

# New Product Development Report

MODULA

ISMAEEL MIR (U1957221) WORD COUNT - 9334

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## Introduction

This report outlines the commercial arguments for Modula the modular furniture. The report covers the market, design considerations and manufacturing considerations, as well as end of life considerations.

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## SECTION 1 - PRODUCT OVERVIEW

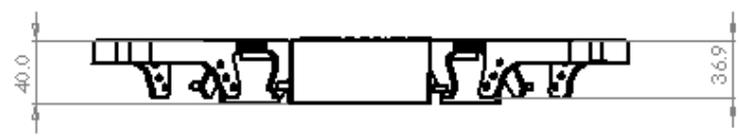
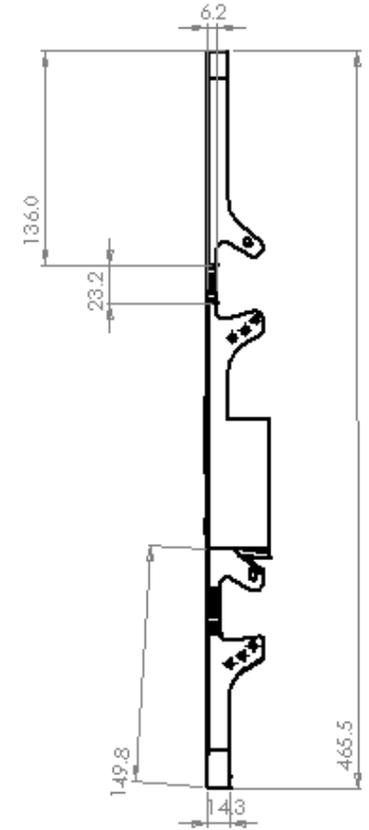
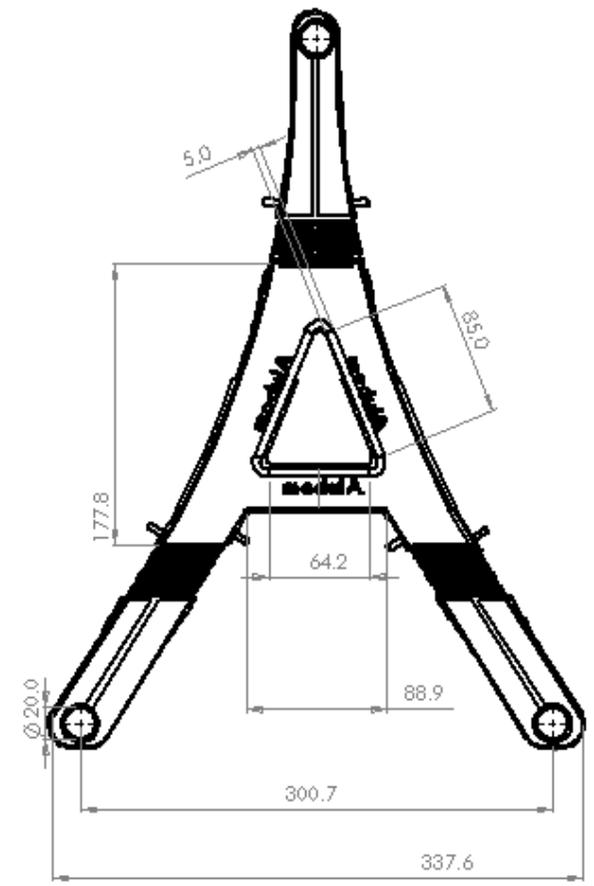
### Product Statement

Modula is a singular module which can be placed together with other identical modules to build the framework of furniture. The modules are placed together and fastened to build different pieces of furniture based on the user. Modula provides multiple opportunities to create what the user requires, providing a more affordable furniture solution where style is not compromised and build products ranging from tables, chairs, and sofas. Quite simple to use, with no need for glues, using pins to hold it together making it easy to assemble and reassemble for use again when the user needs changes.

### Technical Drawings and Renders

Technical Drawings are done to 0.1mm as they are quite big parts so an extreme level of detail is not needed as it would not provide and detriment to the design.

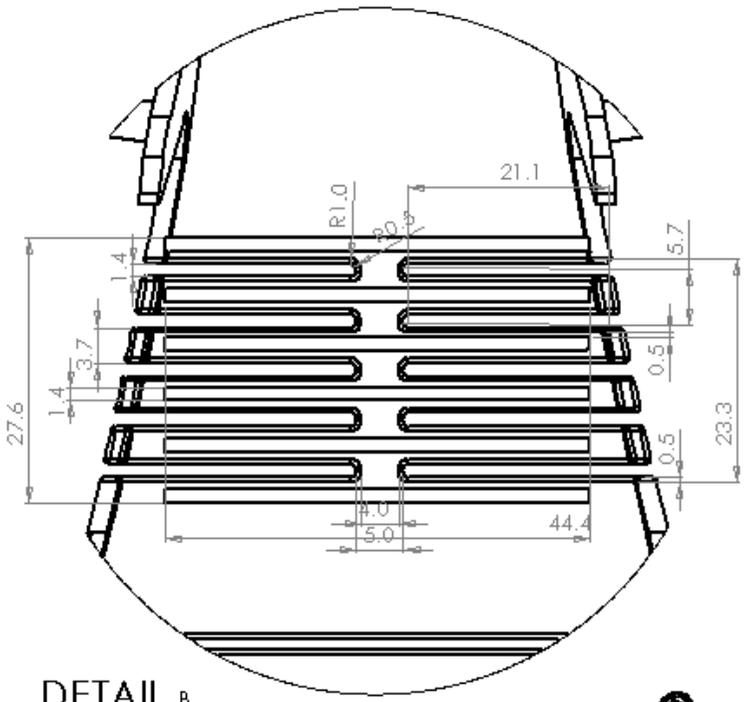
Figure 1



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Module		1
2	Decal Modules		1
3	Silicone Inserts		3
4	Pin		1

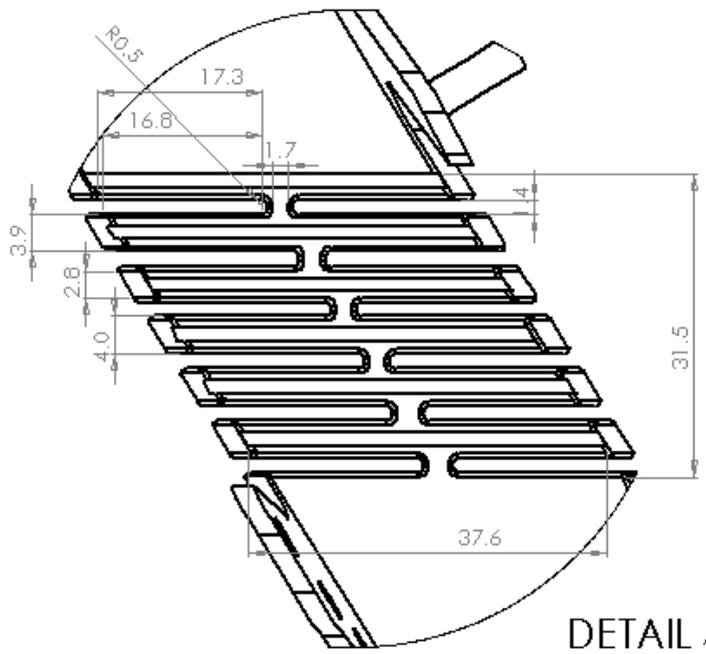
DESIGNED BY: [ ] DRAWN BY: [ ] CHECKED BY: [ ] APPROVED BY: [ ] DATE: [ ]		SPC-C1	CHECKED AND REVAL DATE: [ ]	DRAWING NO.: [ ] REVISION: [ ]
TITLE: [ ] DATE: [ ] APPR: [ ] DATE: [ ]		Outer		QTY: 1 A3
MATERIAL: PP Impact Copolymer		DRAWING NO.: [ ]		REVISION: [ ]





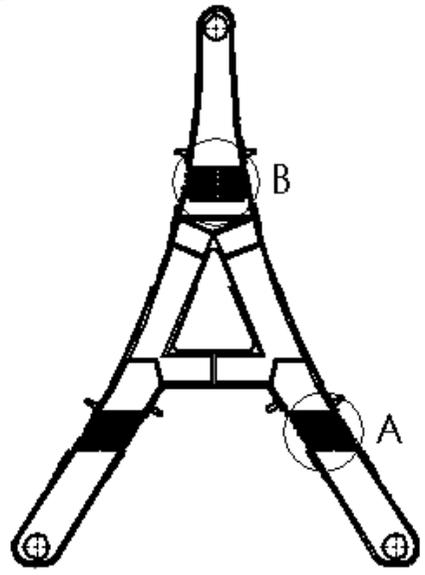
DETAIL B

SCALE 2 : 1

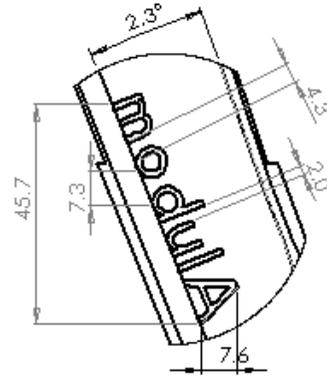
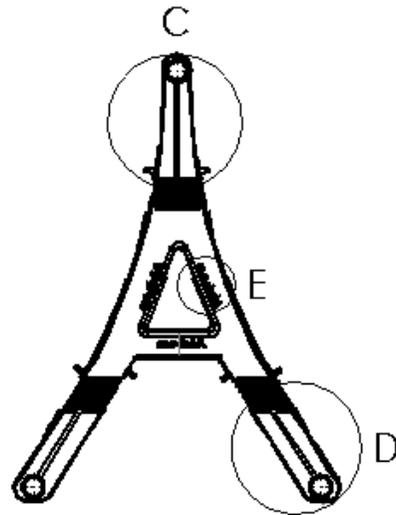


DETAIL A

SCALE 2 : 1  
(both legs identical)



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH TOLERANCES: FRACTIONS DECIMALS ANGLES		FINISH:  SPC-C1	EDGES AND CORNERS SHARP EDGES	DO NOT SCALE DRAWING	REVISION
DATE	DRAWN	CHECKED	DATE	PART	
01/06/09	BRUNO			Hinge	
APP'D				DWG NO	
MFG				3	
Q.A.				A3	
			MATERIAL: PP Impact Copolymer	SHEET 3 OF 3	
			WTCAP	SCALE	



DETAIL E  
SCALE 1 : 1

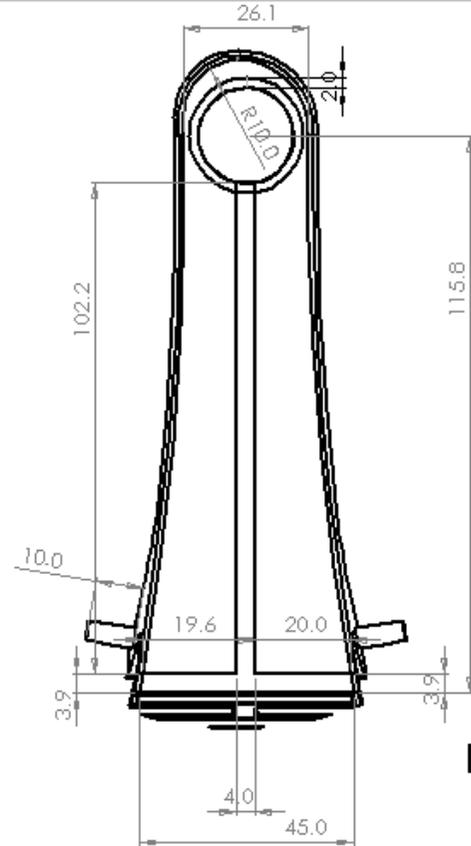
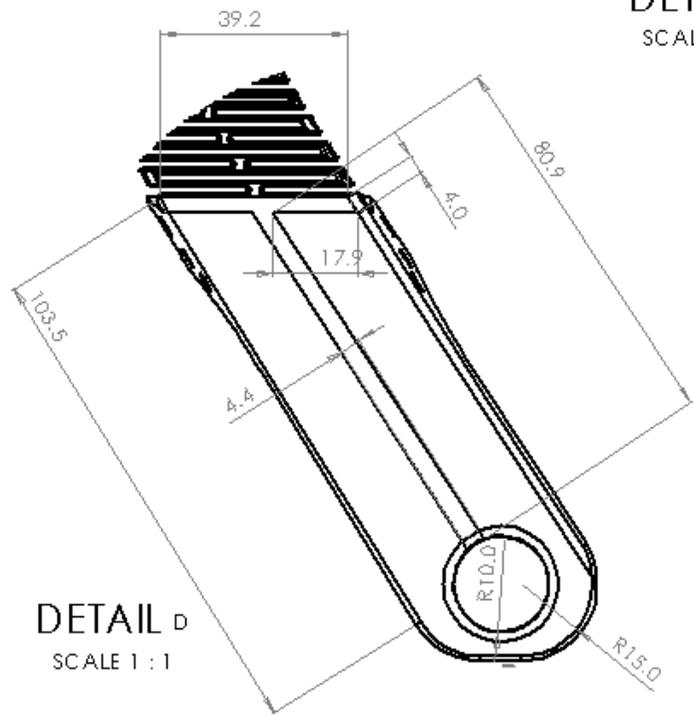


Figure 4

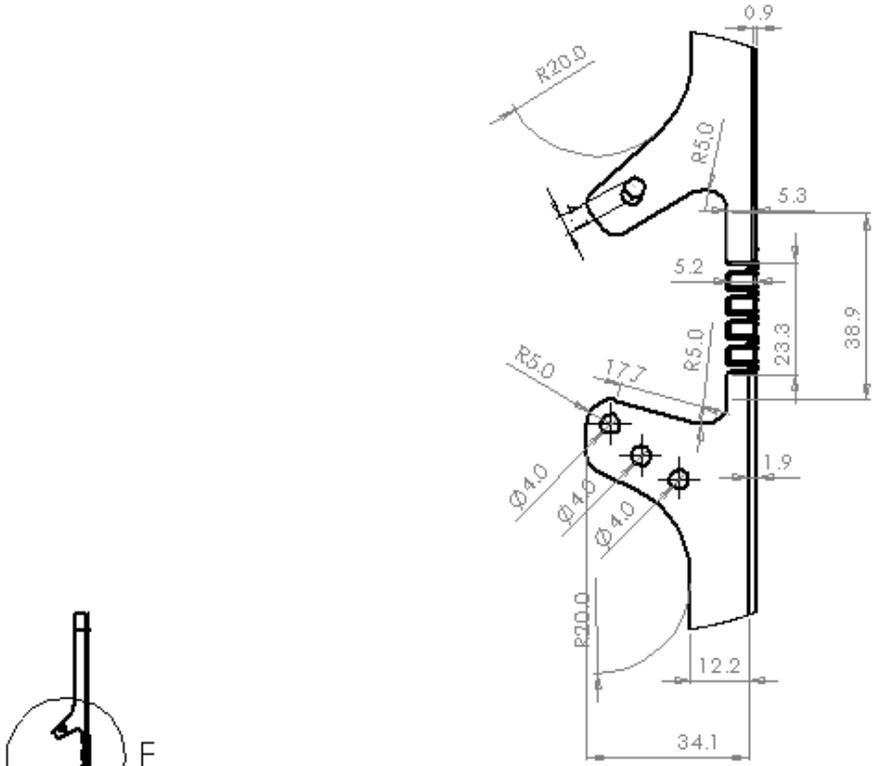
DETAIL C  
SCALE 1 : 1



DETAIL D  
SCALE 1 : 1

UNLESS OTHERWISE SPECIFIED - DIMENSIONS ARE IN MILLIMETERS		FINISH		DURABLE AND RESIST SHARP EDGES		DO NOT SCALE DRAWING		REVISION	
SURFACE FINISH		Gloss							
TOLERANCES		LINEAR							
		ANGULAR							
	FAVOR	SIGNATURE	DATE			M.P.			
11.1.1	Brookville		00/00/00			Detailing			
CHFD									
APPR'D									
WFG									
D.A.				WATTEN	Vinyl	DWG NO	4	A3	
				WFGM		SCALE		SHEET # OF #	

Figure 5



DETAIL F  
SCALE 1 : 1

SINCE DRAFTED OFFERED DA-PROJEKT ASB W-DA-PROJEKT CERNES WERK WIRTSCHAFTS UNIVERSITÄT WIEN		NAME SPC-C1	ZUSAMMEN- GESETZT ZEICHNUNG	DATUM 01.08.2007	VERZEICHNIS 5
NAME SPC-C1	ZUSAMMEN- GESETZT	DATUM 01.08.2007	VERZEICHNIS 5	Locking System	
NAME SPC-C1	ZUSAMMEN- GESETZT	DATUM 01.08.2007	VERZEICHNIS 5	PP Impact Copolymer	





Figure 7



Figure 8



Figure 9



Figure 10

## Product Specification

### **CORE PROBLEM IT ADDRESSES**

To provide a cheap alternative to furniture while allowing for more stylistic choice, including size shape and colour within a lower budget.

### **PRIMARY FUNCTION**

To provide a cheap alternative to “typical” high street furniture, while allowing for more options in terms of style for the user. While allowing for users to build their own furniture to their needs and wants.

### **SECONDARY FUNCTION(S)**

- To look aesthetically pleasing
- Easily slot together and fasten in place.
- Allow creative freedom with shape of furniture
- Allow choice of style and colour based on what the user likes
- 

### **INTENDED MARKET**

The intended market for this product is for all homeowners, but especially those who have greater financial issues. Those who are moved into houses like council flats and council homes due to their financial predicament. As social housing comes completely unfurnished, it is a steep cost to pay to furnish it completely, thousands of pounds which the people living in simply cannot afford. This furniture module provides a cheaper alternative for them.

### **COMPETITORS**

There are no direct competitors for this product with in not just our market but all markets. The level at which the product is modular, down to the skeleton of furniture is new in the market. There are therefore no direct product competitors, however the furniture companies themselves are massive, such as IKEA and Wayfair both specialising in furniture of all kinds for moderate to cheap price and equal quality.

### **ADVANTAGES OF THE PRODUCT/ MARKET OPPORTUNITY**

There is nothing similar to this in the market for this price. The main issue was that people who were more financially stricken could not afford furniture and of those they could afford there was no stylistic choice/ options for that price. This product allows for that.

### **ERGONOMIC FACTORS**

The module is made to withstand the weights of up to 3 Kg on their own. This is when they will be at their weakest, while when placed together are able to support up to a much higher weight of a maximum 500kg

### **STANDARDS**

The product must be in line with nationally and globally set safety standards to allow for the product to go out to market. These standards have all been met and a more detailed analysis can be found in the quality issues section.

### **PRODUCT LIFESPAN**

The life span of the product is largely based on what it will be used for. Those in which the hinges are likely to be locked in place may have a slightly shorter life span than those which do not. However, the product will have a life span of 7 years, around the same time new furniture is bought on average.

### **VISUAL CONSIDERATIONS**

While the product is built more for function over form at the end of the day it still is furniture. People will be more enticed to buy this providing it looks good, which is why the module itself has a slightly duller colour, with decals which are glossier to attract attention.

### **SERVICING**

The product will not need regular servicing, however it may occasionally need fixing or replacing due to general usage/ wear and tear.

### **QUALITY ISSUES**

The quality of the product means there must be visual checks taken in every batch. Due to the high number of products being produced, we will test 1 in every 5,000 and depending on this there may be more testing done for quality assurances.

### **END OF LIFE CONSIDERATIONS**

With regards to end-of-life considerations, the product is made from PP impact Copolymer, which is completely recyclable. The aim from the product is to be either recycled down to the material being used again or the product if still completely intact it is to be donated and reused again by more people.

### **COST**

The cost per part is currently at £3.15, this is for a total of 20,000 parts. The total parts will be .... So, the cost is likely to go down especially at the much higher quantity.

### **LEAD TIME**

There is no exact deadline given for this, but the aim is to be able to produce a first large batch of 20,000 with in the first 2-3 months. Once successful the runtime will be constant. This run time includes testing for regulations and production of mold.

### **LEGAL AND SAFETY**

Any problems with the product will be dealt with before release into general market and before production. Any issues or faults that come after the modules are produced will lie with the manufacturer. To try and minimize this the product will be tested 1 in every 5,000.

### **MATERIALS**

The module will be made from PP Impact Copolymer. With silicone rubber inserts and vinyl decals.

### **TESTING**

Majority of testing will be done before production both virtually simulated and then once produced physically if any issues. For other inserts and parts, they will be bought in and likely tested before sent. However, at the end of the production due to the high number of bikes produced, it is to be that 1 in every 5,000 is tested.

## **DOCUMENTATION**

The product will require a user manual which will detail a number of module configurations, including weight allowance and potential safety issues which may arise if not adhered to.



## SECTION 2 - DESIGN FOR MANUFACTURE & COMMERCIALISATION

### Market Re-assessment

The original proposed market is up for reassessment, with the original market being split into personal use and into temporary accommodation. The Overall furniture market according to Mintel is worth £17.709Bn (2020). This was due to covid, it managed to drop down from £17,852Bn in 2019. This was a drop of 0.8%. The spending did later recover in 2020, towards the end of the first wave of COVID. It was buoyed by the record number of activity in the housing market. The boom in the housing market in 2021, coincides with the rise in sales in the furniture market. This shows in the numbers with the market growing to £18.5Bn and expected to keep growing to £20.28Bn by 2026.

With COVID it caused sales to fall and put a plug in it. When shops re opened, it caused a massive surge for people to change their homes and buy more furniture, it soon levelled out after this and remains growing at a steady. According to Mintel the growth should start to stabilise from 2023 onwards.

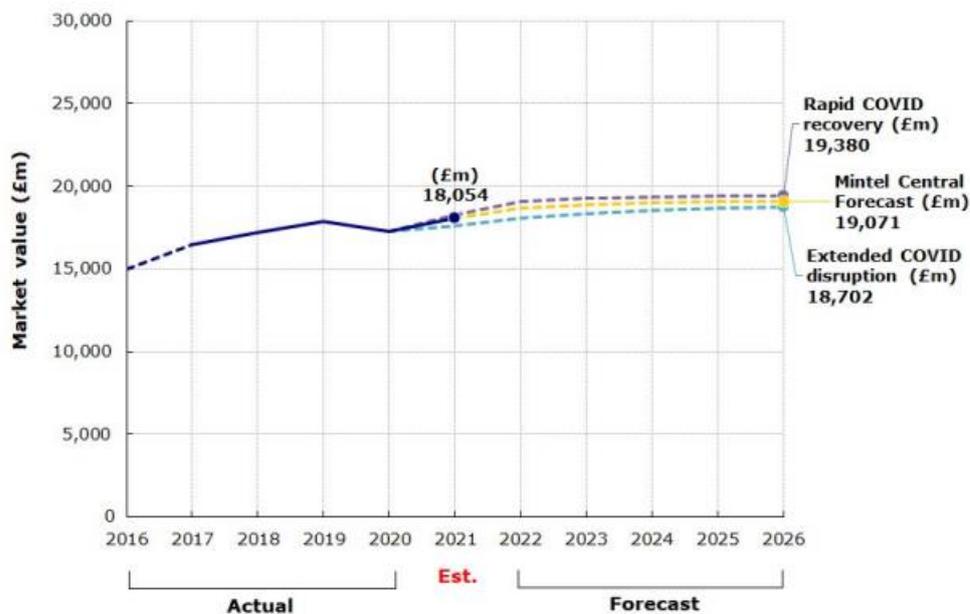


Figure 12

The Mintel report further breaks down the market segmentation. Breaking down the % of the furniture market based on rooms. With living and dining room (the main focus of the product) accounting for £8.5Bn compared to kitchen which is the next highest only accounting for £3.945Bn.

Something that should also be accounted for is the main reasons why new furniture was bought. The top 2 reasons being

20% saying “made space for home schooling in a child’s bedroom”

15% saying “Repaired a piece of furniture”

These are especially important as they can be directly related to the product. With the product it would be easily taken apart and built again which would mean that the room can be changed based on needs all while using the same set of modules that could have made up a sofa.

With regards to repairing new furniture that can be related to how we can replace a singular module at a time that may have shown its wear and tear. Which would be cheaper and easier to fix.

## Market Sectors

### *Personal Use*

#### Acorn

The main market of the product is for personal use. The users it will be designed and marketed for is for those in “difficult circumstances” as written by Acorn. The main types of people this product will be focused on as detailed by acorn are:

There are 2 key markets for this product, there is the standard end user who is defined using acorn Type 57, 58 and 59. This is for their own personal use. Equally the secondary market is larger scale buyers such as “Shelter England”, “SIRVA”, “Salvation Army” and local governments who will be buying this product on a larger scale to provide furniture to their accommodations. These accommodations could be temporary accommodations and student accommodations

#### **Type 57: Social rented flats, families, and single parents**

The large majority of people live in purpose-built flats and older tenement buildings. They are small one- or two-bedroom flats and are likely to be rented from council houses and housing associations. The population includes young people, including young parents with school age children.

Unemployment is much higher than the national average, almost twice. With a very high number of people claiming Income Support, Employment and Support Allowance or Housing Benefits. With the majority of people living completely on their state benefits. Those who do have jobs will be in relatively low-income jobs such as retail.

Some of these households will have unsecured or consolidated loans, with some of these being unable to repay those debts. With very limited funds they are likely to have spare, they may occasionally go out to the pub or night club for a drink.

In terms of technology and internet usage it is all less than the national average, with less than half having access to the internet and a less frequent use of the web than the national average.

Crime maybe an issue in this area, with other issues including the neighbourhood being nosier, with some people feeling their accommodation being in a poor state.

#### **Type 58: Singles and young families, some receiving benefits**

Much of the housing is rented from social housing providers. The majority of houses are terraced, while there are also a number of flats too. There are a high number of single people, as well as single parents with young children.

Jobs, when available are relatively low paid, being well below the national average income. Around half will not earn enough to pay tax. With the level of people claiming benefits is much higher than the national average. This is across all forms of benefits, including benefit, unemployment, disability, lone parent and housing. There is little to no money in savings, pensions or investments. There is a larger number of loans, but there may be a struggle to repay them back or manage their debts.

There is less than half who have access to mobile phones, while less than the average uses the internet. Half of these people may smoke, as well as suffer health issues such as asthma and diabetes.

### **Type 59: Deprived areas and high-rise flat**

Single young people, as well as single elderly people are likely to be found here than average. Most of these flats will be rented from the council or social housing companies, with some maybe being owned. They are typically high-rise buildings in cities or large towns.

The number of people claiming job seeker allowance, will be 3 times the national average, with similarly high numbers of people on benefits. With 1/3 of people living entirely on benefits.

Very few will have educational qualifications and will do poor paid, routine jobs. These areas will include some of the highest concentrations of those on low income. Under half of these people earning enough to pay tax. Many will have been refused credit cards and most will not have one.

There are little to no savings in these areas, with those who take out loans struggling to repay. While very few will have a pension.

Similar to type 58 they may also have health issues such as diabetes or asthma.

They will shop at cheaper stores such as Iceland and LIDL.

#### *Mosaic*

While according to Mosaic the groups we will be targeting is group K

These groups break down further into:

- **K44 Inner City Stalwarts** – Long-term renters of inner-city social flat who have witnessed many changes.
- **K46 Highrise Residents** – Renters of social flats in high rise blocks where levels of need are significant.
- **K47 Streetwise Singles** – Hard pressed singles in low-cost social flats searching for opportunities.

#### *Commercial Use*

With regards to the commercial use, this will be the secondary market. It will be used for mainly social accommodation, but instead of domestic use, it will be used for the likes of temporary accommodations, charities such as Shelter England, SIRVA, Salvation army. This is because using Modula, would provide a cheaper alternative, to the furniture currently in use. They allow more customisation to a room and instead of having rooms that all look identical, they would all have their own uniqueness, and allow who ever lives in the room to choose how it will look. They are likely to order this in a much larger scale, in the hundreds potentially even thousands.

#### *Pricing Strategy*

The price is based on the surrounding competitors, looking at 2 large furniture companies, IKEA and Wayfair. I looked at how much it would cost for certain items of furniture; these items include a coffee table. For these we have to account for the size of the product and price. Which can be found in [appendix A](#)

Due to the nature of the product being individual models, the idea is to sell them in sets of furniture types and in singles if needed. The pricing also has to take into account the cost of the product and all its surrounding costs. Ideally the cost will be 50% of the total price, allowing for if changes were needed to be made, and allowing the wiggle room without making losses to do so.

The price of an individual module would be £7.88 (broken down in cost section). However, there will be multiple options in which it could be sold. Slightly upping the price of the individual model and making it so that the modules will be sold in sets. For example, a set of 4 could be sold, including everything needed for a coffee table for a slightly cheaper price. This can be done for multiple pieces of furniture, selling so it is easier for a user to process and understand rather than the design and how the product work be a bit confusing upon initial view. It is an easier way to digest how the sets work and then further expansion can be done for returning customers, as they are likely to be more familiarised with the product, while they can also explore and experiment more with the product once comfortable.

### Production Forecast

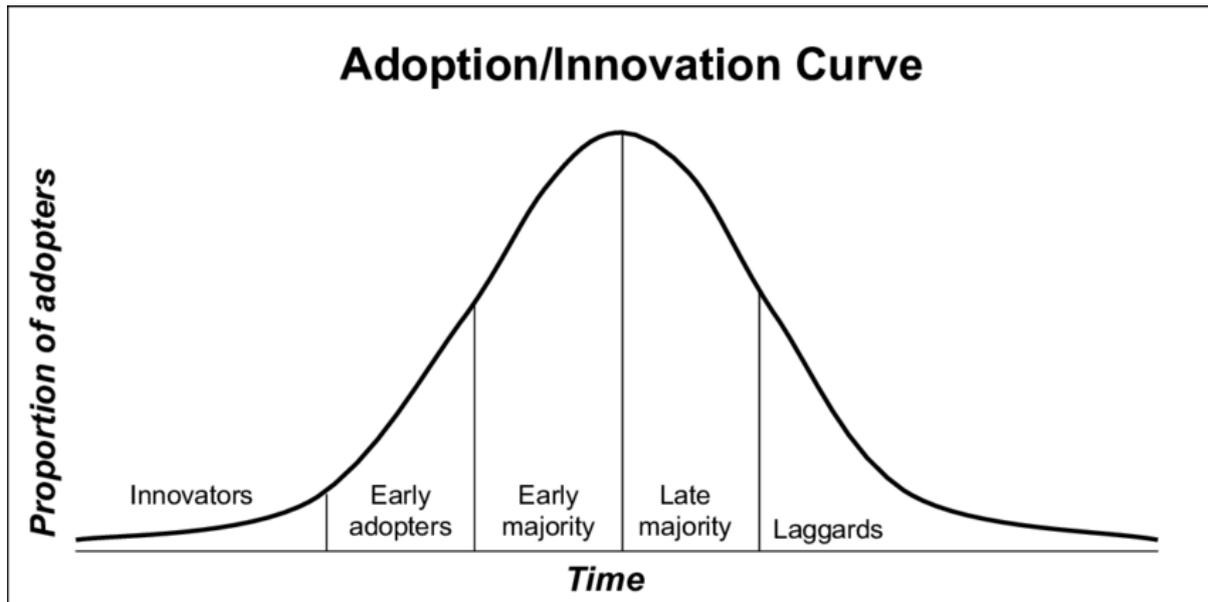


figure 13

The first-year production will be 5% of the market. The total market size is 4.4 million, which is the number of people living in social housing. The 1<sup>st</sup> year sales level is expected to be 220,000.

Due to the nature of the product, and the market we are aiming to pierce. The early adopters we are aiming for is 5% of the total market size. This market being social housing residents and based on government statistics that currently stands at 4.4 million households. This would mean that based on the adoption curve the early adopters will be those ahead of the curve and aiming to be the first of two own the module furniture.

Based on their basic needs which the product will cover, based on my calculations for how many modules it would require to furnish part of a home.

These calculations include 2 small sofas, a coffee table, a dining room table with chairs. These calculations are only for the major pieces used downstairs. The estimated number of modules is 20. This means that we would be aiming to sell 4.4 million in the first year.

### 1st Year Production Levels

The first-year production will be 5% of the market. The total market size is 4.4 million, which is the number of people living in social housing. The 1<sup>st</sup> year sales level is expected to be 220,000. This is not the number of modules sold, but instead the number of buyers we are expecting. The total

number of modules we aim to sell is 4.4 million. This is on the average that each user buys around 20. The breakdown on the figure can be seen in appendix B

## Product Expectations

### Buyers Expectations

The buyer expectations of the product are different to the user expectations. The buyer expectations are those of the commercial users, the temporary accommodation charities and companies.. The buyer is expecting the for the products to have no issues and be able to keep up with order numbers to be completed in a given time rate. The expectations could be similar to those of the users, in terms of allowing them to produce multiple different variations of furniture for their individual uses.

### Users Expectations

The users' expectations are where the products are better aimed for, they will be easily buildable, with little to no instructions needed on how to do so. The users function with it is key, how easy it is to put together and how sturdy the product is. When a user exerts force or weight on to the product how well does it hole up, it should not move at all.

## Market Position

### Key Competitors

The key competitors for this product are not as straight forward as other furniture brands, the nature of this product is different from stereotypical furniture. However, the market is the same, so the competitors will be the same. The market being valued in the UK alone at £3.263BN in 2021.



IKEA



Wayfair



Next Home



Dunelm



DFS



Furniture Village



the Range



John Lewis

### Key Product Competitors

With regards to the market, while there are key competitors in the market, in terms of company. There are no direct competitors to the product for the modularity and market were aiming for. The use of modules to build the frame of the furniture required is not something that has been ventured into. Anything remotely similar to the product, being the fact, it is a seating arrangement which is modular, such as a sofa is extortionate compared to the product. Therefore, when released to market, due to its pricing and market its being aimed at the product considered the first of its kind.

## Product Positioning

The main USP of the product is its modularity, its ability to be completely deconstructed from one combination and re-constructed to another combination, and potentially even multiple combinations depending on excess pieces left. There are products available that cover part of the issue that we solve but they mostly focus on sofas or seating. These products are the closest we have to anything like the product. If there is to be major market competition it would be those. However, they are very high-end products and will be compared on the graphs below.

In these charts we analyse 3 other furniture companies 1 product oppose to ours. These products will be based on their bestselling coffee tables.

### Cost vs Modularity

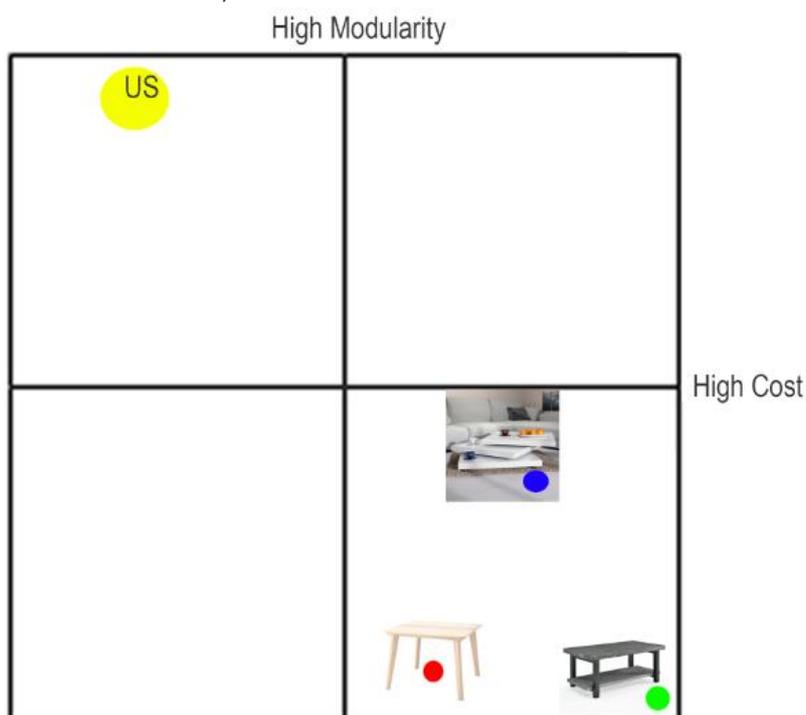


figure 14

### P.E.S.T Analysis

Due to the simplicity of the design and no technology integrated in the design the product is unlikely to be and future issues with the product with regards to P.E.S.T

	PRESENT	5 YEARS	10 YEARS
<b>POLITICAL</b>	✓	✓	✓
<b>ECONOMIC</b>	✓	✓	✓
<b>SOCIAL</b>	✓	✓	✓
<b>TECHNOLOGY</b>	✓	✓	✓

### Market Strategy

The product will be marketed as a new wave of furniture design, it allows complete modularity to a user to choose what piece of furniture they would like to build based on their need, room size and shape too. The overall product will also be cheaper than usual high street retailers and is initially aimed at those who may struggle to buy good furniture as it proves too costly. The product is aimed

to be available on the shelf at various department stores and retailers which sell different brands, such as Argos or Home bargains.

Usually, the nature of furniture means its only bought every 7 – 15 years. However, with the product, the usual wear and tear of the product means whenever pieces begin to stress or fracture under the weight they can be replaced singularly or in groups, allowing a steady stream to replace them, which would overall be cheaper than completely buying new furniture. Also, to be taken into account is that when there is a need for more furniture or additions to a room. By this I mean when a user wants to add more pieces of furniture or make the furniture bigger, they would be allowed to do so by buying more pieces of the product and assembling them again, which would therefore result in another regular income stream.

The trends in furniture may change every year, and by this standard it will mean every year new styles and colours come into trend, allowing easy changes that could be made in the pigmentation to allow it to be sold in a different colour way each year to match the trends and keep a steady income stream.

As the product will grow larger, the aim is to expand and potentially sell the product in high street retailers at a higher quality, making them more expensive and being able to sell them to more affluent users. The overall aim would be to have the product integrated within all classes of society, which would stop the more financially challenged users from being isolated by the product. By which I mean the product would not be made for those who are poorer and highlight their financial issues by the fact they own the product.

### Evaluation of design solution

The product has been designed mainly for users who live in social housing. As well as people who are likely to be financially restricted. It is likely that the rooms in their houses will be small and potentially abnormal shapes, not being perfectly shaped. The module is designed with this in mind. The shape of it and its bending legs means it can be placed into awkward angles. The modules are designed to be a lighter weight too, due to the environment they may be used in. Users are likely to take public transport and not own their own private vehicle, (according to Mintel) which would mean if it's too heavy it may put potential users off from buying due to not wanting to carry it.

## Section 3 - COMMERCIAL ARGUMENTS – DESIGN

### Design Influences & Rational

#### Module Piece

The product will be located in people's houses and is the skeleton for furniture. It will not be hidden and will be shown off to an extent. So, while the function is extremely important, the form is just as important. The original aim with the brief was to produce stylish furniture too. Allowing people their own choice in what sort of furniture they liked, in whatever colour and style they wanted too. This is why there are to be multiple colourways available to cover as many styles as possible. Due to ergonomic factors playing such a large part in furniture, in terms of height relations between different pieces of furniture such as dining table and chairs. There arise limitations with regards to size and material choices based on standards.

The design rational was heavily based on the functionality of the product, the principle of the design is based around having pieces of furniture which allow for modularity, allowing multiple different combinations of pieces to produce the skeleton for different pieces of furniture.

## Pin Piece

The module connector piece was based on the use of a push pin, it allowed multiple pieces to be attached and hung on one another. The connector pieces were designed to allow up to 6 module pieces to be “hung” on one connector piece. This would allow multiple pieces to be connected to one connector, therefore providing a hub for multiple configurations to be connected.

## Style Impacts

### Form

The form was based heavily on its function. The reason for it having 3 legs was based on its possibilities of modularity. Triangle shapes are the strongest shapes to build on. The equilateral triangle base on the inside is what the module is built on. The triangle having 3 identical sides makes it extremely stable and resilient to pressure. Compared to that of a square which under the pressure would eventually shift into the way into a rhombus. Whereas a triangle, no matter the amount of pressure it will absorb the pressure and remain rigid.

This also means the legs of the module are based on each point of the triangle, similarly, replicating the strength and stability allowed. This allows a very good amount of modularity in the 3 legs always having more to be able to combine to, making the possibilities as big as the number of modules available, while simultaneously providing a strong enough base for the furniture to hold the pressure forced on to it.

### Detailing

The small detailing on the legs and the corners of the triangle are to enhance the visual aesthetics of the module. They are there for aesthetic reasons only and are there to make part of the product stand out and have a large contrast to the more plain background.

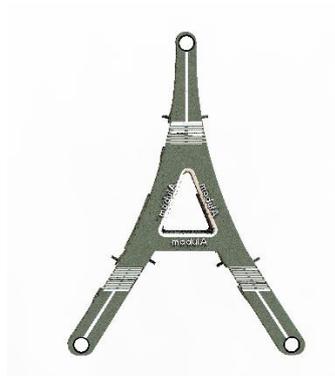


Figure 15

### Texture

The use of the texture is provided by the material, and it being recycled. This is based on the end-of-life disposal, which allows it to be used in a circular economy. This texture also helps with the products grip onto, being more rough than a simple plain material, which is beneficial to the product.



figure 16

### Branding

The branding was used on each edge of the triangle, all embossed, to provide a clear indication of the brand identity. The branding is on each side of the triangle to make it easily readable from any angle at which the module may be angled or placed.

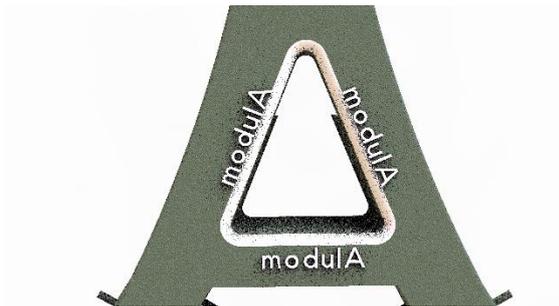


figure 17

### Material Finishes

There are a few finishes which allow the certain areas of the product to pop out. The original material finishes are a matt and slightly rough finish. While the detailing on it uses bright glossy finishes to stand out on the product and give an extra dimension to the design.



figure 18

### Colour

Due to the nature of the product, there are multiple different colours. 3 of these colours are based on WGSN trends for the next year, those colours being Jade Green, Butter, and Clay Red. With these colours, they are the base, while Jade Green and Clay Red have a gloss white detailing, the Butter uses a Clay Red detailing. Due to these also being based on yearly trends and not every user may like

this choice, so the final colour way is black, with dark grey detailing, to give a more neutral and easier colour to work with when placing into a room.



figure 19

### Tactile Elements

The finish of the module plastics gives it a slight rougher feel. This rough feel allows for easier control of the module. It provides more friction to stop it slipping as easily.

The rough material also helps with grip onto the floor of whatever the surface it is.

The same rough surface would also be good at keeping anything placed on top of the product from slipping.

### Ergonomics

The product is heavily linked to the ergonomics, this is why the products height is 465.5mm. the correlation to the user is that tables and chairs have direct correlation to humans and their height. With the key fact being that the vertical difference between the seat of the chair and bottom of the table being 25 - 30cm for optimal comfort. The products height means that at a work table it would be close to an ideal height when in place, depending on the number of modules. The same applies when working on a smaller table due to the height of the legs, the base legs being 149.8mm, while the head is 136mm. This means that the height can be adjusted to different sizes based on the needs of the furniture, and still be in direct correlation with the ergonomic comfort factors.

While the figure below shows the difference between the height relations to the coffee table and working table.

The module is built with this in mind, which is evidenced by the modules folding legs, which not only allow for more combinations but also the adjustability available in the heights based on needs ranging from the 5th to 95th percentile.

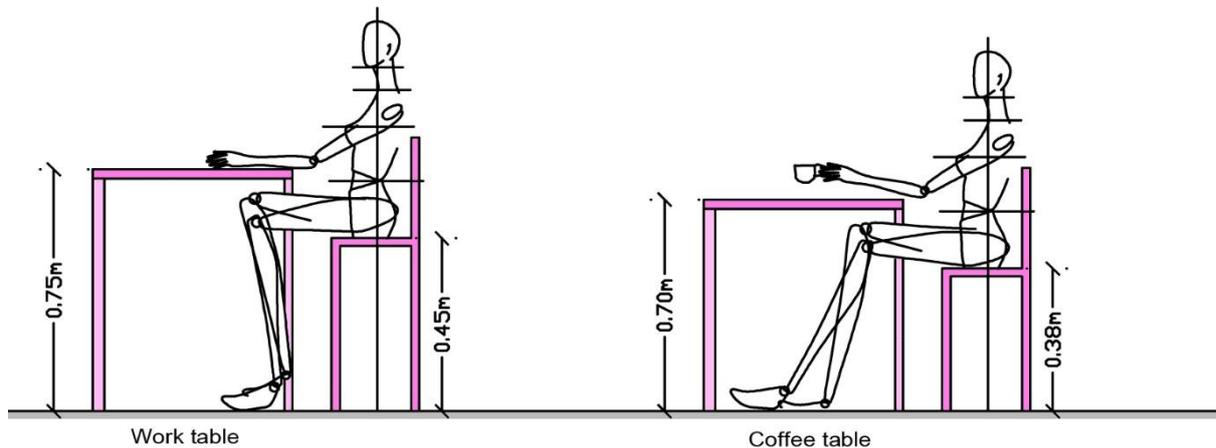


figure 20

### Relationship to Market

The user will be able to pick this product from Highstreet stores, such as B&M bargains, Home Bargains, and other cheap alternatives which sell a plethora of different products. At the same time the product could be the start of a website to be made, where the sales could also be individual, and allow constant updates to the site such as new colour schemes, based on future trends like those of WGSN, as well as new module shapes and changes to the product that may be made, to enhance the products aesthetic and provide more choice to the users.

Another possible avenue the product could take, would be through the UK government. Due to the products primary target market being those who live in social housing, because 98% of them will come completely unfurnished. The government could purchase these modules and provide them as a “starter kit” for new tenants who would struggle to pay for their own furniture. This would be a cheaper alternative for the users as the cost would be subsidised by the UK government, which would allow it also to reach further into the market and make it more well known by the larger market. This would encourage users who already own a fair amount of them to further their interest in the product, meaning they would be able to buy more of the product as well as to build more furniture or allow for them to change and build new colours for their choice of furniture. While there currently already exists schemes for the government to help pay for furniture, Modula allows for the government to save costs and make their schemes cheaper to fund.

The nature of this product means that there can be a constant growth in the product, in terms of the number of products being bought. There is always the ability with the product to buy more of them to make new pieces of furniture. Due to the nature of the product, including price and how much can be done with the product, it is likely that there will be a loyal group of customers, as for starters there is nothing similar to this on the market, and with the product the aim is to have it so that if similar copies of the product were to be bought in, that this product modules and pins would only fit those of the same brand, meaning that if people already own a large number of the modules they are unlikely to switch brands or product due to them not fitting in the module systems. As well as this, the product will be more reliable meaning that people will stick to what they know as it would be a very low cost and risk item that is reliable.

### Design Compromise

With regards to the design compromise in terms of how the modules would be put together. The modules will overlap with one another, ideally, we would like for them to not overlap and instead

touch and hold together. The way to combat this would be to change how they put together. The connection module would have to change from a pin to a holder, the pieces would have to be held by the holder and keep them in place. This can incur further changes which could be the shape of the end of the modules so that they can slot together perfectly.

The more likely and feasible option is to change how the connections work. The way in which they are held together. If the head shape was to change to a square so the heads perfectly touch and the way they would be held together would be something similar to cable ties, allowing a large number of configurations.

Another issue which may arise is the grip the product has on the floor; the plastic may slip on surfaces and not provide enough stability. Giving the base a silicon/rubber grip would provide that stability.

## Section 4 - COMMERCIAL ARGUMENTS – MANUFACTURE

### Parts Issues

There are overall 2 parts to the product, these are

- Module Piece
- Connector Pin

Within these it may be broken down further, for example within the module piece, it would be produced with the module piece being produced using injection moulding as a singular piece, while the detailing will be done using decal. The silicone inserts in the product will be bought in at a standard size to keep costs minimal.

The size of the connector pins may need to be elongated as they only allow for a maximum of 6 modules per piece, which was tested with multiple design combinations to be the maximum amount. However the user may require more, so to make the pins longer may provide a platform for more connections and improve the product.

The pins will be produced using a punch and die/ sheet forming, to produce the pin head and legs. Then it will be stick welded together, as it provides a strong connection as well as being the most cost effective way.

## Component Stress Analysis

### 1 Leg Stress Test

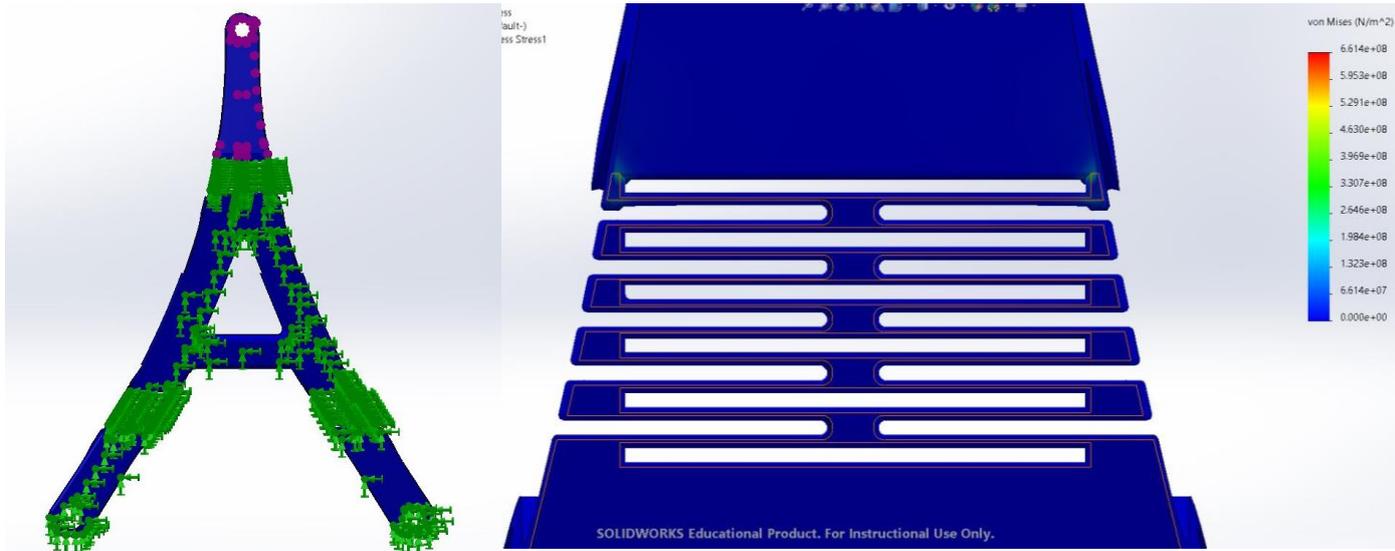


figure 21

As we can see by figure 21 using 1kg of force There is little to no stress on the overall module piece, there are slight stresses showing in the upper corner of the top living hinge. This is with the hinge as a flat piece, not being able to take into account the use of locking system. the slight stresses are also not major.

### Locked Stress Test

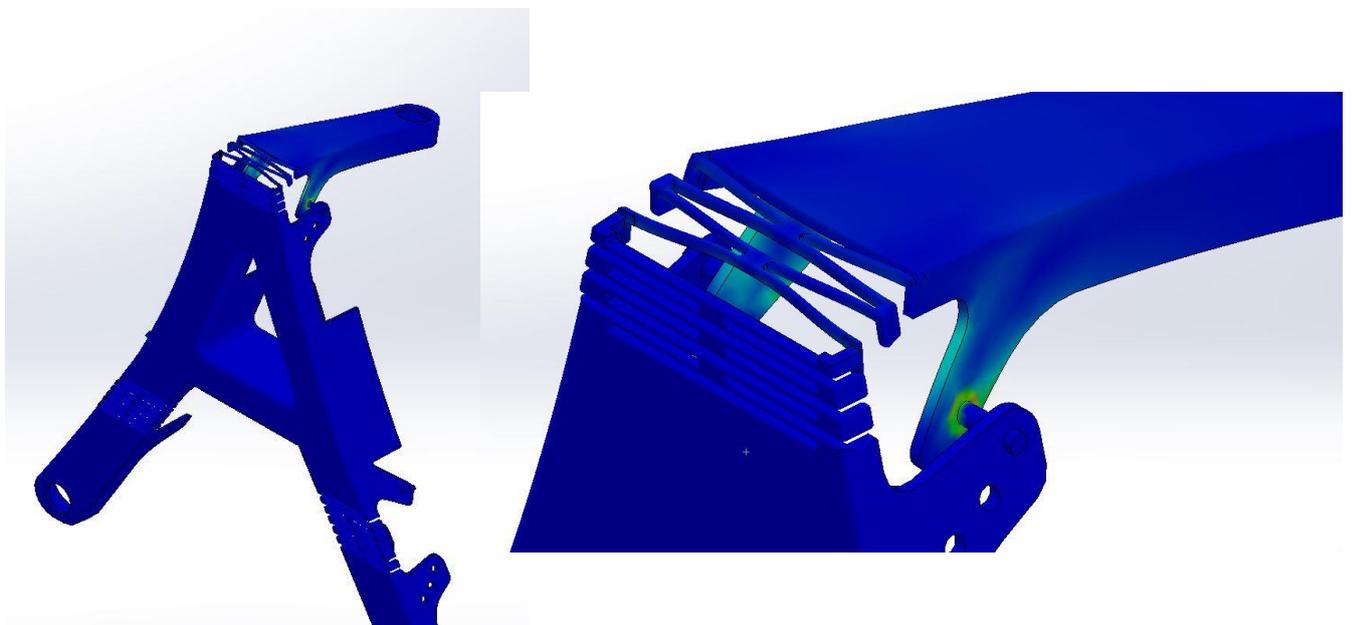


Figure 22

As shown by the figure above and previously mentioned when the hinge was locked into place there was no longer stresses in the hinges and instead the stresses were placed into the locking systems, which is where they would ideally be, meaning the hinges would not snap.

## 1 Leg Strain Test

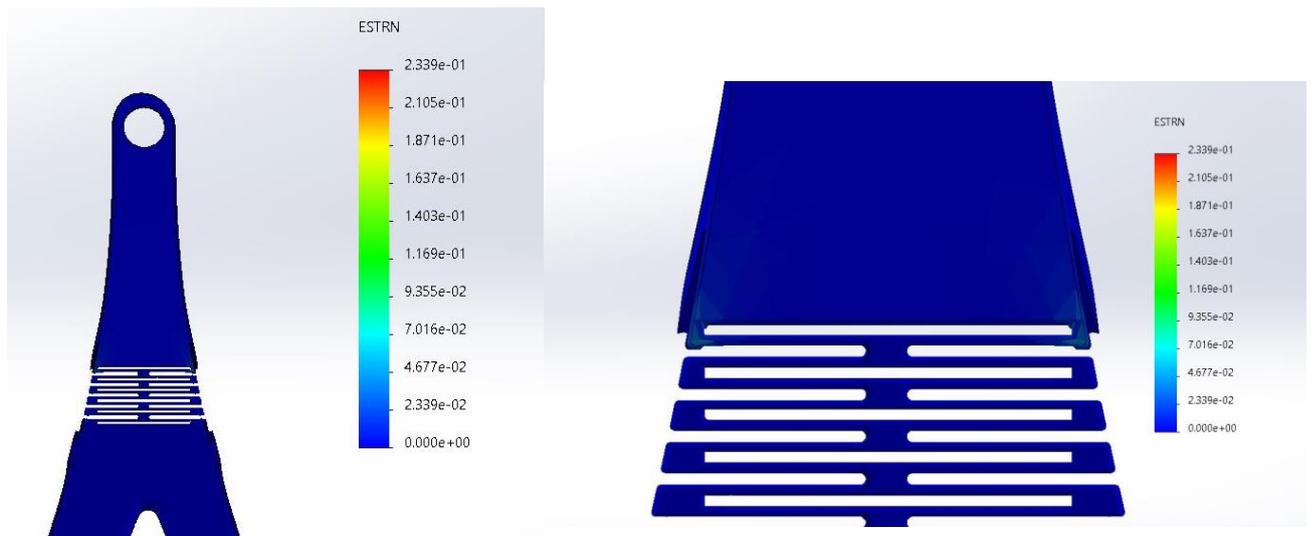


Figure 23

As we can see by figure 23 there are no little to no strain on the module, except for the in the same place as the where the stresses are in the stress tests. The stresses will change based on when the system is locked in place.

## Locked Strain Test

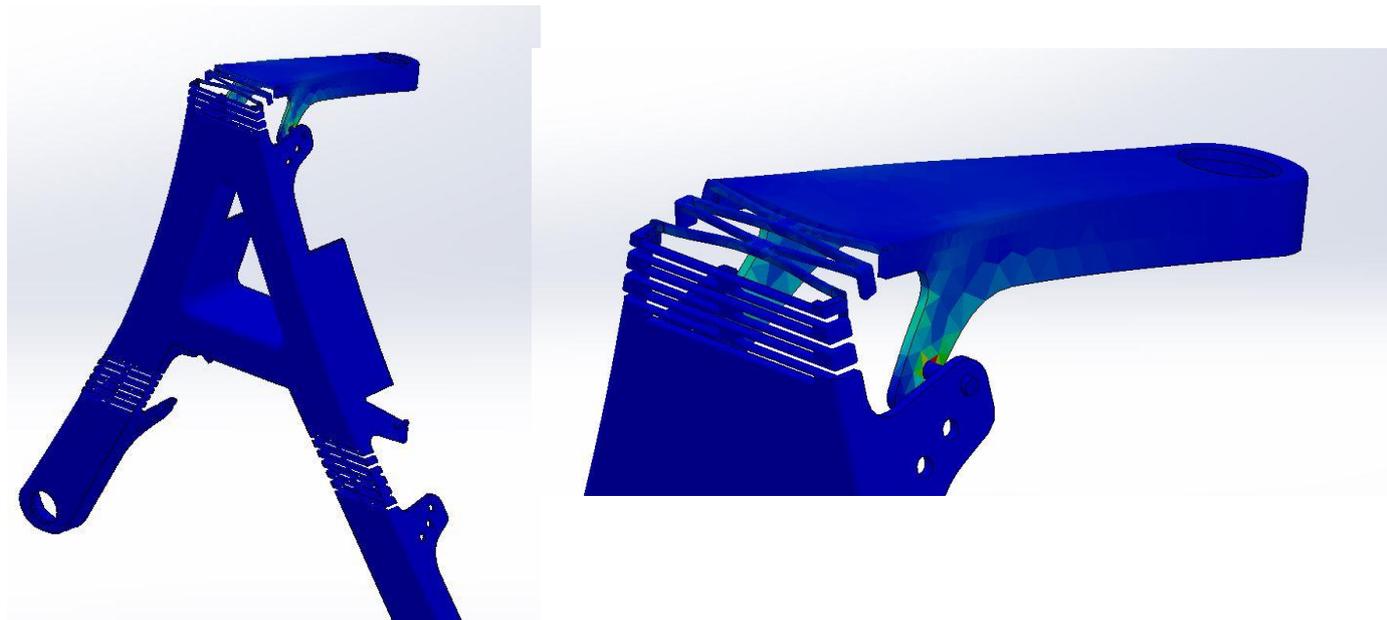


Figure 24

As we can see from the figure above, similar to the stress test, when the product is locked there is no strain on the actual living hinge itself but instead on the locking system, where it should be.

## 1 Leg Displacement Test

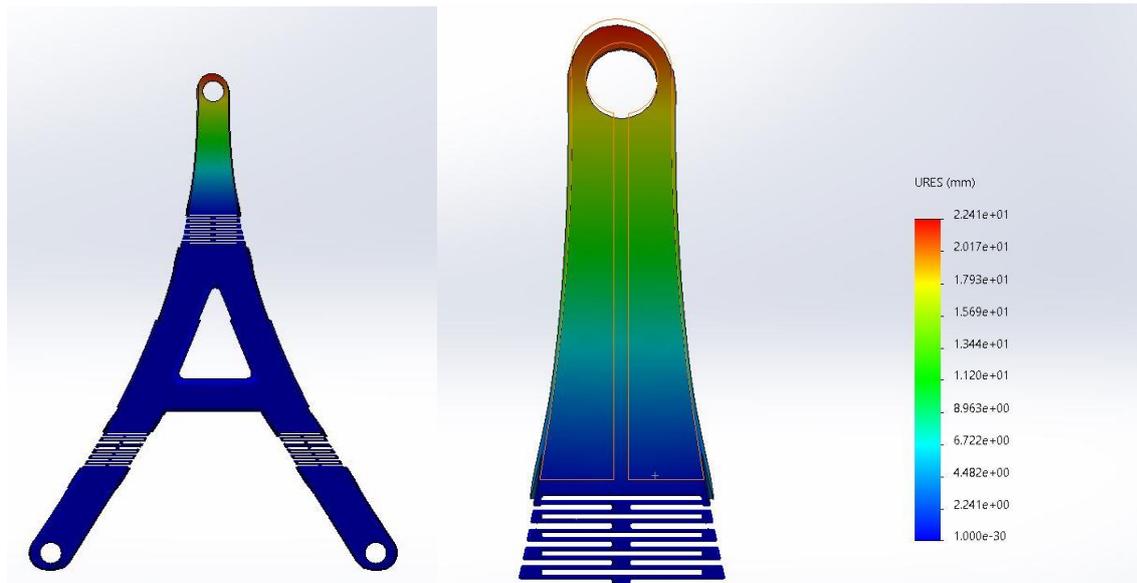


Figure 25

As shown by the figure above the displacement on the leg is heavily on the edge of tip of the leg, where most of the displacement occurs. This is a relatively larger displacement, especially compared to that when locked. The displacement when 1kg of force is applied without the use of the locking system shows a bending of 22.41mm which is larger than would be ideal, however the locking system should negate this.

## Locked Displacement Test

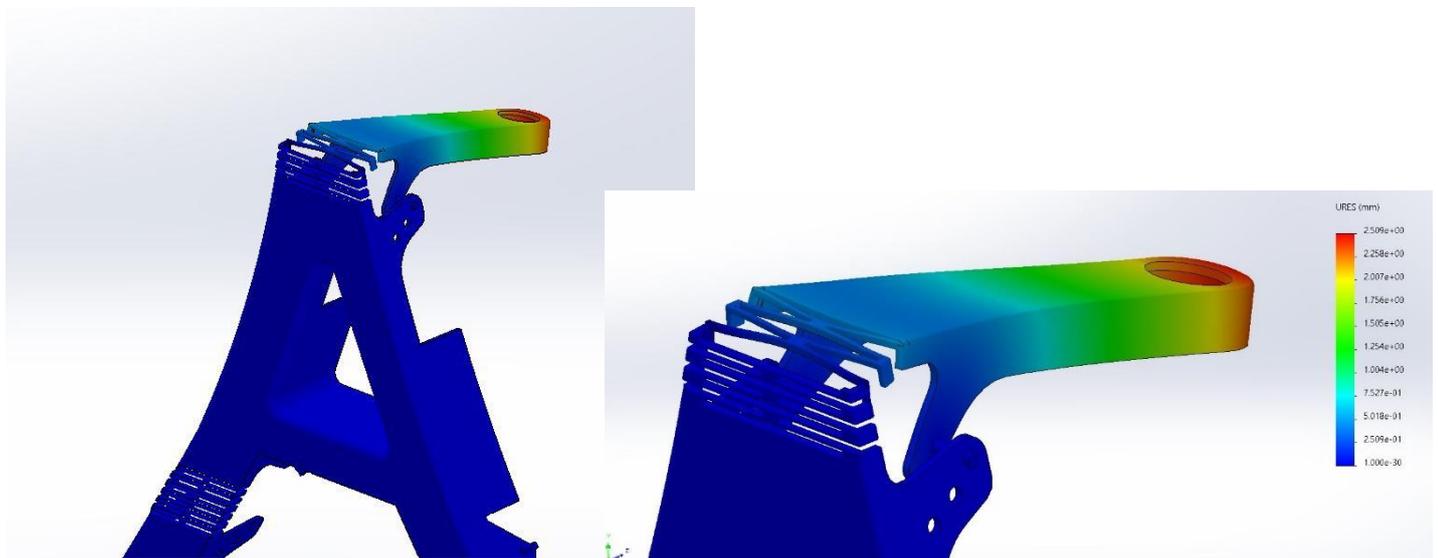
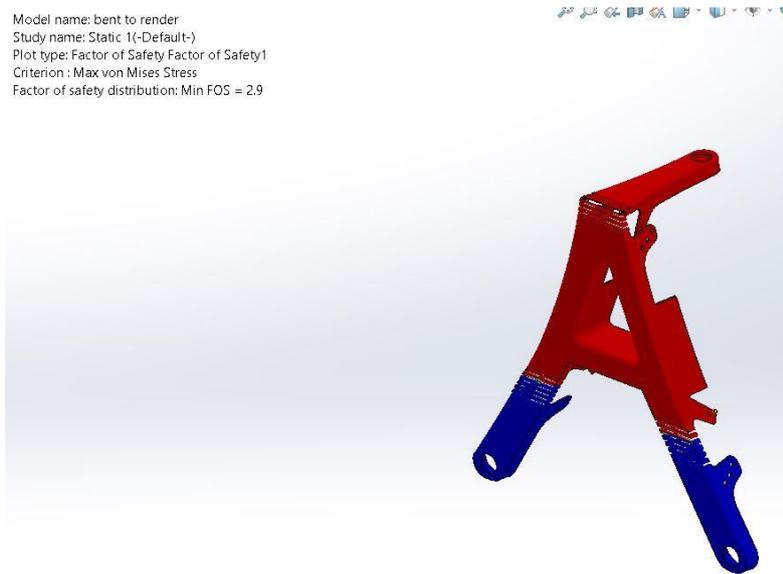


Figure 26

The figure above us shows the displacement would bend at a maximum of 2.5mm of displacement once 1kg is applied solely onto the top leg while locked in place. This is a very small and manageable displacement and will cause no issues.

## Locked Factor of Safety

Model name: bent to render  
Study name: Static 1(-Default-)  
Plot type: Factor of Safety Factor of Safety1  
Criterion : Max von Mises Stress  
Factor of safety distribution: Min FOS = 2.9



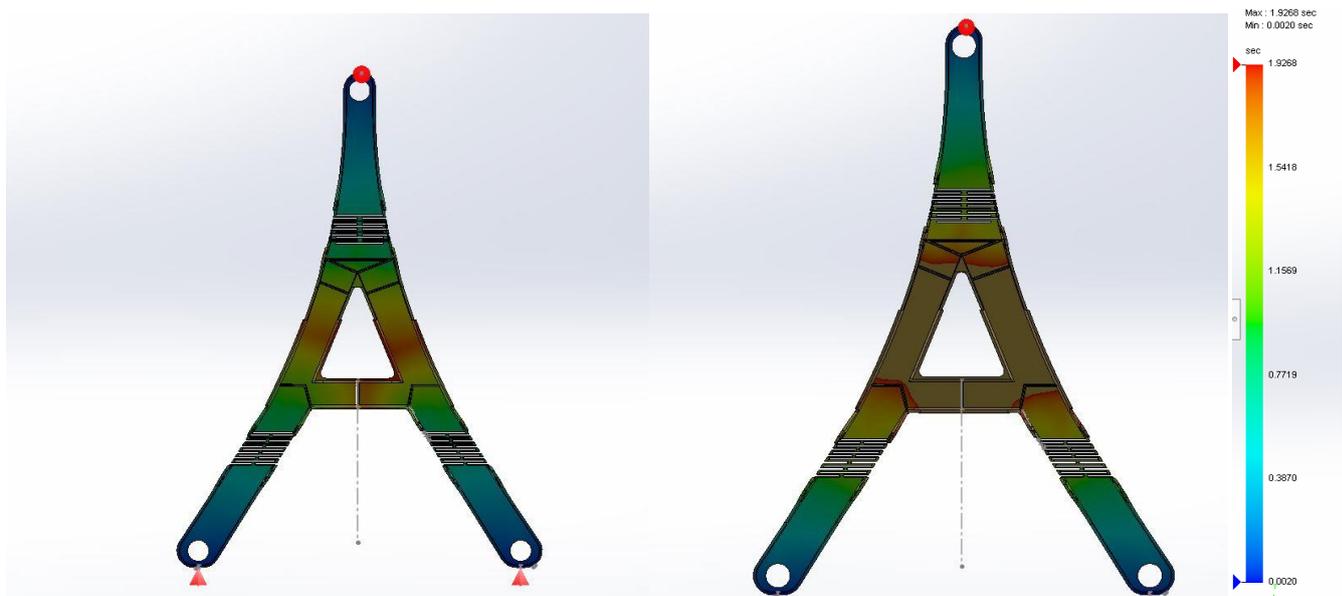
**Figure 27**

The figure above shows that we have a factor of safety of 2.9, this is based on the ultimate strength of the plastics, which on average is around 26.7 mPa. The factor of safety is ideally above 2, which would allow for at least double the weight to be supported. The FOS of 2.9 means that there can be up to 2.9x of weight allowed on the bent module piece.

## Injection Mould Simulation

Injection moulding simulations were done on the module piece to simulate how the product would manufacture, and if was to successfully manufacture. The simulation was done using 3 points of contact, one point at each leg, to allow for even distribution around the module, meeting in the centre, which would take the longest.

### Fill Time



**Figure 28**

As shown in the figure above, the fill time shows the even spread of the plastic, all of which flows into the centre of the module. The module would take a total of 1.9268 seconds to fill completely.

#### Sink Marks

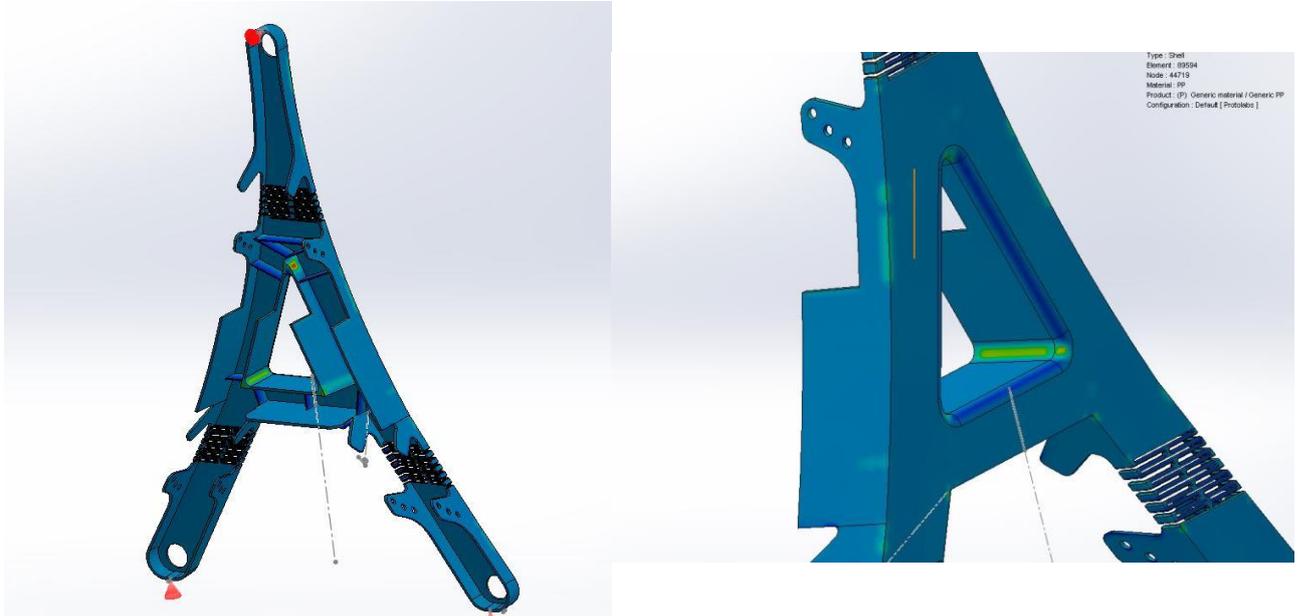


Figure 29

As shown by the figure above we can see a number of sink marks, most of if not all placing around the centre triangle. On first glance this may be concerning, especially with the red-hot spots however even at the red spots, which would indicate the most sunk part, the sinking is of a maximum of 0.0561mm.

#### Ease of fill

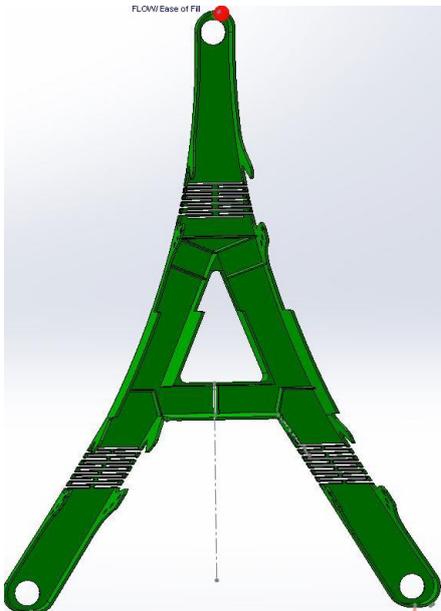


Figure 30

As shown by the figure above the complete module is green, this is a massive positive it means that there will be no problems upon initial view and the module will print completely and with ease.

#### Cooling Time

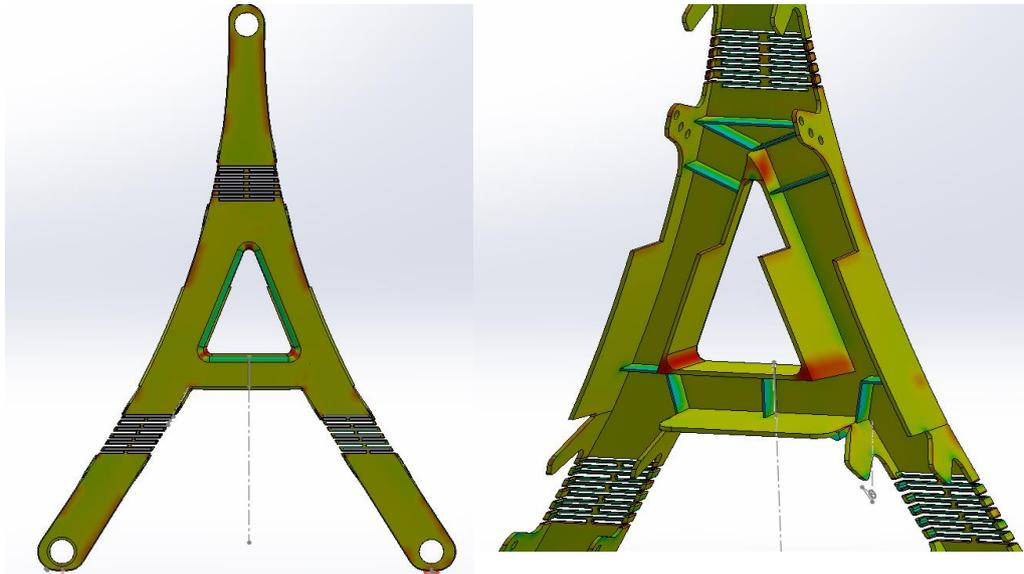


Figure 31

As shown by the figure above the cooling time is varied, the base of the module near enough completely is cooled at the same time, between 9.6 and 12.05 seconds. The ribbing cools the fastest due to it being the shortest point. While the edges of the triangle and certain curves/ edges of the module taking the longest at a maximum of 14.6 seconds. Something that will need to be taken into account during the manufacture design compromises.

More in-depth analysis on injection moulding can be found in appendix C

#### Material Selection

##### Module

This material chosen for the module is Adstif EA5075 Polypropene Impact Copolymer. This material is due to its outstanding properties, these properties include a high impact strength, while being tougher and more durable than the PP Homopolymer, it also has better stress crack resistance. See Appendix D for Material Specification Sheet

##### Pin

The material used for the pins will be Aluminium 3003 alloy. This material was chosen due to its cheaper nature while also having high tensile strength with good welding properties. There is excellent corrosion resistance to atmospheric conditions. The material is also very easy to work with and is largely considered “a very practical general-purpose aluminium for moderate strength applications” (*Kloekner metals*). See Appendix D for Material Specification Sheet

#### Material Justification

The material chosen is Polypropylene Impact Copolymer. This was chosen after testing between PP, ABS, Polyethylene, Polycarbonate, and triple corrugated cardboard. These materials were all simulated on the module through Solidworks, as well as analysed independently by me with regards to their individual traits which could be potentially suited to the product and its needs. PP was chosen due to its properties such as strong impact strength and excellent colour and processing stability.

PP is also more cost effective for its mechanical and physical properties compared to the other materials mentioned. It was the most suited not just for the product needs but also the market.

### Material – Design Compromise

Within the manufacturing, an issue which could arise is the lack of weight that can be supported by the material. The product will need to have some level of reinforcement to this. It will need to be either reinforced using a metal “skeleton” on the module or the module itself material being changed to one that it can support more weight such as steel or copper etc.

The module could be completely made from another material and coated in a plastic in to allow to keep the same look but being more reinforced. Another option would be to wire frame the module with a metal such as copper and steel.

The main issue with this this will be the cost, adding a metal such as steel or copper could increase the price of part, which would mean all costs would increase, becoming too expensive for the market itself.

With the product potentially slipping due to lack of traction on the surface, changing the design so that the vinyl’s could be potentially over moulded instead, this would combat the issue without removing or changing the design, stopping whatever is placed on top of the modules from slipping.

### Costs

The product was placed into ProtoLabs to test how much it would cost to manufacture 20,000 pieces, with the total cost accruing to £3.15 per module. This was the cost per module, then we take into account the profit and overhead costs too which would total a cost of £7.875, which would be rounded up to £7.88

The cost of £7.88 is broken down as follows:

40% for manufacturing = £3.15

40% for overheads = £3.15

20% for profit = £1.575

The need for the module should remain at a constant output due to its nature, while more traditional furniture is expected to last years and the production level may not be as high the need for this module may be at a more constant rate due to its price and the usability of it, allowing it to be used for multiple different pieces of furniture when needed.

The initial manufacturing part number will be a lot higher in the first year to try and stay within demand of the first year. With the nature of the product, it is certain there will be a high number of modules needed even for a small % of the total market. Working on averages, each household would have around 20 modules.

What also needs to be taken into account is the number of pins, which based on the average number of modules would also mean that, there would be a need for 25 pins.

With this cost, it was done on a quantity of 20,000 this is the maximum that could be done using ProtoLabs. The number we are aiming for would be a much higher quantity than that 4,400,00 therefore once started up it may be cheaper to take it overseas or somewhere else which would be able to deal with the higher quantity needed. The higher number of modules needed would therefore mean that it is likely that the overall cost would drop from £3.15.

Using On demand manufacturing a total cost of £88,690 for 20,000. The initial mould will cost a higher amount than the use of prototyping, standing at £25,690. While it will cost £3.15 per module piece equating to £63,000.

In addition to the initial \*total cost of £88,960 there is also a £500 set up cost per production run.

See appendix E for full ProtoLabs pricing

### Overheads

The overhead costs are crucial in terms of pricing cost, they will make up 40% of the cost of the product. These overhead costs may include:

- Packaging
- Transport
- Labour
- Salary
- Set-up
- Utility
- Legal
- Protection
- Regulation
- Testing

The costs will also have to take into account future issues that may occur pop up, if the profit is not enough and the product then has an issue, it could be detrimental to the company as it could result in the cost of the product being more than can be afforded. It also must be taken into account the current economic climate, with regards to potential increases on goods and taxes making the product more expensive to offset those.

These costs will ideally be the same as that of the manufacture meaning it would equate to a total of £3.15 too per module.

### Manufacture Specification

Name	Module
<b>Component Image</b>	
<b>Dimensions</b>	465.5mm x 337.58mm x 40mm
<b>Manufacturing Process</b>	Injection Moulding
<b>Material</b>	PP Impact Copolymer
<b>Cost Per Unit</b>	£3.15
<b>Parts Required per Part</b>	1
<b>Quality Inspection</b>	Visual Inspection
<b>Quality Check Failures</b>	Sink marks, warps, snapping, bubbles, flash, burn marks

Figure 32

<b>Name</b>	Rubber Inserts
<b>Component Image</b>	
<b>Dimensions</b>	20mm Diameter
<b>Manufacturing Process</b>	Bought in
<b>Material</b>	Silicone Rubber
<b>Cost Per Unit</b>	£0.06
<b>Parts Required per Part</b>	0
<b>Quality Inspection</b>	1
<b>Quality Check Failures</b>	No rips or visual issues when put in.

Figure 33

### Manufacture – Design Compromise

With the manufacturing of the product, we have seen the cooling time taking longer in certain places, which would potentially result in warpages and sink holes. To combat this there would be minor changes made to the design.

The inner triangle edges would be filleted to give less plastic on the inside, which would allow it to cool faster and stop the warping or sink holes.

The outer edges of the module also showed a slightly longer cooling time, as well as the possibilities of sink holes too, the way to combat this would be to soften the edges and fillet them slightly, allowing for smoother and flowing plastic, not having to fill creases which would cause larger build ups of plastic/ thicker concentration areas of plastics compared to other parts of the module.

The product has 2mm diameter holes on each edge to allow the pieces to connect and to stop the surfaces from scratching there will be rubber inserts placed inside to soften that. These pieces will be bought in at standard sizing to keep pricing low.

The module material itself can be bought at exactly 40mm thick, which means that it can remain its exact size/ thickness at 40mm maximum without the need to shave any edges off which will save costs and keep them to a minimal.

### Manufacture Processes

The finish on the main module piece itself will be dull especially compared to the decal on it. The finish on the module will be SPC-C1. While the decal will use Calendered Vinyl. The pin itself will be natural anodised. All of these have been previously stated in the manufacturing spec

The main module piece will be produced using injection moulding. This will allow the module to be moulded in one singular piece. This will be done at a large scale, which also means that a module needs to be randomly tested at a rate of 1 in every 5000. the module edges are rounded and soft and must be checked to make sure they are produced like this.

The model will be made continuously, however due to the nature of the product the die that will be coloured in the polymer will change to be able to manufacture equal numbers of module in the 4 colour ways.

Once they have been moulded, they will next be polished to give it the necessary finish.

The module will then be passed through a digital printer, which will allow the product to have the finishing decals on it.

The final piece will be to insert the rubber inserts in the holes for protection.

With the module being a large size and the intricate details not being of the utmost importance the tolerance of the product needs to be +/- 1mm. This allows for the product still work to a very high standard and will not be a cause of issues. The tolerance does need to be the same throughout as too much one way or the other could cause issues at a later date with regards to how perfect they may sit together.

The pins will be produced using a punch and die/ sheet forming, to produce the pin head and legs. Then it will be stick welded together, as it provides a strong connection as well as being the most cost effective way.

Once the pins have been fixed together they will then be naturally anodized giving it a more rough surface and a finishing coat which won't wear like paint.

## Material Weight

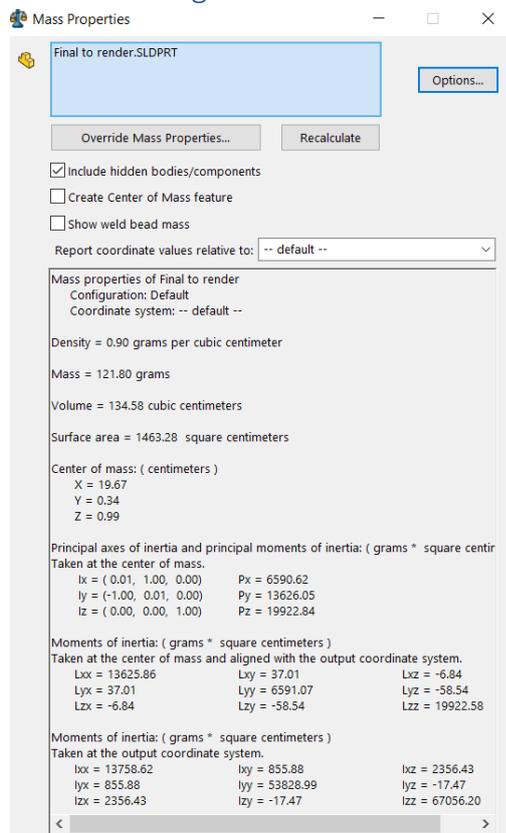


figure 34

As we can see the low density of the plastic shows that the plastic modules end up only being 121.8g. The density of the PP is 0.905 g/cm<sup>3</sup>.

The mechanical properties of module are shown in appendix F

## Assembly Elements

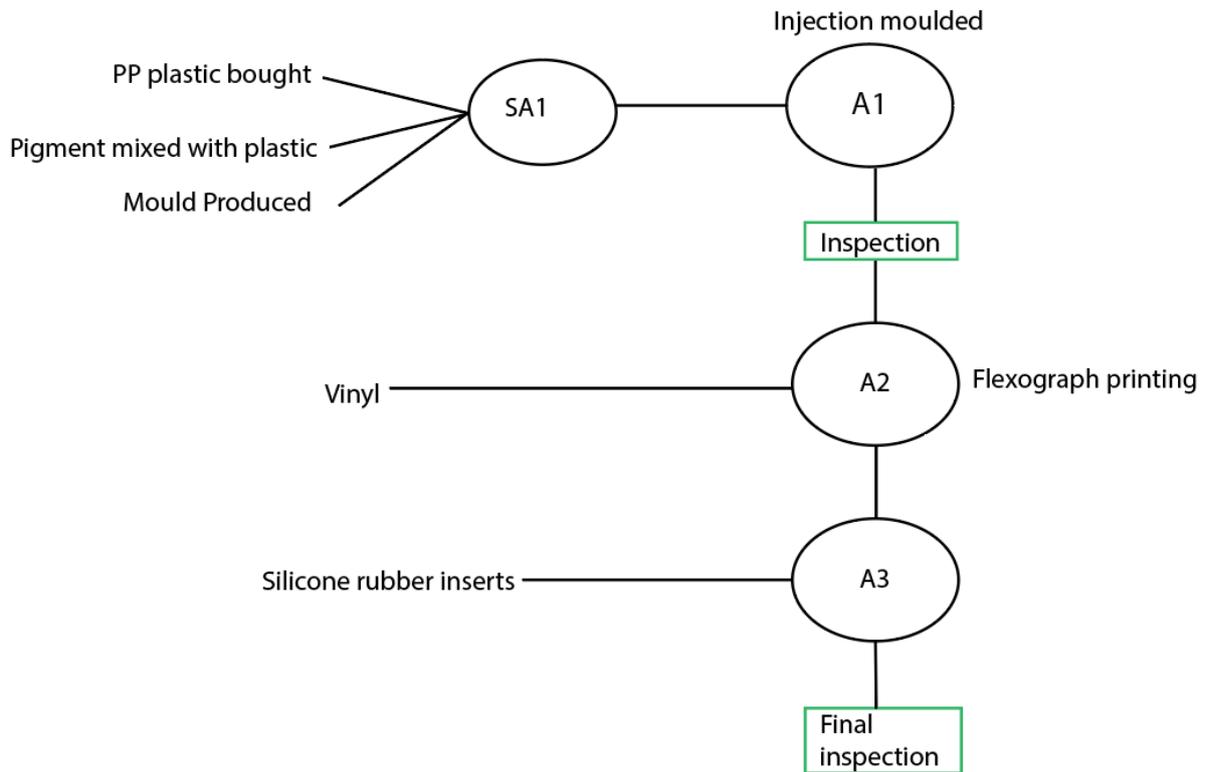


figure 35

## Tooling

Using ProtoLabs the module cost for tooling would be a lot higher, using on demand manufacturing, which we have chosen due to overall price reduction with 20,000 parts.

The initial tooling cost for this mould would therefore be £25,690.

The other pieces of the module will not require tooling cost.

With the tooling process there may be a need for a fixture in the product, where the gaps in the product to be, those include the fastening holes, as well as in between the hinges which allow the hinge to flex. This is only if the mould for the product means that the molten plastic could potentially leak into the holes and cause quality issues.

## Parts Tree

CFMN = Clarification from manufacture needed

Part Number	Part Name	Material	Finish	Tooling Cost (£)	Unit Cost (£)
1	Single module piece	Polypropylene Impact Copolymer	SPI-C1	25,690	3.15
2	Decal of module	Calendered Vinyl	Glossy	CFMN	CFMN
3	Connector hole protector	Recycled Silicone rubber (Silicrub)	Natural	none	0.06

4	Pin	Aluminium 3003	Natural Anodising	CFMN	CFMN
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Figure 36

#### Parts List

Part Number	Part Name	Material	Finish
1	Single module piece	Polypropylene Impact Copolymer	SPI-C1
2	Decal of module	Calendered Vinyl	Glossy
3	Pin Holes	Silicone	Natural
4	Pin	Aluminium 3003	Natural Anodising
5	Pin	Aluminium 3000	Natural anodising

Figure 37

#### Product Detailing

The product needs certain markings and detailing to comply with product needs, these markings include:

- PP recyclable marking
- BSI Kitemark
- Ecolabel EU
- CE marking

These detailing will be printed on the inside of the product, on the inner side of the ribbing.

#### Quality Issues

Throughout the manufacturing and design process there are legal issues we need to take into account. These standards include British, European, and international standards for which all must be accounted. As well as this, there are also standards which may differ between domestic and non-domestic. As well as this, there are also standards which may differ between domestic and non-domestic. domestic. domestic. This is important, due to the aims of the secondary market use, and it not being in domestic settings.

#### **British Standards**

**BS EN 1022 Furniture** - Seating - Determination of stability

**BS EN 1729-2 Furniture** - Chairs and tables for educational institutions

**BS EN 13721 Furniture** - Assessment of the surface reflectance

**BS EN 16611 Furniture** - Assessment of the surface resistance to micro scratching

**BS ISO 7173 Furniture** -- Chairs and stools -- Determination of strength and durability

**BS EN 14434** Writing boards for educational institutions - Ergonomic, technical and safety requirements and their test methods

**BS ISO 19682 Furniture** - Tables - Test methods for the determination of stability, strength and durability

**BS ISO 19682 Furniture** -- Tables -- Test methods for the determination of stability, strength and durability

**PD CEN/TR 17202:2018** Furniture. General safety guidelines. Entrapment of fingers

**BS EN 15372:2016** Furniture. Strength, durability, and safety. Requirements for non-domestic tables

**BS EN 12521:2015** Furniture. Strength, durability, and safety. Requirements for domestic tables

**BS EN 12520:2015** Furniture. Strength, durability, and safety. Requirements for domestic seating

**BS EN 16014:2011** Hardware for furniture. Strength and durability of locking mechanisms

**BS EN 15828:2010** Hardware for furniture. Strength and durability of hinges and their components. Stays and hinges pivoting on a horizontal axis

**PD CEN/TR 16015:2010** Hardware for furniture. Terms for locking mechanisms

### **European standards**

**EN 1021-1:** Ignition source smouldering cigarette

**EN 1021-2:** Ignition source match flame equivalent

**EN 12521:2015** – Furniture. Strength, durability, and safety. Requirements for domestic tables

**EN 15372:2008** – Furniture. Strength, durability, and safety. Requirements for non-domestic tables

**EN 14072:2003** – Glass in furniture. Test methods

Standards are different for children’s furniture – need to define what the product is to be used for – if it is not to be used for cribs and bunk beds etc.

### **General Product Safety Directive (GPSD)**

REACH is a set of limits to harmful substances in all consumer products sold in the EU.

Some of the restricted substances include.

### **Substance of Very High Concern (SVHC)**

The European Chemicals Agency (ECHA) provides a list of SVHC for authorization.

Furniture paints and coatings may contain excessive amounts of restricted chemicals and heavy metals. – if the paints or coating are not compliant with the REACH.

When dealing with the suppliers, they must work within the standards of reach before placing a large order. Which most suppliers can’t do, and we therefore require 3rd party testing before placing any orders with suppliers.

The substances which must not be used can be found in [Appendix.....](#)

### **ISO Furniture Standards**

**ISO 4211-4:1988** - Furniture — Tests for surfaces — Part 4: Assessment of resistance to impact

**ISO 4211-5:2021** - Furniture — Tests for surface finishes — Part 5: Assessment of resistance to abrasion

**ISO/DIS 4769** - Hardware for furniture — Strength and durability of hinges and their components — Hinges pivoting on a vertical axis

**ISO 7170:2021** - Furniture — Storage units — Test methods for the determination of strength, durability and stability

**ISO 7172:1988** - Furniture — Tables — Determination of stability

**ISO 7173:1989** - Furniture — Chairs and stools — Determination of strength and durability

**ISO/CD 7173** - Furniture — Chairs and stools — Determination of strength and durability

**ISO 7174-1:1988** - Furniture — Chairs — Determination of stability — Part 1: Upright chairs and stools

**ISO/DIS 19682** - Furniture — Tables — Test methods for the determination of stability, strength and durability

**ISO 19833:2018** - Furniture — Beds — Test methods for the determination of stability, strength and durability

**ISO 21016:2007** - Office furniture — Tables and desks — Test methods for the determination of stability, strength, and durability

**BSI Kitemark** – there is a domestic kitemark certification for furniture, based on 3 core standards, but it largely depends on the further range that is being tested, for example beds and mattresses are tested differently to sofas and recliners to reflect their different uses.

The 3 main parts of the BSI kitemark are

1. **Factory process control**
2. **Technical review**
3. **Sample product test**

### Quality and Reliability Issues

- No sink marks
- Hinge must be fully operational
- Must have no sharp edges
- Hinge must not snap once locked
- Locking system must hold hinge in place
- Hinge must bend to angles of 90, 60 and 45 degrees and lock into place there.
- No cracks or stresses in the plastic when under pressure.
- Colour must not wear on the product.

### Operational and Performance aspects

- Module must connect to other modules
- Module must be suitable for any room in house
- Must be waterproof – for drinks or in bathroom
- Easily cleanable
- Must not have loose parts which are a choking hazard
- 1 module must support at least 1kg

- Module combinations must support minimum weights or mention weight supported per combination. Minimum weights that should be supported are up to 500kg, when assembled properly.

## Testing & Failures

First test done must be visual, to inspect if any flaws have come from the injection moulding. This can include sink marks, burn marks and flashes.

Due to the nature of the product and its need to support weight, this was kept in mind with when designing. It was designed with thicker walls, ribbing, fillets, and hinge locking systems.

The locking systems are used to reduce pressure on the hinge itself and allow for the weight to be not cause stresses in the hinge, which could result in the hinge snapping.

The pins are created using aluminium alloy which allow for the product to be formed, whilst also keeping structurally strong and secure.

The internal ribbing is used to provide strength on the inner product, in places where it would potentially fail.

All testing and failures are in line with the British standards and quality testing with regards to the function.

Testing must be done to check the hinge bends as well as locks.

These tests have been done on Solidworks simulation, however, must be done with the real modules too to ensure.

Testing much also check can also be supported and the pieces connect together with ease and modules when connected can support the weight needed.

These tests were also carried out using an FMEA, which can be found in appendix H

## Section 5 – Disposal

### End of Life Considerations

The end-of-life considerations for this product are relatively simple. The module being 1 piece makes it easily for disassembly. The impact PP is a recyclable thermoplastic polymer meaning it can be broken down and reused, keeping in line with a circular economy.

This also is the same case for the aluminium pins being recyclable and able to use again.

If the product is not to be recycled it can also be reused. The nature of the product means that like stereotypical furniture it can be donated and reused as there will also be needed. While also in the case of breakage in things such as the hinge or the locking system/ general wear and tear, it may be able to be fixed or if cheaper it could be easier to have a system where a broken one is donated for a % discount of a new module. The old module either being repaired or melted down and run back through to be used again.

### Packaging Aspects

The packaging of the product will change based on what is needed. While the packaging for the module sets will be cardboard with labelling on it to indicate the number of modules, colour, and a side with potentials to build the with that set. It will also include a set number of pins for the products. The modules itself will be “cased” in cardboard packaging bent to the inner and outer

parts of the module, this will be done on only the hinges itself as they are to be the weakest points of the product. The modules inside the box would be held together using moulded pulp, which can also be recycled, to hold multiple pieces in the box safely. The individual modules will be packaged when sent and distributed, however will be stocked on to shelves individually when sold.

All the packaging will be in in line with RAP regulations.

## User Manuals

With regard to the user manuals even though it may seem easy to use the product, the manuals will indicate a set number of configurations produced by which I mean there will be a guide on how to build items in different styles/ furniture pieces. The manual will show how many different items can be built based on a number of modules. The manual will show as many module configurations per number of modules up until .... Modules. This would allow the product to be shown in a variety of different natures and possible outcomes. They will be provided and tested guidelines to build, however the product is there to allow for the user to have freedom with the product and design how they would like and choose. There will be mentions in the manual of how to always have the most structurally sound furniture to help with building of the product.

The manual will also state the safety regulations and issues that could occur such as trapped hands or other safety issues which may occur.

## Conclusion

This report has validated and explored the Modula and its possibility of market, accompanied by its possible limitations. The product is well produced with regards to what it solves and how the product could work. It solves many issues but has its own few issues. The design of it means it can be taken into market, however personally I believe the product could be improved to make “perfect” or as close to perfect as possible. There is an obvious gap in the market for a product such as this and if the product was to go into market it could be a potential success. Overall, the product has the ability to be put into market.

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## Appendix

### Appendix A

Cost analysis of coffee tables

IKEA (£)	Wayfair (£)
 <p>80</p>	 <p>£38</p>
 <p>129</p>	 <p>64</p>
 <p>40</p>	 <p>78</p>
 <p>50</p>	 <p>38</p>

 <p>29</p>	
 <p>19</p>	
 <p>35</p>	

## Appendix B

### Estimate Module Requirements

To work out a more in detailed and closer number to how many modules and pins may be needed, I decided to work out a rough estimate of furniture pieces, these pieces include any tables and stands. The use of seating is also included in the table however is not necessarily included in the average due to the current issues with the design which would need modifications to allow for the higher weight needed on them.

This estimate is on a 3-bedroom home, as the average for the UK is 2.95 bedrooms at 13.4 square meters.

Furniture	Module	Pins
Coffee Table	4	4
Dining Table	12	13
Bedside Table	6	8
<b>Total</b>	<b>20</b>	<b>25</b>

## APPENDIX C

### Injection Mould Analysis

The analysis has completed with a Clamp Force warning in the {X|Y|Z} direction. Please review your design and determine if this is the actual clamp force direction.

"Note: You can specify the clamp force direction in the Clamp Force PropertyManager."

This part can be successfully filled with an injection pressure of 60.4 MPa (8760.84 psi).

The injection pressure required to fill is less than 66% of the maximum injection pressure limit specified for this analysis, which means you are well under your specified limit.

You may be able to reduce the part thickness and decrease cooling time but be sure to run an additional analysis after changing the thickness to ensure your part will still fill within the specified injection pressure limit.

Since the Maximum Temperature at End of Fill has remained within 10 deg C of the starting melt temperature, there is little to no risk of plastics material degradation.

The predicted cooling time is determined when 90% of the part temperature is less than the material ejection temperature.

## Appendix D

General properties	Test method	Value	Unit
ISO code:	ISO 1183		
Density:	ISO 1183-1	0,91	g/cm3
Water absorption in Air (23°C / 50% RH)	ISO 62	<0,1	%
Water absorption in Air (23°C / 100% RH)	ISO 62	<0,1	%
Resistance to hot water	n/a	+	
Weather resistance	n/a	-	
<b>Mechanical properties</b>			
Elongation at break:	ISO 527	>50	%
Ball indentation hardness	ISO 2039	50	MPa
Tensile modulus of elasticity	ISO 527	1100	MPa
Charpy impact strength - notched	ISO 179	40	kJ/m2
Charpy impact strength - unnotched	ISO 179	No Break	kJ/m2
Compressive stress at 1%	n/a	7	MPa
Coefficient of friction	ASTM D 1894	0,3-0,4	
<b>Thermal properties</b>			
Melting temperature	n/a	162	°C
Max. allowable service temp (short period)	n/a	150	°C
Max. allowable service temp (long period)	n/a	100	°C
Min. service temperature	n/a	-20	°C
Coefficient of linear expansion	n/a	120	x10 <sup>-6</sup> m/(m*K)
Flammability	UL94	HB	
<b>Electrical properties</b>			
Dielectric dissipation (at 1MHz)	ISO 60250	n/a	Ω
Electric strength	ISO 60243	45	kV/mm
Volume resistivity	ISO 60093	>10 <sup>14</sup>	Ω.cm

PP Impact Copolymer material specification sheet

## Aluminium Alloy 3003 'O' Sheet



### SPECIFICATIONS

Commercial	3003
EN	3003

Aluminium alloy 3003 is a medium strength alloy with very good resistance to atmospheric corrosion and very good weldability as well as good cold formability. It has better mechanical properties, especially at elevated temperatures than the 1000 series alloys.

Applications - Alloy 3003 is typically used for:

Building industry: roofing and sidings, acoustic ceilings, corrugated sheets

Chemical and food industries: storage tanks, pipes, metal work

Equipment for heating and cooling: heat exchangers, air condition evaporators, motor vehicle radiators, freezer linings

Home appliances: cooking utensils, bakery moulds

Office equipment

Tube & Pipe

Packaging: containers, closures. Cladding alloy.

### CHEMICAL COMPOSITION

BS EN 573-3:2009 Alloy 3003	
Element	% Present
Magnesium (Mg)	1.00 - 1.50
Hydrogen (H)	0.0 - 0.70
Silicon + Iron (Si+Fe)	0.0 - 0.60
Cobalt (Co)	0.05 - 0.20
Others (Total)	0.0 - 0.15
Zirconium (Zr)	0.0 - 0.10
Other (Each)	0.0 - 0.05
Aluminium (Al)	Balance

### ALLOY DESIGNATIONS

Aluminium alloy 3003 also corresponds to the following standard designations and specifications:

### SUPPLIED FORMS

Alloy 3003-0 is normally supplied as soft sheet

- Sheet

### GENERIC PHYSICAL PROPERTIES

Property	Value
Density	2.73 g/cm <sup>3</sup>
Melting Point	655 °C
Thermal Expansion	23.1 x10 <sup>-6</sup> /K
Modulus of Elasticity	69.5 GPa
Thermal Conductivity	190 W/m.K
Electrical Resistivity	0.034 x10 <sup>-6</sup> Ω .m

### MECHANICAL PROPERTIES

BS EN 485-2:2008 Sheet 0.2mm to 6.00mm	
Property	Value
Proof Stress	35 Min MPa
Tensile Strength	95 - 135 MPa
Hardness Brinell	28 HB

The properties above are for material in the soft 'O' condition

### WELDABILITY

Alloy 3003 has very good weldability

### FABRICATION

Workability – Cold: Very Good  
Machinability: Acceptable  
Weldability – Gas: Very Good  
Weldability – Arc: Very Good  
Weldability – Resistance: Good  
Brazability: Very Good  
Solderability: Very Good

specification sheet

Aluminium 3003

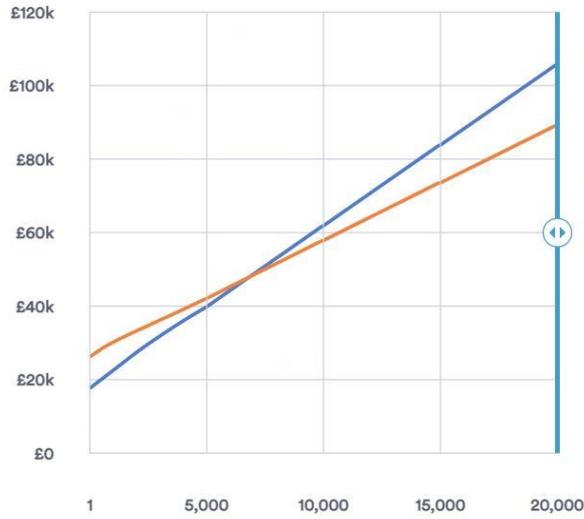
# Protolabs.SLDPRT



Total Price

Part Price

Service Level



Prototype	
Chart Colour	<span style="color: blue;">■</span>
Mould Life	Limited
Cavities	1 ▾
Quantity	20,000
Mould	£17,130.00
Part Price	£4.40
Total Price	£105,130.00
Preferred Option	<span style="background-color: #0070C0; color: white; padding: 2px;">Select</span>

On-Demand Manufacturing

<span style="color: orange;">■</span>
Unlimited
1 ▾
20,000
£25,690.00
£3.15
£88,690.00
<span style="color: green;">✔</span> Selected

Add £500.00 setup charge for each production run.

Appendix F  
materials mechanical properties

		Homopol	Copolymer
Density	/ kgm-3	905	905
Price / Tonne	/ £	680	620
Tensile Strength	/ Mpa	33	25
Tensile Modulus	/ Gpa	1.4	1.0
Elongation at Break	/ %	150	300
Hardness	/ Rockwell "R" Scale	90	80
Notched Izod Impact	/ kJm-1	0.07	0.1
Heat Distortion Temp (HDT)	@ 0.45 MPa / °C	105	100
Heat Distortion Temp (HDT)	@ 1.80 MPa / °C	65	60
Volume Resistivity	/ logÙm	19	19
Oxygen Index	/ %	17	17

APPENDIX G

SVHC hazardous chemicals (200+ pages so were not added into appendix)

[https://echa.europa.eu/documents/10162/13642/data\\_candidate\\_list\\_substances\\_in\\_articles\\_en.pdf/d48a58e4-0d67-4c54-86a5-0b15877a8c93](https://echa.europa.eu/documents/10162/13642/data_candidate_list_substances_in_articles_en.pdf/d48a58e4-0d67-4c54-86a5-0b15877a8c93)

APPENDIX H

Issue	Occurrence	Severity	Detection	RPN	Action
Hinge snapping	2	6	2	24	Test 1 in every 5,000 to make sure.
Hinge not able to support weight	1	10	1	10	Testing done in simulation and warning issued in user manuals.
Module not locking in place	1	9	1	9	Testing done and module once locked

					will not fall out of place so will not be used and returned if not working.
Sink marks	3	5	1	15	Visual inspection upon finish
Modules not connecting properly	1	10	4	40	Allow for smaller tolerances.