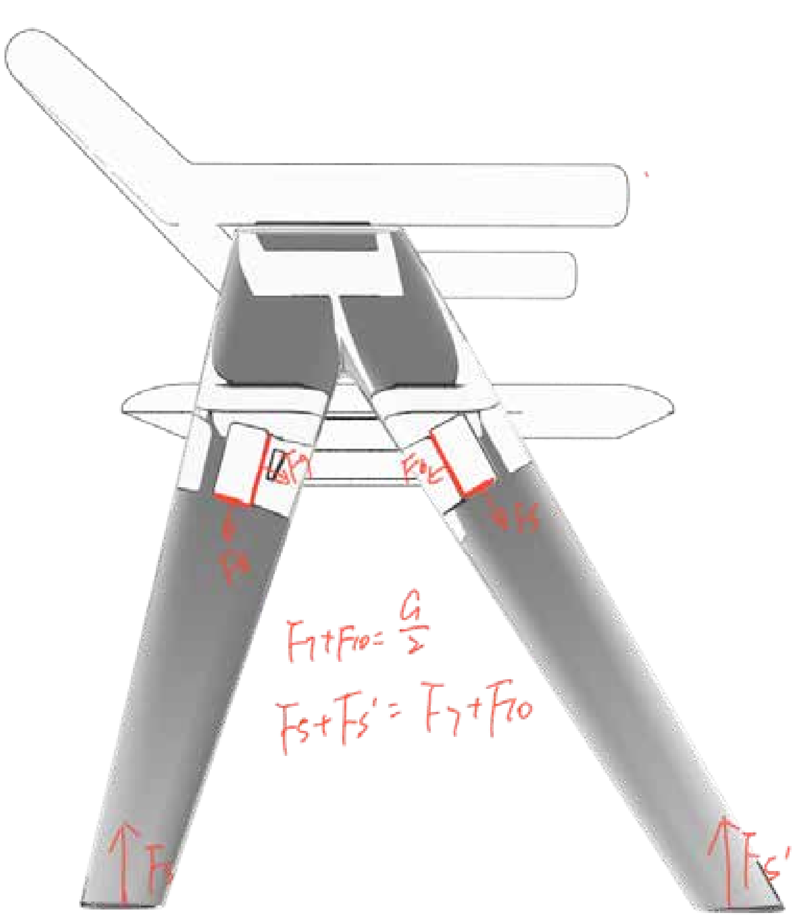
INDUSTRIAL DESIGN PROFESSIONAL PRACTICE 3B

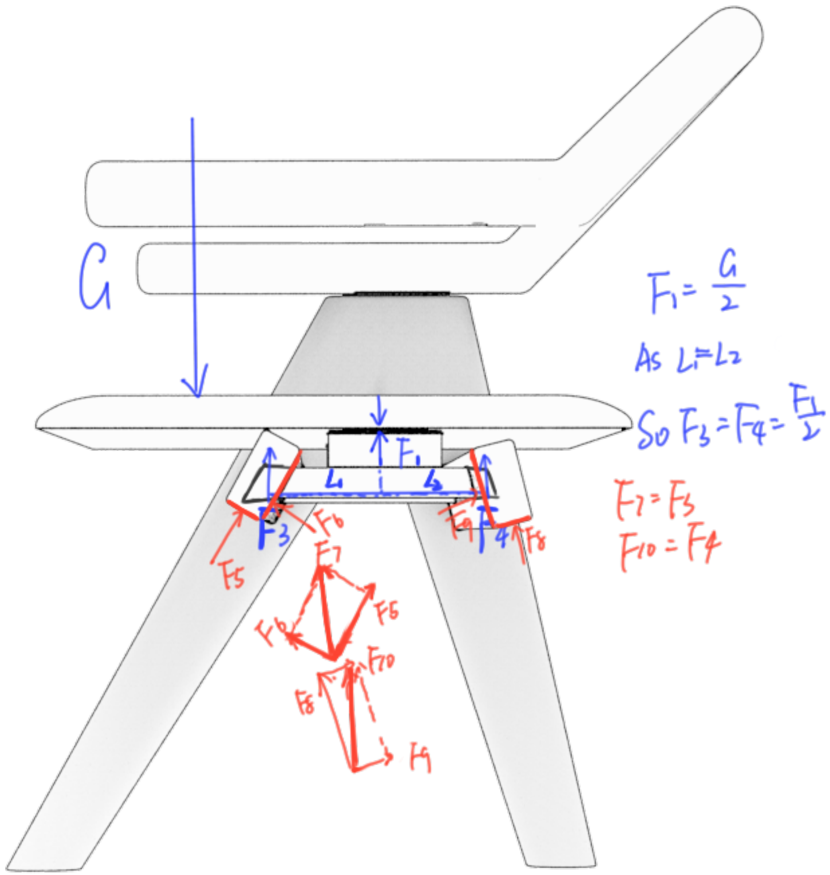
COURSEWORK 1: PORTFOLIO OF WORK

Xingyu Li

PART A

DESIGN CHALLENGE: FEA



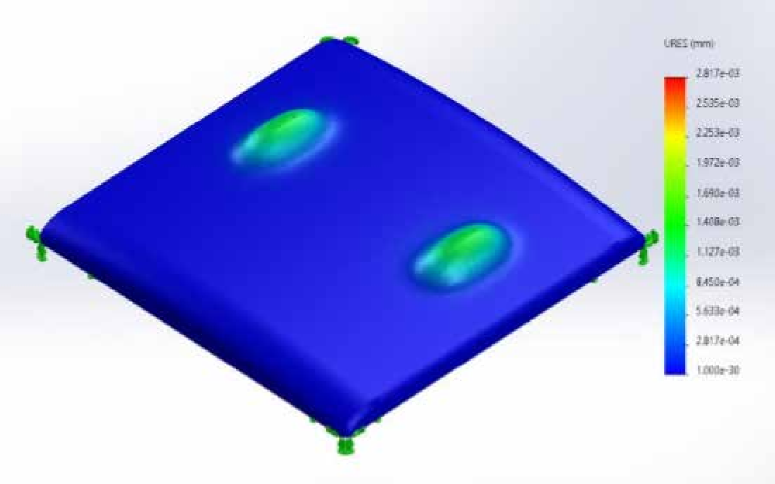


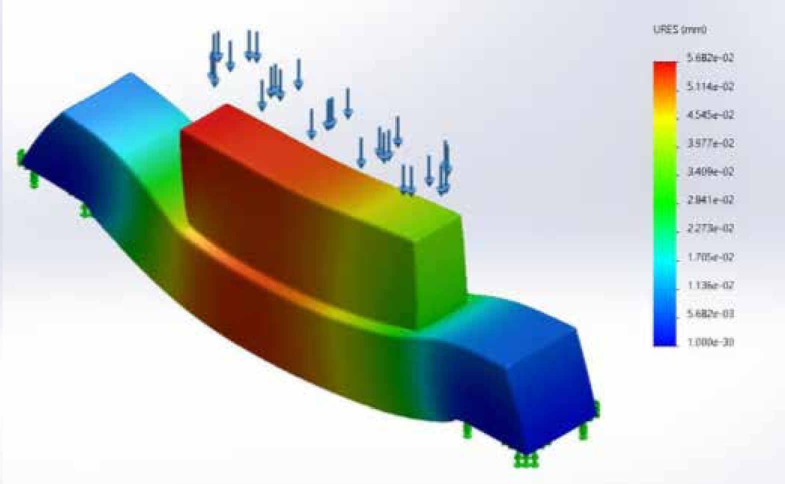
Description

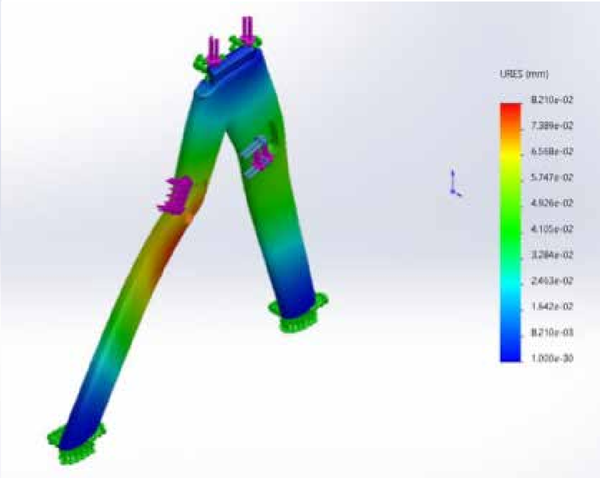
This page includes requirements and my plan.

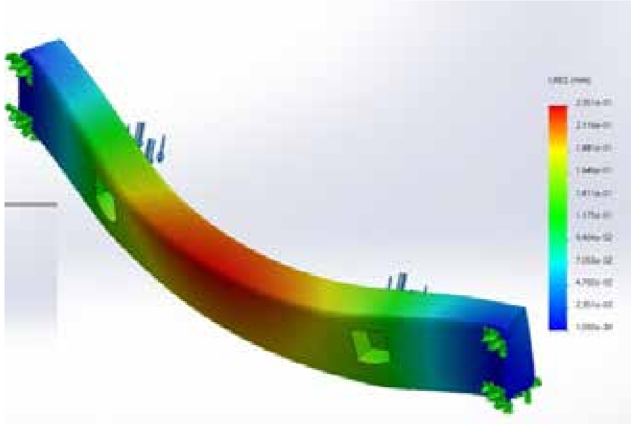
In Part A, in order to ensure the chair designed by me is stable enough, we are required to analyze the designed chair with finite element analysis method and improve the unreasonable shape or the weak parts of the product according to the analysis results.

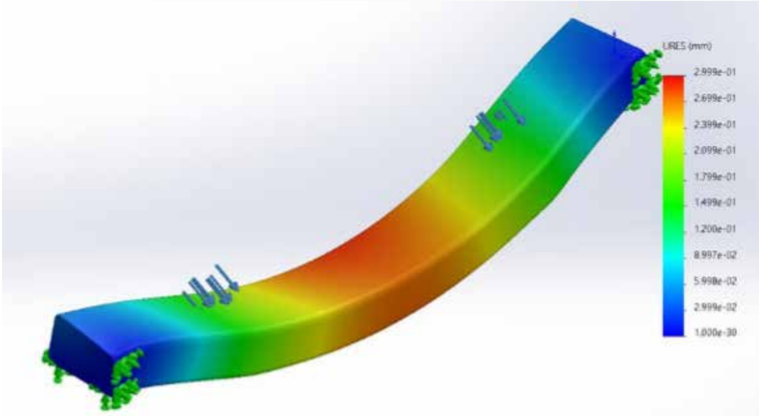
As my chair design is composed of a number of units, so I can't regard them as a whole.I need to analyze each of them individually. First, I analyzed stress distribution of each parts. (There are a lot of ways that people interact with chairs, but I've only considered one of the most ideal situations,sitting upright on a chair .

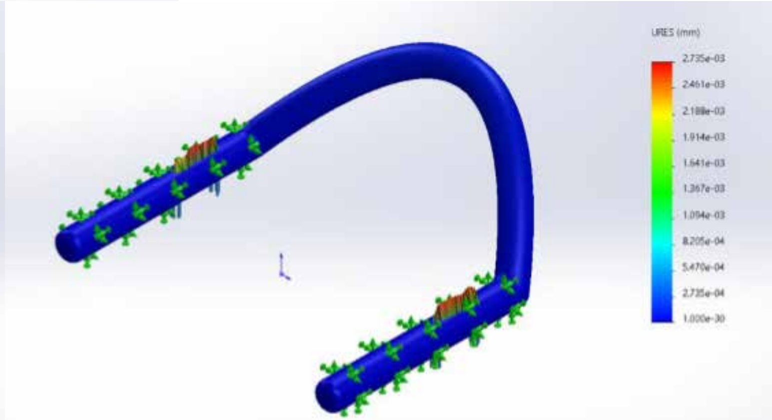


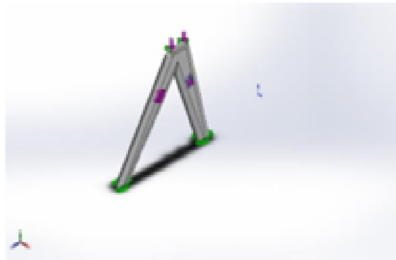










Contact	Contact image	Contact properties
Global contact		Type: joint Components: 1 Option: not compatible with grid

Access to information, I found that ABS and PP is compared common engineering plastics. Compared to PP, ABS with higher tensile strength , is considerded to be more suitable for the chair. So, I assume parts of the chair is all made by ABS. After that, I used the grid tool and the finite element analysis method to evaluate the shape and material of the chair . Although some parts showe red areas, after comprehensive consideration, they can be accepted. Apart from that, each part is used mesh system. Except legs, the ratios(a/b>10) of the other parts are all zero. The smaller the ratio is, the more reality the shape is. For legs, the maximum ratio is 17. 671 which is high. But considering the whole part, the unit, ratio is larger than 10, is 0.578 which is still acceptable as it is smaller than 1.

Total number of nodes	24755
The total number of units	15044
Maximum height to width ratio	17.671
Unit (%), whose height to width ratio is < 3	94
Unit (%), its height to width ratio > 10	0.578
Of the twist unit (Jacobi)	0

Development

After analysis by Solidworks, results can be seen clearly. Supporting structures are the most important parts in the design as they load most of the weight. So I come up with three methods to improve my design. Firstly, the width of the crossbar can be increased so the area connected two parts can increase. Secondly, harder and stronger materi-als can be used in design such as stain steel and aluminum alloy. Moreover, the crossbar can be longer which can to-tally through beams.

This is the final design in part A.

PART B

DESIGN CHALLENGE: Sustainability

Description

This page includes requirements and my plan.

In this part, I am requested to use the sustainability tools in solidworks to analyze the chair we designed. According to the data, the environment impact will be reduced to the lowest. In addition, I also need to provide engineering drawings of the chair in order to communicate with other designers and engineer easier. By the way, the coursework done in class will also show in this part.

Based on the part A, FEA analyze, the chair is stable and safety, however, considering the manufacture, I also need to select materials and manufacture methods. During this process, I will consider in three aspects, environment, society and economy. In the part A, I have preliminarily selected materials and in this part, I will evaluate or replace them to fit requirements of sustainability. Apart from that, I will also consider the manufacture places and methods to reduce the cost.

Description

What is Sustainability?
The way sustainability is relevant to Product design.

Sustainable design is a design that meets the needs of the present without jeopardizing the ability of future generations to meet their needs. Based on the Natural Step 's (2019) theory, it proposed four system conditions derived from thermodynamics, which can achieve sustainability. In the sustainable environment, the concentration of material extracted from the earth's crust, the concentration of substances produced by human society and physical means degeneration will not increase and humanity does not face a situation in which its ability to meet its own needs is systematically impaired. The above two perspectives give different overviews of what sustainability is. In my point of view, sustainability is the communication and interaction between the human-made world and the nature. Sustainability doesn't mean complete absence of destruction or waste. It means that minimizing the impact of human behaviors on the environment without affecting social development. As for how to balance three elements, economy, environment and society, I think the healthy environment is the most important as both the healthy economy and the society depend on it.

I considered the design for disassembly (DFD) at the beginning of the design. For my chair, its parts and materials can be recycled easily at the end of its life. Only when the product can be removed cleanly and efficiently, its components can be reused and processed. Moreover, I will also consider the principles of Design for Environment (1992) (DFR0settled by EPA to reduce the pollution from the chair via choosing non-toxic materials and low energy and waste manufacture process. In addition, 12 Principles of Green Chemistry (1998) will also be considered in this stage.

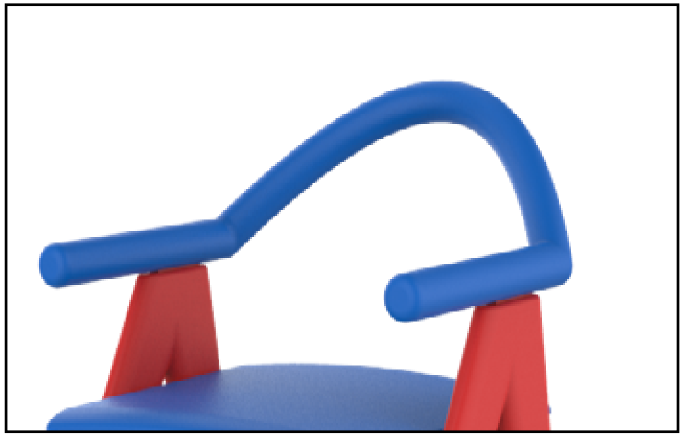
Firstly, it needs to be defined that sustainability is relative rather than absolute. Chair, one of the necessities in our life, it must impact our environment. Sustainability is aim to reduce this impact. The only way to assess whether a design is more sustainable is to see how its impact compares to other options. So, the standard is important. One of the common methods is to find the “function unite”. Based on the FEA analysis, a stable chair made by less than two kinds of materials (mainly by plastics) can be a compared standard.

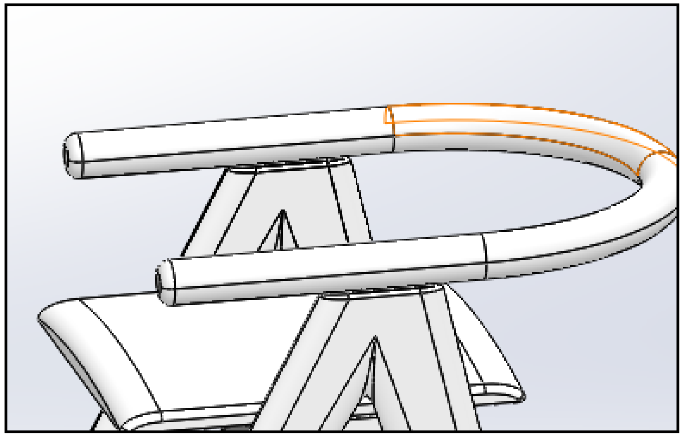
Based on EPA, the environmental impact category is divided into five main areas.

1. Consumption of natural resources;
2. Air influence;
3. Land and water impacts;
4. Climate impacts;
5. Human health.

The second major consideration in evaluating product sustainability is life cycle stage which includes Raw material extraction, material processing, parts manufacturing, assembly, product usage, end of life and transportation. (Jolliet, O., 2003)
Based on these criteria, there are several methods to analyze products. According to the requirement, I use the templet from the Moodle.

Evaluate the shape





In the original design, there is an obvious bent at the armrest which causes great difficulties in production. If it is made by injection molding, the sharp area will increase the risk of faults. If I use other materials, such as stain steel, this process will increase the cost of the product.
Considering there is almost no force on the back of the armrest, as this part is just a decoration, I change the shape(see second diagram)

CML Method

In the part A, I use engineer intuition to choose the plastic, ABS, however, intuition will make mistakes. For example, cotton is known as the environment friendly material, but, in fact, considering the plenty of pesticides and water used in the growing process, it is not the sustainable material. In the part B, I will choose more suitable materials.

MMME 3096 - Solidworks Sustainability

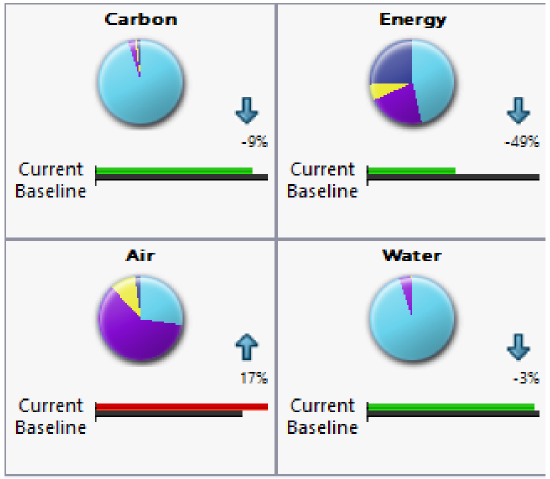
GENERAL INFORMATION				MANUFACTURING								USE	TRANSPORTATION				END OF LIFE		
Configuration	Class	Name	Weight	Region	Built to last	Unit	Process	Electricity (kWh/gm)	Natural gas (BTU/gm)	Scrap rate (%)	Paint	Region	Train (km)	Truck (km)	Boat (km)	Plane (km)	Recycled (%)	Incinerated (%)	Landfill (%)
Configuration 1 (Baseline)	Plastics	ABS	26573.57gm	Asia	1	Day	Injection molded	1.85	0	2	No paint	Asia	0	1609	0	0	15	2	83
Configuration 2	Plastics	ABS	26573.57gm	Inida	1	Day	Injection molded	1.85	0	2	No paint	Asia	0	0	6437	0	15	2	83
Configuration 3	Plastics	igh density	25247.58gm	Asia	1	Day	Injection molded	1.85	0	2	No paint	Asia	0	1609	0	0	15	2	83
Configuration 4	Plastics	:(PP) the re	24741.55gm	Asia	1	Day	Injection molded	1.85	0	2	No paint	Asia	0	1609	0	0	15	2	83

ENVIRONMENTAL IMPACT

		CARBON FOOTPRINT (kg CO2)					ENERGY CONSUMPTION (MJ)					AIR ACIDIFICATION (kg SO2)					WATER EUTROPHICATION (kg PO4)				
Configuration	Duration of use	Material	Manufacturing	Use	End of life	Transportation	Material	Manufacturing	Use	End of life	Transportation	Material	Manufacturing	Use	End of life	Transportation	Material	Manufacturing	Use	End of life	Transportation
Configuration 1 (Baseline)	4 years	390	230	0	2.40E+04	3200	9500	2300	0	1.70E+04	4.30E+04	0.854	3.2	0	9.4	16	0.149	0.125	0	40	3.3
Configuration 2	4 years	390	230	0	2.40E+04	660	9500	2300	0	1.70E+04	8000	0.854	3.2	0	9.4	21	0.149	0.125	0	40	2
Configuration 3	4 years	230	210	0	2.20E+04	3000	8200	2100	0	1.60E+04	4.00E+04	0.482	3	0	8.8	15	0.043	0.116	0	38	3
Configuration 4	4 years	210	210	0	2.20E+04	2900	7700	2100	0	1.60E+04	3.90E+04	0.451	2.9	0	8.5	15	0.041	0.113	0	36	3

Configuration 2

Process region change

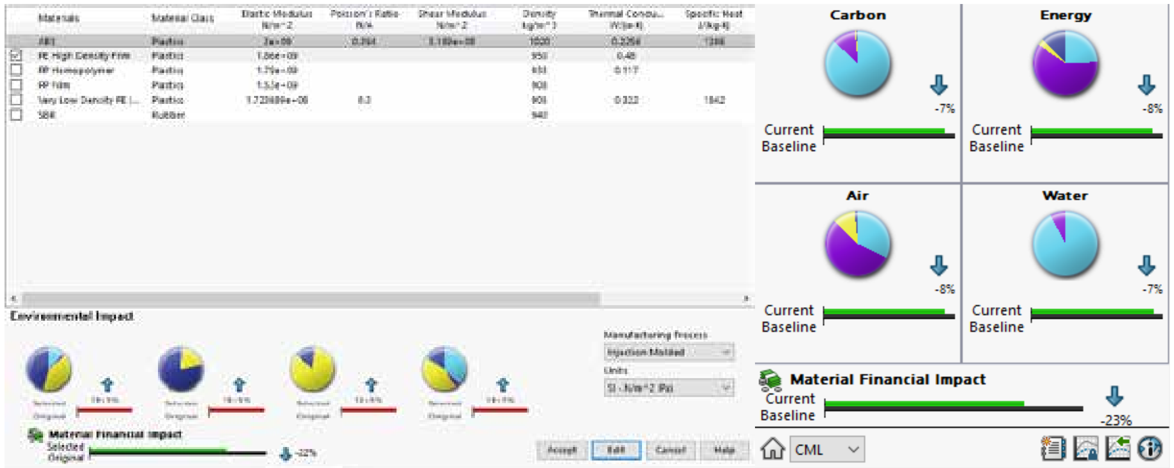


I change the process area from Asia to India. At first, I thought the product made in the local and sold in this area was the best choice, however, the data below shows that except Air, the other three standards all decrease. Moreover, the material financial impact also decreases.

From the data changes, it can be found that these changes are mainly due to the change of transportation. A boat traveling 6437 km has less impact on the environment than a truck traveling 1609km.

Configuration 3

Material change



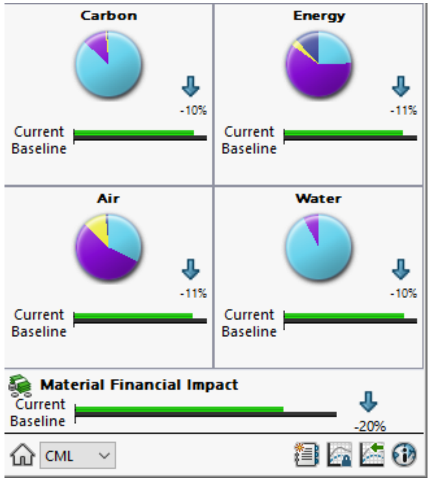
I find that the weight of the chair is high, so I try to decrease it through changing the materials without impact its physical properties.I find that the weight of the chair is high, so I try to decrease it through changing the materials without impact its physical properties. So, I use “similarity” instruction and limited the density and the tensile strength of the material. By the way I also check safer Material List, PE is safer material. Surprisingly, the new material had less impact on the environment

Product Development

Change the shape of armrest

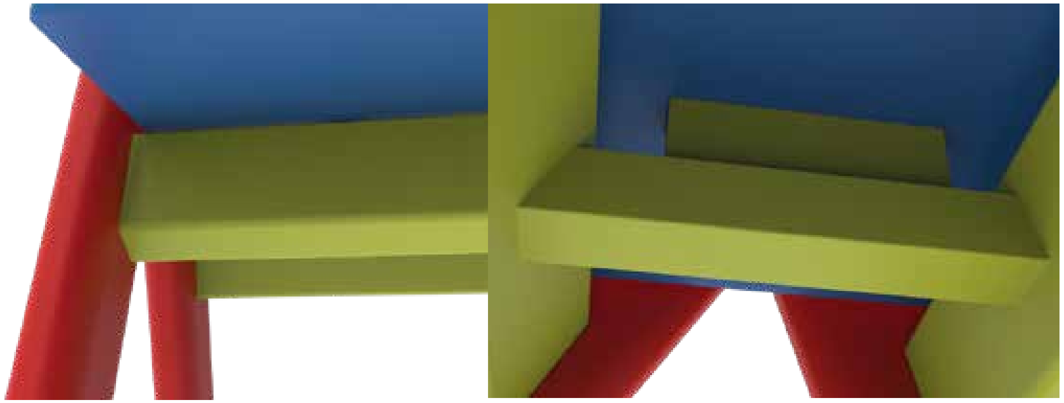
Configuration 4

Material change



Considering not all parts require great strength, I change the armrest and the seat into PP. Compared to the above two configuration, this one has the least imapct on the environment and changing ABS into PP do not need extra processes on manufacture.

Based on the above analysis, I plan to process the chair in India and use it in Asia which can reduce the consumption of the transportation. The materials of the seat and the armrest will be changed from ABS into PP. The weight of the chair can decrease and it is more friendly to the environment.



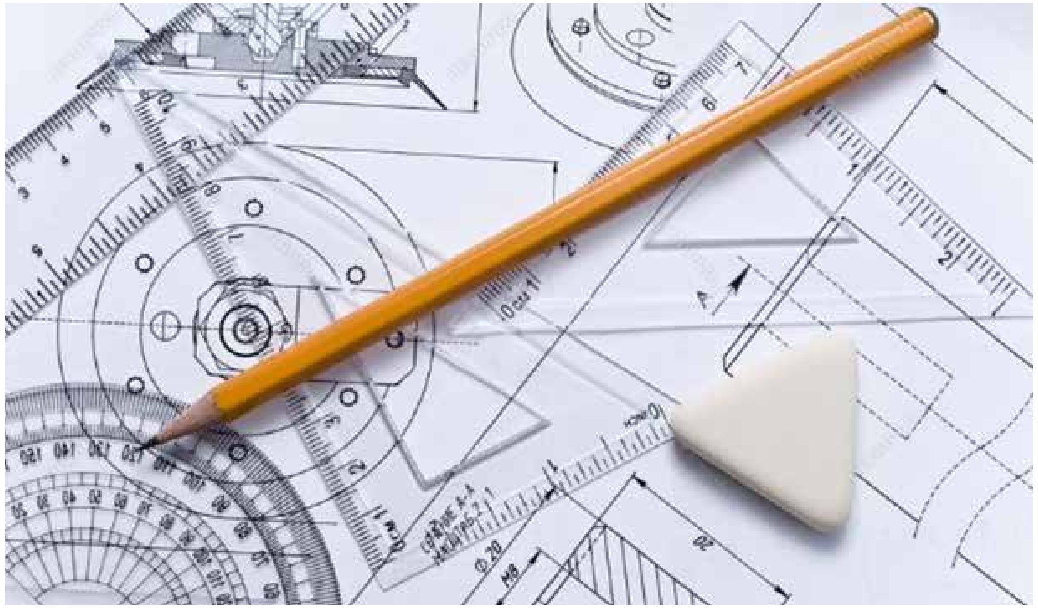
In order to reduce the use of glue, which makes the chair hard to disassemble, the parts where the two parts touch are designed as interference fit.

Engineering Drawing

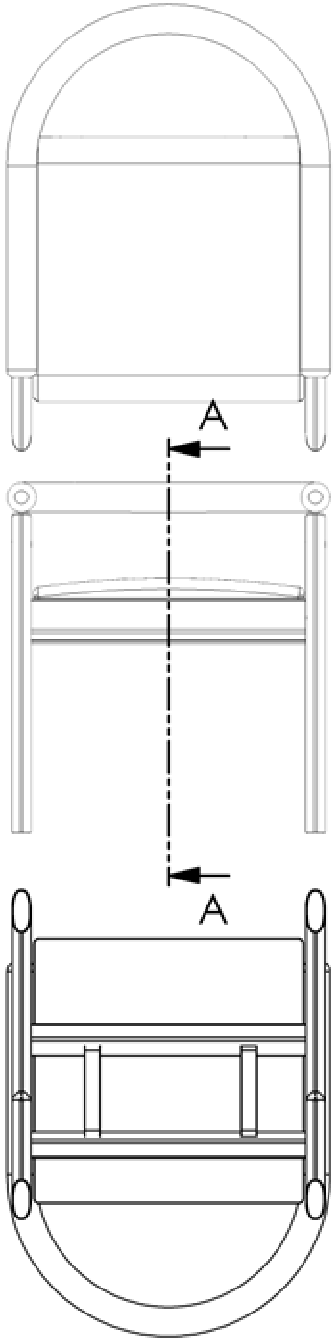
Description of Engineering Drawing

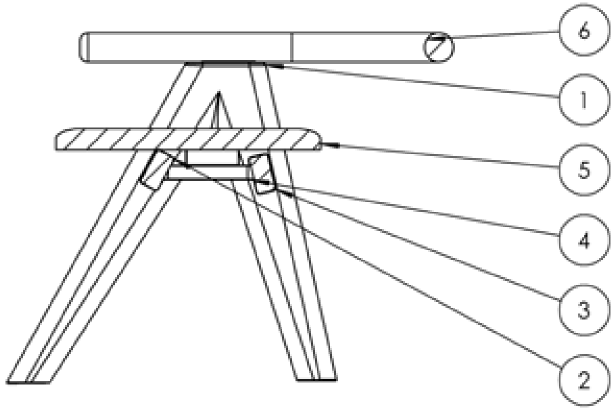
Engineering drawing is a tool which help designers and engineers communicate with each other. It can provide high-precision dimension information about the product in order to produce products in mass.

As the product designer, I must be familiar with this because if I want to mass produce my product, I need to communicate with the factory. For engineers, they need to analyze the manufacture process through dimensions and details. During this process, some parts will be redesigned to fit the requirement of the manufacture. If the designer does not provide the engineer drawing, the efficiency of the communication will reduce a lot. A lot of time will be wasted on argument.



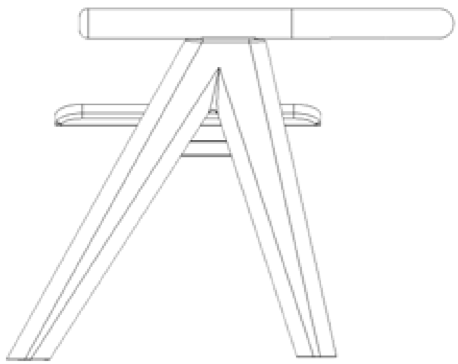
No.	Name	Materials	Quantity
1	Legs	ABS	2
2	Beam	ABS	1
3	Beam	ABS	1
4	Crossgirder	ABS	2
5	Seat	PP	1
6	Armrest	PP	1





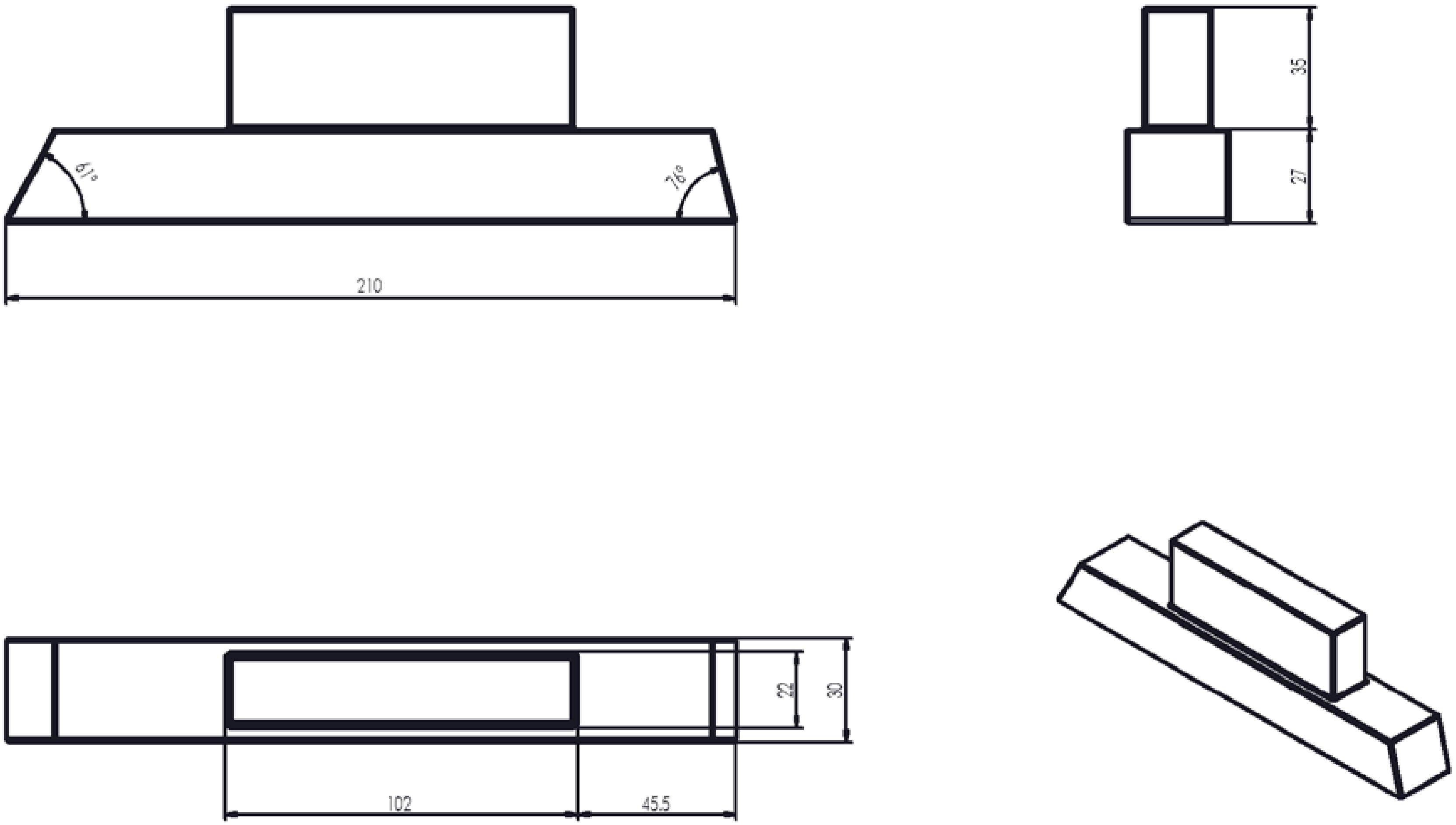
SECTION A-A

SCALE 1 : 9.5



TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

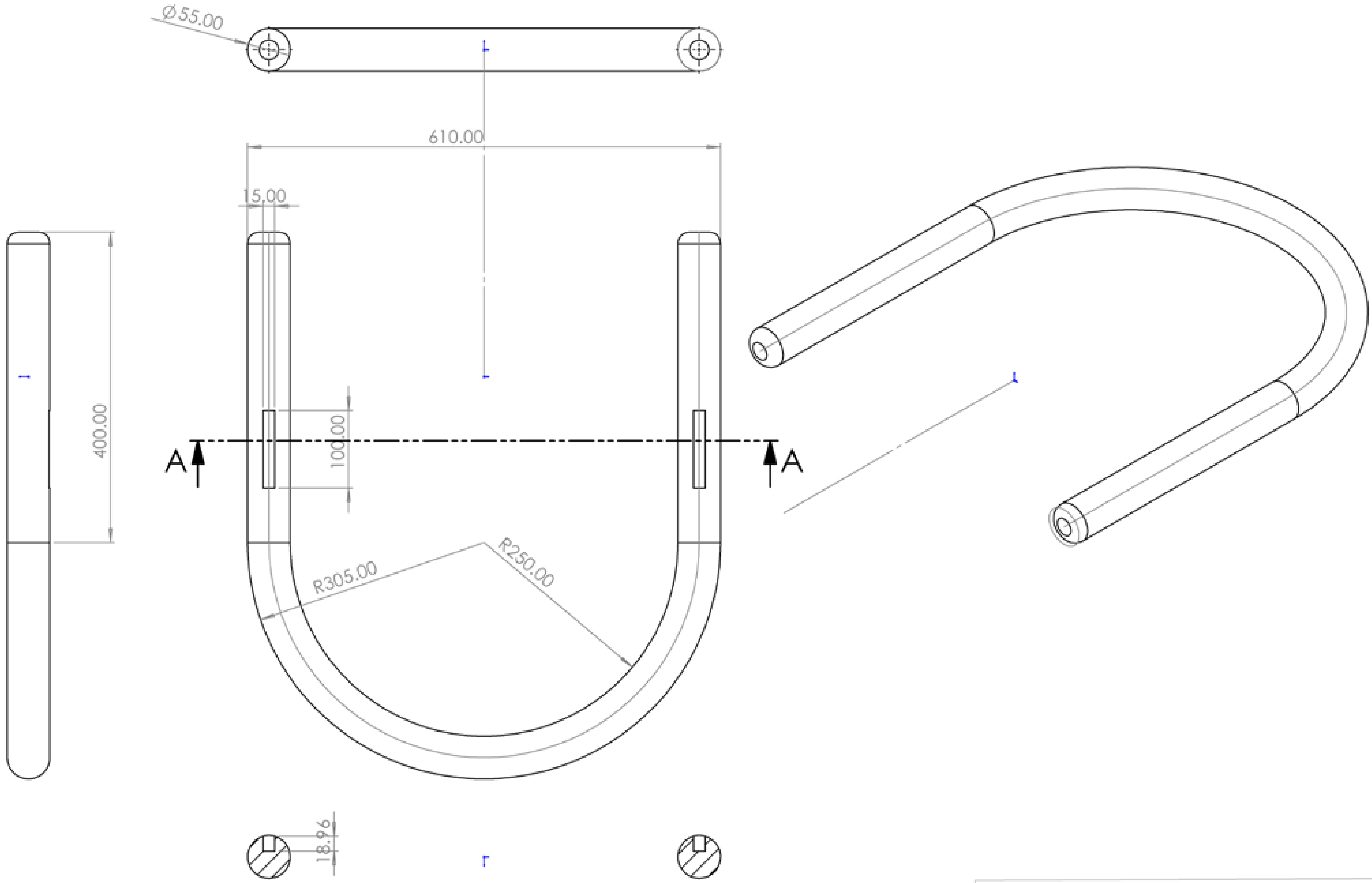
NAME OF PART	Chair Assembly
ALL DIMENSIONS IN MILLIMETRES	DESCRIPTION
DRAFTING STANDARD BS 8888	BS. DATE 12/19/2019
REV	
DRN BY	Xingyu Li
DWG NO.	1
MATERIAL CODE	
MATERIAL	ABS
SCALE	1:9.5
SIZE	A3
SHEET	1of 1



Radius are 5mm

TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

	Crossrigder			
ALL DIMENSIONS IN MILLIMETRES				
BS 8888	19/20/2019		Xingyu Li	
	ABS	1:5	A3	1 of 1

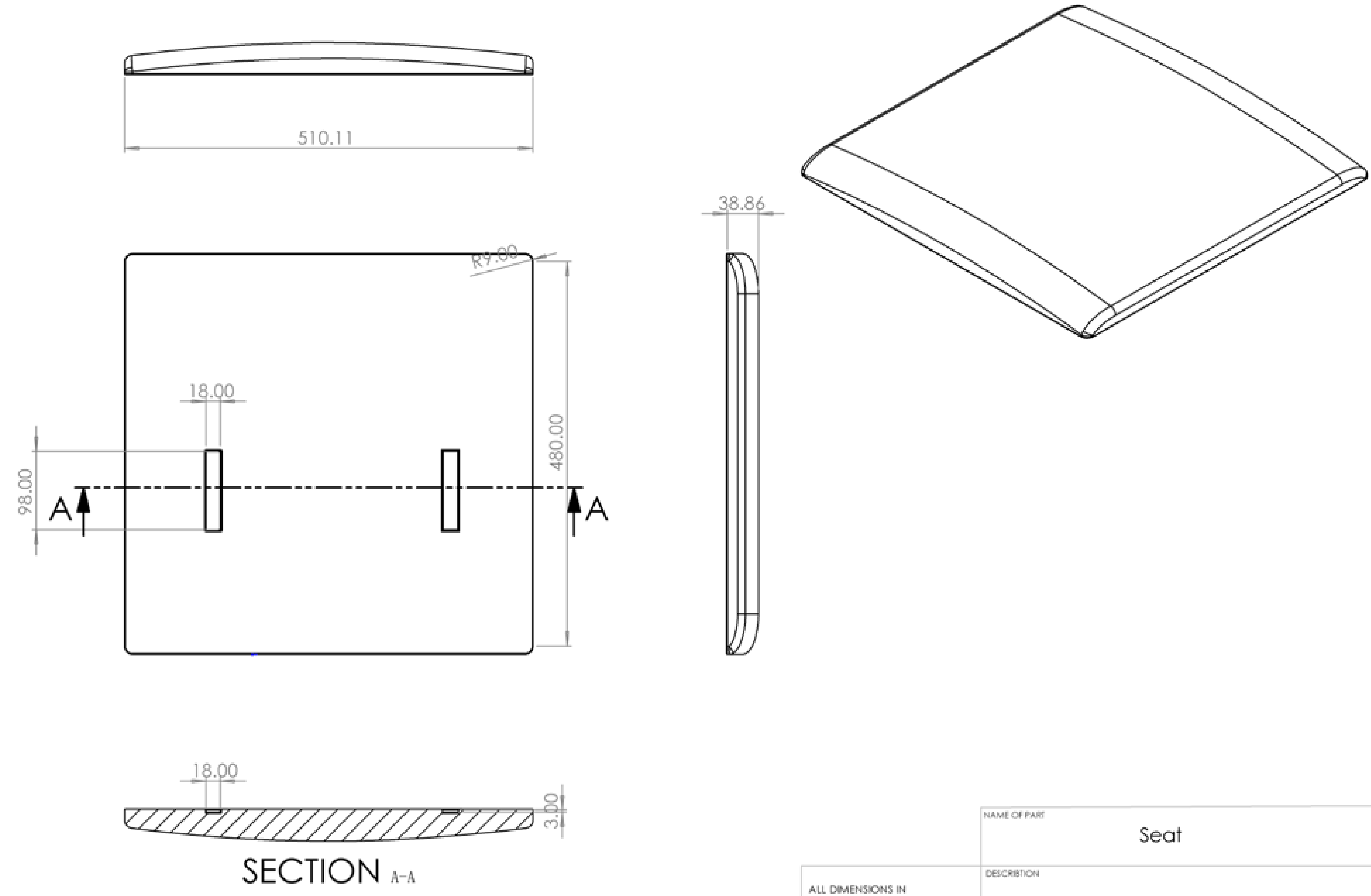


SECTION A-A

SCALE 1 : 5

TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

	NAME OF PART: Armrest				
ALL DIMENSIONS IN MILLIMETRES	DESCRIPTION				
DRAFTING STANDARD: BS 8888	ISS. DATE	REV	DRN BY	DWG NO.	
MATERIAL CODE	MATERIAL	SCALE: 1:5	SIZE: A3	SHEET: 1of 1	



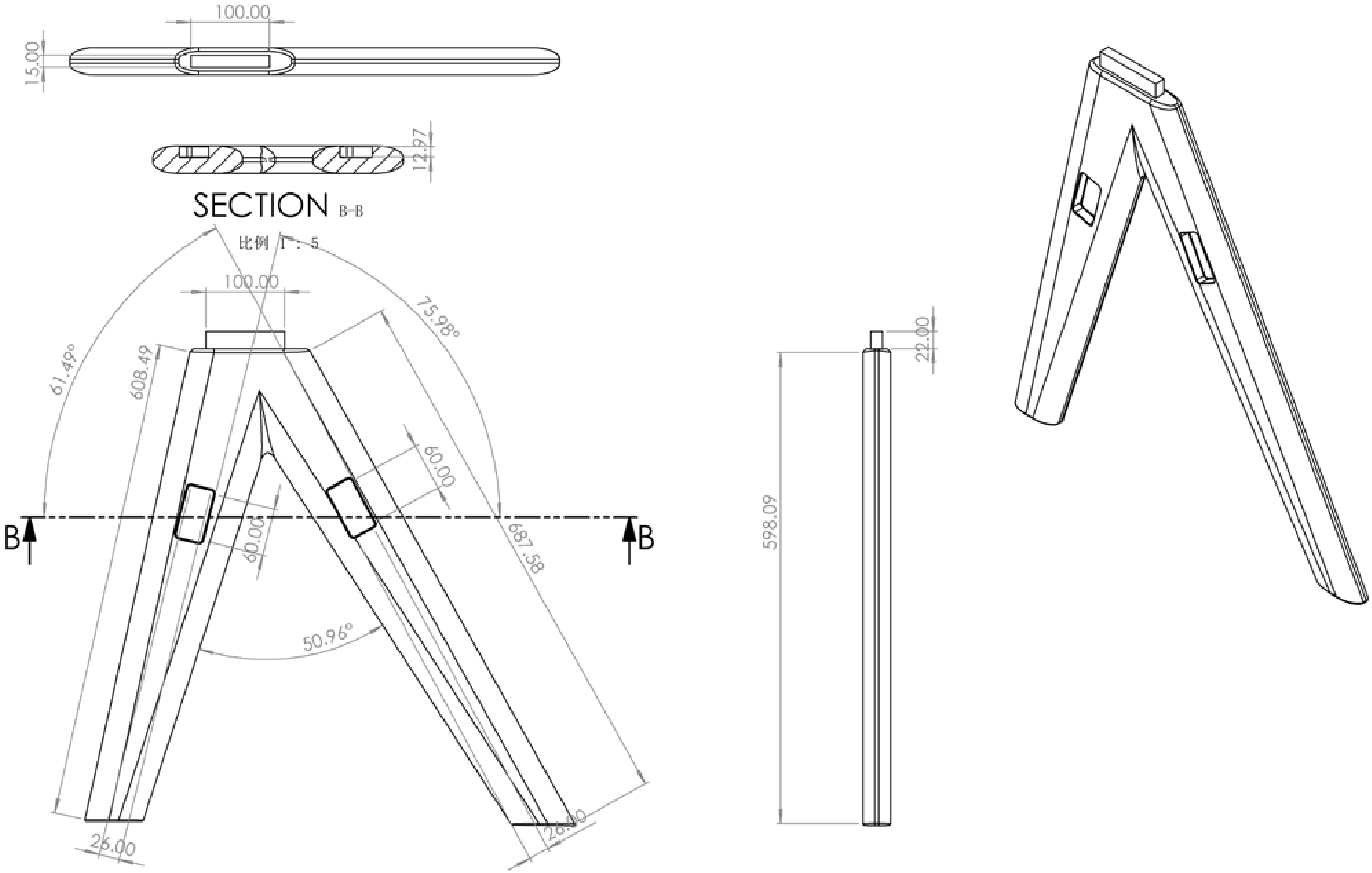
TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

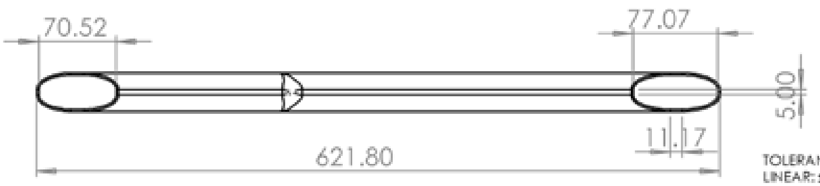
ALL DIMENSIONS IN MILLIMETRES

NAME OF PART	Seat
DESCRIPTION	
DRAFTING STANDARD	BS 8888
MATERIAL CODE	

ISS. DATE	REV	DRN BY	DWG NO.

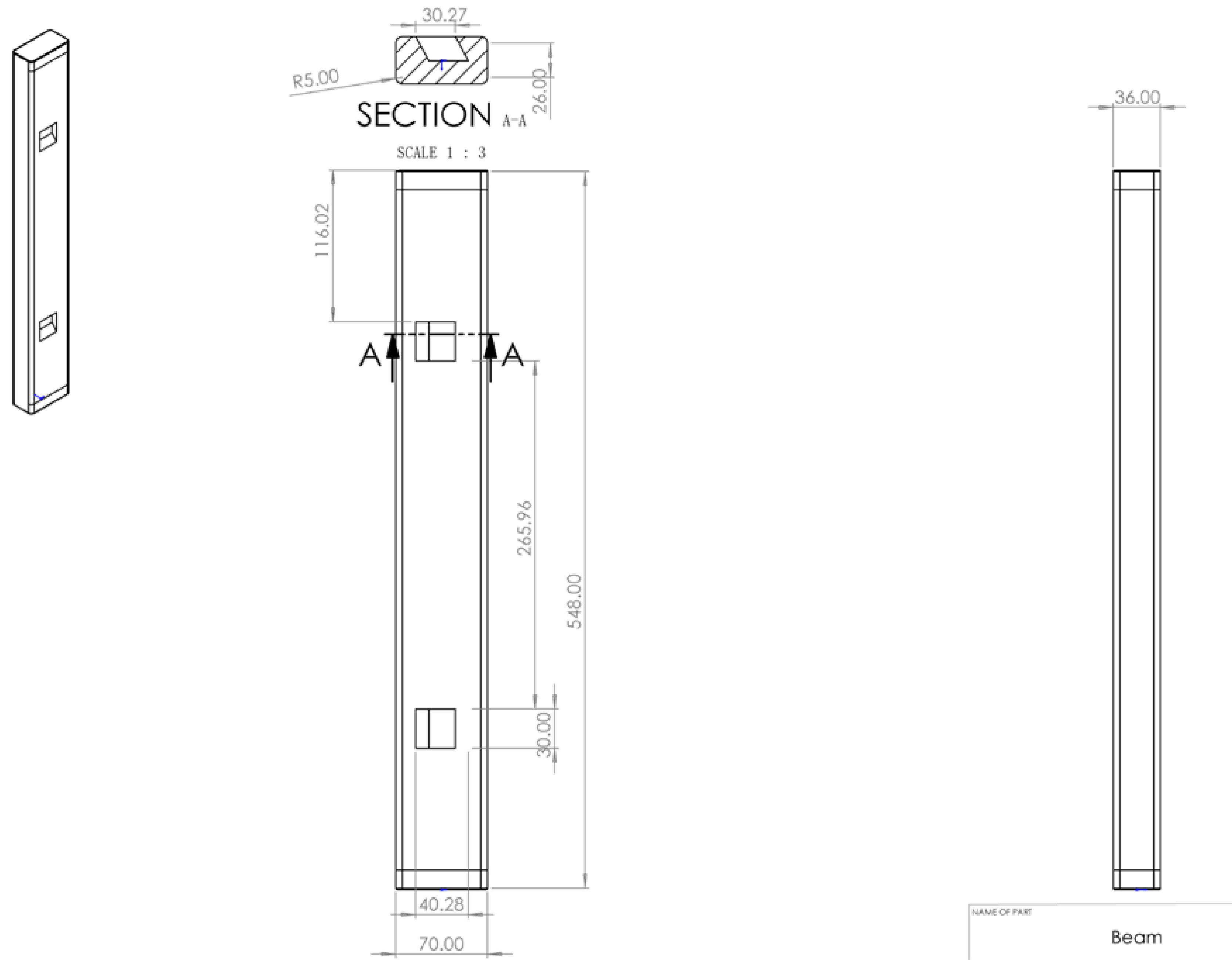
MATERIAL	SCALE	SIZE	SHEET
PP	1:10	A3	1of 1





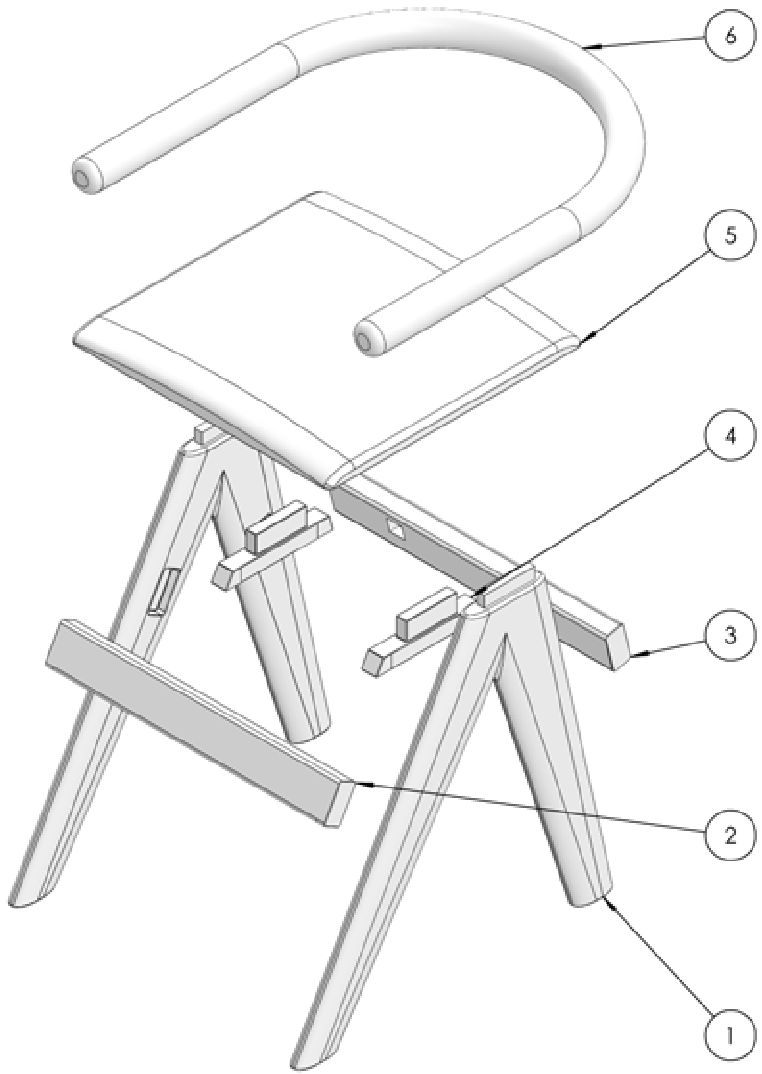
TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

	NAME OF PART: Leg				
ALL DIMENSIONS IN MILLIMETRES	DESCRIPTION				
DRAFTING STANDARD: BS 8888	ISS. DATE	REV	DRN BY	DWG NO.	
MATERIAL CODE	MATERIAL: ABS	SCALE: 1:5	SIZE: A3	SHEET: 1of 1	



TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

	NAME OF PART: Beam			
ALL DIMENSIONS IN MILLIMETRES	DESCRIPTION			
DRAFTING STANDARD: BS 8888	ISS. DATE	REV	DRN BY	DWG NO.
MATERIAL CODE	MATERIAL: ABS	SCALE: 1:3	SIZE: A3	SHEET: 1of 1



No.	Parts	Materials	Quantity
1	Legs	ABS	2
2	Beam	ABS	1
3	Beam	ABS	1
4	Crossgirder	ABS	2
5	Seat	PP	1
6	Armrest	PP	1

TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

ALL DIMENSIONS IN MILLIMETRES

NAME OF PART: Exploded View of Chair					
DESCRIPTION					
DRAFTING STANDARD: BS 8888	BS. DATE: 19/12/2019	REV	DRN BY: Xingyu Li	DWG NO.: 7	
MATERIAL CODE	MATERIAL	SCALE: 1:7	SIZE: A3	SHEET: 1of 1	

Class Exercise

Coursework

MMME3096 - Class exercise 1

The waste produced by:
Student A(LIAO Xirui) & Student B(LI Xingyu)


Student A: Day 1


Student A: Day 2


Student B: Day 1


Student B: Day 2


Waste generated

DETAILS OF THE WASTE PRODUCED BY...													
STUDENT 1													
DAY & No.	WHAT?			WHERE...?		WHEN?		WHO...?	SUSTAINABILITY				
	Product/Object	*Material(s) or Material family*	*Number of components*	*...was produced?*	*...was used?*	*For how long was used?*	*For how long can last?*	*...made it?*	*Can be reused?*	*Can be easily recycled?*	*Is sustainable? Why?*	*Can be better? How?*	
D1 - 1	Paper bag	Paper and nylon	3	China	China	0	1 year	N/A	Yes	Yes	Yes. It can be disassembled easily, and most of the material can be degraded	Yes, replace the nylon by paper or cotton.	
D1 - 2	Paper cup	Paper and PP	1	China	China	2h	1 year	N/A	No	no	No, the plastic film is hard to be separated from the paper.	Yes, the straw can be reduced.	
D1 – 3	Plastic bottle	PET	3	China	China	1h	1 year	N/A	No	Yes	Yes, all of the material can be recycled.	Yes, the straw can be reduced.	
D1 - 4	Note book	paper	1	China	China	3mouth	10 years	N/A	yes	yes	Yes, all of the material can be recycled and degraded.	No.	
D2 - 5	Highlighter	PMMA, cosmetics, metals	3	China	China	1year	1year	A cosmetics factory in Hangzhou	Yes	Yes	Yes, most of the parts can be recycled	Yes, the paper and metal packages can be used in this product.	
D2 - 6	Plastic bottle	PET	3	China	China	1h	1 year	A factory in Guangzhou	No	Yes	No, the plastic film is hard to be separated from the paper.	Yes, the straw can be reduced.	
D2 - 7	Sketch papers	paper	1	China	China	2h	10 years	N/A	no	yes	Yes, all of the material can be recycled and degraded.	Yes, reduce the use of bleach	
D2 – 8	Napkin	paper	1	China	China	5min	5 year	N/A	no	no	Yes, the material is degradable.	No.	
STUDENT 2													
D1 – 1	Plastic bottle	PET	3	China	China	2h	1 year	N/A	No	yes	Yes, all of the material can be recycled.	Yes, the straw can be reduced.	
D1 – 2	Plastic bag	2 different type of plastic	1	China	China	4h	1 year	N/A	no	yes		Yes, it can be replaced by papers.	
D1 – 3	Take-out box	PET	2	China	China	1h	1 Year	N/A	Yes	Yes	Yes, all of the material can be recycled.	Yes, it can be replaced by paper box, or the meal can be ate in the canteen.	
D1 – 4	Napkin	paper	10	China	China	1h	3 years	A factory in Shandong	No	Yes	Yes, the material is degradable.	Yes, reduce the use of bleach	
D2 – 5	Gel pen	3 different type of plastic metal, gel	5	China	China	6 mouth	3years	N/A	No	No	No, the parts are hard to disassembled.	Yes, reduce the plastics parts	
D2 - 6	Paper bag	Paper	1	China	China	1h	1 year	N/A	Yes	Yes	Yes. All of the material can be degraded	No.	

What we think about the products lifecycle and the waste we generated in just 2 days?

Most products use plastic, and they are basically disposable products. Many plastics can be recycled, but some products are very difficult to disassemble, resulting in a low recycling rate and being landfilled or incinerated, resulting in waste of resources and the pollution.

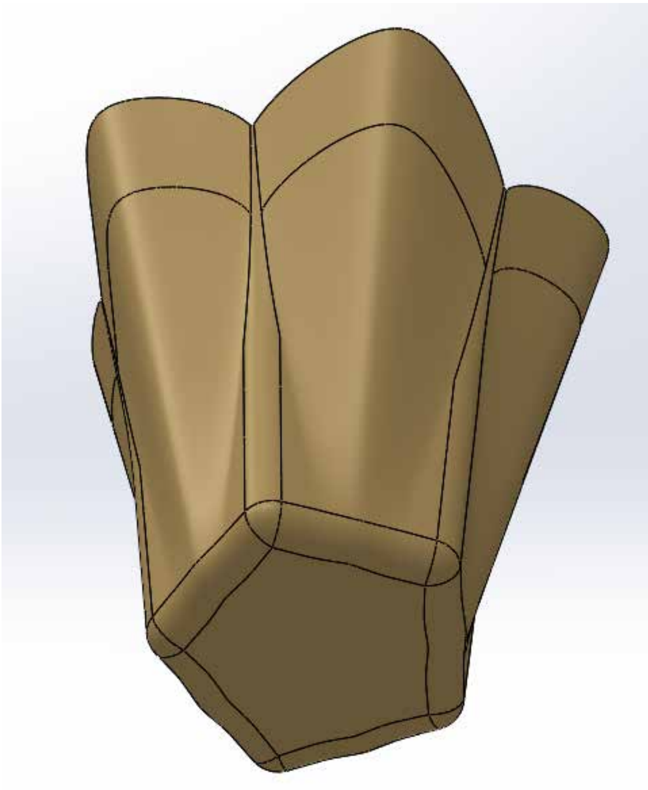
MMME 3096 - Solidworks Sustainability

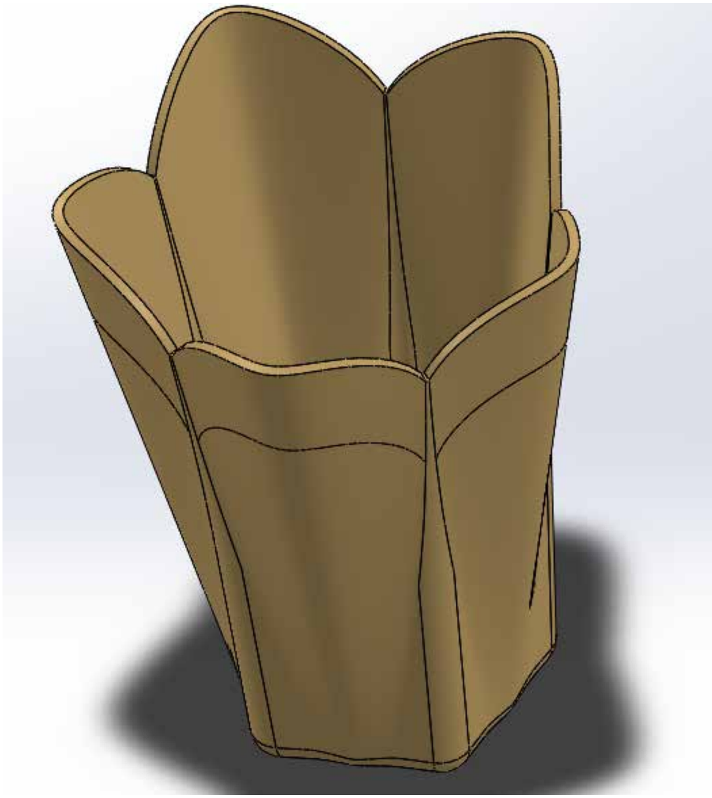
GENERAL INFORMATION				MANUFACTURING								USE	TRANSPORTATION				END OF LIFE		
Configuration	Class	Name	Weight	Region	Built to last	Unit	Process	Electricity (kWh/gm)	Natural gas (BTU/gm)	Scrap rate (%)	Paint	Region	Train (km)	Truck (km)	Boat (km)	Plane (km)	Recycled (%)	Incinerated (%)	Landfill (%)
Configuration 1	Plastics	PET	83.62gm	Asia	1	Day	Injection molded	1.85	0	2	No paint	Asia	0	1609	0	0	15	2	83
Configuration 2	Plastics	PVC Rigid	76.65gm	Asia	1	Day	Injection molded	1.85	0	2	No paint	Asia	0	1609	0	0	15	2	83
Configuration 3	Copper Alloys	minum Bro	436.32gm	Asia	1	Day	Wire	0.64	21.32	0	Vater-based Pair	Asia	0	1609	0	0	15	2	83
Configuration 4	Aluminium Alloys	00-H12 Ro	159.79gm	Asia	1	Day	Milled	0.42	0	9.9	No paint	Asia	0	1609	0	0	33	13	54

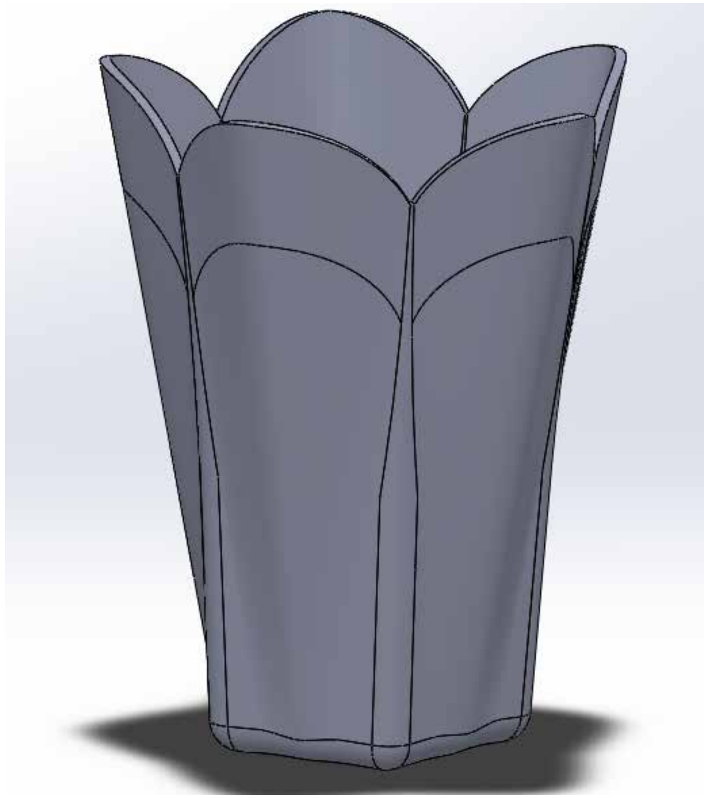
ENVIRONMENTAL IMPACT

		CARBON FOOTPRINT (kg CO2)					ENERGY CONSUMPTION (MJ)					AIR ACIDIFICATION (kg SO2)					WATER EUTROPHICATION (kg PO4)				
Configuration	Duration of use	Material	Manufacturing	Use	End of life	Transportation	Material	Manufacturing	Use	End of life	Transportation	Material	Manufacturing	Use	End of life	Transportation	Material	Manufacturing	Use	End of life	Transportation
Configuration 1	1 year	92	65	0	19	2.5	2500	650	0	13	33	0.162	0.914	0	7.3 E-3	0.012	0.015	0.035	0	0.031	2.5 E-3
Configuration 2	10 years	450	590	0	170	22	1.40E+04	5900	0	120	310	54	8.3	0	0.066	0.321	1.4	0.321	0	9.90E-03	0.65
Configuration 3	5 years	4200	710	0	28	64	4.70E+04	7800	0	120	870	54	8.9	0	0.066	0.321	1.4	0.341	0	9.90E-03	0.65
Configuration 4	5 years	4000	140	0	10	23	5.00E+04	1400	0	45	320	27	2	0	0.024	0.118	0.856	0.076	0	3.60E-03	0.024

BEST CONFIGURATION FOR THIS DESIGN	ninium Alloys (1100-H12 Ro	**Rationale:** The best is aluminum, which uses less power during processing than plastic and compared to the copper, it is lighter and has less impact to the environment as it release less carboon and consume less energy.



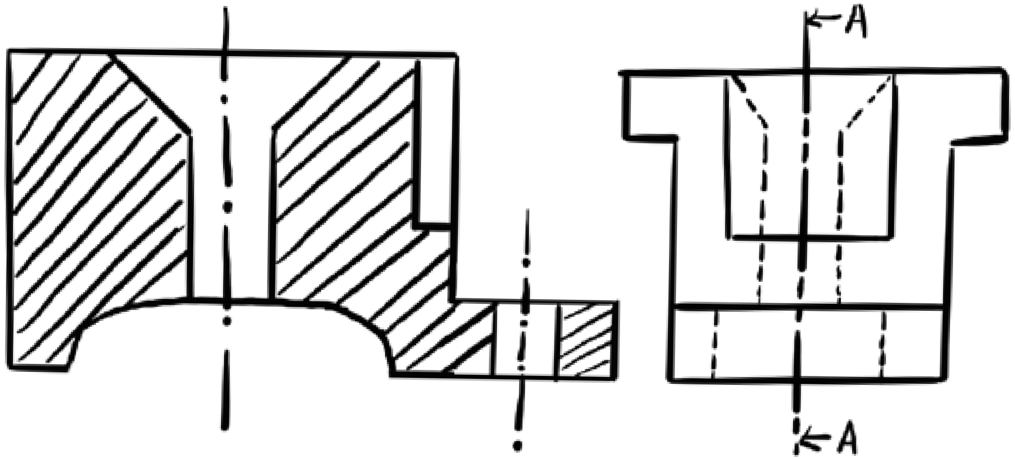




TOLERANCE
LINEAR: ±0.5
ANGULAR: ±1

ALL DIMENSIONS IN MILLIMETRES

NAME OF PART				
DESCRIPTION				
DRAFTING STANDARD BS 8888	ISS. DATE	REV	DRN BY	DWG NO.
MATERIAL CODE	MATERIAL	SCALE	SIZE A3	SHEET 1of 1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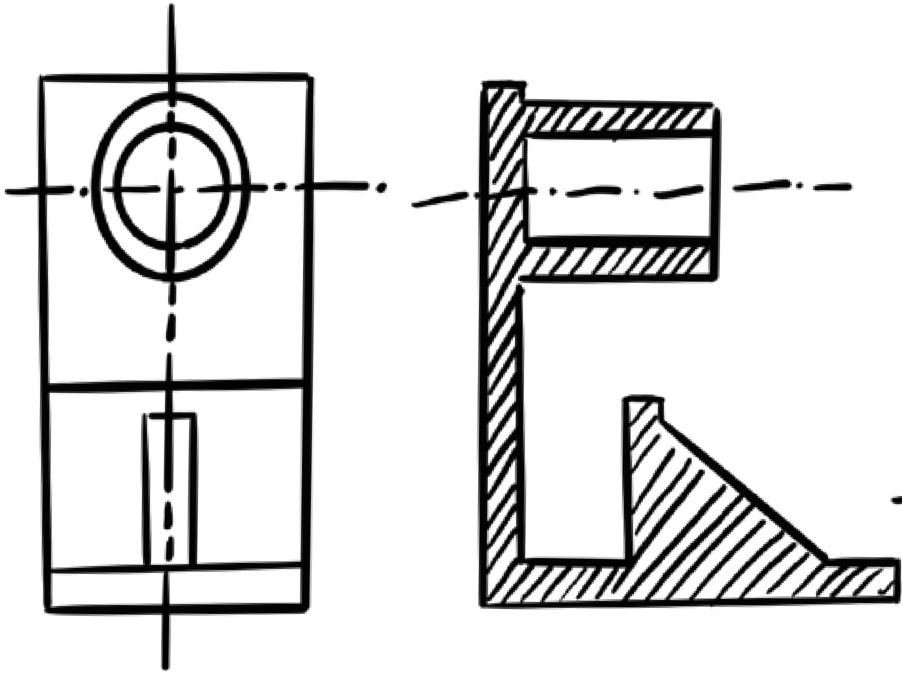

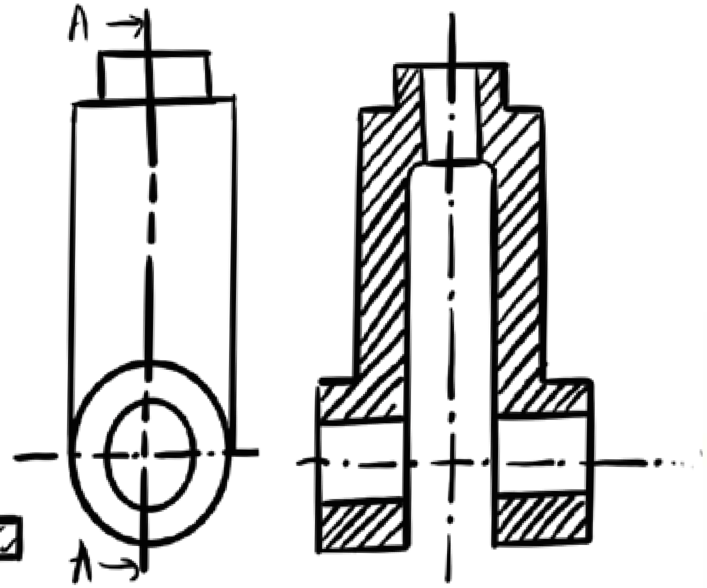
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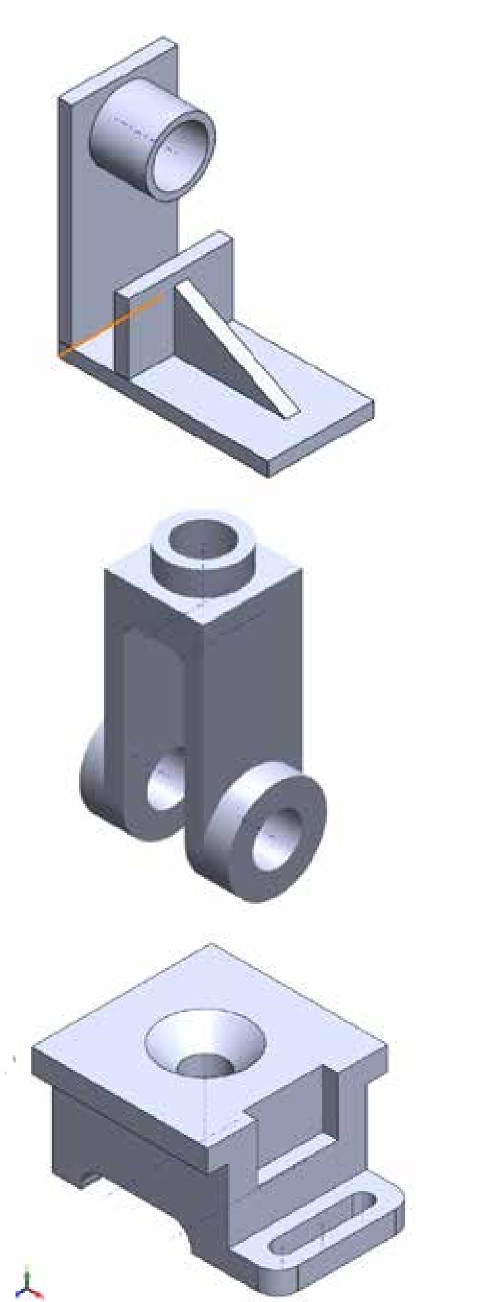

Reflection

Both the finite element analysis and the sustainable analysis of Solidworks are ideal, with certain errors, so we need to use more sophisticated systems such as ANSYS in the future.For sustainable development, I personally think it is a problem of systematic management, which requires the cooperation of various departments.At the same time, I have my doubts about the reliability of the model it builds. For example, Asia is very big. When evaluating products made in Asia and sold to Asia, the number of miles traveled by the truck in the software did not change during the process, which is very imprecise.

But as an introductory course, I learned a lot in the process.As a designer, we need to be responsible for the whole life of the product.In the process from concept to actual production, we need to consider not only outlook and production, but also environment, cost and other factors.In the future design, I need to learn to balance these factors in practice.