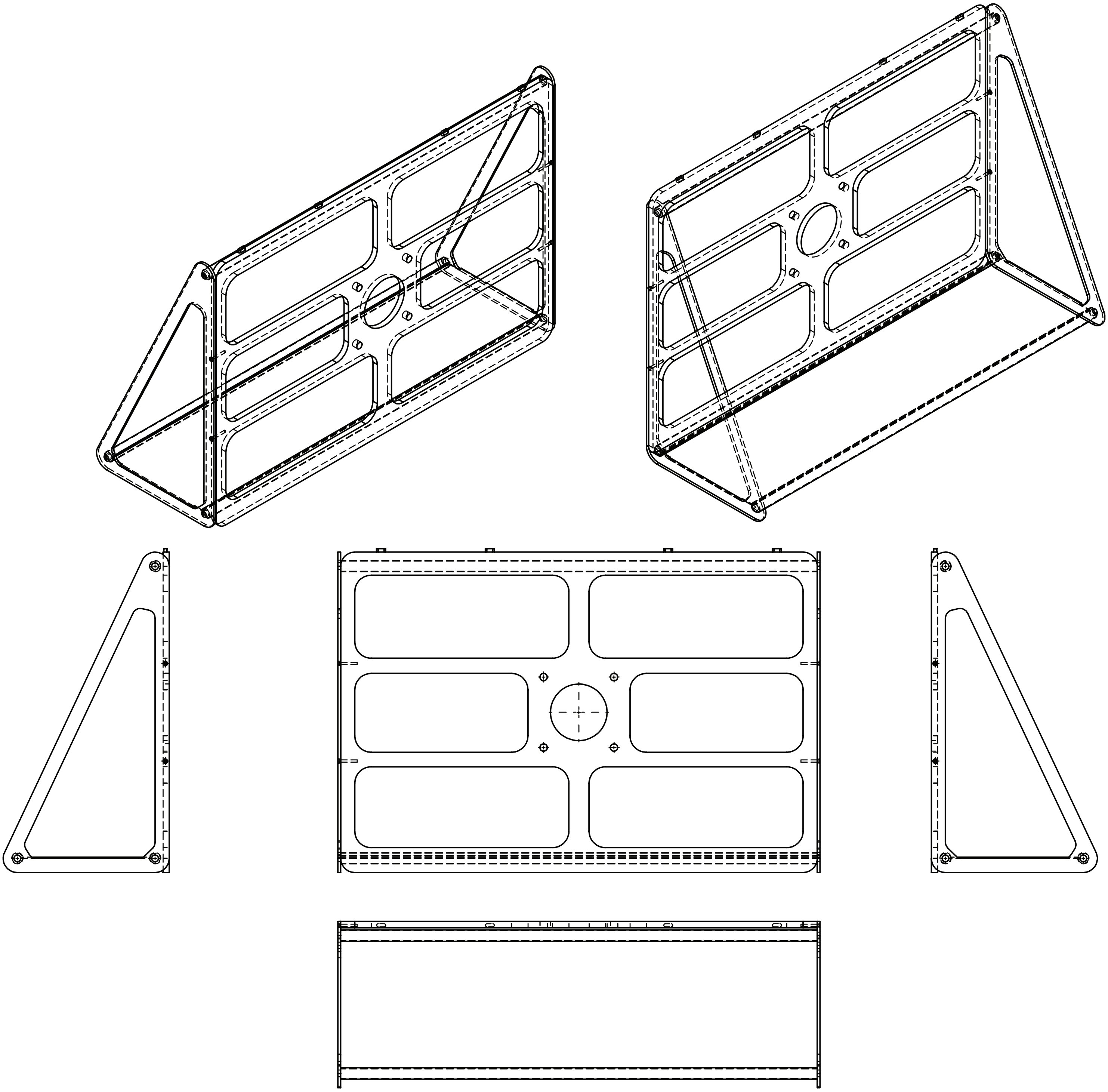
Weight: 5490g
Electricity consumption: 0.715 kWh/lbs
Natural Gas consumption: 2900 BTU/lbs
Built to last: 15 years.
Carbon footprint: 74kg CO2e

4.2.8 Part/Component Drawings:

4.2.8.1 Casing:

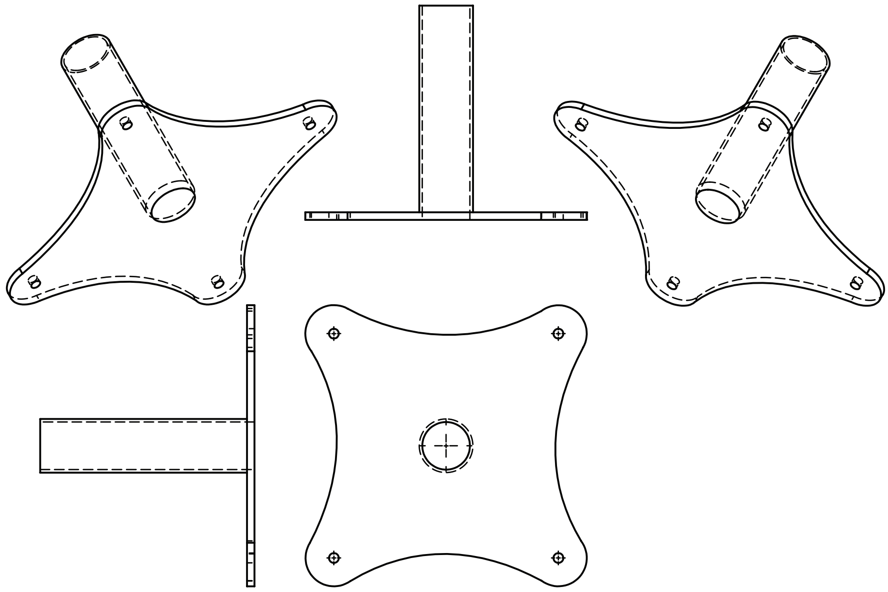


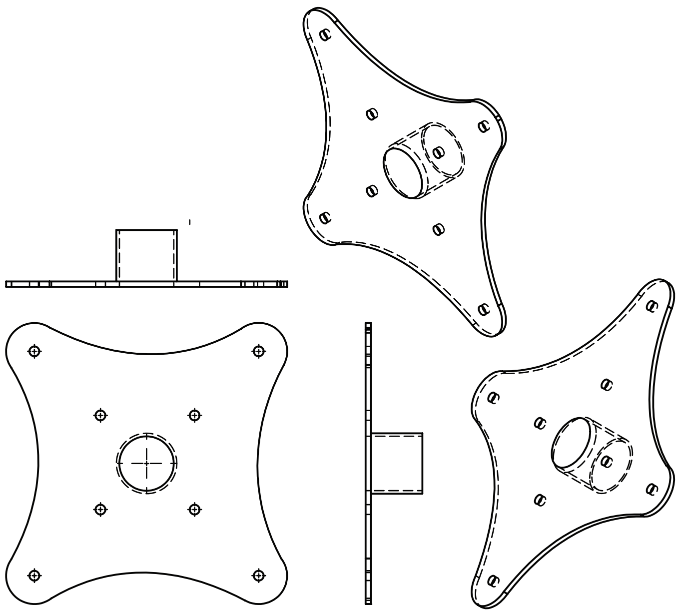
4.2.8.2 Chassis:



DEBUR AND BREAK SHARP EDGES	TITLE: Chassis	
MATERIAL: Anodized aluminum	DWG NO. 1	A4
WEIGHT: 7433.54g	SCALE:1:10	SHEET 2 OF 3

4.2.8.3 Internal and external conduit:



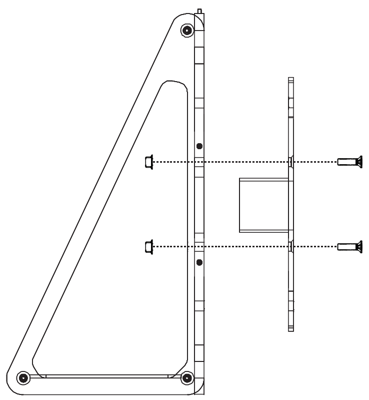


DEBUR AND BREAK SHARP EDGES	TITLE: Internal/External Conduit	
MATERIAL: Anodized aluminum	DWG NO. 1 A4	
WEIGHT: 3400g and 2090g respectivly	SCALE:1:10	SHEET 3 OF 3

4.2.9 Assembly process:

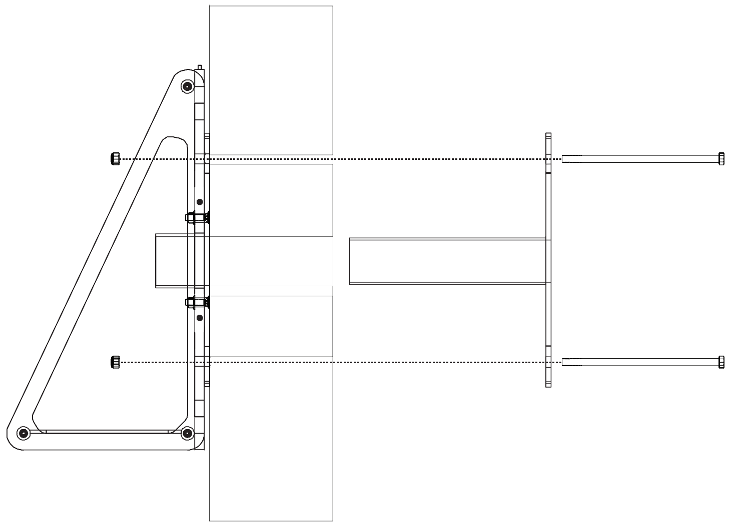
1

Stage 1 involves the connection of the **chassis** and the **external conduit** using the **chassis nuts** and **bolts**.



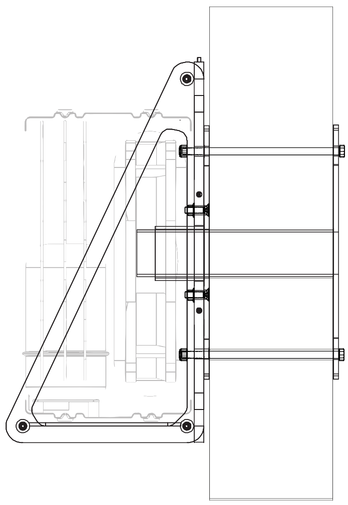
2

Stage 2 is a **two person** job. Once the 5 holes have been drilledthe **internal conduit must be inserted first**. As the bolts are being pushed through from the inside the chassis and externalconduit can be placed over.The tube protruding from the inside should pass through the external conduit and then **the bolts must be fully tightened before releasing**.



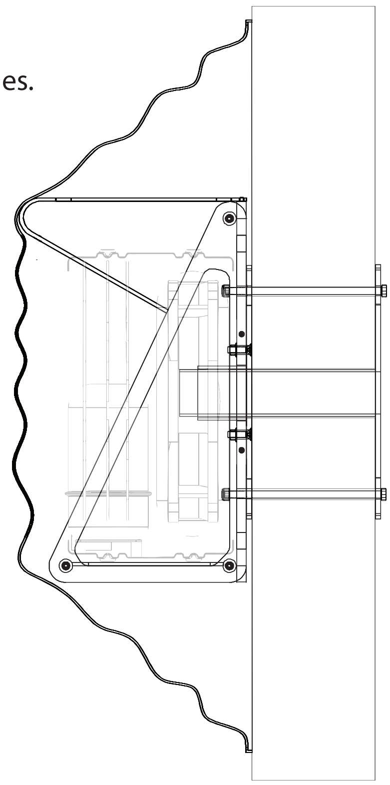
3

Once stages 1 and 2 are complete the heat internals can be installed. As soon as this is complete a silicon cap will be inserted on the internal conduit to seal the gap only allowing the cabling to come through.



4

As soon as instalation is complete the outer casing can be placed over the heat pump. Once the outer casing is in place a clear sillicon seal must be applied to the edges.



4.3 Component Specification:

4.3.1 Production Specification, tolerances: The straightness tolerance for all aspects of the product must be within 0.2mm. The use of a water cutter will greatly aid the accuracy and precision required to manufacture the majority of the parts.

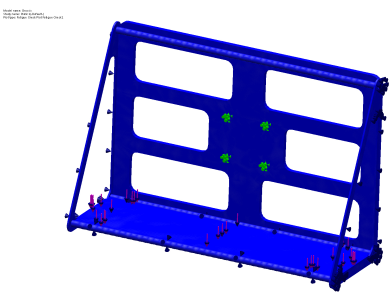
As for the flatness tolerances, the both parts of the conduit need to be accurate to within 0.08mm. This is particularly important as the surface butting up against the wall need to be flush to ensure the wall cavity doesn't become exposed.

4.3.2 FEA testing: After having proved the bracket was no longer required (refer to section 4.2.4) the only weight bearing part to the product is the chassis. The evidence for the strength and safety of the chassis is presented below.

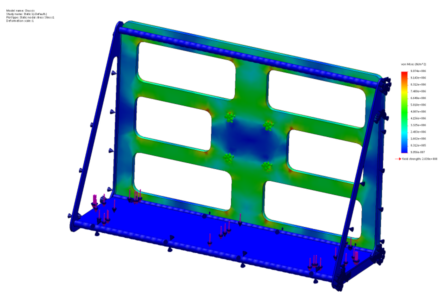
Material: Steel sheet and tubing anodized aluminum alloy.
Production Process: Rolling and cold drawing.
Manufacturing Strategy: 150,00 units per annum.
Plots: Plots use an 80kg loading force applied upon the heat pump resting surface.

Enterprise Factors: The use of existing materials that can be purchased directly from a supplier reduces tooling and labour costs.

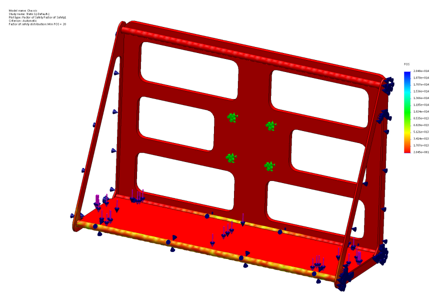
Information gained from the FEA evaluation: The final design for the chassis is efficent and safe enough to be put into production. The factor of safety plot shows that the chassis is 20 times safer that required as well as this the fatigue plot shows no issues what so ever. In conclution to this FEA study the chassis is perfect for it required job, if required in the future it could be further developed upon to reduce weight and reduce its environmental imapact.



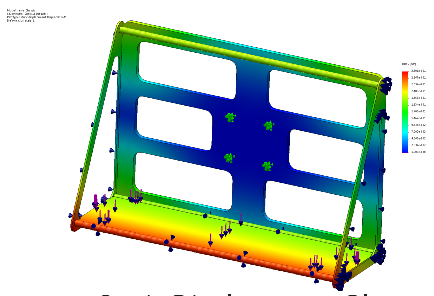
Fatigue Plot



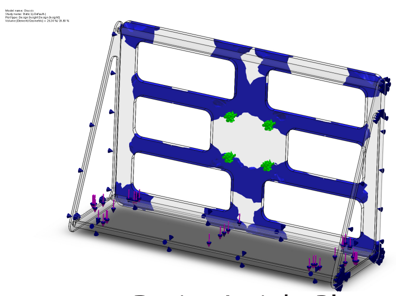
Static Stress Plot



Factor of Safety Plot



Static Displacement Plot



Design Insight Plot

4.3.3 Material Costs: In reference to section 4.1.2 a JIT (Just in Time) strategy will be adopted in order to reduce short-term expenses. As for the material costs, they are broken down like so. The cost to manufacture the:

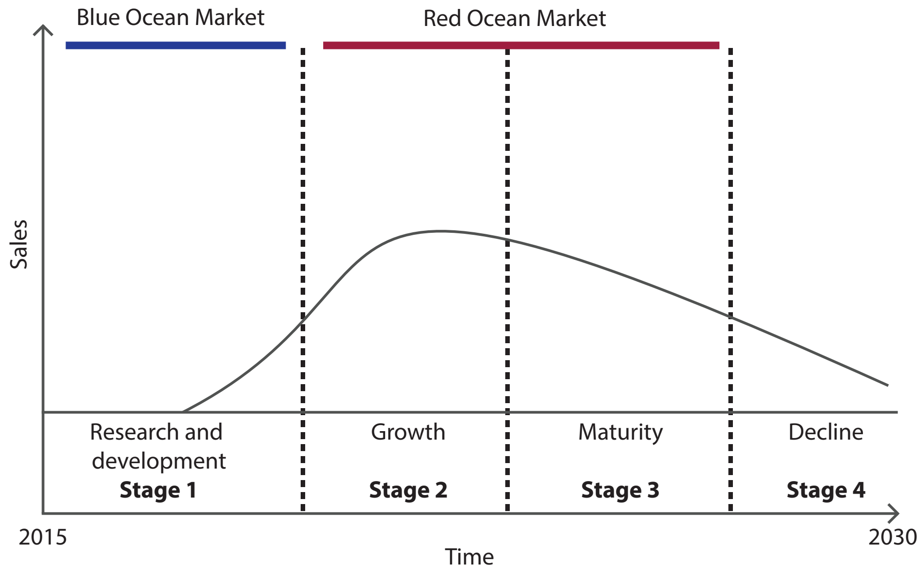
Casing: £12.76 per unit.
Chassis: £10.68 per unit.
Conduit: £4.86 + £2.98 = £7.84 per unit.

Total per unit = £31.22 x number of units to be manufactured in year one (150,000).

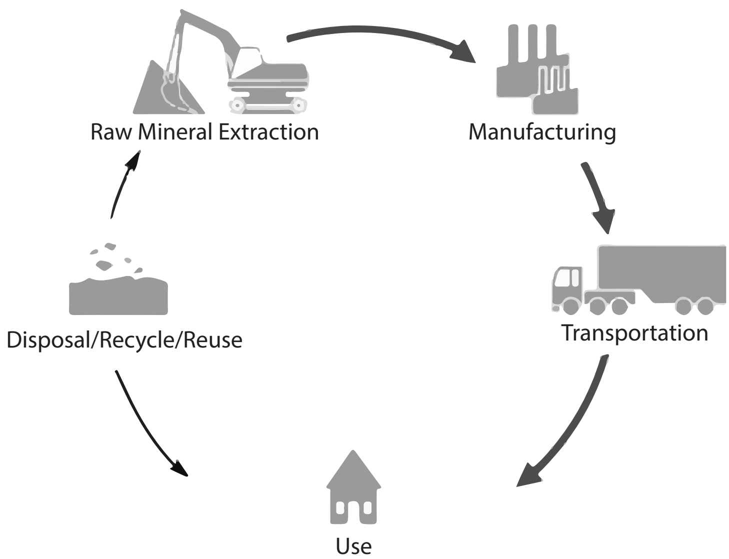
Total material cost = £4,683,000.

4.4 End of life concideration**s:**

4.4.1 End of life specification: The graph presented below show the expected life cycle of the product over the course of 15 years.



This diagram also shows the life cyle of the product in a sympified form.



4.4.2 De-manufacturing: The advantage of using an anodized §aluminum alloy for the product is that is one of the most sustainable metals. As well as the anodizing process increasing the life span of the product it can also be recycled and reused. The buy back scheme will allow Samsung to purchase the product back off of the consumer at scrap worth of the material at the time. This could then either be reused in other products or melted down and used to make another parts.

4.4.3 Costs savings and income:

4.4.3.1 Manufacturing costs (Inc. Materials, manufacture and assembly and development costs: £5,043,000.

4.4.3.2 Planned maintenance: A yearly service is suggested by the manufactures of the internal heat pump components, however it is up to the user to organize them. If the heat pump were to fail with out the maintenance check certificate the warranty will become void and the cost of repairs will fall on the user.

4.4.3.3 Warranty and uninstallation: The internal heat pump components fall under the 5-year warranty voided (as discussed in section 4.4.4.2). The other parts of the product are guaranteed for 15 years (the life span of the product). If any of these parts were to fail within this time period the expense and replacement will be passed to Samsung.

If the user wishes to remove the heat pump workers will uninstall the heat pump for the amount discussed in section 4.2.6. Once this has occurred the product and all other parts thereby belong to Samsung to with what they wish.

Appendix

FEA Evaluation Bracket

Material: Cast Stainless Steel.

Production Process: Sand Casting.

Manufacturing Strategy: 150,00 units per annum.

Plots: Plots use an 80kg loading force applied upon the central four bolt sockets.

Enterprise Factors: The shape of the bracket makes the sand casting proccess harder due to the more complex shape. However the advantage of the alteration is that it reduces the amount of material used therefore decreasing the carbon footprint of the product.

Information gained from the FEA evaluation:

After the alteration the bracket still proves to be significantly stronger than it needs to be however the most noticable differences can be seen in the static displacement plot. It is clear that the four internal bolts have become weaker, however this is only weaker in comparison to the rest of the bracket. In realtiy it is still more than stong enough to support the weight of the heat pump.

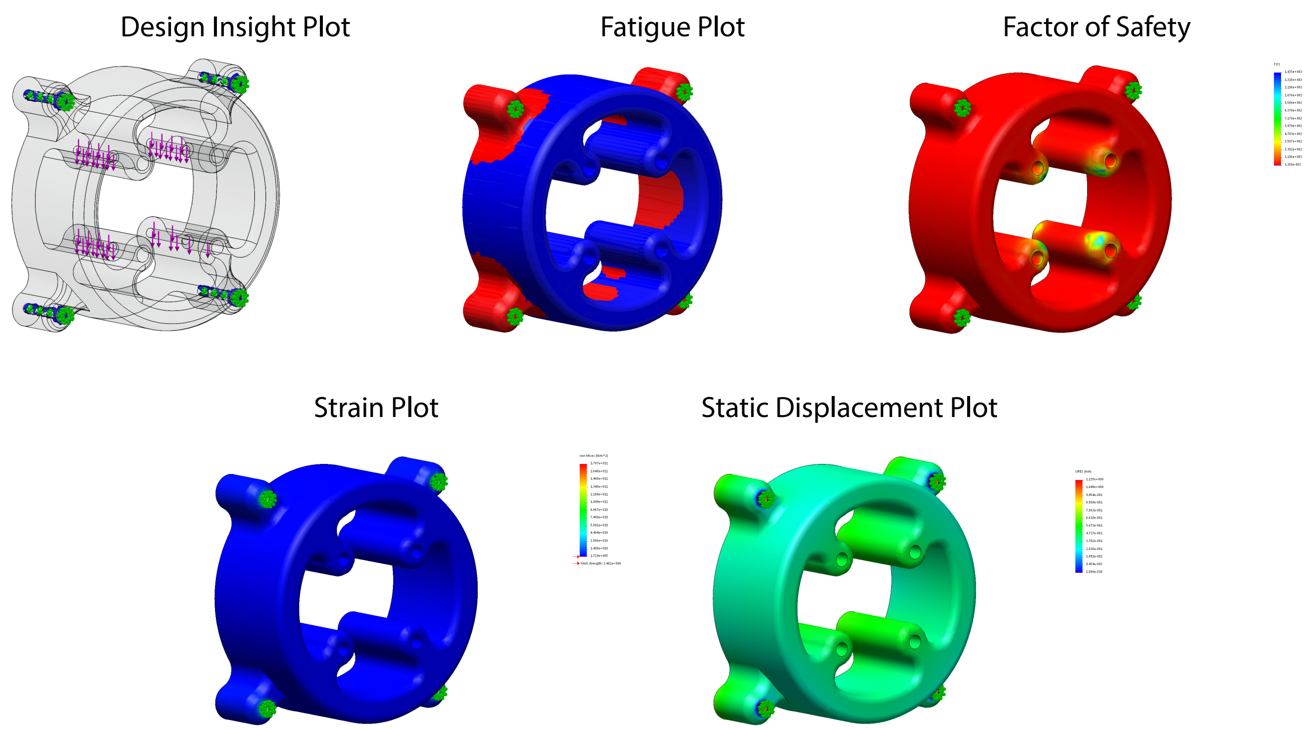


Figure 2: FEA testing.

The images in figure 2 are taken from simulation studies within solidworks. The most important of these are the fatigue plot and the factor of safety. The information gained from this testing is paramount to the sucess of the bracket. The fatigue plot has shown that there is a large amount of material that isnt strengthening the bracket. The blue area needs to be further developed in order to create a bracket that is strong but has a reduced effect on the environment. The factor of safety analysis shows that it is strong enough to hold more that 3 time the mass of the heat pum, this mean that some material can be stripped away, reducing its carbon footprint.

FEA Evaluation Bracket

Material: Cast Stainless Steel.

Production Process: Sand Casting.

Manufacturing Strategy: 150,00 units per annum.

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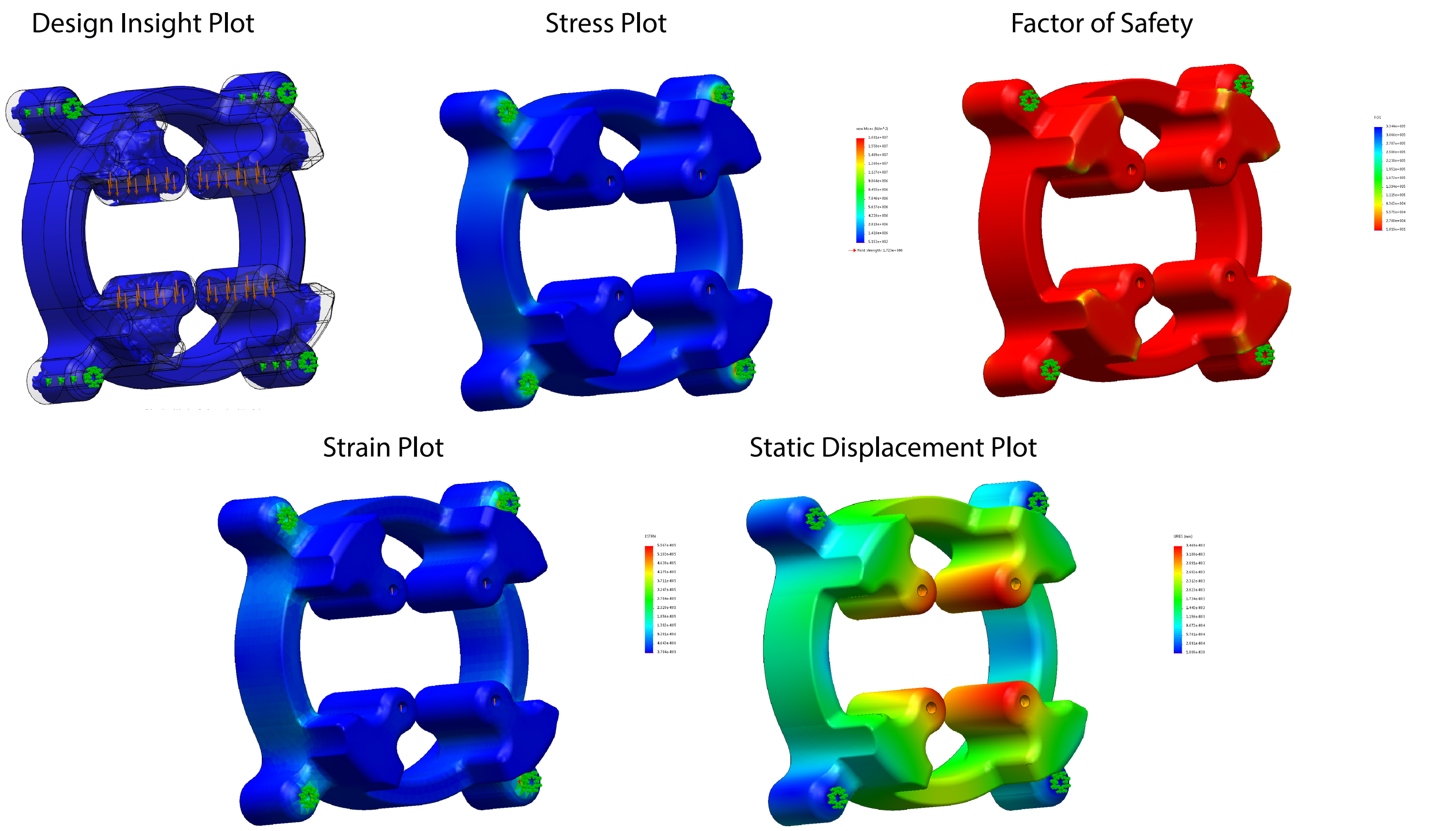

Figure 2: FEA testing.

The images in figure 2 are taken from simulation studies within solidworks. The information gained from the FEA testing on the previous version of the bracket showed the areas where strongest and where material wasnt needed. However the negative aspect of this alteration is the manufacturability of the bracket, this issue will be addressed immediately.