

Bamboo Sliver Furniture

M.Des, Industrial Design

Project II

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I take this opportunity to express my gratitude to my guide prof. Avinash Shende for his constant support and guidance in this project.

I thank the entire faculty of IDC School of Design for the inputs that helped me successfully complete this project. The feedback which are received at every stage of the project where immensely helpful and it allowed to look at wider perspective of the project.

I am really thankful to the Artisans working in the Bamboo Studio at IDC helped me making the idea into a reality.

Last but not least I am grateful to my classmates to this product

Sumit Ranjan Kumar

11th November 2019

Mumbai

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1 Design Brief

To design a lounge chair using bamboo slivers for the airports, where people can just sit and relax!

In Guwahati, Assam airport, They are promoting bamboo just by creating interior wall paneling to the pillars, which seems to be very less effective! whereas Madrid Airport in Spain shows a complete contrast of it.



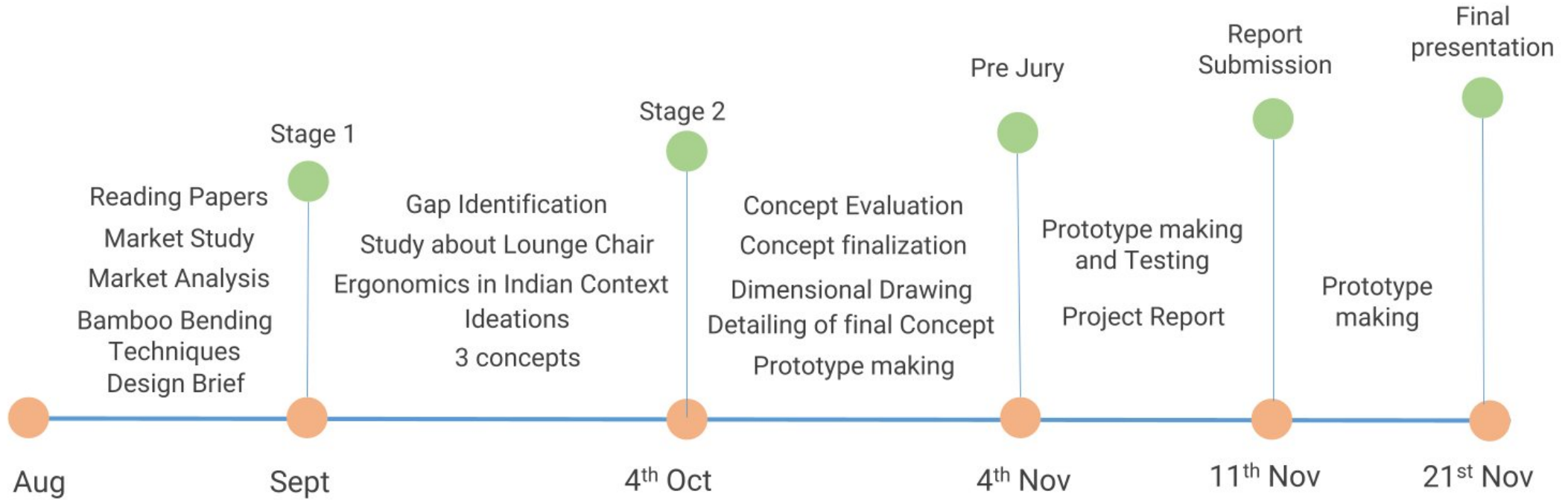
Fig. 1. Guwahati and Madrid Airport

Gap Identification and Opportunity

An opportunity to include bamboo material for sitting, so that people get to interact with it directly!

Key words: Bending, Flow, relax, inviting

Timeline



2 Background Research

Bamboo as a new material for Design

Bamboo is an excellent material for indoor and outdoor furniture's with its light-weight structure, superior mechanical properties and naturally resistance against biological attacks. It is easy to produce different bamboo furniture designs because it is a versatile material, easy to shape and process with simple equipment. The knowledge of a proper processing of bamboo is still not well distributed over the world. The furniture obtained from bamboo has a different look and aesthetic value.

Bamboo has some positive features like mechanical strength, easy processability a renewable material as substitute of wood. Many wood processing companies have recently started to prefer bamboos for sustainable building material and furniture design with the growing trends in environment awareness. Bamboo furniture has been called as a green or eco-friendly material for furniture since the natural resources are being depleted.

It is found that the mechanical properties of bamboo veneers, stripes, strands, particles and fibers are comparable and sometimes better to those generated from wood (Hidalgo 2003, Zehui 2007, Malanit et al. 2010). The tensile strength of bamboo is higher than teak or walnut and twice as stable as oak. It can be used both in building structure, interior design and furniture structures to make long-lasting and competitive products due of its many advantages.

The obvious economic and environmental advantages of bamboo follow as: it grows quick as a straight reinforced segmented culm, after drying it is resistant to swelling or shrinkage due to climate changes, it is extremely durable and resistant after some treatments for reservation, it has a very fine grain, allowing it to come in different styles. Bamboo which is an excellent material for eco-friendly furniture products has drawn as a green building material. It decreases the atmospheric concentration of carbon dioxide which is the main reason of global warming.



History of Bamboo Furniture in Taiwan

- Bamboo furniture used to be one of Taiwan's specialty products.
- The rise of cheap labor in China and Southeast Asia, imported furniture, and service and electronics industries all had a major impact on the bamboo furniture industry in Taiwan in the 1970s.
- To change the stereotypical image of bamboo furniture in Taiwan and revive the industry, it is necessary to create "innovative value" in its style and production for greater appeal and popularity.
- It then changed to modern Design from Traditional crafts as the process was different and machined to achieve the outcome.

Role of Taiwan Government

- Bamboo crafts and bamboo furnitures in Taiwan are mainly designed, created, produced, and sold in Chushan city, a place that prospered during the period of economic growth in the 1970s and 80s in Taiwan.
- In those days, there were about 2000 bamboo factories but over time, the number declined.
- The researchers personally participated in the production process to understand the differences between **the making of bamboo furniture** with *traditional techniques* and *carpentry*.
- Over past 20 years, the private Taiwanese companies and NTCRI have achieved significant progress in design and development of bamboo furniture styles.
- During 1996 and 2003, they started arranging training programs with training and research institutes Dept. of Bamboo Crafts, NTCRI, Ministry of Economic Affairs and got promoted largely.

Traditional Crafts

Modern Design

1. Style

- Product feature cultural and regional characteristics.
- Less ergonomic
- Adjustable forms to different specifications and simpler style

- No historic or cultural background
- Emphasizes more on human factors
- Design is more delicate and intricate
- Due to high cost, specification can not be easily changed

2. Production Process

- Manually intensive production
- Tools and techniques are simple

- Mostly bamboo laminates
- Machined parts are more, most of which are carpentry equipment.

3. Application

- Easily replaced by furniture of other materials
- Materials are readily available
- Inexpensive and good quality
- Fujian and Guangzhou Ming Style, such as armchairs, basin stands, bamboo stands, lounge chairs, bamboo stools, etc.

- Material is hard and smooth, Blends effortlessly into one's living environment

Local Research



Truss Me - By Sandeep Sangaru

- A sustainable furniture system, exploring the possibilities of using solid bamboo poles as construction material.



Cube Stool by Prof. M. P. Ranjan

- It is basic cube shape with a repetitive element of bamboo tied with metallic wire, makes it stable and playful looking.



By Getkraft

- Made of Bamboo and is Foldable.
- Uniquely Engineered Chair that does not cause any kind of discomfort to the Back while Relaxing on it.
- Ideal Poolside chair, Lawn or Garden chair, or Beach Chair.



By Prajakta Bamanikar at IDC

- The main characteristic of the chair is its structure, which has a nice curved shape made from thin pieces of metal that are combined to form a continuous shape.
- it's not as comfortable as other chairs because it doesn't have a soft cushion.

Global Research



Cantilever chair '43: Yii by konstantin grcic

A collaborative project organized by NTCRI (National Taiwan Crafts Research Institute) and TDC (Taiwan Design Center),

Yii represents the “transformation” in traditional crafts, the “respect” for Mother Earth, and the “harmony” between human and Nature.

- created a forty-three-slatted chair that pushes the structural potential of the material, turning its flexibility to the service of user comfort.
- The piece works visually to underscore its lightness and strength.



Spring Chair : By Anthony Marschak

- versatile seating piece with inherent strength and flexibility of bamboo, and provides a unique response to the weight and movement of each individual



Nendo's Bamboo Steel Chair

- Collaborative project organized by NTCRI – Yii Series
- Inspired from bamboo weaving technique and use it in tubular Steel pipes



A New Layer II: 2012-2018: By Jin Kuramoto Led by NTCRI

Aimed to transform traditional Taiwanese craftsmanship products into contemporary design objects and furniture

3 Bamboo Bending Techniques



Steam Bending



Blow Bending



Hot Air Gun

4 Types of Lounge Chair

Classic Lounge Chairs



Long chair, can stretch out completely on without to use an ottoman

Chaise Lounge



Long chair, can stretch out completely on without to use an ottoman

Club Chairs



Low back with deep seats. It also inspired the Eames lounge Chair

Recliners



Arm Chair with Recliner for better comfort

Poolside Loungers



Designed for outdoor uses

5 Grand Master's design



Eames Lounge

Price: 4 Lacs



Le Corbusier's Lounge

Price: 2.9- 3 Lacs

Inferences:

Great curves and lines to admire the beauty!

Cushioned Seats given for better comfy

Fixed and adjustable inclination

Metal base structure

6 Lounge Chair in different scenarios

Lounge Chair in hotels

Fixed inclination type lounges

Inclination is less

Club and Arm chair type used

People mostly use it for reading, having conversations



Lounge Chair at swimming pool

Reclined type of lounge.

Arm rests are not there mostly.

Mostly have ventilation, and have low height

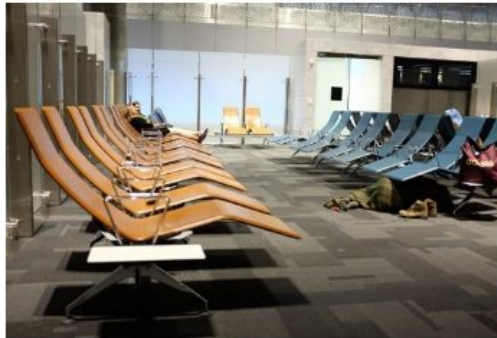
People mostly use it for a good free time break, have sunbath, relax, drink or sleep



Lounge Chair at Airports

Cushion Lounges are installed mostly.

Fixed inclination type lounges.



Lounge Chair gives a good opportunity for designing with bamboo sliver.

Design Brief

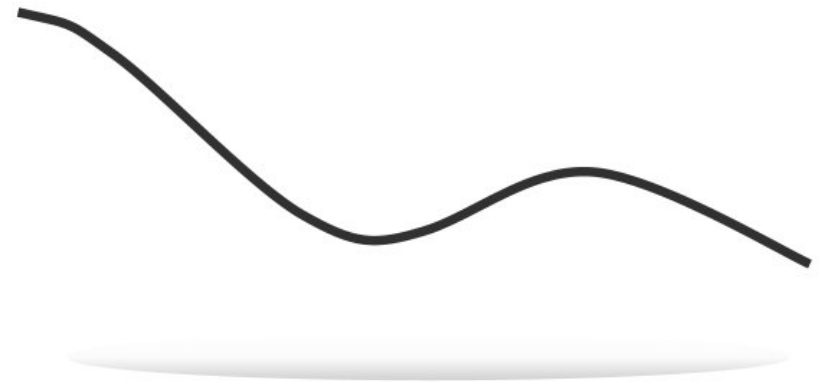
To design a Lounge chair for the Airports using bamboo slivers, where people can just sit and relax!

And also appreciate the material!

Why bamboo sliver??

its gives more opportunity to play and experiment in terms of form, flexibility

Key words: Bending, Flow, relax, inviting



7 Activities while lounging at the airport

Activities people do while lounging at the airport

- Relax!
- Watching Movies on Laptop
- Surfing social media
- Listening to music
- Reading book
- Reading about the new place!
- Playing video games on smartphone
- Drinking coffee, soft drink



Emotions of people while waiting at the airport

Stressed

- Long waiting hours in international flights
- Have to reach early to avoid rushing!
- Have missed the flight
- Travelling becomes hectic



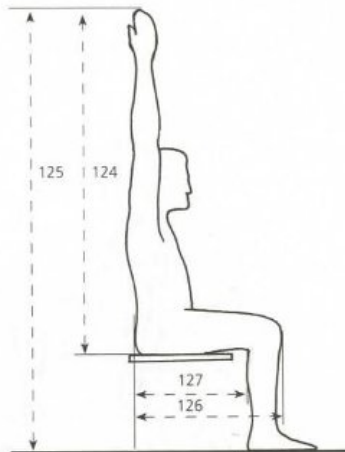
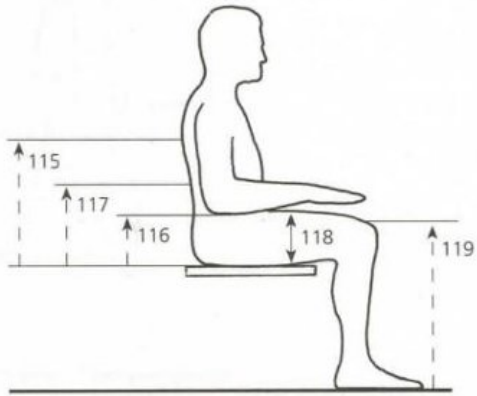
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<https://edition.cnn.com/travel/article/airport-arrival-time-opinions/index.html>

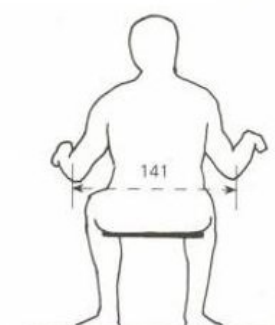
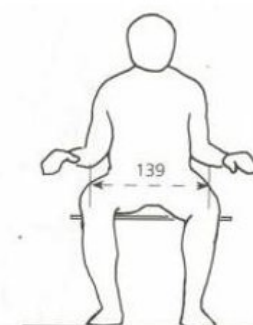
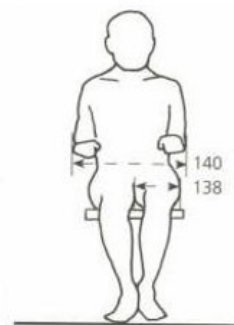
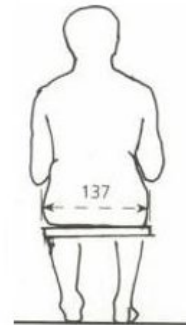
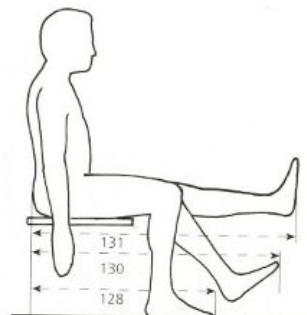
<https://www.zoomlite.com.au/blogs/news/while-waiting-at-an-airport>

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Anthropometric consideration as per Indian Dimensions

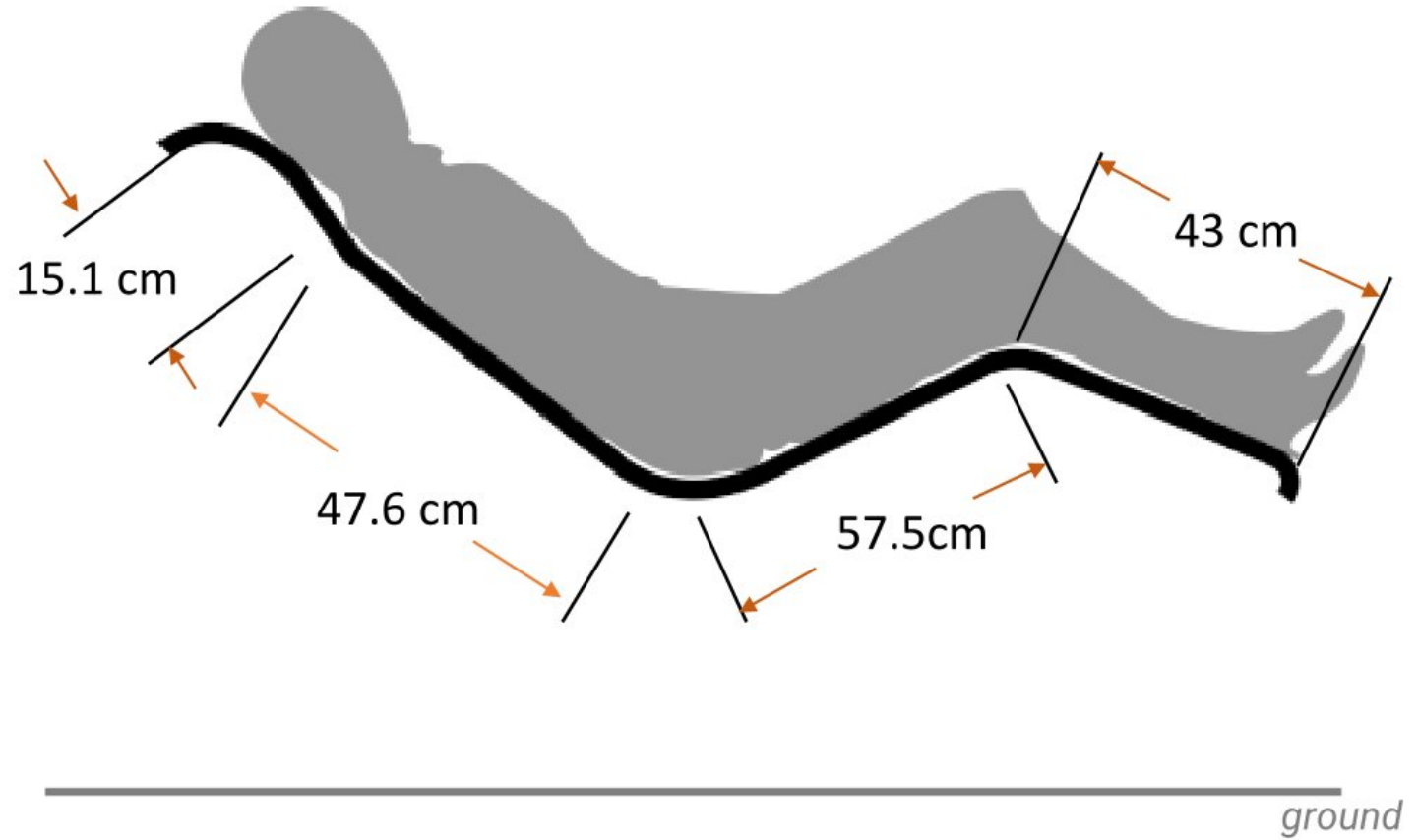


R.No.	Parameters		Min	Percentiles					Max	Mean	±SD	Ratio
				5th	25th	50th	75th	95th				
115	Tip of shoulder blade	Male	341	373	399	417	442	476	600	422	32	0.26
		Female	231	303	351	364	385	419	448	367	36	0.24
		Combined	231	350	389	411	437	470	600	412	39	0.25
116	Elbow rest	Male	112	158	192	213	236	270	335	215	34	0.13
		Female	102	124	170	194	218	265	290	195	39	0.13
		Combined	102	150	188	210	234	268	335	211	36	0.13
117	Waist	Male	103	154	173	188	199	221	327	189	24	0.11
		Female	136	165	188	204	221	260	287	207	29	0.14
		Combined	103	157	176	189	203	231	327	192	26	0.12
119	Knee	Male	438	472	497	519	539	567	612	520	30	0.32
		Female	412	440	462	484	499	520	578	483	28	0.32
		Combined	412	456	489	509	534	563	612	511	33	0.32
126	Buttock to knee length, normal sitting	Male	400	489	529	558	581	615	861	556	43	0.34
		Female	409	459	503	526	553	585	670	527	40	0.35
		Combined	400	479	520	549	575	613	861	549	44	0.34
127	Buttock to popliteal length, normal sitting	Male	350	399	431	455	477	512	595	456	35	0.28
		Female	340	384	417	439	468	494	560	442	36	0.29
		Combined	340	394	429	451	474	509	595	453	35	0.28



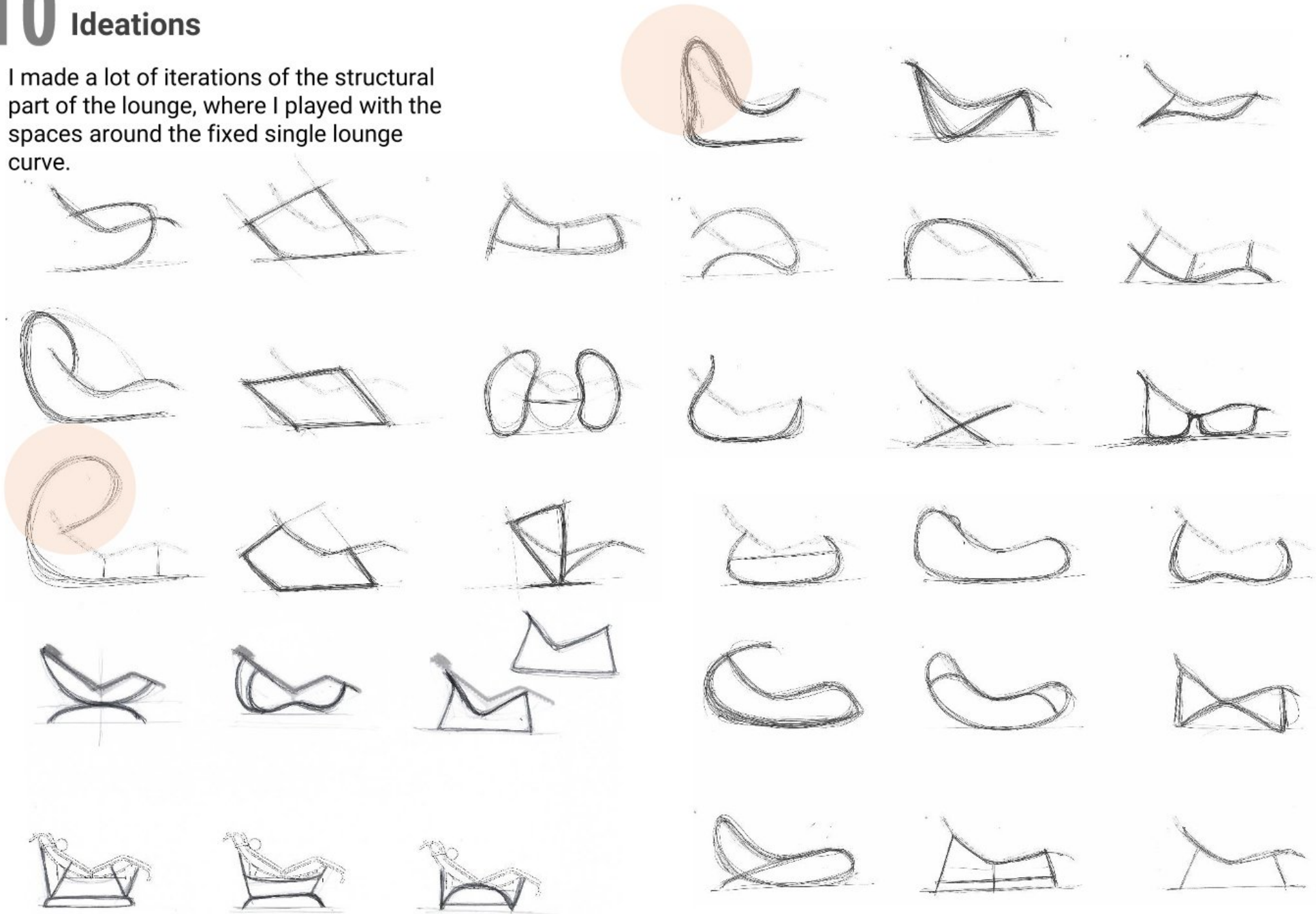
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Ergonomics considerations as per Indian Standard

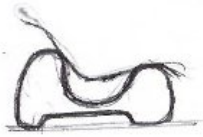
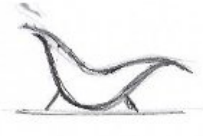
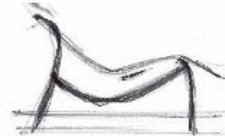
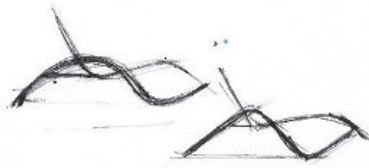
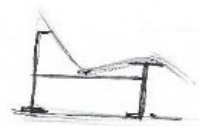
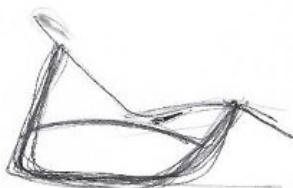
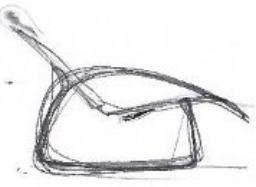
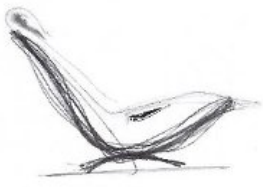
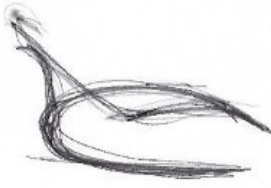
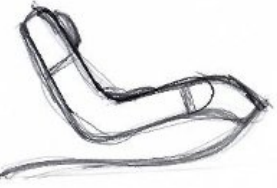
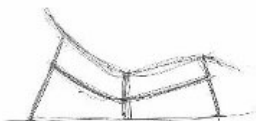
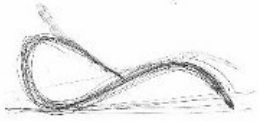
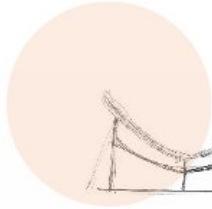


10 Ideations

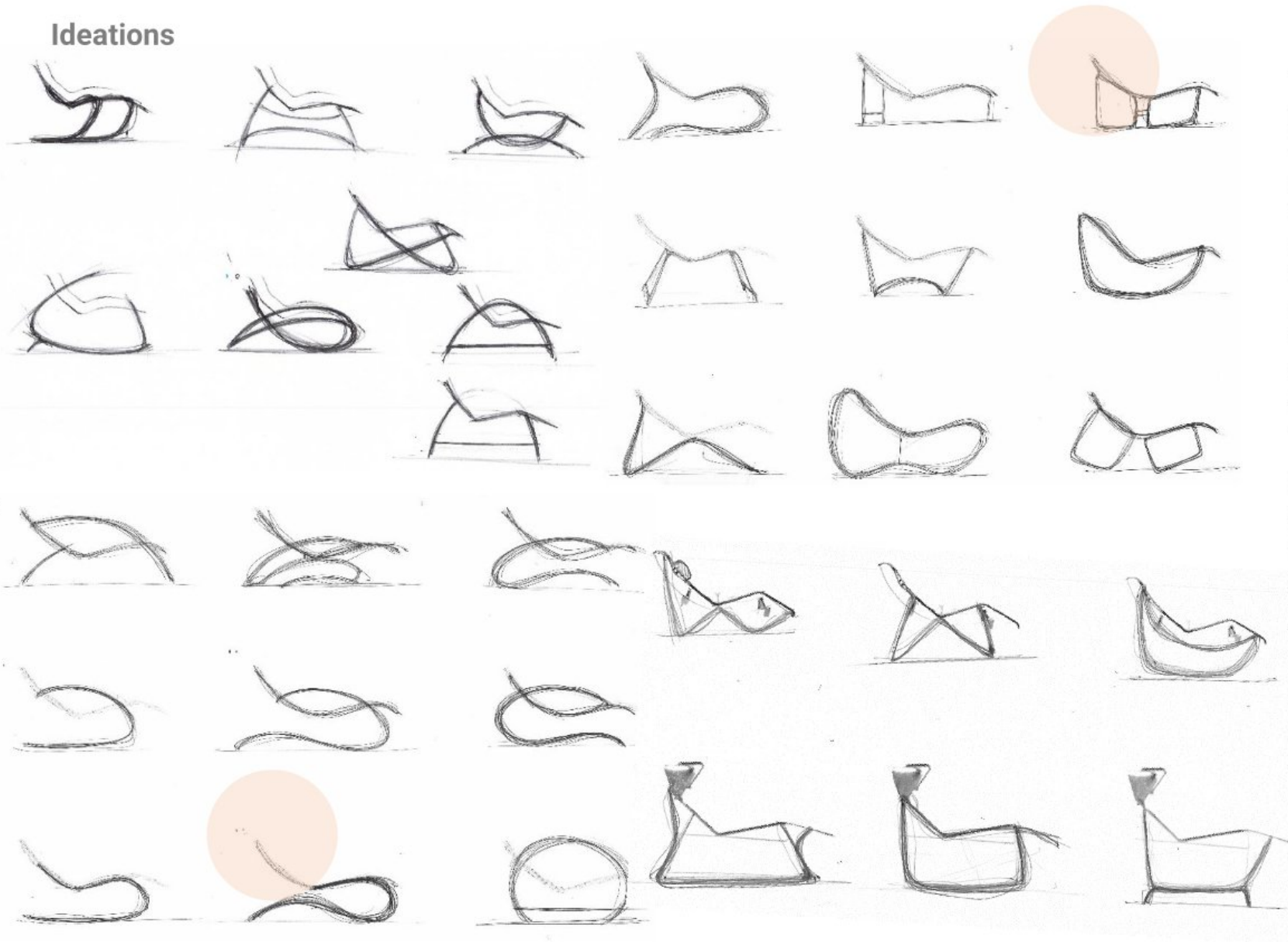
I made a lot of iterations of the structural part of the lounge, where I played with the spaces around the fixed single lounge curve.



Ideations



Ideations



These are the initial iterations which I did where I focused upon side profile of the lounge chair which also gives a good understanding of how your chair will look like. After a discussion with my guide we selected few ideas out of all, where we considered the newness in line and forms, which could lead to different directions. Then I started detailing it out and then made few scaled mockups to get a better picture of the idea.

11

Concept 1: Alpha

This concept has continuity in its form that shouts out, so we worked upon it further. there are three repetitive strips on the both side that creates a spring mechanism while sitting, which can enhance the experience while lounging. we Also considered the activities which are done while lounging at the airport.



I started making prototype concept one at 1:1 scale and I found that it is not sturdy enough and would not be able to support the human weight.

More insights from the failed prototype are:
- A metallic frame would be needed to support the structure and person's weight.



12 Concept 2: Voronoi

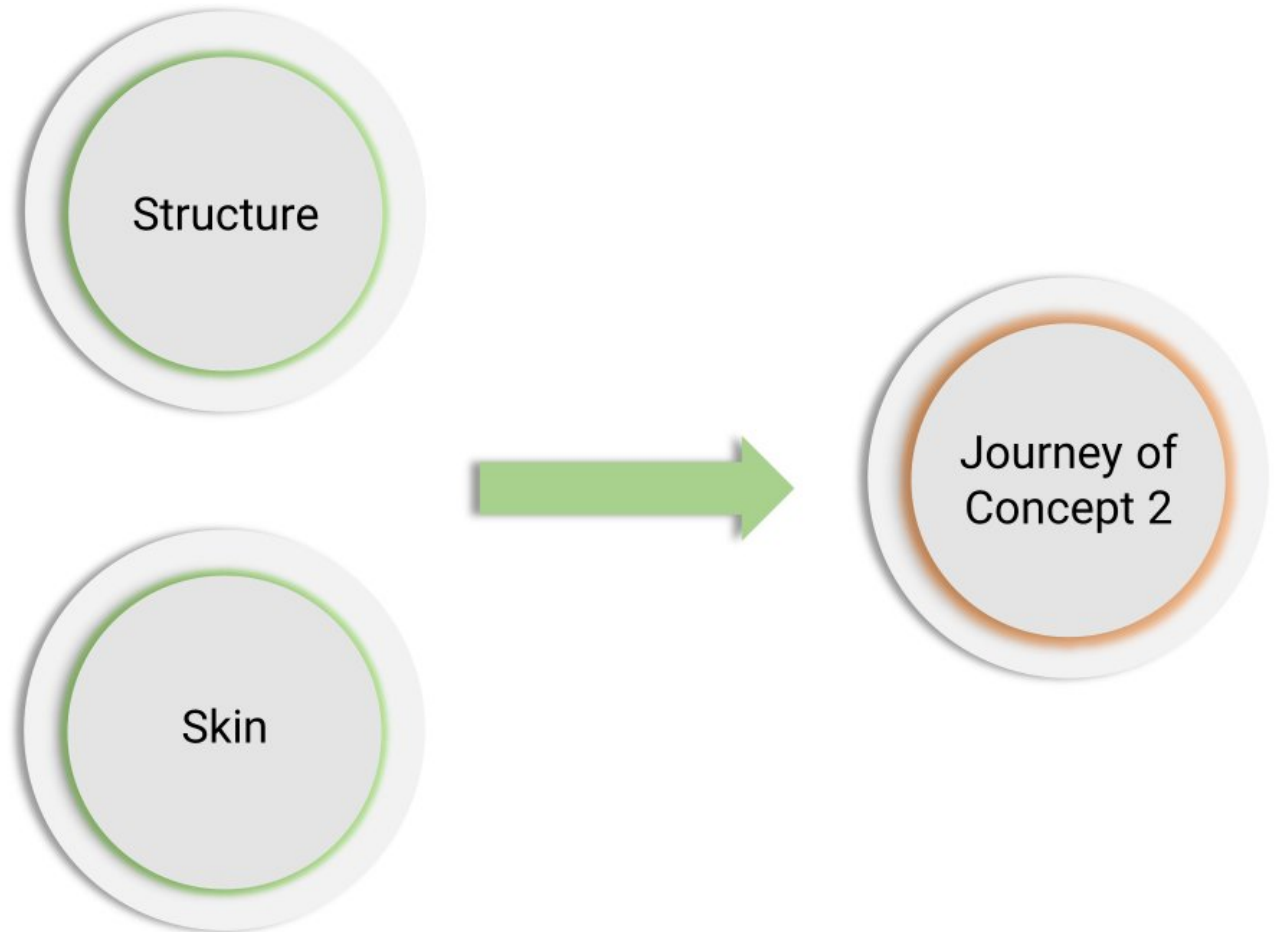
This concept is inspired from Voronoi pattern, which has a similar structural part supporting the structure.



Voronoi Pattern

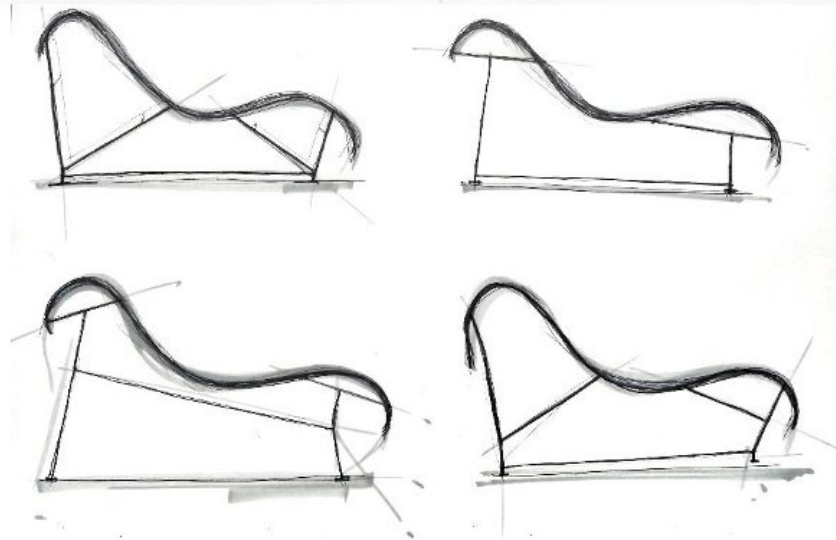
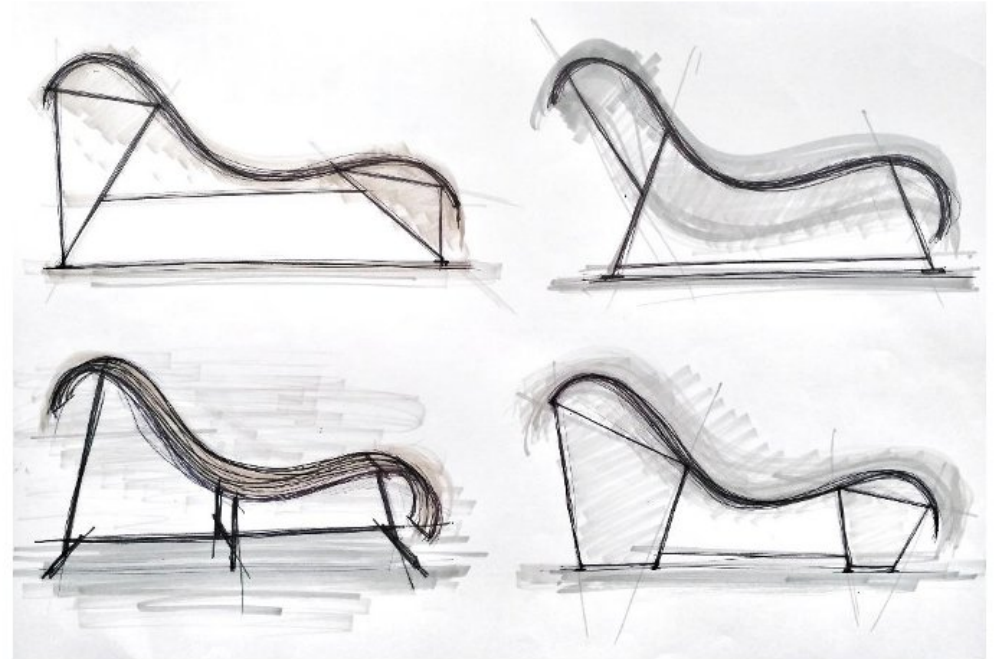
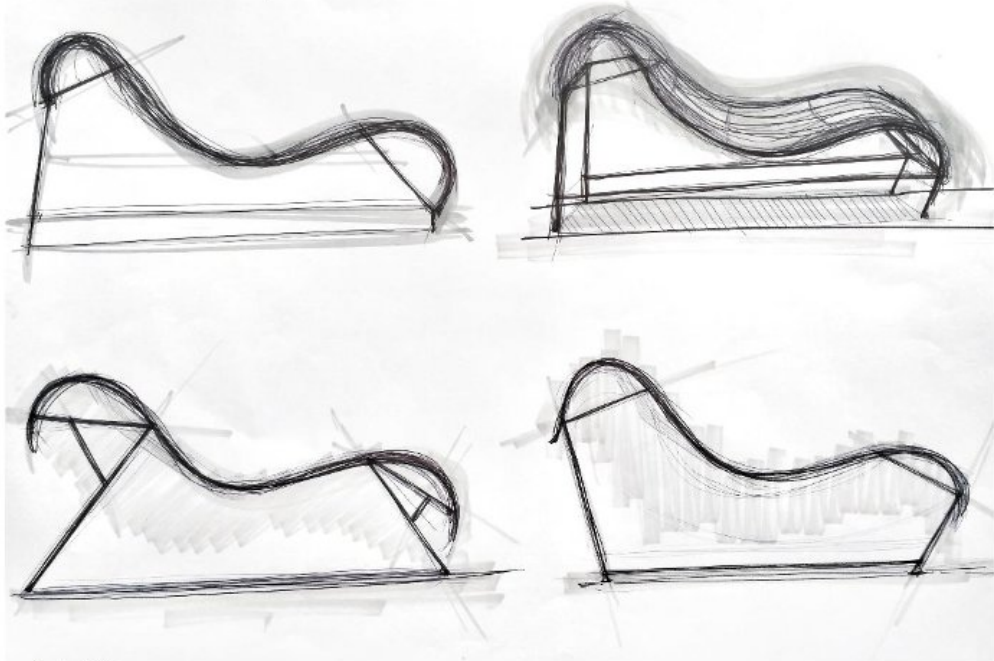
13 Journey to concept 3

I considered Bamboo as a skin element and structure as other one and started ideating to get a new direction. Have a look!



Ideations

Here, I considered the base structure to be metal, and did few iterations considering which one goes with the form, that should be stable, with least structural element.

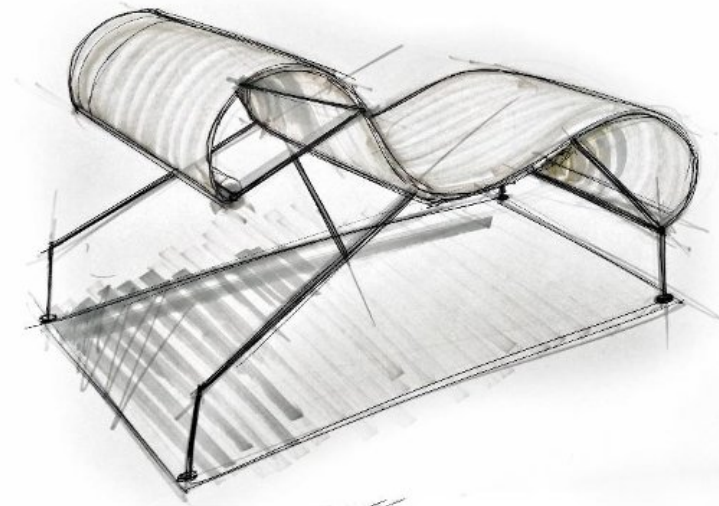
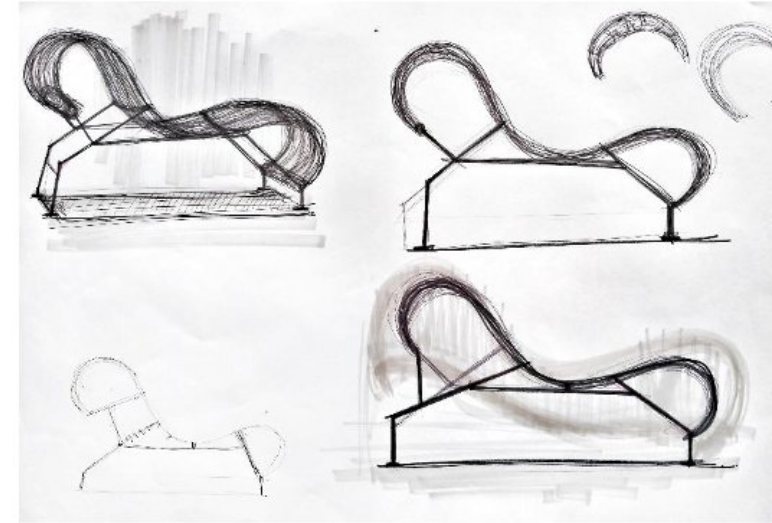




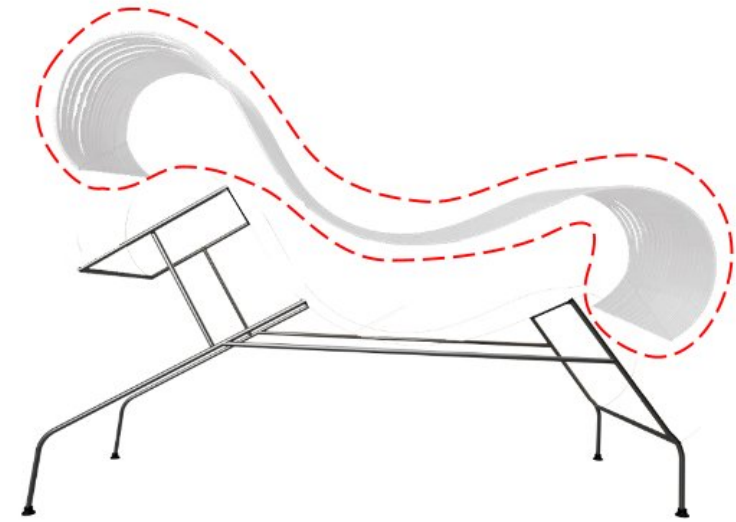
Here, the base point of the structure is towards inside, which might create instability in the overall form. Also, I was not happy with the form, so worked upon it further more!



Here, the base point of the structure is taken slightly outwards. Also, the metallic element got increase to create the balance in the form.



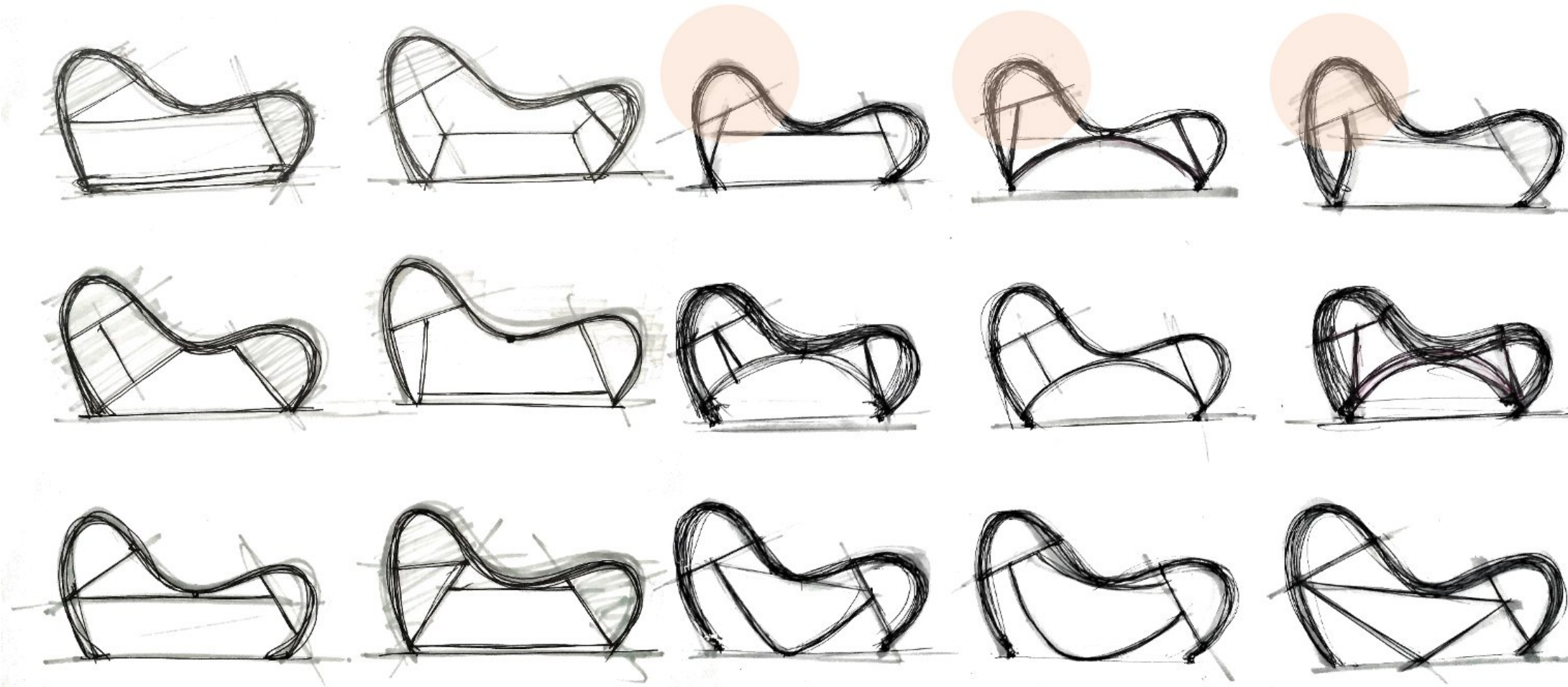
After playing with this idea, it started showing a **horse** form, I tried to keep the metallic element least possible, which can make the overall form stable.



Paper Prototype
Scale 1:7

I with my guide analyzed this idea, and concluded that here structural part is dominating compare to Bamboo element. So, I started ideating further and the later spline concept evolved from it!

14 Spline Concept



The highlighted ideas were taken further and worked upon, other ideas either dominate in structure, or have more elements than required, or not stable when analyzed.

3D Exploration



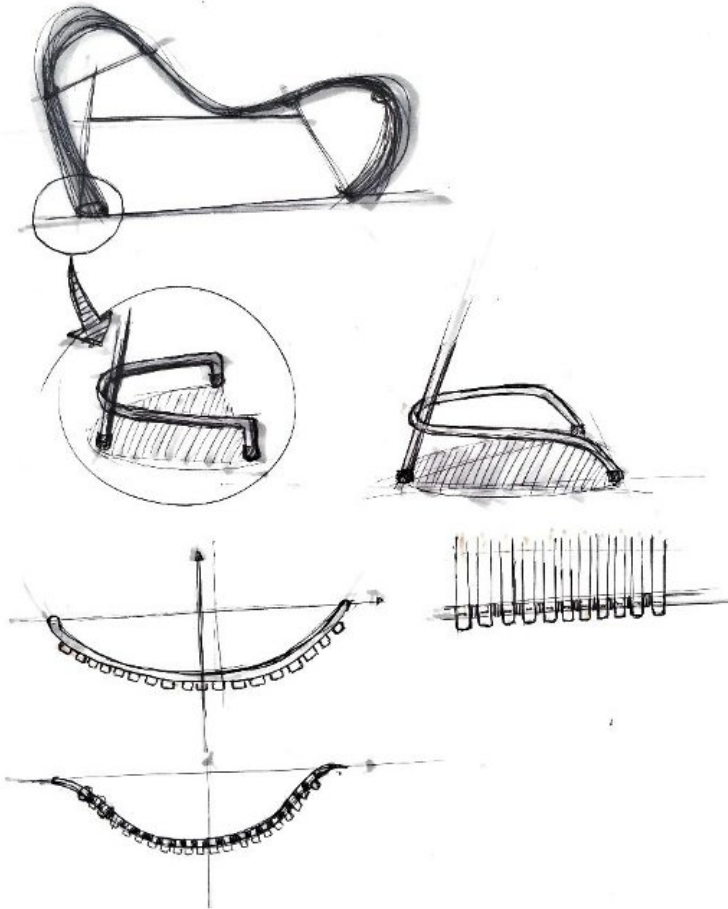
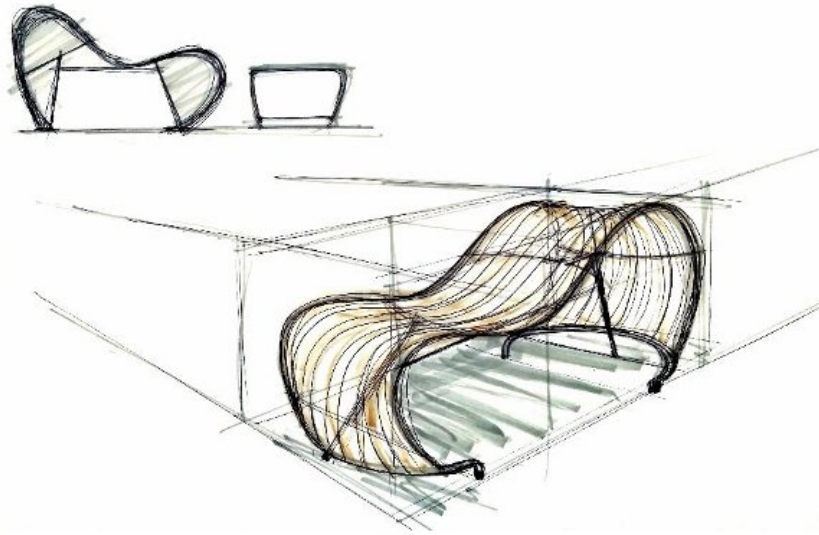
Metal structure to both the ends
make the structure more
dominating

metallic base is required at
ground connected to the rest of
the structure, for good stability
and sturdiness



metallic base is required at ground
connected to the rest of the structure,
for good stability and sturdiness

Curved metallic structure, and lowest
base part are disturbing and disrespects
the beauty of overall form



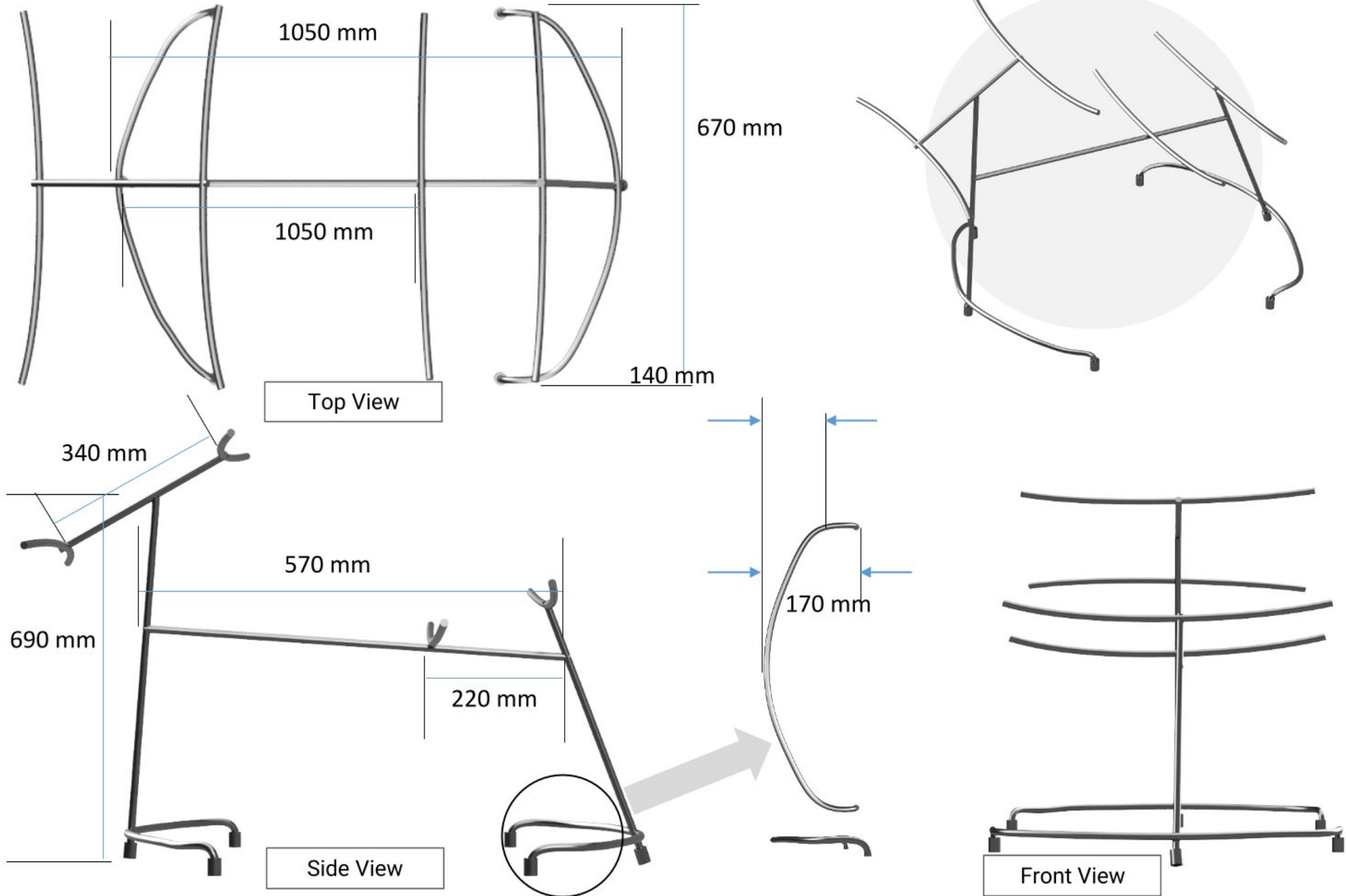
The side bases at both sides are little extended outside which goes along the curve, that creates a better stability to the form

Paper model of Spline concept

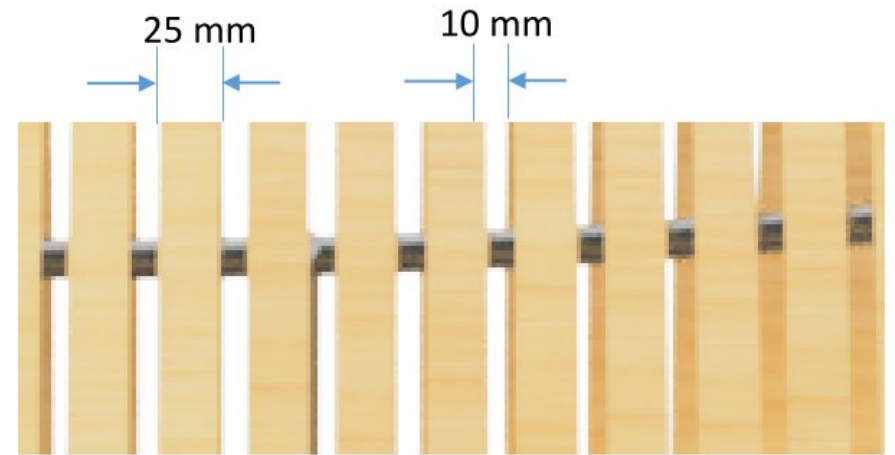
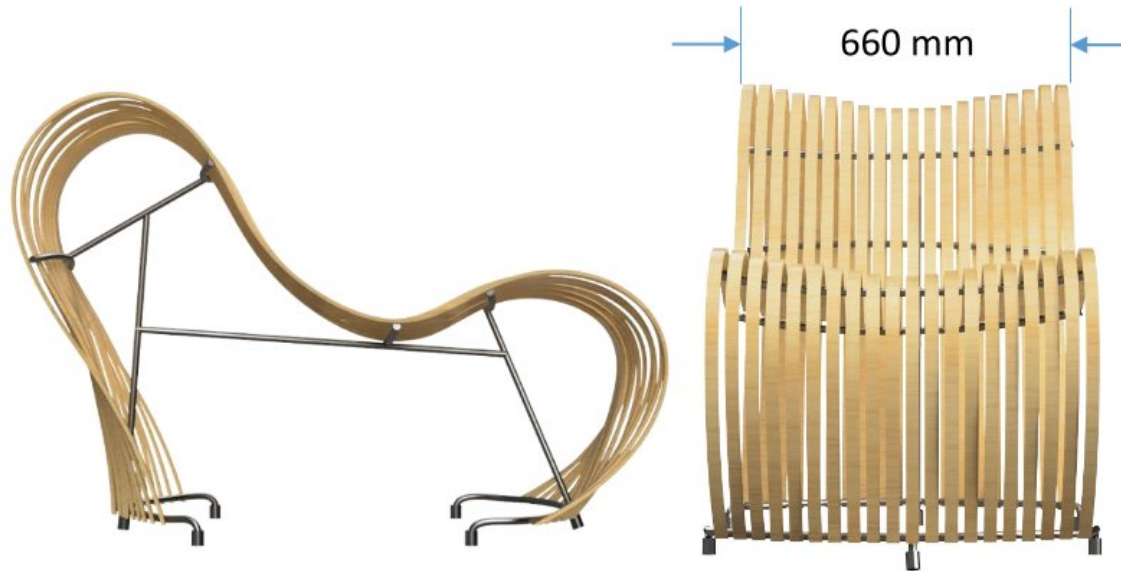
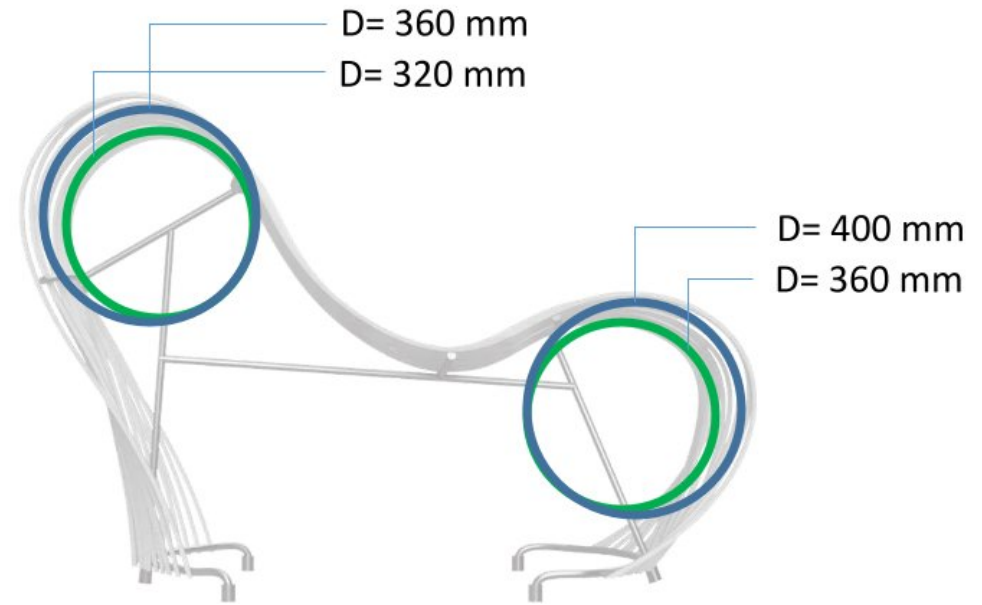
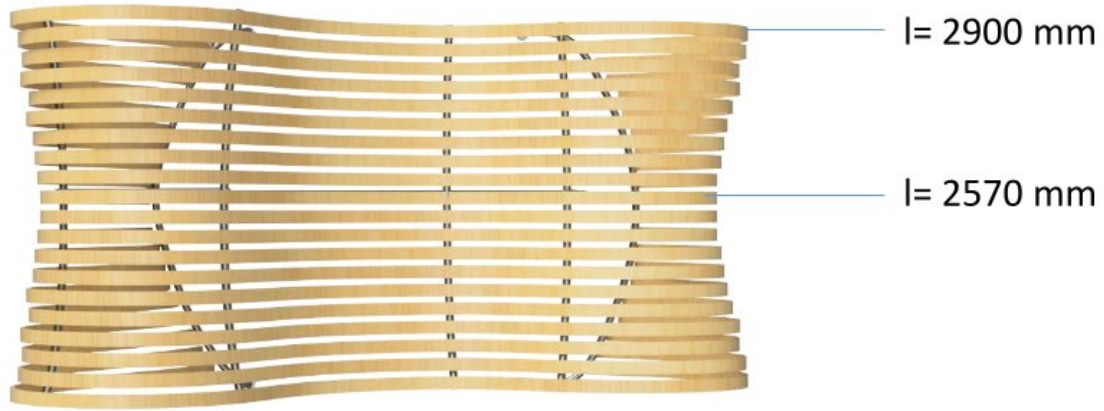


Scale 1:7

15 Detailed Dimensions



16 CAD Drawing with dimensions



Spline Lounge



17 Manufacturing process

1. Making of Steel structure



Manufacturing process

2. Bamboo sliver forming



Bamboo slivers kept in water to make it softer for further treatment



Heating and bending



Bent slivers putting on frame



18 User testing



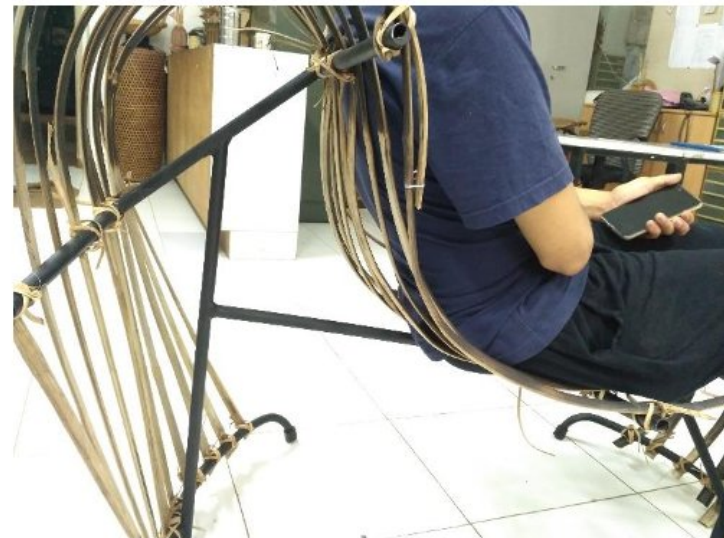
Sitting Position1- the head part should be little up for better comfort, cushioning is a good option!



Sitting posture 3



Sitting posture 2



Gap to be filled by changing the sliver curve or some cushioning need to be provided



Sitting Position



Resting Position



Required Ottoman position

Feedback from user testing:

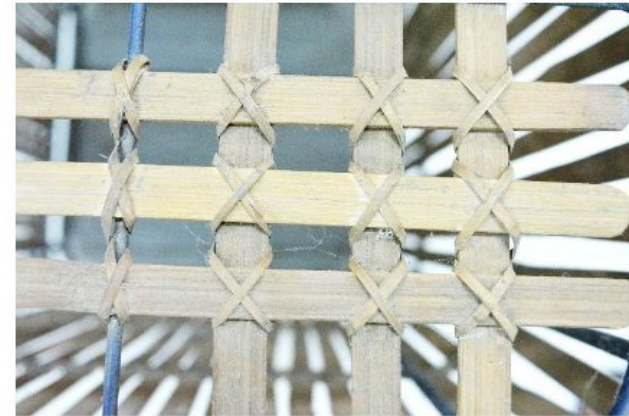
Head and back need cushioning

A Leg Rest/ Ottoman would be great!

Person can sit in various position as per the need

*This is not the final prototype**

19 Joinery Study

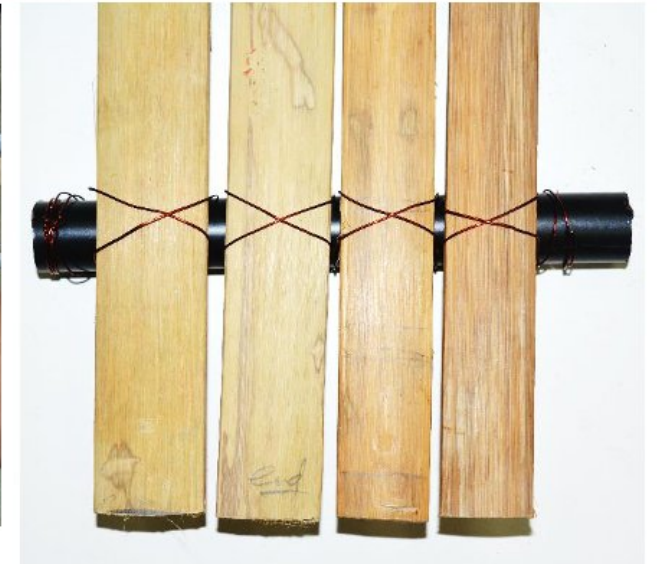
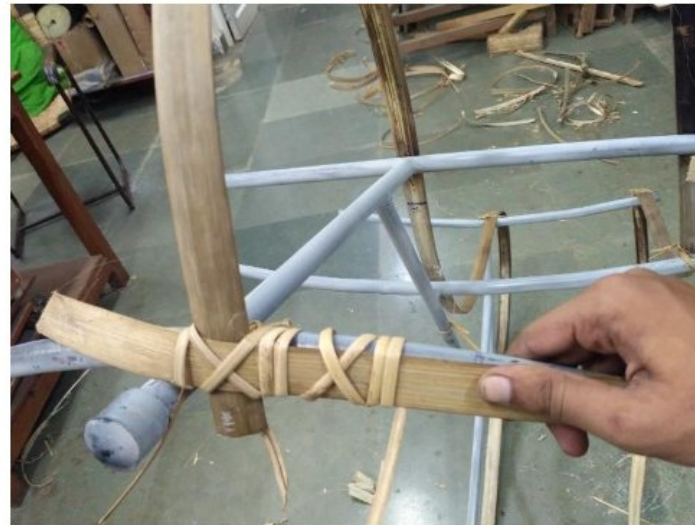
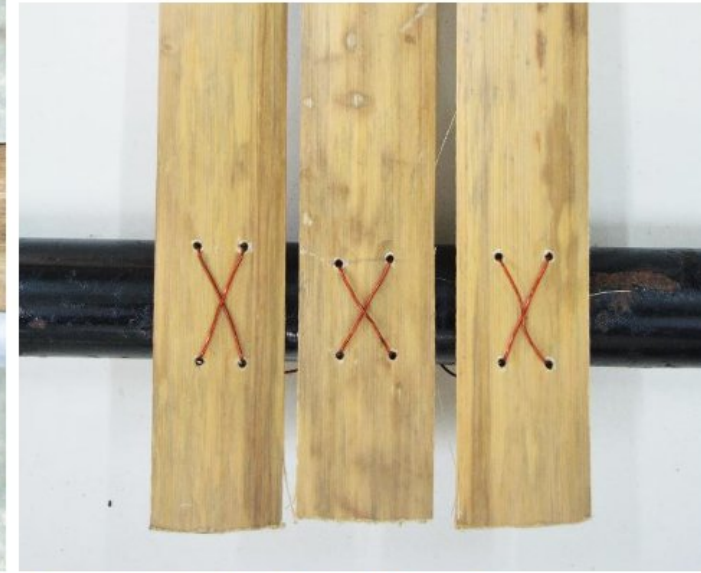
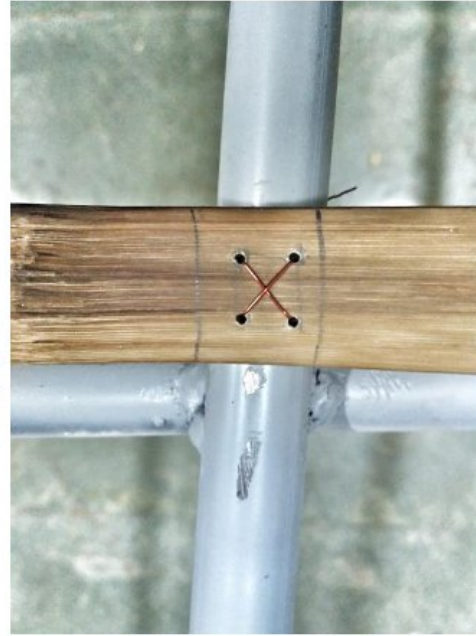
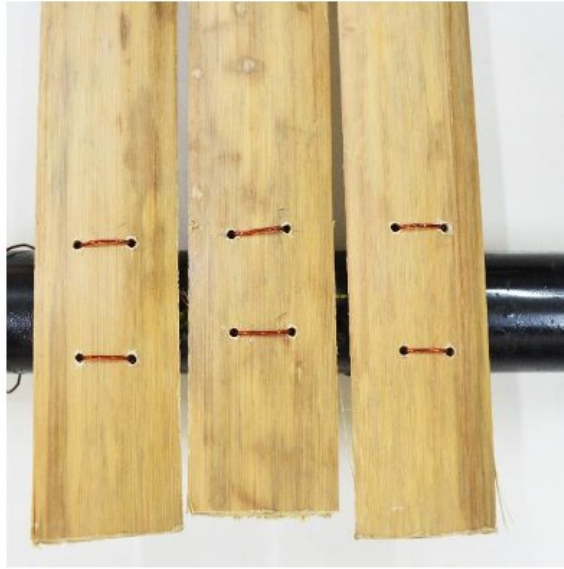


Joinery study in Bamboo Studio

Joinery study from Prof.
MP Ranjan's work



Joinery Detailing



Joinery with holes in bamboo tied up is more strong and stays tightly at the position

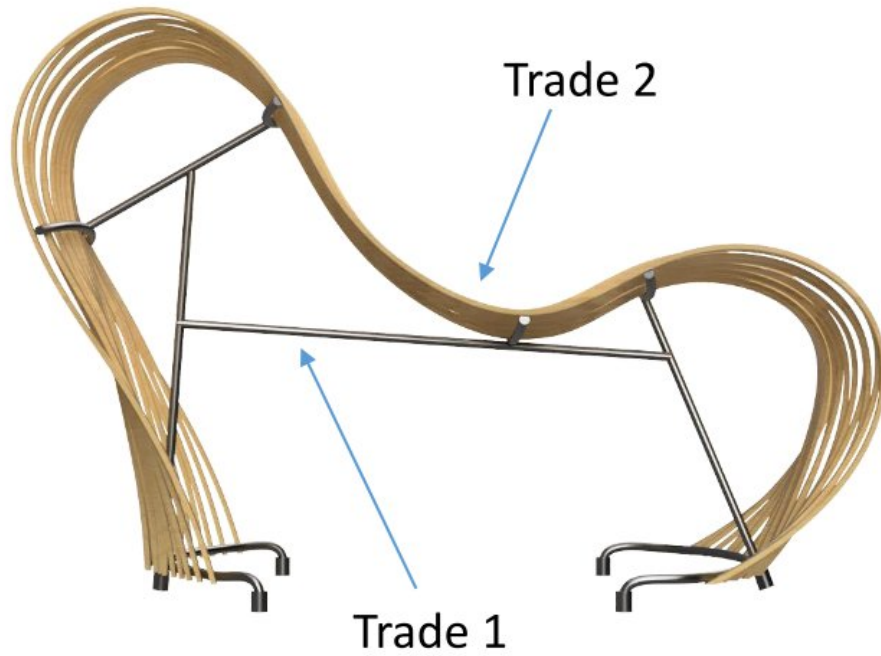
20

Material and Manufacturing cost of a unit (BOM)

Material cost		Labor cost	Time Taken
Bamboo - 24 ft. Bamboo. - 20 slivers from 2 bamboo	400/-	MS Bending and welding- 400/-	Bending and welding- 4 Hrs.
MS Pipe - 50 Rs. Per meter	600/-	Bamboo Bending work (2 craftsmen) - 3000/-	Bamboo bending- 4 days (8 hrs.)

Total Cost– 5000/- (approx.)

Spline Lounge



-It gives Bamboo Entrepreneur more opportunity

-they are mostly from non-design background.
So it gives a new approach to use it!

21 Inspiration

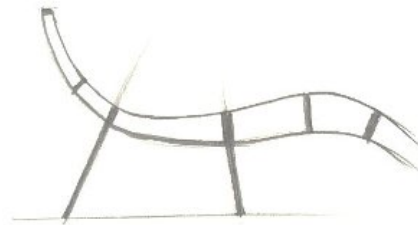
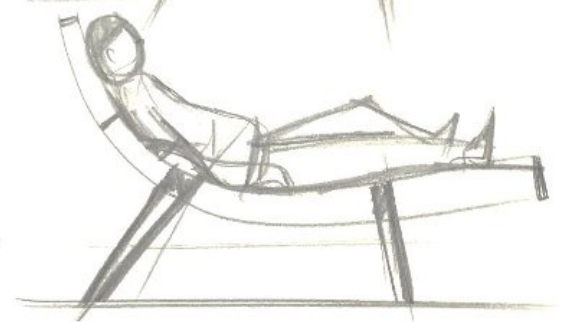
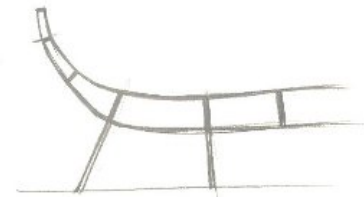
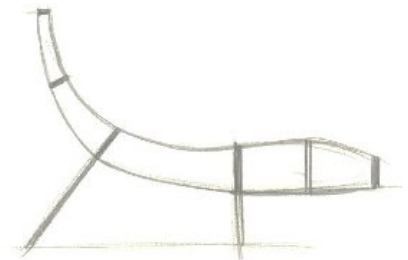
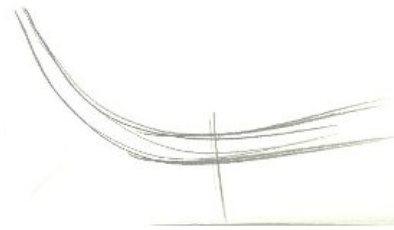
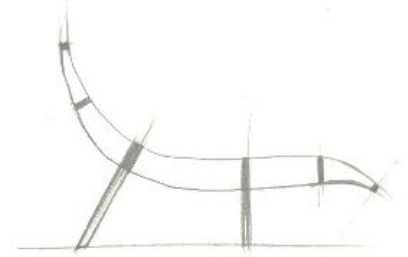
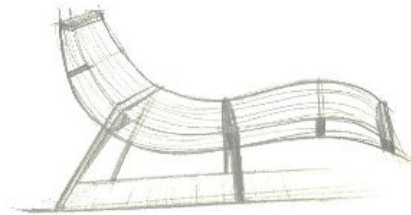
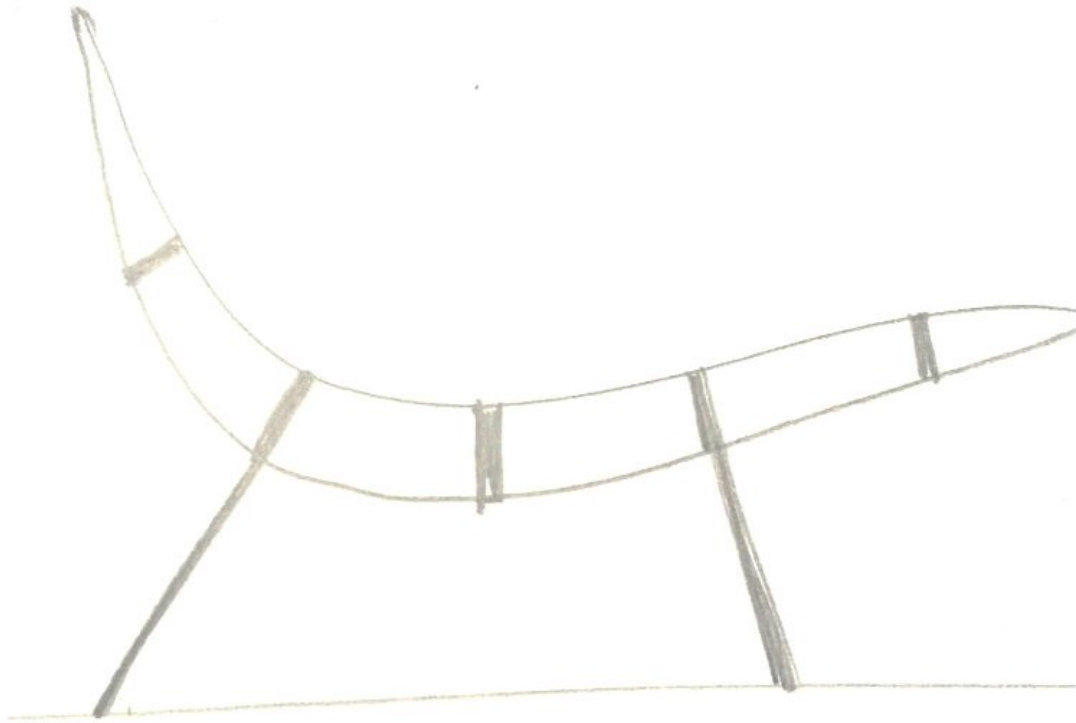
For final design



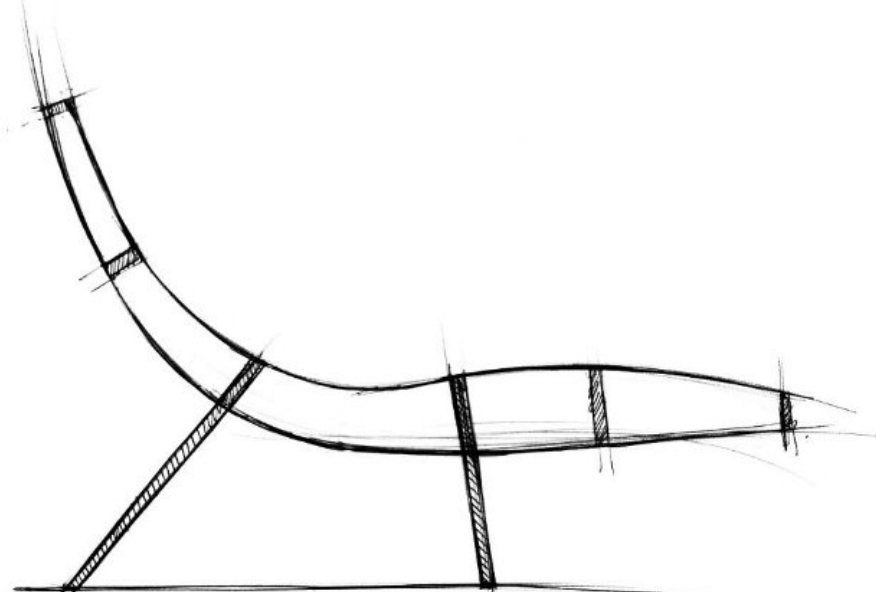
Style Board



CONCEPT DEVELOPMENT

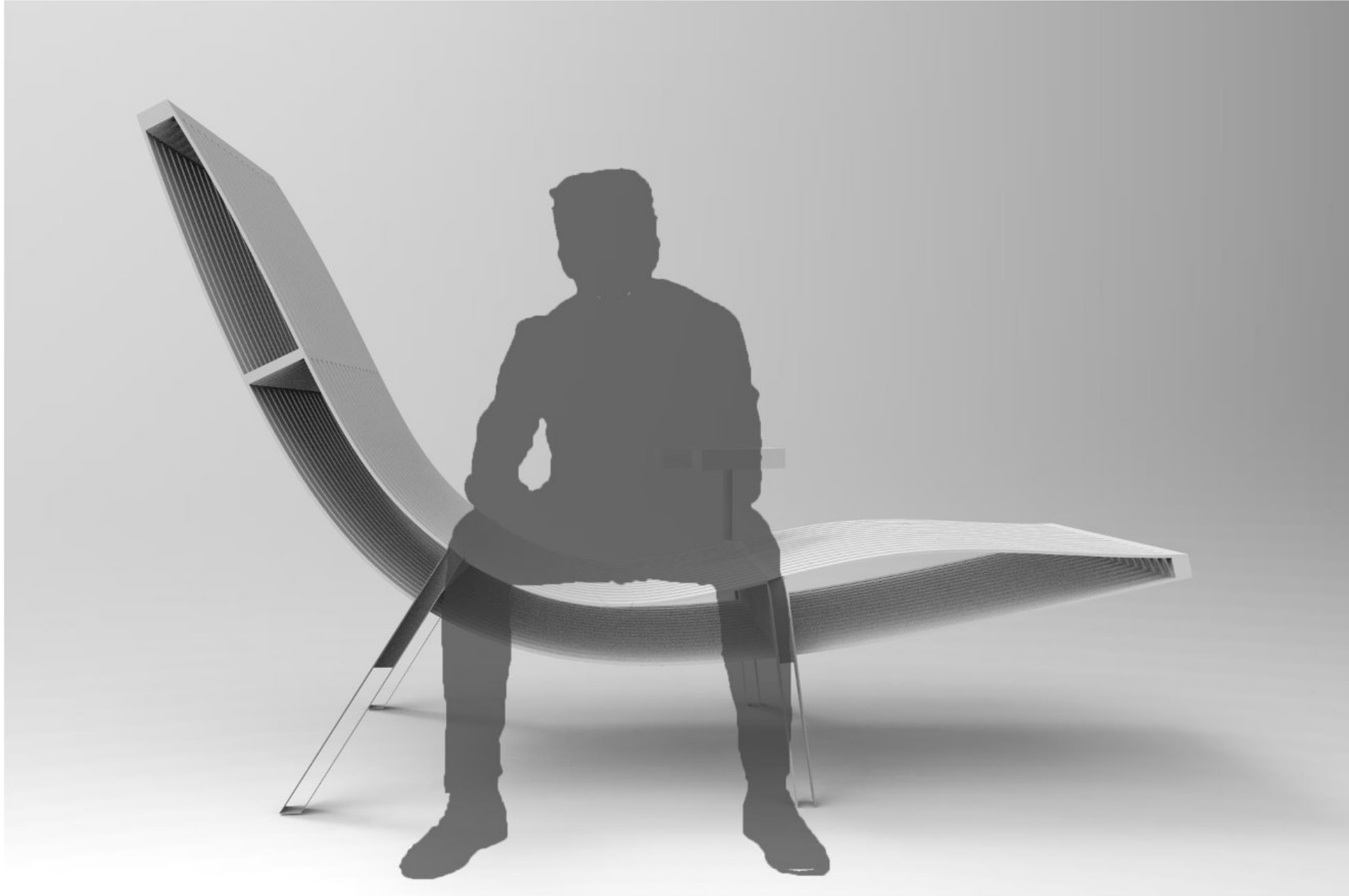


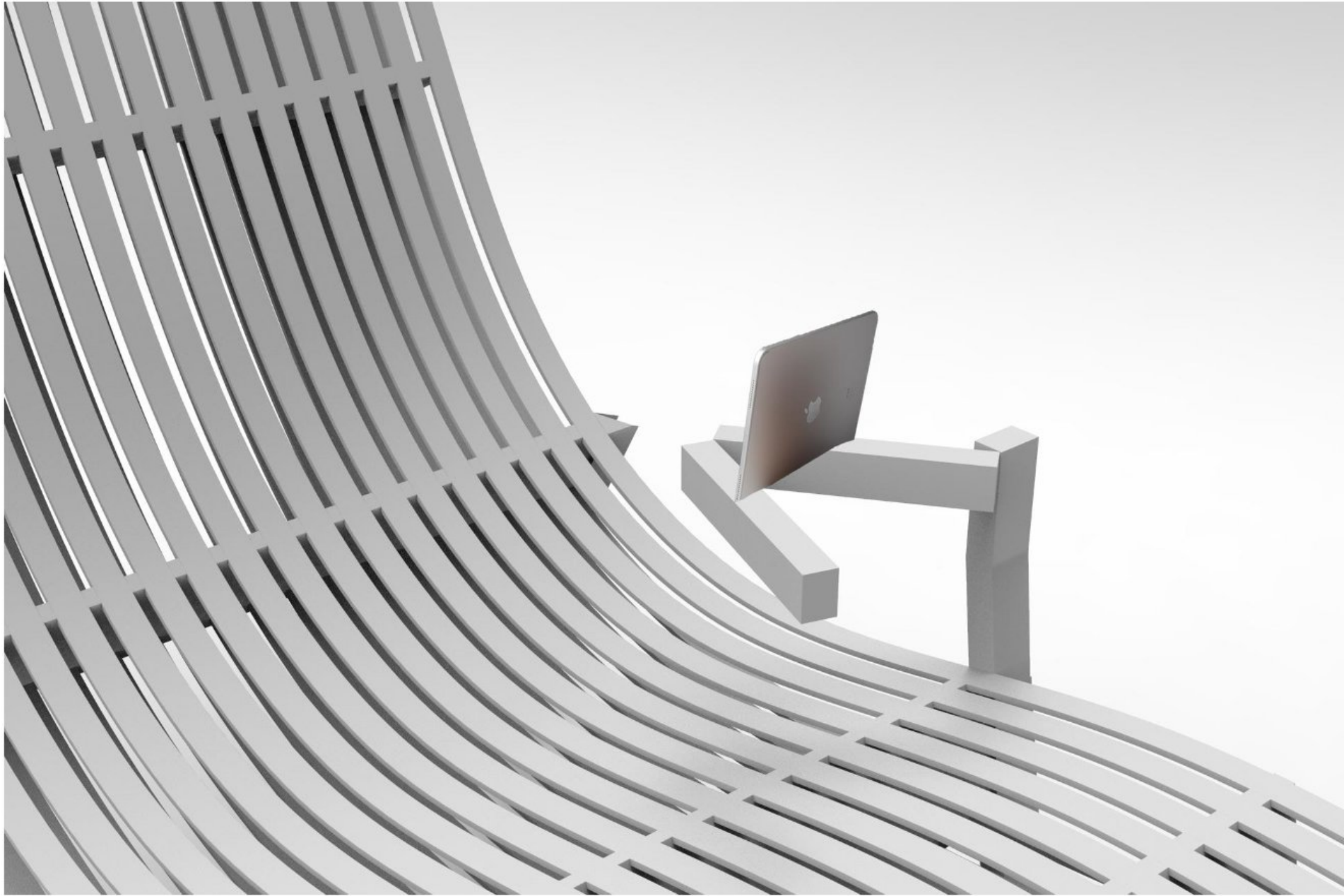
CONCEPT DEVELOPMENT

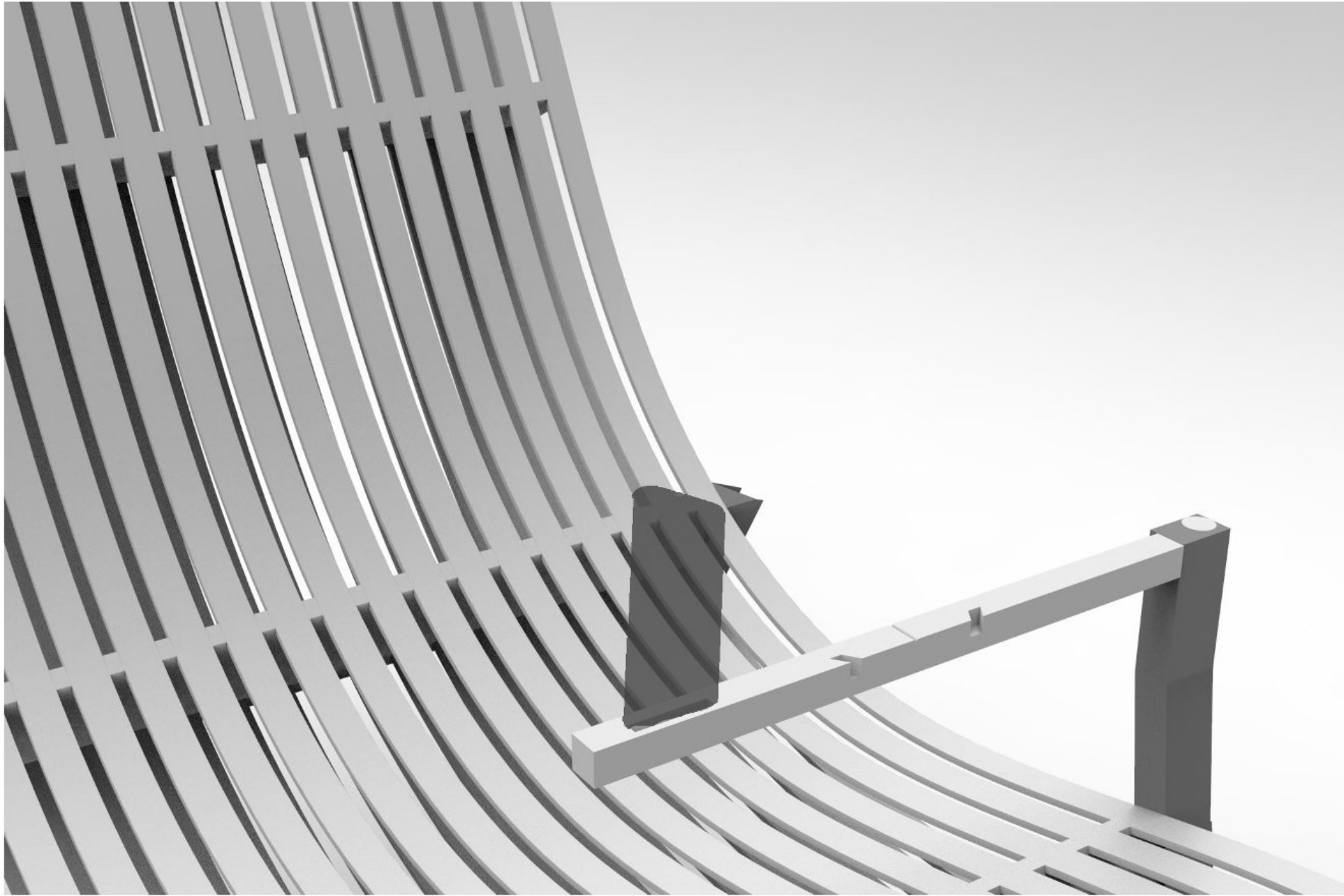


Muse Lounge

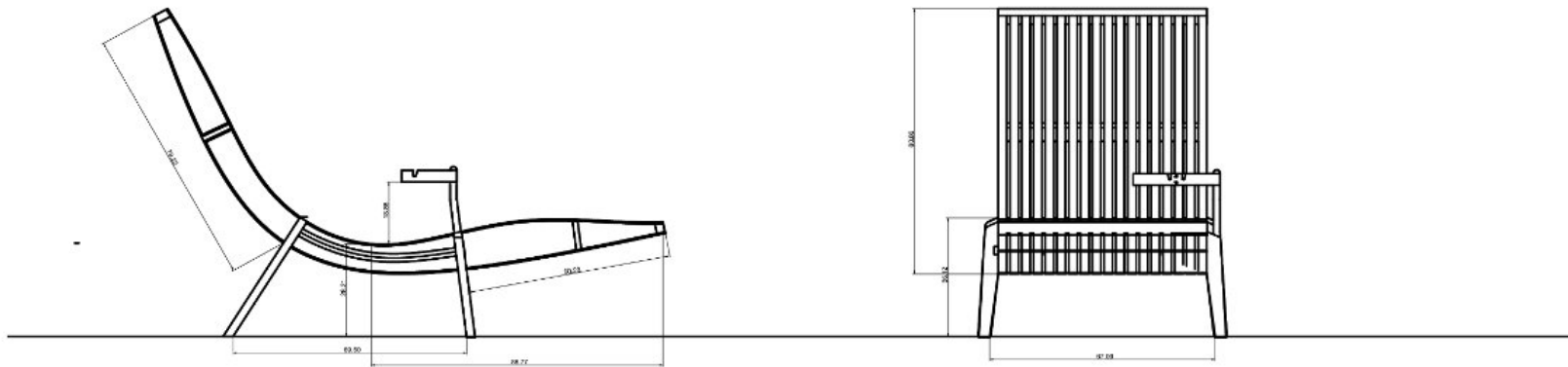
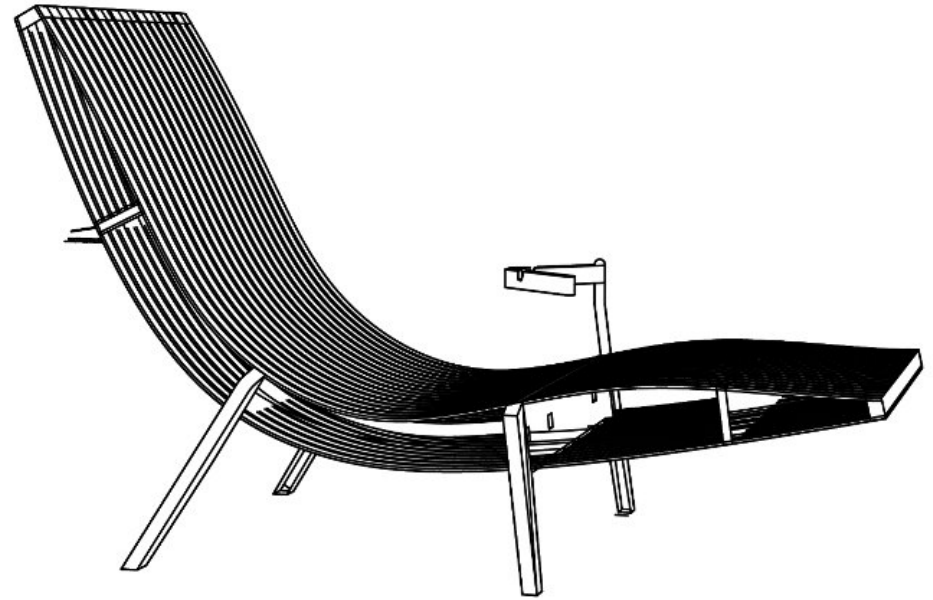
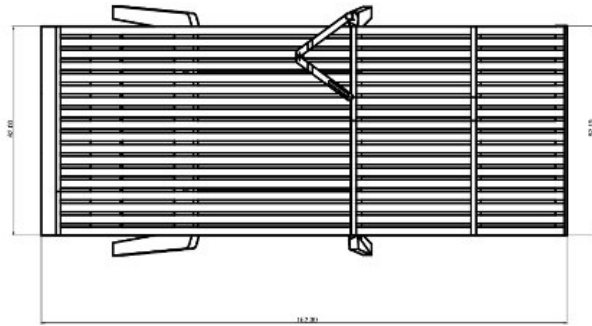




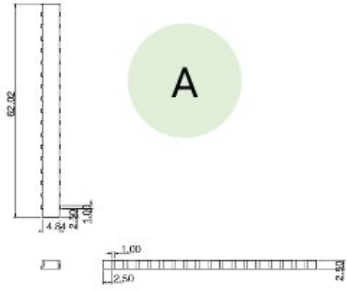




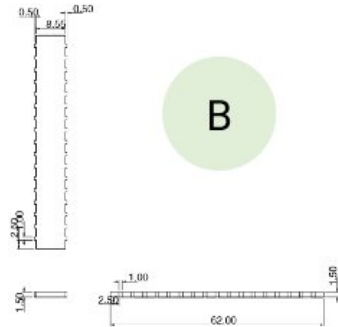
Dimensional Drawing



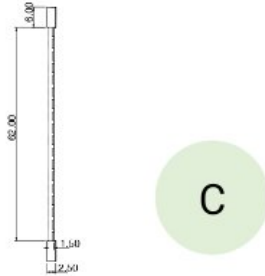
Dimensional Drawing



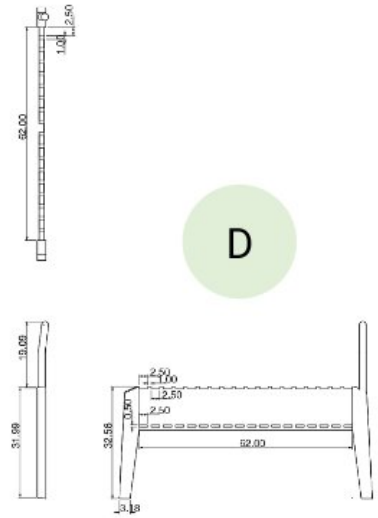
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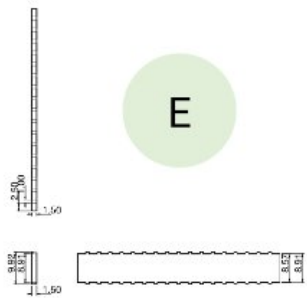
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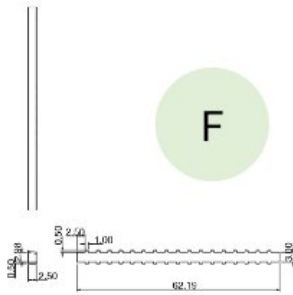
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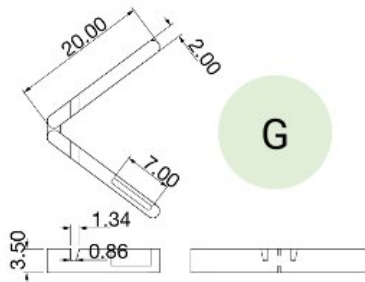
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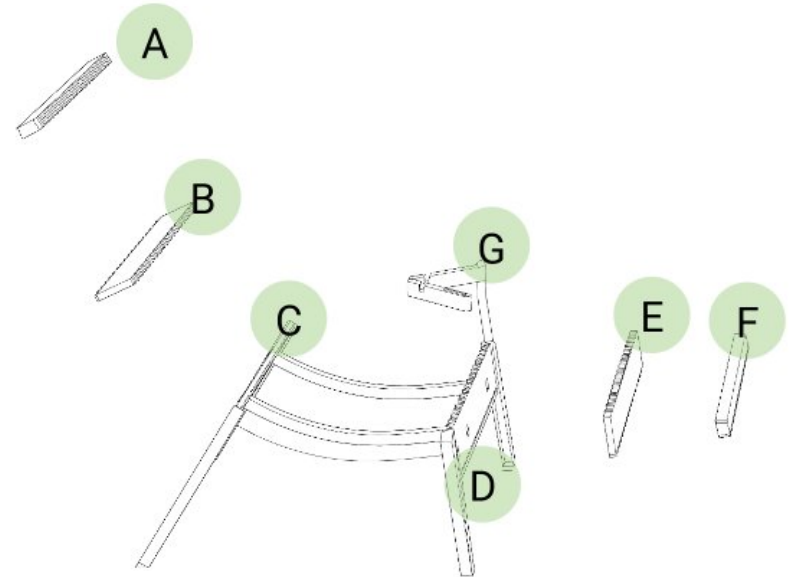
E



F



G



Process of Making









Smoke Curing

PROTOTYPING PROCESS



PROTOTYPING PROCESS



Material and Manufacturing cost of a unit (BOM)

Material cost		Labor cost	Time Taken
Bamboo - 24 ft. Bamboo. - 20 slivers from 2 bamboo	400/-	MS Bending and welding- 400/-	Wooden base- 5 hrs.
Pinewood	1500/-	Bamboo Bending work (2 craftsmen) - 3000/-	Bamboo bending and fixing - 2 days (8 hrs.)

Total making cost of one unit – 7000/-
(approx.)

Selling cost- 16,000/-

Not designed for mass manufacturing

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