EXPLORATION OF **COIR** (COCONUT FIBER) IN PRODUCT DESIGN

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Acknowledgement

The success and end result of this Design Project is a cumulative outcome of a lot of guidance and assistance from my Project guide Prof. Kums and many others and I am extremely privileged to have got this all along the completion of my project.

I respect and thank my Project Guide for giving me all support and guidance which made me complete the project duly. I owe my deep gratitude to him for taking keen interest in my project and in guiding me all along till the completion of the project by providing all the necessary information for developing a good system.

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Introduction

- An overview of Coir
- Structure of coir fiber
- Introduction
- Production and utilization of Coir

An overview of Coir

COIR is a versatile natural fibre extracted from mesocarp tissue, or husk of the coconut fruit Generally fibre is of golden color when cleaned after removing from coconut husk; and hence the name " The Golden Fibre".

Coir is the fibrous husk of the coconut shell. Being tough and naturally resistant to seawater, the coir protects the fruit enough to survive months floating on ocean currents to be washed up on a sandy shore where it may sprout and grow into a tree, if it has enough fresh water, because all the other nutrients it needs have been carried along with the seed.

STRUCTURE OF COIR FIBRE

The individual fibre cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature but later become hardened and yellowed as a layer of lignin, is deposited on their walls.
White fibre is smoother and finer, but also weaker. The coir fibre is relatively waterproof and is the only natural fibre resistant to damage by salt water. Green coconuts, harvested after about six to twelve months, contain pliable white fibres.
Brown fibre is obtained by harvesting fully mature coconuts when the nutritious layer surrounding the seed is ready to be processed into copra and desiccated coconut. Mature brown coir fibres contain more lignin and less cellulose than fibres such as flax and cotton and so are stronger but less flexible.

Introduction

India accounts for more than two-thirds of the world production of coir and coir products. Kerala is the home of Indian coir industry, accounting for 61 percent of coconut production and over 85 per cent of coir products.

Not more than 28% of the coconut husks are utilised in the coir industry, the remaining being used as fuel or as a waste material in rural areas. Since the development of coir sector contributes towards the sustainable development agenda in terms of creation of environment friendly products, its application for domestic use along with the usage in housing, building, agriculture, horticulture, and infrastructure production are significant.

The world population is becoming more and more conscious about the need of preserving the nature with an increasing number of people opting for environment friendly products. This is the opportune time to promote the case of coir to replace synthetic furnishings and certain wooden building materials.

The present utilization of coconut husks for coir industry is at a low level. There is a need to raise the level.

02

Research journey

- Properties of Coir
- Uses of Coir
- Coir products
- Statistics of coir production
  - Coconut production in the world
  - Coconut husk utilization and market potential
  - Coir fiber & yarn consumption and market potential
- Stakeholders involved in Coir production
- Coir products as livelihood
- Export of coir and challenges
- Inferences from primary study

Properties of Coir

COIR is extracted from mesocarp tissue, or husk of the coconut fruit. The husk contains 20% to 30% fibre of varying length. After grinding the husk, the long fibres are removed and used for various industrial purposes, such as rope and mat making.

The remaining material, composed of short and medium-length fibres as well as pith tissue, is commonly referred to as waste-grade coir.

The waste grade coir may be screened to remove part or all of the fibre, and the remaining product is referred to as coir pith.

PROPERTIES OF COIR

Versatile

Durable

Tensile strength

Resilient

Thermal & Acoustic insulator

Low rate of decomposition

Resistant to rot, moth & fungi

Fire retardant

Easy to clean

Uses of Coir

BROWN COIR

• Brown coir is used in brushes, doormats, mattresses and sacking.

• A small amount is also made into twine.

• Pads of curled brown coir fibre, made by needle-felting (a machine technique that mats the fibres together) are shaped and cut to fill mattresses and for use in erosion control on river banks and hillsides.

• A major proportion of brown coir pads are sprayed with rubber latex which bonds the fibres together (rubberized coir) to be used as upholstery padding for the automobile industry in Europe.

• The material is also used for insulation and packaging.

WHITE COIR

• The major use of white coir is in rope manufacture.

• Mats of woven coir fibre are made from the finer grades of bristle and white fibre using hand or mechanical looms.

• Coir is recommended as substitute for milled peat moss because it is free of bacteria and fungal spores.

Coir products

Statistics of Coir production

COCONUT PRODUCTION IN THE WORLD

Coconut is produced in about 91 countries of the world. India produces 12685 million nuts and occupies the third place after Indonesia and the Philippines. The Indian share in the world coconut production is about 16.28% and 17.07% in the area harvested. Annual production is about 216651 million nuts with an average of 10122 nuts per hectare. The high producing state is Kerala in terms of area, followed by Tamil Nadu, Karnataka, Andhra Pradesh and Odisha.

COCONUT HUSK UTILIZATION AND MARKET POTENTIAL

Currently 36310.44 lakh husks are utilized for generating fibres. The market value of husks consumed is between Rs 259.36 crore to Rs 315.12 crore. If the government succeeds to tap the husks, it has the potential to generate additional revenue of Rs 653.67 to Rs 794.22 crores per annum.

COIR FIBER & YARN CONSUMPTION AND MARKET POTENTIAL

539815 ton fibres are being consumed in India. The market value of the consumed fibres is Rs 890.69 to Rs 1199.16 crore. The utilization of coir fibre stands at 28.41 %. It has the potential to generate revenue of Rs 3135.54 to Rs 4221.44 crore per annum.

Stakeholders involved

For the people living by the side of the backwaters of Alappuzha and Kollam districts of Kerala, coir making is their primary occupation. Coir industry is one of the major traditional industries in the State and second only to agriculture in terms of employment. It provides employment to around 4 lakh persons.

1 2 3 4 5 6 7

Coconut farmers/ Daily wage laborers

Traders/ Trade participants

Distributors and Retailers

Market associations & Industrial Co-op societies

Industry owners

Artisans

Coir Board & State Government

Coir production as livelihood

EMPLOYMENT IN COIR INDUSTRIES (ALL INDIA)

The industry employs about 7 lakh coir workers and majority of them are from rural areas belonging to economically weaker sections of the Society.

Women constitute 70% of the workforce and primarily engaged in spinning and household industries. In organised industries, the participation of women is observed to be more than men in permanent, contractual (temporary) and as daily wage labourers.

The study reveals, a total of 719883 people are working in the coir industry in the year 2014-15.

If one compares the data with 2013-2014, the growth rate revolves around 1 percent. The data indicates younger generation / new people participation is less in the coir industry.

State-wise analysis indicates Kerala tops the list with share of 65.28 percent, followed by Tamilnadu (18.05 percent), Andhra Pradesh (7.36 percent), Odisha (4.72 percent) and Karnataka (4.16 percent). The other states have not succeeded in generating much employment in coir industries.

Export of Coir and challenges

The study indicates continuous growth is seen in the export of coir and coir products in the last five years. The growth analysis for the year 2013-14 and 2014-15 suggests there is an overall upward trend in export. Highest growth is witnessed in Coir Rugs & Carpets which constitutes 45.2% in quantity and 37.8% in value.

Second highest growth is observed in coir fibre which constitutes 26% in quantity and 27.5% in value. The overall export scenario reflects a positive trend in export of coir fibre and coir pith while export of value added products market is decreased.

China is the major importer of coir fibre for manufacturing mattress boards for their domestic requirements. They are focusing to import more coir pith / grow bags for horti/agriculture requirements. The coir handloom products export from India has shown a marginal increase by quantity but no increase by value comparing last year.

The worrisome factor is high growth trend observed in the export of coir fibre, coir pith and rubberized coir while the growth in export of coir yarns and other value added coir products are not catching up.
The development that we witness in terms of growth in the coir export market is not a positive trend. If one analyses data, it shows the export of geo-textiles and handloom matting have witnessed a downward trend. Thus, initiatives may be taken to increase exports of value added products besides raw-materials such as coir fibre and coir pith.

Inferences from Primary study

- Utilization of coconut husks (currently only 28% is being used)
- The government may come out with a plan to directly engage the farmers in husk trade.
- Direct engagement will not only help the farmers to earn more money but will also ensure high utilization of husks.
- Establish more fiber extraction units.
- Set-up new coir industries.
- Upgradation in existing technology.
- The technology currently used in Coir Industry and Coir Yarn production is partially mechanised and the sector is dependent on skilled manpower.
- Improvement in power supply.
- Disposal of accumulated coir pith.
- Remove spatial distribution of coir industries.
- Shortage of skilled workers.
- Providing training to workers.
- Tapping of younger generations.
- Artisans/ Workers welfare and social security.
- Establishment of Research and development.

Inferences from Primary study

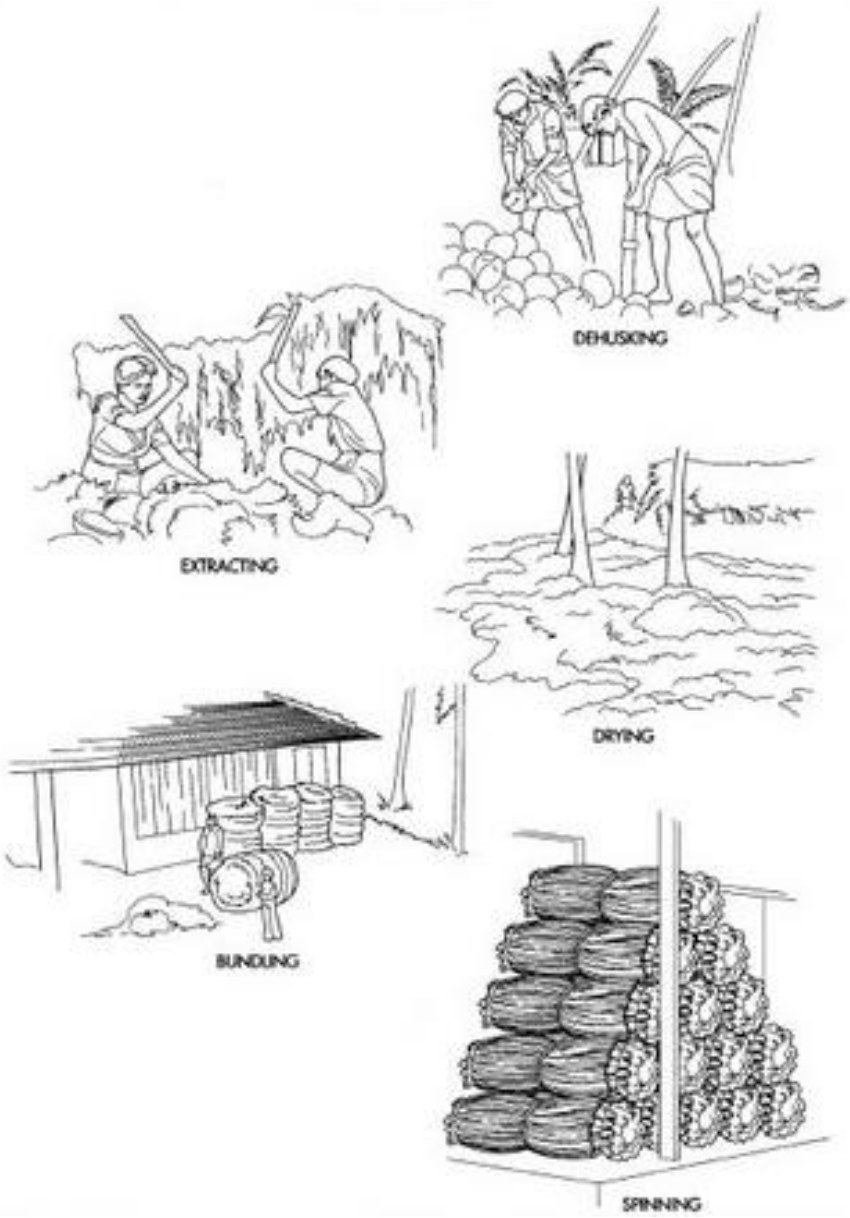
- Newer usages of coir
- New product design and development.
- Standardization of process and products.
- Eco-labelling of coir products.
- Consider Coir industry as a priority sector under MSME (Ministry of Micro, small and medium enterprises)
- Provide financial support to coir industries.
- Export trend- China importing coir fiber and raw materials from India and producing value added products in the International market.
- Incentives under Foreign trade.
- Announcing Fiscal measures (subsidy/ Tax relaxation)
- Strengthening of agencies and awareness campaigns.
- Aggressive marketing of coir products.
- E-Commerce platform.
- Brand-building and promotion.

03

Manufacturing process of Coir

- Coconut Harvesting
- Coconut Husk Peeling
- Fiber Extracting
- Traditional Twine Making
- Automated Twine Making
- Tools and Machinery
- Final Product making

Coir- Manufacturing process



Manufacturing process of Coir

HARVESTING AND HUSKING

- Coconuts that have ripened and fallen from the tree may simply be picked up off The outer layers covering the coconut seed are processed and spun into fibers commonly known as coir.
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- Ripe coconuts are husked immediately, but unripe coconuts may be seasoned for a month by spreading them in a single layer on the ground and keeping them dry.
- A skilled husker can manually split and peel about 2,000 coconuts per day. Modern husking machines can process 2,000 coconuts per hour.

RETTING

- Retting is a curing process during which the husks are kept in an environment that encourages the action of naturally occurring microbes.
- This action partially decomposes the husk's pulp, allowing it to be separated into coir fibers and a residue called coir pith.
- Freshwater retting is used for fully ripe coconut husks, and saltwater retting is used for green husks.

Manufacturing process of Coir

DEFIBERING

- Traditionally, workers beat the retted pulp with wooden mallets to separate the fibers from the pith and the outer skin. In recent years, motorized machines have been developed with flat beater arms operating inside steel drums. Separation of the bristle fibers is accomplished by hand or in a machine consisting of a rotating drum fitted with steel spikes.

DRYING

- The clean fibers are spread loosely on the ground to dry in the sun.

FINISHING

- Bristle fibers that will not immediately be further processed are rolled and tied into loose bundles for storage or shipment. More mechanized producers may use a hydraulic press to create compact bales.
- However, if more processing is desired, the fibers are combed with mechanical or manual carding tools, then loosely twisted into a thick yarn (wick), and wound into bundles. Later, the wick can be re-spun into a finer yarn.
- Depending on its intended final use, the yarn may be shipped to customers, or multiple strands may be twisted into twine and bundled for shipment. For some uses, such as upholstery padding, bristle fiber is loosely spun into yarn and allowed to rest.

04

Coir- Existing products

Coir yarn | Needle felt | Coir mattresses | Coir geotextiles | Acoustic panels | Coir mats | Coco logs | Coco fiber composites Coir pith | Garden articles

Existing products in Coir

BROWN COIR

- Brown coir is used in brushes, doormats, mattresses and sacking.
- A small amount is also made into twine.
- Pads of curled brown coir fibre, made by needle-felting (a machine technique that mats the fibres together) are shaped and cut to fill mattresses and for use in erosion control on river banks and hillsides.
- A major proportion of brown coir pads are sprayed with rubber latex which bonds the fibres together (rubberized coir) to be used as upholstery padding for the automobile industry in Europe.
- The material is also used for insulation and packaging.

WHITE COIR

- The major use of white coir is in rope manufacture.
- Mats of woven coir fibre are made from the finer grades of bristle and white fibre using hand or mechanical looms.
- Coir is recommended as substitute for milled peat moss because it is free of bacteria and fungal spores.

Existing products in Coir

Existing products in Coir

05

Design brief

Exploring Coir in product design for **enhancing the Art** of Coir craft and **elevating the livelihood** of craftsmen.

Design brief

Exploring Coir in product design for **enhancing the Art** of Coir craft and **elevating the livelihood** of craftsmen.

DESIGN OBJECTIVE

- To create value added products using Coir in its true form or in an enhanced exploratory form.
- The product should be mass-producible.
- Traditional coir making craft could be incorporated so as to provide ease of manufacturing and production by the local craftsmen.

USER GROUP

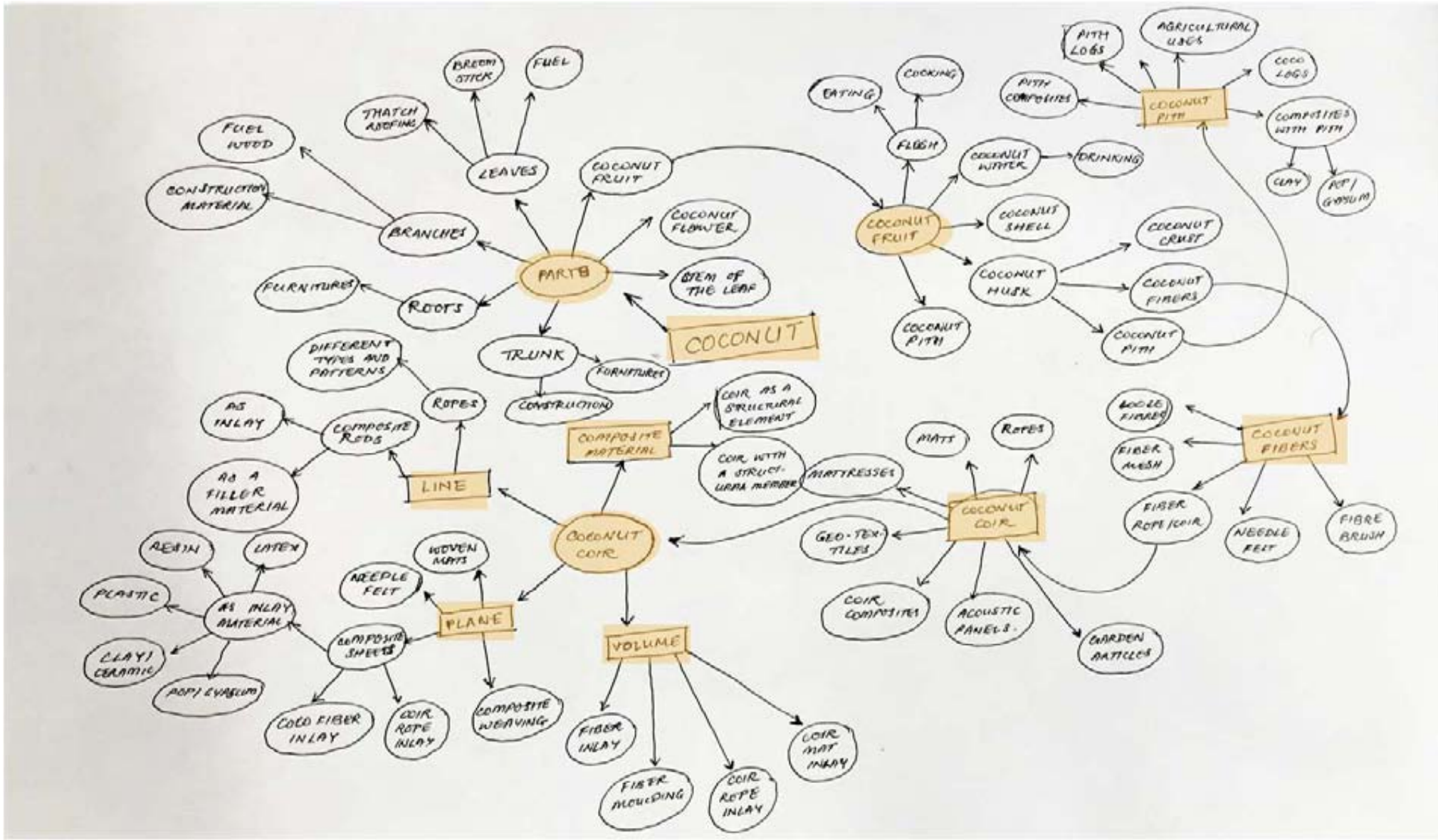
- Residential users, who could range from Middle or Upper classes.
- For Commercial areas and spaces that would want the cultural identity of Coir and its craft to be displayed, such as Airports, Cultural centers, Exhibition spaces, etc.

06

Exploration
(STAGE 1)

Exploration of coir rope and fiber in various media in no particular manner to form composite materials.

Mind mapping



EXPLORATION OF COIR (STAGE 1)

MATERIAL SPECIFICATIONS

Coir fibers formed into 3 dimensional forms by reinforcing with EVA layer and vein-like EVA structure.

EXPLORATION OF COIR (STAGE 1)

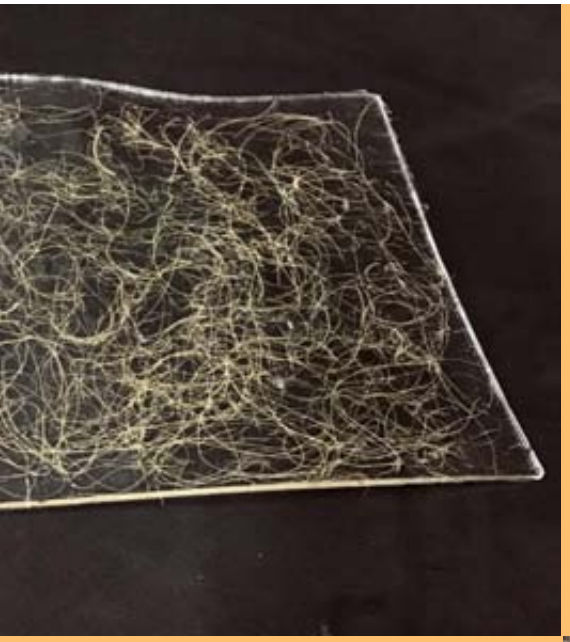
MATERIAL SPECIFICATIONS

5mm- 8mm thick Coir ropes combined with cotton rope to form a basket. Then layered with resin to give a solid form.

EXPLORATION OF COIR (STAGE 1)

MATERIAL SPECIFICATIONS

15mm- 20mm thick Coir rope combined with Silicon and Epoxy resin inlay.



EXPLORATION OF COIR (STAGE 1)

MATERIAL SPECIFICATIONS

Coir fibers (uncut and shredded) formed into sheets on resin bed.

EXPLORATION OF COIR (STAGE 1)

MATERIAL SPECIFICATIONS

Coir fibers combined to form bunches that are inserted into baked clay pots and also into an unbaked clay layer.

EXPLORATION OF COIR (STAGE 1)

MATERIAL SPECIFICATIONS

5mm- 8mm thick Coir ropes combined with baked clay pot by inserting into it. Coco fibers combined with clay.

07

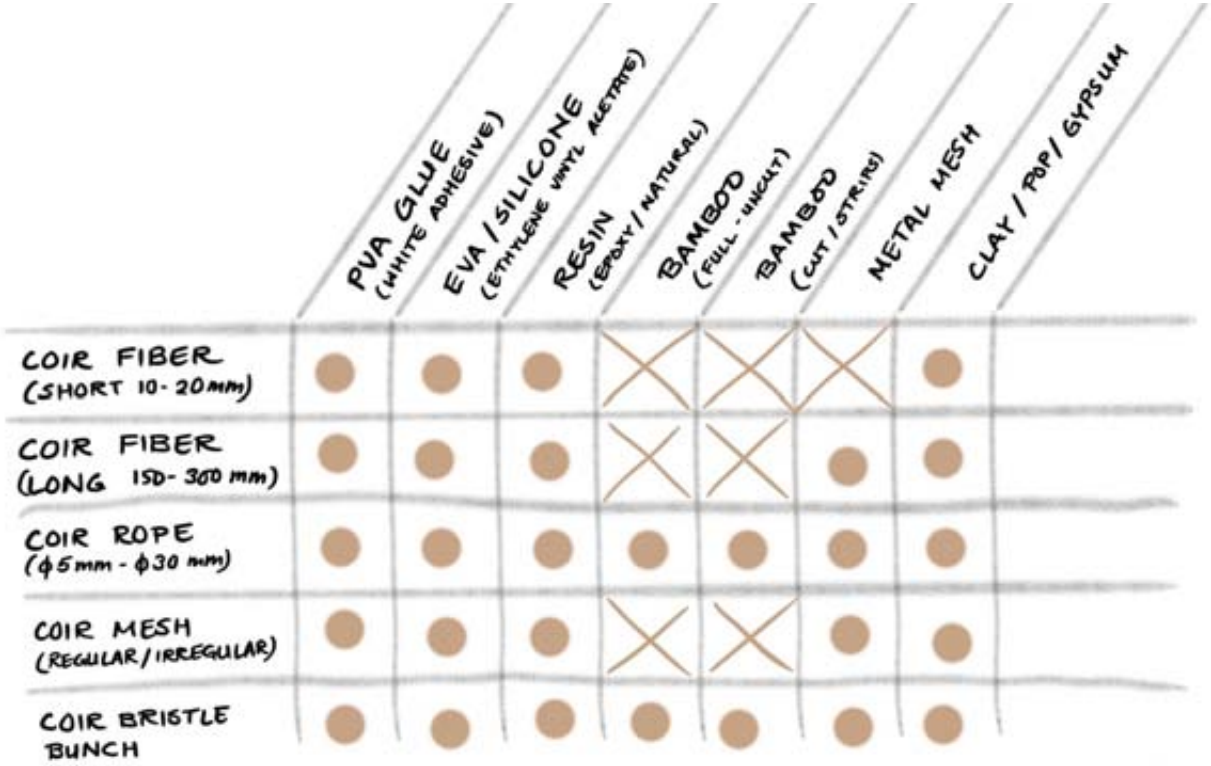
Exploration
(STAGE 2)

Exploration of coir rope and fiber in various media in a structured manner to form composite materials.

Exploration matrix

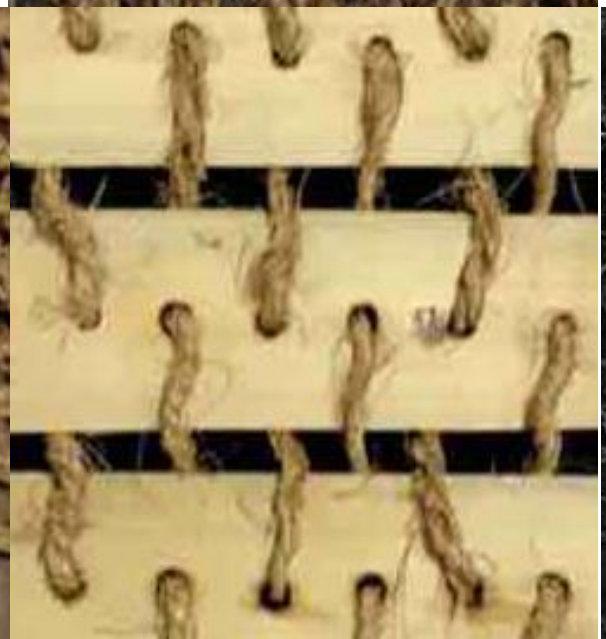
After the exploration done in Stage 1, a brief idea was formed of the material and the possibilities with it.

Further exploration was done in a structured manner by forming an exploration matrix. In this matrix, the various forms of raw materials of coir (primary material) are listed in the column and the different possible binding materials are listed in the row.
Stage 2 explorations were then carried forward with reference to the exploration matrix.



EXPLORATION (STAGE 2)

Exploration of coir rope and fiber in various media in a structured manner to form composite materials.



Exploration of Coir (STAGE 2)

1. Coir- Long fiber in PVA adhesive

2. Coir- Short fiber in PVA adhesive

3. Coir- Long fiber in EVA as binder

Exploration of Coir (STAGE 2)

4. Coir- Long fiber in epoxy resin (front view)

5. Coir- Long fiber in epoxy resin as binder (rear view)

6. Coir- Long fiber in EVA as binder

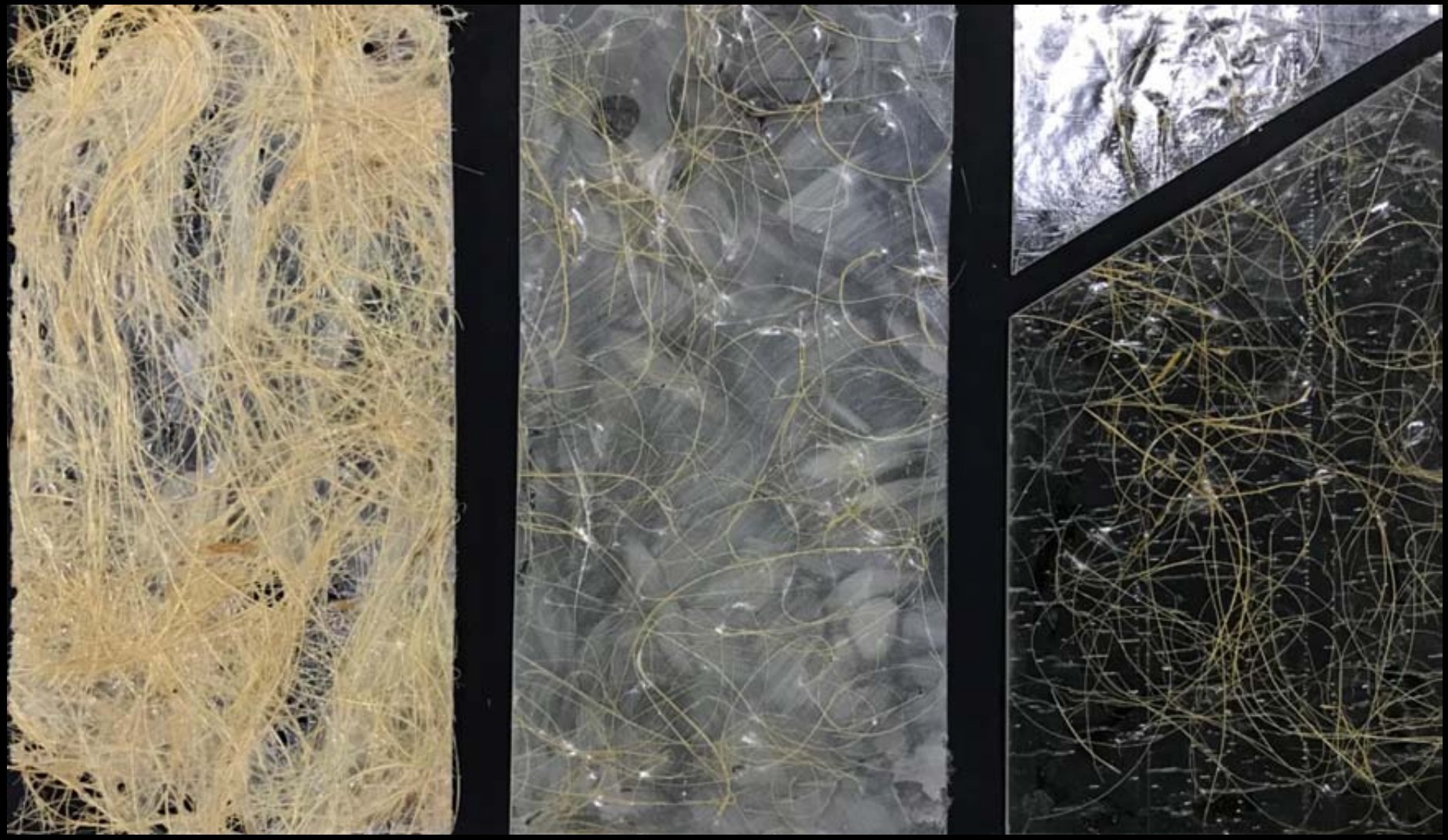
Exploration of Coir (STAGE 2)

7. Coir- Long fiber in epoxy resin (front view)

8. Coir- Long fiber in epoxy resin (rear view)

9. Coir- Thick rope partly inlaid in epoxy resin

Exploration of Coir (STAGE 2)



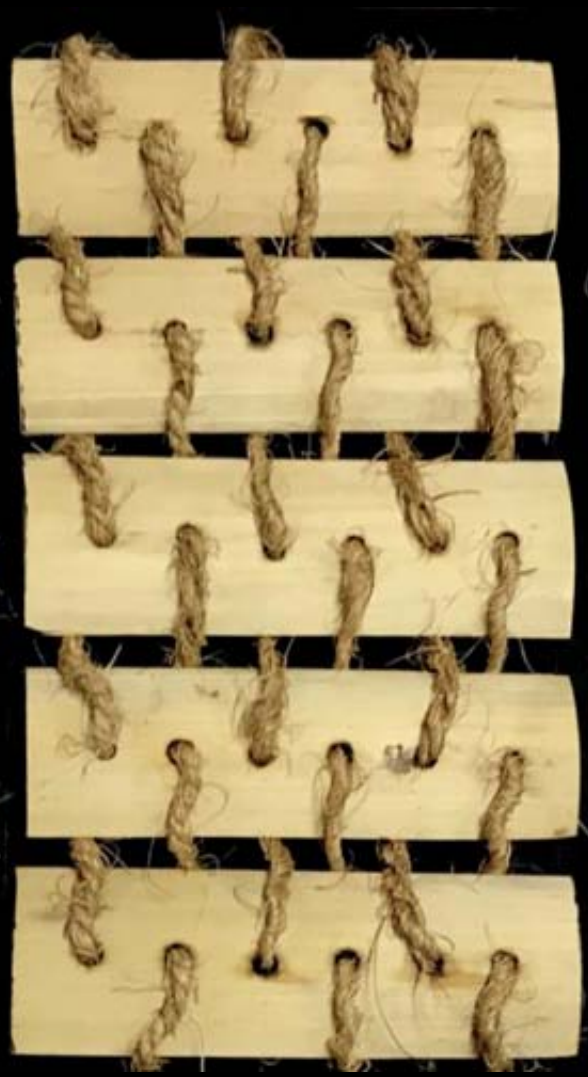
10. Coir- Long fiber in epoxy resin (sprinkled with water for translucent finish)

11. Coir- Long fiber in epoxy resin (sparsely spread- frosted finish)

12. Coir- Long fiber in epoxy resin (sparsely spread- transparent finish)

Exploration of Coir (STAGE 2)

13. Coir rope (thin) woven with thin bamboo strips



14. Coir rope (thin) woven with bamboo slivers

15. Coir rope (thin) woven with bamboo strips

Exploration of Coir (STAGE 2)

16. Coir bristles inlaid in aluminium mesh

17. Coir rope (thin) woven on aluminium mesh

18. Coir rope (thin) woven on aluminium mesh

Exploration of Coir (STAGE 2)

19. Coir fibers (long) inlaid in clay

20. Coir fibers (long) inlaid in clay forming jali pattern

Exploration of Coir (STAGE 2)

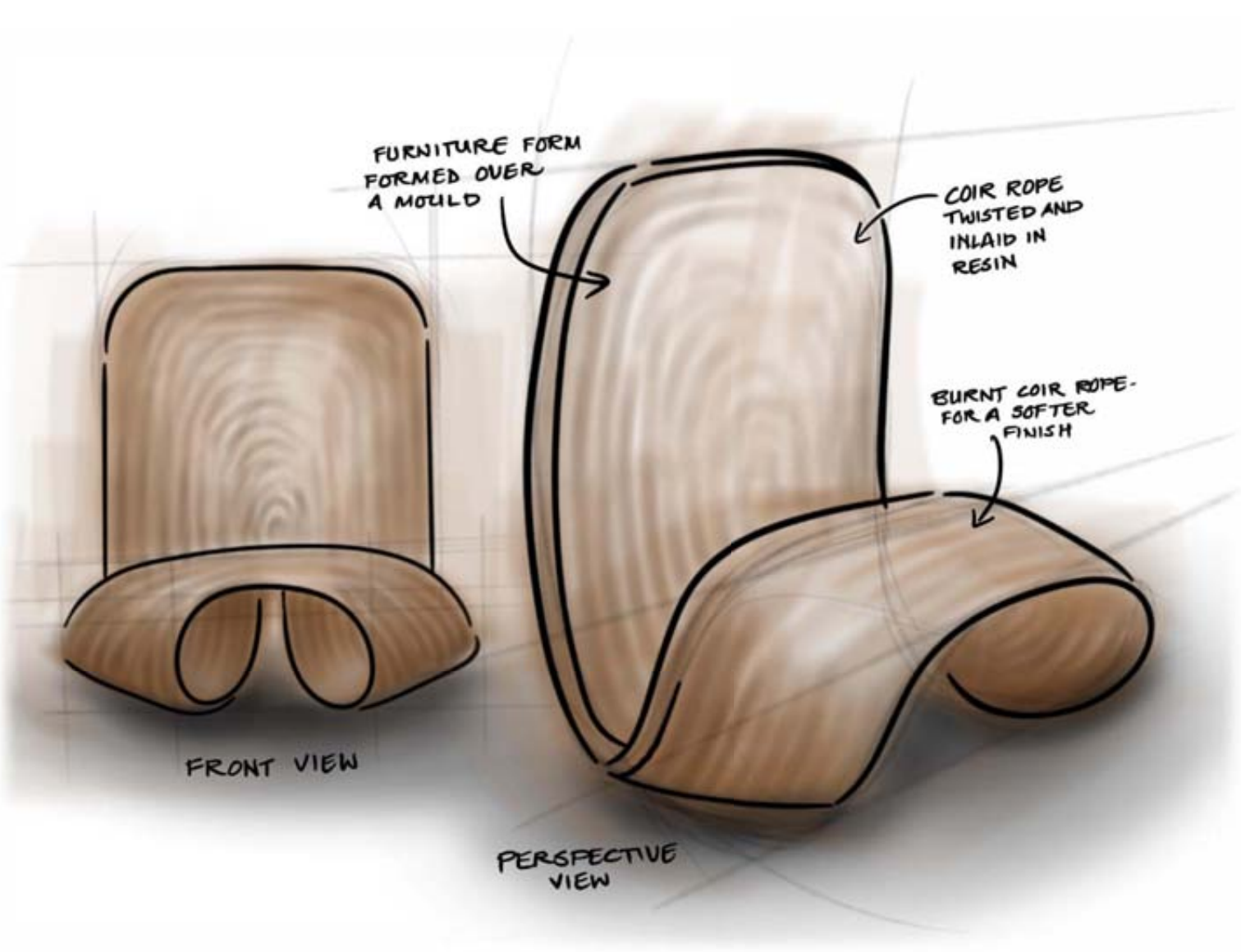
21. Coir rope (thick) unraveled to form branching fractal pattern, with EVA (Ethylene vinyl acetate) inlay

08

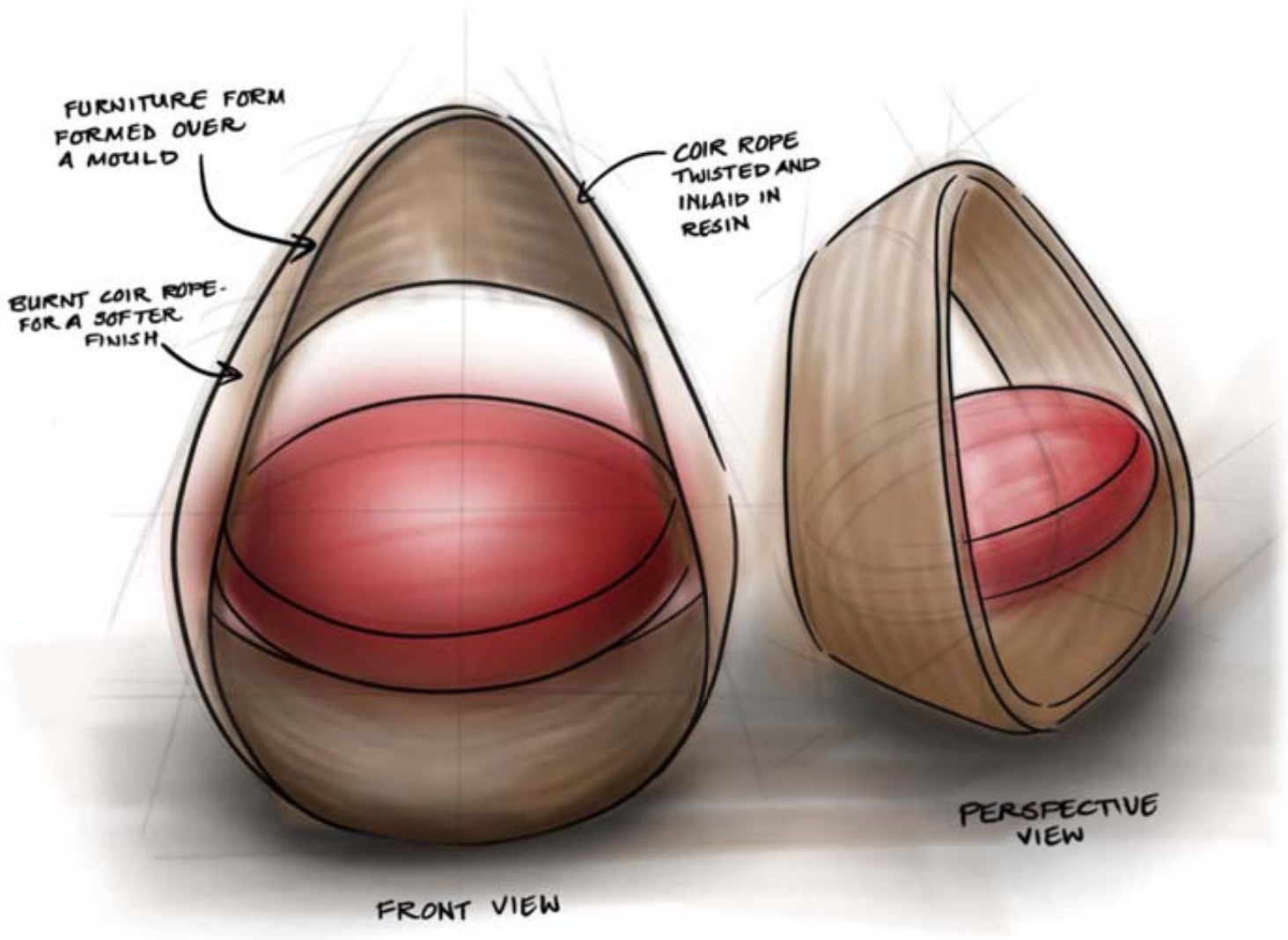
Design ideations

Ideation of Coir furniture incorporating the explorations made in Stage 1 and 2 of material explorations.
Design possibility with each of the material explorations were ideated and sketched.

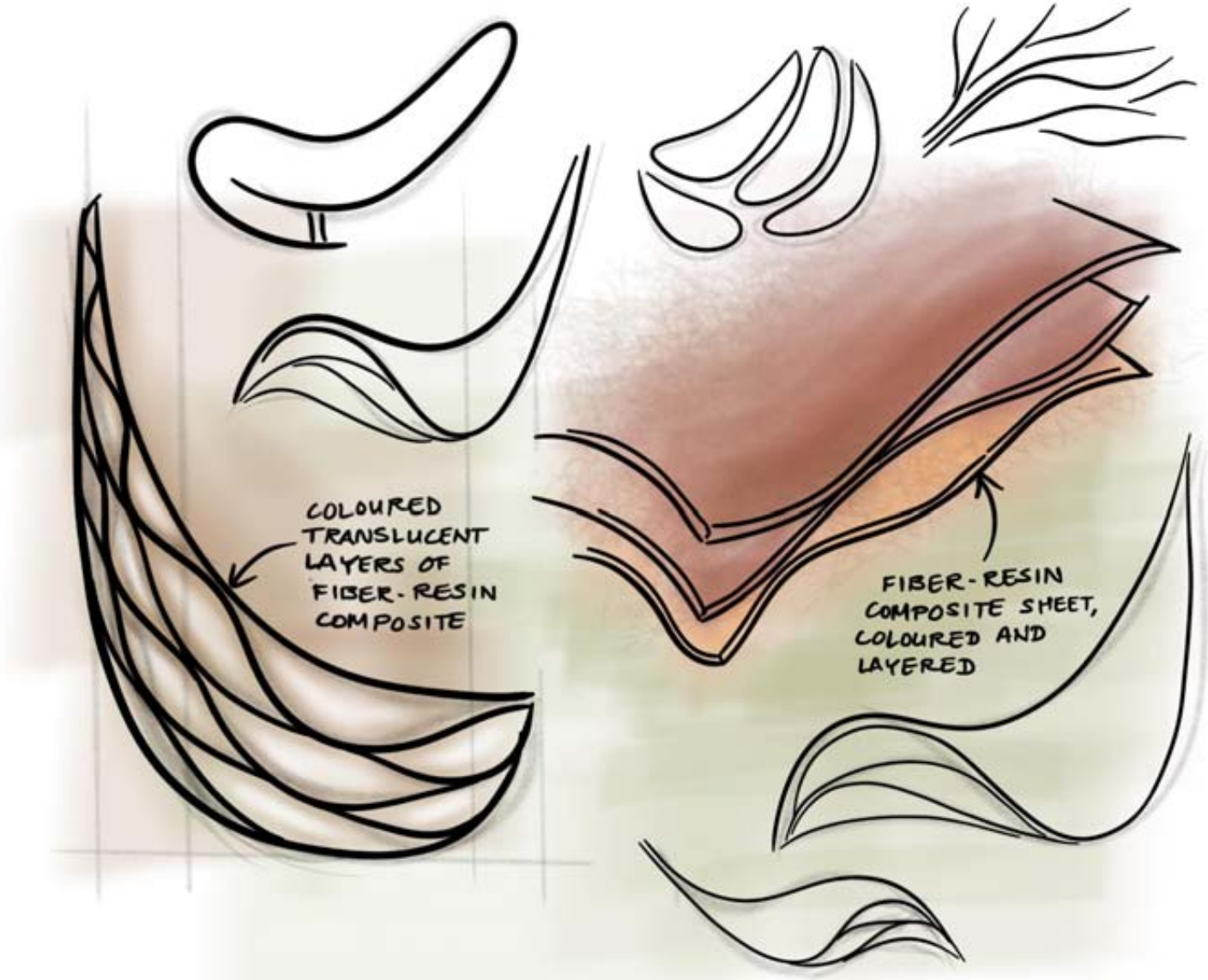
Coir furniture: Ideation 1

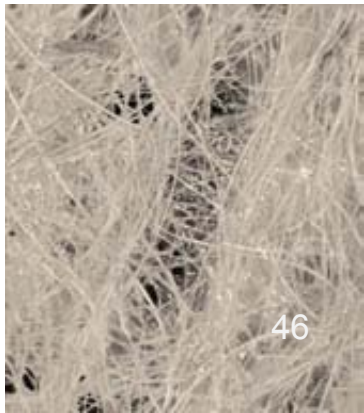


Coir furniture: Ideation 2

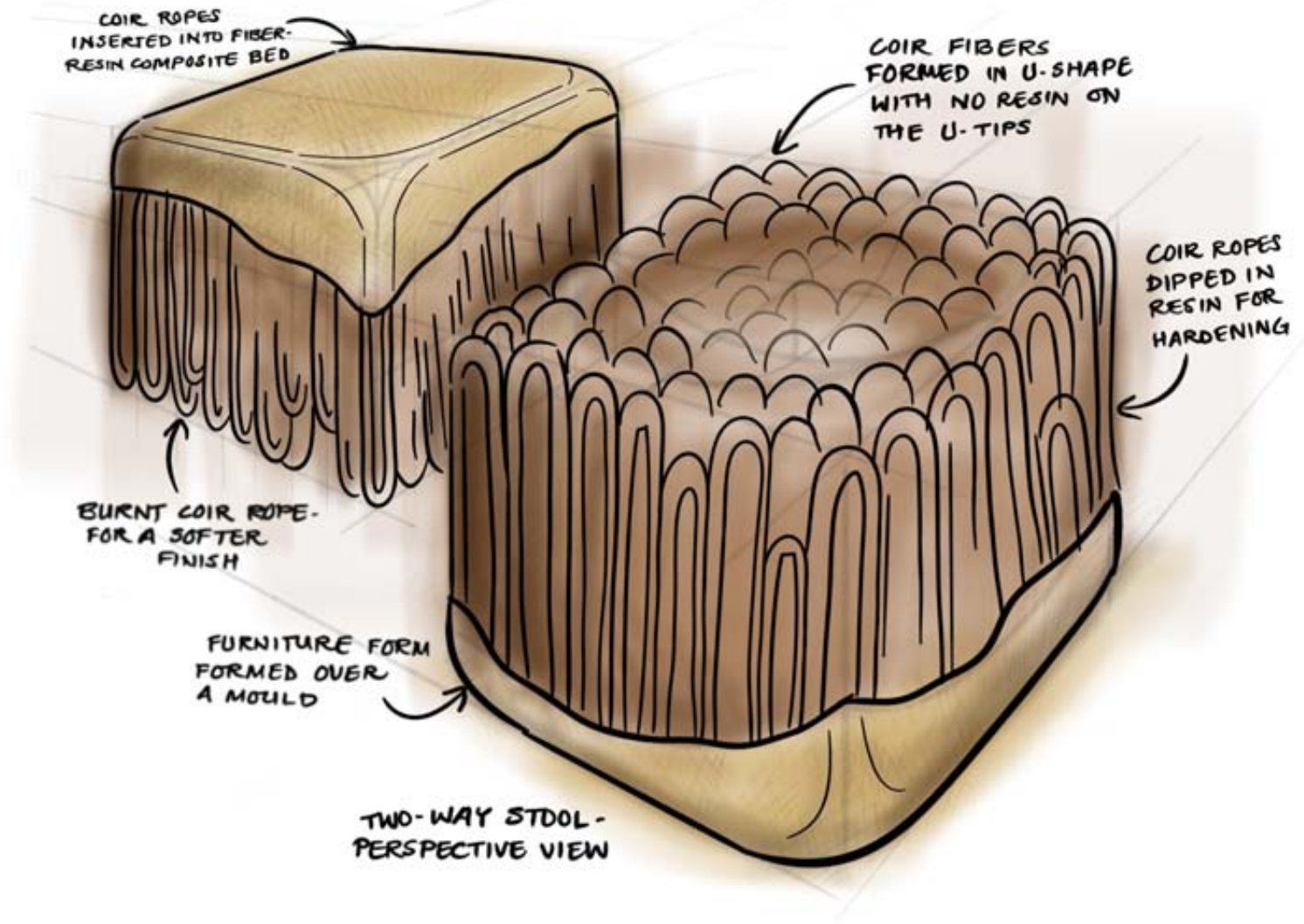


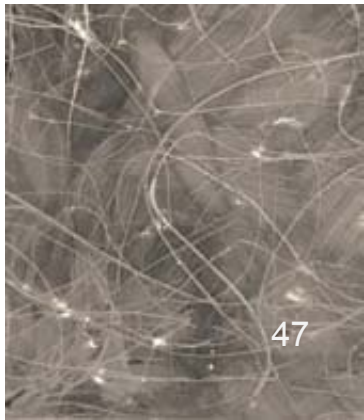
Coir furniture: Ideation 3



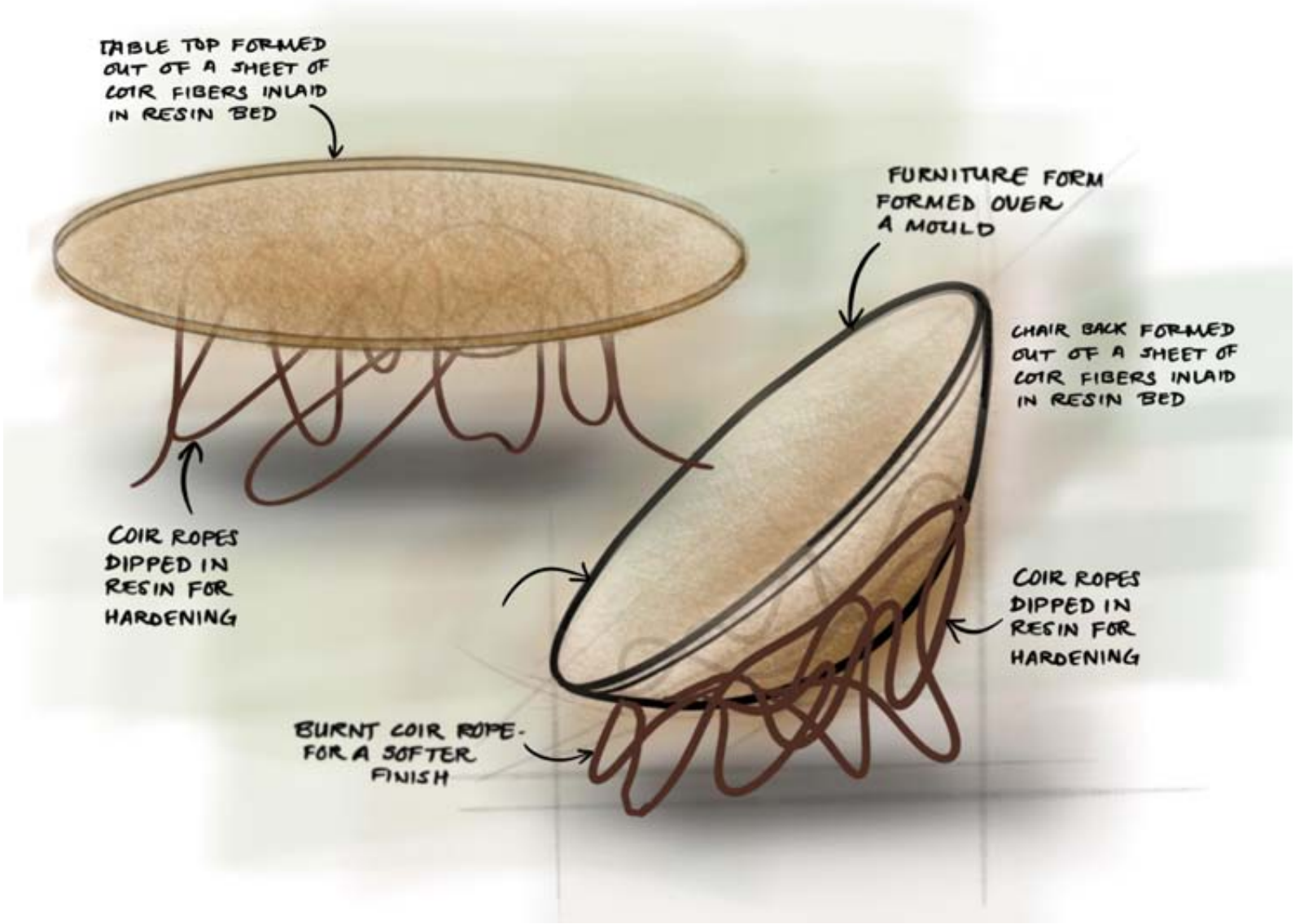


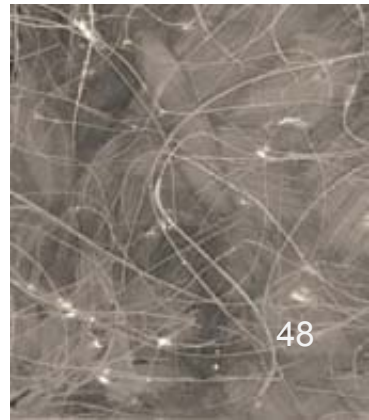
Coir furniture: Ideation 4



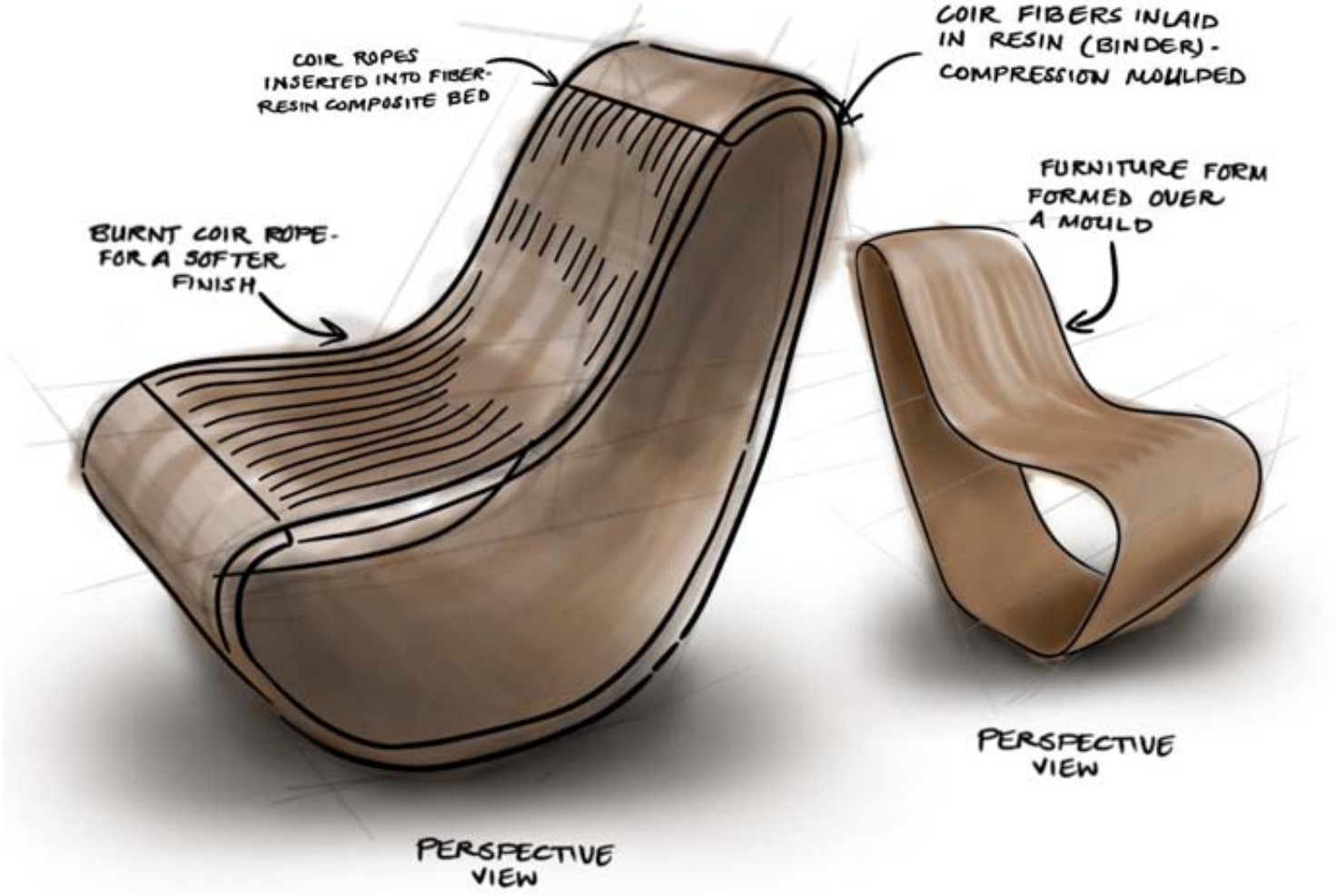


Coir furniture: Ideation 5

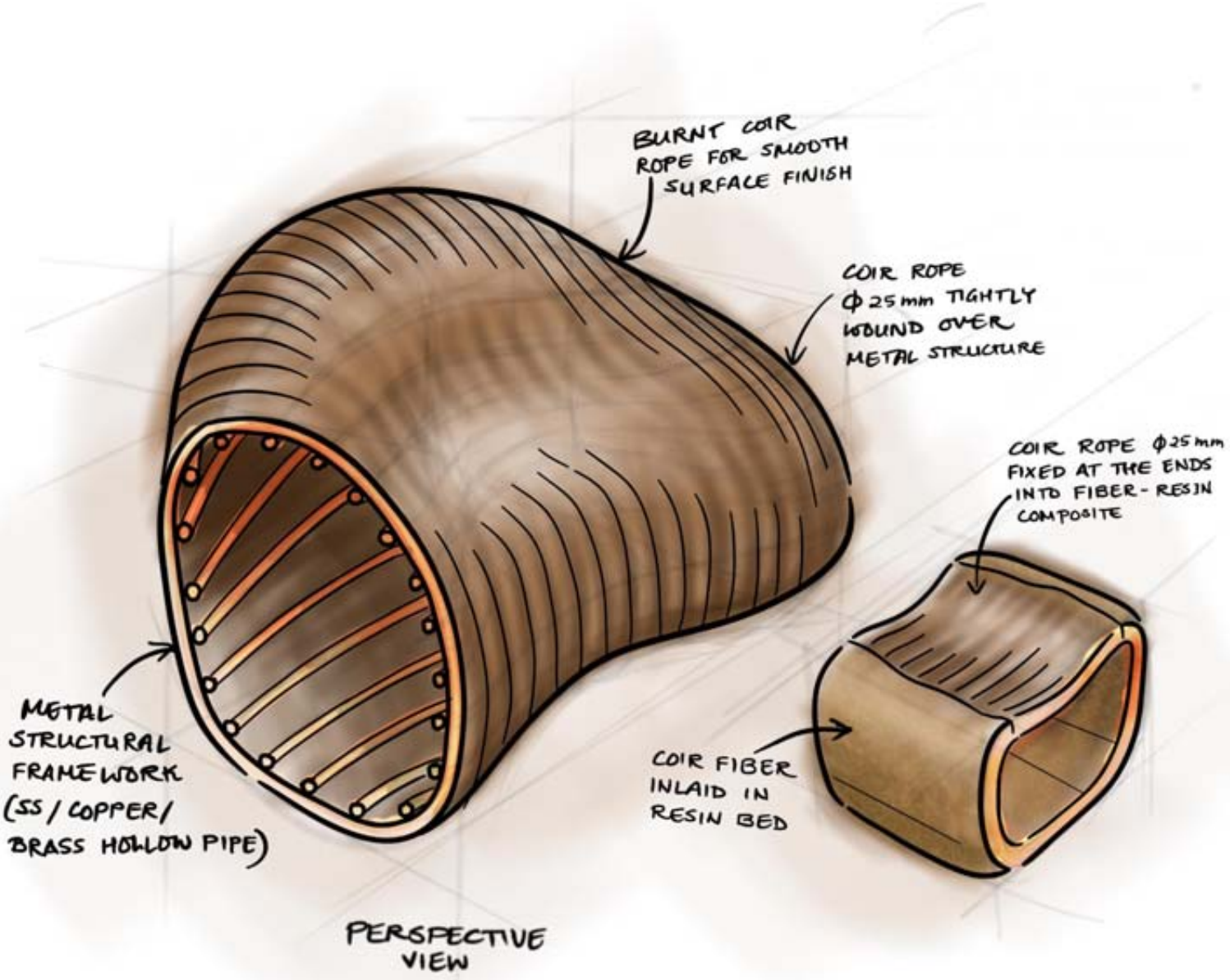


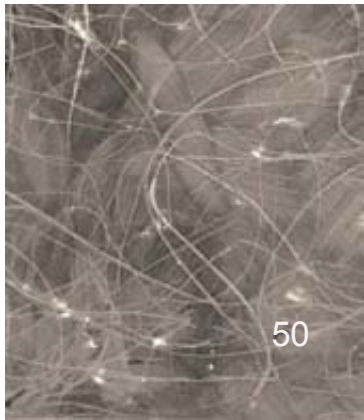


Coir furniture: Ideation 5



Coir furniture: Ideation 6



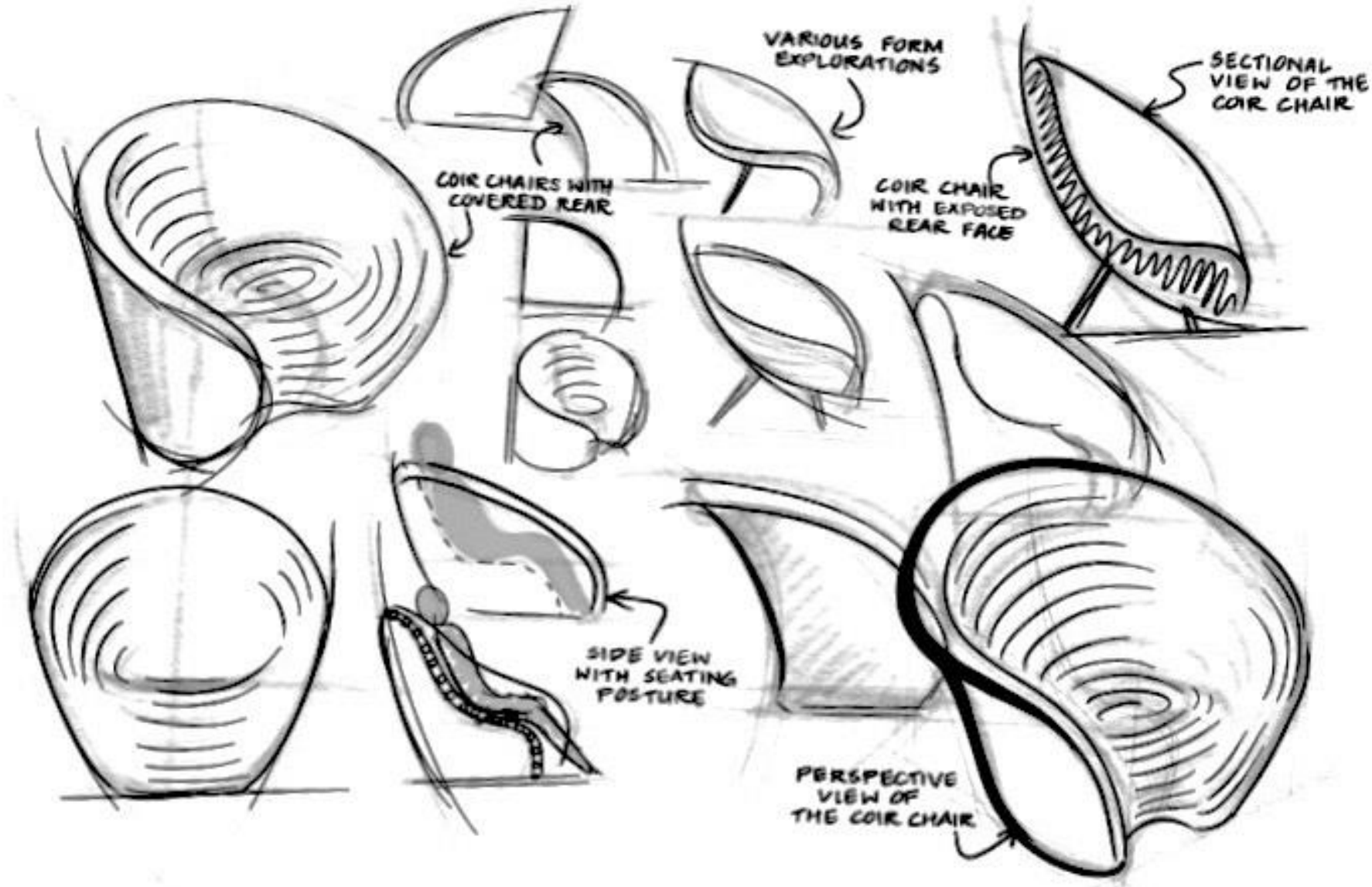


09

Finalized design concept

‘Kayar’ range of furniture in coir for the interiors of homes, restaurants, cafes, etc., that portray the essence of traditional coir craft that is blended with designs that suit the national as well as the international users.

Ideation sketches

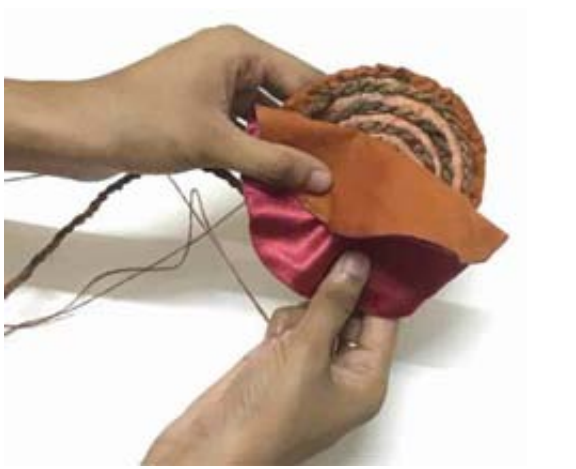


‘KAYAR’

Spiraling stories in coir

Furniture range in coir for the interiors of homes, restaurants, cafes, etc., that portray the essence of traditional coir craft that is blended with designs that suit the national as well as the international users.

THE BARREL CHAIR

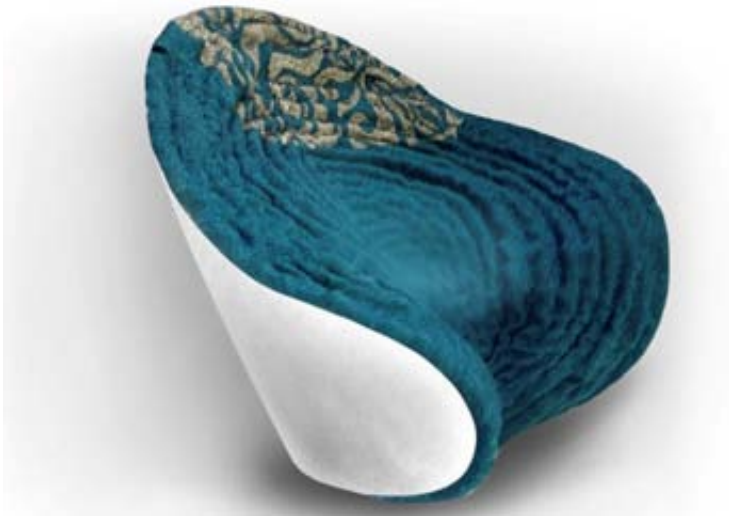



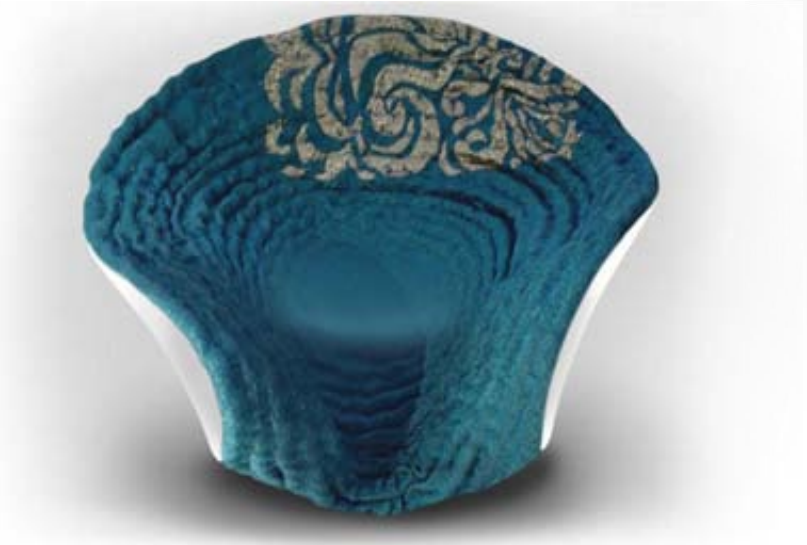




FURNITURE 1:

THE BARREL CHAIR





FURNITURE 1:

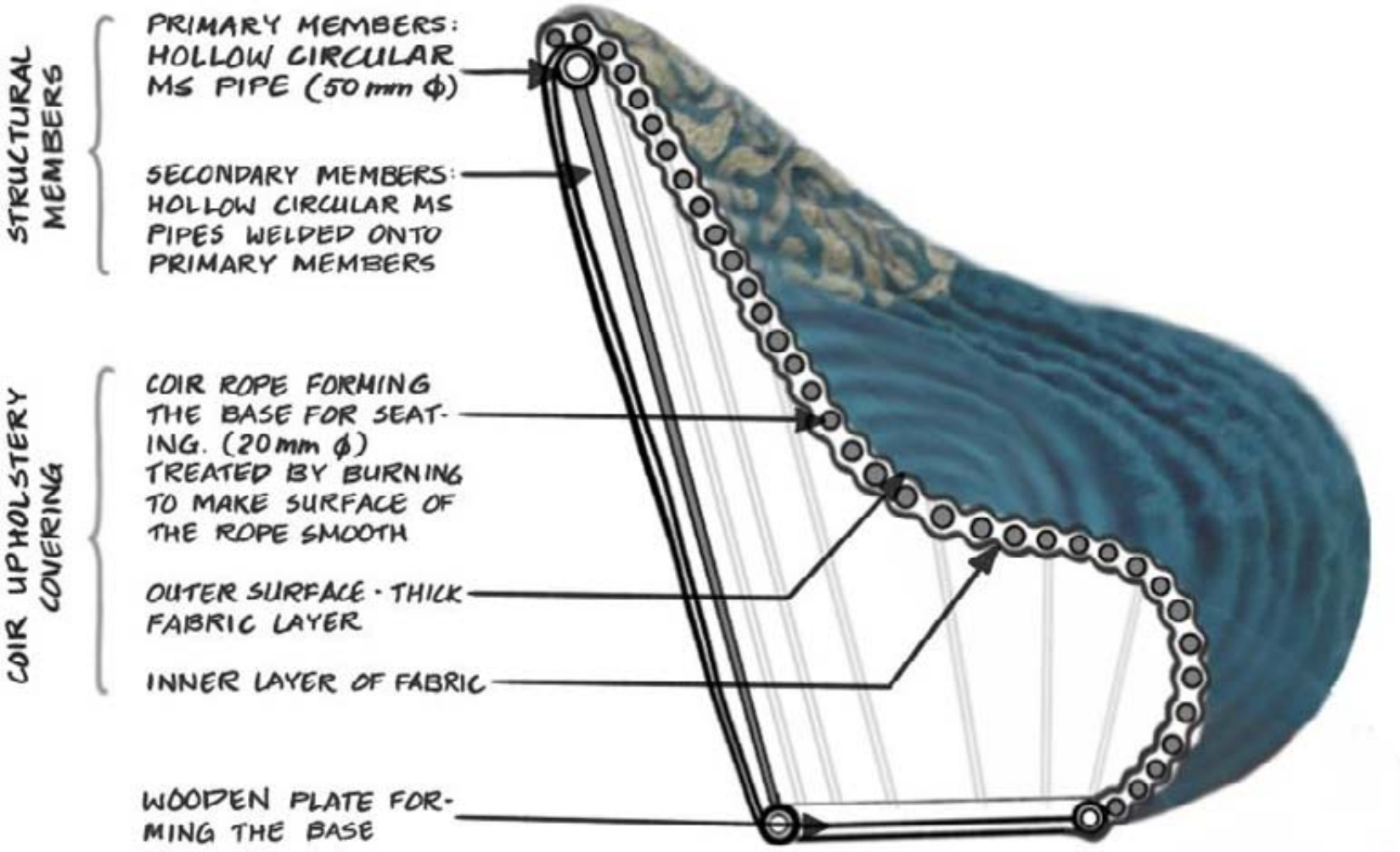
THE BARREL CHAIR

Refined product model at 1:5 scale

FURNITURE 1:

THE BARREL CHAIR

Sectional view with structural details



FURNITURE 2:

THE BARREL CHAIR

Product model at 1:5 scale with seating postures

FURNITURE 2:

THE BARREL CHAIR

Product model at 1:5 scale with seating postures

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