

INDUSTRIAL DESIGN PROJECT-III
REPORT



Coir In Furniture

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Coir in Furniture

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Industrial Design
Project - 3

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Approval

Industrial Design Project III

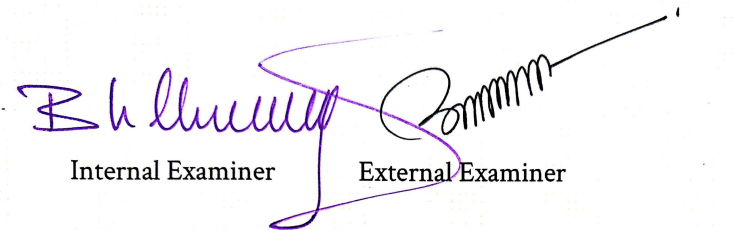
“Coir In Furniture”

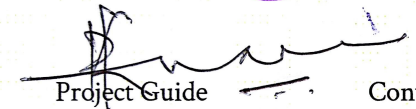
By: Arun Shah,


156130016

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Is approved as a partial fulfillment of requirements of post graduate Degree in Industrial Design at IDC, IIT Bombay.


Internal Examiner External Examiner

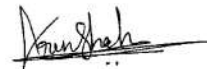

Project Guide Convener





Declaration

I declare that this written submission represents my idea in my own words and where other ideas or words have been included, I have adequately selected and referred the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any ideas / data / facts / sources in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources that have not been properly cited, or from whom proper permission has not been sought.



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Acknowledgement

This work would not have been possible without my friends and faculty here at IDC. I would like to thank My guide, Prof P Kumaresan, for all the valuable inputs and directions. I would also like to thank Central Institute for Coir Technology Bangalore, Kerala State Coir Corporation Beypore, Department of Industries (Project office - Coir) Kozhikode for the valuable inputs and Cooperation.

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01

Preface

The coconut tree is called “Kalpa vriksha”. Which means that the tree that make every dream come true. Whis is pretty much the truth after all. Coconut tree is one of the most useful trees in the environment, from flower to roots, every bit of it can be used for many applications. Coir is the natural fibre from coconut. There are many products made out of coir.

The coir board of India, is a Government institution under the ministry of Micro, small and medium enterprises, They have been researching on the development and betterment of this sector. There has been a lot of new turnovers in terms of processing, product development and India is one country with a really large scale of coconut tree plantation. This amazing fibre contributes more than just a handful of products to different sectors in Kerala. It is also being exported to many countries because of its characteristics and durability.

Furniture design using coir is not an entirely new thing. There have been many innovations in design using coir as a raw material. The coir board itself promotes student projects in many areas to bring innovation to the sector.

In this project I will be exploring the possibilities of coir as a material for furniture design. I will look into different manufacturing processes and see whether we can manipulate them, to yield new forms and textures etc.



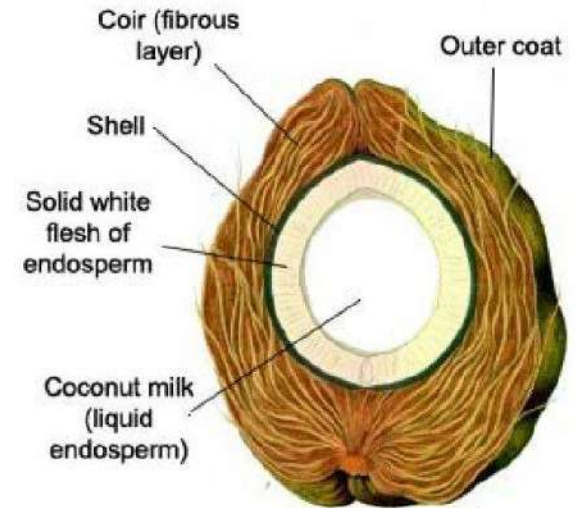
02

Understanding Coir

2.1 What is Coir?

coir
'kɔɪə/
noun

A natural fibre extracted from the outer husk of the coconut, used in potting compost and for making ropes floor mats, doormats, brushes and mattresses.



https://usercontent1.hubstatic.com/7032490_f520.jpg

COIR is a versatile natural fibre extracted from mesocarp tissue, or husk of the coconut fruit. Generally fibre is of golden colour when cleaned after removing from coconut husk; and hence the name “The Golden 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. Mature brown coir fibres contain more lignin and less cellulose than fibres such as flax and cotton and so are stronger but less flexible. They are made up of small threads, each less than 0.05inch (1.3 mm) long and 10 to 20 micrometres in diameter. 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 saltwater.

2.2 Extraction of coir from coconut

1. Harvesting and Husking

Ripe coconuts naturally fall to the ground which can be picked up and stored. Coconuts still clinging to the 40-100 ft (12-30 m) tall trees are harvested by climbing laborers. If the climber picks the fruit by hand, he can harvest fruits from about 25 trees in a day. If the climber uses a bamboo pole with a knife attached to the end to reach through the treetop vegetation and cut selected coconuts loose, he can harvest 250 trees per day. (A third harvesting technique, in which trained monkeys climb trees to pick ripe coconuts, is used only in countries that produce little commercial coir.) Ripe coconuts are husked immediately, but unripe coconuts has to be seasoned for a month by spreading them in a single layer on the ground and keeping them dry. To remove the fruit from the seed, the coconut is impaled on a steel-tipped spike to split the husk. The pulp layer is easily peeled off. A skilled husker can manually split and peel about 2,000 coconuts per day. Modern husking machines can process 2,000 coconuts per hour.



2. Retting

Retting is the process which unbounds coir fibre from the husk to 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. Coir pith is an alternative material for agricultural soil. Freshwater retting is used for fully ripe coconut husks, and saltwater retting is used for green husks. For freshwater retting, ripe husks are buried in pits dug along riverbanks, immersed in water-filled concrete tanks, or suspended by nets in a river and put on a weight to keep them submerged. The husks typically soak at least six months. Saltwater retting is done by the following method; green husks are soaked in seawater or artificially salinized fresh water. This is accomplished by placing them in pits along riverbanks near the ocean, where tidal action alternately covers them with sea water and rinses them with river water. Saltwater retting usually takes eight to 10 months, But adding the proper microbes can fasten up the process.



Mechanical techniques have recently been developed to hasten or eliminate retting. Ripe husks can be processed in crushing machines after being retted for only seven to 10 days. Immature husks can be dry milled without any retting. After passing through the crushing machine, these green husks need only be dampened with water or soaked one to two days before proceeding to the defibering step. Dry milling produces only mattress fiber.

3. Defibering

Traditional method is that, the workers beat the retted pulp with wooden mallets to separate the fibers from the pith and the outer skin. But motorized machines have been developed by recent researchers in the coir board, which has 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.

Separation of the mattress fibers from the pith is done by washing the residue from the defibering process and combing through it by hand or tumbling it in a perforated drum or sieve. (Saltwater retting produces only mattress fibers.)The clean fibers are spread loosely on the ground to dry in the sun.



4. Finishing

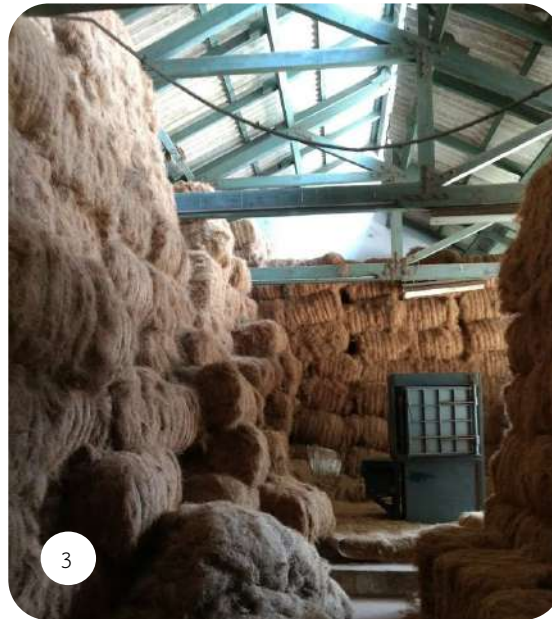
Bristle fibers that will not immediately be further processed are rolled and tied into loose bundles for storage or shipment. More mechanized producers may use a hydraulic press to create compact bales.

Similarly, mattress fibers may simply be baled with a hydraulic press. 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. There are techniques varying from simple hand spinning to use of a hand-operated spinning wheel or a fully automated spinning machine.

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. Both traditional manual techniques and newer mechanical methods are used to braid twine into rope and to weave yarn into mats or nets.

For some uses, such as upholstery padding, bristle fiber is loosely spun into yarn and allowed to rest. Then the fibers, which have become curly, are separated. These fibers are lightly felted into mats that are sprayed with latex rubber, dried, and vulcanized to be made as rubberized coir. Those are used in mattresses and pillows





2.3 Field Visit

Kerala state coir corporation factory at Beypore, Calicut. The facility extracts fiber from coconut husks, in a fully mechanised process. they manufacture coir yarns of 10mm dia, and Twisted coir for rubberised coir making.

The extraction process is described as follows;

- The defibering is done using a mill, which grinds the husk, giving a mixture of fiber and the pith



- The pith and short fibers are filtered out in rotating rollers. The length of a fiber should be min. 8 cm to be utilised effectively.
- Fibers are then bundled and stocked.
- Before using them for yarn making, they are sent through a gravity separating machine to remove any large chunks.

2.4 Coir Products

The fibre extracted is processed in many ways to produce various products. These include, Coir yarn, Mats, Brushes, composite boards, etc.

Coir Yarn is generally of 2 ply, spun from coir fibre by hand as well as with the help of traditional ratts, fully automatic spinning machines etc. The Coir yarn is of different qualities/grades based on the quality of fibre used, the nature of twist, presence of impurities etc. Available in different forms like hydraulically pressed bales, spools bobbins, dolls, balls etc. cut length for various industrial and agricultural purposes.



Coir Fibre



Coir Yarn



Coir mat showroom, Kozhikode, Kerala

Coir Mats are made on handlooms, power looms or frames and with or without brush. Creel Mats are known for its thin brush. Rod Mats for thick brush and Fibre Mats for compact brush. Latex/rubber backing makes the mats non-slip. Available with woven or stenciled designs and bevelled patterns for use in interior or exterior door fronts.



Coir Rope



Coir Geotextiles



Coir Brushes



Coir needled felt



Geotextile



Rubberized Coir



Coir Pith



Garden Articles

A spongy material that binds the coconut fibre in the husk, It is an excellent soil conditioner and is being extensively used as a soil-less medium for agri-horticultural purposes. With its moisture retention qualities, **coir pith** is ideal for growing anthuriums and orchids. Available in raw form or converted into organic manure.

Products made out of Coir fibre in garden articles; There are poles, plant pots and hanging baskets, coir makes just about every accessory that is essential for modern day gardening. Coconut husk chips also are widely used in horticultural applications.

Coir Geo Textile

2.5 Advantages of Coir

- Coir is natural, eco-friendly and It is abundantly available
- Coir has very high strength due to its high content of crystalline alpha cellulose (40%) and It is highly resistant to borer, termite, water and other natural elements, which is due to high lignin content (45%).
- Other several advantages which are, light weight, high strength and stiffness, non- corrosive, water resistant, long durability, low cost, etc.
- The coir composite has been approved by Bureau of Indian Standards, Indian Railways, DGS & D, CPWD, Road Transport Corporation and it has been approved for roofing. Coir ply has also been used as shelters for the earthquake affected victims of Gujarat and has been proved as earthquake proof shelters.



03

**New
Developments
in Coir**

3.1 Coir Composite boards

It is a product manufactured from coir combined with synthetic resin. The panels are manufactured to a specific gravity of 0.5 to 0.9 by the application of heat and pressure by a process in which the inter fibre bond is substantially created by the added polymer binder. In general, this indigenous technology utilized to manufacture of coir medium density fibreboard is an improvised combination of that used in the existing medium fiberboard and particleboard industry and the one used in the hardboard industry. Coir fibres manufactured by mechanical process are processed through needled felt plant (Non-woven system) to make uniform mat in different densities according to the requirement.

Coir Composites Characteristics

- Coir-composites are Phenol Bonded Board.
- Stronger as it is made of fibre known for its strength and load bearing properties.
- Attractive natural look and can be used as it is.
- Water proof with minimum surface absorption.
- More economical than other Phenol bonded Strong and rigid.
- Terminate and insect resistant.
- Flame Retardant.
- Can be Nailed, Screwed and cut sharply .
- Interior of furniture and cabinets made with coir ply need not be painted or polished.
- Environment friendly.
- Low paint consumption.

Relevance of coir composites

From ancient times, Timber has been one Vital construction and raw material for many applications. But this comes at the cost of the tropical forest. The amount of trees cut down for various purpose are increasing every year.

- A new study published in Nature estimates the planet has 3.04 trillion trees.
- The research says 15.3 billion trees are chopped down every year.
- It also estimates that 46% of the world's trees have been cleared over the past 12,000 years[5].
- in India it is estimated that on an average about 45000 acres of tropical forest being cleared every year and the Honourable Supreme Court of India has in a recent judgment, banned felling of trees from natural forests to conserve tropical evergreen forests.

It is highly relevant to replace timber in as many applications as possible. The major available replacement for wood products is plastic, metals and few other products. Coir, a byproduct of coconut and therefore, considered as an eco-friendly alternative to natural forest based timber. The coir wood can substitute logs and fuelwood, otherwise exploited from natural forests. The economically available volume of coir and its utilization therefore can reduce the pressure on natural tropical forests and contribute towards biodiversity conservation.

One unit of coir ply with a production capacity of 40 cubic metres a day would be able to save about 22 trees per day which means 6,600 trees per year. Assuming that one 5 Coir Wood such tree requires 40 sq. metre, then it would be 25 trees in one acre so that a coir ply unit could save about 264 acres of tropical forest in every year. If 10 % of coir fibre produced is utilized in the manufacture of coir ply, it would save about 8, 80,000 tropical trees per year which corresponds to 8,800 acres of tropical forests per year.

Coir wood made from coir fibre and phenol formaldehyde resin is an innovative wood substitute. It is a composite board and other hard fibres such as sisal and jute etc. and pre-treated plantation rubber wood veneers could be incorporated. The diversified new uses of coir composite will save the tropical forests, increase rural employment opportunities and also promote agriculture leading to sustainable development.



3.2 Manufacturing Process of Coir Composites

Fabrication of coir felts is made in Needled felt plant. Coir available in bale form is opened by bale opener. If the moisture in coir is very high it has to be dried. opened and dried coir is passed through the feeding system consisting of more openers, distributors and conveyors. The uniform coir web of required width formed by the feeding system is then needle punched with a needle punching machine consisting of reciprocating needle board, stripper plates and base plates. The needles having bars push some of the fibres vertically down, the fibres form loops below the web bottom surface by which the fibres are mechanically entangled. Then a discontinuous web of coir becomes a continuous felt which can be handled easily.

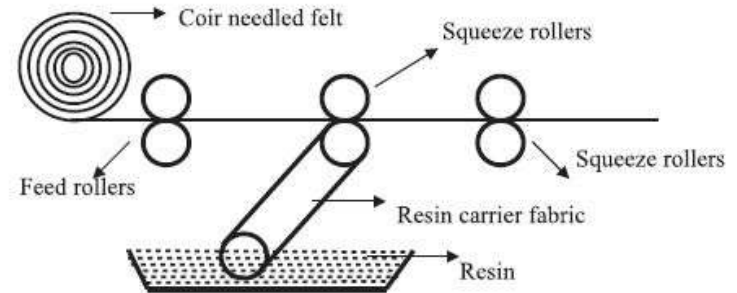
After needling, the edges are trimmed and if required cuts are made by adjustable rotating cutters. Finally it is rolled by winder which always maintains constant speed in winding in spite of continuous increase in roll diameter. When a particular length is wound, the roll is removed from the winder and core of the next roll is put. Depending on the weight per square meter, the feeding and distribution are adjusted. The density of coir needled felt can be controlled by the amount of fibre going through the needle board or by overlapping needled felts to give the desired density. A prepreg sheet is a polymer impregnated coir fibre mat. More than 60% by weight of coir fibre can be incorporated in the composite by prepreg sheet moulding process.



*needle felt
machine and
needle felt
roll
CICT,
Bangalore*



Nonwoven coir needled mat is used for impregnation with resin to prepreg sheets. The non-woven coir needled mat is preferred as it is more economic and the resulting prepreg can be moulded into desired shapes. The coir mat is ideal due to uniformity and ease of handling.



Prepreg Sheet Resin Coating Process for Coir Wood Composite



Composite products from prepreg sheets are prepared by hot press moulding. The prepreg sheet are cut into the required size and stacked one over the other. The number of layers is dependent on the requirement of thickness of the component and the pressure applied for moulding varies depending on the density and surface finish of the product. The overall mechanical strength of the fibre reinforced plastic depends on the combined effect of the amount and kind of reinforcement and on its arrangement in the finished article.

Resin Impregnated needle felt (above)

Hydraulic press for hot moulding (below), CICT Bangalore

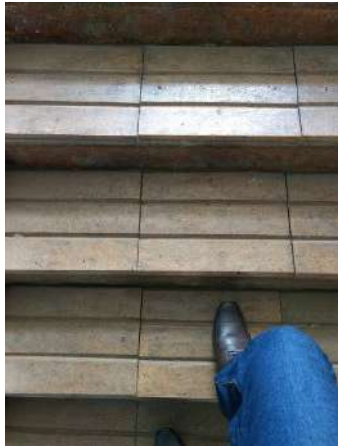
	Coir-Ply	Plywood	Medium Density Fibre Board	Particle Board
Tested as per IS.No	IS-1734	IS-1734	IS-2380	IS-2380
Density (kg/m ³)	748	400-+700	750-850	700-800
Moisture (%)	6.50%	5-15%	5-15%	5-15%
Glue shear strength (N/mm ²)	1720	1200-1750	N.A	N.A
Water resistance (8 hrs. boiling)	No delamination	No delamination	Disintegrate	Disintegrate
Tensile strength (N/ mm ²)	23.6	35.55	7.0-8.0	4.0-4.5
Compressive strength (N /mm ²)	51.02	29.24	N.A	N.A
Modulus of elasticity (N/ mm ²)	6440	3500-7400	N.A	N.A
Modulus of rupture (N/ mm ²)	47.5	29.49	25.28	12.5-15.0
Nail holding power (in kg)	50	125	N.A	N.A
Screw holding power (in kg.)	245	300	125-150	85-125
Surface strength (kg/ cm ²)	30	N.A	30	30

Wood panel industry has a huge footing in Indian market. There is an enormous demand for wood panel products in India. When compared to solid timber products Wood panel based products help in saving a considerable amount of scarce wood. The basic types of wood based panels are; **Plywood**

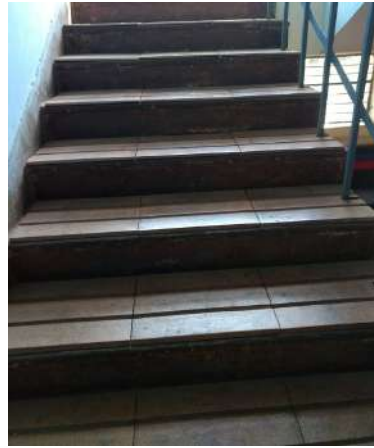
Particle board

Medium density fibreboard

Products with Coir Composites (Field Visit - 2, CICT Bangalore)



Composite floor tiles



Wall panels



Cabinets and cupboards



Mini Tables



Products owned by CICT
Bangalore.



Living Room Furniture



Composite Doors



Molded Articles



Custom Printed Composite boards for wall decorations

Products with Coir Composites (Market)



The products already existing are Cots, Kitchen cabinets, Tables etc.

Images at the bottom are coir products developed by designers from abroad



dinz Designers Institute
of New Zealand
the voice of New Zealand designers
BEST Design Awards
2009 Bronze Place





04

**Project
Brief**



Design a set of furniture products by using Coir;

Exploring Coir as a material Using new Manufacturing
methods for Coir, Material explorations and developing
new methods to process Coir.



05

**The Design
Process**

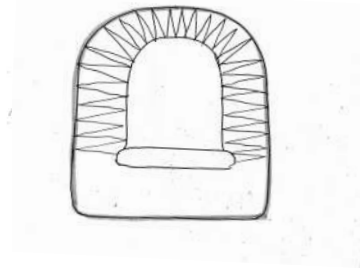
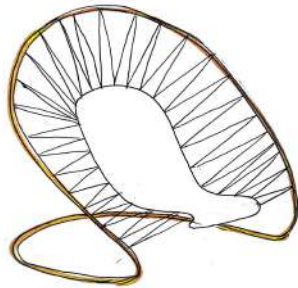


**DESIGNING
WITH THE
PRODUCTS**

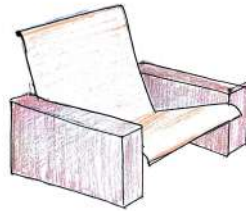
The Initial approach was to design products using the existing products of coir. Currently, there are different varieties of coir products which are used in furniture. Like, rubberised coir, mats, coir composite boards etc. If there are new designs using the same material, it could add value to the material and the sector.

Existing processes like weaving can be used.

Explorations in this direction would be focused majorly on how the products can be utilised, modified, manipulated or played with.

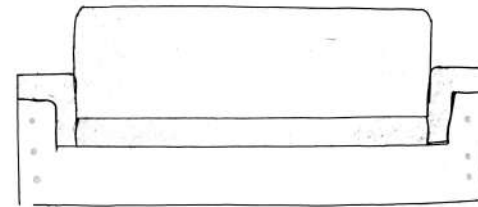
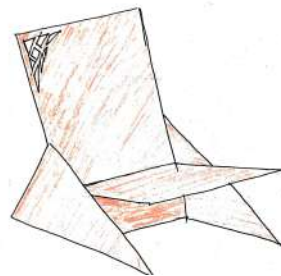
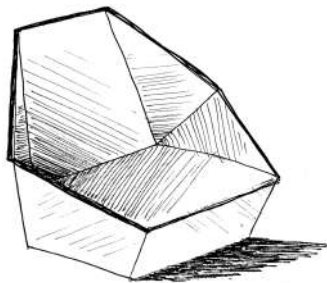
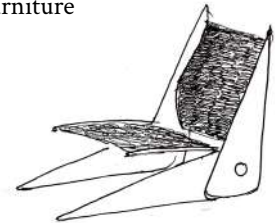
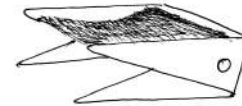


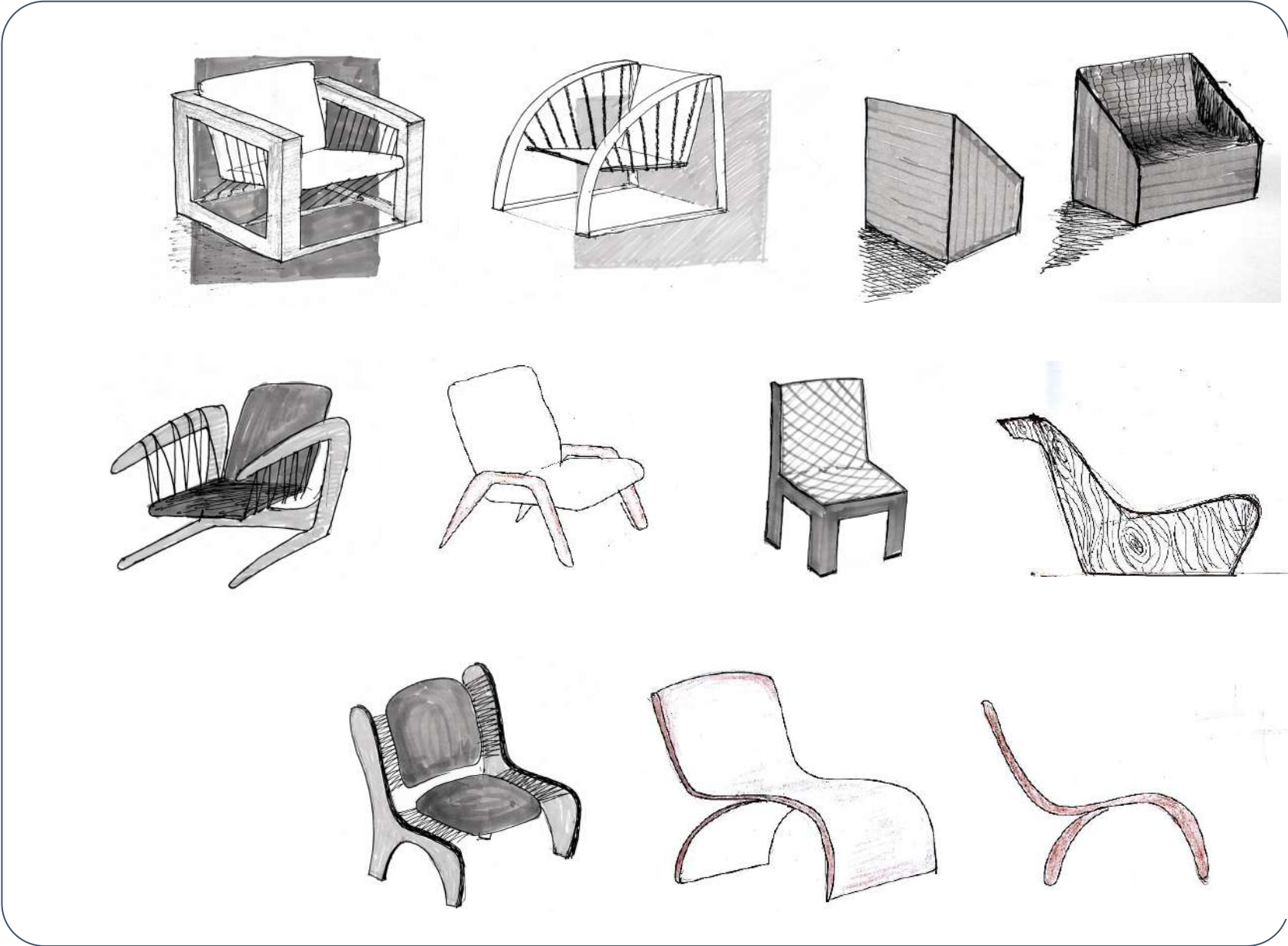
Bent Composite board seating supported by coir yarn in bamboo/ steel frame

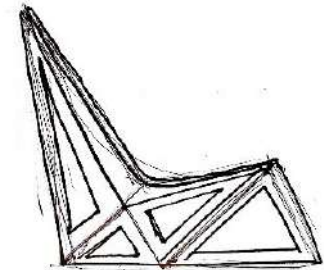
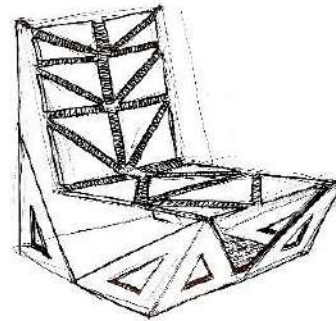
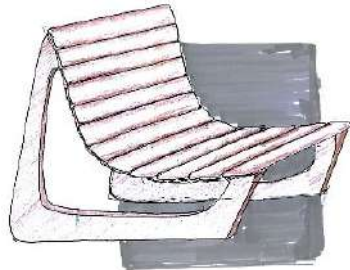
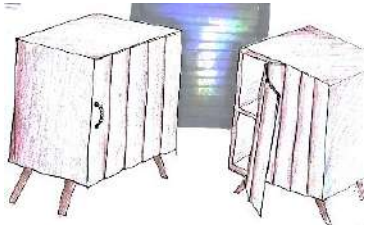


Seating material can be of reinforced coir felt, body made out of coir ply

Hybrid furniture/ folding furniture

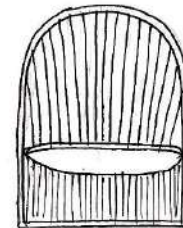
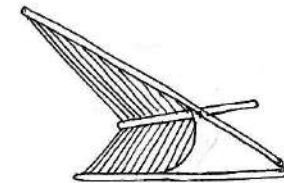
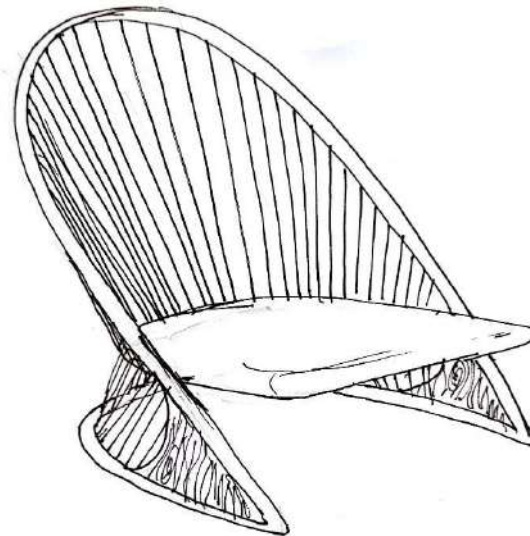






The designs majorly involves products using coir composite board.

Unlike other existing products, in this approach combining coir products are experimented.






**DESIGNING BY
THE PROCESS**

This approach follows the already existing manufacturing methods for coir. Currently used in making composites, Hot pressing with resin gives many kinds of coir products like bowls, composite boards etc. By creatively utilizing this method, various kinds of furniture products can be developed.





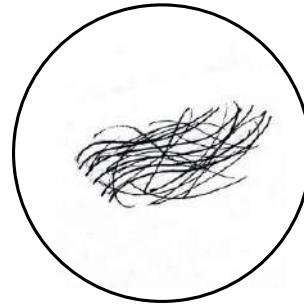


**DESIGN BY
MATERIAL
EXPLORATION**

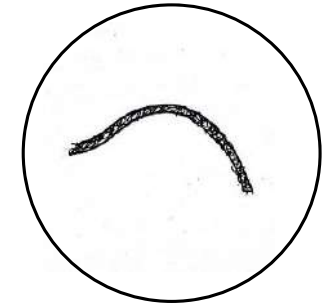
Exploration of processes can give new meanings for coir as a material. Processes those are existing in other industries can be adapted, Experimentations can be done for bringing in new ways to process coir.

This direction can bring in great modifications in the mechanical and chemical properties for coir, Resulting in a new coir composite material.

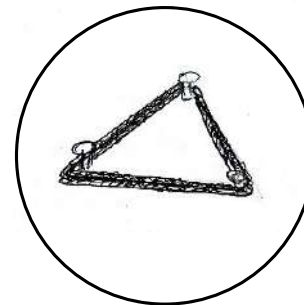
IDEATION // PROCESS ONE



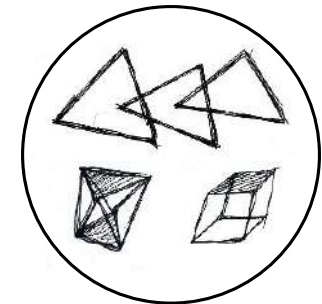
Raw Coir Fibers



Coir yarn (Impregnated with phenol formaldehyde)



Yarns arranged onto a certain mold and dried.
Lateron, baked at curing temperature of resin.



Rigid 2D and 3D Structures are obtained when removed from the mold

Coir yarns and ropes are the largest produced coir products. Using them as a raw material is not exactly a new approach, but reinforcing them to get structures is.

The process was tested by reinforcing coir ropes with P.E.(Polyethylene)/GPR by making a small mock-up.

Opportunity

Structures out of coir; Reinforcing coir ropes would give us surreal structures out of coir.

The applications of this process can also go beyond furniture. Can be made into be used in interior and exterior structures.

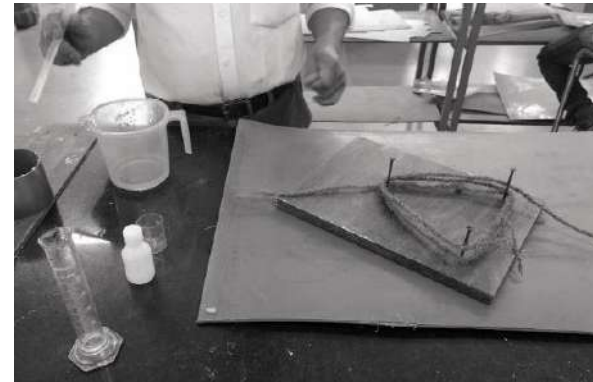
Limitations

Reinforcement could not bring in expected amount of strength in the ropes.

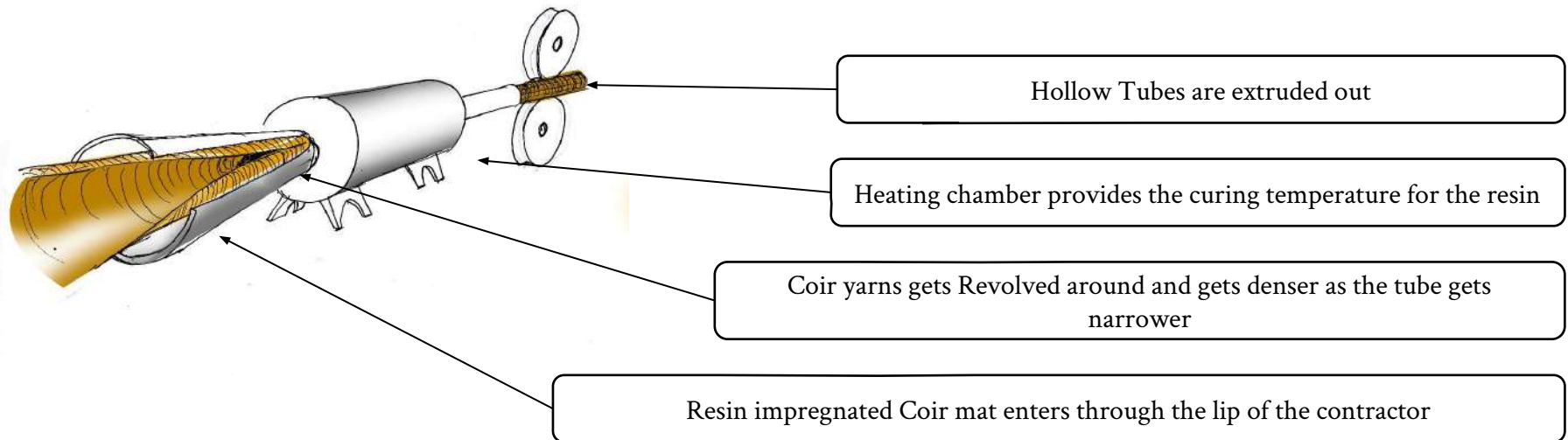
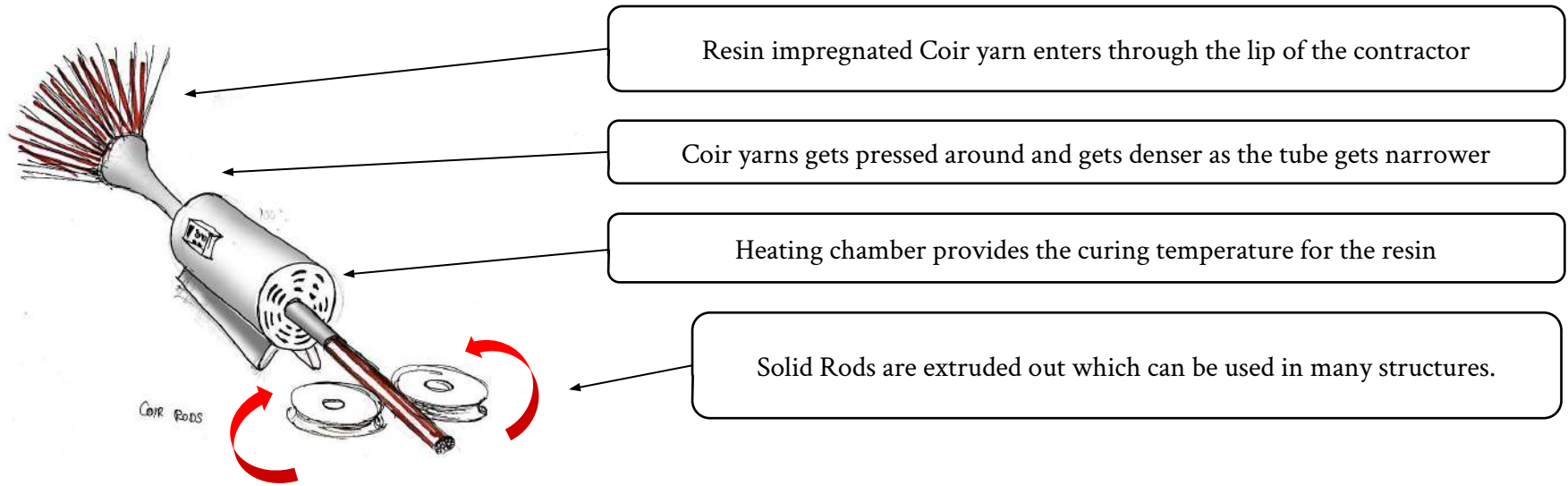
Molds needed to be in a sophisticated design for the process.

PE and epoxy resins imparts strength to coir but they become brittle. Also individual yarns separate out as well. Hence structures out of this material would not be as strong as that of other materials.

Inclusion of typical joineries like hinges cannot be equipped in this, Since this would disturb the fiber structure and make the part weaker.



IDEATION // PROCESS TWO



The process is an adaptation of pultrusion process, which is an FRP process that gives extruded FRP structures. Continuous fibers are pulled into a resin bath followed by a die where the fibers get formed and the resin gets cured. This gives out reinforced continuous member, which is cut and used in many structural parts. FRP Pipes and rods can also be made by this process.

The process can be coupled with the yarn making process.

Opportunity

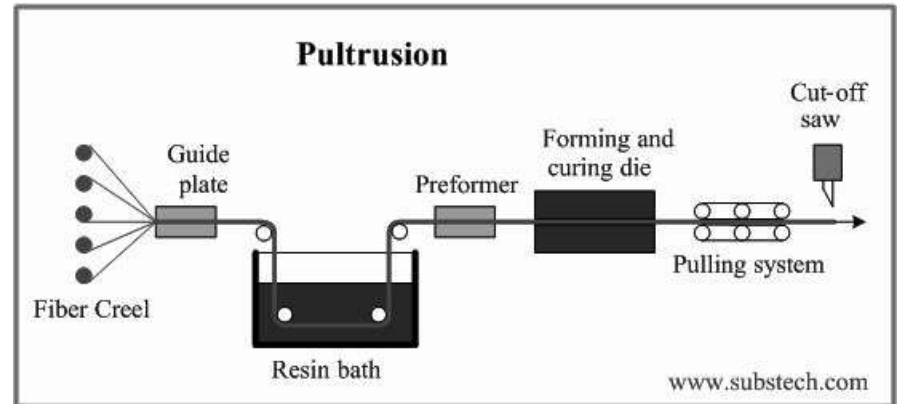
This process may bring out an entirely new kind of coir product. or a number of products, like coir rods, coir pipes, coir structural members etc. this can be used as a substitute material for bamboo, wooden rods etc.

The process will give rise to a whole new category of coir products. this will enhance the reach of coir as a material in various sectors.

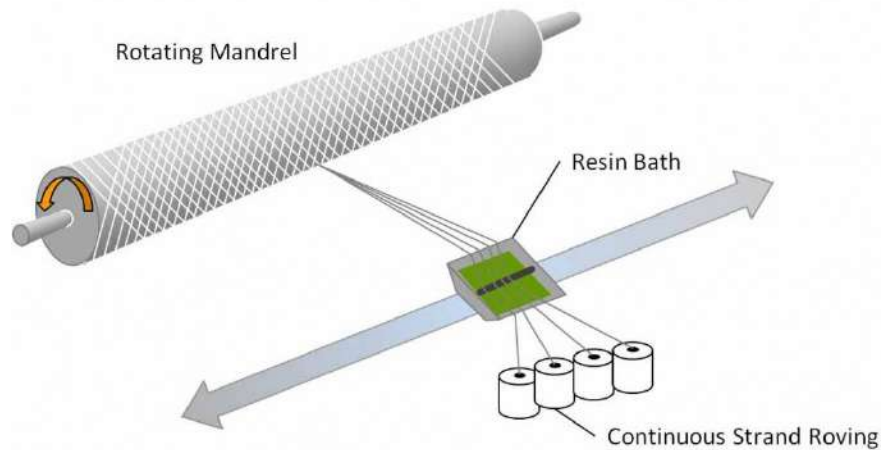
Limitations

The process required advanced and sophisticated machinery. Hence this could not be tested.

The process will require quite a lot in terms of modification as well as standardisation. The amount of work on the process will be beyond the scope of this project.



IDEATION // PROCESS THREE



Similar to the pultrusion process, Filament winding process uses fiber yarns as a raw material. Instead of compressing and pulling, this process consists of a rotating mandrel, on which resin impregnated fibers under tension are rolled. The process used majorly to make open/closed pressure vessels and tanks.

A small mockup was made to test the material and the process.

Opportunity

The process can be coupled with the yarn making process, which is an advantage for small/medium scale industries. They can manufacture furniture parts as well, adding more value to the outcome.

The process does not require advanced machinery. Simple molds will be efficient enough to give out

Limitations

The process was found to be effective, but in a longer run, for the material to be strong, the mold has to be given enough pressure and tension, which is difficult to achieve.

The surface finish of the material would be very much rugged, which makes it less suitable for sitting furniture.

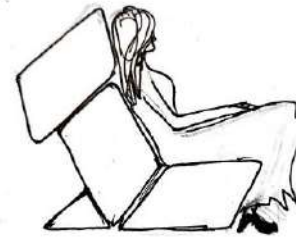
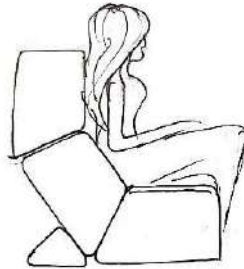
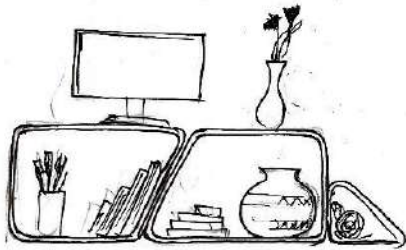
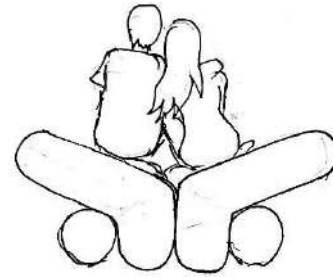
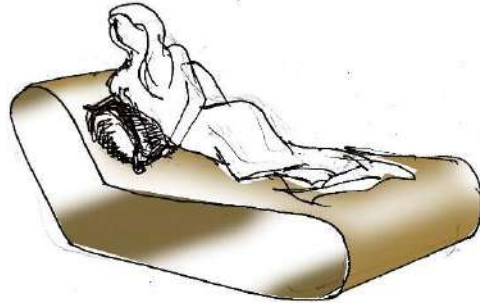
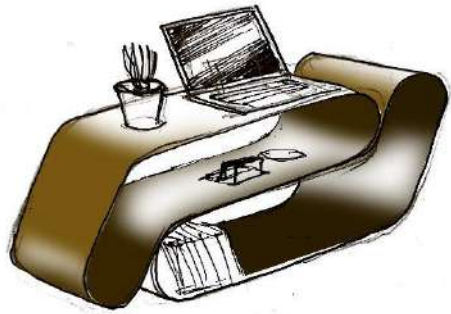
typical joineries would not work well with the material.

PRODUCT POSSIBILITIES // PROCESS THREE

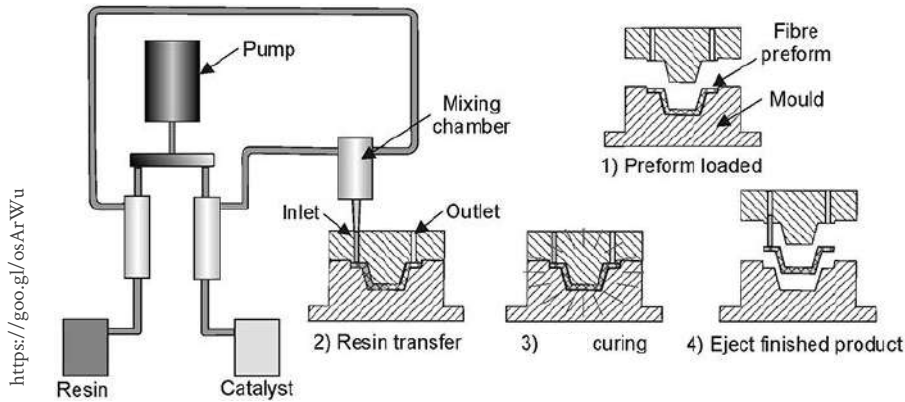




Coir in Furniture



IDEATION // PROCESS FOUR



The Resin transfer process is a common molding process and very widely used to make furniture products

The resin can be mixed with the catalyst and later can be transferred to the mold, Where coir felt will placed. The resin is cured overtime, but the curing process can be fastened by heating.

Opportunity

The process is widely used so it is easier to procure tools and machines for this.

3d shapes can be achieved by this process which is hard to obtain from other processes.

Both sides of the mold has a finished surface.

Limitations

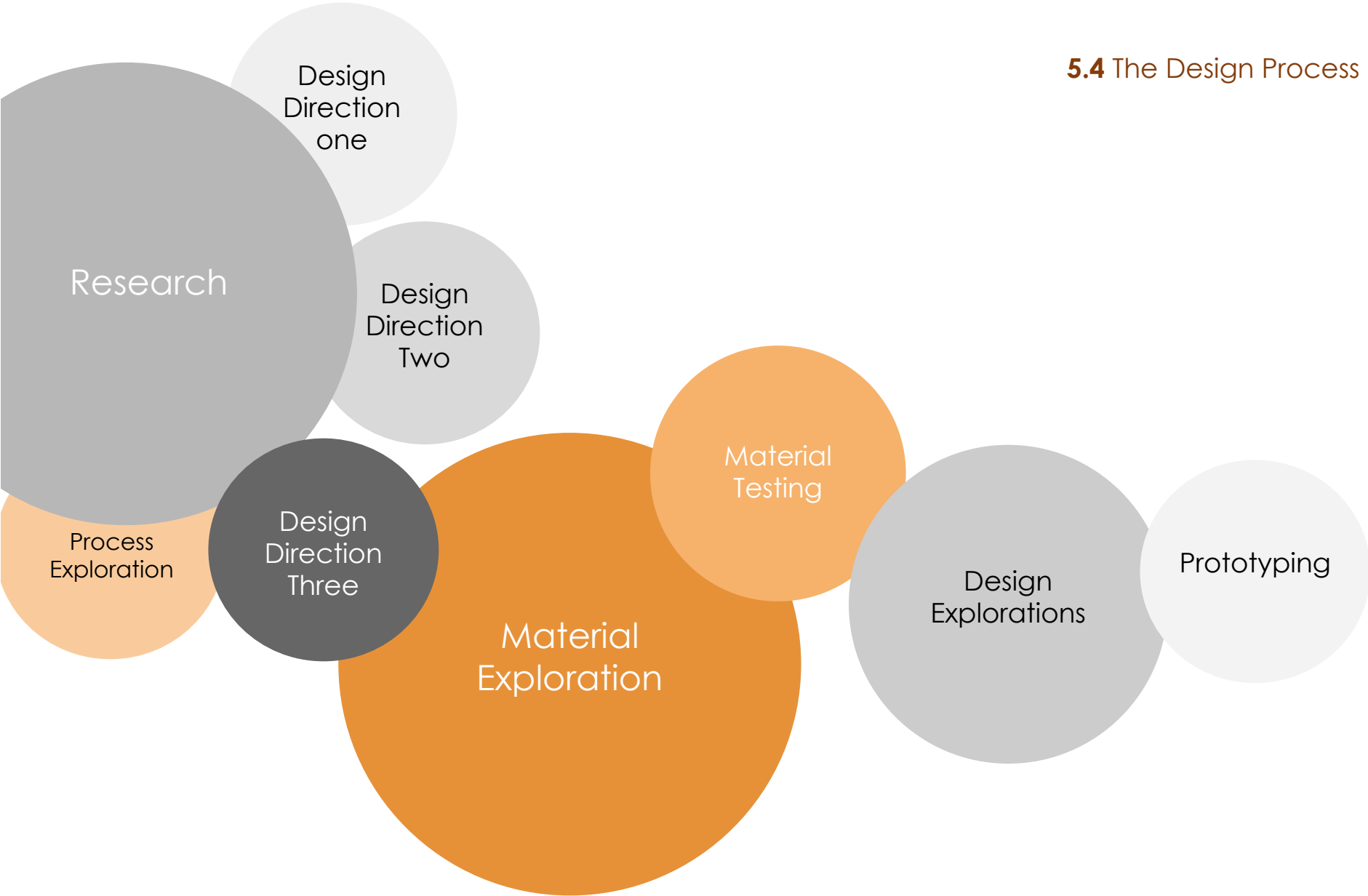
High tooling cost

It is generally limited to smaller parts

Unimpregnated areas can occur resulting in very expensive scrap parts.

PRODUCT POSSIBILITIES // PROCESS FOUR







06

Material Exploration

6.1 Brainstorming

The possibilities of material exploration was listed down in a quick brainstorming session with student designers.

Addition of material

Resin
Reinforcement
(Metal, Plastic,
Terracotta,
Wood, Bamboo)
Rubber
Leather
Ceramics
Bamboo
Silicone
Cowdung
Fungi & bacteria

Laquer
Wood filler
Melamine
Paint
Putty
Sanding
Trimming
Jute
Textile
Bamboo mats

Surface
Treatment

Joineries

Metallic
Plastic
Coir
Synthetic yarn
3d printed
Snap on
Brass
Stitches
Nut and bolt
Silicone Glue

Seating furniture
Cabinets
Cupboards
Sidetable
Office
Kids
Hammocks

Furniture
type

6.2 Bonding // Polyethylene Resin



Coir fibers were molded with PE (General Purpose Resin) for design direction 2. The raw material used for molding is raw coir fibers. It came out well but the amount of resin that required was high.



PE resin (GPR) is the most commonly used plastic resin. It is cheap, durable and easily available. Resin was applied to the coir needle felt by hand layoff process (Ideally it has to be resin transfer molding)

The sheets become hard, but brittle and it may crack under pressure. The amount of resin required is higher than expected to attain proper strength.

*1 part cement.
1 part coir,
2 part water.*

Cement is one of the most common bonding material. 15*15 cm piece of coir felt was casted in cement in 1:2 ratio.



Opportunity

Cement is an abundantly available raw material and it is cheap
The material casted turned out to be unexpectedly light

Limitations

Cement bonds the fibers together well but it lacks strength.
Curing time of cement was over 24 hrs.



Terracotta clay is a widely used clay which gives clay products like matkass, bricks etc.



Opportunity
Reinforcing terracotta could
bring out new and exciting
forms

Limitations
Unless major amount of clay
given, the material cannot be
given for firing, it will burn.

6.2 Bonding // Synthetic Rubber

After experimenting with binders that hardens the felt, it was decided bond it with rubber. It has the property of undergoing elastic stretchability or deformation under stress but can also return to its previous size without permanent deformation. The Natural rubber latex can be molded into shapes and can also be used in RTM, but it will require processes like vulcanisation. Hence synthetic rubbers can be used.

Some of the popular synthetic rubber types include the following.

- Acrylic Rubber (ACM)
- Butadiene Rubber (BR)
- Butyl Rubber (IIR)
- Chlorosulfonated Polyethylene (CSM)/ Hypalon
- Ethylene Propylene Diene Monomer (EPDM)
- Fluoroelastomers (FKM)/ Viton
- Isoprene Rubber (IR)
- Nitrile Rubber (NBR)
- Perfluoroelastomer (FFKM)
- Polychloroprene (CR)/ Neoprene
- Polysulfide Rubber (PSR)
- Silicone Rubber (SiR)
- Styrene Butadiene Rubber (SBR)

Silicone rubber is one of the most widely used rubber rein among them all

Advantages of Silicone Rubber

Due to the physical, mechanical and thermal properties of silicon rubber, its advantages are many.

- High and low temperature stability
- Inertness, that is no taste or smell
- Translucent and easy to color
- Wide hardness range
- Chemical resistance
- Weatherability
- Sealing performance
- Electrical properties
- Compression set resistance

Disadvantages of Silicone Rubber

Although silicone rubber has many advantages to its many properties, there are certain disadvantages of silicone rubber too.

- Silicone rubber is generally high in cost.
- It is sensitive to substances like sulfur clay that may prevent the silicone from curing which is known as cure inhibition.
- Silicone rubber is usually very thick, having high viscosity.
- It must be vacuum degassed before pouring to minimize bubble entrapment.



Silicone is an incredibly flexible material. But it is not much strong. Coir felt is made of strong fibers and it was flexible sheet, But it could be torn easily.

Coir-silicone adds up their properties and a material of much higher value of material is made.



*5 grams of coir felt,
30 grams of silicone*

It was an experiment to see whether the material can be used to mold 3D forms.

The coir felt was just sandwiched between two mold parts, on which a small layer of silicone was brushed upon.

Even though the amount of silicone was less the fibers were bound well and the material turned out to be very strong.

*molding with transparent
silicone resin*



Limitations

Silicone is generally very expensive material
The coir-silicone sheets are flexible but cannot be bent to extreme angles or positions because it disturbs the inner structure of the fibers and they piece out of the surface. The surface has fibers protruding out, which would ruin the surface in a longer run. Hence Surface finishing with many many other materials has to be considered.
the edge is always very rough,



Wash with Poly Vinyl Alcohol

PVA is an easily available and affordable polymer resin. Fevicol is a PVA based adhesive.

Coir felt is washed in 50% diluted fevicol and water solution, and dried out in sunlight.

PVA holds the fibers together, adds a good amount of strength to the fiber.

Limitations

PVA is not durable when exposed to humid conditions. It is alcohol based hence soluble in water.

It requires airflow and light to cure, Hence it is to be dried open at sunlight otherwise it has to be dried under hot air.

Opportunity

PVA is easily available material

Easy to handle and clean.

Affordable

Its an inert material so that can be used as a pretreatment for the silicone sheet for added strength

6.3 Reinforcement // Selective Molding



Selective molding

Coir felt is brushed with silicone at one side and molded with GPR at either sides of the opposite side.

This is to give toughness and strength at selected areas in the felt



Opportunity

Coir is given structural reinforcement at selected areas and having flexibility at points where there are just silicone binds the felt.

This methods can bring out transformable structures out of coir.



Limitations

But GPR resin was brittle and was cracking when it was bent.

6.3 Reinforcement // PVC Rods



Selective Reinforcement

Coir felt is sandwiched between PVC frames and bonded with PVA resin.



Coir felts sheets bonded with PVA and sandwiched between PVA rod frame

Opportunity

Similar to selective Molding, this method gives scope to structures using coir felt.

This also gives scope to molding coir with frame itself.

Limitations

PVA was bonding two of the layers hence the flexibility was greatly reduced.

6.4 Surface Treatment



Metal Mesh

Metal mesh was giving a smooth surface at the side, also it was providing enough strength.

But as a limitation, it was having wrinkles at pressure/stretched areas as well as bent areas.

Also It was not aesthetically pleasing



Jute mesh

It was giving a good texture and surface at the side, also providing enough strength.

As a limitation it was not having much aesthetics.



Bamboo mats

Bamboo mats gave out interesting and aesthetically pleasing designs and texture.

Bamboo mats were providing good stability to the fibers. It prevents the fibers from protruding out.



Glass fiber mats

Glass fiber fabric is used in FRP molding as the outermost layer, to give better finish.

This material was serving the purpose, but at some points fiberglass was exposed and it appears as a defect. Also, fiberglass causes irritation for skin.



Silicon coir supports bolting; It didn't tear or deform under strain. This gives scope for other joineries like rivets, eyelets etc.



The sheets were bent using sheet bending device, it did not deform, giving scope for similar operations.

6.6 Testing



Testing Rig 1



SS frame with coir silicone
Felt was directly moulded into to frame.
Single layer of silicone used, 300g of silicone for 1sq.ft.

The rig was made from the reference from section 6.5.
The felt was directly molded onto the frame. the binder was silicone resin. approximately 300g of silicone was utilised to make this testing model.

Findings

Silicone was not properly spread over the surface due to imperfections in molding. Silicone was not well distributed because of low pressure.

Excessive sagging; due to less pressure when pressed, Also felt is slipping off from frame.

It requires a sophisticated and well equipped mold to cast silicone coir into the chassis.

Hence, The coir silicone sheet was decided to be casted prior to connecting it to the
The chassis.



Prefabricated coir silicon sheet bolted on the seat of an office chair.

Testing Rig 2

The sheet was 15x16” in size. And approx. 350g of silicone was used for it. For added strength, then sheet was washed with 50% PVA solution. Coir sheet was added with Jute as well for added strength.

The sheet was attached at the seat of a normal office chair.

Findings

The sheet was flexible and was sagging upto a limit, but this was also giving comfort.

Fibers were coming out at stress points.

The edges has to be treated since it was poky and was uneven.

Bigger washers were given for preventing the material ripping off.

Sheet can be bent to a certain limit. Hence for 3d surfaces, coir felt has to be molded in that shape itself.



07

Design

7.1 Design Considerations

Material;

Coir Silicone Composite (Molded into 2D or 3D shapes); From the light of material explorations,

Type of furniture;

Indoor Seating ; Coir silicone is a flexible material which is most suitable as a seating part. Hence design explorations can focused onto seating furniture.

Product Attributes;

Modern, Minimalistic, Semantic-Typical

The current trend in furniture sector is in minimal details. and since coir composite has a natural appearance, it would be interesting to bring in designs that are modern and minimalistic for the material.

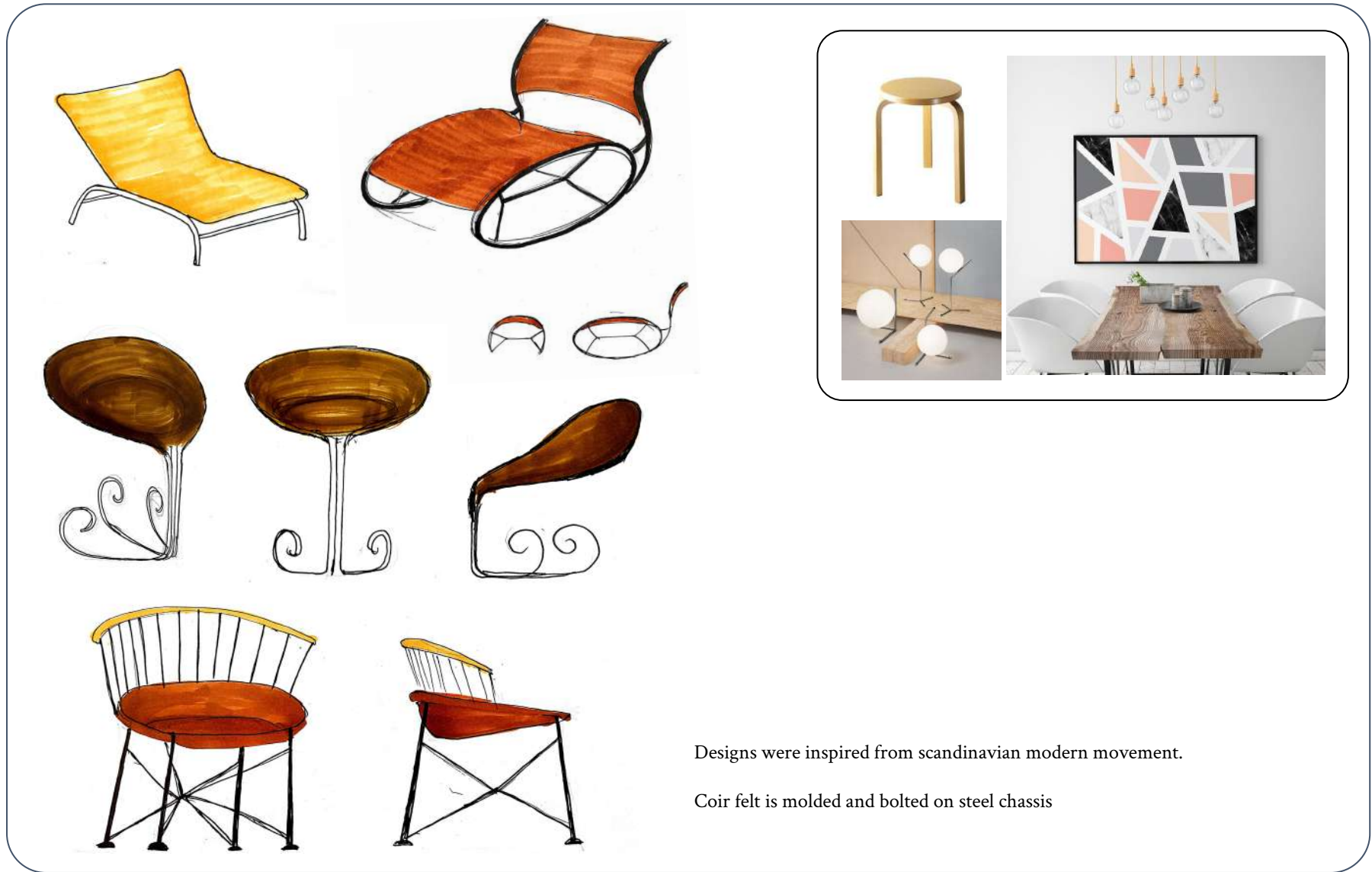
Structure and joineries;

Coir felt Bolted on Metallic Chassis

From the material exploration, it was found that bolting coir felt was a suitable method for joining felts sheets and chassis together



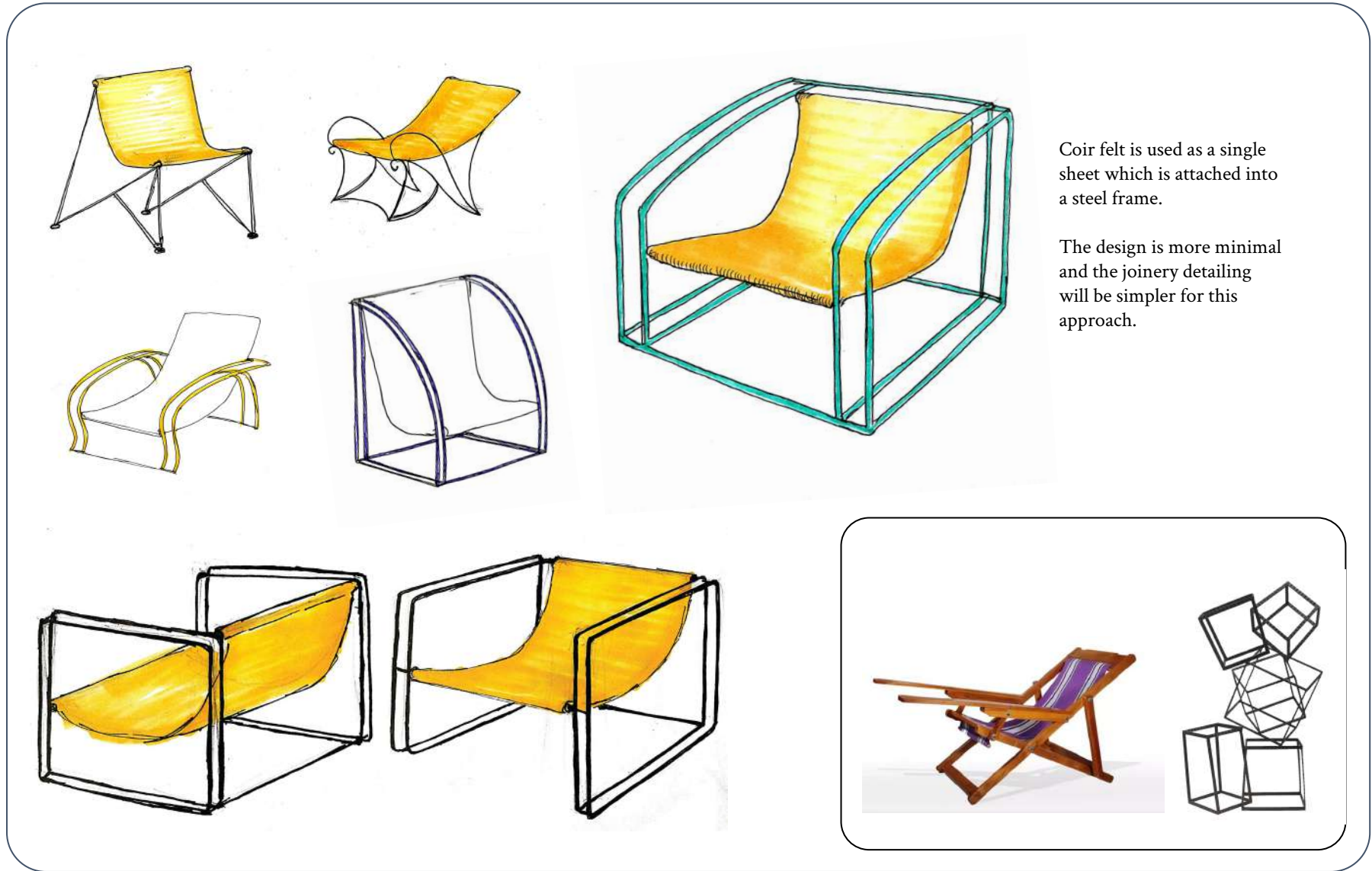
7.2 DESIGN EXPLORATIONS // SET #1



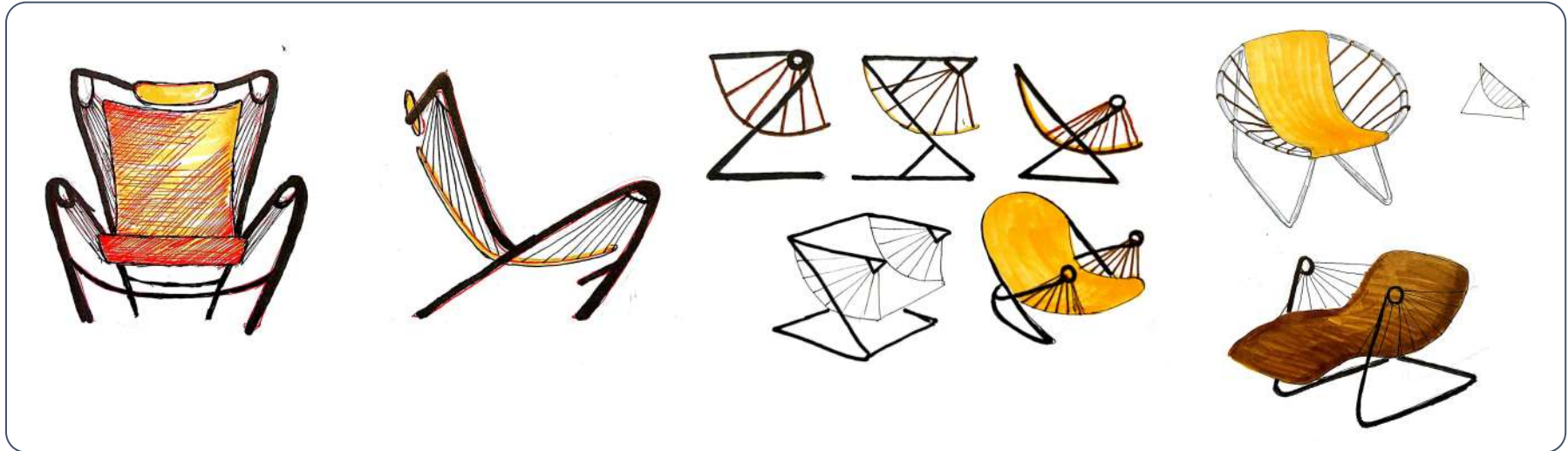
Designs were inspired from scandinavian modern movement.

Coir felt is molded and bolted on steel chassis

7.2 DESIGN EXPLORATIONS // SET #2





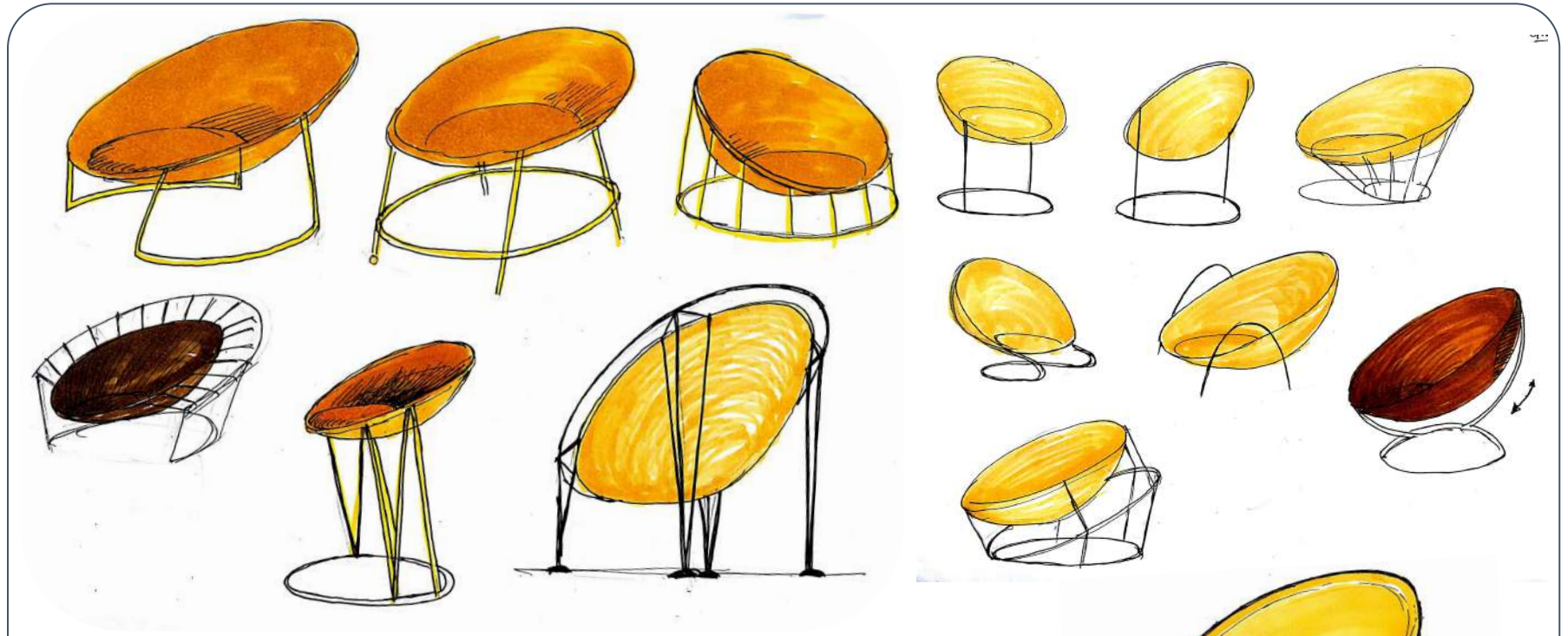


7.2 DESIGN EXPLORATIONS // SET #3



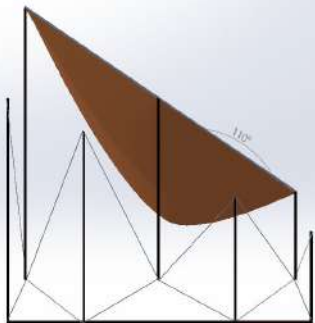
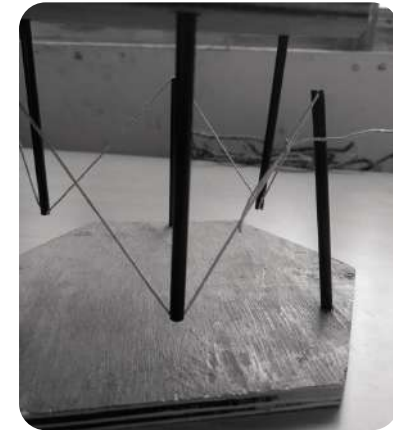
Modular and Multi Use.

Coir feil body reinforced with steel frames.



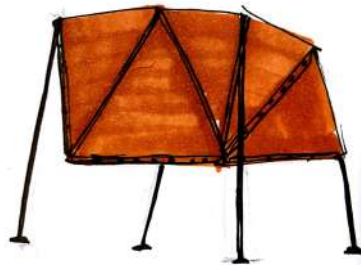
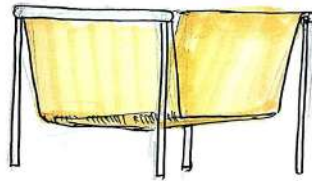
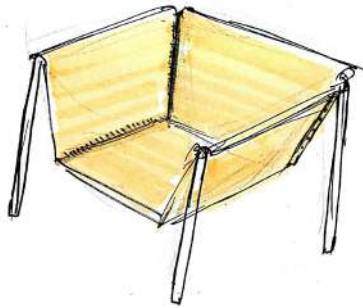
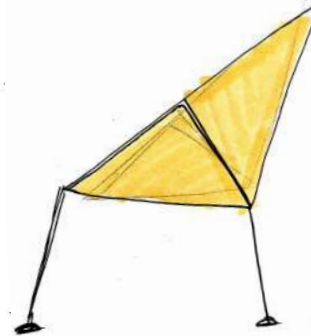
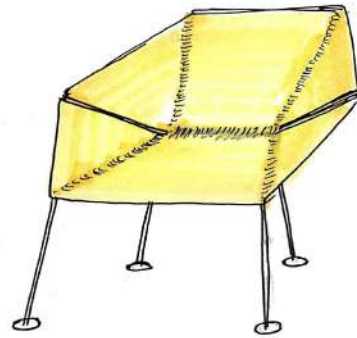
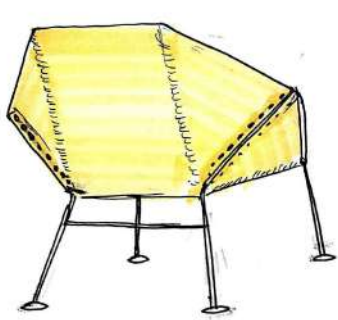
Chairs inspired from space age design movement.
Form explorations based on the satellite - Sputnik.





Concept Based on tensegrity

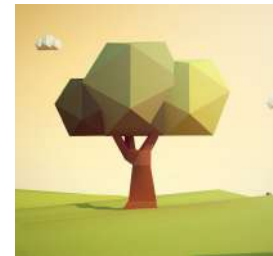
7.2 DESIGN EXPLORATIONS // SET #5



In all the previous explorations, The seating material was less highlighted either because of the simplicity of the coir silicone design or because of the complexity of chassis.

Thus making an interesting form out of flat coir sheets was tried out, which led to 'Low poly' inspired designs.

The 3d seating structure is constructed out of single sheets which is, then mounted on a metallic chassis.







Selection and Evaluation Criterion

The Concept of low poly structure is to construct larger forms out of smaller 2D sheets.

The advantages of this method over others are;

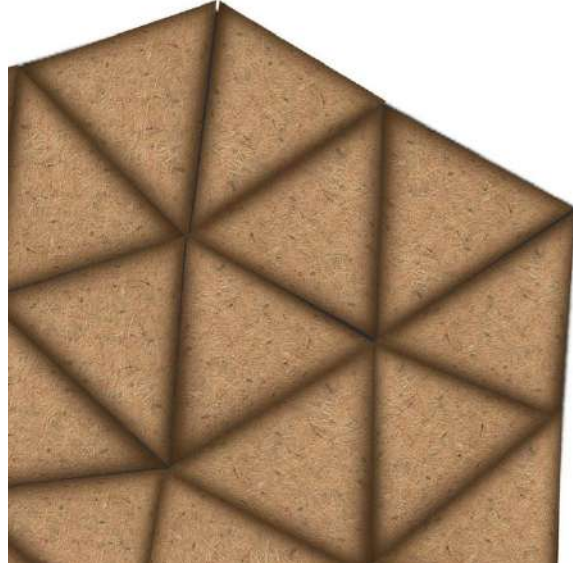
Convenience and efficiency in manufacture; Smaller modules of coir structures are easier and more efficient in manufacturing. Generally the coir felt would have imperfections and density variations across the area. Taking smaller modules of them and molding them will reduce structural weak points in coir.

The design also allows customisation in design. Different surface finishes(bamboo mats, leather, fabric etc) can be employed in different modules.

in other concepts, the coir sheets are minimalistic in design. This makes them less highlighted in the overall design. Here, the seating material itself constructs into a structure and in becomes a visual element.



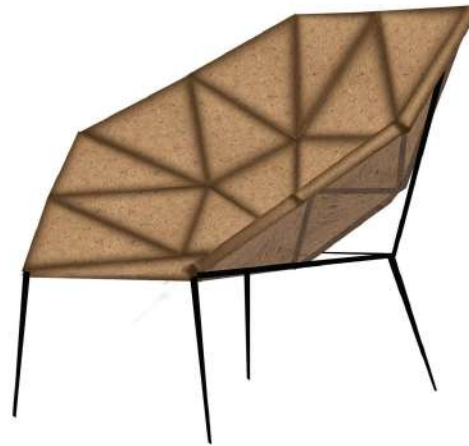
Bolting/riveting detail for joinery

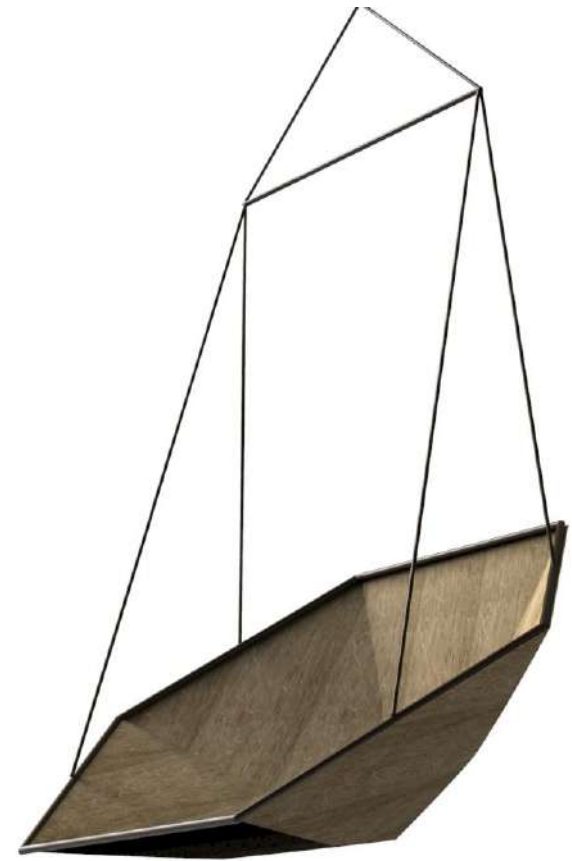
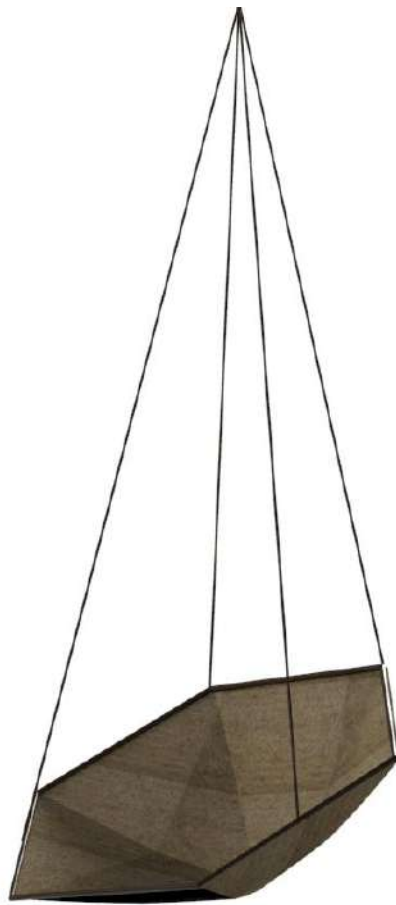


Explorations for Chassis

The texture

The Set of Products



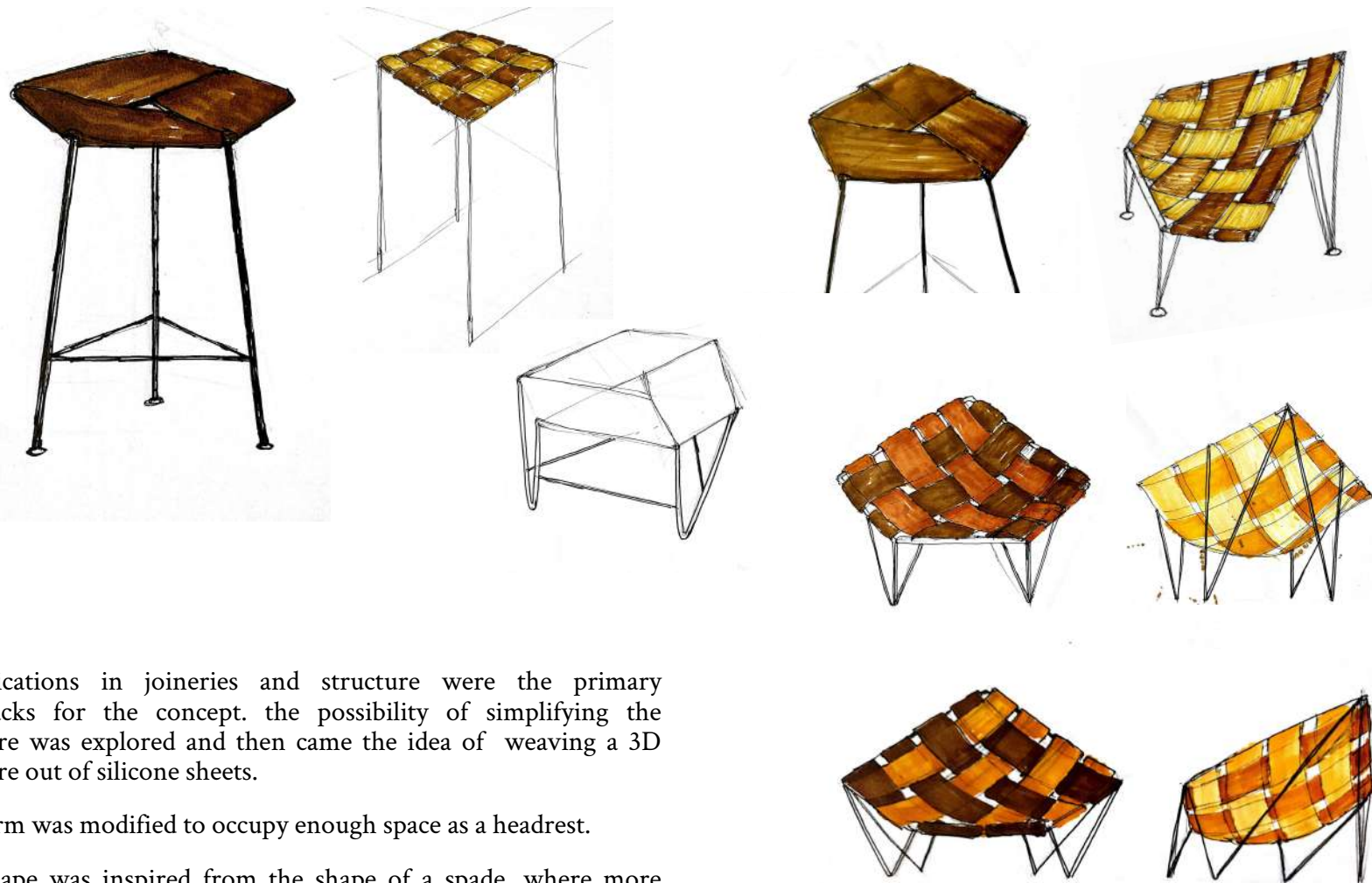


3D model of the hanging chair



Scaled Mock-up(Left)
Usage Scenario(Up)

7.2 DESIGN EXPLORATIONS // SET #5 ALTERNATIVE



Complications in joineries and structure were the primary drawbacks for the concept. the possibility of simplifying the structure was explored and then came the idea of weaving a 3D structure out of silicone sheets.

The form was modified to occupy enough space as a headrest.

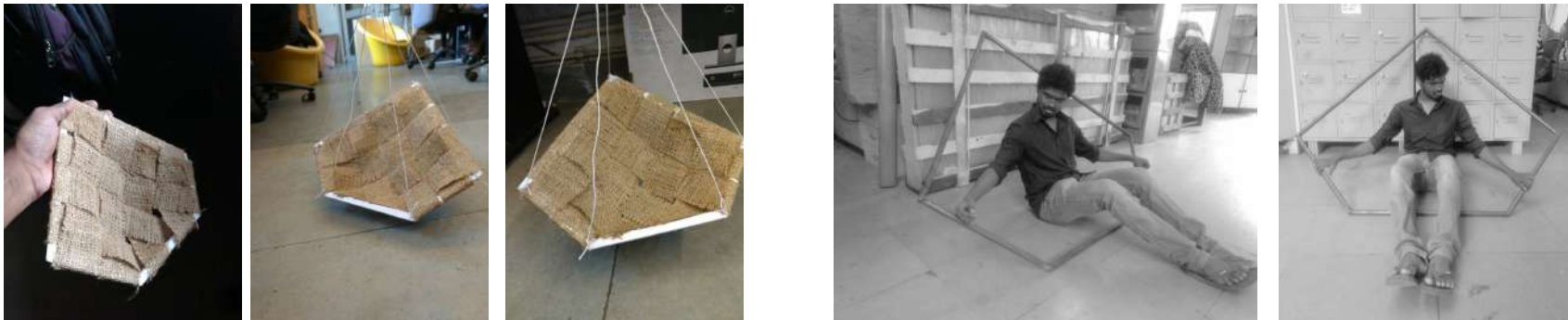
The shape was inspired from the shape of a spade, where more seating space is provided for a comfortable postures.

7.3 DETAILING



Anti-clockwise from top right; Mockups to study the structure and usability, Full scale testing rig.

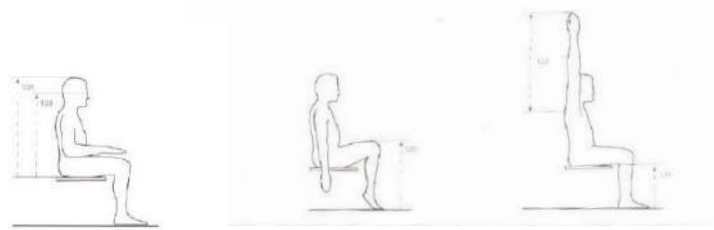
Mock-Ups for testing with paper (top), with paper (bottom left), full scale testing rig (bottom right)



The concept was refined through mockups, It was checked for usability, structure and form.

Weave patterns were explored and a simple cross weave of 8 sheets were selected.

To test out the actual size, a testing rig was made and an activity analysis was carried out



R.No	Parameters	Min	Percentiles					Max	Mean	±SD	Ratio	
			5th	25th	50th	75th	95th					
107	Normal sitting	Male	671	757	794	819	842	893	829	851	41	0.46
		Female	650	698	721	735	771	809	841	751	34	0.40
		Combined	650	715	768	805	836	886	829	803	30	0.49
108	Erect sitting	Male	692	759	809	837	867	905	883	837	45	0.51
		Female	679	712	748	774	802	834	861	775	39	0.51
		Combined	679	738	784	824	857	901	863	822	51	0.51
109	Eye	Male	579	678	709	738	760	805	867	738	39	0.45
		Female	515	574	628	653	686	731	762	657	45	0.42
		Combined	515	623	685	723	751	795	862	716	54	0.44

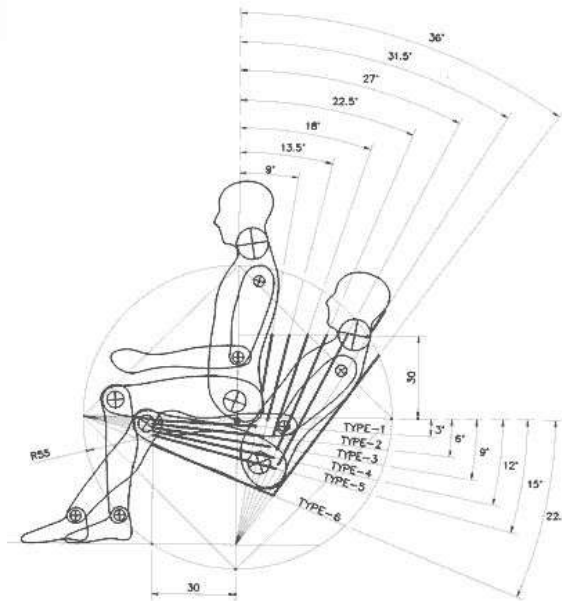
R.No	Parameters	Min	Percentiles					Max	Mean	±SD	Ratio	
			5th	25th	50th	75th	95th					
120	Thigh clearance ht at tibial point with raised knee	Male	479	530	564	587	610	644	710	588	35	0.36
		Female	480	506	525	540	556	596	627	542	27	0.36
		Combined	479	517	552	577	603	639	710	579	38	0.36
121	Popliteal	Male	335	380	406	425	443	471	540	426	28	0.29
		Female	365	365	385	399	412	441	455	359	39	0.25
		Combined	305	414	409	419	439	466	540	420	37	0.28
122	Vertical upward arm reach from mid shoulder	Male	484	623	675	701	736	774	854	704	47	0.42
		Female	476	576	612	638	670	740	772	629	50	0.40
		Combined	476	605	661	693	729	771	854	692	61	0.43

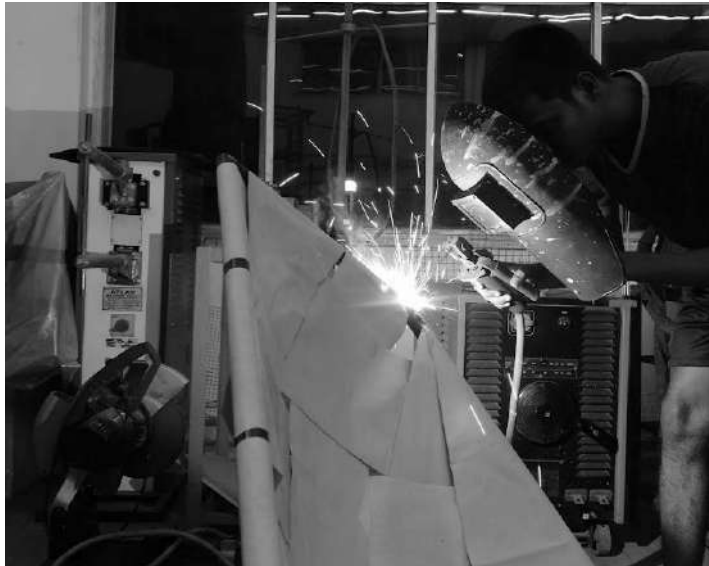
The seating height was formulated from ergonomic standards. But since the chair was a low seating chair, The seating height was reduced compared to the ergonomic considerations.

Dimension for 50th percentile of the height was chosen and was further reduced as reference to standards in low seating.

The final dimension for Popliteal height was set as 35cms.

The seat frame is designed to fit the entire back along with the head.





Testing model for Hanging chair (*Top right*), Lounge chair (*Bottom*)



There were two product possibilities with the Frame designed.

The hanging chair as well will be a low seating chair. Testing model was used for both and the activity analysis was carried out for both of them.

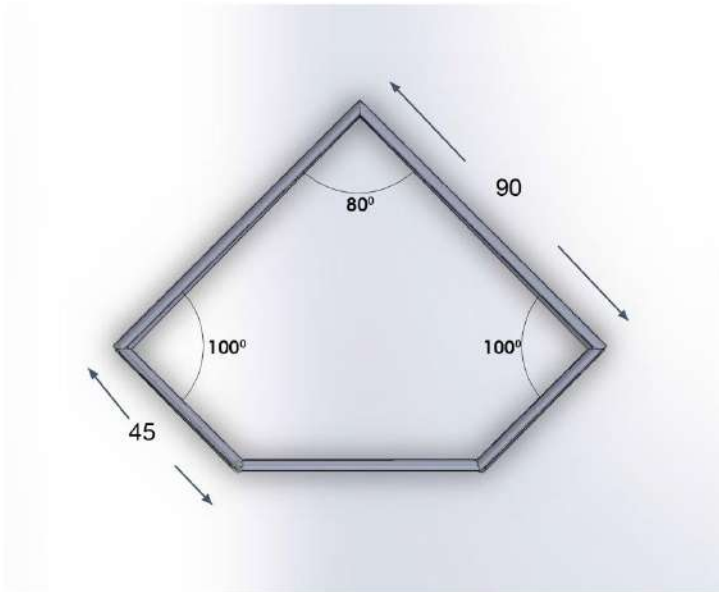
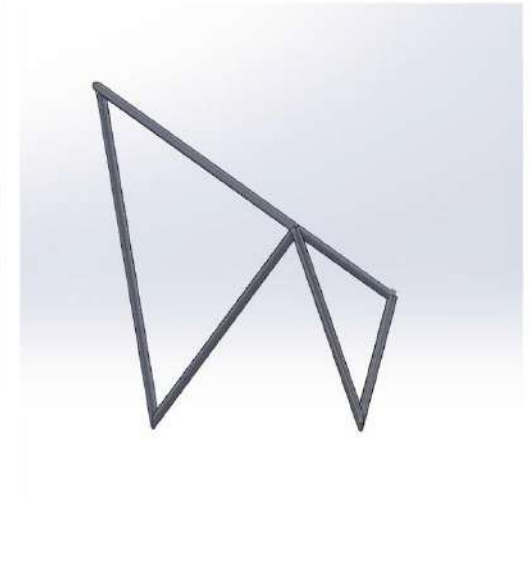
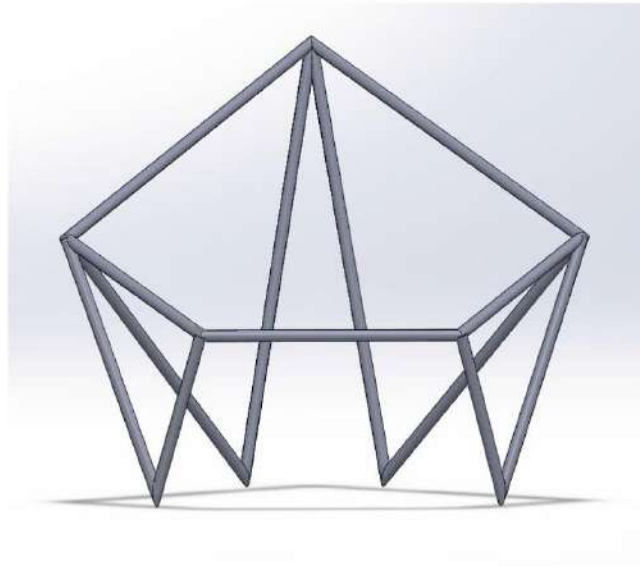
The hanging chair had usability issues like the inconvenience of the strings dangling in front, in installing and limitations in mobility.

The lounge chair came out as a convenient product for relaxation and for unwinding.

For prototyping, the lounge chair was further detailed out.



3D Model framework



Manufacturing considerations

Chassis ; MS 1" dia, 1.5mm thick. (9.5 m required)

Powder coated/Chrome plated

Color; Mat black/ Copper

Coir silicone sheets; (8 nos) Resin transfer molded

Silicone requirement 3.5kg/square m coir felt.

Total Coir felt required; 2m

Total Silicone required; 7kg



Top from left; Coir silicone sheet fabrication by sandwiching felt between silicone layers, Fabrication of steel chassis



left; The sheets are woven and attached to the chassis by using silicone as an adhesive.

The prototype was made in similar dimensions to the testing model.

For the prototype, the sheets were made by sandwiching coir between silicone layers. The silicone resin is cured under pressure for better strength and bonding as well as surface finish.

The chassis structure is formed to suit the triangular structure of the form. The chassis was painted mat black .

The coir silicon sheets woven and were attached to the chassis by using more silicone as a sealant.. Additionally, RTV silicone glue was used for extra support.

7.4 FINAL PRODUCT







Branding

The chair was named spade.

The name suits and states the chair's overall design language. The form of the chair was developed on the basic shape of a spade.





Annexure 1

Material Study; Coir Composite Boards - Classification and Manufacturing

3.3 Classification of coir boards

3.3.1. COIR HARDBOARD FOR GENERAL PURPOSES

IS:15878-2010

3.3.2. MEDIUM DENSITY COIR BOARDS FOR GENERAL PURPOSES

IS: 15491-2004

3.3.3. COIR VENEER BOARD FOR GENERAL PURPOSES

IS: 14842-2000

3.3.4. COIR FACED BLOCK BOARDS

IS: 15887-2010

a) Medium Coir Hardboard-Coir Hardboard having uniform thickness and a density between 350 kg/m ³ and 800 kg/m ³	b) Standard Coir Hardboard-Coir Hardboard having uniform thickness and a density exceeding 800 kg/m ³	c) Tempered Coir Hardboard-Coir hardboard which has been further treated in order to improve or modify one or more of their properties (this may have the effect of altering the density) and having a density exceeding 800 kg/m ³
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3.3.1. COIR HARDBOARD FOR GENERAL PURPOSES (IS:15878-2010)

Coir based panel material with a normal thickness of 1.5 mm or greater. It is manufactured from coir needle felt (non-woven) with or without the combination of other ligno cellulosic materials like jute fibres, paper etc by the application of heat and pressure. The primary bond is usually derived from the felting of the fibres. Bonding materials and /or additives may be added, for better properties.

3.2.2. MEDIUM DENSITY COIR BOARDS FOR GENERAL PURPOSES (IS: 15491-2004)

It is a panel material manufactured from renewable natural fibres such as coir, jute and paper impregnated with synthetic resin or other suitable binder. The panels are manufactured to a specific gravity of 0.5 to 0.9 by the application of heat and pressure by a process in which the inter fiber bond is substantially created by the added binder. Other materials may have been added during manufacturing to improve certain properties.

When manufactured, to give a smooth surface, fine fibres like jute fibres are carded and spread to give a uniform layer on suitable carrier like paper. These fibre mats thus produced are then impregnated with resin and later pressed into panels by passing into press under controlled temperature, pressure and time.

Materials used;

Coir; Coir fiber layer used in the manufacture of medium density coir boards shall be uniform with minimum mass of 600g/m². The coir needled felt is manufactured by mechanical inter-loop of coir fleece by use of barbed needles to form a non-woven felt of different densities.

Jute or other fine fibre; Will be uniform with a minimum mass of 60g per sq. m.

Paper; Will be used uniform with a minimum mass of 20g per sq. m.

Adhesive; BWR type of synthetic resin adhesive conforming to IS 848 shall be used



Coir hard board



MDC board

3.2.3. COIR VENEER BOARD FOR GENERAL PURPOSES (IS: 14842-2000)



Coir veneer board

This standard covers the method of manufacture and the requirements of coir veneer board (coconut fiber with veneer) for general purposes. Coir veneer board is a panel material manufactured as a combination of coconut fiber, coir needle felt, veneer and jute fibres with paper impregnated with suitable resin adhesive and wood veneers. Coconut fibre needled felt can be used as core/ cross bands or as outer skins formed with jute fibres and craft paper. However, the composite ply should be in balanced construction on either side of central ply. The blended mass of glued fibres is laid to form a mat which is pre needled. Alum, wax resins or other additive may be introduced to the agglomerate for coir veneer board prior to forming primarily to increase water resistance.

Grades

- a) Boiling water resistant (BWR) Grade.
- b) Moisture Resistant

Manufacture

Coconut fibers manufactured by mechanical means is processed through needled felt plant (Non-woven system) to make uniform mat in different densities according to the requirement. Jute layers are carded and spread to give a uniform layer on paper. These fibre mats thus produced are blended with resin and wax, if required. The impregnated fibre mats thus produced are sandwiched with wood veneer in a press under controlled temperature and pressure. Veneer shall either rotary cut or sliced.

Veneers from non-durable species and sapwood of all species shall be soaked in 1.25% boric acid equivalent solution at a temperature of 85-900 C for a period of 10-40 min depending up on the thickness of the veneers or the veneer may be dipped in 2% boric acid equivalent solution for 2min and block stacked at least for 2h. Thickness shall be uniform with a tolerance of $\pm 5\%$.

Materials used; Coir; Coir fiber layer used in the manufacture of coir hardboard shall be uniform with minimum mass of 600g/m².

Jute or other fine fibre; Will be uniform with a minimum mass of 60g per sq. m.

Paper; Will be used uniform with a minimum mass of 20g per sq. m.

Adhesive; BWR/MR type of synthetic resin adhesive conforming to IS 848 shall be used

Veneer; Any species of timber may be used for the manufacture of veneers

3.2.4. COIR FACED BLOCK BOARDS (IS: 15887-2010)

Coir faced block board is a recently developed product in the panel industry. It finds use in bus bodies, furniture making, partitioning, paneling etc. Coir faced block board is manufactured from coir and jute fibres combined with synthetic resin or other suitable binder. The panels are manufactured by the application of heat and pressure by a process in which the inter fiber bond is substantially created by the added binder. Other materials may also be added during manufacture to improve specific properties.

This indigenous technology utilized to manufacture coir faced block board is an improvisation of that used by the existing block board industry and has been developed by Central Institute of Coir technology, Bangalore, a research institute of Coir Board.

These are boards having a core and border strips made up of wood, the core strips each not exceeding 30 mm in width and the border strips of minimum 45 mm in width which may not be glued together. The core is glued between one or more outer surface layers formed with coir and bast fibers like jute with paper. The core strips can be made of compressed coir strips also, of width.

Materials used;

Coir; Coir fiber layer used in the manufacture of coir hardboard shall be uniform with minimum mass of 600g/m².

Jute or other fine fibre; Will be uniform with a minimum mass of 40g per sq. m.

Paper; Will be used uniform with a minimum mass of 20g per sq. m.

Adhesive; BWR/MR type of synthetic resin adhesive conforming to IS 848 shall be used

Timber; Any suitable species of timber may be used for manufacture of coir faced block board.



Annexure 11

Market
Analysis;
Furniture
sector



4.1 Industry Overview – Growth and Developments

The furniture sector in India makes a marginal contribution to the Gross Domestic Product (GDP), It represents only about 0.5% of the total GDP. The major part of this industry, approximately 85 per cent is in the unorganised sector. The remaining 15 per cent comprises of large manufacturers.

The range of indigenous furniture available in India, includes both residential and contract system furniture. Manufacturers in India usually use a three-tier selling and distribution structure, comprising of the distributor, wholesaler and retailer. The market is mainly concentrated in A, B and C category cities (the top 589 cities). A and B type cities together constitute 33 per cent of the total market. With a healthy economy and increased household and institutional spending, the market is growing steadily.

- Demand for furniture in India was at 12% annual rate over 2007-2012, and in 2013 it increased at a rate of 15% and is now on the rise
- The market is moving more towards organised segment. This is marked by increasing customer preference for readymade, branded furniture.
- Preference is tilting towards high-end, low maintenance, quickly installable products, with customisation options.
- Simple, contemporary designs are preferred over heavy, complex traditional furniture.

As with the global market, home furniture is the largest segment in the Indian furniture market, accounting for about 65 per cent of furniture sales. This is followed by, the office furniture segment with a 20 per cent share and the contract segment, accounting for the remaining 15 per cent.

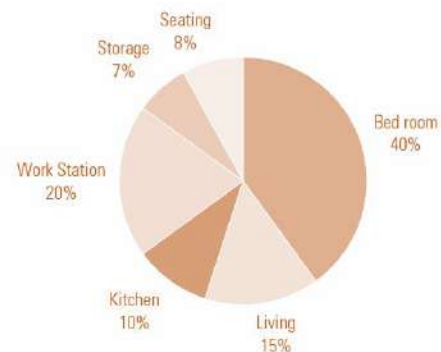
Home furniture Home furniture in India is available in a wide range, to cater to different customer needs. A typical middle class urban Indian home usually has 5 rooms (including the kitchen and bathroom). About 25 per cent of the urban population live in homes with five rooms or more, while 45 per cent live in houses with three rooms or less. About 16 per cent is estimated to live in single-room homes. The type of furniture used depends on the customer's affluence and taste.

The rich and upper middle class is typically very attentive to design and quality, so price is rarely a determining factor. In general, European style furniture is only found in homes of the urban upper class. Demand for furniture of international standards is limited to the larger cities. It is also estimated that the wealthier classes do not change furniture very frequently; the average life of a piece of furniture is about 20 years and some craftsmen's pieces are used for as long as 50-70 years. Colonial furniture is still very common in India, but the trend seems to be declining slowly.

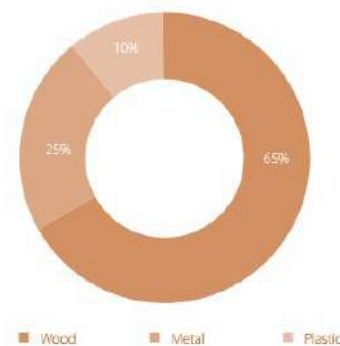
4.2 Foreign trade in the furniture sector

Top five countries from which India imported furniture in 2012 were China, Germany, Malaysia, Italy, and the China largely dominates the furniture imports into India followed by Germany, Malaysia, United States of America, Italy and the US.

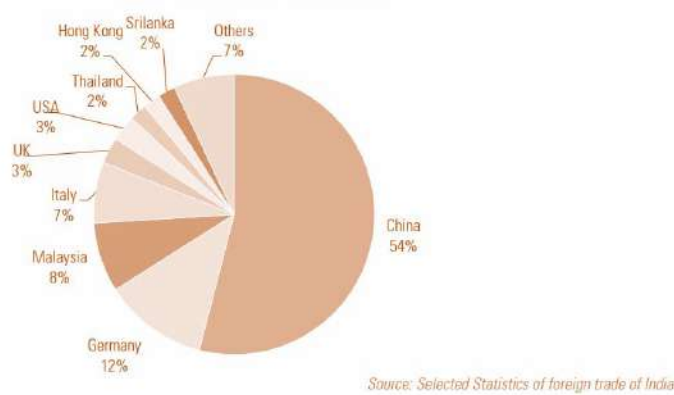
Product wise market share



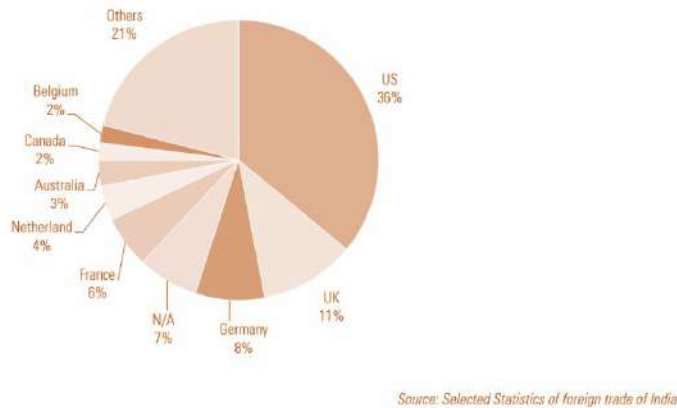
Raw material usage



Country wise breakup of Furniture import



Furniture major countries by value in USD



Average value per shipment of Furniture imports in India is USD 608,948

- The demand for branded furniture has increased in India due to the emerging upper and middle class urban population.
- Although demand for local artisan furniture still exists, the growth is in imports as Indians seek contemporary designs in a modern world.
- The reduction in import tariffs has also driven the growth of imported furniture. All these factors provide a very favourable environment for those importers interested in importing furniture to India.
- Import products are Bedding, Mattresses, Mattresses supports, Cushions & similar stuffed furnishing, lamps & lighting fitting

India is exporting maximum share of furniture to United States and United Kingdom accounting for 47% of total export. However, from US and UK, India is importing only 5% of total imports. India is importing maximum share from China and Germany accounting for 66% of total import. However, India is not exporting furniture to China. Mundra accounted for 37% of export followed by Delhi TKD ICO and JNPT which accounted for 18% and 10% of imports respectively. Average value per shipment of Furniture exports in India is USD 250,522.

4.3 Key players in the market and Online markets

The current USD 400 million organized residential furniture market is dominated by Godrej (USD 80 million sales in 2015), Style Spa (USD 30 million sales in 2015) and some other sub 30 million players. While having a few leading players dominate the market is consistent with the global furniture market structure, markets in the USA and UK also have a large number of smaller organized players.

What is distinctive in the Indian market is the small number of such players and their presence being restricted to bigger cities. They cover only 50 out of close to 500 Indian cities in India, serving just about 10% of the Indian population. The key challenge faced by these players has largely been around managing the high cost of real estate, poor logistics and the cost of inventory.

These are some of the key long term challenges restricting the rapid expansion of offline organized players in the Indian market. To put things in perspective, only 6% of the overall Indian residential furniture market is organized, while the same for USA is around 30-40%.

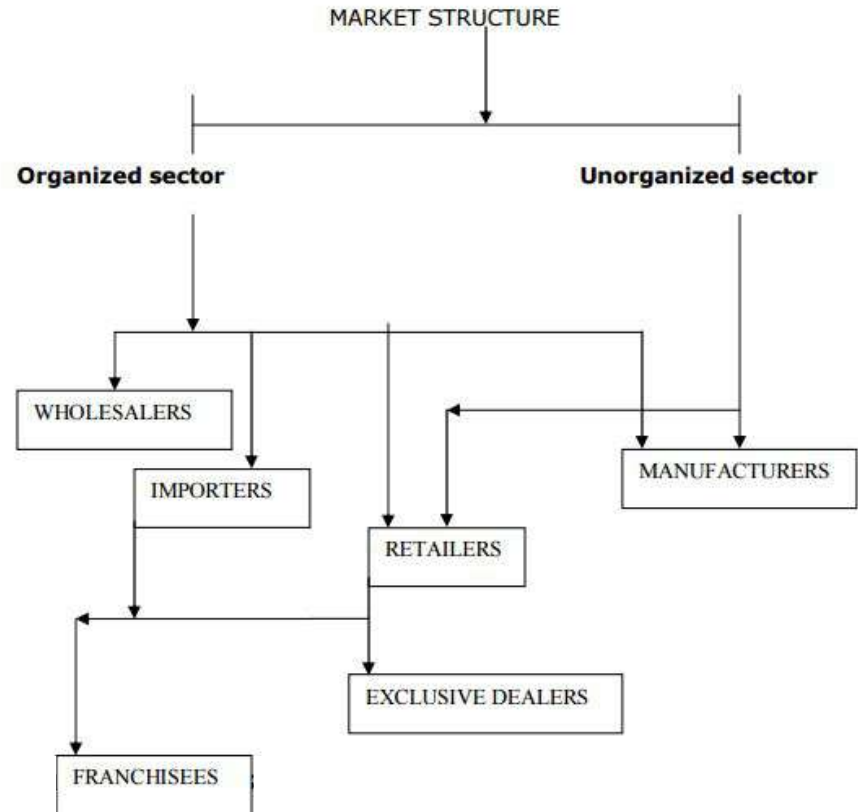
By the time the e-tailing market started to grow in the developed countries, the furniture market was already organized to the certain extent. Thus the e-tailing market made furniture players to resort to the Omni-channel route.

It is expected that India is going to leapfrog the brick and mortar organized channel and move to the pure play online market. So while the organized market share in India and other developed markets would look similar in the long run, Omnichannel would have a limited share in India. Red Deer expects online players to control 3.1% of the overall furniture retail market (of USD 22 billion) by 2020.



<https://goo.gl/3ED75y>

4.4 Market Structure of Furniture Industry



5.1 Educational Profile of Indian Market

- Over 3 million scientific & technical manpower
- Stock of over 0.8 million post graduates in science.
- Over 1 million graduate engineers.
- 0.4 million doctors
- 0.3 million graduates in agriculture and veterinary sciences.
- Today India turns out more than 50,000 computer professionals and 360,000 engineering graduates each year.

5.2 Various Market Sizes based on the per capita expenditure

The average monthly per capita expenditure of urban Delhi in 2003 was INR 1,606. Tamilnadu comes a second at INR 1,131, followed by Andhra Pradesh at INR 1,102. Gujarat,

Punjab and Haryana are not very far behind, at INR 1,092, INR 1,059 and INR 1,050 respectively. At the bottom of the list is Uttar Pradesh at INR 827, Madhya Pradesh at INR 793 and Bihar at INR 784.

5.3 Market Division/Groups of Consumers, based on Income and their product profile

Groups	Number of households In Million		
	1994-1995	1999-2000	2005-2006
Rich (Above INR 215,000) Owns cars, PCs, Luxury Items	1	3	6
Consumers (INR 45,000 -215,000) Owns bulk of branded consumer goods, 70 percent of two-wheelers, refrigerators.	29	66	75
Climbers (INR 22000-45000) Have at least one major, durable (TV, mixer, sewing machine	48	66	78
Aspirants (INR 16000-22000) Have bicycles, radios, fans	48	32	33
Destitute (Less than INR 46,000) Hand to mouth existence	32	24	17

Table 3.1

Over 70% of the urban population is estimated to reside in Class I cities (population of over one million). This is largely as a result of increased employment opportunities in cities as well as a preference among the younger generation to move away from agriculture.

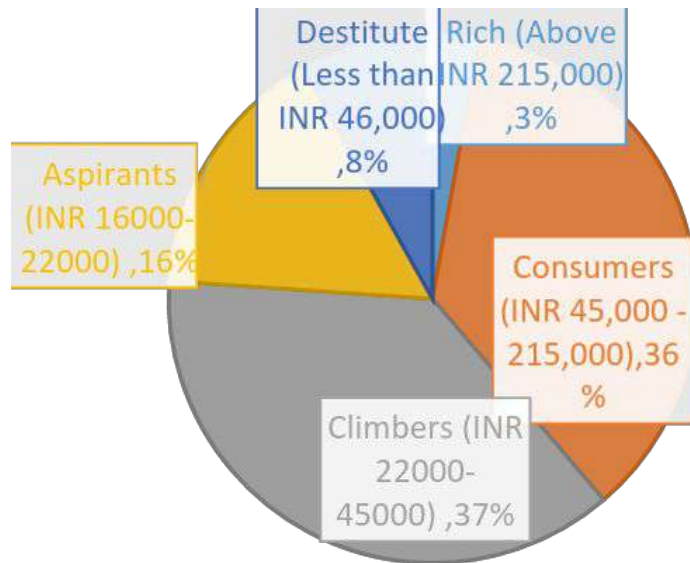


Fig 3.2

A typical middle class urban Indian home has five rooms (including kitchen and bathroom). About 25 per-cent of the urban population lives in homes with five rooms or more. 45 percent live in houses with three rooms or less. About 16 percent is estimated to live in single-room homes. The type of furniture used depends on the customer’s affluence and taste.

Over 60% of the population belongs to the categories Consumers and Climbers as combined. In recent years, the higher GDP and growth rate has raised the total income of these categories.

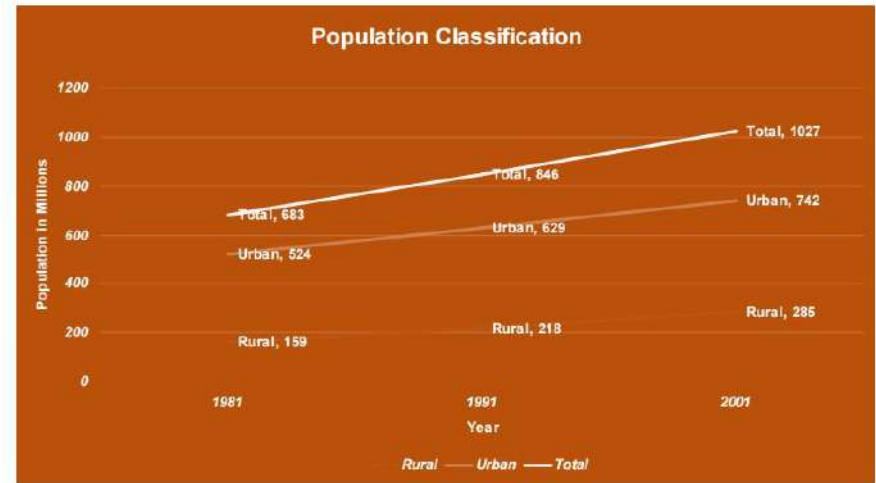


Fig 3.3

Growth in income is expected to continue. This has led to an increase in the number of middle class and affluent households- the number of households of the rich and consuming segment has more than doubled. Coupled with this is the increased propensity to spend on lifestyle and consumer products, driven by trends like increasing number of double income families, increased ease of financing for consumer durables and increased exposure to global products. All these factors have had a positive impact on the furniture sec-tor and are expected to drive demand for furniture in the future.

5.4 Observations

The Indian furniture industry is gradually transforming into a more organised and competitive sector because of the entry of global brands in the sector and emergence of large retail players and franchise

Imported products give better finish taking into consideration their use of modern technology and machinery. Also the products are style and ergonomically designed.

The quality of Up market locally manufactured products is quite good but, they are much expensive.

There is a good demand for mass produced imported furniture as they could be purchased “off the shelf“ and could be used instantly.

Availability of the local product is good in comparison to the imported products.

More people buying differently styled foreign furniture

Key Raw materials used for furniture making se wood, metal and plastic

Knock down furniture available reduces the cost of manufacturing and transportation

Manufacturers should provide more flexibility in furniture and should offer customization to meet customers needs.

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