

BLENDING CRAFT AND TECHNOLOGY FOR SMART LIGHTING APPLICATIONS

PROJECT 3
INDUSTRIAL DESIGN 2017 - 2019

NIRMAL P J
176130009

GUIDED BY: Prof. SANDESH R



INDUSTRIAL DESIGN CENTRE (IDC), IIT BOMBAY,
POWAI, MUMBAI, MAHARASHTRA
400076

BLENDING CRAFT AND TECHNOLOGY FOR SMART LIGHTING APPLICATIONS

PROJECT 3
INDUSTRIAL DESIGN 2017 - 2019

NIRMAL P J
176130009

GUIDED BY: Prof. SANDESH R



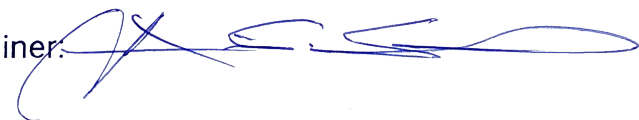
INDUSTRIAL DESIGN CENTRE (IDC), IIT BOMBAY,
POWAI, MUMBAI, MAHARASHTRA
400076

APPROVAL

This project titled as “Blending craft and technology for smart lighting applications” by Nirmal P J is approved in partial fulfilment of the requirement for the degree of ‘Master of Design’ in Industrial Design.

Guide: 

Chairman: 

Internal Examiner: 

External Examiner: 

DECLARATION

I hereby declare that this written submission represents my idea in my own words and were 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

ACKNOWLEDGMENT

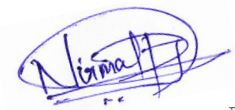
To my project guide Prof. Sandesh, For all his valuable inputs
and guidance throughout the project

To all other PD faculties, For their precious time and feedbacks
at every stage of the project.

To all the studio staff, For their help and assistance in the
studios.

To all my other friends and batch mates, For their constant
support and suggestions.

Finally To my Parents and God, For being there for me and
their immense support throughout.



CONTENTS

APPROVAL	I
DECLARATION	III
ACKNOWLEDGMENT	V
CONTENTS	VII
1. INTRODUCTION	01
2. CRAFT	03
2.1. Value of craft	04
2.2. Various crafts of India	05
2.3. Bamboo craft	06
2.4. Bamboo	07
3. TECHNOLOGY	09
3.1. Technology in craft	10
3.2. The system	12
3.3. Smart products	13
4. LIGHTING	15

4.1. Types of lighting	16
4.2. Source of light	17
4.3. Advantages of LED	18
4.4. Smart lighting	19
4.5. Components of smart lighting	20
4.6. Addressable LEDs	21
4.7. Single board Micro-controller	22
4.8. Other peripheral components	23
4.9. Arduino IDE	23
5. DESIGN DIRECTIONS	25
5.2. Blue-Sky Ideations	26
5.1. Blooming Lamp	26
5.3. Art & Music Lamp	27
5.4. Final design direction	27
6. DESIGN BRIEF	29
6.1. Project Statement	30
6.2. Objectives	30
6.3. Scope	31
6.4. Targeted Market Segment	32
6.5. Opportunities	33
7. IDEATIONS	35

7.1. Initial Ideations	36
8. INITIAL CONCEPTS	43
8.1. Concept 1	44
8.2. Initial Prototypes	50
8.3. Concept 2	51
8.4. Prototypes	60
9. CONCEPTS STAGE 2	63
9.1. Panel Form Refinement	64
9.2. Surface Treatment	64
9.3. Initial Table Lamp concepts	65
9.4. Initial Wall lamp concepts	69
9.5. Prototypes - Bee lamp	70
9.6. Prototypes - Taro Leaf Lamp	71
10. FINAL CONCEPTS	73
10.1. Final Range of Table and wall lamps	76
11. FINAL PROTOTYPES	81
12. PRODUCTION	91
12.1. Production process	92
12.2. Process documentation	93
REFERENCES	99

1. INTRODUCTION

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 by combining the craft with technology, and how this can lead to the betterment of the craft community of India and the livelihood conditions of the craft-person.

There are two primary aspects to this project; craft and technology. They are the two different ends of the spectrum. Craft products are generally very low tech, and all the high-tech products have zero connection to the craft. Combining craft and technology will work for each other's advantage. This will place craft products onto a new market segment and attract a broader range of user groups.



2. CRAFT

India is a multicultural country, enriched with lots of different innate craft practices associated with it. These craft practices are not only a way of expressing their cultural values, traditions, and religious beliefs, but also a means of livelihood for those people. The demand for these craft products is decreasing as the world is progressing, and many of those craft practices are getting lost in the way because of it. The craft-person are also forced to switch their carrier paths because they can't make a stable living from what they are doing. One of the main reasons for this is because those traditional craft products lack the refinement offered by a modern industrial product in-terms of its design and features.

2.1. VALUE OF CRAFT

We appreciate craft products by their values. We cannot compare them with industrial products and should perceive them differently, but many times people fail to fathom this.

To truly relish a craft product, one should try to understand and appreciate its values. Several values associated with a craft product are:

- * The human touch - They are made by hands.
- * The amount of hard work and effort.
- * Craftsmanship - The experience and skill set required.
- * Minor irregularities and imperfections - Each piece will be unique and one of a kind.
- * The cultural and traditional values, distinct style, and the indigenous techniques and knowledge of the use of materials.

2.2. VARIOUS CRAFTS OF INDIA

There are many different types of craft forms associated with various parts of the country. These craft forms can be broadly categorized based on the material they are specialized. Some of the common materials used for crafts are:

- * Wood
- * Metals like Brass, Copper, wrought iron, silver, and various other metal alloys
- * Bamboo
- * Terracotta
- * Fabric
- * Leather

Some of the famous craft practices in India with these materials are Etikoppaka Toys, Sankheda Furniture, Bidriware, Dhokra, Thanjavur Doll, Kolhapuri Chappals, etc.

2.3. BAMBOO CRAFT

Bamboo is one of the commonly used materials for crafts in various parts of the country. North-eastern states of India are renowned for bamboo crafts, but it is also used in almost every other states in the country. Bamboo crafts were practiced since ancient times. Most of the traditional bamboo craft products were primarily utilitarian-oriented; suited to local requirements and required for day to day use. Today there is a broad range of products available; both functional and decorative to satisfy the tastes and demands of the more sophisticated user groups.

2.4. BAMBOO

Bamboo is known for its eco-friendly attributes. A variety of bamboo species are used for various crafts and structural applications. It has a unique aesthetic and structural characteristic. It is also considered as a sustainable and renewable material due to its fast-growing nature. It is fairly an easy material to work with enough strength and durability. Its durability against the moisture and fungal attacks can be improved by various simple treatment methods. One of the most commonly used methods for treating bamboo is by boiling it with a mixture of boric acid and borax.

Bamboo is used in various forms in the craft. Weaving is an age-old technique used in traditional bamboo crafts. Thin strips of bamboo are used for this. It is also used in its natural solid form or made them into reapers for crafts. Bamboo is also used in timber form for industrial purposes



3. TECHNOLOGY

Technology is a huge part of our daily life. We use technology in numerous ways to make our life simpler. By simple definition, technology is the application of scientific knowledge into any form of practical purpose.

Technology is the collection of techniques, skills, methods, and processes used in the production of goods or services. The simplest form of technology is the development and use of basic tools. Developments in historic times, including the printing press, the telephone, and the Internet, have lessened the physical barriers to communication and allowed humans to interact freely on a global scale.^[1]

1. <https://en.wikipedia.org/wiki/Technology> (02/06/2019)

3.1. TECHNOLOGY IN CRAFT

We can use technology in two ways in a craft product. The first is to incorporate it in the production process by the use of machines and industrial processes. This can reduce the human effort, include parts in craft products which cannot be crafted or too difficult to craft by hand, or this can improve the efficiency of the production. This should be done very carefully so that the authenticity and values of the craft are not lost. There should be some balance between the application of technology and craft.

The second way is to incorporate technology within the product as an element to make it more sophisticated. This is a less explored area in the field of craft. The basic idea is to bring the craft products into the realm of smart products by incorporating digital technologies into craft products.

One of the advantages of combining technology into the craft in this way is that we will be able to position the craft product onto an upscale market segment. Since we are incorporating technology to add more value to a craft product, the craft doesn't lose its authenticity and value. This will take the craft products to the next level in this era of smart products.

3.2. THE SYSTEM

When we are combining craft and technology together in a product, we are building a collaborative system of designers, technicians, and craft-person. The technicians can be people from the craft community itself or anyone else who is interested to work with the community; this will be creating new job opportunities. The craft-person themselves can also get trained to be the technicians; providing them with the opportunities to learn a new trade.

The role of a designer will be to develop and test new designs and to critically analyse how it can be implemented and produced, based on market trends and user requirements. Once a new design is developed and optimized, short term training can be given to both the craft-person and the technicians, to execute the craft and technical aspects of the design respectively.

3.3. SMART PRODUCTS

The technology aspects we will be dealing along with craft in this project will be digital electronics and smart lighting technologies.

The term smart as a prefix to products is a fairly new concept. A smart product is a data processing object, which has several interactive functions. A smart product combines physical and digital interfaces. The usage of a smart product is interactive and requires also some cognitive work by the user.^[1] In smart products, physical worlds and digital representations become tightly interconnected, so that manipulations in either would have an effect on the other.^[2]

1. <http://www.uiah.fi/tmo/uideSIGN/index.html>

2. https://en.wikipedia.org/wiki/Smart_products



4. LIGHTING

Lighting is the use of light to illuminate a space or to create an aesthetic effect by an artificial or natural source of light. Based on this the lighting is categorized into natural lighting and artificial lighting. The area of interest in this project is artificial lighting. A lighting system comprised of three aspects; The light, controls, and services.

4.1. TYPES OF LIGHTING

Lighting can be broadly classified into three types based on its function. They are:

- * Ambient/ General lighting - A more diffused form of lighting used for general illumination of a space or an area or to create an ambiance.
- * Task lighting - A more concentrated form of light used to illuminate a specific activity area for a particular task or purpose.
- * Accent/ Decorative lighting - Light is being used as an object for decorative purposes or to create an aesthetic effect, rather than illumination purposes.

4.2. SOURCE OF LIGHT

A source of light is where the light is being emitted. There are various types of artificial sources are there. People were using oil lamps and gas lamps as the source of light before the invention of electric lamps. The source of light then evolved from incandescent lamps to fluorescent lamps to now LEDs.

LEDs were first invented at the beginning of the 20th century, but the first LEDs with practical use were invented in the 1960s. A lot of research and development have happened over the years and then the first white LEDs were developed in the 90s. The technology is then further developed over the years and today LEDs are the most advanced lighting technology of the 21st century.

4.3. ADVANTAGES OF LED

LEDs are the latest solution for lighting applications. They are available in a wide variety, shapes, and sizes. They can be purchased as individual chips, or strips or as pre-made lamps.

LEDs have a lot of advantages over other sources of lights.

- * They have low power consumption and are energy efficient
- * They have low heat emission and safer
- * They are resistant to breakage
- * They are long lasting
- * They are very small in size
- * They have great colour rendering index
- * The colour and of intensity of the light can be manipulated.
- * They have high design flexibility

4.4. SMART LIGHTING

The concept of smart lighting is fairly new. The development of LEDs made it possible to create smart lighting solutions. By using LEDs we will be able to manipulate its colour, intensity, mode of lighting, etc. through various digital platforms. Lamps with multiple smart features like remote access through the internet, connectivity to smartphones or smart home devices, etc. are available in the market.

Today all these technologies are easily accessible to everyone through various open-source hardware and software. They can be programmed as per their needs.

4.5. COMPONENTS OF SMART LIGHTING

Today smart lighting solutions can be developed using very minimal hardware components, but One should have some basic knowledge about coding and programming languages in order to use them for their advantage.

The minimum hardware components needed for creating smart lighting solutions are:

- * LEDs &
- * Single board Micro-controller

There may or may not have more components depending on the micro-controller being used and what are the additional features needed.



Fig 1. Neopixel strip

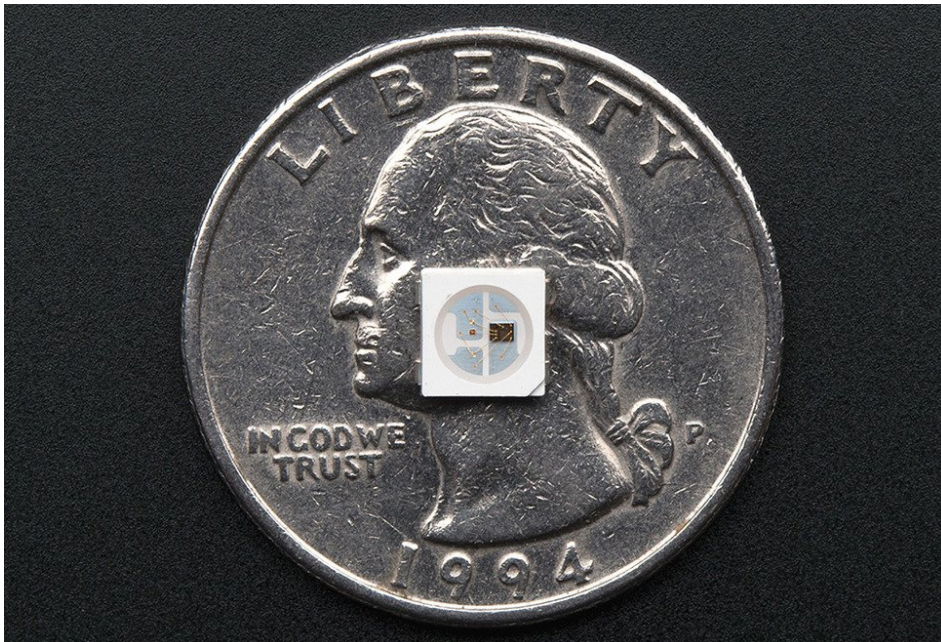


Fig 2. Single ws2812B 5050 led chip

4.6. ADDRESSABLE LEDS

The common types of LEDs used for smart lighting applications are addressable RGB LEDs. The most popular LEDs available in these type are WS2812B RGB LEDs. They are commercially available by the name of neopixels. These LEDs can produce any colour because they are comprised of red, green and blue LEDs in one single chip. They have a built-in driver, which enables us to control the RGB values of each LED individually in a strip or matrix. They can be used to create multiple lighting modes for both ambient lighting and decorative lighting purposes by manipulating their colour and intensity.

4.7. SINGLE BOARD MICRO-CONTROLLER

A single-board micro-controller is a micro-controller built onto a single PCB. This board provides all of the circuitry necessary for a useful control task: a microprocessor, I/O circuits, a clock generator, RAM, stored program memory and any necessary support ICs. The intention is that the board is immediately useful to an application developer, without requiring them to spend time and effort to develop controller hardware.^[1]

There are various types of single board micro-controllers are available today. One can use any of these depending on their needs. Most of them can operates the same way, but there are certain differences is in the amount of memory availability, number of I/O pins, size of the boards, etc.

1. https://en.wikipedia.org/wiki/Single-board_microcontroller

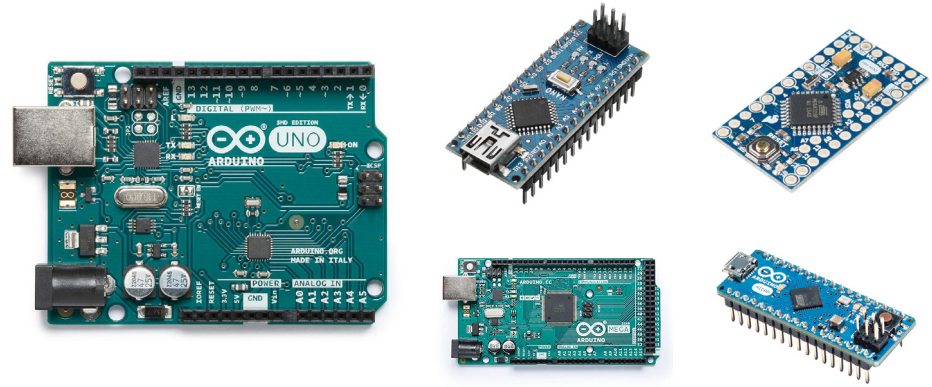


Fig 3. Various arduino development boards

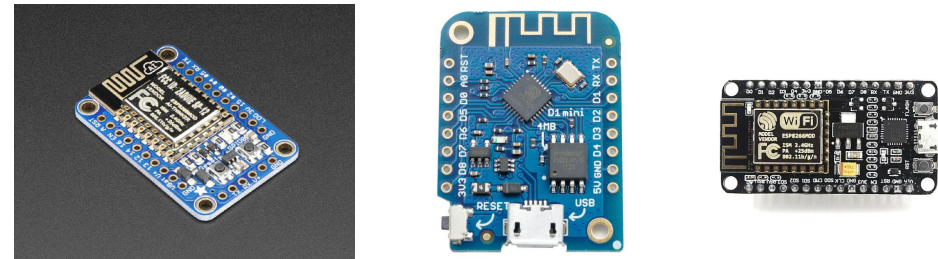


Fig 4. Various ESP8266 based development boards

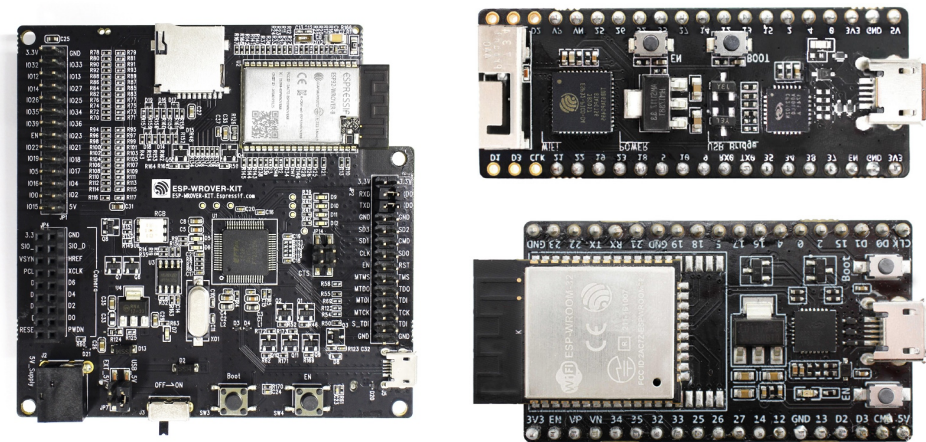


Fig 5. Various ES32 based development boards

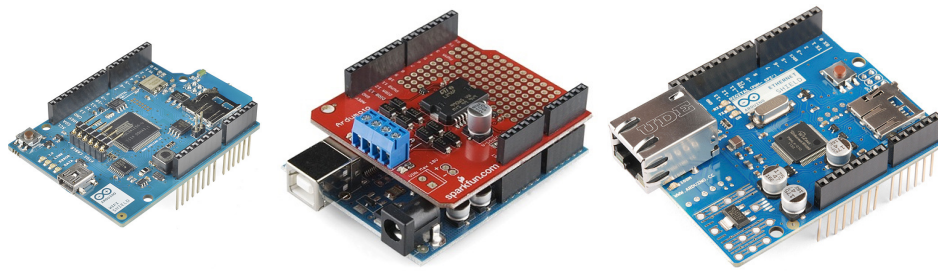


Fig 6. Various shields for arduino boards

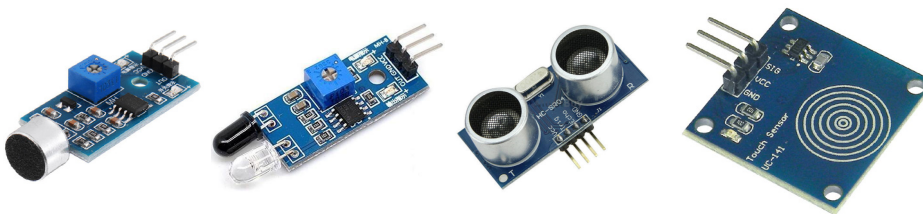


Fig 7. Various types of sensor modules

```

strandtest | Arduino 1.8.9 (Windows Store 1.8.21.0)
File Edit Sketch Tools Help
strandtest$
1 #include <Adafruit_NeoPixel.h>
2 #ifdef __AVR__
3 #include <avr/power.h> // Required for 16 MHz Adafruit Trinket
4 #endif
5
6 // Which pin on the Arduino is connected to the NeoPixels?
7 // On a Trinket or Gemma we suggest changing this to 1:
8 #define LED_PIN 6
9
10 // How many NeoPixels are attached to the Arduino?
11 #define LED_COUNT 60
12
13 // Declare our NeoPixel strip object:
14 Adafruit_NeoPixel strip(LED_COUNT, LED_PIN, NEO_GRB + NEO_KHZ800);
15 // Argument 1 = Number of pixels in NeoPixel strip
16 // Argument 2 = Arduino pin number (most are valid)
  
```

Fig 8. Arduino IDE interface

4.8. OTHER PERIPHERAL COMPONENTS

There are so many other peripheral hardware components like various sensors, WIFI/ Bluetooth modules, etc. are available to be used along with single board micro-controllers for additional features. These components are available as individual modules or they are available as easy to use shields which can be stacked on top of a particular development board.

4.9. ARDUINO IDE

The Arduino integrated development environment (IDE) is a cross-platform application that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, and also to other vendor development boards with the help of 3rd party cores.^[1]

1. https://en.wikipedia.org/wiki/Arduino_IDE

5. DESIGN DIRECTIONS

The broad directions identified as the initial direction for the project were:

- * Exploration in Bamboo craft by combining other materials like wood, metal, paper, etc.
- * Combine a 2D art-form with craft - Eg: Warli or Mural paintings of Kerala
- * Exploration in Bidri/ Dokhra craft

5.2. BLUE-SKY IDEATIONS

The first design direction was chosen to take forward and created few blue-sky ideations.

5.1. BLOOMING LAMP

The idea was to mimic the movement of a blooming lotus flower in a lamp form to create a visual interest.

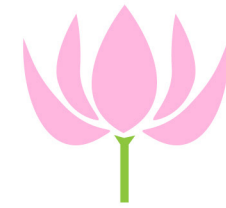
It can have be in a ceiling lamp/ table lamp/ floor lamp form. The movement can be automated or mechanical. The movement automation can be achieved by incorporating micro servo motors.

The lamp will have the following features:

- * RGB Lighting with various lighting modes
- * Movement and visual harmony
- * Smart connectivity and controls

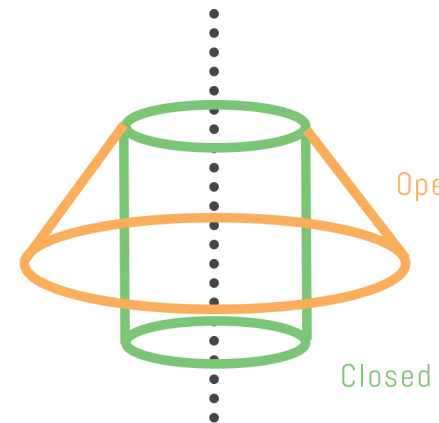


Bud

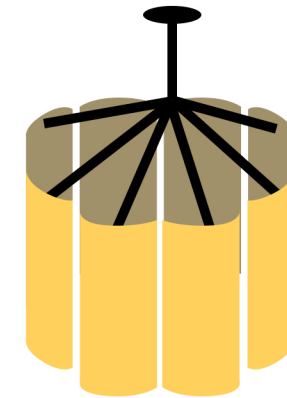


Bloom

Fig 9. Inspiration



Schematic Diagram

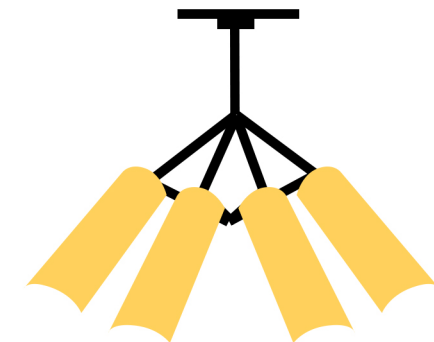


Schematic Lamp form

Fig 10. Schematic diagram of the movement and lamp form



Closed position



Open position

Fig 11. Movement of the lamp

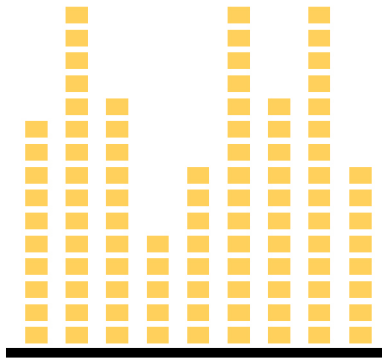


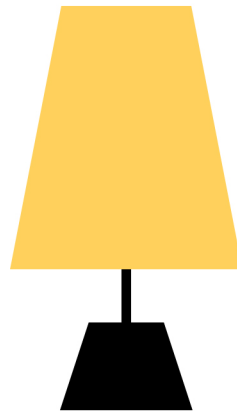
Fig 12. Music visualisation



Fig 13. Art panels



Ceiling



Table



Floor

Fig 14. Lamp forms

5.3. ART & MUSIC LAMP

The idea was to incorporate a music element and an art-form in the lighting. The lighting can be reactive to music and can create patterns based on the art-form to create an interest. The lamp can be of any form like ceiling lamp/ table lamp/ floor lamp. It can also have audio playback in table or floor lamp forms.

The features of the lamp will be:

- * RGB Lighting with multiple lighting modes
- * Music reactive lighting with art-forms
- * Audio playback (Only in Table/ Floor lamp forms)
- * Smart connectivity and controls

5.4. FINAL DESIGN DIRECTION

Final design direction is then narrowed down to an exploration of smart lighting with movement and visual harmony in bamboo craft.

6. DESIGN BRIEF

6.1. PROJECT STATEMENT

The project is to design and develop a new range of smart lighting systems with movement and visual harmony by combining craft and technology together using bamboo as the primary material and explore the possibilities.

6.2. OBJECTIVES

- * To design and develop new range of smart lighting systems with movement and visual harmony by combining craft and technology.
- * To explore new ways to create craft products using bamboo by combining it with other materials like wood, metal, handmade paper, etc.

6.3. SCOPE

The scopes of the project are:

- * To study and understand the culture and the techniques of the craft sector.
- * Study and understand smart lighting using LED and various existing technologies associated with it.
- * Design a range of products by combining these two aspects and optimize them for production.
- * Develop a protocol for training the new designs and the technical aspects to a craft-person.

6.4. TARGETED MARKET SEGMENT

Target Market segment of this project are:

- * Middle class and Upper middle class users
- * Smart home users/ enthusiasts
- * Craft product collectors/ enthusiasts
- * Souvenirs/ Gifts

6.5. OPPORTUNITIES

- * Combining craft and smart lighting technology is new – Creating a new market for craft products
- * Revival of craft sector and improving the craft person's livelihood.
- * New employment opportunities
- * Together technology and craft can create a more valuable product to the users - Both of them will work for each others advantage by adding values to one another.

7. IDEATIONS

7.1. INITIAL IDEATIONS

7.1.1. IDEATION 1

The first ideation was based on the initial blue-sky ideation of the blooming lamp. One of the primary focus of this ideation was to use Lighting panels made of a solid form of bamboo to represent flower petals. These panels are made of two thin layers of solid bamboo with LEDs embedded on to the rear panel. The idea for the movement mechanism was to use link joints and cables. The cables can be connected to a servo motor and can pull them to slowly open the panels to create the effect of a blooming flower. The panels can be made in various shapes to create variations and it can have multiple layers of panels as well.

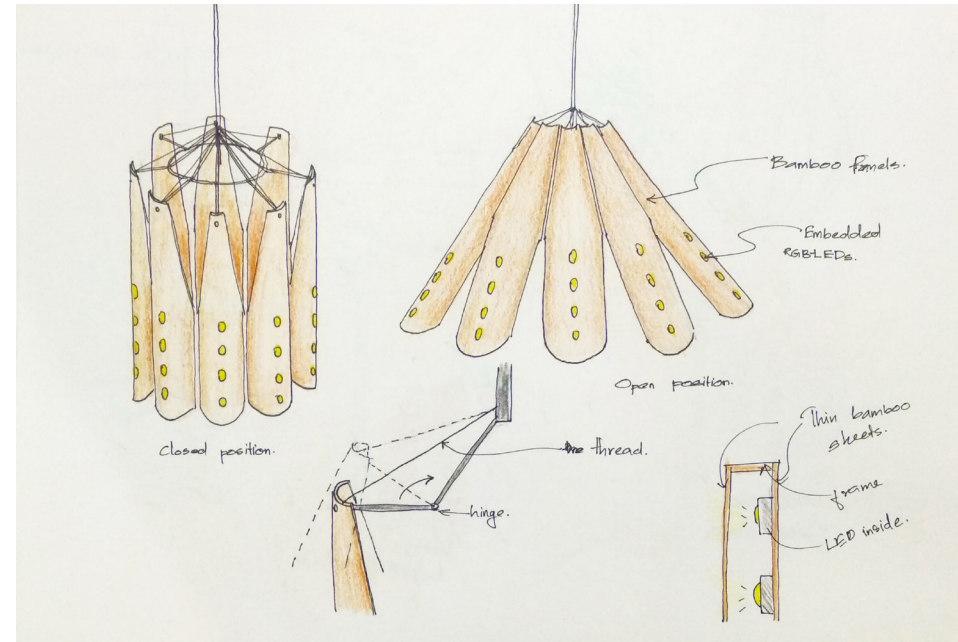


Fig 15. Ideation 1

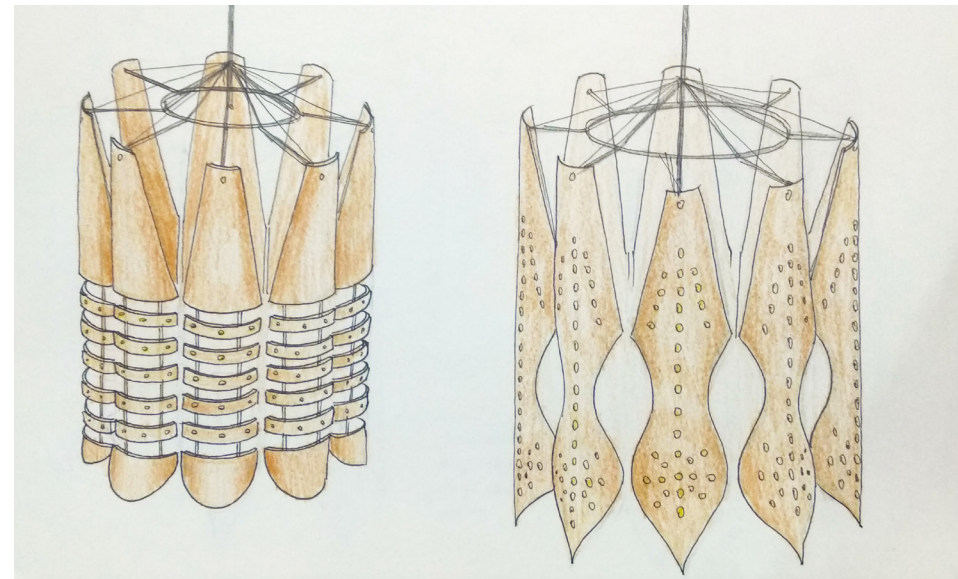


Fig 16. Formal variations

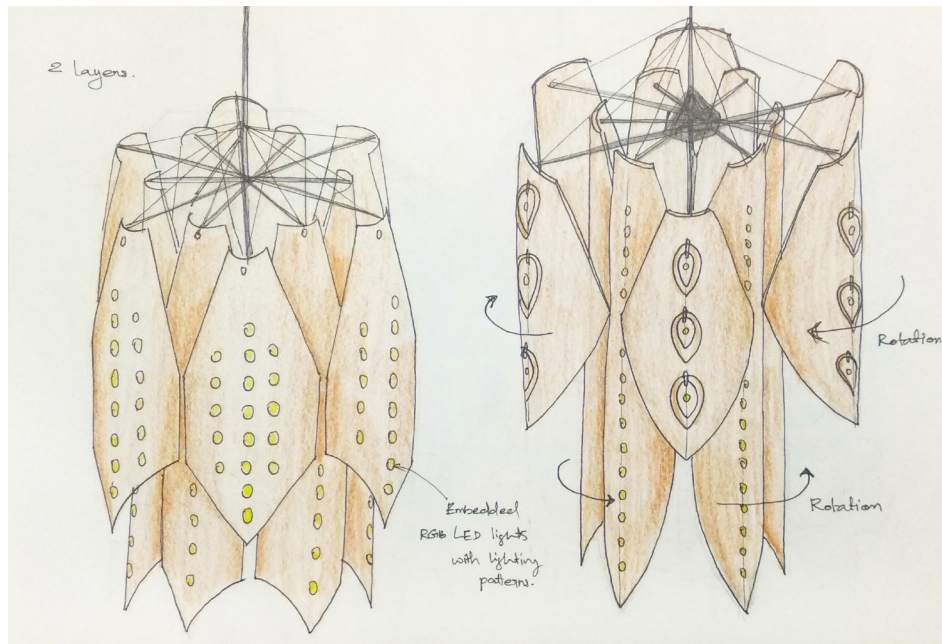


Fig 17. Formal variations with two layers

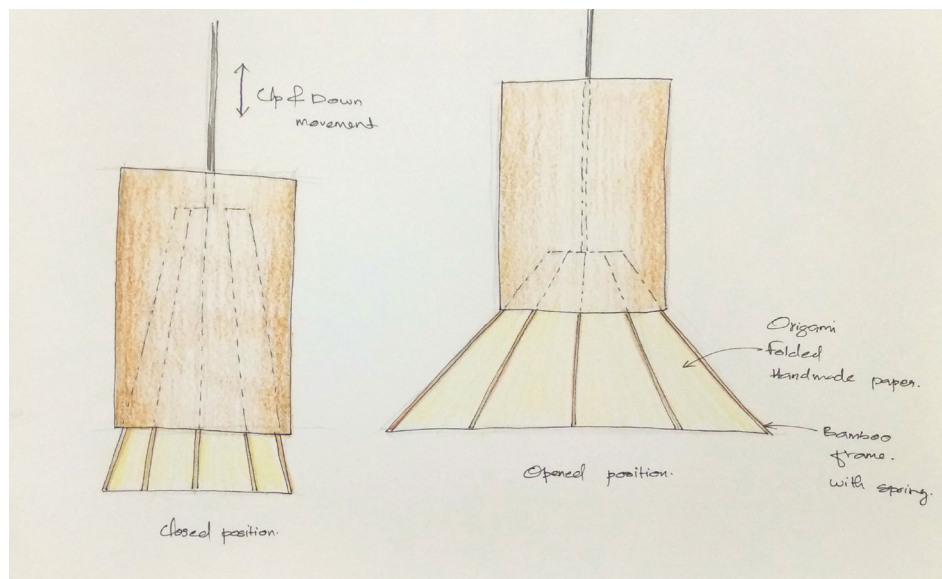


Fig 18. Ideation 2

7.1.2. IDEATION 2

The second ideation is based on the up and down movement of the panel and spring action. In this, the panel is spring loaded and they can move up and down in a static cylindrical form. The panel will open up and close as it moves down and up in the cylinder because of the springs. One of the ideas for the panel was to use paper folds. It can also be made of multiple panels of solid bamboo and multi-layered [FIG 19].



Fig 19. Ideation 2 Variations

7.1.3. IDEATION 3

The third ideation was to look at how to incorporate paper and solid bamboo together to create lighting panels. The idea was to create straight industrial cuts on solid bamboo and attach handmade paper on it to create panel forms. These panels can be then used to create light forms. The sketch shown in [FIG 20] is an idea for a table lamp.

Another variation to this idea was to use bamboo weaving technique to create mats and use them instead of handmade paper [FIG 21]. Other ideas were to use these panels to create chandeliers or use a single panel to create a simple table lamp.

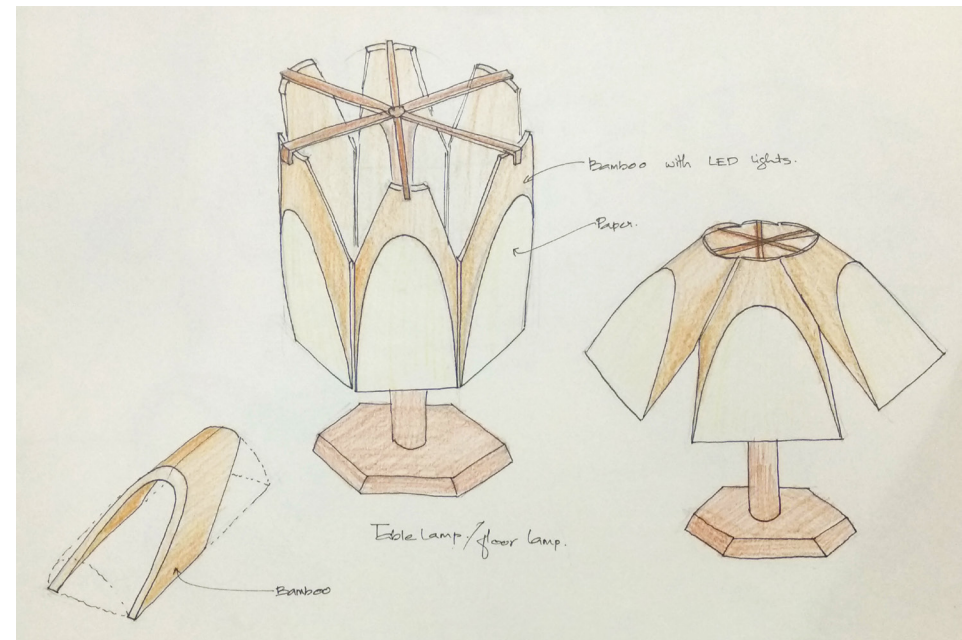


Fig 20. Ideation 3

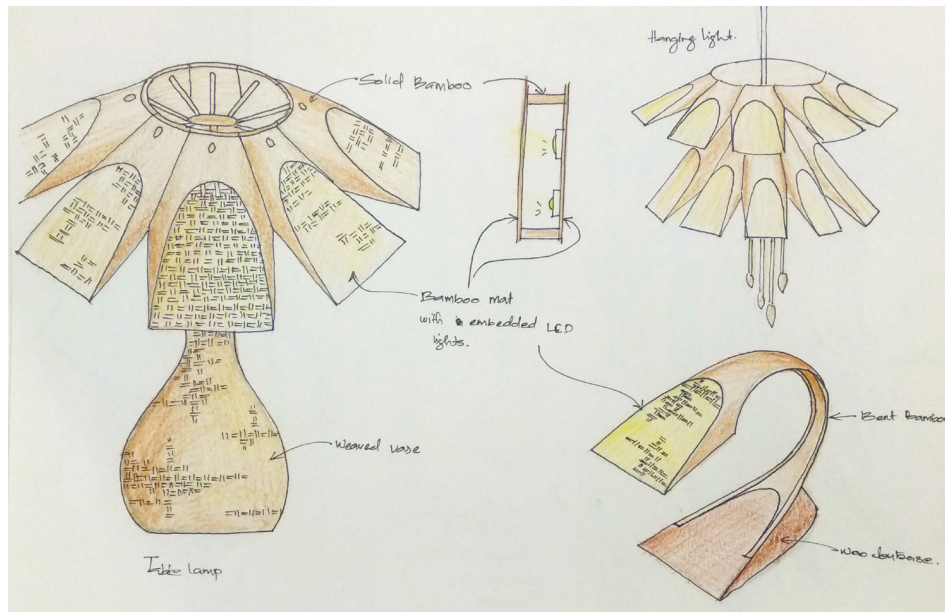


Fig 21. Ideation 3 variations

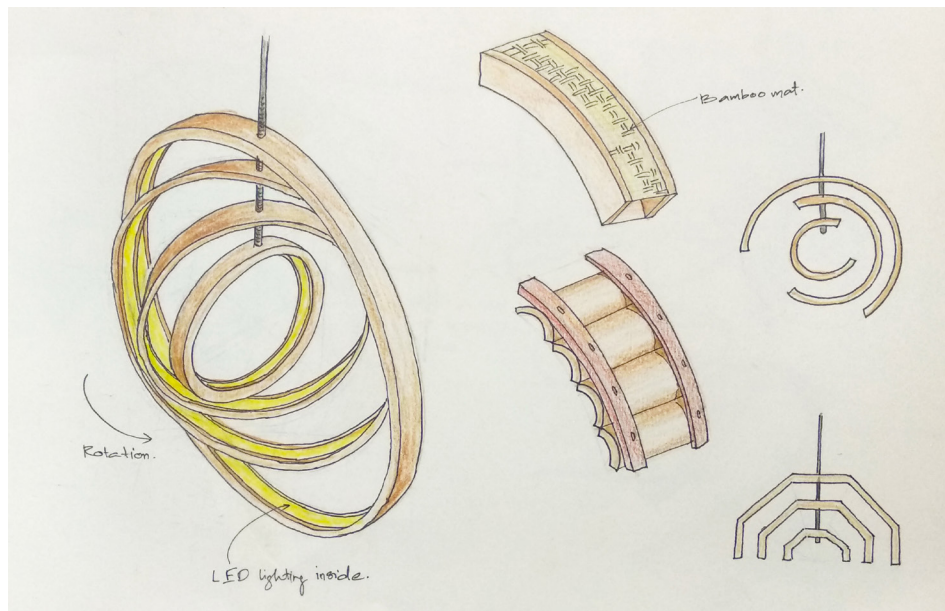


Fig 22. Ideation 4

7.1.4. IDEATION 4

The fourth ideation was based on a rotational movement principle. There will be multiple concentric rings with lights in them. These rings can rotate independently on a single axis; creating a harmonic movement. The idea for the rings was to use bamboo reapers and handmade paper. But it can also be of weaves instead of paper. Another idea for the ring was to use metal rings and attach solid bamboo pieces with LEDs embedded in them. The overall form of the lamp can also vary from circles to arcs or other geometric shapes.

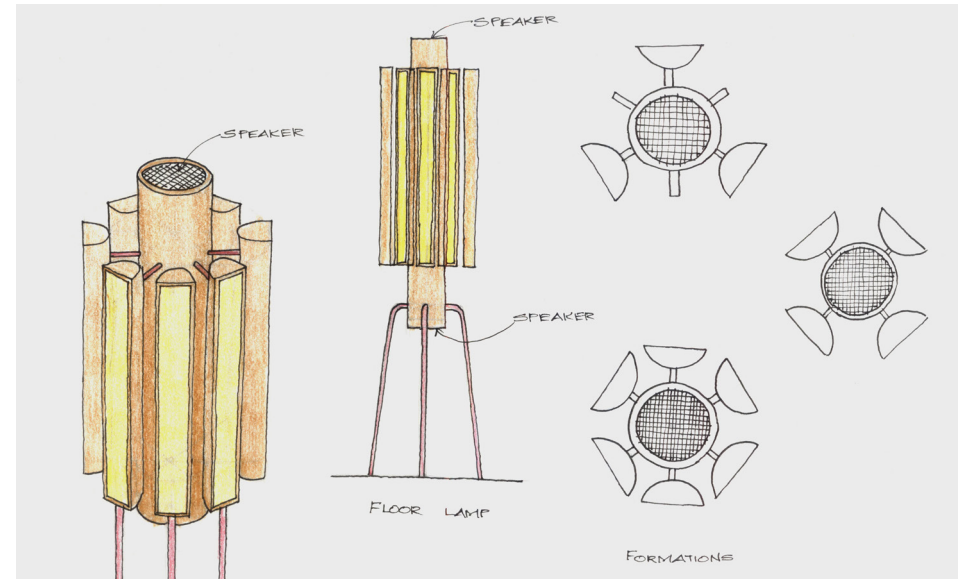


Fig 23. Ideation 5

7.1.5. IDEATION 5

This ideation was again an exploration into rotational movement. The idea is to have a floor lamp with a rotating head. The idea for the lighting panels can be using solid bamboo or bamboo reapers with handmade paper. Multiple configurations of the panels are shown in [FIG 23].

Another idea with the rotational motion was to create a spiral lamp configuration of panels with rotation. This will create an interesting visual pattern while rotating [FIG 25]

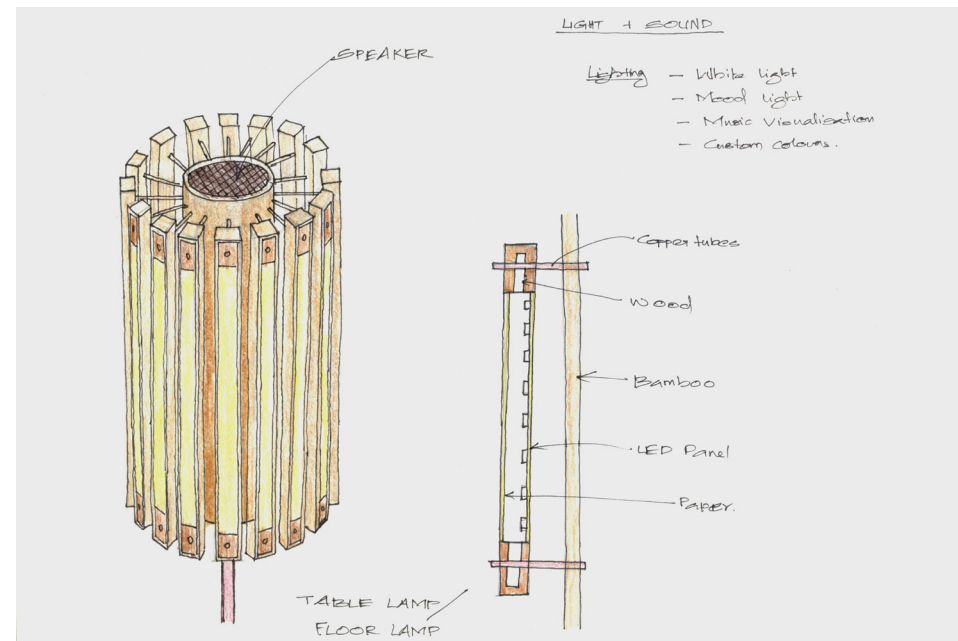


Fig 24. Ideation 5 formal variation

7.1.6. IDEATION 6

This idea was to create a wave movement animation using a cam mechanism in a table lamp. The lamp can also have Wireless speakers for audio playback [FIG 26].

Another idea using the same movement character in a chandelier is shown in [FIG 27]. The lamp will create a harmonious sine wave movement.

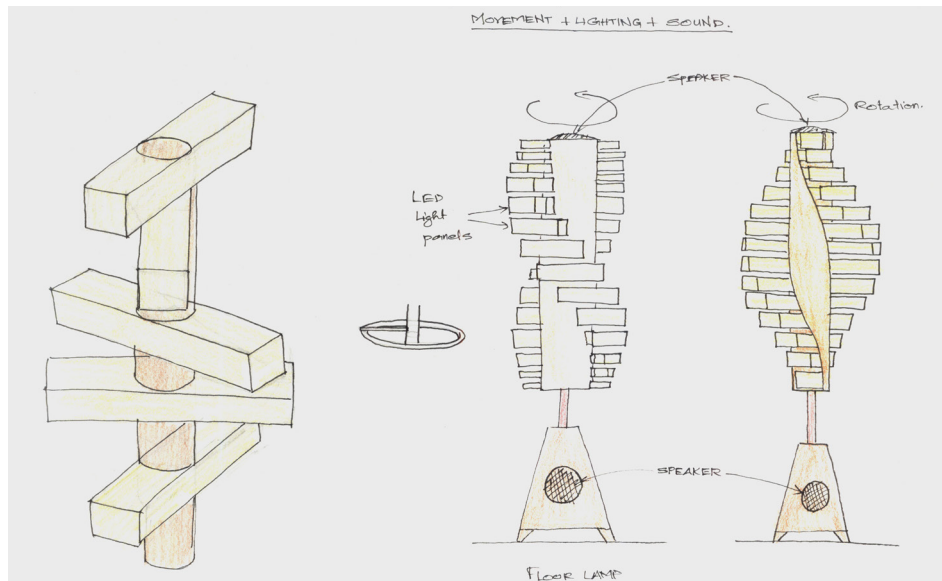


Fig 25. Ideation 5a

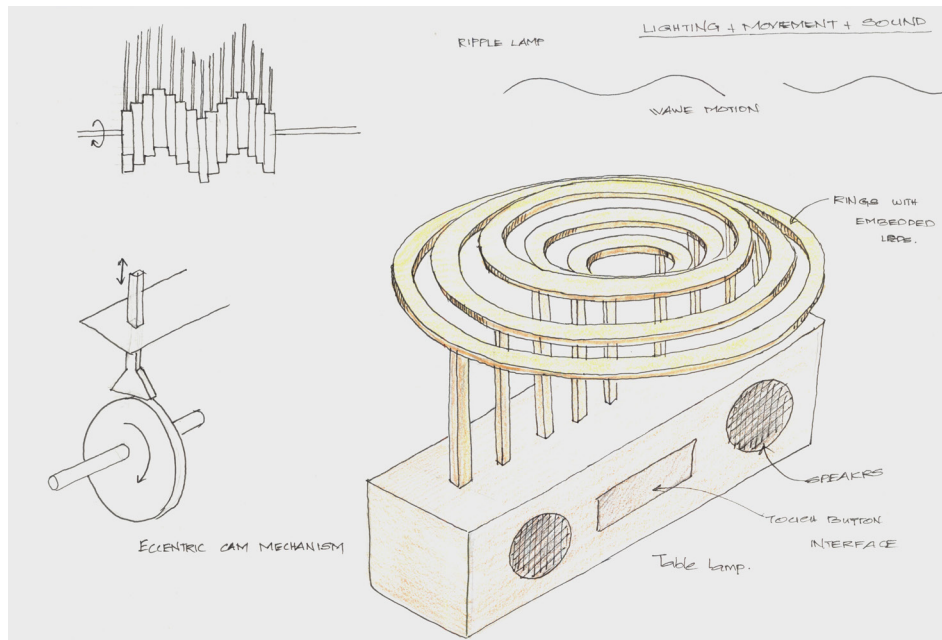


Fig 26. Ideation 6

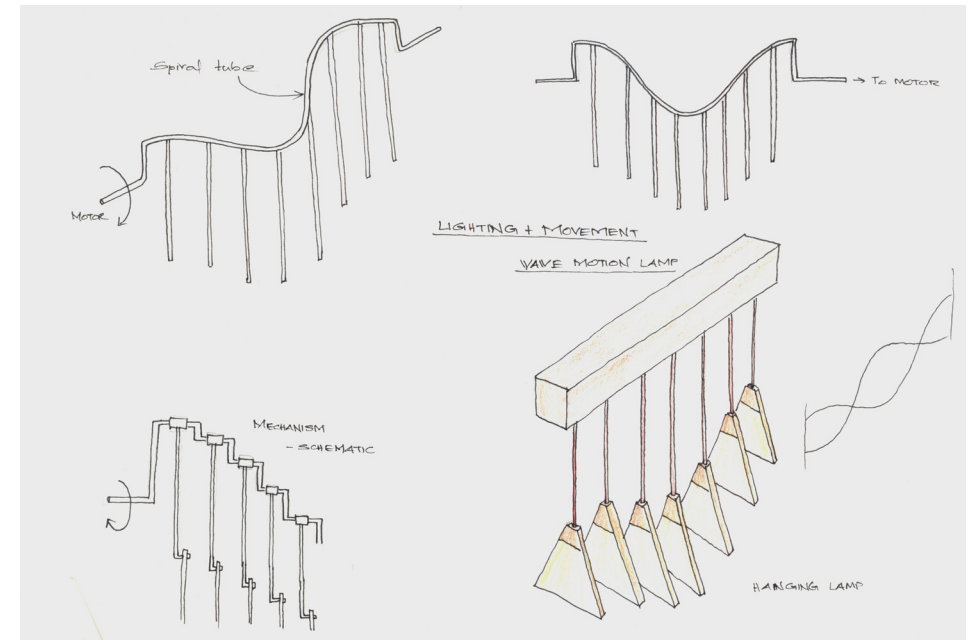


Fig 27. Ideation 6a

8. INITIAL CONCEPTS

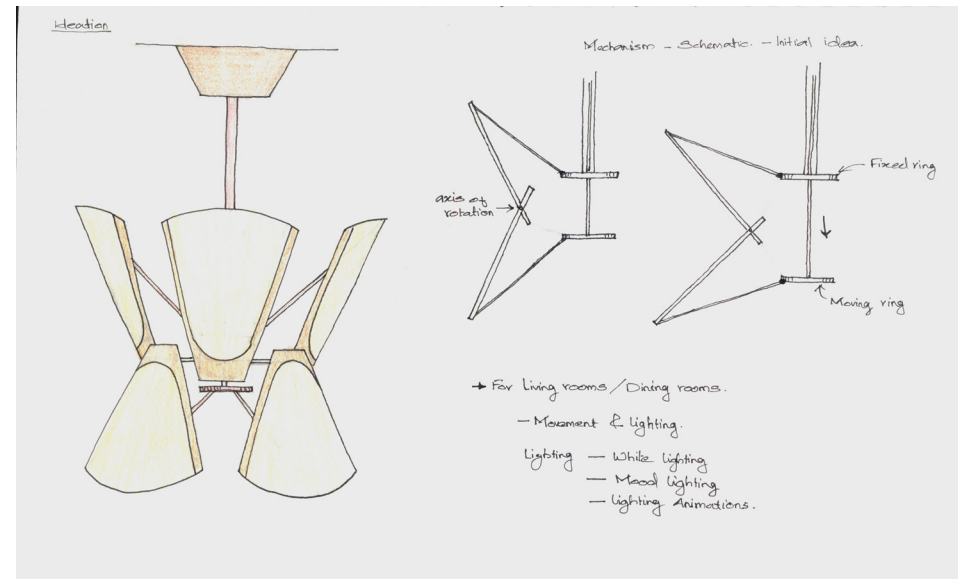


Fig 28. Concept 1

8.1. CONCEPT 1

This concept was primarily based on ideation 3. The idea of the panel is taken to develop further into a concept. The idea was to create a two-layered chandelier which works with a scissor mechanism. A schematic of the mechanism and how it is attached to the servo motor is shown in [Fig 29]. [FIG 30] shows the details of the panel. The panel contains two layers of handmade paper on both sides of the bamboo. LEDs are embedded on the inner paper panel to create a diffused lighting. A quick 3D model was also developed with a schematic visualization of the mechanism and movement [FIG 31 & 32].

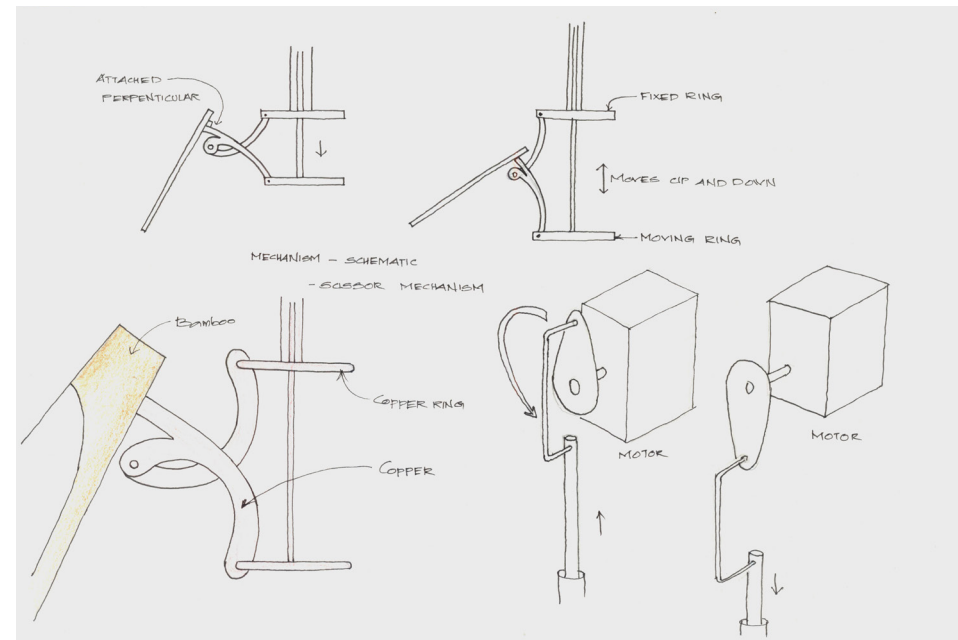


Fig 29. Schematic of the mechanism

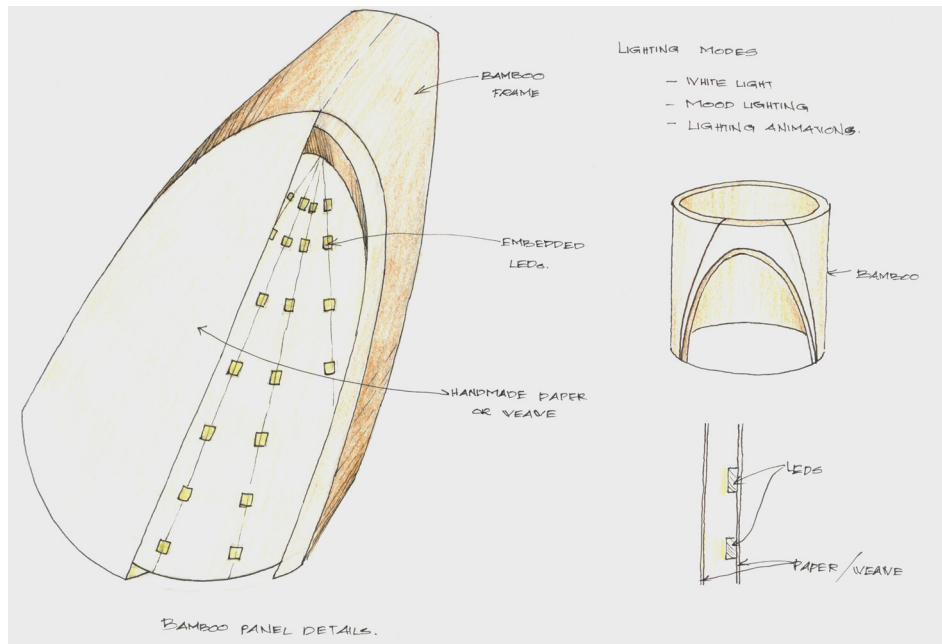


Fig 30. Details of the light panel

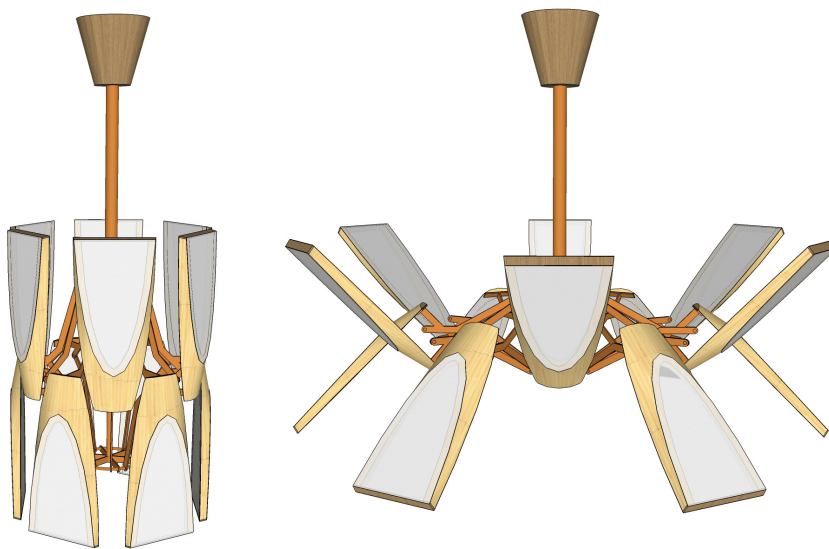


Fig 31. 3D models showing the arrangements and movement

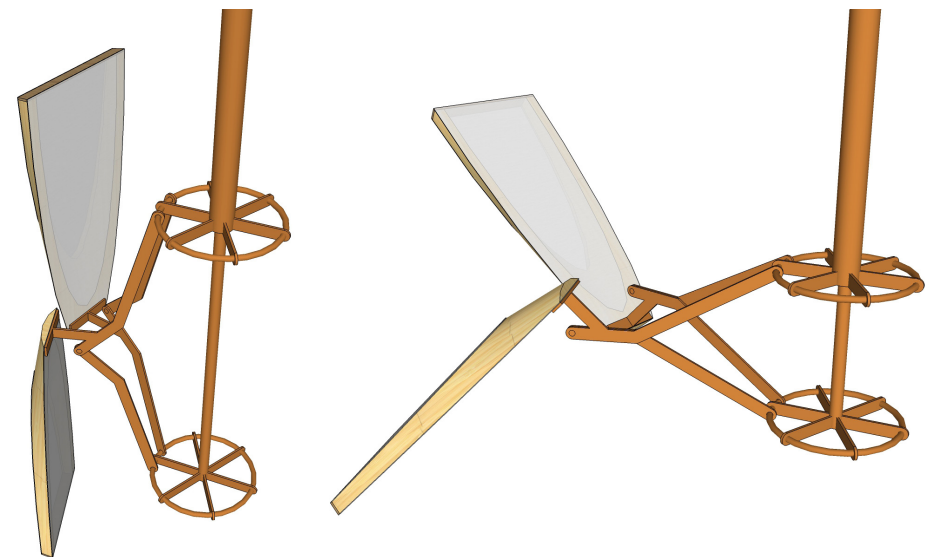


Fig 32. Schematic 3d Model of the mechanism

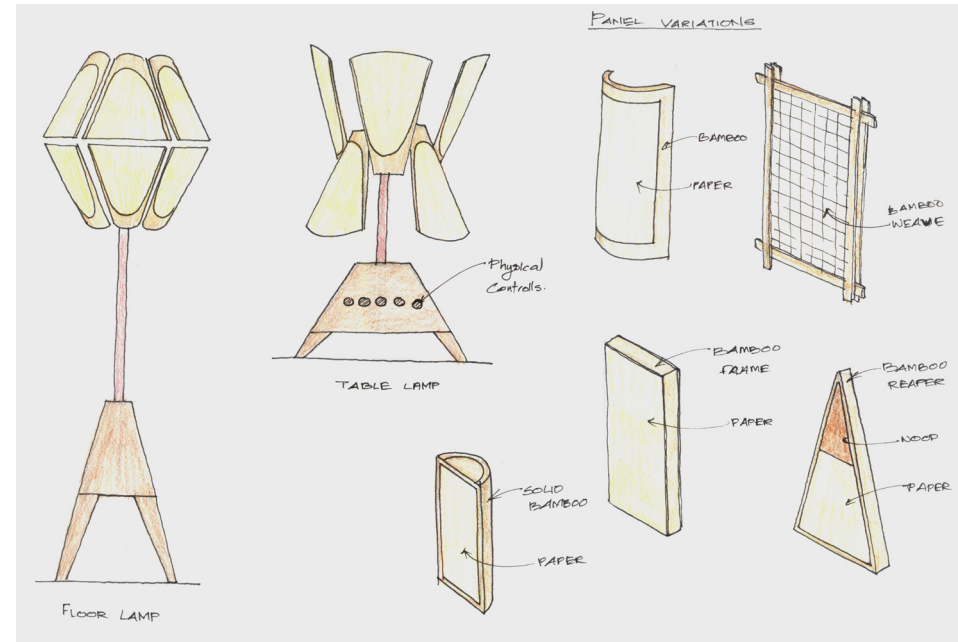


Fig 33. Ideas for table lamps and floor lamps and various panel designs

Ideas for other types of lamps like a table lamp and floor lamp using these panels were looked at. More variations of panel designs were also explored through sketches [Fig 33].

Another idea was to look at a larger lighting system by combining two or more lights in various formations and have synchronous harmonious movement [FIG 35].

Another important thought was to look at what could be the smart features of the lamp and a schematic mobile interface with various controls was also developed. [Fig 36]

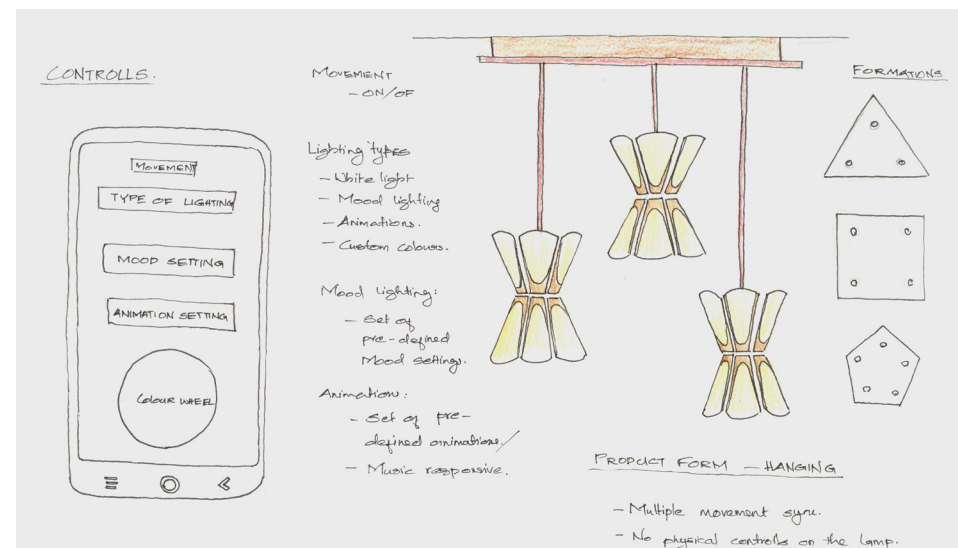


Fig 34. Ideas for mobile connectivity and multiple lamp configurations



Fig 35. Multiple lamp configurations

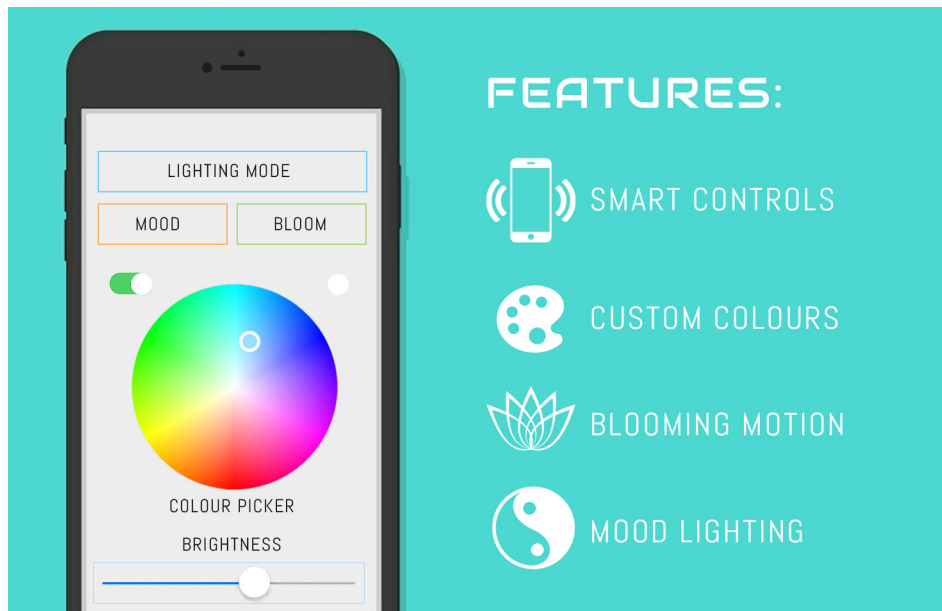


Fig 36. Mobile interface and smart features

The lamp will be able to control through a mobile application.

The features of the lamp will be:

- * Smart controls using mobile devices
- * Custom colour selection
- * Mood lighting
- * Blooming motion

There will be predefined lighting modes and mood lighting options to set different ambiance and aesthetics. One can also set their own custom colour lighting using the colour wheel. The brightness of the lighting can also be adjusted using the slider.

Multiple formal variations of the design were also explored through sketches and 3D models.

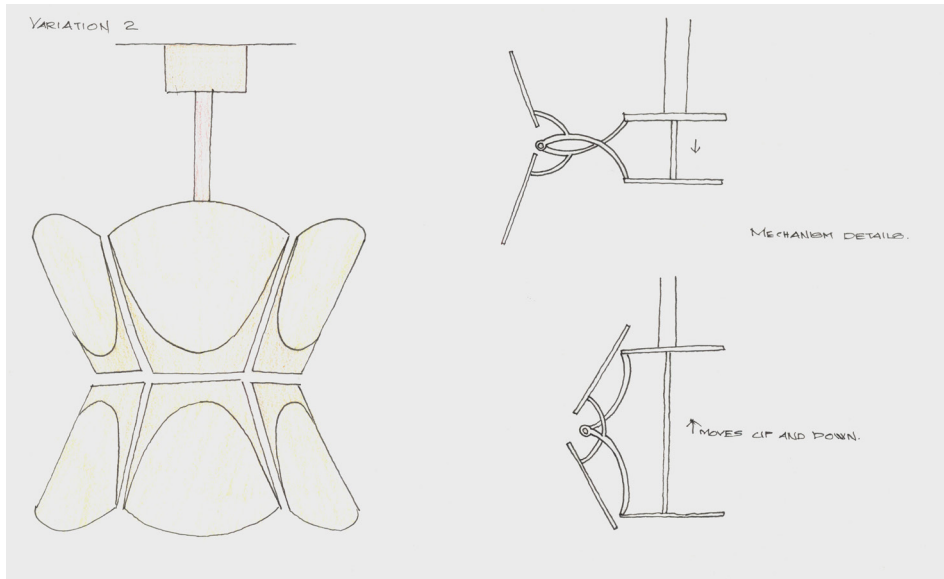


Fig 37. Formal variation 1

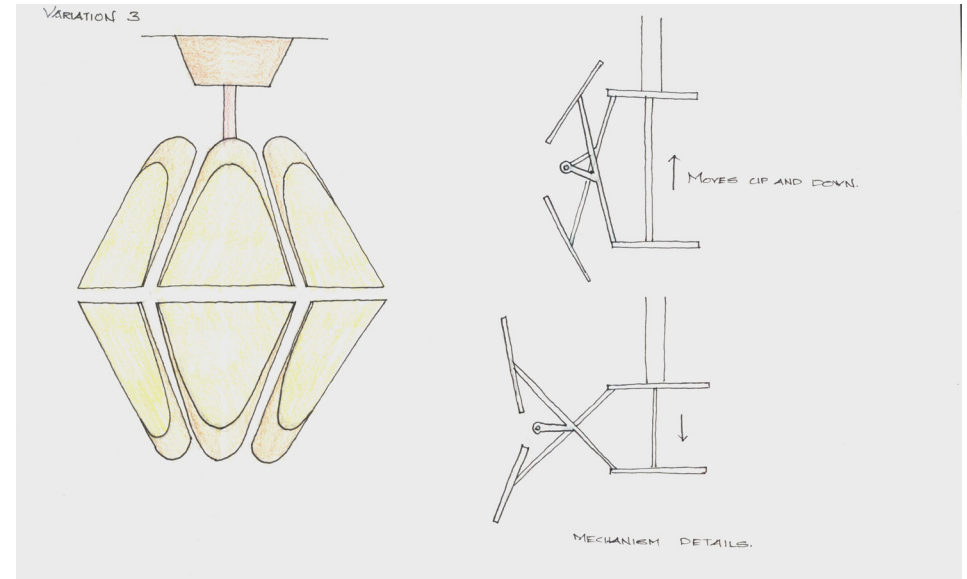


Fig 39. Formal variation 2

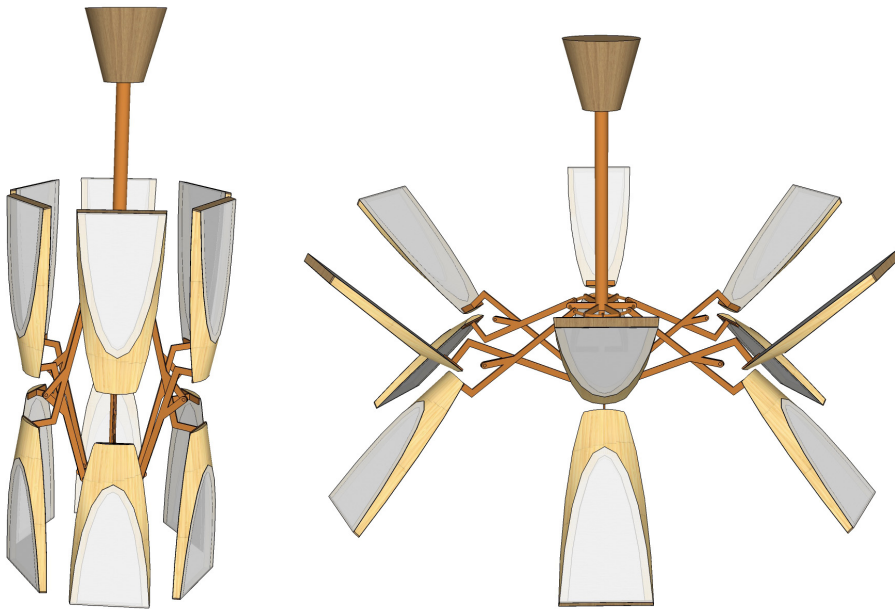


Fig 38. Formal variation 1 3D model



Fig 40. Formal variation 2 3D model

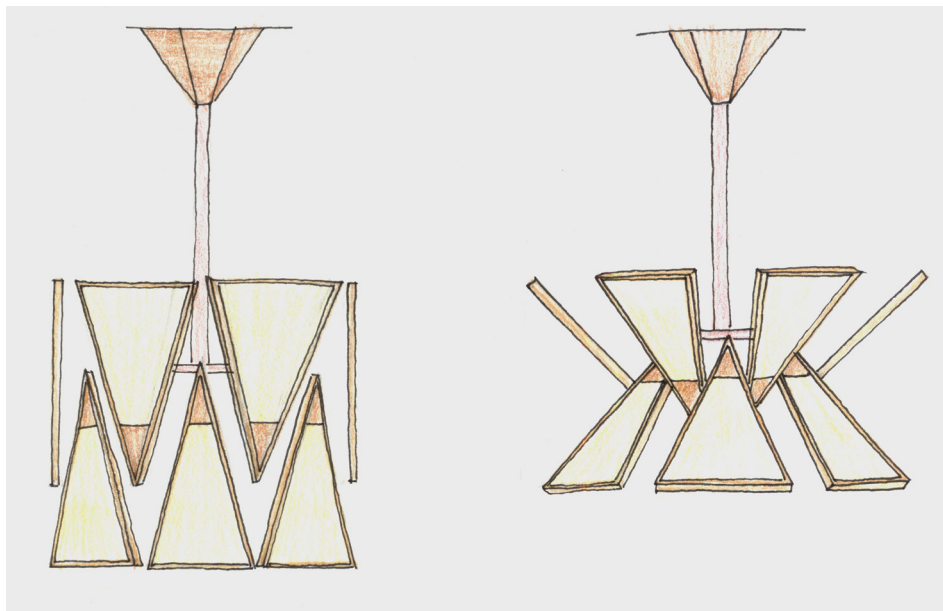


Fig 41. Formal variation 3

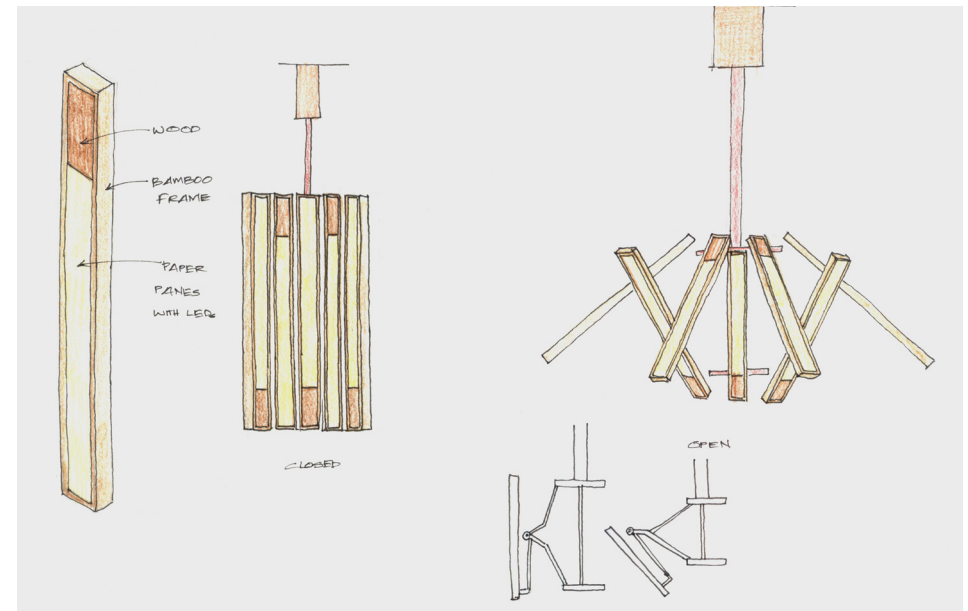


Fig 43. Formal variation 4

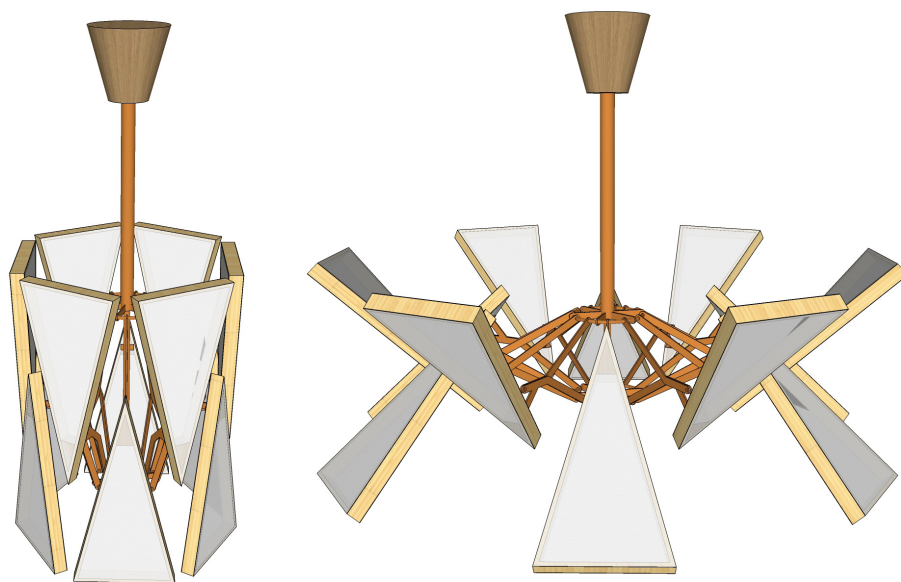


Fig 42. Formal variation 3 3D model



Fig 44. More formal variations in 3D



8.2. INITIAL PROTOTYPES

Few initial prototypes of various types of panels were made using bamboo and paper to get a hands-on feel of the form [FIG 45].

Fig 45. Initial prototypes of the panels

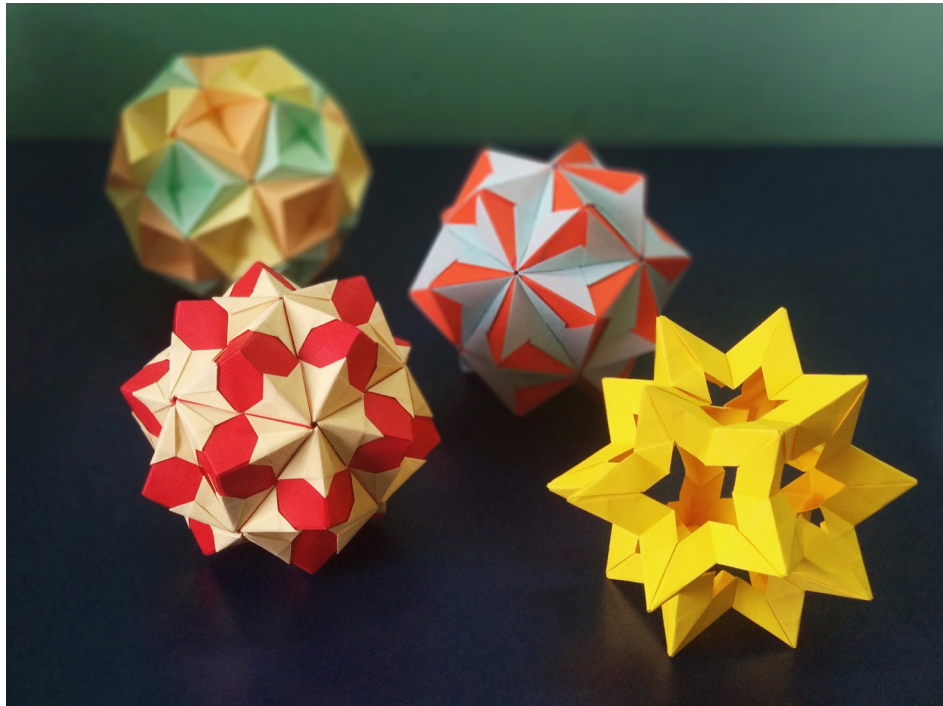


Fig 46. Modular origami

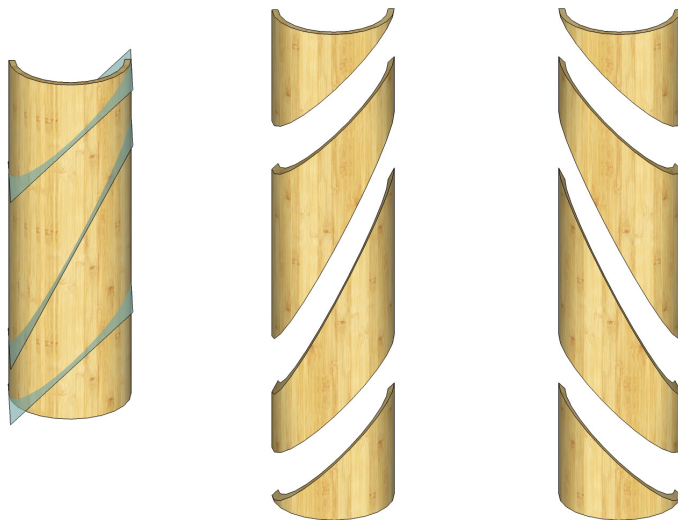


Fig 47. Various cuts to create different modules

8.3. CONCEPT 2

After analysing the initial concept, it is found that the concept is lacking the aesthetic qualities and novelty in the use of material and forms. A new idea for the panels was then attempted.

8.3.1. IDEA OF MODULARITY

This idea is inspired by the concept of modular origami. In modular origami, complex 3-dimensional forms are constructed using one or two types of simple modules. These modules are made separately and then interconnected to create the overall form.

This concept of modularity is applied to create modular forms in solid bamboo. The objective was to look at various industrial cuts in solid bamboo to create basic module which can be then combined to create other forms.

8.3.2. MODULAR UNITS IN SOLID BAMBOO

The exploration was done using 3D modelling as it is easy and quick to explore possibilities.

A half split of bamboo is taken as a base module and attempted to make cuts of various angles and dimensions [FIG 49 & 50]. These forms then attached together to create larger modules [FIG 48]



Fig 48. Combine simpler modules to create complex forms

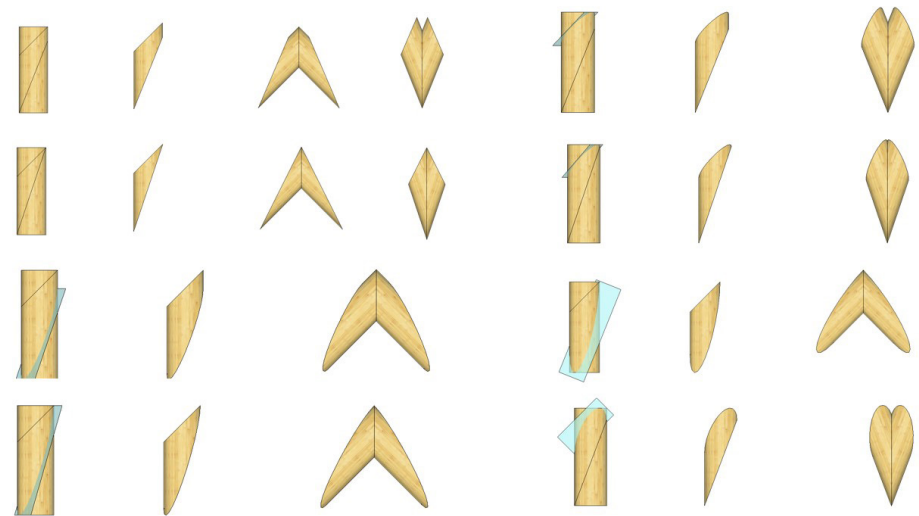


Fig 49. Various cuts and resulting modules and combinations

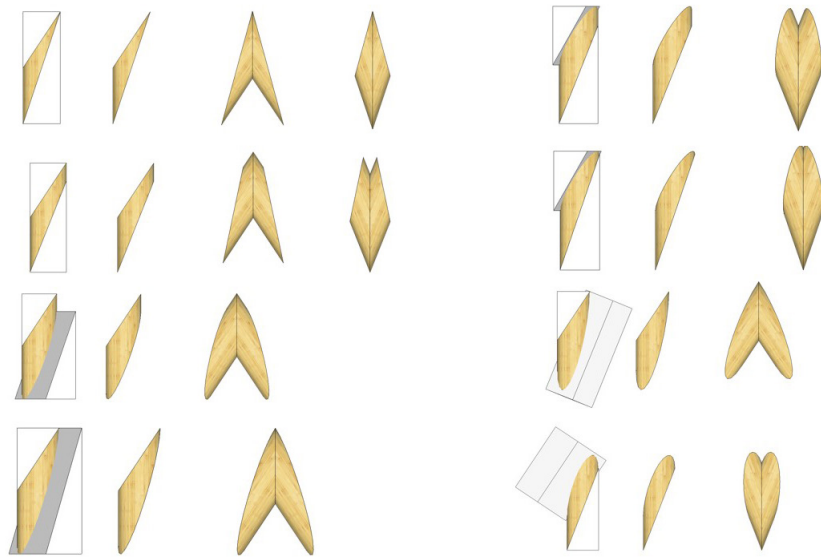
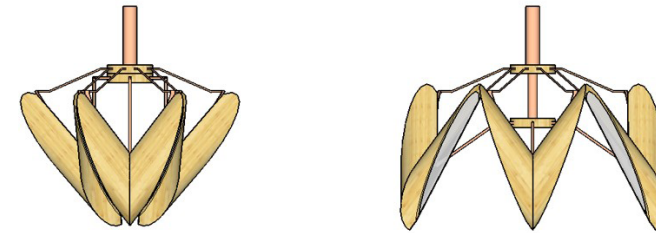


Fig 50. Various cuts and resulting modules and combinations

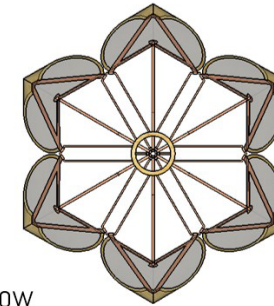
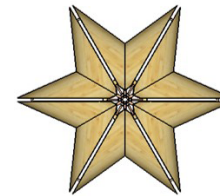


Fig 51. Prototypes of the models

A few prototypes of few of the different forms were made [FIG 51]. These forms opened a new direction to look at the lamp forms and found promising and novel. We decided to explore further in this direction.



Elevations

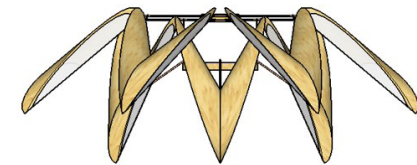


View from below

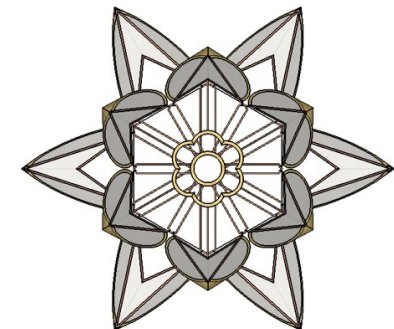
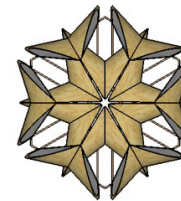
Fig 52. Chandelier - Concept 1

8.3.3. CHANDELIER

This concept is a combination of some of the previous ideas. The primary idea was to use the modular panels and to create a chandelier. The chandelier can open and close, creating a blooming motion. There were two variations to this concept with one layer and two layers of panels.



Elevations



View from below

Fig 53. Chandelier - Concept 1a

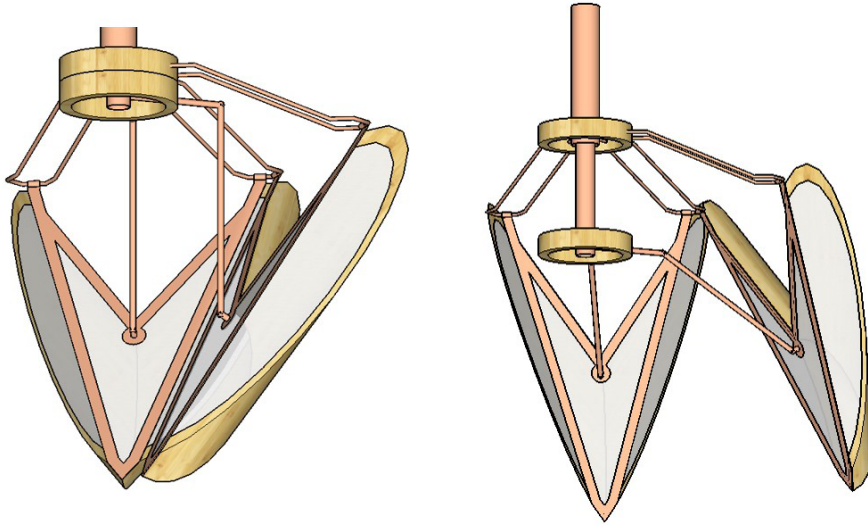


Fig 54. Moment mechanism

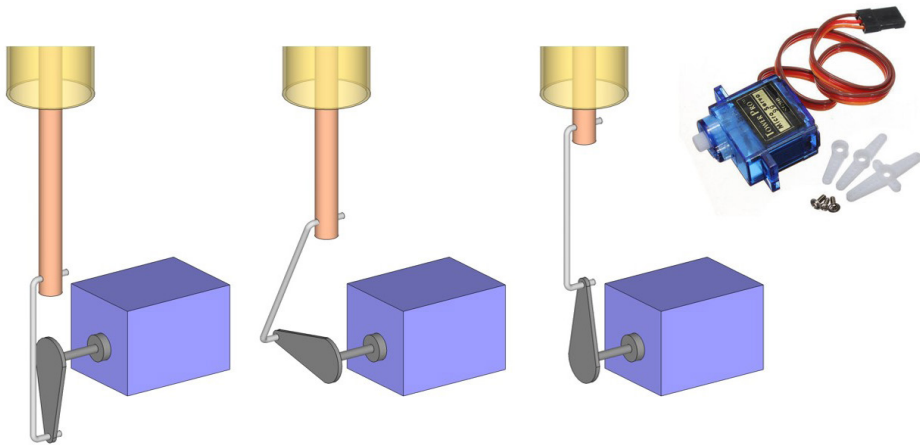


Fig 55. Details of the servo motor

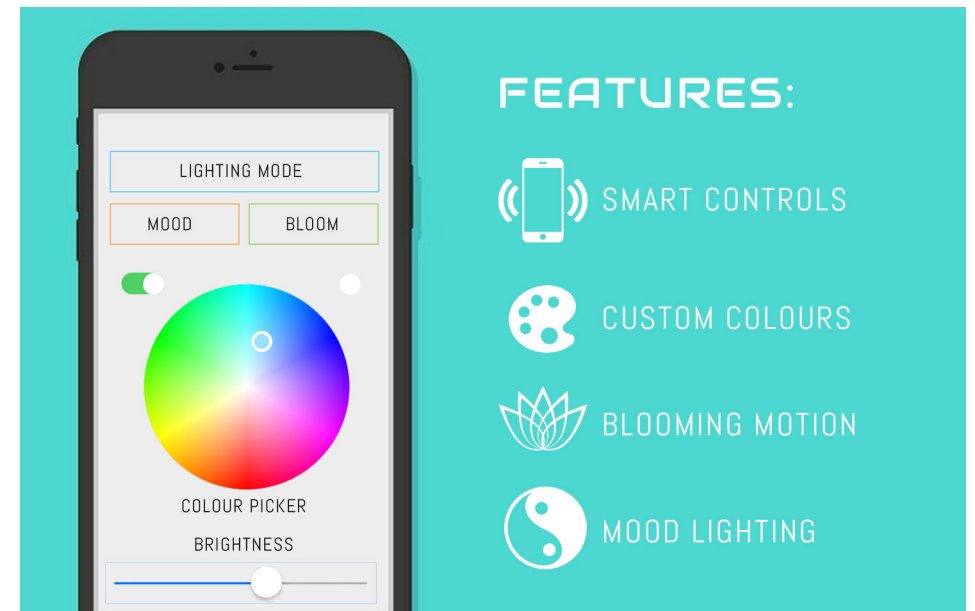


Fig 56. Mobile interface and smart features

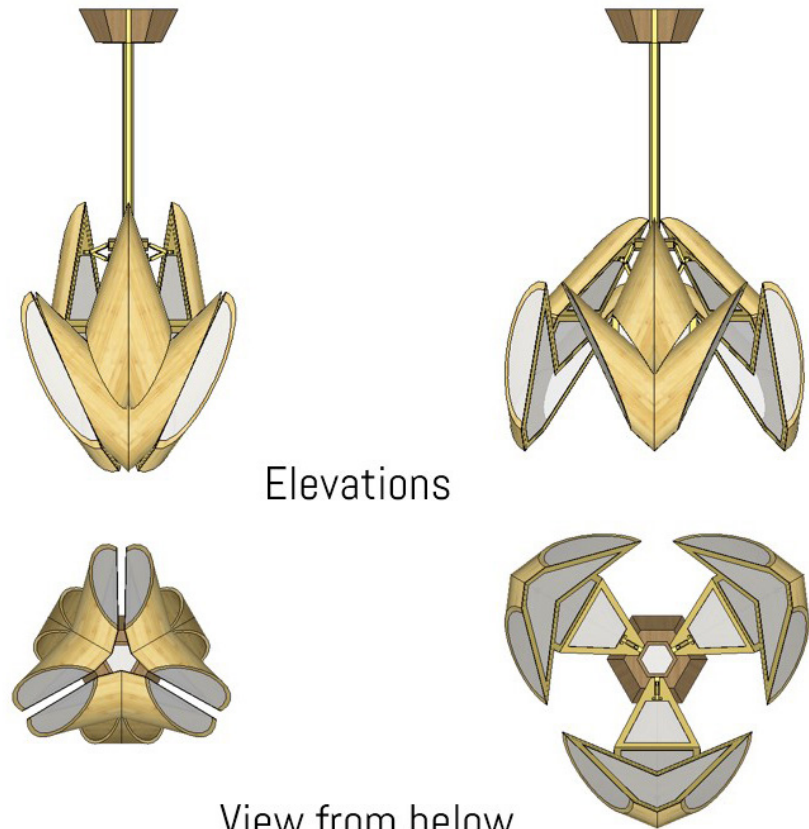


Fig 57. Combinations of multiple panels

8.3.4. FORMAL VARIATIONS

Many formal variations to concept 1 were attempted. One of the ideas was to try combining two types of modules to create one panel [FIG 57 & 58]. Another idea was to use independent modules to create lamp forms [FIG 62 & 63]

A new idea in these variations was to use small C sections to make the mechanism [FIG 59]. The thought behind this was to use them as a conduit for the wires. All the ideas of movement and technology are the same as concept 1.



Elevations

View from below

Fig 58. Chandelier - Formal variation 1

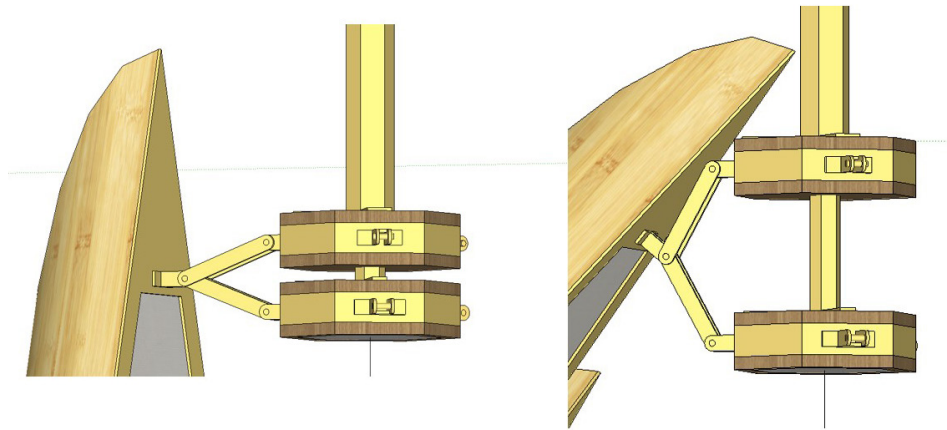
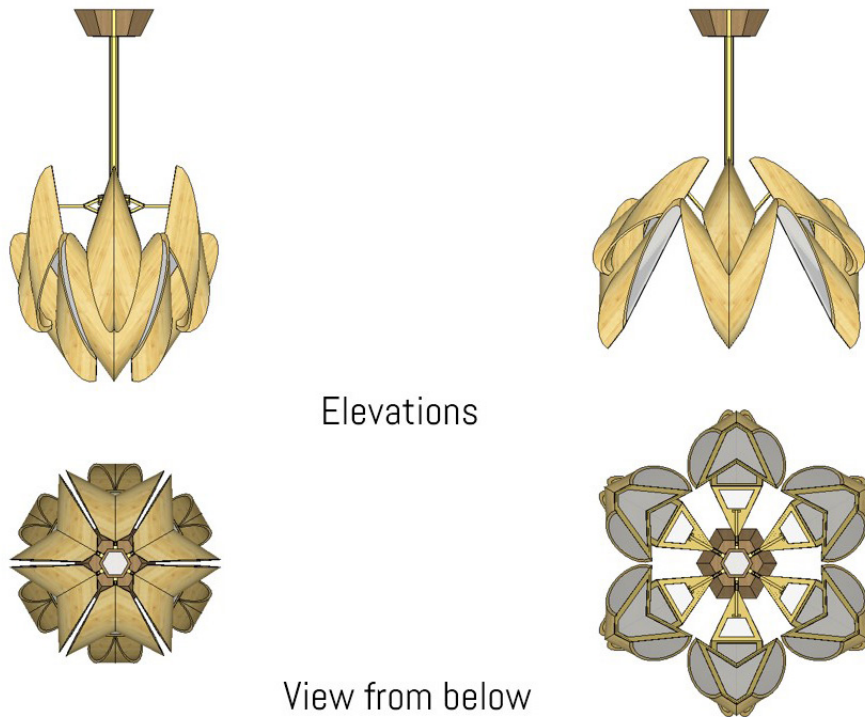
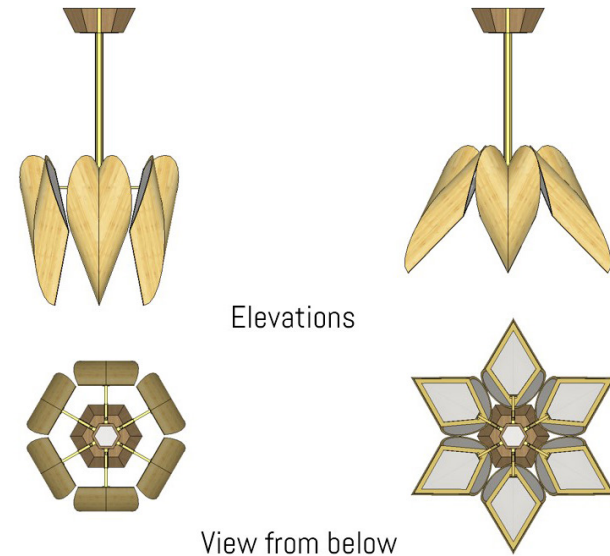


Fig 59. Mechanism using c sections



View from below

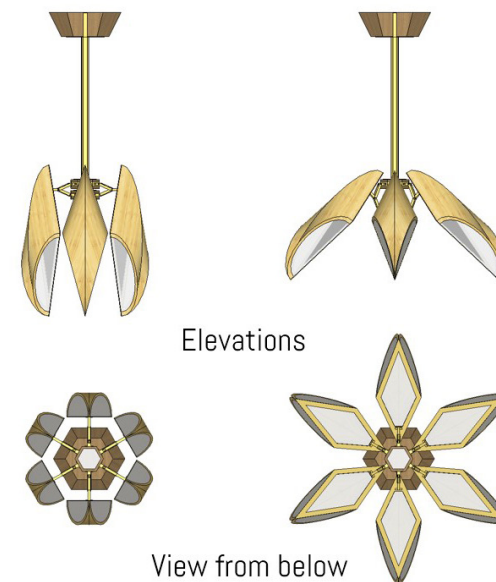
Fig 60. Chandelier - Formal variation 2



Elevations

View from below

Fig 61. Chandelier - Formal variation 3



Elevations

View from below

Fig 62. Chandelier - Formal variation 4

8.3.5. FLOOR LAMPS

These concepts were also an extension to concept 1. The idea was to use the modules to make table lamps. Three various ideas using different panels were attempted.

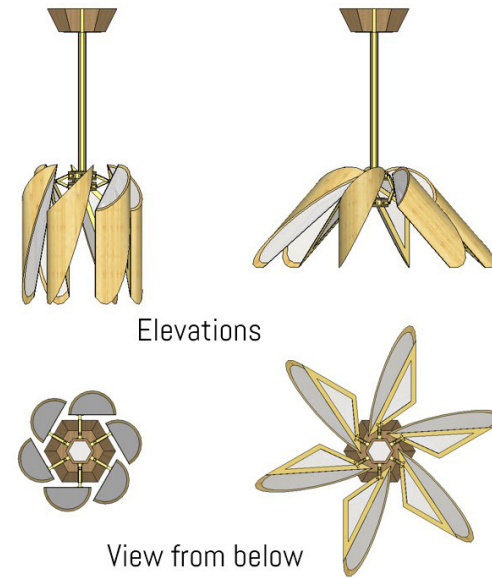


Fig 63. Chandelier - Formal variation 5



Fig 64. Concept 2 - Floor lamp



Fig 65. Floor lamp - Formal variation 1

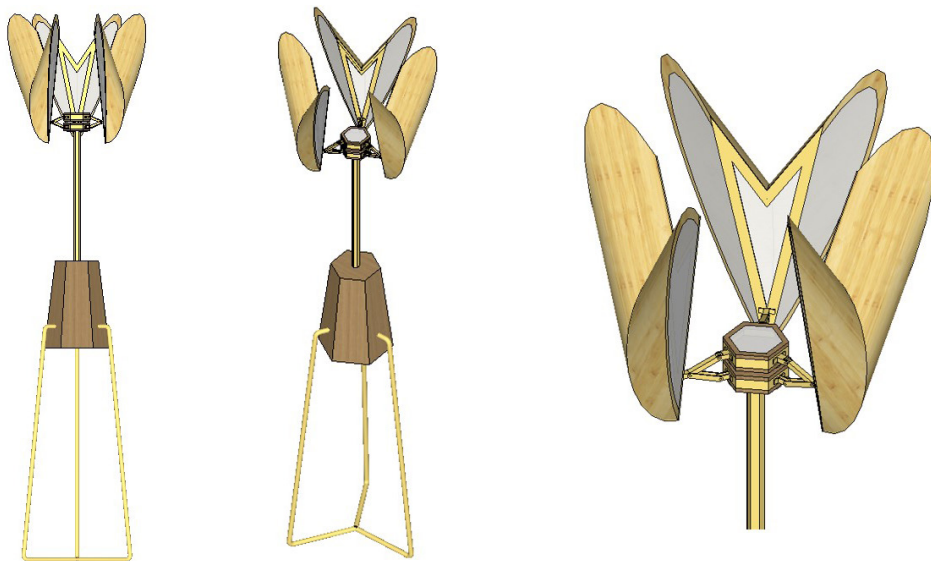


Fig 66. Floor lamp - Formal variation 2

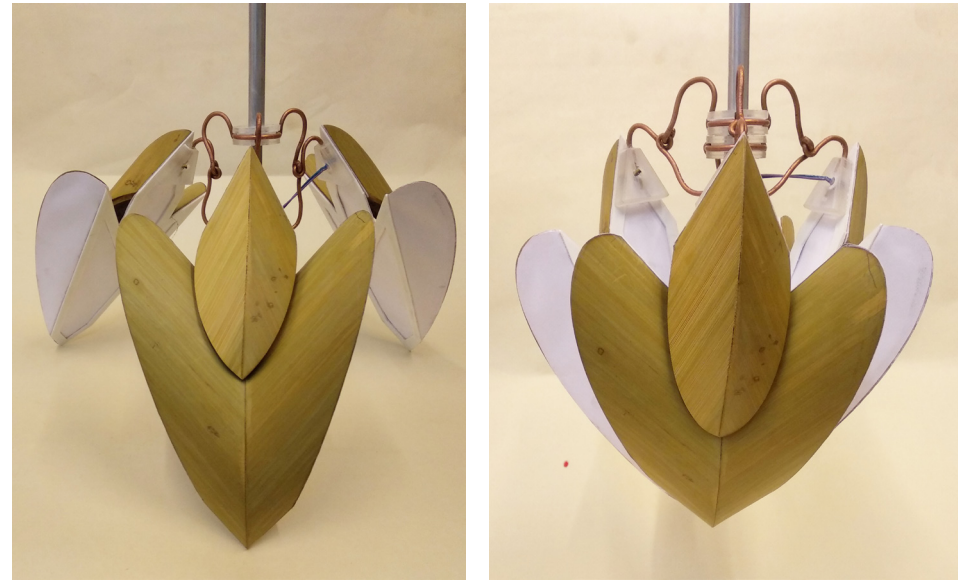


Fig 67. Chandelier prototype

8.4. PROTOTYPES

After making 3d models, a prototype of chandelier concept is made. A new details for the mechanism was also made.

After making one prototype of chandelier, it is found that the identity of the form is getting lost and too many panels were making it more complicated.

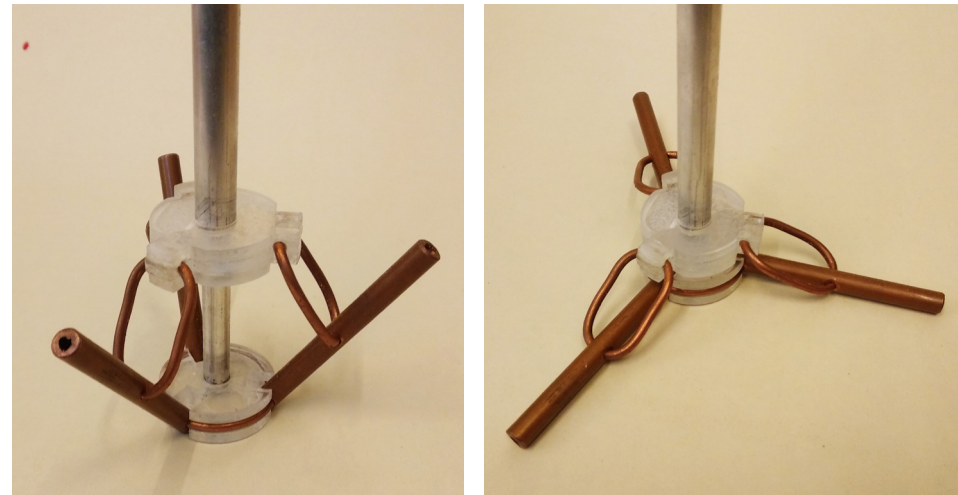


Fig 68. Prototype of an alternate mechanism without screws

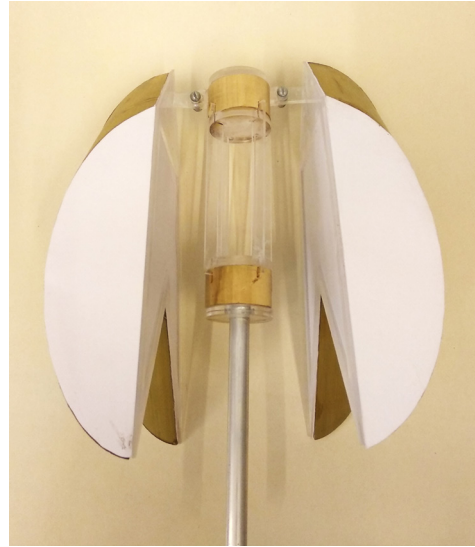
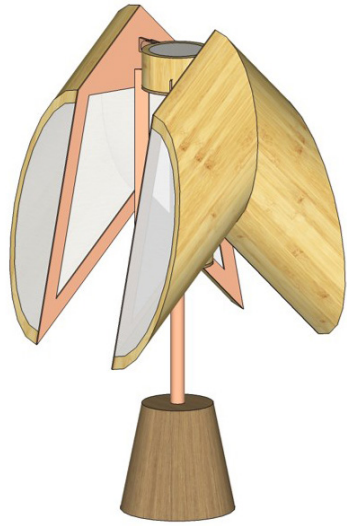


Fig 69. Table lamp concept and prototype

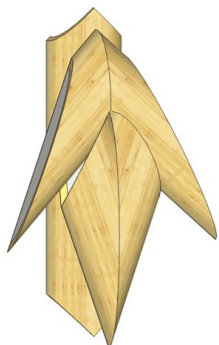


Fig 70. Wall lamp concept and prototype

After finding that the chandelier form may not be an ideal direction, we decided to look at table or wall lamps with one or maximum of two panels.

One prototype of a table lamp and a wall lamp were made. The prototype of wall lamp using one combination panel was a promising direction to explore further.

9. CONCEPTS STAGE 2

9.1. PANEL FORM REFINEMENT

After making the table and wall lamp prototypes, one important observation that, the panels needed further refinement in form. The Original form was looking too rigid and bulky. An attempt to remove the sharp edges formed on the inner side of the panels were made. The sharp edges were made into smooth curves and gave an organic feel to the form.

9.2. SURFACE TREATMENT

Another aspect of the panels was its surface treatment. An exploration to manipulate the natural texture on the bamboo surface was done on a sanding wheel. Also tried to create a more warm and brownish colour and shades by heating the bamboo with a hot air gun.



Fig 71. Development of panel form



Fig 72. Texture exploration

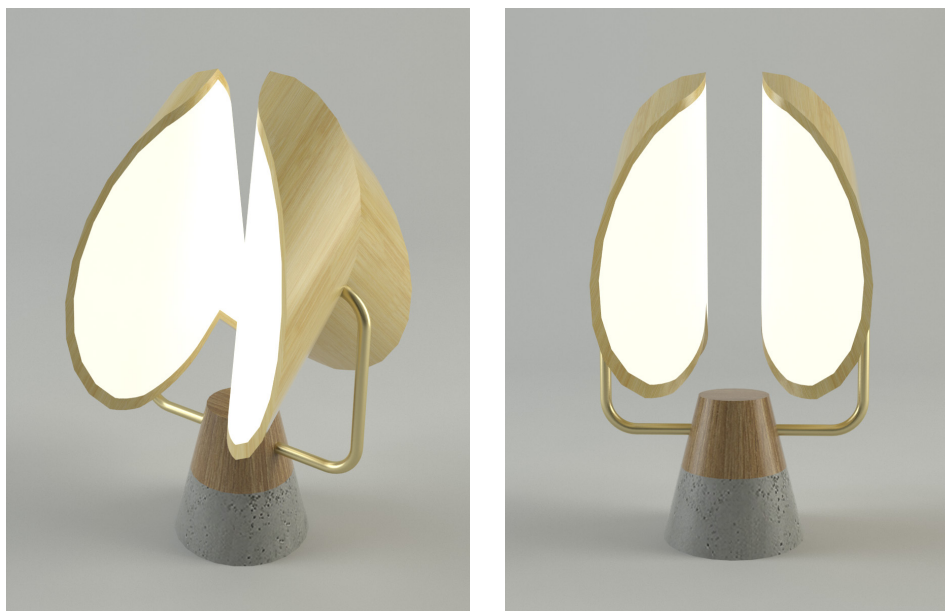


Fig 73. Table lamp concept 1



Fig 74. Table lamp concept 1a

9.3. INITIAL TABLE LAMP CONCEPTS

After deciding to look at table lamps and wall lamps, a few concepts of table lamps were made in 3D. The idea was to look at how we can use only one or just two panels to create interesting lamp forms. A few different options were explored. Another point to look at was mechanical movements instead of automated movement.



Fig 75. Table lamp concept 2



Fig 76. Table lamp concept 2a



Fig 77. Table lamp concept 3



Fig 78. Table lamp concept 4





Fig 79. Table lamp concept 5



Fig 81. Table lamp concept 6a



Fig 80. Table lamp concept 6



Fig 82. Table lamp concept 7





Fig 83. Table lamp concept 8



Fig 84. Table lamp concept 9



Fig 85. Wall lamp concept 1



Fig 86. Wall lamp concept 2





Fig 87. Wall lamp concept 3

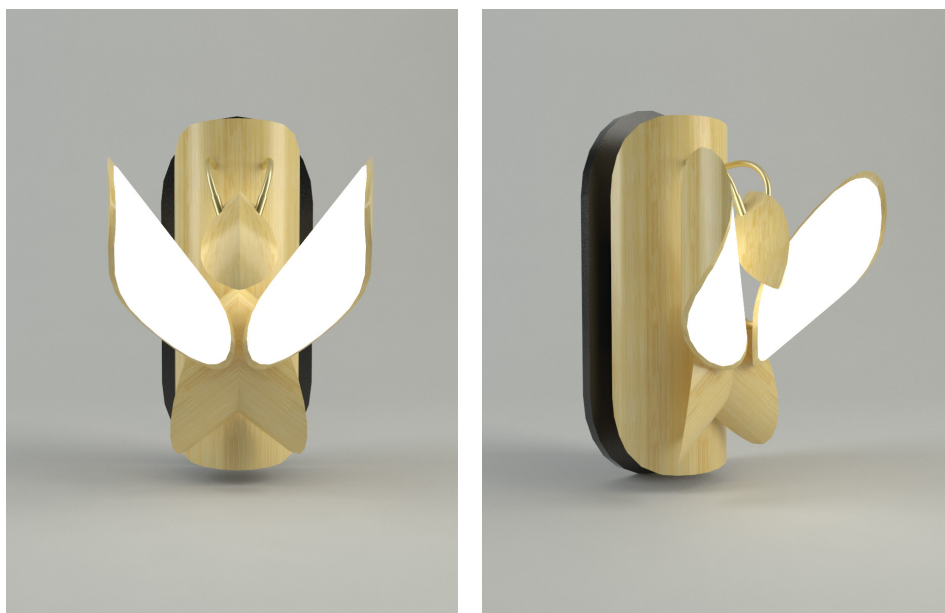


Fig 88. Wall lamp concept 4

9.4. INITIAL WALL LAMP CONCEPTS

After making a few various options for table lamps, a few different concepts for wall lamps were generated. While creating these, a new idea to create abstract forms of insects came to light.

9.5. PROTOTYPES - BEE LAMP

This is a wall lamp. The form is an abstraction of a bee form. The lamp consists of one large light module as the wings, two smaller modules as the head and body, and the base. The wing module is moveable; to adjust the lighting as well as to change the visual appearance of the bee. Brass tubes were used as the conduit to carry wires. It is also used to create the abstract form of an antenna as an element in the design.

The initial idea of the wings was to provide the wings in such a way that it throws light outside. But this was taking away the beauty of the bamboo panel and decided to change the orientation in the final concept. The materials used in this lamp are Bamboo, Handmade paper, Wood, and Brass.



Fig 89. Prototype of the Bee lamp



Fig 90. More images of the prototype



Fig 91. Table lamp prototype of the taro leaf lamp

9.6. PROTOTYPES - TARO LEAF LAMP

This is also a table lamp. This is an abstract form of a taro leaf and a pot. This lamp has one large light module as the leaf, and a base with bamboo, wood, and concrete. The leaf panel is movable; to adjust the lighting as well as to change the visual appearance of the lamp. Brass tubes were used as the conduit to carry wires and as a design element.



Fig 92. Details of the hinge and base

The base of the lamp also holds a Wireless speaker as an additional feature. The materials used in this lamp are bamboo, handmade paper, wood, brass, and concrete.

10. FINAL CONCEPTS

After making the prototype and having a discussion with the guide, we observed that it would be better to keep the design simpler and reduce the number of elements. The idea of modular panels may be a good form as it is, but it was not going along with the overall aesthetics of the lamp. We then decided to leave the modular form and look at more simpler forms in bamboo.



Fig 93. More ideations of Wall lamps



Fig 94. More ideations of table lamps

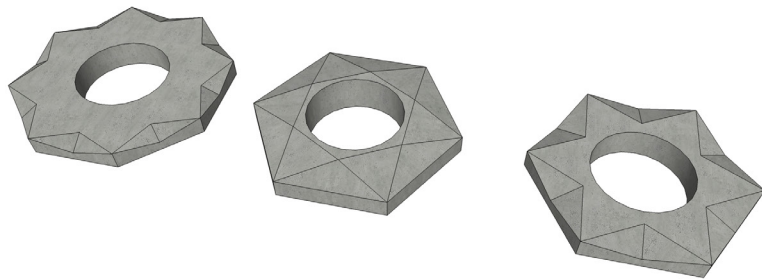


Fig 95. Ideations for the concrete base forms

10.1. FINAL RANGE OF TABLE AND WALL LAMPS

After a few more explorations, we finalized on using simple bamboo forms, and metal tube as the main featuring elements of the design and developed a range of table lamps and a series of wall lamps. The final designs also features the use of wood, and concrete. The lamps uses addressable LEDs as the light source, and can be controlled through a mobile application and single touch button. The lamp features lighting options for various mood settings and subtle lighting animations. The table lamps re portable with rechargeable batteries. The wall lamps features the regional artworks on the bamboo panels.



Fig 96. Table lamp concept 1



Fig 97. Table lamp concept 1 variation



Fig 98. Table lamp concept 2



Fig 99. Table lamp concept 3



Fig 100. Table lamp concept 3



Fig 101. Table lamp concept 4





Fig 102. Table lamp concept 5



Fig 103. Table lamp concept 6



Fig 104. Wall lamps range



Fig 105. Wall lamp - Top



Fig 106. Wall lamp - Middle



Fig 107. Wall lamp - Bottom

11. FINAL PROTOTYPES



Fig 108. Table Lamp 1



Fig 109. Table Lamp 1



Fig 110. Various Lighting modes



Fig 111. Various Lighting modes



Fig 112. Mobile Application for controlling lighting modes



Fig 113. Table Lamp 2

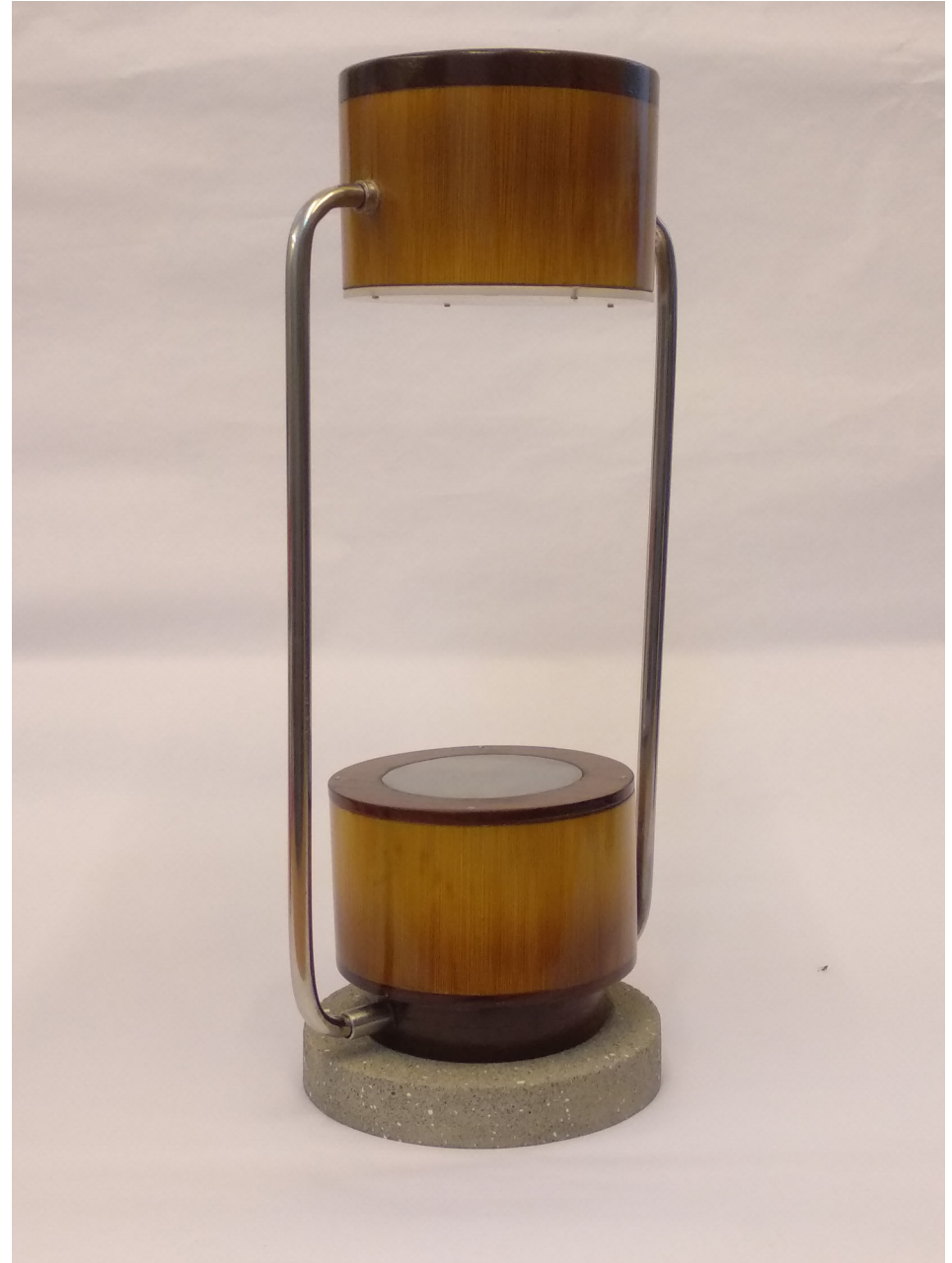


Fig 114. Table Lamp 2



Fig 115. Table Lamp 3



Fig 116. Table Lamp 3



Fig 117. Table Lamp 4



Fig 118. Table Lamp 4



Fig 119. Exploration in Vacuum forming



Fig 120. Exploration in Custom woven rings



Fig 121. Exploration in Laser etching on bamboo



Fig 122. Table lamp 5



Fig 123. Table lamp 5



Fig 124. Wall lamp with exploration in printed sticker



Fig 125. Regional artwork on wall lamp panels

12. PRODUCTION

12.1. PRODUCTION PROCESS

The final aspect of this project is production. There are three stages involved in the production process

- * Crafting the parts
- * Wiring the electronics &
- * Final Assembly

The craft-person is involved in the first and last stages of the production. The second stage of the production is carried out by the technicians.

The craftsmen can craft the parts of the lamp. Once they are finished and polished, they will go to the technicians for fitting the electronic components inside. After the electronics are fitted into the lamp, it will again go back to the craftsmen, for the final assembly and finishing of the lamp.

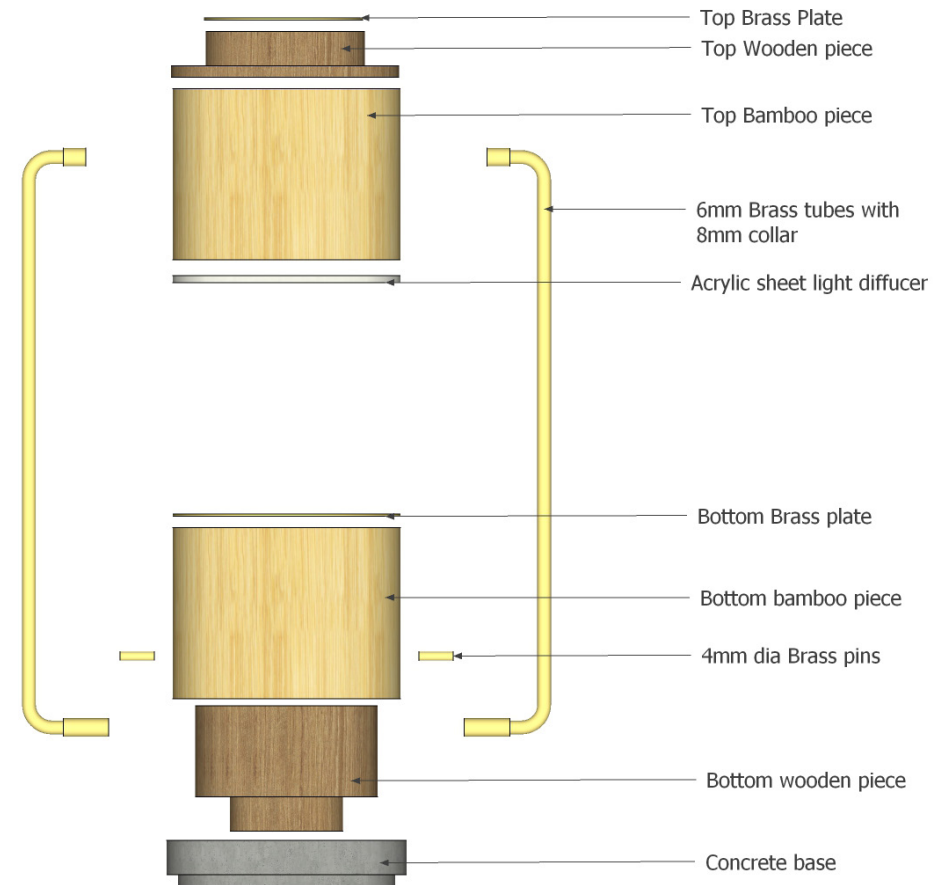


Fig 126. Parts of Table Lamp 1

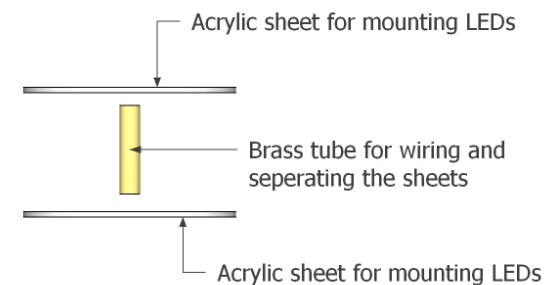


Fig 127. Internal parts of the top segment for mounting LED

12.2. PROCESS DOCUMENTATION



Fig 128. Cutting the bamboo piece to the required size



Fig 129. Removing the outer layer by using a sanding machine





Fig 130. Creating a gradient by burning the surface using a hot air gun



Fig 131. Correcting the roundness of the bamboo by using a hot air gun and bench vice.



Fig 132. Making the wooden parts for the top piece and attaching it to the bamboo piece.



Fig 133. Bending the tubes

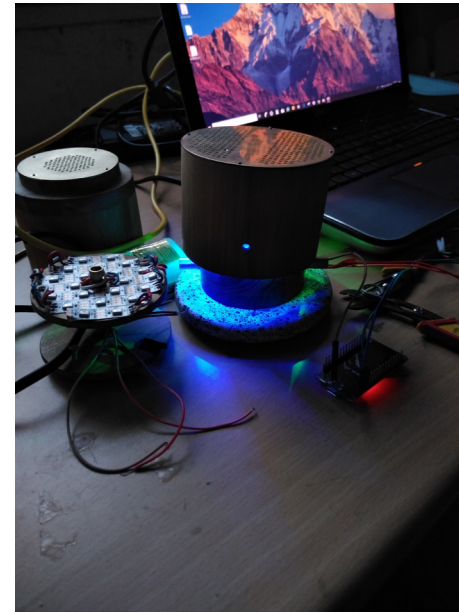


Fig 136. Test assembly of parts

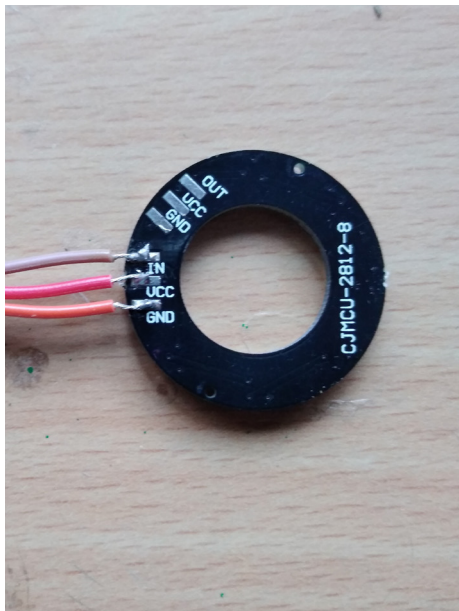
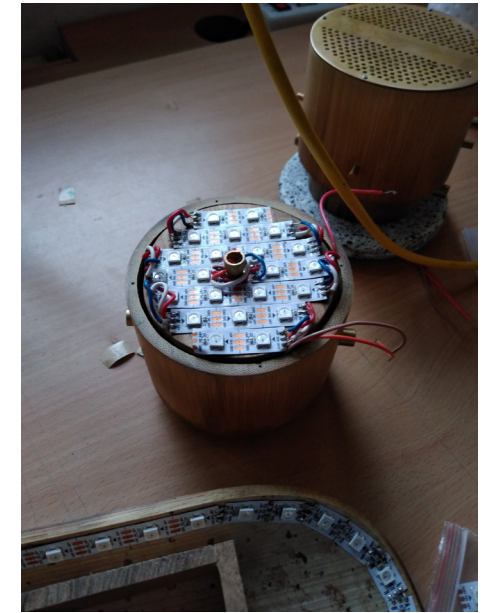


Fig 134. Soldering and mounting the LEDs on to the internal disks

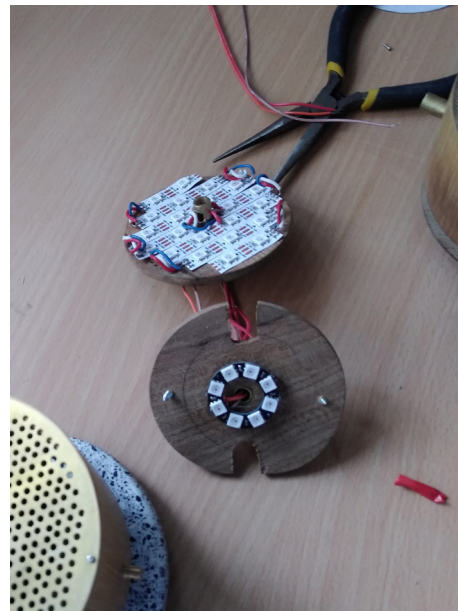


Fig 135. Testing the Working of LEDs

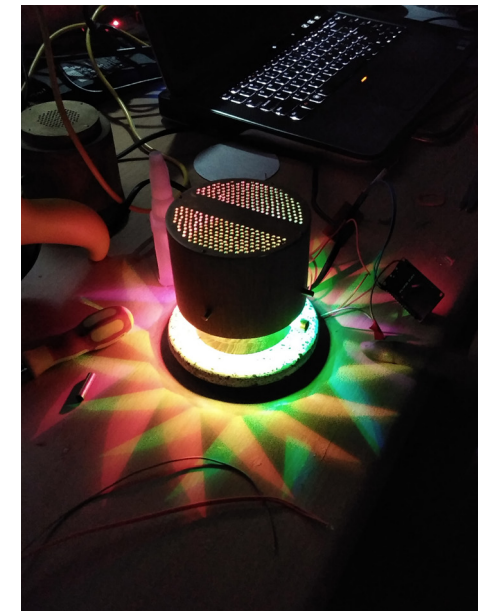




Fig 137. Laser etching on Bamboo



Fig 139. Applying melamine spray polish

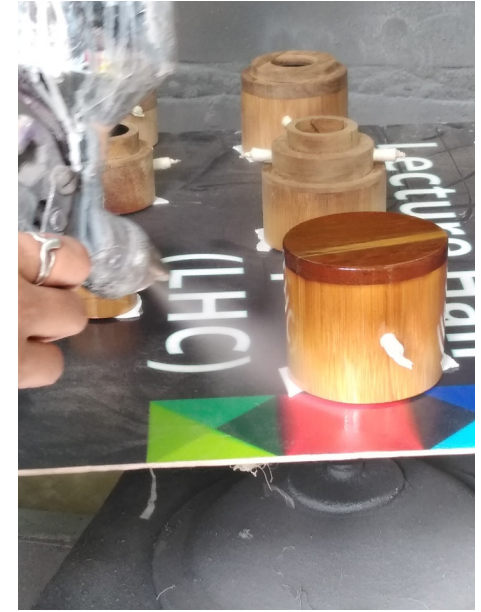


Fig 138. Vacuum Forming



Fig 140. Casting the concrete base

REFERENCES

IMAGE REFERENCES

Figure No.	Source
Craft	https://s3-ap-southeast-1.amazonaws.com/gounesco.com/wp-content/uploads/2014/05/11160638/BIDRIWARE-ARTISTS-AN-EXQUISITE-PIECE-OF-VASE.jpg
Technology	https://images.unsplash.com/photo-1470350576089-539d5a852bf7?ixlib=rb-1.2.1&ixid=eyJhcnRfaWQiOjEYMDd9&auto=format&fit=crop&w=1000&q=80
Lighting	https://anad.org/wp-content/uploads/2016/05/bigstock-Christmas-candles-burning-at-n-108500090.jpg
FIG 1	https://cdn-shop.adafruit.com/970x728/1138-00.jpg
FIG 2	https://cdn-shop.adafruit.com/970x728/1655-03.jpg
FIG 3	https://cdn.shopify.com/s/files/1/0174/1800/products/a000073_front_1_93d36068-b342-4564-8cca-ae2feef26891_1024x1024.jpg?v=1530371789
FIG 3	https://img.staticbg.com/thumb/large/oaupload/banggood/images/4D/75/bfacef5e-9ca0-4650-85a3-87a23e196292.JPG
FIG 3	https://cdn.sparkfun.com//assets/parts/6/5/3/9/11113-01b.jpg

FIG 3	https://images-na.ssl-images-amazon.com/images/I/71WYcNLIVpL._SX522_.jpg
FIG 3	https://cdn.shopify.com/s/files/1/0061/7735/7891/products/lc-053-2_600x.png?v=1549370818
FIG 4	https://gloimg.gbtcdn.com/soa/gb/pdm-product-pic/Electronic/2017/06/13/goods_img_big-v1/20170613180408_64572.jpg
FIG 4	https://cdn.shopify.com/s/files/1/2396/0755/products/Wemos_D1_mini_v3.0.0_top_2_1000a_grande.JPG?v=1511813105
FIG 4	https://cdn-shop.adafruit.com/1200x900/2471-10.jpg
FIG 5	https://dl.espressif.com/dl/schematics/pictures/esp32-pico-kit-v4.1.jpg
FIG 5	https://dl.espressif.com/dl/schematics/pictures/esp32-devkitc-v4-front.jpg
FIG 5	https://dl.espressif.com/dl/schematics/pictures/esp-wrover-kit-v4.1-front.jpg
FIG 6	https://cdn.sparkfun.com/assets/3/e/e/f/d/51ddc93fce395f8764000001.png
FIG 6	https://cdn.sparkfun.com//assets/parts/6/9/5/4/11287-01a.jpg
FIG 6	https://cdn.sparkfun.com/assets/4/b/5/b/0/51193957ce395fa447000000.jpg
FIG 7	https://sc01.alicdn.com/kf/HTB1eUxwJVXXXXcKXFXq6xXFXXS/HC-SR04-Ultrasonic-Distance-Measuring-Sensor-Ranging.jpg
FIG 7	https://5.imimg.com/data5/PH/XF/MY-45321773/ir-sensor-module-for-arduino-2f-raspberry-pi-500x500.jpg

FIG 7	https://img.staticbg.com/thumb/large/oaupload/banggood/images/1C/80/94db0a4e-61fa-4dc6-9533-83a7d301a016.JPG
FIG 7	https://www.mpja.com/images/31301-large.jpg
FIG 8 - 140	Author