Paper Making in Third Dimension

Product Design Project II
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Submitted in partial Fulfilment of the requirement for
The Masters in Design degree in Industrial Design

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My special thanks to Anupam Chakraborty founder of Nirupama Academy for giving me his valuable time and suggestions.
At the end I would like to thank the workshop staff of IDC for their kind cooperation and help.

Contents

01 Project Journey

The project started as a material exploration where I was trying out different material fibres and ways to mould them into 3d forms. Later on to explain the process that I had developed, I chose to design products. The project has two part one is process development which is research oriented and then the product design.
Both the elements were running parallelly with lots of experimentation and application required.

Process development

Understanding Material

Types of Fibres

Mould Design

Determine process capabilities

Design Direction

Product Design

Design Brief

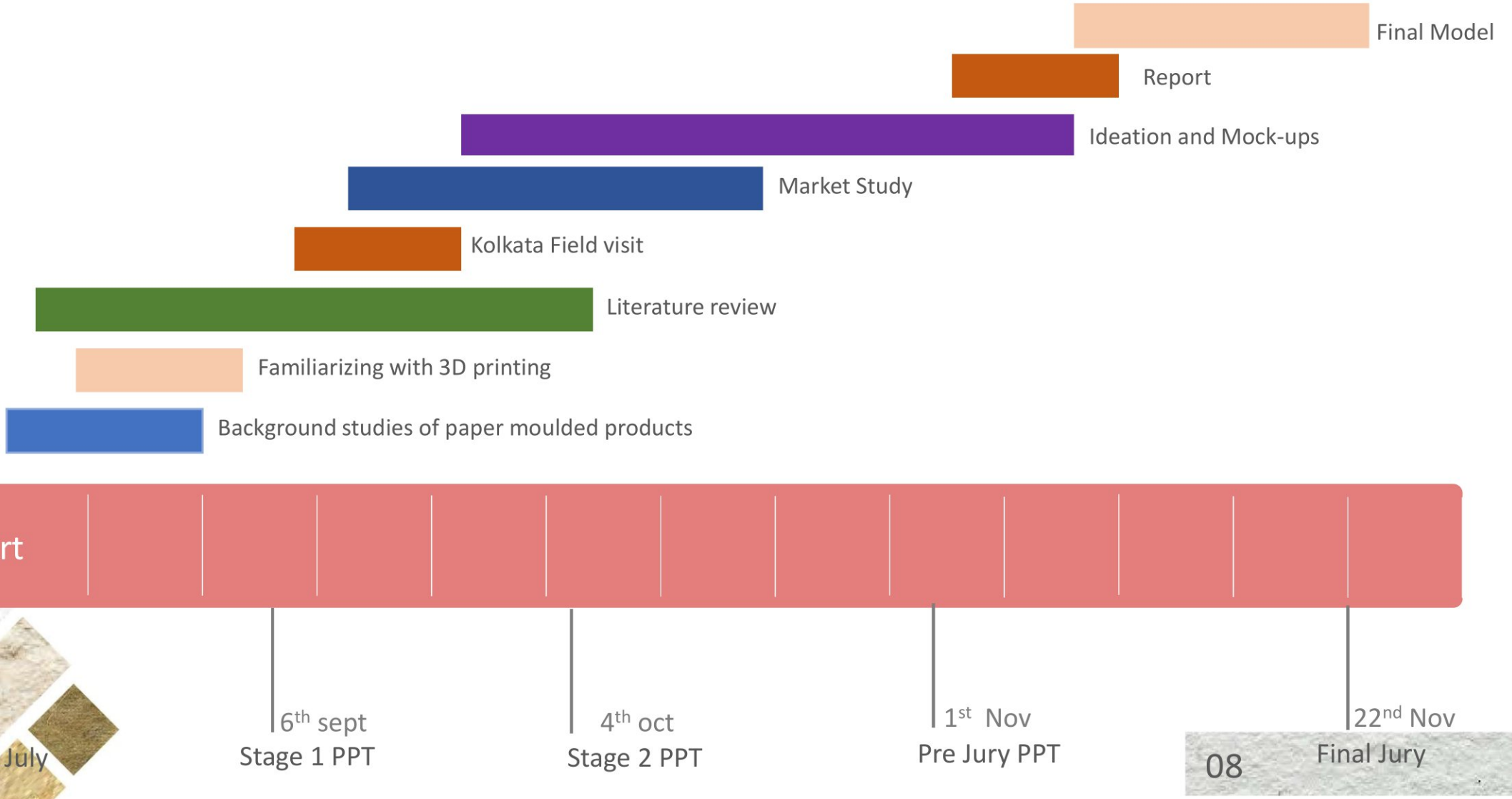
Market Study

User Study

Concept Development

Design Details

1.1 Project Timeline

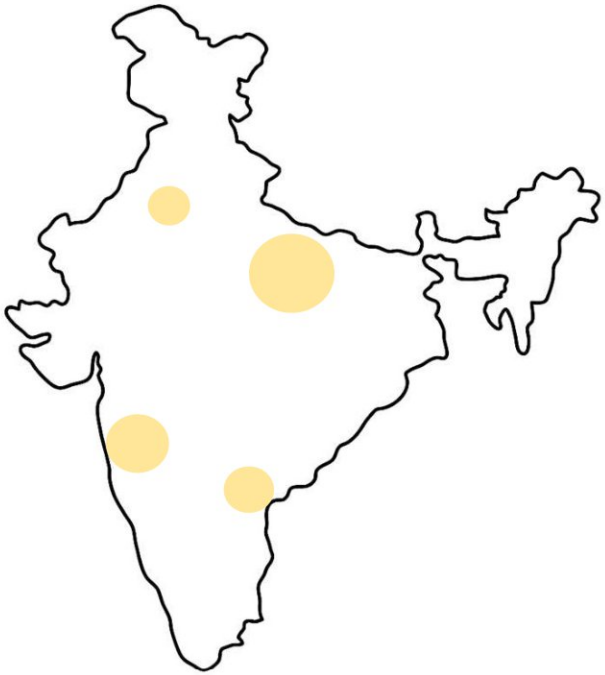


02 Research

2.1. Handmade Paper Industry

Handmade paper industry which today spans over **4,000 units** across the country
Generating revenue of over **Rs 700 crore**.
2nd largest exporter of handmade paper
Iconic places like Sanganer in Rajasthan, Kalpi in Uttar Pradesh and Auroville.

	Units		Employment
Uttar Pradesh	21 %	Uttar Pradesh	20 %
Maharashtra	11 %	Kerala	13 %
Tamil Nadu	11 %	Tamil Nadu	20 %
Haryana	10 %	Haryana	7 %
Rajasthan	8 %	Rajasthan	7 %



Ref: https://www.unido.org/sites/default/files/2007-11/43164_FINAL_EVAL_REPORT_19970430_DPIND90037_0.pdf

USP of the Industry

- Upcycling Materials
- Chemical Free
- Zero waste

Handmade Paper Products

Handmade paper sheets

Photo Frame

Office Stationery

Carry Bags

Fig 2: Handmade paper products

2.2 Paper Products around the world

PaperUp

It’s a company of Rita Koralevics from Budapest, Hungary. They experimented with moulding paper Mache. Their simple design and great use of the material made them very famous.

Fig 2: Paperup product

Paper moulded helmet

The helmet is made up of moulded recycled paper. The form of the helmet is designed such that it increases the strength of the helmet.

Fig 3: Paper Helmet

Ref: https://www.designandpaper.com/paper-up/

Midori's Pulp Stationery Storage Box

- Midori's Pulp Stationery Storage Box offers a modern, minimalist and mindful way to tidy one's desk space. mostly comprised of recycled paper and promises to add a sophisticated look to one's office or workspace.
- **Process used**- Conventional Pulp Moulding
- **Material**- Virgin pulp with 51% recycled news paper

Fig 4: Pulp Stationery Box.

Thermoformed paper products

- This is the sustainable packaging design for a liquor bottle. It has two parts one is thermoformed outer shell and the other is plastic container which contains the alcohol.

Fig 5: Thermoformed paper bottle

Ref: https://www.midori-japan.co.jp/english/products/pulp-storage/

Paper Mache Gun by James Shaw

- James is a graduate of the Royal College of Art's Design Products program and now runs a studio in South London specializing in the design and manufacture of bespoke and production furniture and products, sculptural objects and material research.

Fig 6: James Shaw gun and products

Llegado series by Taeg Nishimoto

- Involving a constructive and appealing process of paper pulp, the design of the Llegado stool aims to explore the structural strength of recycled paper. The legs and the seat have which different construction and drying process are crafted in two different types of configuration. For most of us, paper seems to be a fragile material choice, but this stool changes that perception. The Llegado stool is durable and practical while promoting sustainability.

Fig 7: Nishimoto Stool

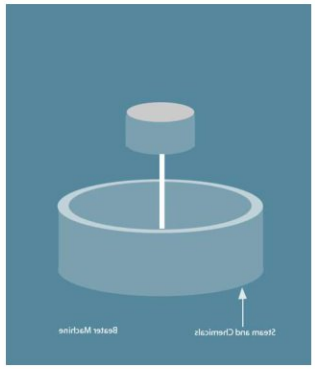
Ref: https://www.designboom.com/design/james-shaw-creates-furniture-using-spray-guns/

2.3 Manufacturing Process

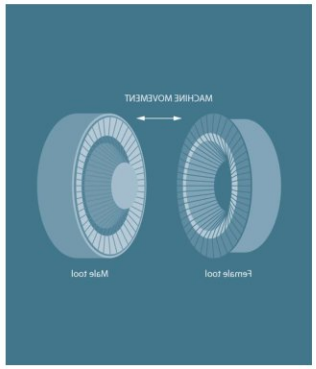
Paper Pulp Moulding

Paper Moulding process is a mass manufacturing process for paper products. In this a thin layer of pulp is formed over the mould.

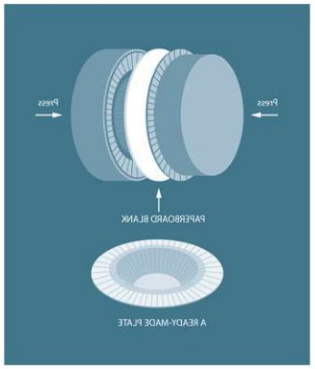
Raw Material



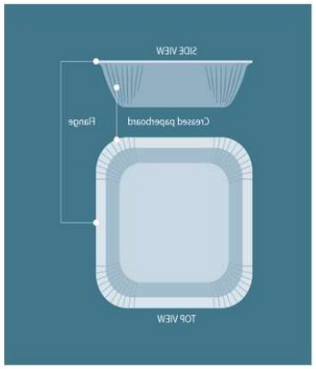
Pulping



Passing through moulds



Forming



Drying

Reference; Moulded Pulp Manufacturing: Overview and Prospects for the Process Technology (2017) DOI 10.1002/pts.2289

2.4 Kolkata visit

I got a chance to go to Kolkata to learn the various techniques of making handmade paper. Prof. Anupam Chakraborty has a small industry of making handmade paper. I was there for one week and learnt the nature of the pulp material from the expert.

Fig 8: Kolkata visit photos

2.5 Paper Making Techniques

In Kolkata I got to learn various paper making techniques that are used to create art. These techniques have evolved through ages and help me widen the possibilities in paper

Watermarking

Fig 9: Frame for watermarking

Fig 10: Watermarking on paper

Layering Technique

Layering techniques layers two dissimilar pulp sheets and you can make shapes in the layers.

Fig 11: layering 1

Fig 12: layering 2

Rust Texture

In this technique a rusting mesh of iron is kept on the wet surface of the handmade paper sheet. They are left overnight under wet condition. The rust seeps into the sheet and creates an impression.

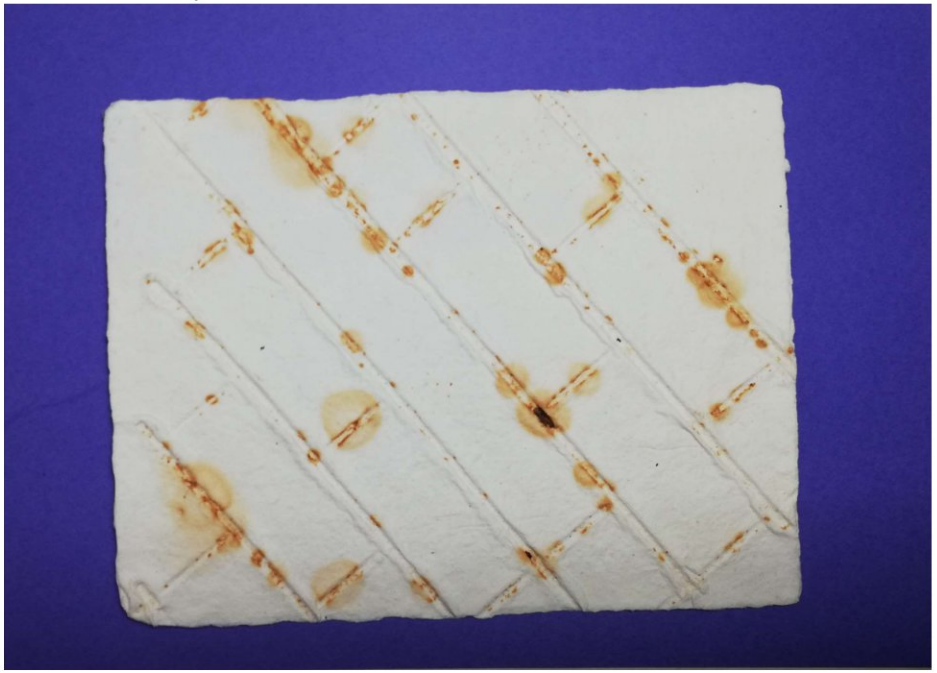


Fig 13: Rust texture

Pressed Texture

While the paper sheet is in wet condition a wooden block of pattern is pressed on to the sheet to create the texture.

Fig 14: Pressed Texture

2.6 Sources of fibrous pulp

Recycled

News paper
Print paper
Cardboard boxes

Upcycled

Cotton
Jute
Sugarcane Bagasse

Upcycled agricultural waste

Banana tree Stem
Jackfruit
Ladyfinger stem
Lemon grass
Mulberry

Botanical Name	Local Name	Parts Used
Abelmoschus esculentus	bhendi, ran turai	outer bark of stem
Adansonia digitata	gorakh amli	inner bark
Agave ameriana and varieties	ghaipat, ketki	leaf fibre / waste / rope
Abulation indica	chakrabhend, mudra tuthinar	outer bark
Ananas sativa	ananas, anasapandu	fibre of leaves
Antiaris taxicaria and varieties	valkal tree, chanduka karvat	valkal or inner bark
Bamboo	bamboo, vans, bans	culms, basket, mats
Boehmeria nievea	china grass of rhea	bark fibre
Broussonetia papyrifera	white mulberry, tut	inner bark of young branch
Butia frondosa and varieties	dhak, palas or chichara root	inner bark of young branch
Calotropis procera	madder plant	bast fibre
Cannabis sativa / indica	hemp, ganga, bhang	bast fibre of the plant
Corchorus capsularis	jute of Bengal	bast fibre, toe, gunny bag
Careyas arborea	kumhia, vakumbha, dudhippi	inner bark of tree
Crotalaria juncea and varieties	sunn hemp, sona tag, sunn, bags, etc.	bast fibre,ropes, twins
Curcuma varieties	halad, harder, amba, ginger	whole plant but not coims
Cyperus rotunds and varieties	motha, musta, korai, gandula, mutha	whole grass
Doemia extensa	utarni	outer bark
Daphne cannabina and varieties	nepal paper plant maha-deva	inner bark and stem
Daphne bholua	nepal paper plant lokta	inner bark
Ficus varieties	bar, vad, pimpal	inner bark of young branch
Girarddinia heterophylla	mothi, kahajati, agai	bast fibre
Gossypium varieties	kapas, cotton	textiles, rags
Heliacteres isora	murudsing	bast fibre
Hibiscus varieties	bhendi, ranbhendi, lal ambari, roselle	stem bark
Ischoemum angustifolium	sabai, badhar grass	grass, leaves, ropes
Lasiosphon erriocephalus	rameta	inner bark
Linum usitatissimum	alasi, javas	bast fibre
Musa varieties	plantain, kela, chavai	stem fibre
Oryza sativa	rice straw, bhoosa	whole straw, not ropes
Pandanus odoratissimus	kevda, ketki	leaf fibre
Palae varieties	palms	leaves, stalks
Saccharum munja	munj or sara grass	leaves, ropes
Saccharum officinum	sherdi, sakar, sugarcane, usa	bagasse, leaves
Sansevierla zeylancia	bow string hemp, nagpuri	leaf fibre
Triticum sativa	wheat, straw, gehu	whole straw, not tops
Typha elephantine	bul-rush, jungle bajri	whole plant, not tops

Fig 15: Plant Fibres

2.7 Process of extracting plant fibre

Steps of making paper from plant fiber

- Gathering
- Identification
- Preparation 1. Stripping / Decorticating / Removal outer bark
  2. Soaking
  3. Cooking in Alkali (washing soda / caustic soda)
  4. Finishing and testing - pH 7 (neutral)
- Beating – Mechanical (Hollander beater / kitchen blender) /
- Formation – Traditional (Western / Japanese)
- Pressing (Hydraulic press / screw press)
- Drying
- Sizing

Fig 15: Banana Stem for fibre extraction

Gathering

The hunt of interesting raw materials can be an adventure. Any natural material composed of cellulose and capable of being reduced to pulp-like consistency can be considered as appropriate material for experimentation, including:

Cotton, Jute, Hemp, Straw, Bamboo leaves & twigs, Coarse grasses, Banana stem, Hibiscus, Cabbage stumps, Mulberry, Corn stalks, Sugarcane, Gladiolas leaves, Flax, Nettles etc.

Identification

The part of the plant which can be used for making paper is identified according to its fibre type in the following manner:

1. Fruit seed hair – example: cotton
2. Bast / Inner Bark / Phloem – example: banana, hemp, jute, flax
3. Leaf – example: bamboo, gladiolas
4. Grass – example: sedge, reeds
5. Stem structure – example: bamboo, mulberry

Preparation

Once the raw material is gathered, workable parts are separated either by stripping or by decorticating or by removing outer bark and core. Selected parts are then soaked in plain water for overnight in plastic container.

For boiling transfer wet stuff in a stainless steel container and pour water to cover that.

Application of Alkali: alkali removes impurities from fibre and also looses the fiber structure. Percentage of alkali depends upon the strength of the fibre.

Alkali chart for use with fibres for papermaking:

10 grams of caustic in 1 litre of neutral pH water equals 1% solution

15 grams of caustic in 1 litre of neutral pH water equals 1.5% solution

20 grams of caustic in 1 litre of neutral pH water equals 2% solution

The pH (potent of hydrogen) scale is used to determine the acidity and alkalinity of a substance. The numbers of the scale range from 0 (strong acid) to 14 (strong alkali) with 7 being neutral.

For hard / tough fibre (like bark of a tree) use 2% solution. For medium strength fibre (like hemp, jute) use 1.5% solution. For soft fibre (like banana, leaves, rushes) use 1% solution of caustic soda (sodium hydroxide). Always mix caustic soda in cold water. Be advised that caustic can cause skin irritation. Rubber gloves, aprons and a well-ventilated room is strongly recommended.

Pour caustic solution in that stainless steel container and cook the plant for 2-4 hours.

Wash cooked fibre in running water until it shows pH 7.

Beating

By now the vegetable material is a pulpy mass with a somewhat slick and fatty appearance. Much of the unwanted dirt and lignin (an organic substance which acts as a binder for the plant material) has been separated from the crude pulp.

Cut the pulpy mass in small pieces and beat them either in hand grinder (kitchen mixer / grinder) or in Hollander beater. In another way, shortened pieces of pulpy mass are placed on a wooden plank and are pounded with heavy pestle or mallet to separate the fibre.

Formation

The pulp is now poured in a tub or vat and water is added to give proper consistency for forming the sheet on the hand mold. The mold is placed inside a deckle.

Mold is the chief tool for making handmade paper. It is a wooden frame on which the pulp is drawn from a tub or vat. The frame is covered with a metal (copper or stainless steel) or nylon mesh. There are two types of mold – Wove mold and Laid mold. The screen on a mold which contains wire sewn transversely is called wove mold. Paper formed on wove mold evinces no lines. The screen on a mold having a pattern of more widely spaced longitudinal wires held together with smaller transverse wires, called a laid mold. The mold pattern imprints itself on the finished sheet of paper.

Pressing

After the deckle has been taken from the mold, the mold is turned over and the sheet of paper is laid smoothly on a felt (woven woolen cloth). Another felt is laid over the sheet of paper, and the process is repeated. The process of placing the paper between two felts is known as couching. When a number of sheets of paper have been interleaved with felts, the entire pile, called a post, is placed in a hydraulic press and subjected

Drying

The paper can now be placed in between blotting papers or can be hung for drying in shadow until its moisture has almost completely evaporated.

Sizing

Sizing is a solution used to make the paper moisture resistant in varying degrees. Size can be added at two stages of the papermaking process. The degree of sizing of paper determines their resistance to the penetration of moisture.

2.8 Natural Dying for paper pulp

Natural dyeing method is an eco-friendly and organic way for coloring paper pulp. Colored pulp can then be used for making unique paper. Following are the steps for coloring pulp using natural dyes.

PROCESS

Step 1 Collection of plant There are varieties of indigenous flower, herb & vegetable that can be used for colouring pulp. You need to collect them and can store them after drying. Colour produced from plant won't differ whether it is used in fresh or in dry state.

Step 2 Preparation of dye-bath Chop or crush plant parts and fill ½ of a stainless steel container. Pour water in it till it reaches ¾th of the container. Boil plant parts and continue the process till water level reduces to ½. Boiling helps to extract the colouring component of the plant. Once boiling gets over, plant material should then be strained out and the solution or dye-bath cooled to room temperature. Dye-bath is then stored in a plastic container.

Step 3 Soaking prepared pulp in dye-bath solution Take prepared paper pulp and remove excess water from it by using a nylon/stainless steel sieve. Wet pulp is then soaked in dye-bath for at least an hour. Pulp absorbs more colour if soaking takes place for longer duration. You need to stir the pulp after every short interval so that colour penetrates evenly in the pulp.

Step 4 Preparation of Mordant. Grind the mordant and soak in luke warm water. Once it dissolves completely, strain the solution and store it in a plastic container.

Fig 16: Pulp dying using Marigold Flower

Step 5 Soaking prepared pulp in mordant solution
Strain out pulp from the dye-bath and dip it in mordant solution for 5-20 minutes. Keep on stirring so that mordant penetrates evenly in the pulp.

Step 6 Washing coloured pulp Strain pulp from the mordant solution and wash it in running water. That helps to washed away excess colour & mordant that pulp is unable to absorb. Now the pulp can be used for making unique handmade paper.

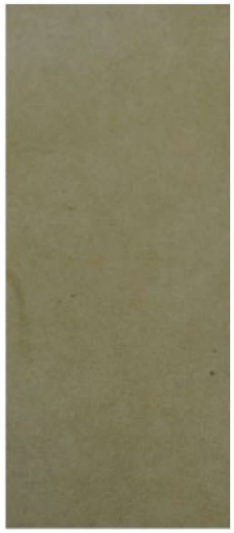
List of colour extracted from plants

Plant name	Part used	Mordant	Colour produced
Madder *(Manjistha, Majith)*	Root	Aluminium sulfate *(Alum)*	Red
Indigo	Bark	Not required	Beep blue
Red cabbage	Leaves	Not required	Blue
Hibiscus *(Jaba)*	Petals	Aluminium sulfate *(Alum)*	Blue
Mayrabolan	Fruit	Not required	Yellow ochre
Mayrabolan	Fruit	Ferrous sulfate	Black
Mayrabolan	Fruit	Aluminium sulfate *(Alum)*	Greenish yellow
Mayrabolan + *Madder*	Fruit + Root	Copper sulfate *(Tut, Tu-te)*	Dark brownish red
Yellow Onion	Skin	Aluminium sulfate *(Alum)*	Yellow
Red Onion	Skin	Aluminium sulfate *(Alum)*	Purple
Turmeric	Root	Not required	Yellow
Turmeric	Root	Lime	Red
Tea (CTC)	Liquor	Not required	Beige
Coffee	Liquor	Not required	Brown
Henna	Leaves	Not required	Brownish yellow
Carrot	Root	Chromium sulfate	Yellowish orange
Catechu *(Cutch, khayer)*	Bark	Chromium sulfate	Brown
Spinach	Leaves	Not required	Green
Pomegranate	Fruit rind	Chromium sulfate	Yellow
Red Cabbage	Leaves	Not required	Blue
Henna	Leaves	Not required	Gold
Eucalyptus	Leaves	Ferrous sulfate	Grey
Dahlia	Petals	Alum	Yellowish brown
Marigold	Flower heads	Alum	Yellow
Marigold	Flower heads	Copper sulfate *(Tut, Tu-te)*	Greenish yellow
Betel nut	Nut	Chromium sulfate	Deep pink
Plum	Bark, Root	Chromium sulfate	Purple
Sunflower	Flower head	Aluminium sulfate *(Alum)*	Yellow

2.9 Sample of Plant Fibre Paper

Banana Paper
Natural and over beaten

Banana Paper
Semi Bleached



Banana Paper
Bleached and over beaten

Banana Paper
Bleached and slightly beaten

Ramie Paper
Natural

Ramie Paper
Natural and Over Beaten

Ramie Paper
Bleached and slightly beaten

Ladyfinger Paper

Jackfruit Paper

Lantana Paper

Elephant Paper

Lemon grass Paper

Sugarcane Paper

Pineapple Paper

03 Process

3.1. Comparing Various process

Below is the comparison of the process in terms of the production volume. In this
I was that there is a huge gap in medium volume production.

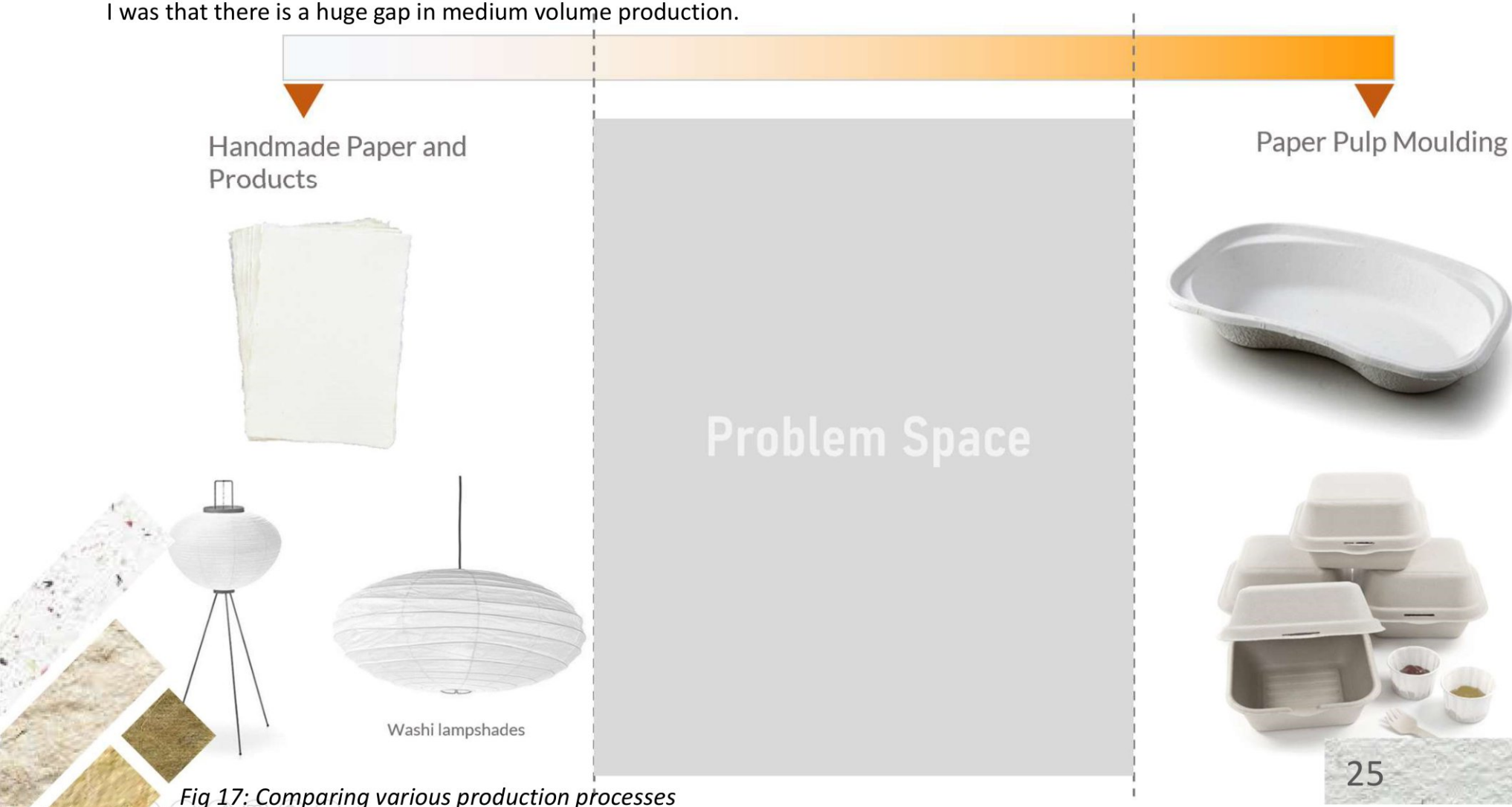


Fig 17: Comparing various production processes

3.2. Idea !

Making mould using 3D printing

Paper pulp moulding uses very expensive metal moulds which increases the cost of manufacturing products. This makes this process suited for high volume products. If we reduce the cost of making moulds the cost for low volume products will reduce, this will help in increasing the number of paper products in the market.

Fig 18: Current Paper pulp mould

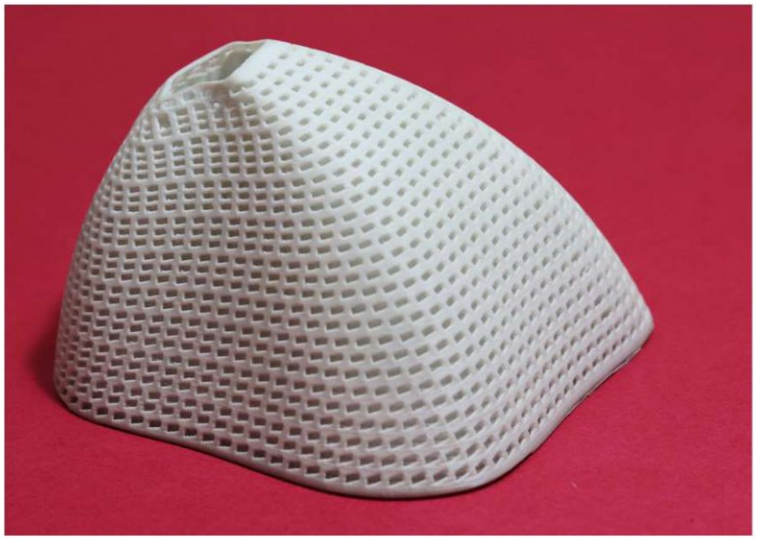


Fig 19: 3d printed mould

3.3. Proof of Concept

Making simple surface using 3d printed moulds

The design of the mould is in 2 parts one with mesh and the other with smooth surface. The mesh helps in removing the excess water from the mould and the frame helps in the clamping of the both parts. In this mould design we can get a very smooth surface on one side and a pattern on the other.

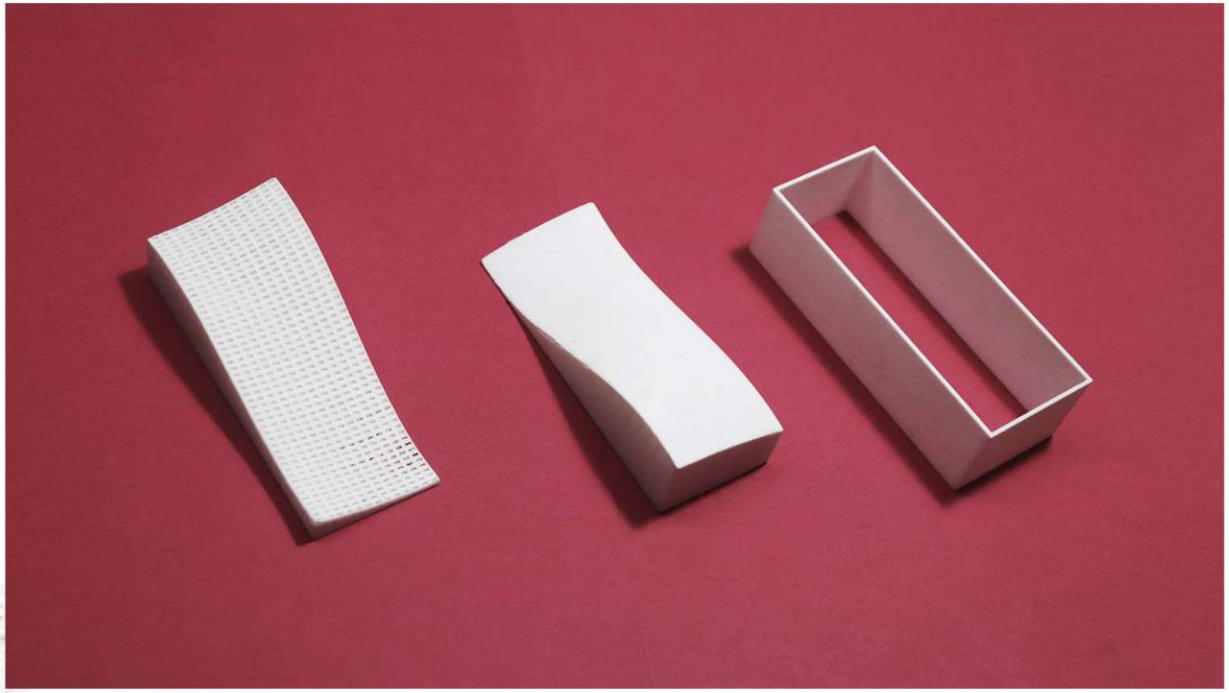
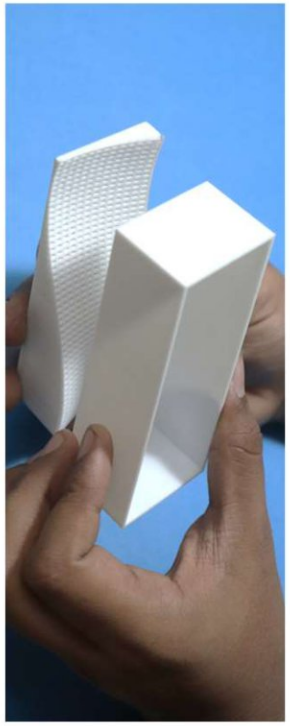


Fig 20: 1st POC mould

Moulding Process



Fix positive mould to the frame

Dip the mould into the vat

Remove the mould from the vat

Fix the negative mould to the frame

Press to remove the excess water

Above is the process of moulding paper with two part mould. Here I have used pulp made out of 100 percent recycled paper

3.4. Proof of Concept for complex surfaces

Continuous curved surface with two curve edges

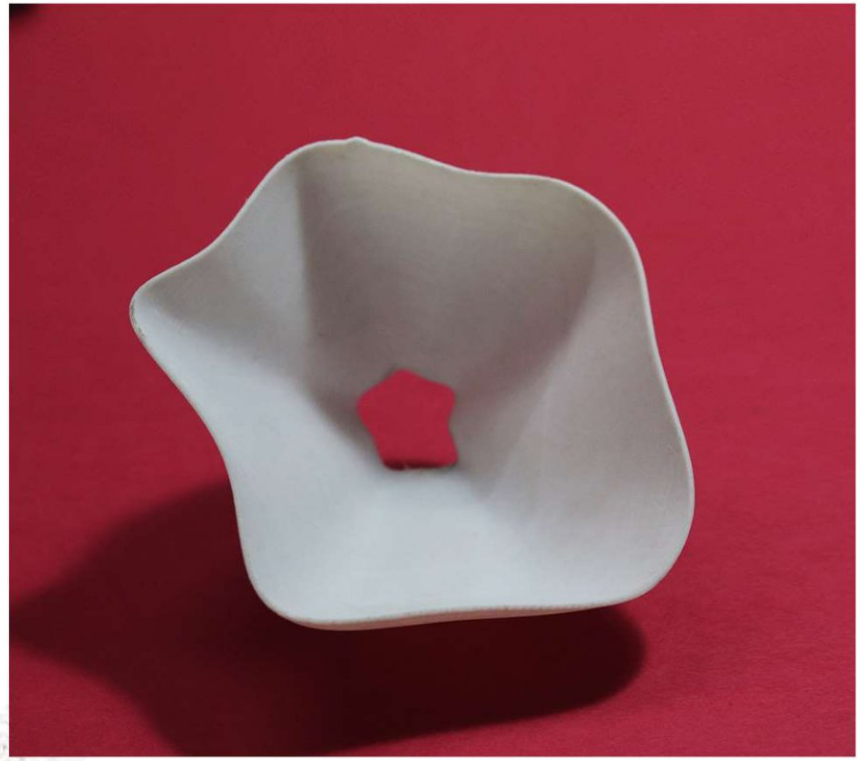


Fig 21: Top mould for curved surface

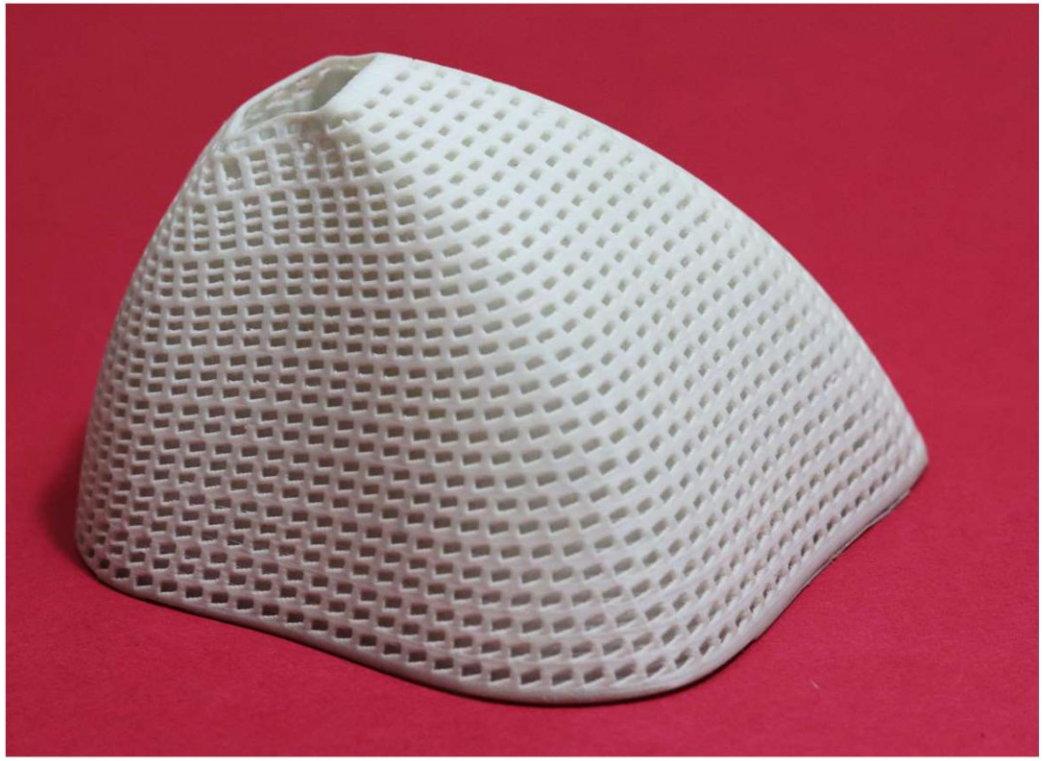
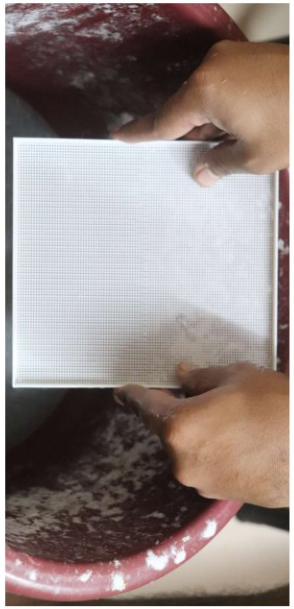


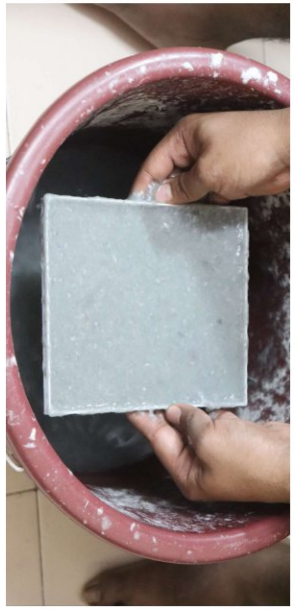
Fig 22: Bottom mould for curved surface

Moulding Process

This process is a bit different to the first process. In this process we first make a thin sheet of pulp and then apply the layer on to the mould.



Hold the screen with frame



Dip it in the vat to make thin sheet of wet pulp

Transfer the wet pulp sheet to a smooth surface

Press to remove excess water

Transfer the sheet to the positive mould

Put the negative mould on the top

Fig 23: POC moulded forms

In this method we are able to create a very thin surface into desired form with high level of finish

3.5. Proof of Concept for Closed geometric forms

Continuous curved surface with two curve edges.
Need of collapsible core
Outer mould should be able to take variable thickness

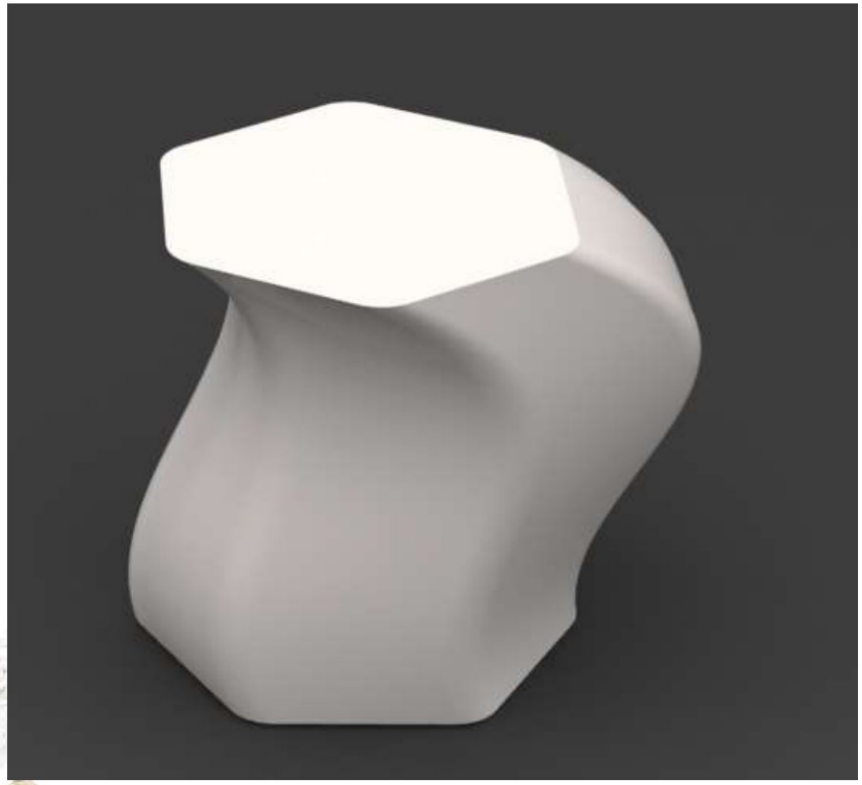


Fig 24: Closed geometric form

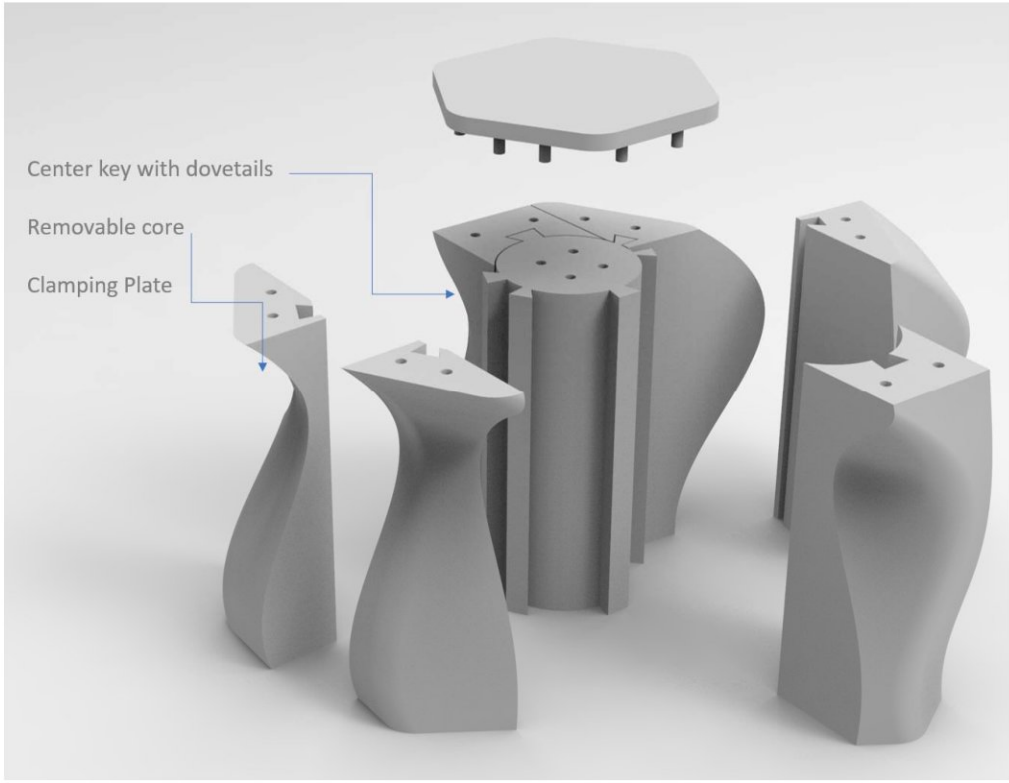


Fig 25: Closed geometric form mould design.

The outcome was satisfactory though there was some shrinkage happening when it is drying. For moulding this we used upcycled sugarcane waste which is called bagasse.

Fig 26: Closed geometric form product sample

3.6. Study of Binders

There are many binders used in the paper industry. Since I was designing a product I need to know which binders are best suited to enhance the strength of the moulded product. I did this study using four different binder and test their relative strength.

Natural Glue
Rice Water
Fevicol
Carboxy Methyl Cellulose (CMC)

Natural Glue
Rough and Flexible

Rice Water
High Shrinkage
Good Strength

Fevicol
Less Shrinkage
Best Strength

CMC
Least Shrinkage
Good Strength

Fig 27: Study of Binders

3.7. Process demonstration using a product

Desk lamp Design

The outcome was satisfactory though there was some shrinkage happening when it is drying. For moulding this we used upcycled sugarcane waste which is called bagasse.

Fig 28: Desk lamp using different kinds of material

Forms Derived from Cactus

Warm
Inspiring

Fig 29: Product ideation 1



Fig 30: Process demonstration product

The product was inspired by cactus from and the form used a collapsible core mould design. The output of the from was not good as the light brought out all the flaws in the papermaking and brings the rawness.

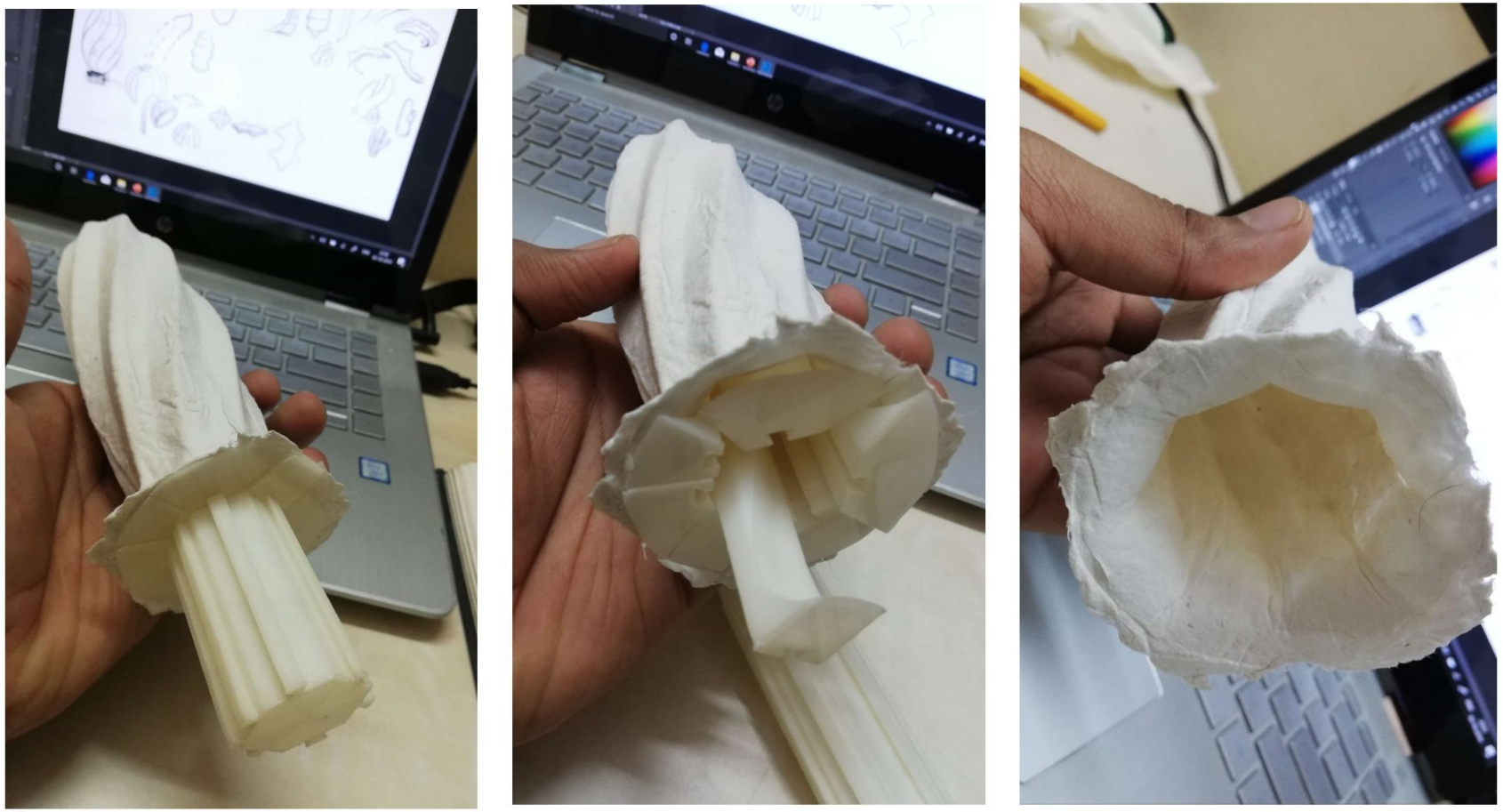
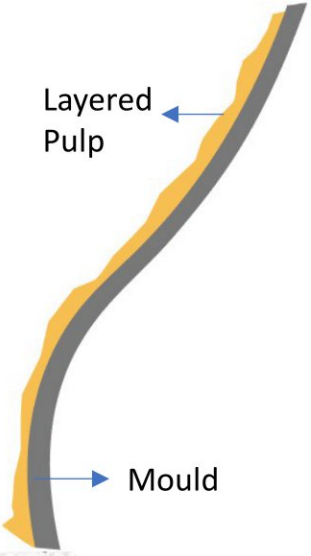


Fig 31: Process demonstration product Mould.

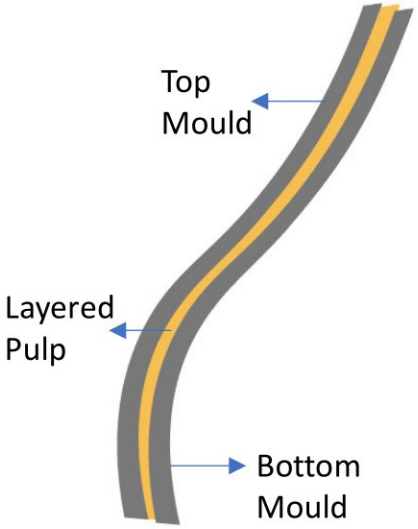
3.8. Mould Design

In summary of all the incremental mould design work that I have done. I have categorised moulds in 3 types

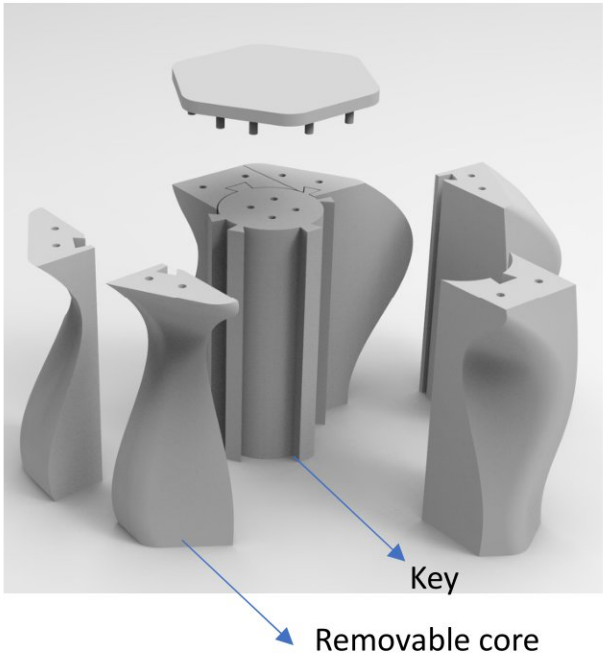
One surface open mould



Two surface open mould

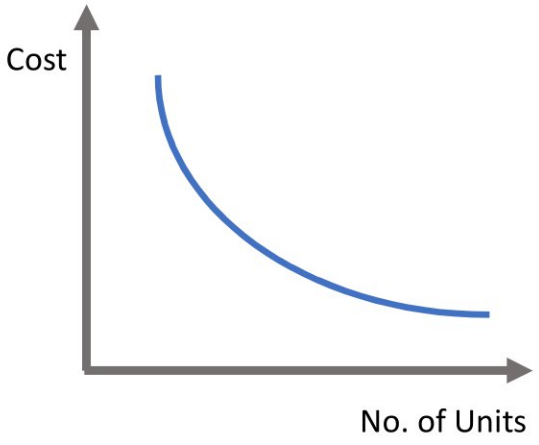


Part closed mould

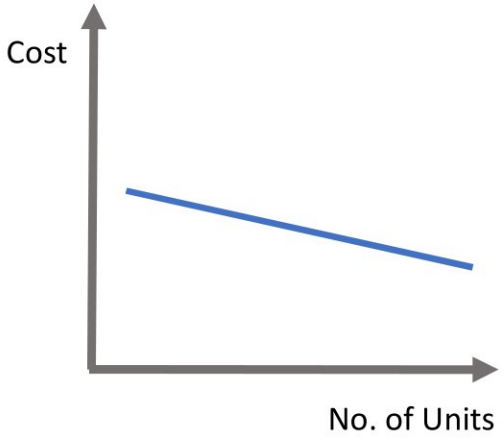


3.9. Process USP

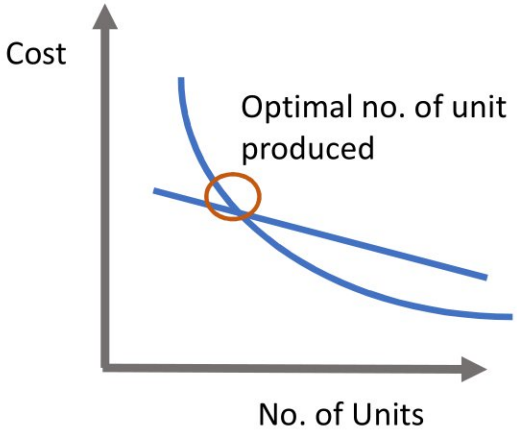
Cost



Traditional manufacturing process cost



3D Printing process cost



Comparing manufacturing process cost

The above graphs compares the cost of a traditional manufacturing process cost for moulds. A typical pulp moulding mould cost about 12 lakh rupees, while a similar mould will cost thousands to make. There is a very optimal volume of production which cause a breakeven point for both traditional and 3d printed moulds. Since I am targeting low volume production the 3d printing manufacturing is way cheaper.

Fine patterns and Surface finish

The process is able to create very fine texture and patterns on the surfaces. We can use this factor to create a range of products

Fig 33: Possible patterns

Less Lead time

3d Printed mould takes very less time to manufacture than the other traditional process

Flexibility and customisability

Since the lead time is very less we can do multiple ideation fast and bring more flexibility in the design.

Ability to make complex forms

Since we are using 3d printing, complex core design are possible. Which makes it possible to make a range of complex form for product design.

3.10. Process Capabilities

Electronics embedded between paper layer

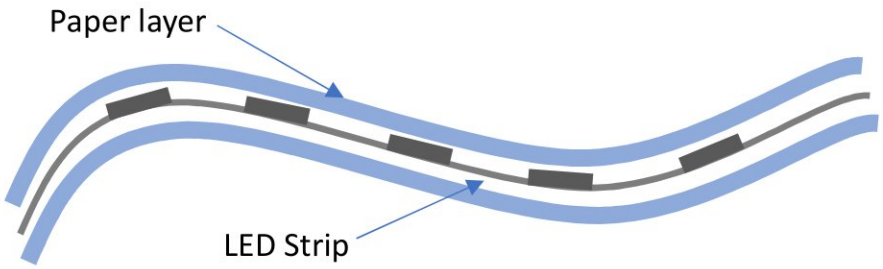


Fig 35: Embedded electronics into paper layer

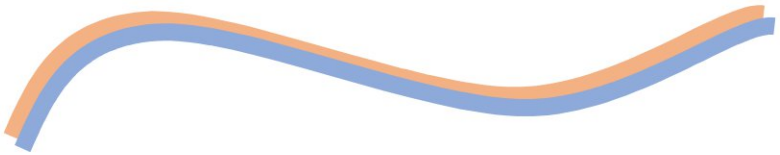
Since we are laying one pulp layer over other we can embed some solid parts in that, one of the thing is electronics.

Closed Geometry Complex forms

Fig 36: Complex geometric forms

Since we are using 3d printing, complex core design are possible. Which makes it possible to make a range of complex form for product design.

Layering different materials and colour



Ability to layer different colour materials into one moulded product.

Light translucence Effect

Fig 37: Nendo Lamp

The light passes through a thin layer of paper. This process brings out the inner texture of the paper and helps to make light products.

Structural Products

Fig 36: Nishimoto Stool

Ability to make structural products as the pulp fibres have a good amount of strength and can be used to make furniture.

04 Product Design

Lamp Design

Design a Dining light using paper as a material, Positioned as a luxury lifestyle product. Targeting an urban user segment.

Market Segment- Urban
Positioning- Luxury Lifestyle

Material- Upcycled Paper
Process- 3D paper Moulding

Fig 37: Nendo Lamp

Reference; https://www.dezeen.com/2014/10/09/bi-color-washi-nendo-3d-moulded-light-shades/

Dining lamp

Large Size: 200mm to table length
High light spread area
Generally warm light

Fig 38: Sample dining lamp in context

Reference; https://www.dezeen.com/2019/04/18/ho-perfect-darkness-tiles-exhibition-interior-design-milan/?li_source=LI&li_medium=rhs_block_1

Activities around dining

Function	People Activities	Feelings	Senses
Breakfast	Get Together	Relaxing	Vision
lunch	Family meetings	Calming	Sound
Dinner	Private talks	Soothing	Smell
Reading place	Reading books	Ownership	Taste
Working place		Reflection	Touch
Food preparing place			

Lighting Requirements

Intensity-
100 – 150 lux for dining
500 – 750 lux for work

Colour-
Warm light

Spread-
Target table with general spread

Fig 39: Lighting requirement

Ref: https://www.noao.edu/education/QLTkit/ACTIVITY_Documents/Safety/LightLevels_outdoor+indoor.pdf

4.1. Market Study

Material Specific

Recycled paper
Banana Fibre
Mould
Marino Wool

Fig 40: Sustainable material lamps

Market Study

Brand Specific
Studio Pepperfry

Price Range-
750 – 5000 Rupees

Wide range of glass lamps with Edison bulb

Fig 41: Studio Pepperfry Lamps

Market Study

AD Design Show

Wide range of materials:
Glass
Bamboo
Metal
Plastic

Price range
20000 – 150000 Rupees

Fig 42: AD Design Show Lamps

Inspiration

While I was looking for inspiration for the lamp, I saw bean by Anish Kapoor. I was mesmerised by the way the city was reflecting on the mirror surface. Then I decided to find a way of reflection of city on my lamp

Fig 43: "Bean" by Anish Kapoor


Reflection of the city

4.2. Concept 1

Mumbai

Derive the essence of Mumbai

Fig 44: Mumbai City Sky line

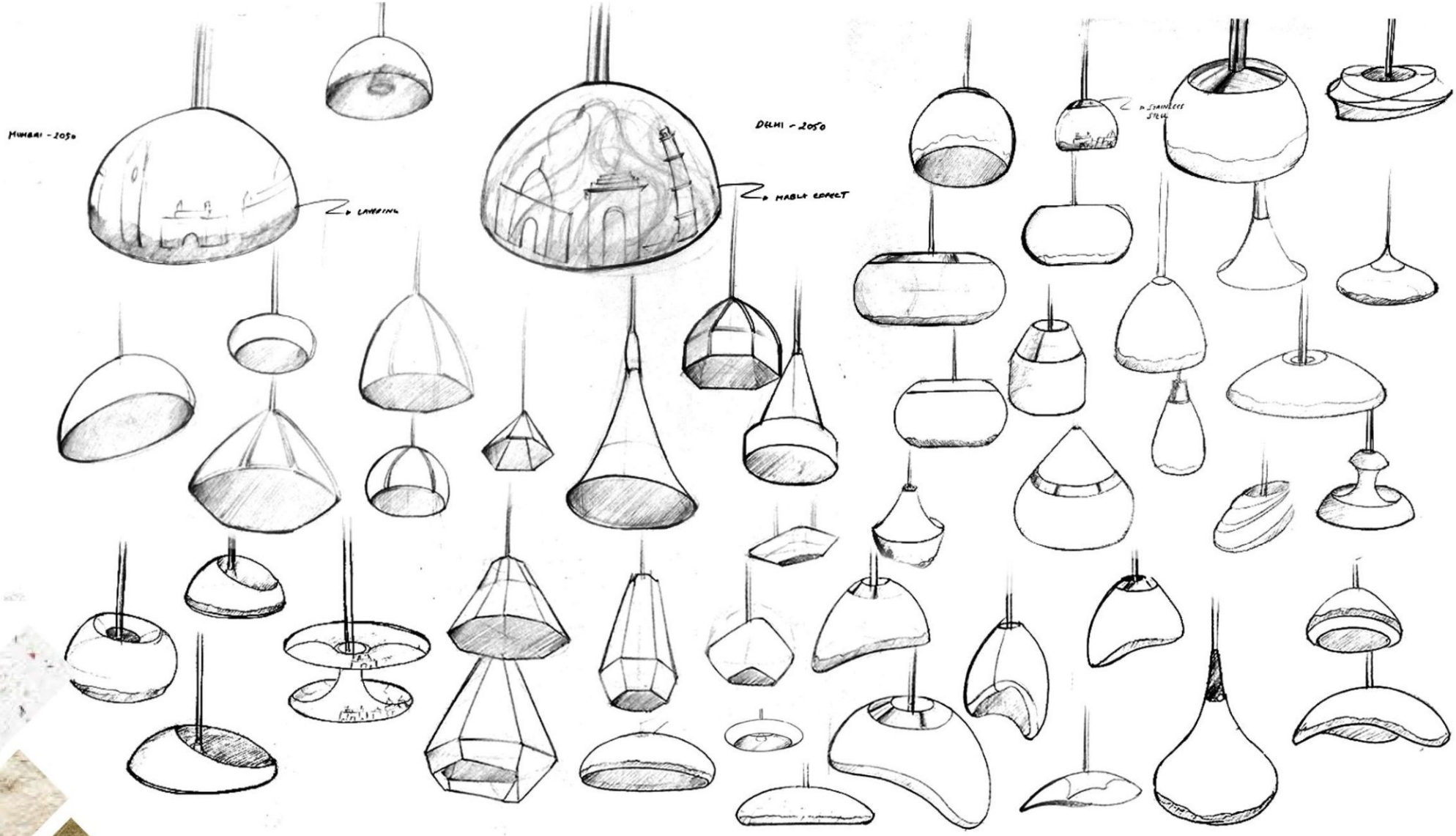
Ref: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.reddit.com%2Fr%2FIndiaSpeaks%2Fcomments

Mumbai Architecture

Fig 45: Victorian Gothic and Art Deco architecture of Mumbai

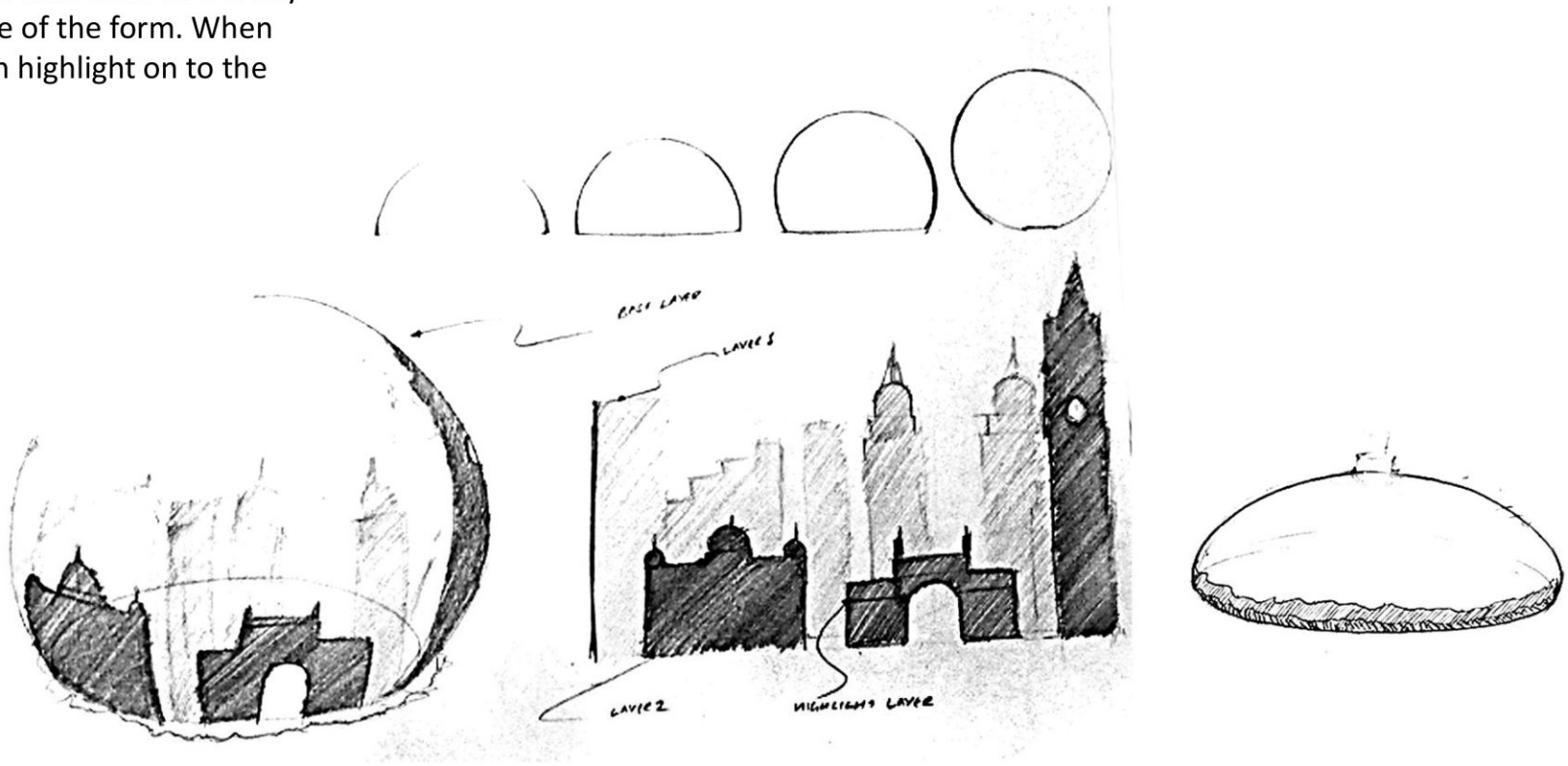
Relationship of the sea with the people and the city

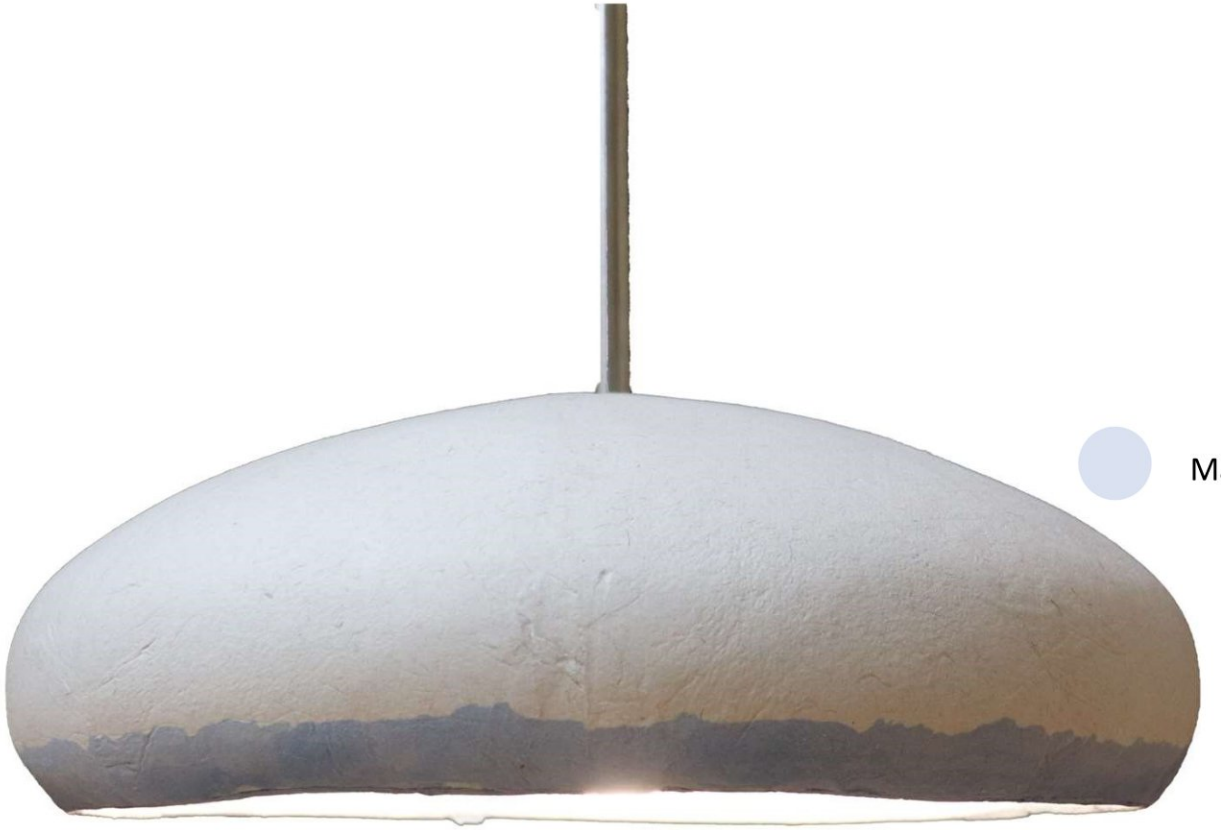
Ideation


MUMBAI - 2050
LANDING
DELHI - 2050
MARBLE EFFECT
STAINLESS STEEL

Final Concept

The idea was to create a silhouette of the city on to the curved surface of the form. When light are on it creates an highlight on to the silhouette.





Material- Mix of jute and cotton fibres

Blue highlight that represent sea

City landscape debossed on the inside layer

Blue highlight that represent sea

Mumbai Lamp

Warm light
LED 9 Watt - 750 Lux

Dimension
500 * 200 mm

Height From the Table
4 – 5 Feet

Fig 50: Contextual Render of Mumbai Lamp

Mumbai Lamp

Product Details

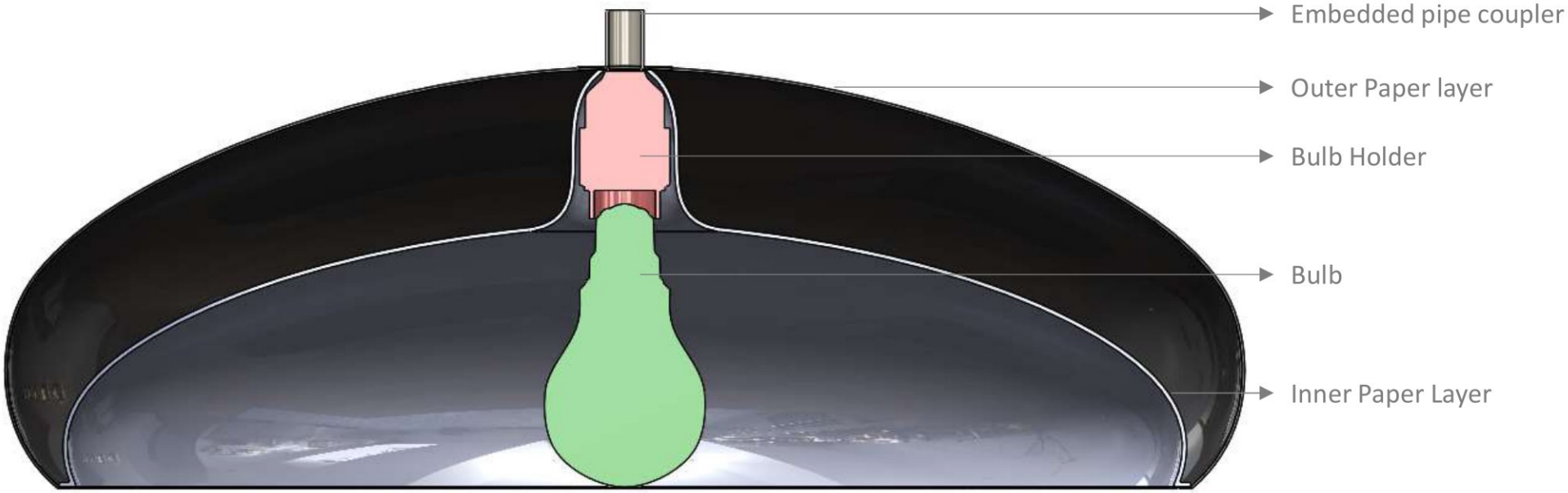


Fig 51: Design Details of Mumbai Lamp

4.3. Concept 2

Delhi

Derive the essence
of Delhi

Fig 52: Jama Maszid


Material- Mix of jute and cotton fibres
Copper accent

Delhi Cityscape

Delhi Lamp

Warm light
LED 9 Watt - 750 Lux

Dimension
500 * 250 mm

Height From the Table
4 – 5 Feet

Fig 53: Contextual Render for Delhi Lamp

Delhi Lamp

Product Details

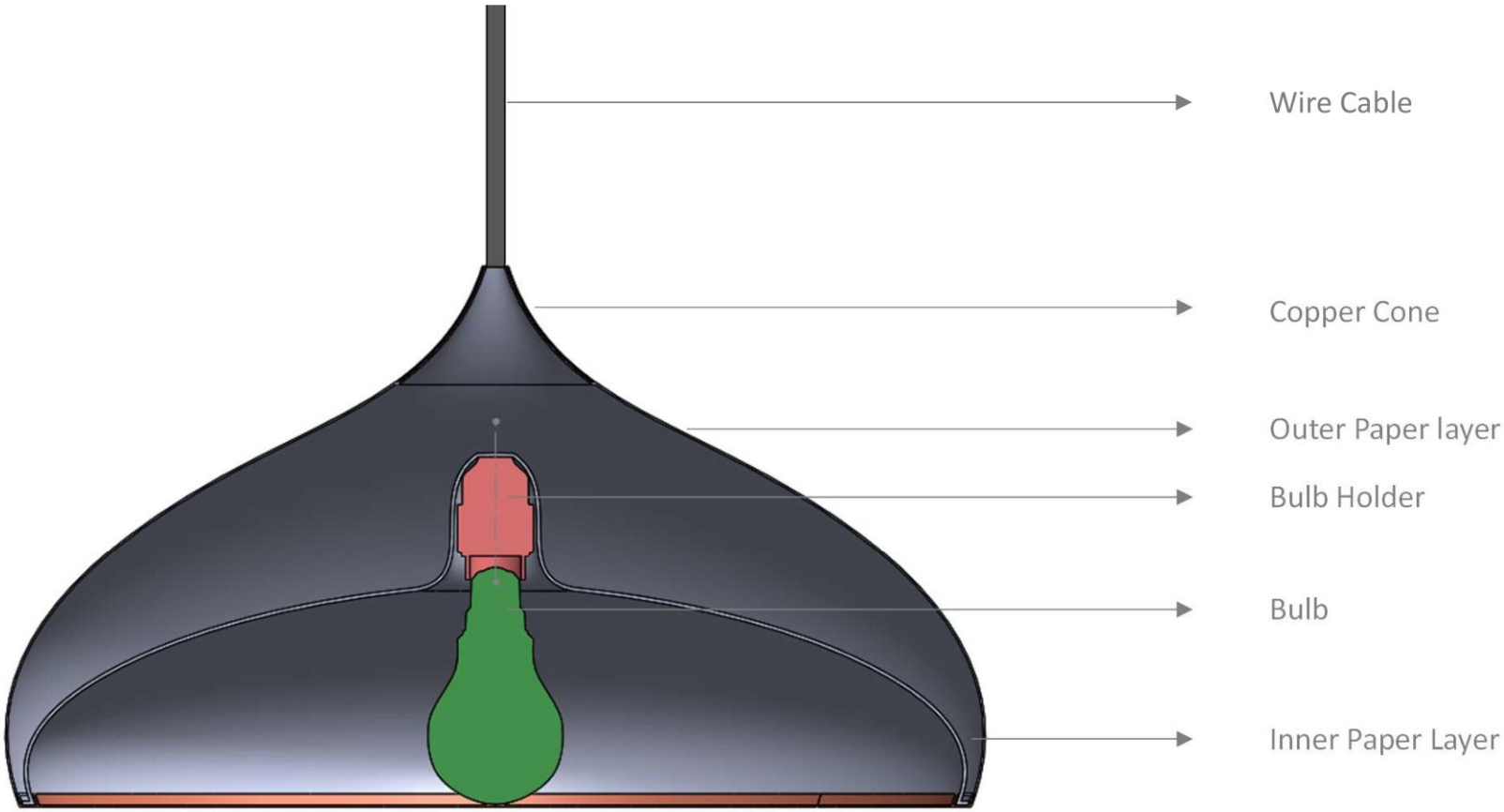


Fig 54: Design Details of Delhi lamp

05 Reference

Books

- The papermaker's companion by Helen Hiebert
- Paper Making as an artistic craft by John Mason
- Pulping chemistry and Technology by Monika Eek
- Japanese Washi Paper by Robertta A uhl

Papers

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- The impact behavior of ecofriendly cellulosic Fiber-based packaging composites by Detao Lui
- Mechanical behaviors of molded pulp material by Hongwei Jie
- Mechanical Properties of Molded Pulp Pallet by Hangtao Wang
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- Moulded pulp products manufacturing with thermoforming by Mattia Didone
- Paper Pulp Molding with FDM Tooling
- The Re-invention of Molded Pulp By Emily Howe
- Life cycle analysis of tissue paper manufacturing From virgin pulp or recycled waste paper Aneta masternak-janus, Magdalena.
- Life Cycle Assessment of Printing and Writing Paper Produced in Portugal Ana Cláudia Dias
- Improving barrier and strength properties of paper By multi-layer coating with bio-based additives Tudor balan
- Moulded Pulp Manufacturing: Overview and Prospects for the Process Technology Didone, Mattia; Saxena, Prateek
- The History of Molded Fiber Packaging; a 20th Century Pulp Story Renee Wever and Diana Twede

Links

- All the reference links are on the left corner on each page.