

DESIGN DEVELOPMENT AND PRODUCTION OF COOKING ACCESSORIES

USING COCONUT SHELL, BAMBOO, WOOD AND METAL

PROJECT 2
INDUSTRIAL DESIGN 2017 - 2019

NIRMAL P J
176130009

GUIDED BY: Prof. SANDESH R



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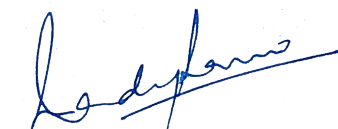


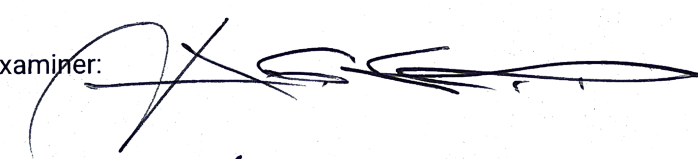
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APPROVAL

This project titled as "Design development and production of cooking accessories using coconut shell, bamboo, wood and metal" by Nirmal P J is approved in partial fulfillment of the requirement for the degree of 'Master of Design' in Industrial Design.

Guide: 

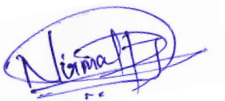
Chairman: 

Internal Examiner: 

External Examiner:  Jayesh Sawant

DECLARATION

I hereby declare that this written submission represents my idea in my own words and where others' ideas have been included; it has been adequately cited and referenced the original source. I declare that I have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any data/ idea/ facts/ sources in our submission. I understand that any violation of the above entitles the institute to take disciplinary action against us to which I shall be answered to.



Nirmal P J

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For all his valuable inputs and guidance throughout the project.

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Figure 1. Coconuts.

1. INTRODUCTION

Coconut shell is being used as a material to make various cooking accessories for many years. Coconut shell is a hard, durable and more importantly a natural material. There are other materials which are also associated with the use of coconut shell; like bamboo and various types of wood. People have been using various products made of coconut shell, bamboo and wood in their kitchen for many years. All those products are mainly referred as craft products because they are hand crafted by the craftsmen. But today the demand for these products have gone down because of various reasons.

The focus area of this project is to look at how we can develop new designs, and reposition the craft products to a higher market segment, and how this can lead to the betterment of the coconut shell and bamboo craft community and the livelihood of the craftsmen. There are two major aspects to it. The primary aspect is developing new designs and repositioning of these to a higher market segment. In order to do that, we have to look at various aspects like the materials and techniques, aesthetics, usability, and manufacturing of these products. All these aspects are very important and needs to be scrutinized from two perspectives; one, as a craftsmen and the other as a user. As a craftsmen it is important that the design is do-able and easy for them to manufacture. And as a user it is important that the product is usable and aesthetically appealing to them. The second aspect is the manufacturing. To be able to manufacture it by the craftsmen, they must undergo through a training. This will enable them to learn new design ideas and techniques, which will help them in the long run.

1.1. What is the need?

As we indicated earlier, there is a strong need for developing new designs for cooking accessories using coconut shell, and a need to reposition them in a better market segment. Most craftsmen have been producing the same old designs over these years. Those products used to sell in the market before. Today the competition among various products in the market is very huge and the current crafts products fails to attract attention. The market for these craft products are abating because of it, and it affects the income generated by the craftsmen; which is insufficient to provide an adequate livelihood for him and his family. Today there are enormous range of industrially manufactured products available in the market with ample material choices, designs, and price range. All this creates a great challenge, and creates a need for new designs and aesthetic approach in craft products. The advantage of craft products is that they have an associated craft value over the mass manufactured products.

1.2. How will it affect the craftsmen?

The primary focus of this project as we discussed earlier, is to develop new designs and reposition the cooking accessories made of coconut shell to a better market segment. As industrial designers we can contribute better design solutions which concern both the needs of craftsmen and the user. We can then train the craftsmen to manufacture these products, through a systematic training protocol. If we contemplate the larger system, this can provide a wide range of opportunities to the craftsmen. Once they got the training, they can become entrepreneurs, they can become trainers and train others in their community, they can work with various craft organizations or societies, etc. This will also be helpful for people who don't have a job, or people who are interested in craft and want to turn into craftsmen.

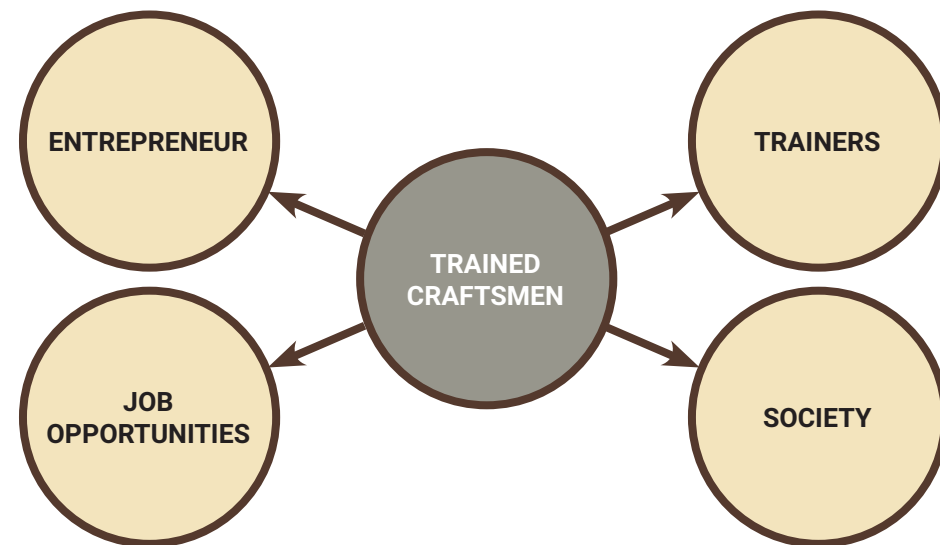


Figure 2. Opportunity mapping

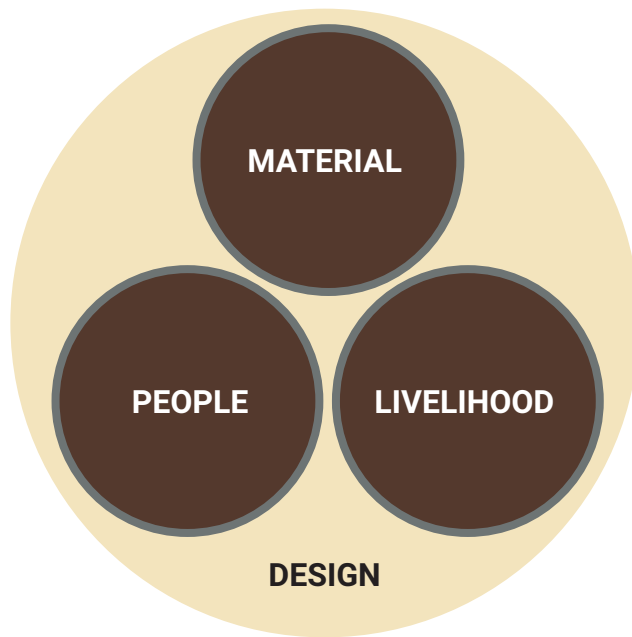


Figure 3. Design Model

1.3. Design Model

After discussing the thoughts about the project with my guide Prof. Sandesh, He proposed a design model [Figure 3] which he is working on and my project was also in the same line. This design model deals with three elements; People, Material, and Livelihood. The idea of this model is, how do we design around these aspects and how we can use design as a medium to improve the livelihood of the people in it.

1.4. How is it going to be produced?

Since it requires the craftsmen to make the new designs, it is important that, the designs have to be doable. The first important aspect is standardization. Why standardization is important? The design and process should be standardized in order to make it production-able. Standardization is important because, the output product needs to have a uniform quality and standards. Standardization will make it easy to monitor the product quality during production. It is also important because we require to have a standardized set of procedures and steps for training the craftsmen. This will also help the craftsmen to understand the process easily and avoid any ambiguity in the process.

The second aspect is, where is it going to be produced?, and what are the tools and machines which are going to be used? In this project, we are looking at a community level system; like a small scale craft industry or an NGO as our production unit. Those will be suitable and can cater to many craftsmen. The tools and machines we are looking at will be based on these facilities; which they may already have or may be something new, which can bring value to the system in the long run. Another important thing in this is the development of jigs and other aids which can help the production process.

The third aspect is the training protocol. Since the craftsmen are not familiar with the new designs, a step by step breaking down of the production processes and designing a training protocol is very important.

2. DESIGN DIRECTIONS

Before finalizing the cooking accessories as the design direction to take up further, we had looked at various other directions.

Initial directions which were identified for this project were

Furniture:

- Café furniture
- Office furniture
- Flat pack furniture

Lighting fixtures:

- Hanging lights
- Wall lights
- Table lamps
- Decorative

Kitchen accessories:

- Cooking accessories
- Cutleries
- Racks
- Trays
- Cutting tools
- Other accessories

After looking at all these various directions, kitchen accessories were selected and further looked at in detail. Since the scope of this category was very broad, and not feasible to look at all of them for the given time period of this project, after detailed discussions with the guide, cooking accessories were found one of the promising choice in terms of various aspects like, scope for designing and detailing, feasibility, material exploration, and scale.



Figure 4. Ladle



Figure 5. Ladle



Figure 6. Cooking/ Serving spoon



Figure 7. Cooking/ Serving spoon

3. PRODUCT STUDY

After finalizing cooking accessories as the desired direction to take forward, The next step was to look at what are the various types of products available in this category which can be further explored in coconut shell. Cooking accessories are a range of tools used for cooking and serving purposes. There are a wide range of products available in this category. An essential criteria maintained while looking at these was considering the prospects of making them in coconut shell. Now let us look at few of those products available in this category based on their uses and cuisine.

3.1. Ladle

Ladle is one of the most common cooking tool in almost every types of cuisines. A ladle consists of two parts; a deep bowl cup part and the handle. The main purpose of a ladle is to serve anything of liquid state; like Dal, sambar, soup, sauce, curry, etc. Ladles are available in various sizes, shapes and designs. The most common form is the hemispherical bowl. The handle of a ladle meets the bowl part at an angle between 45 to 90 degrees in most of the designs.

3.2. Cooking Spoon/ Serving spoon

These are also a very commonly used cooking accessory in many types of cuisines. These products have a very shallow bowl part. They are commonly used for sautéing, stirring while cooking, and serving dry items like subji, fry items, etc. They are available in various sizes, shapes and designs. The most commonly available forms are elliptical or egg shaped. The angle between the head and the handle is usually a very low angle which is less than 30 degrees or often co-extending.

3.3. Draining Spoons/ Skimmers

These are also a commonly used cooking accessory in many cuisines. They have perforations on the head part to facilitate draining or skimming application. They are available in various sizes, shapes, and designs. They are mainly used for deep frying, draining etc. The most commonly seen forms in these are the circular form or the spoon form. The handle is attached to the head at a very low angle or often co-extending.



Figure 8. Draining spoon/ Skimmers



Figure 9. Draining spoon/ Skimmers

3.4. Spaghetti Fork

Spaghetti fork is not a common accessory in many of the kitchens. As its name says this is mainly used in Italian cuisine for preparing spaghetti/ pasta. This can also be used for making noodles. The form of the head is usually with a round or elliptical profile and with the finger like parts. These finger like parts ease the process of draining the spaghetti/ pasta after cooking. There may be some holes at the center of the head to drain water. The handle is attached to the head at a low angle.



Figure 10. Spaghettifork



Figure 11. Spaghettifork



Figure 12. Serving Fork



Figure 13. Serving Fork

3.5. Serving Spork

This one is not a common accessory in most of the kitchens, but they are useful for serving or mixing salads. They have three pointed finger like part. Commonly these are used along with a serving spoon for better serving experience.



Figure 14. Cooking/ Serving spoon



Figure 15. Cooking/ Serving spoon

3.6. Saute Spoon

These are also not a commonly seen cooking accessory. They are specifically designed for sautéing application. They can be adapted to any type of cuisines. They are similar to cooking/ serving spoons, but saute spoon have a flat edge at the end dedicated for sautéing application.

4. DESIGN BRIEF

4.1. Objectives

To design and develop a new range of cooking accessories for an upscale market segment; using coconut shell, bamboo, wood and metal. To develop a protocol for production by standardizing the design details and processes for the purpose of training the craftsmen.

4.2. Scope

The scope of the project is to develop a new range of cooking accessories using coconut shell, bamboo, wood and metal and to develop a production protocol by standardizing the design details and processes.

4.3. Constraints

There are few constraints we need to consider while dealing with this project. The most important thing is that, all the design details and their production processes should be standardized. There should be a proper production protocol for training. All the production processes should be broken down into various small tasks, and develop a step by step manual for manufacturing. We should avoid using processes which require a higher skill level since every craftsman will be having different skill levels. We should also avoid using skill-sets which require a longer learning curve. Finally we should avoid the use of any costly machineries or large scale industrial machineries for production.

4.4. Target market segment and product placement

Since we are looking at repositioning the market for these products, the targeted user groups and where it is going to be placed are very important parameters. The targeted market segment we are looking at is middle class to upper middle class users. These new range of products will be designed as premium range designer products with the look and feel of upscale products. These products will not be designed to be used as daily use products. They will be designed to serve food on special occasions or at fancy house parties where people will showcase their best set of products; like the fancy china-ware everybody keeps in their homes.

4.5. The challenges and the opportunities

This project offers a wide range of challenges and opportunities. Cooking accessories are one of the most common products available in the market. There are immense amount of choices available for customers with broad range of material choices, designs and price range. This offers a great deal of challenge to design something innovative and new. The quality, aesthetics, and finish of the products are very important measures to consider while designing and manufacturing. Design has a very important role in capturing the customer's attention.

Since we are dealing with craft products, it offers a great opportunity to create something unique and valuable. Craft products have the advantage over the industrial products in terms of its identity and values. Craft products are also a very good choice for gift-able items. Coconut shell, bamboo and Wood are suitable materials for non-stick cookware. They are very good alternatives for the plastic cooking accessories used in non stick cookwares. Because of all these, this is a very good product choice for the craftsmen to be employed.

5. GUIDING PRINCIPLES

5.1. Usability

Usability of the product is a very important aspect in designing. The use of cooking accessories can be broadly classified in to two; cooking and serving. Each of these can be further looked at in detail. It is very important that we understand, what are the functions they need to fulfill, when we use them.

We required to understand the primary use of these products in detail. Cooking and serving are two broad category of uses. We have to look at the details like, for what type of dish or cuisines, these products are going to be used. What are the functions; like sautéing, frying, turning etc, and what are the temperature conditions; whether its going to be used in hot conditions or cold conditions, etc. The overall form, size, shape, type of materials, ergonomics, etc of the product will be decided based on all those aspects.

Another important aspect we have to look at is cleaning and maintenance. The product should be easy to clean and maintain. Especially when we are dealing with craft products with natural materials like coconut shell, bamboo and wood; for hygiene concerns and durability of the product. The details of every joints needs to be addressed while designing and manufacturing. There should not be any gaps at the joints which collects food, or design details which are difficult to access and clean. Another important fact the user must understand that, these materials needs a little more care in maintaining and storing, compared to other products with materials like stainless steel or plastic.



Figure 16. Power Grip

5.2. Ergonomics

Ergonomics of the product is a very important aspect in designing. We operate the cooking accessories using our hands, so the length of its handle, the type of grip and holding posture, and dexterity are important aspects of ergonomics to consider when designing.

The common type of grip we use to hold the cooking accessories is called power grip [Figure 16].

5.3. Production

Another important aspect we need to consider while designing is the type and scale of production; what are the tools/ equipments/ machines that are going to be used in production?. Since we are looking at small scale unit level/ organization level production, it is important to consider the tools and machines are fit for the context. We can also look at and propose any new technology or equipments which can bring in a lot of values to the product and the system. But it is important that we should not try to implement any large scale industrial level production machineries or equipments which will take away the value of the product as a craft.

5.4. Understanding materials

Coconut shell

Coconut shell is a hard fibrous layer between the coconut meat and the husk of a coconut. There are three eye like holes on one end of the coconut shell. One of these holes is active and the sprout will come through this hole when the coconut germinates. The shell is also divided into three parts with a visible ridge line at the division.

Every coconut shell is unique in nature. The shape, size, thickness, the curvature, etc. vary from shell to shell. This creates a challenge for designers to standardize the material.

Coconut shell is a hard and tough material, because of it, the shell becomes very brittle when an impact load is applied on it. So care should be taken when dealing with this material. Coconut shell is also very durable and resistant to abrasions and suitable for long standing use. It is resistant to fungal attacks and resistant to temperature.

Bamboo

Bamboo is an evergreen perennial plant in the grass family. There are a lot of species of bamboo are available, but not all of them are used for various types of applications. Some of the common species of bamboo which are used for construction and making various products in India are *Dendrocalamus giganteus*, *Dendrocalamus strictus*, *Bambusa tulda*, etc.

Bamboo has a linear fiber grain structure. They are stronger along the grain and weaker across the grain. They are prone to fungal attacks and moisture absorption if not taken care of. So in order to use it for general purposes, they need to be treated with chemicals for making it durable.



Figure 17. Coconuts

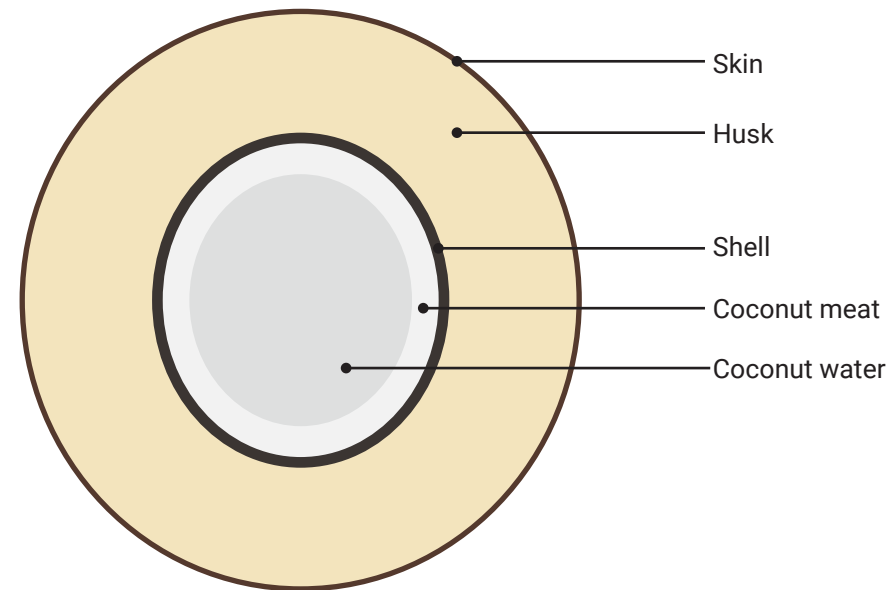


Figure 18. Cross section of a coconut



Figure 19. Various types of woods. Examples: Teak, Mahogany, and Rosewood

Wood

Wood is a very commonly used material for vast range of applications from products to structures because of its strength and versatility. Wood have a naturally beautiful texture, pattern and color, so that we doesn't need to do any additional coloring or texturing. Wood gives a very good finish to the product and has a naturally warm feel to touch.

Wood is a natural dense fibrous material obtained from trees. Depending on the type of tree, the properties of wood changes. Wood can be majorly classified into two; softwood and hardwood. Softwoods are generally not used for long term applications or structural applications because they are low in strength and more prone to various termite and insect attacks and moisture attacks than hardwoods. Wood needs to go through a seasoning process before its application to increase its stability and minimize its dimensional changes post application.

Metal



Figure 20. Various types of metals. Examples: Stainless steel, Copper, and Brass

Metals are the most versatile material which are used for a broad range of applications. There are various types of metals available. Metals may be a chemical element like copper, aluminum, iron etc, or it could be an alloy such as brass, stainless steel, etc. The properties of each metal varies, but they are typically very strong, malleable and ductile. They are also good conductors of heat and electricity. The disadvantage of many of the metals is that they are prone to oxidization when exposed to atmosphere.

5.5. Nontoxic treatment methods of bamboo

Bamboo needs to be treated with some chemicals or organic substances to extend the life and durability of its products. Treatment of bamboo is done to protect it from various fungal attacks and stabilize it against the moisture absorption. The most typical way of treating bamboo is using a mix of boric acid and borax. This method is used for common applications of bamboo, but this cannot be implemented for food grade applications. Since we are making cooking accessories, we have to look at nontoxic methods to treat bamboo. There are various other treatment methods are available for bamboo, which are nontoxic. Bamboo can also be used without treatment for food grade applications, but it will affect the durability of the product, if not maintained carefully. Treating bamboo can reduce the moisture absorption and fungus attack. Some of the nontoxic treatment methods are as follows:

- Treatment with lime water (saturated calcium hydroxide solution)¹
- Treatment in boiling linseed oil / oleo-thermal process¹
- Treatment with plant extract-based preservatives; Azadirachta indica Extract, Aleurites moluccana, Neobalanocarpus heimii, etc.²

1 http://www.kitilfarm.com/bamboo_preserving.php

2 Dua, Perminder & satya, Santosh & Pant, Kamal & Naik, Satya. (2016). *Eco-Friendly Preservation of Bamboo species: Traditional to Modern Techniques*. Bioresources. 11. 10.15376/biores.11.4.Kaur.

5.6. Nontoxic adhesives

We also have to look at various non toxic adhesives for our applications. There are food grade silicon sealants and food grade epoxy resin adhesives available.

Few of the available products in these regards are listed below.

- ASI 502 Industrial grade RTV Silicon
- Kohesi Bond - KB 1452 HT-2 FG - 2 part epoxy system
- Fine Finish Organics - Epofine-250/Finehard-847 - 2 part epoxy system
- Reoltech 3030 AL/3038 AL Hardener - 2 part epoxy system

5.7. Nontoxic finishes

Nontoxic finishes are also important to look at. Following are few of the nontoxic finishes available.

- Pure tung oil
- Raw linseed oil
- Wall-nut oil
- Bee wax
- Carnauba Wax (from palm tree)
- Shellac

6. EXISTING PRODUCTS

We have also looked at various existing products using coconut shell in order to understand the available range of products, their details and product aesthetics.

The traditional designs [Figure 21 & 22] are made by creating two holes on the bottom side of the coconut shell and inserting a wooden or bamboo handle through them. The problems with these products are, the handle tends to come off of the shell most of the times. This joint also creates a tight space between the coconut shell and handle, which is difficult to clean. Another issue is chances of leakage because the holes are at the bottom.

Then there are other types of joints [Figure 23 & 24] which uses rivets or screws to join the shell to the handle. This is a better way compared to the traditional method but, this also creates a small gap between the shell and the handle. Also steel screws are commonly used, which catches rust very easily. The third method is similar to the second method, but in this they have created a groove on one end of the handle and the coconut shell is inserted inside [Figure 25]. Then using screws/ rivets or by means of tying them together to fasten the shell in place. This one also has the same kind of problems as the previous one. The fourth type [Figure 26] is inserting the handle through two holes at the top of the coconut shell. This makes it very difficult to clean the inside of the shell after use.



Figure 21. Handle inserted through two holes



Figure 22. Handle inserted through two holes



Figure 23. Joined with rivets/screws



Figure 24. Joined with rivets/screws



Figure 25. Inserted inside the groove and fastened with ties/ rivets



Figure 26. Through and through insert

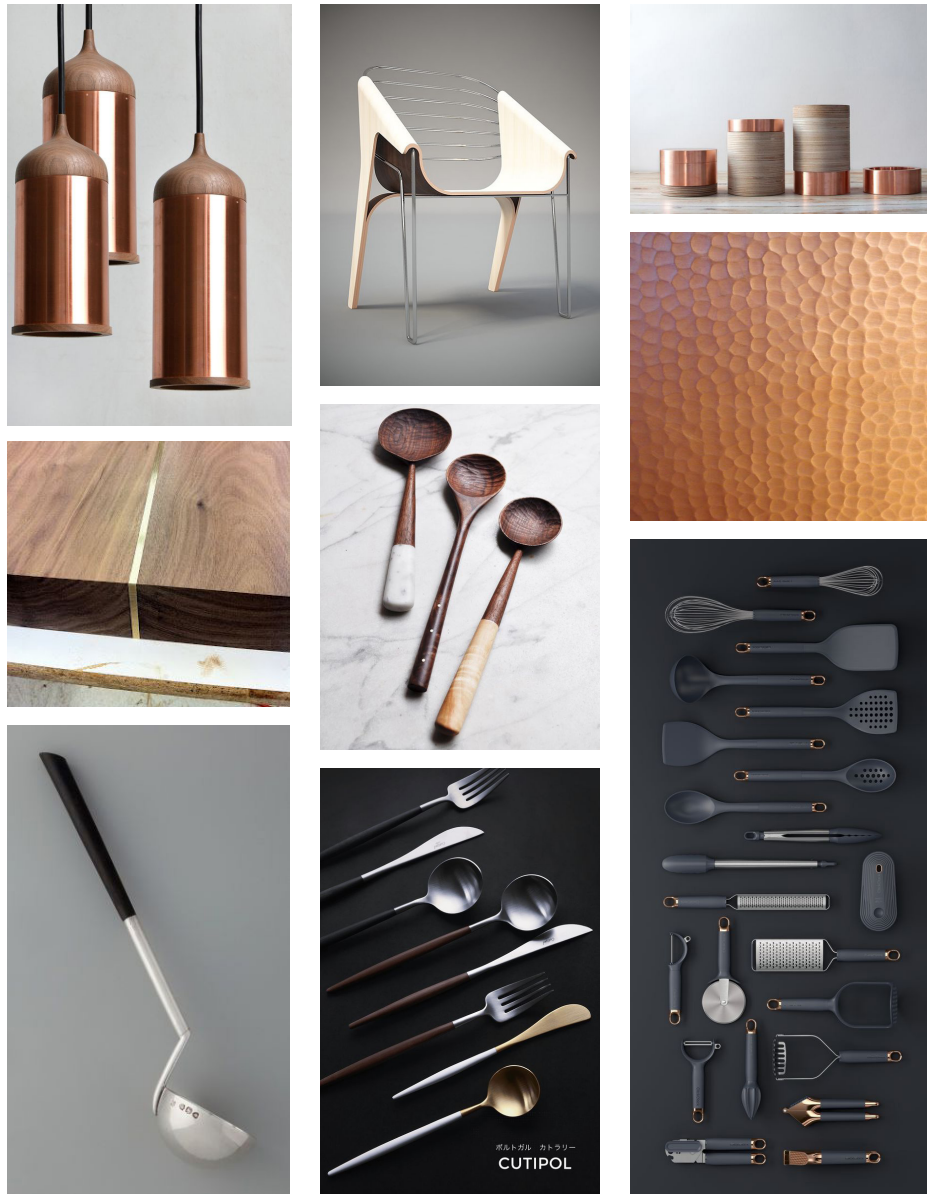


Figure 27. Mood Board

7. IDEATION

7.1. Mood board

A mood board was created in pinterst to have a feel about the kind of aesthetics and design language of the upscale designer products. Few of the images from the board are shown here.

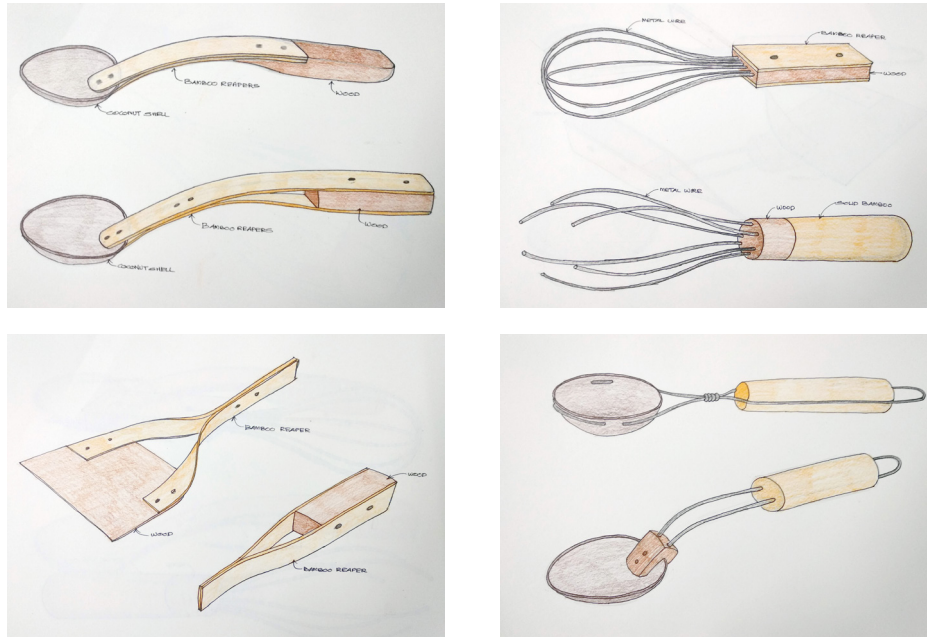


Figure 31. Ideation sketches



Figure 32. Ideation 3d models

Different product forms were also explored through sketches and then made few 3d models in sketchup for better visualizations of the ideas

7.3. More Ideation sketches

Further, more ideas were explored through sketches. Explorations were done for various ways to attach coconut shell and the handle, Various combinations of materials, Forms, product aesthetics, design of handle, etc.

Ideation 1

The idea was to use bamboo reapers and wood to make an interesting handle. Also riveting was considered as an option to attach the coconut shell to the handle. Two options were looked at. One was using one reaper and the second using two reapers.

Ideation 2

This idea was also exploring the design of handle using bamboo reapers and wood. In this a new method to attach the coconut shell to the handle using riveting on the sides were explored.

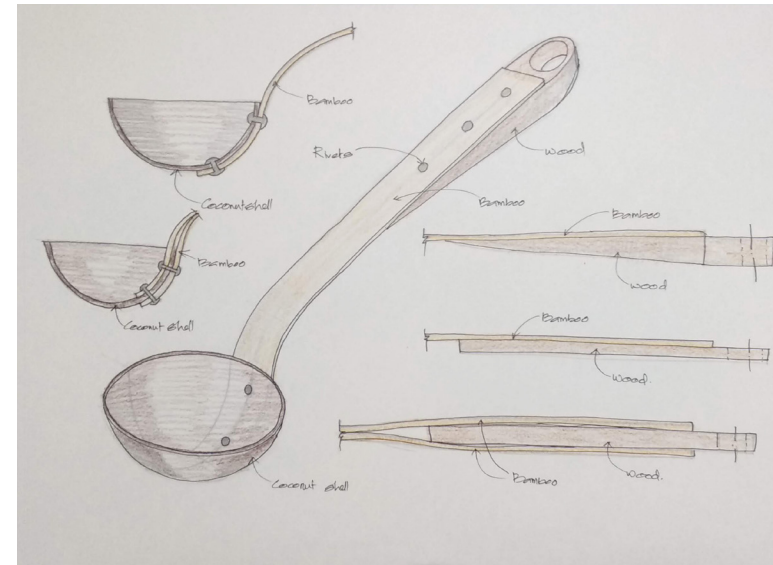


Figure 33. Ideation 1

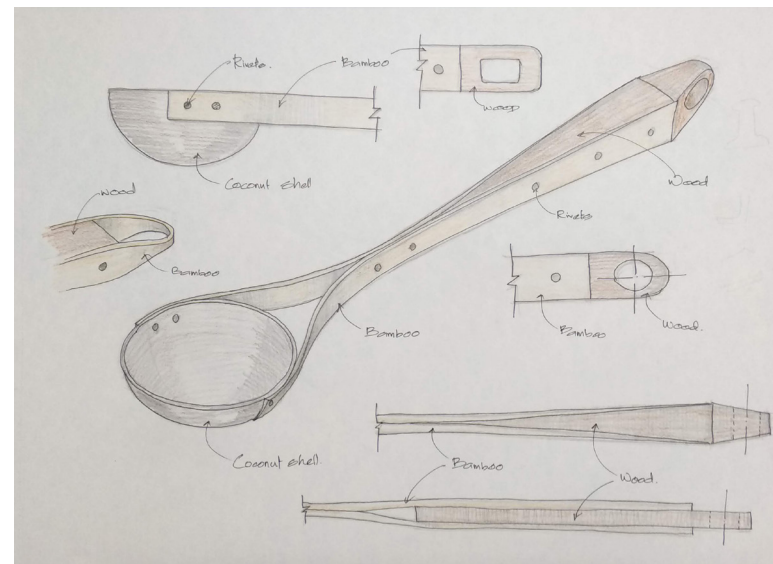


Figure 34. Ideation 2

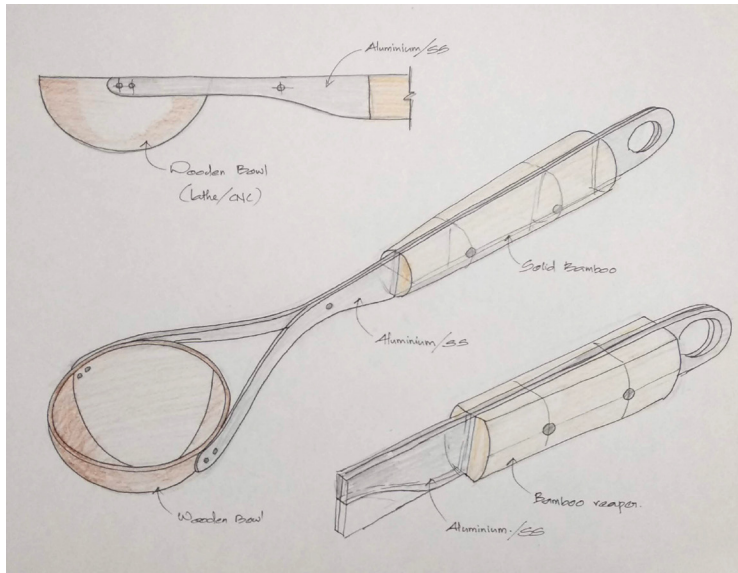


Figure 35. Ideaation 3

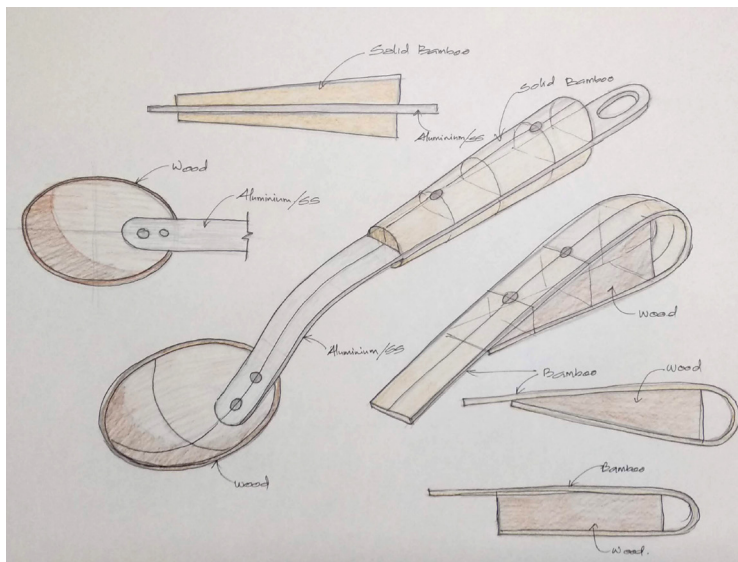


Figure 36. Ideaation 4

Ideaation 3

This ideation was similar to ideation 2. This was an exploration using wooden bowl instead of coconut shell. Also In this, instead of using bamboo reapers, metal sheets were considered for the handle. The handle part was explored by sandwiching the metal sheets between two pieces of bamboo; they can be either using solid bamboo or using two pieces of bamboo reapers.

Ideaation 4

This idea was also an exploration using wood instead of coconut shell. Here for the handle, a combination of metal sheet and bamboo, and a combination of bamboo reapers and wood, were explored. Another thought on this was forming a loop with the bamboo reaper around the wooden piece to create a hanging part in the handle.

Ideation 5

This was also an exploration using wood for the head part. Exploration was done in rectangular form for the head. Also a new detail for joining the handle to the head part were looked at. The idea was to bent the metal sheet at an angle and attach it to the wood using screws from the back for a new aesthetics and style

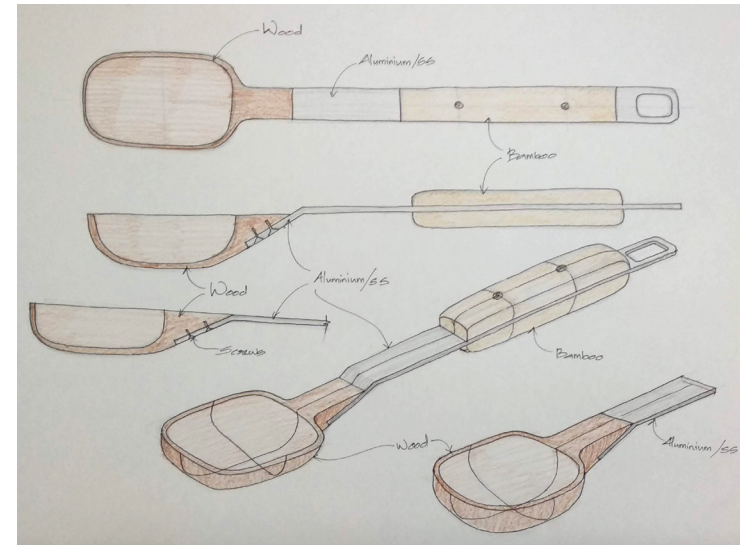


Figure 37. Ideation 5

Ideation 6

This ideation was also an exploration with wood and rectangular form. There were two options explored in this. The first one was inspired from the ideation 2 and 3 in which there were two bamboo reapers/ metal sheets were used. In this also two metal sheets were attached on the sides of the wooden part and then bent them inward to form a single stem for the handle. In the second option, a neck part was provided with the wooden head part. A slit is also provided in the neck piece, in which the handle can be inserted and fastened. The inserted handle could be of metal or bamboo, or it could be a combination of those two sandwiched together with the metal sheet at the center. This method of sandwiching a metal sheet between two bamboo reapers can provide more strength to the handle and also adds to the aesthetics of the product by creating a thin metal line all around the edges.

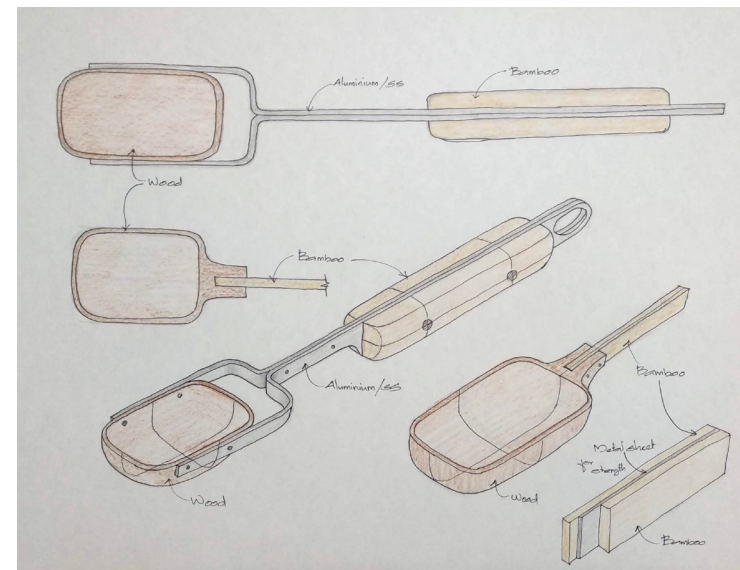


Figure 38. Ideation 6

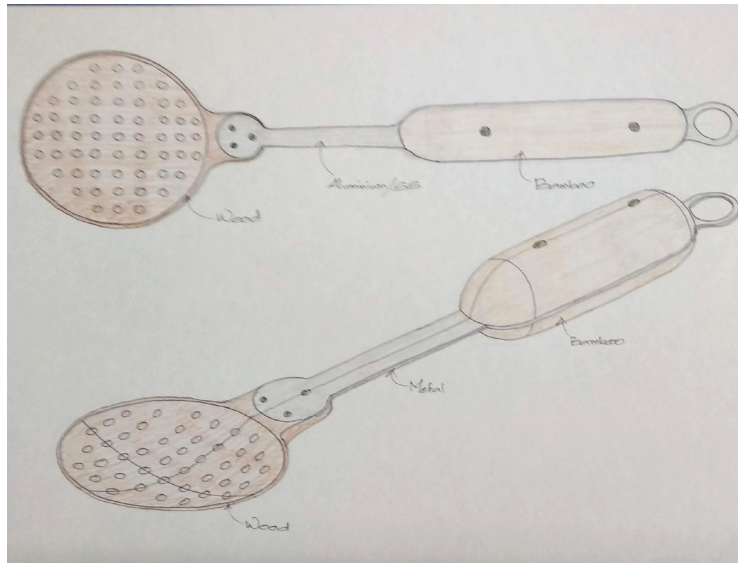


Figure 39. Ideation 7

Ideation 7

This ideation was an exploration to give a character to overall product. The idea was to give a circular character. The joints, the hanging part of the handle, the profile of the handle, the shape of the head, everything was done in a circular shape. This was also an exploration using wood.

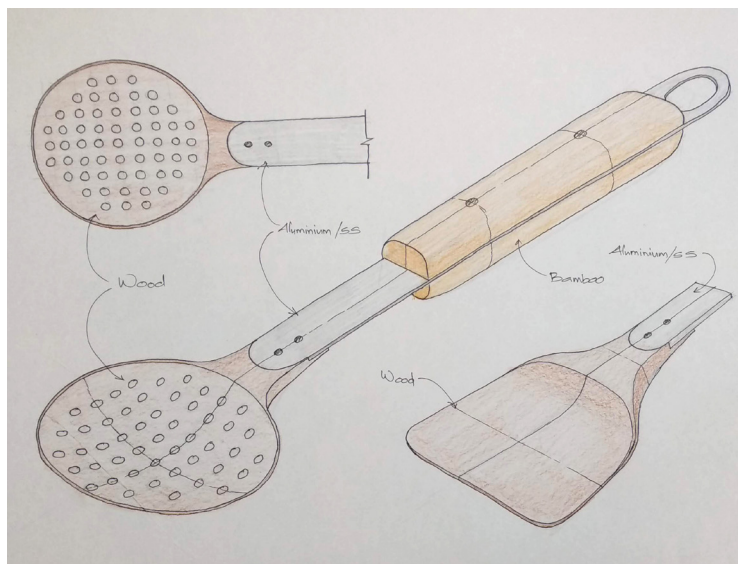


Figure 40. Ideation 8

Ideation 8

This was similar to previous ideation, with a different design language for the handle. Also looked at an idea for a turner in wood.

Ideation 9

This Ideation was a continuation of the ideation 6. The idea of the handle was taken further to explore. Also a formal variation for the head was also explored. An idea using a grinding wheel with a desired profile for making the head part in wood was also looked at.

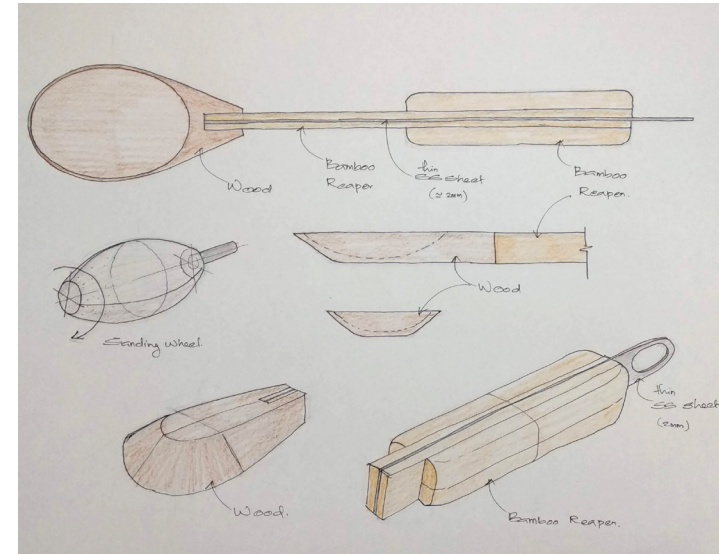


Figure 41. Ideation 9

Ideation 10

This ideation was an exploration using only round sections. The handles were of solid bamboo sections. Various profiles for the handle like straight handle, and tapered handle were also explored to create various aesthetics. Details of how to join these together were also explored.

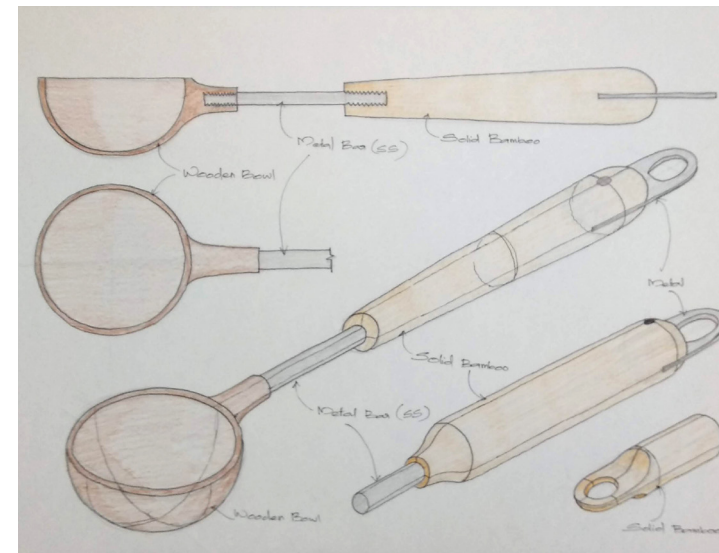


Figure 42. Ideation 10

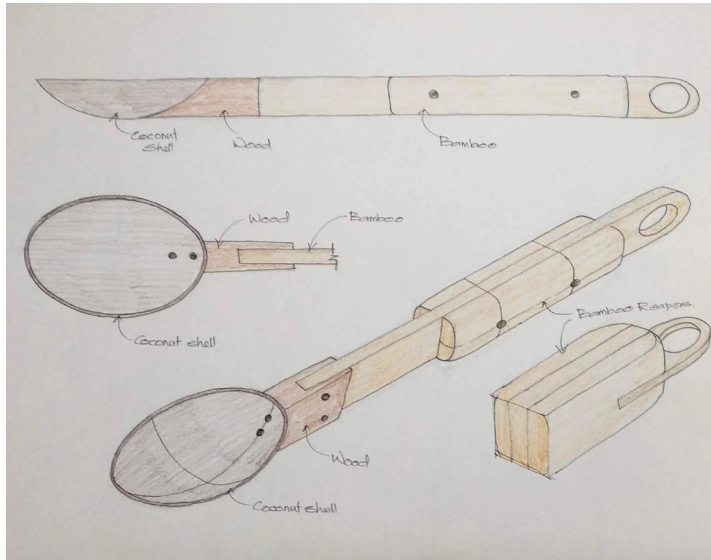


Figure 43. Ideation 11

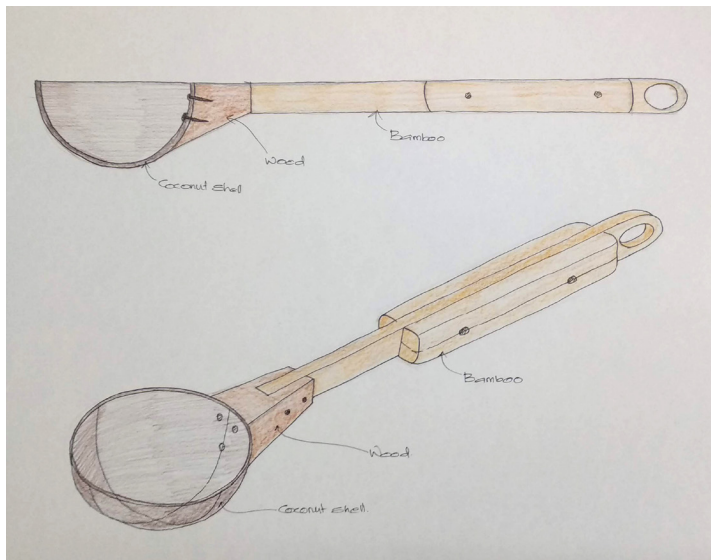


Figure 44. Ideation 12

Ideation 11

After exploring various ideas using wood instead of coconut shell, we looked back into using coconut shell. The main drawback of using wood we found while doing the explorations was that, they require more industrial processes to turn the wood into desired shapes, and it loses the identity of a craft product because of this. But there were a lot of take aways from those ideation.

This ideation was an inspiration from the ideation 6 and 9, but here we have looked at how we can reconstitute the coconut shell in place of wood.

Ideation 12

This ideation was similar to the previous one with the modification in the neck part of the design. A tapered profile for the neck piece was given to make joint look visually more strong.

8. CONCEPTUALIZING AND PROTOTYPING

8.1. Quick prototypes

After done a lot of explorations in various ideation through sketches, many different ideas were taken and combined to form different concepts. Those were then made into quick prototypes using Styrofoam, and aluminum sheet, mimicking the actual materials



Figure 45. Quick prototypes



Figure 46. First set of prototypes

8.2. Prototyping with actual materials

After making some quick prototypes, we started prototyping with actual materials.

First set of prototypes

The first set of prototypes were made from the 12th ideation with modifications at the joint where the coconut shell and wooden piece meets. An outward tapering was given in Ideation 12 were creating a larger area of contact between the coconut shell and the wood. This was creating a problem to match those two surfaces seamlessly because of the non-uniform curvatures of the coconut shells. So an inward angle was given at the joint to reduce the area of contact for better matching of the two surfaces [Figure 47]. Even though this worked for the joint, the form of the wooden piece was breaking the continuity of the design and creating a visual tension at the joint. In these prototypes, different shapes for the coconut shell, the design of the handle, and how to attach the coconut shell at an angle with the handle, were also explored.



Figure 47. Details

Second set of prototypes

After noticing the problems with the first set of prototypes, the second set of prototypes were made. Since the diamond form of the wooden piece in the previous set of prototypes were creating a visual tension, a new form for that needed to be looked at. The idea of inserting the wooden piece between the handle instead of inserting the handle inside the wooden piece seemed to be an alternative to change the geometry of the wooden piece. To accommodate this idea, two pieces of bamboo reapers were used. The idea of sandwiching a metal sheet between those two reapers, from one of the earlier ideation, was also incorporated as an experiment to add an element and to give more strength to the handle. The handles of the first set of prototypes were too bulky and the proportions were wrong. In the second set, different handle sizes were explored. Also Different other explorations; with the detail of the hole for hanging, type of metal sheet, coconut shell form, detail at the junction between the wood and bamboo [Figure 48] were done.



Figure 48. Details



Figure 49. Second set of prototypes



Figure 50. Third prototype



Figure 51. Side view



Figure 52. Detail a



Figure 53. Detail b

Third prototype

The second prototype was promising, but the problem was, the hole for hanging the product was provided on the side and needed to be addressed immediately. So in third prototype, a new design detail was added to the back end of the handle for the hole to hang [Figure 52]. The detail was done in wood to match the other end and using the same detail of inserting the wooden piece between the bamboo reapers of the handle. This detail solves the issue of bringing the hole to the front side, but this was not working as a solution. The detail was really small and it was prone to breakage. The process to make this was also tedious, found difficult to standardize, and more time consuming. An exploration with a new form in coconut shell, handle dimensions [Figure 51], a different size metal pins [Figure 53] were also explored in this prototype.

Fourth prototype

One major problem found in previous explorations was the joint between the coconut shell and the wooden piece. In all the previous prototypes, we were looking at riveting or screwing the coconut shell to the wood. This was creating gaps between the coconut shell and the wooden piece. It was difficult to match the two surfaces seamlessly, because the two way curvature of the coconut shell. It was also found difficult to standardize the detail because of the irregularities among various coconut shells.

After given some thoughts on this issue, a new idea for the joint came to light. The idea was to join the coconut shell directly to the wood by adhesion. One end of the coconut shell was grind-ed at an angle to get enough surface area for sticking it to a piece of wood. The wooden piece then grind-ed to match the profile of the coconut shell to create a seamless joint. As a result of this process an interesting detail was formed on the rear side of the wooden piece [Figure 55]. Another issue from the previous ideation was, how it is hanging. In the third prototype we have tried solving it, but it did not work as intended. So in this, the idea was to turn the handle by 90 degrees to the side. Doing this was easy with the new wooden piece detail. The handle was made with the same idea of sandwiching a metal sheet between two bamboo reapers. The wooden piece is then inserted between the two bamboo reapers.



Figure 54. Detail a



Figure 55. Detail b



Figure 56. Fourth prototype



Figure 57. Fifth prototype



Fifth prototype

In the previous prototype, the idea of sandwiching the metal between two bamboo reapers was found lost its attention because, now the detail was only visible from the side. So another iteration was made by removing one piece of bamboo reaper from the back to expose the metal sheet. The idea was to provide the metal sheet at the back side, and the bamboo on the front side; because the piece at the back side needs to bent to accommodate the wooden piece in it [Figure 58], and bending metal was an easier solution than bending bamboo, considering the time and effort in production. Another reason to remove one of the bamboo reapers was to reduce the overall visual complexity of the design. This idea seems to be working quite well in various regards, but providing metal on the back side does not seems to be justifying the use of metal in the design.



Figure 58. Detail

8.3. Final concepts - Design 1

Sixth prototype

The idea of removing one reaper found to be a good idea in the previous prototype, but providing the metal sheet at the back was not working as per the expectations, so the solution was to provide it on the front side. This seems to be working better for exposing the metal and bring out its value. This also opened up the possibilities for more explorations in metal to add value to the whole design.

At this stage the design seemed to be working as per the expectations without further issues. A few tests were conducted for testing the joints, to finalize the design as concept number 1. Further explorations were then done on this design to bring in more aesthetic and creative values, and to finalize the possible product range.



Figure 59. Detail



Figure 60. Sixth ideation



Figure 61. Drop test



Figure 62. Tap test 1



Figure 63. Tap test 2



Figure 64. Tap test 3



Figure 65. Dip test

8.4. Testing for joinery

In order to check the strength of the joints, few testing strategies were developed and tested the product.

The various tests which were conducted were as follows.

Drop test

In this testing the product was dropped multiple times to stimulate the accidental dropping conditions in a kitchen, to see the impact on the joint [Figure 61]. At 27th drop, the coconut shell broke at the tip, but the joint was still intact

Tap test

This test was to stimulate the various accidental taps that can happen when using the product. This was done in three ways. In test 1 [Figure 62] the product was tapped on the back where the joint is. In second test [Figure 63], The product was tapped on the side of the joint. In test 3, the product was tapped with its handle [Figure 64]. In each of this test, 100 taps were carried out and found no effect on the joint

Water dip test

This experiment was to test the effects on longtime contact with hot water. The test was done by immersing the product in hot water for 30 minutes [Figure 65].

This test was also came through without any impact on the joint

After carrying out these tests, the joint seems to be intact and decided to accept and finalize.

8.5. Explorations

Various experiments were done during and after finalizing the concept to explore different possibilities, the product range, and various ways in which we can add more aesthetic and creative values.

Explorations in coconut shell

Experiments were done to cut a coconut in different ways to explore various shapes we can obtain from them [Figure 66]. Experiments were also done to obtain various shapes from discarded coconut shells [Figure 67]. The first method of cutting a coconut by ourself to get the desired shape, gives us more freedom to work with. Where as obtaining desired shapes from discarded coconut shell had its limitations. Getting uniform sizes from various shells were difficult because the shells were already cut.



Figure 66. Cutting coconut in two ways



Figure 67. Obtaining usable shapes from discarded coconut shells



Figure 68. Exploration in laser etching on bamboo

Explorations in Laser etching

To add more interest and value to the products, laser etching on bamboo were explored. Three different patterns were made and tried them on bamboo strips [Figure 68]. This idea found promising and decided to take it forward. This offers a wide range of possibilities to crate various patterns and artworks, and customizations possibilities on the products, which can add huge value to the products.



Figure 69. Textures and patterns in copper



Figure 70. Textures and patterns in Brass

Patterns and texture on metal

Since we are exposing the metal sheet, further more explorations were done on it to create various patterns and textures using various different techniques. Copper and brass were used for explorations [Figure 69 & 70]. This also created interesting results and added more value to the overall aesthetics and character of the product.

Product range , form and angle variations

An exploration was done in various types of heads possible in coconut shell to decide on the range of products. Products like ladle, draining spoon, serving spoon, and skimmer were explored. Different shapes like hemispherical, elliptical, squarish, triangular, and egg shaped forms were experimented.

The angle between the head and the handle is different for each type of product. This was also looked at in these explorations

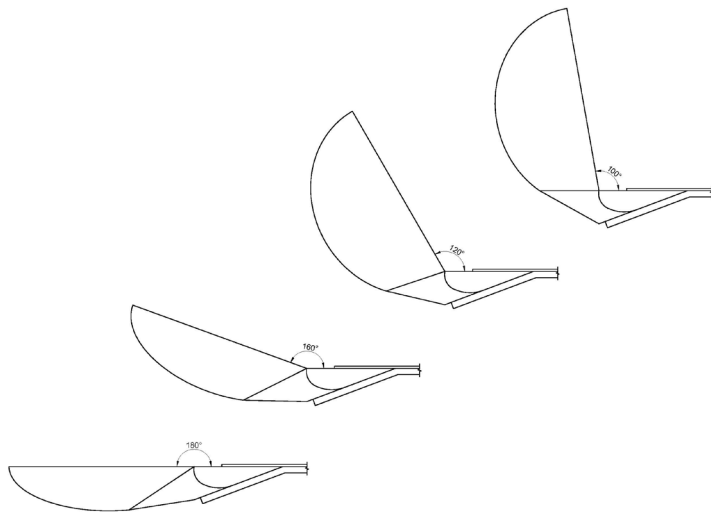


Figure 71. Various angles for the head



Figure 72. Exploration in product range, form and joining angles



Figure 73. Deign 2 prototype

8.6. Design 2

After finalizing the first concept, Another design option for the handle using round sections were explored. A prototype was made using the combination of round sections of solid bamboo and wood [Figure 73]. The detail for the head part kept constant. Further explorations were done on this design to see the prospects.

8.7. Further explorations on design 2

Exploration using lathe

Lathe was looked at another area of interest for making handles. Various forms were explored through sketches and then made prototypes using a lathe machine. Various sizes for the handle were also explored.

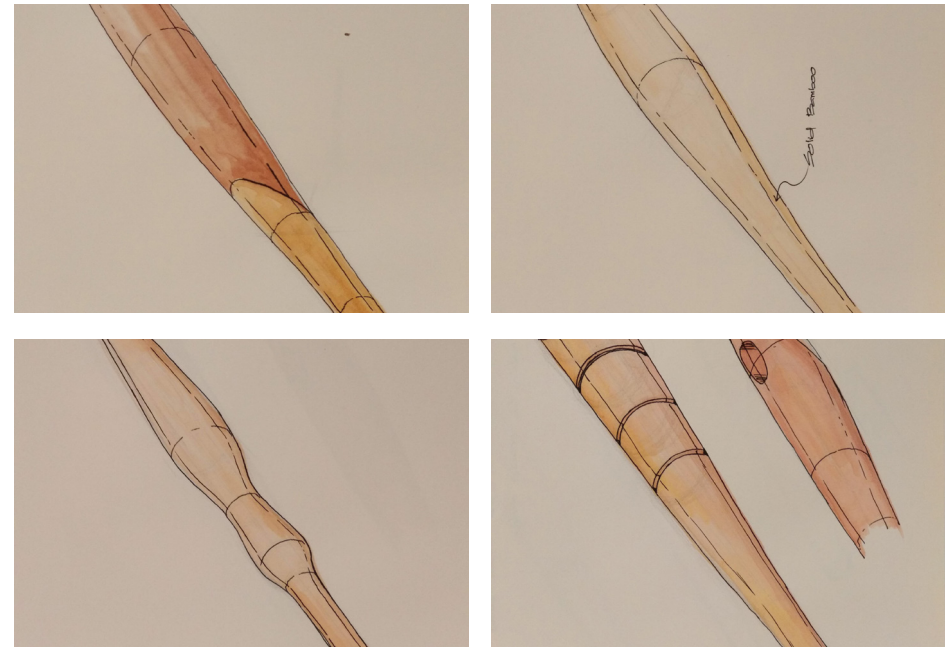


Figure 74. Ideation sketches



Figure 75. Prototypes - Exploration in form



Figure 76. 3 v-grooves on one end and a step on the other end of the handle



Figure 77. 3 v-grooves on one end with a seamless form



Figure 78. 2 v-grooves on both the side of the handle



Figure 79. Rectangular groove on both the ends of the handle



Figure 80. Rectangular grooves at an interval with silicon filling

Explorations in groves

An exploration was done in various possibilities of groves to add more aesthetic and functional value. Groves are simple yet adds a visual interest and gives more definition to the handle. It can also add to the function as it can provide more grip. Various explorations were done in these aspects. Another important aspect of groves is that they can be done along with the lathing process itself and do not need an additional process.

Simple handle forms were made in lathe and added 3 v-grooves on one end to add an element of interest to the handle [Figure 76 & 77]. Groves were used as a mean to define the handle area. Two different types of groves were experimented with this idea [Figure 78 & 79]. Groves as a means for better grip were also experimented [Figure 80]. Additional exploration was done on this with silicon filling for even better gripping.

9. FINAL PRODUCTS



Figure 81. Final product range 1





Figure 82. Final product range 2



Explorations in joineries

Different joining methods for attaching the lathed handle to the wooden piece were also experimented with prototypes. The handle can be attached to the wooden wedge by making a half cut on the stem of the handle, or make a diagonal cut on the stem and then attaching it to the wooden wedge and then round of the top edges of the wedge to match the handle. It could also be made from one single piece of wood or attach it with butt joint or finger joint.



Figure 83. Explorations in joineries



Figure 84. Various stages of production

10. PRODUCTION

The first design concept was taken further to detail out the production process.

9.1. Documentation of the process

The first step was to document the whole process at each step. The complete production process was then categorized into various tasks and processes involved to complete each of those tasks.

10.1. Tools and machines used

Following are the tools and machines used for making the products.

Hand tools

Chisel

Knife

Hammer

Power tools

Angle Grinder

Hand drill

Hot air gun

Machines

Disc Sander

Lase cutter

Drill machine



Figure 85. Chisel



Figure 86. Knife



Figure 87. Hammer



Figure 88. Angle grinder



Figure 89. Hand drill



Figure 90. Hot air gun



Figure 91. Disc sander



Figure 92. Laser cutter



Figure 93. Drill machine



Figure 94. Sanding bit for sanding the inside of the coconut shell

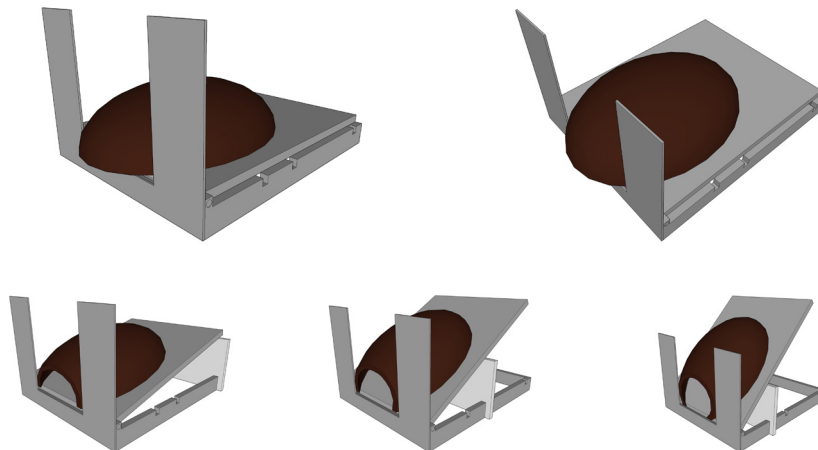


Figure 95. Jig for disc sander to grind the coconut shell to a desired angle and width

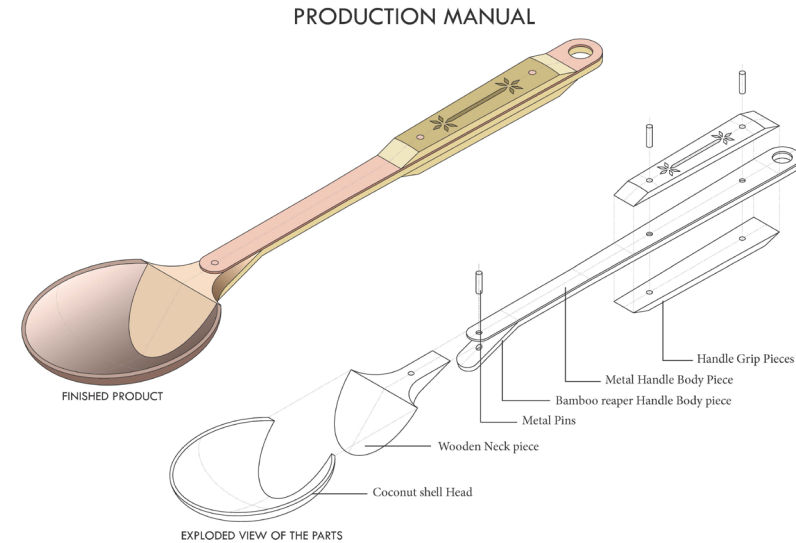
10.2. Jigs and other tools development

Development of jigs and additional tools were also looked at to help the standardization processes, accuracy and to save time in production.

A sanding bit which can be fit into a hand drill is developed [Figure 92] for sanding the inside of coconut shells. Also a jig for disc sander to grind the coconut shell to a desired angle and width is also designed [Figure 93]

10.3. Production manual

The final objective of the project was to develop a production manual for training. After breaking down the overall production process into various categories of tasks and processes involved in each of them, a production manual was developed explaining each step in production.



Task 1 - Wooden Neck Piece

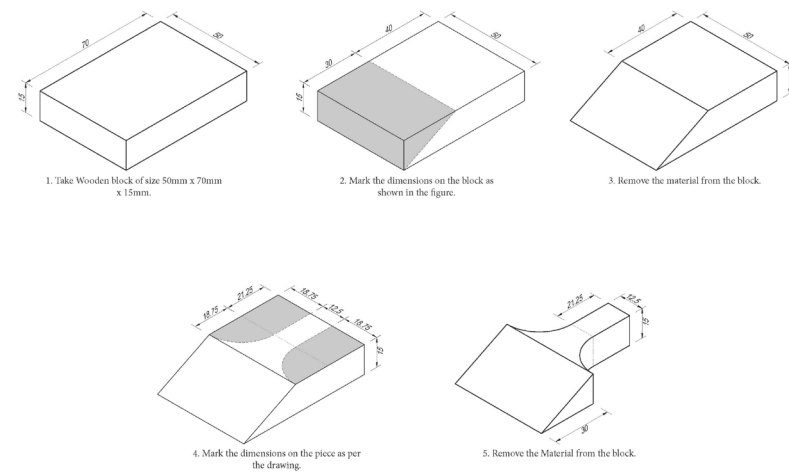


Figure 96. Production manual - Sample pages

11. REFERENCES

Image references

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Figure 1	https://static1.squarespace.com/static/5824e8ec9de4bb47a9cd5b3b/t/5b791b51758d46b6ff85dfb3/1534663630452/shutterstock_564483010.jpg?format=2500w
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