



Product Design Project II

KNOCK DOWN BAR STOOL IN BAMBOO

Submitted by

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Guide

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knock - down BAR ST_oOL in bamboo



Approval Sheet

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Knock Down Bar Stool in Bamboo

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1.0 ABSTRACT



knock - down BAR STOOL in bamboo



The project aims at designing a knock down bar stool in full bamboo for KONBAC in Kudal, Maharashtra.

In today's world, globalization has opened up access to customers all over the world. To ensure success of the products in distant markets, it is important that the products are easy to transport and are made light in weight. This could help in reducing the transport cost.

Depletion of natural resources and the side effects have been a cause of great concern. Environmentalists have stressed on the use of renewable resources. Green design is looked upon as a solution and work in this field is need of an hour.

Bamboo is the fastest growing biomass on earth. It is endowed with exclusive and unique look. If the richness of bamboo is enhanced in furniture, it will cater to a niche market. Well designed and finished bamboo furniture is being positioned as a premium range of furniture in international market.

If ease of transport is achieved by transporting in a knocked down state, it will prove to be an important development for Bamboo furniture market.

The existing bamboo furniture manufactured at KONBAC does not have this feature. This poses difficulty in transport and increases the end cost to the customer substantially. This also creates limitation to business expansion.

Since the bar stool will be manufactured at KONBAC, the possibilities for design are in accordance with the infrastructure and resources available with them including the type of bamboo.





Bamboo will be combined with other materials like cane and steel to open up the new possibilities as compared to what currently KONBAC is making(ref. Sec 3.4).

Many of the components used for making prototypes such as member in MS plate (ref. Section 11.1, Fig. 11.8), ring, Knock Down fittings (Fig 11.9), cane seat (Fig. 11.23) have been manufactured by vendors and KONBAC can easily procure these components from the same vendors in Mumbai.

The design input does not end with the bar stool but the details like knock down joinery worked out for bar stool can easily be adopted for other type of furniture that they manufacture. Suggestions and ideas for improving richness of bamboo by retaining skin, using brass rings etc can add value to the furniture; making it more exclusive.

The methodology for the project includes field trip to Kudal (KONBAC), understanding manufacturing scope and constraints, documenting bamboo variety (Kanak & Manga) for knowing nodal distances and diameter range, market study, user study, working with material for hands on experience, making mock up models and details.





2.0 ABOUT KONBAC



knock - down BAR STOOL in bamboo



Fig. 2.1
Photograph showing Kudal



Fig. 2.2
Map showing geographical
location of kudal

Bamboo is one of the most abundant and environment friendly resources available in the Konkan region (Thane, Mumbai, Raigad, Ratnagiri and Sindhudurg districts of Maharashtra). This area is very much suited for bamboo cultivation and bamboo product development. Some of the backward communities in this region are earning their livelihood through bamboo products. But no organized efforts have been taken up to explore the possibilities of bamboo linked livelihood options

With the objective of strengthening the bamboo sector in the Konkan region, the Centre for Indian Bamboo Resource and Technology (CIBART) having its Head Quarters in New Delhi established an office in Kudal of Sindhudurg District in June 2004. Fig 2.1.and 2.2 shows beautiful landscapes of Kudal and its geographic location respectively.

The strategic reason for setting up the office in Kudal is its proximity to Goa (Tourist destination) and Mumbai, the business hub. It is around 500 km from Mumbai and 60 km from Goa. Another reason is abundant availability of bamboo resources in Sindhudurg. Sindhudurg district of Maharashtra has a geographical area of 5087 sq. km with a forest area of around 910 sq. Km.

CIBART has established a Common Facility Centre (CFC) at Kudal of Sindhudurg District of Maharashtra with the funding support from Development Commissioner (Handicrafts) under Ministry of Textiles in January 2005.

The technical inputs and guidance were extended by International Network on Bamboo and Rattan (INBAR) which is a global network having its Head Quarters in Beijing, China.



To promote the local ownership, the Konkan Bamboo and Cane Development Centre (KONBAC) was registered as a Section 25 company in June 2004. Though the CFC was initially set up by CIBART, the implementation is done by KONBAC.

Till now, KONBAC was a supporting agency for CIBART's initiatives and it is expected to take the lead role in strengthening the bamboo sector initiatives in the Konkan region. The KONBAC is governed by a Board of Directors.

Along with development and manufacturing bamboo furniture, KONBAC is also working in developing structures in bamboo. They have successfully implemented projects of constructing semi-open shelter for a restaurant in Sawantwadi, covered waiting area for railway station of Rajapur etc.



knock - down BAR STOOL in bamboo



3.0 EXPERIENCING BAMBOO



knock - down BAR STOOL in bamboo



Fig. 3.1
Basket from Assam



Fig. 3.2
Basket from Japan

3.1 Introduction

Bamboo has always fascinated designers as well as artists throughout the world. It is the fastest growing biomass and an eco friendly material, which is why it is drawing attention of many ecologists and designers today.

This tropical and sub-tropical perennial grass is increasingly being recognized in the modern world as a substitute for plastics, steel and cement in new applications for housing, furniture construction. People are trying to find newer and newer applications of bamboo. Bamboo has reached in the world of design, fashion and fabrication and is being rated very high as a viable replacement for wood as a structural material.

In Northeast part of India, it has been used with utmost innovation by tribal and hill communities not only for interiors and accessories, but for basic architectural construction such as houses, bridges, stilts, doors, windows, partitions and irrigation equipment too. Apart from this, everyday utility items such as baskets, furniture, fishing rods, hats, walking sticks and storage bins are crafted using this wonder material. In other parts of India, bamboo is mainly used for scaffolding and paper industry. Figure 3.1 shows Bamboo basket from Assam.

It has always been a part of life and culture in various Asian countries like Japan, China and Northeast part of India. In Japan, successful efforts have been made to industrialize this craft based tradition of bamboo products. Figure 3.2 shows a Basket from Japan



Fig. 3.3
Antique Chinese Furniture

In countries like China, Japan, Malaysia, Thailand, Bamboo craft is one of the cherished traditions and well respected craft. Baskets, containers, furniture have been extensively made and used for various day to day activities as well as rituals Figure 3.3 shows antique Chinese Furniture piece.

Bamboo has a natural habitat in most of the regions in India. There are over hundred identified species of bamboo in India and has meeting variety of user needs.

Two Bamboo varieties that grow in Konkan region in Maharashtra are successfully used for manufacturing furniture by KONBAC. These are also used as structural members for bamboo construction.



Fig. 3.4
Product from Thailand

knock - down BAR STOOL in bamboo



Fig. 3.5
Image showing 'bamboo bet'



Fig. 3.6
Mr. Palkar and workman
from Kudal



Fig. 3.7
Cutting of matured
bamboo

3.2 Field Trip to Kudal

Designing of anything in bamboo starts with selecting the bamboo. It is important to see and feel bamboo right from its natural habitat. How to select a matured bamboo, how to cut, which one should be cut....all these things are very important for understanding the material.

Hence, I visited the Factory of KONBEC at Kudal. There I could gain most of the knowledge about this fabulous material from the people who have been working and living with this plant from generations. Its like going to the source of the knowledge itself.

Bamboo always grows as a cluster. It is known as 'bamboo bet (island)' in local language - Malvani. Usually, the head crafts person goes for selection of bamboo. Then, the bamboo is cut and sent to the factory. The 'bamboo bet' is located around 6-7 km from the factory of KONBEC. There are several 'bamboo bet' of different varieties situated in and around Kudal and Vengurle. Mr. Palkar from Vengurle is working with KONBEC is an expert in bamboo selection. I went along with him to know how to identify a matured bamboo. We were also accompanied by Mr. Suban Rudrapal, chief craftsperson of KONBEC and Mr Shilpesh Gambhire.

A bamboo in early period of its life cycle is normally dark or deep green in colour. The colour starts changing as it matures over three to five years. As it grows, from deep green, the skin starts becoming yellow. Bamboo is usually ready to use for furniture when it is 1-2 years old. This could be seen in figure 3.7 and 3.9



Fig. 3.8
Manga variety
A : 3-5 months old bamboo
B : 1 year old bamboo



Fig. 3.9
Manga variety
C : 2 years old bamboo:
Ready for cutting

The cutting season of bamboo is in winter - from October till May. New bamboo shoots sprout only in monsoon season - from June till September. Cutting of bamboo is avoided in monsoon to prevent damage to new shoots while cutting.

The bamboo varieties that grow near Kudal are called Kanak and Manga locally. I visited the actual place where these varieties grow. Mr. Palkar showed and explained how to identify, which bamboo is ready for cutting. Both, Kanak as well as Manga are used for furniture making at KONBAC. Information about these varieties is given below.

1. *Pseudo oxytenanthera ritcheyi*
Local name: **Manga**

This is a medium sized strong bamboo. This specie is distributed in Maharashtra, Karnataka, Kerala and Tamilnadu. It's a light demanding specie and generally found on the tops if the ridges and hills in Western Ghats. This has uniform structure and there are two types found in this

- a. bamboo with hollow core
- b. bamboo with solid core

As told by Mr Palkar, if bamboo is planted on top of the hill or hillock, its core becomes solid due to lack of water and we get a solid bamboo. If the same species is grown at the bottom of hill or hillock, the core becomes hollow due to availability of water giving hollow bamboo. Structural properties of both types of bamboo vary slightly. The solid Manga shows better performance with respect to joining by drilling holes and nut bolting. Splitting is reduced and it behaves like a solid wood. Hollow Manga shows good tensile properties.. Figure 3.8 and 3.9 shows Manga. The change in the colour can be seen clearly as it matures, the colour becomes yellowish with white spots.

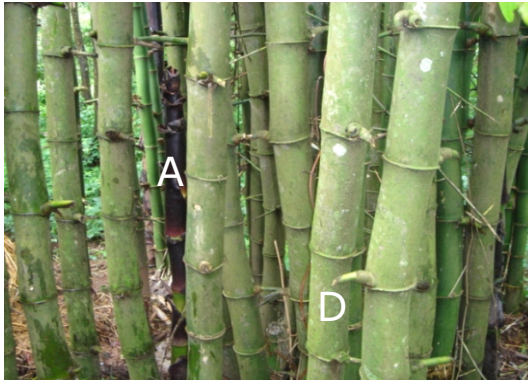


Fig. 3.10
Kanak variety
A : 2-3 days old bamboo
D : 2-3 years old bamboo :
Ready for cutting



Fig. 3.11
Kanak variety
B : 3-5 months old bamboo
C : 1 year old bamboo

The outer diameter of matured Manga culm varies from 2" to 2 1/4" and internodal distance range is from 8 1/2" to 20". As the plant grows, the diameter of culm goes on decreasing whereas the internodal distance goes on increasing.

2. Bamboosa bambo

Local name: **Kanak**

This occupies 15 percent of total bamboo area in India. Native to South East Asia, this species was introduced and cultivated throughout the tropics. The species prefer rich, moist soil and grows near perennial rivers and valleys.

This variety of bamboo has larger culm diameter compared to Manga, whereas the inter-nodal distance is lesser compared to Manga. This variety is mainly used for furniture making and has good material strength.

The outer diameter of matured culm varies from 2 3/4" to 4". The inter-nodal distance shows a range from 4" to 16".

For specifying the material for any designed furniture, it is very necessary for a designer to know two important dimensional aspects of Bamboo (a) Diameter of culm and (b) Inter-nodal distances.

Ten pieces of both the varieties of bamboo were measured and documented in a tabular form. Also the average diameter variation per node was calculated. This data is attached as appendices in the end.



Fig. 3.12
KONBAC Office



Fig. 3.13
Manufacturing of Furniture
at KONBAC



Fig. 3.14
Furniture ready for delivery

3.3 Working with bamboo: Factory visit to KONBAC at Kudal

I visited the office and the factory of KONBAC in Kudal, Maharashtra. Fortunately, not only does a manufacturing unit like KONBAC exist but is also within easy reach from Mumbai. As against few years back, when furniture making was happening only in North east part of India.

From my project perspective, this was extremely beneficial. Since, rarely students get an opportunity to see how the product designed by them would be manufactured commercially. There are very few such setups which manufacture full bamboo furniture. Other places where bamboo furniture is made are situated in North East part, which is not so easily reachable from Mumbai. Unlike KONBAC, furniture manufacturing in other parts is more craft oriented.

Figure 3.12 shows the KONBAC office. In figure 3.13 and 3.14 one can see the scale at which furniture is manufactured. The factory has two centers - one for manufacturing and other for final finishing, polishing and delivery. The people working there are from carpentry background as well as skilled craftsman from Assam. KONBAC holds workshops periodically to train new people from various communities and provide them training for improving the skills. Mr. Suban Rudrapal from Assam works as the chief craftsman.

The machinery in the factory consists of Vacuum pressure treatment plant, Chemical treatment tank, Splitting machine, Knot removing machine, Sizing machine for getting uniform strips, Sanders and Polishing machine, Drill machine, Heat bending machine etc.



Fig. 3.15

Fig. 3.16
Knot Removing MachineFig. 3.16
Knot Removing Machine

The process of furniture making starts with procuring the appropriate bamboo from their natural habitat. The bamboo is selected by chief designer/craftsman or expert in this field. It is cut and brought to the factory. The green bamboo has to be treated for preventing fungus attack. Small holes are drilled near the knot (shown in fig. 3.15) and they are immersed in chemical treatment plant for one week. They also have a vacuum pressure plant, which they have procured recently.

The knot of treated bamboo is removed using Knot Removing Machine as shown in figure 3.16. Due to non uniformity of bamboo diameter, they have been practicing the method of removing knots and skin of bamboo which offers them slight flexibility in terms of sizing bamboo. In reality, the shiny bamboo skin and beautiful positioning of knots is what makes the product exclusive. The beauty of bamboo lies in the non uniformity of its diameter and the look and feel of the skin. For removing the skin, there is no design inputs seen in terms of visual play of skin and skinless bamboo surface. It would be wise to mention here the surface treatment by craftsman working in Chandrapur area in Vidarbha, Maharashtra. It would be one of the focus of my project to see the possibility of creating interesting designs even by removing skin. Also seeing the possibility of using bamboo with skin and knots.

For getting strips of bamboo, Splitting Machine is used. It splits the bamboo in radial divisions. Number of divisions will depend upon the cutting fixture used. Figure 3.17 shows splitting in process. Here bamboo is split into six equal parts. Traditionally, this is done by hand which does not give accuracy and lot of labour is involved.



Fig. 3.17 (a)
Splitting Machine



Fig. 3.17 (a)
Splitting Machine



Fig. 3.17 (a)
Splitting Machine

The strips obtained from splitting machine does not have uniform thickness due to presence of knots at regular intervals. The Sizing Machine is used for removing extra material from the strips. The machine produces strips having uniform thickness throughout the length. This can be seen in Figure 3.18a & 3.18b



Fig. 3.18(a)
Sizing Machine

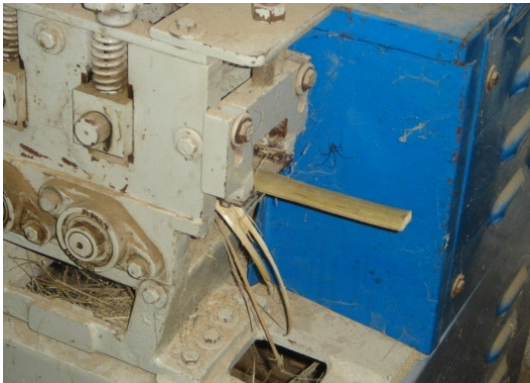
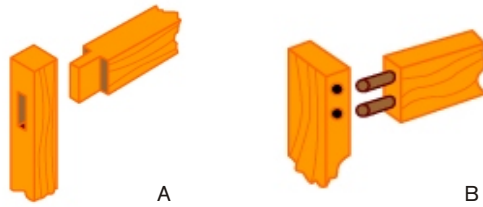


Fig. 3.18(b)
Sizing Machine

knock - down BAR STOOL in bamboo



A - Tenon and Mortise Joint
B - Dowelled Joint

Fig. 3.19
Woodworking Joints



Fig. 3.20
Tenon and Mortise joint in
Bamboo



Fig. 3.22
Gaps filled with Sawdust
and Fevicol

The details used for joining bamboo furniture parts are derived mainly from Wood working details and joinery. Joints like tenon and mortise joint, dowelled joint are extensively used (Figure 3.19).

The nails used for strengthening the joint are bamboo nails. The metal nails tend to rust with time and it results in weak joints. To prevent this, bamboo nails are used. Fixing of these nails is done by first drilling a smaller diameter hole and then hammering the bamboo nail as shown in Figure 3.23. This is to avoid splitting of bamboo. Due to linear fibrous structure, bamboo tends to split if nail is hammered. Nail acts as a wedge, splitting bamboo apart. By drilling hole with the help of drill bits, splitting could be avoided.

The gaps left due to unfinished joints is filled with Fevicol mixed with fine sawdust as shown in Figure 3.22. This many times lead to unfinished joints, if not executed properly.



Fig. 3.23
Bamboo Nails



Fig. 3.24
Making of Bamboo bed



Fig. 3.25
Craftsman working on
finishing the bamboo for
Bed



Fig. 3.26
Mr. Suban Rudrapal
working for new design

The adjacent images shows the working area of the main manufacturing unit of KONBAC.

Figure 3.24 and 3.25 shows craftsman working on a Bed

Figure 3.26 shows Mr Suban Rudrapal, Chief craftsman, working on a newly designed Center Table.

Figure 3.27 shows a craftsman working on fixing the backrest of a dining chair.



Fig. 3.27
Craftsman making a Chair



3.4 Image Board

The adjacent image board shows types of bamboo furniture manufactured at KONBAC. The range of furniture includes Dining table, Living Room furniture, Dining Chairs, Beds, Dressing Table, Center Table etc.

The customers are from private as well as government sector which includes Resorts, Residences, Restaurants etc



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3.4 Image Board

This image board shows bamboo furniture developed internationally. Furniture from countries like Thailand, Malaysia etc. Here we can see the finish and detailing used for the furniture making it exclusive.



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4.0 Why Bar Stool ???

knock - down BAR STOOL in bamboo



The decision of selecting a Bar stool for this project is an outcome of analytical approach adopted which led to selection of bar stool. It involved the following steps

- A Interviewing Architects and Interior Designers
- B Taking feedback from Users
- C Feedback from the current manager of KONBAC
- D Expectations from the project

A. Interviewing Architects and Interior Designers

Previous knowledge of Architecture and Interior design helped me in analyzing types of furniture used in different areas. They could be broadly divided as furniture for

Corporate/office Interiors

Residential Interiors

Restaurants/hotels/resorts Interiors

Talking to practicing architects and interior designers in the above areas gave me insights regarding positioning of Bamboo furniture. The questions asked were regarding

- current trend followed for interiors of above areas
- where Bamboo furniture could be positioned
- what were the current problems for using bamboo furniture.

The result could be summarized as follows-

The features of **Corporate** or **Office Interiors** are-

- a. The interior should be harmonious to the international counterparts of the company e.g. Microsoft in India and in USA
- b. Materials used are mainly - Steel, glass, leather, wood
- C. Have a simple and formal look





Places where Bamboo Furniture could be used are -

- d. Breakout areas
- e. Executive Lounges
- f. Libraries
- g. Cafeterias
- h. Customer care area

Current problems with using bamboo furniture-

- i. Bamboo gives very informal look due to unfinished joinery
- j. Difficult to procure and not readily available
- k. Transport is difficult

The features of **Residential Interiors** could be summarized as -

- a. In case of small urban household - furniture is used for more than one purpose. In such cases, space saving and storage becomes important feature important.
- b. In case of Bungalows/ larger flats, theme based designs, areas are possible. There is availability of garden spaces, semi open areas, informal areas. Space saving is not constraint.
- c. Dining chairs for small households

Possibility of using Bamboo furniture in-

- d. Semi open patios
- e. Libraries
- f. Dining areas
- j. Informal living room setup
- k. Family room

Current problems with using bamboo furniture-

- l. Finishing is not up to the mark





Characteristics of **Restaurants/Hotels/Resorts** Interiors are -

- a. They have more of informal atmosphere
- b. People are looking for an experience there. ex Mocha, Barista, Cafe Mondegar
- c. In case of luxurious Hotels, they need to harmonize their interiors with their counterparts, for example J. W. Marriott
- d. In case of Resorts- use of natural materials is seen evidently. This is mainly to harmonize with the experience of 'nature' which the resorts mainly give.

Possibility of using Bamboo furniture in-

- e. Cafes, coffee joints
- f. Hotels theme based restaurants. Ex. Indian, Chinese etc.
- J. For resorts wider application

Current problems with using bamboo furniture-

- K. From where to procure is unknown to designers
- l. Transport cost is high

B. Taking feedback from Users

Along with architects, I selected few random users to know their viewpoint about use of bamboo furniture. It was evident that very few people were aware of 'Bamboo Furniture'. They mistook it for cane furniture. Pictures of existing bamboo furniture manufactured at KONBAC as well as internationally were shown to them.

Those who were aware of bamboo furniture did not know where to but it since it is not available in furniture showrooms.



knock - down BAR STOOL in bamboo



Fig. 3.28
Bar Stool designed by
Mr. Suban Rudrapal

General feedback regarding appropriate areas for using bamboo furniture could be summarized as follows -

- a. **breakfast stool (high chair)** or a **dining table** since it gives an ethnic look similar to wrought iron.
- b. **outdoor chair.**
- c. Theme based living room or family room.

C. Feedback from the current manager of KONBAC

Interview with the manager of KONBAC gave following insights-

- a. They are interested in manufacturing products for **International market.**
- b. Need for Knock Down bamboo furniture
- c. Due to heavy transport cost, they have clientele in limited area.
- d. Possibility of immediate market demand for Bamboo Bar Stool. (Mr. Chaugule, owner of Indage Wines have a proposal of setting up 'wine bars' at various locations in India. They are interested in considering possibility of using bamboo bar stools for their project. The designed developed at KONBAC for this purpose (Figure3.28) has limitations with respect to transport)

D Expectations from the project

The scope of the project should offer good learning potential with respect to material exploration, form and expression as well as product detailing.

The scale of the project is also important since it has to be finished in defined time span.



Considering all the above 'Knock Down Bar Stool' was selected for the project.

Bar stool has wider application in terms of its usage. It is not only restricted to bars and pubs but also used in cafeterias, fast food centers, ice cream parlors, houses etc.

Immediate market is available in context with the proposal of Wine Bars by Indage group.

Working with bamboo demands hands on experience to understand the material. Hence designing barstool was feasible and within the scale.

Barstool offered possibilities of experimentation with respect to form and expression better than any other piece of furniture.



5.0 Designing knock down bar stool in bamboo

knock - down BAR STOOL in bamboo



5.1 What is a Stool?

A stool is essentially a seat with no back or arms and intended for one person. As such, it was for many centuries the standard seating arrangement for the majority of people; a chair (a seat with a back) was reserved only for the most important personages. Unlike chair, stool is a piece of furniture to be 'sat on' and not to 'seated in'.

Bar stool is a type of stool often with foot rest which, due to their height and narrowness, are designed for seating in a public house or bar. However, bar stools are becoming more popular in homes, usually placed at the kitchen counter or home bars. Also in eateries and fast food joints where customers are not expected to sit for longer periods.

Bar stools are becoming popular due to variety of styles that are not only more appealing but also accentuate the theme of home decor. Bar stool can be looked at, as not only a piece of furniture but there are many subtle and elusive aspects attached to it.

Apart from catering to basic functional need of providing support, it responds to the environment in which it is used in. Unlike chair, bar stool has a very specific and demanding context. It may not have a very strong presence but it is more like a poetry in itselfpoetry composed with lines and curves and twists and turns.

Looking at the history of Pubs would give us some insights into how bar stool design came into being.





5.2 History of Pub/Bars

Public houses, usually known as Pubs, are an establishment that sells alcoholic drinks for consumption on premise, usually in homely settings. These were the social places based on scale and consumption of alcoholic beverages, mainly beer, wine, spirits and soft drinks. They were more common in English speaking countries like United Kingdom, Ireland, and Australia etc.

Each pub would have a crowd of regular people, coming there for a drink and it was more like a gathering place or venue for friends. The bar tenders would also be a part in the conversation and had friendly relations rather than just a commercial relation. People would expect to meet new people, make new acquaintances and enjoy their drink. Bar is essentially a business that sells alcoholic beverages for immediate, on premise consumption. Some bars may serve food and could be a part of a restaurant. Bars that are part of a hotel may also be known as 'long bars'.

Bar is also referred to the Specialized Counter on which drinks are served and from this term, the establishment itself derives its name. Bar tender is a person who serves customer drink over the Bar counter. Customers normally would sit across the bar counter, facing the bar tender and use the counter as a table for support as well as keep their drinks. The height of bar counter is according to the convenience of the standing bar tender since he has to constantly move around and serves the drinks on the bar counter. Hence the height of the stool on which customers would sit is height than normal chair height since it is meant for the bar counter, which is higher than the normal table.



knock - down BAR STOOL in bamboo



The customer sitting at the bar counter are not expected to sit for a very long duration since business demands rolling customers. Hence the bar stool never had features like backrest or armrest. Barstool offers higher view while eating, drinking or socializing and can add to the atmosphere, given the right barstool.

The standard height of a barstool is 30" (760mm) but there are many variations possible and can be customized as per the height of the bar counter. Ideally seat height is 9 to 12" lesser than the bar counter's top.

I will be considering the standard height of 30" for the design. The bar counter has a 6" high step at the base, making it easier for the users to get onto the barstool. Also, it provides support for resting the legs.





Fig. 5.1
Skipping Stool
by **Karim Rashid**



Fig. 5.2
High Chair K65
By **Alvar Aalto**



Fig. 5.3
Screw Stool
By **Ron Arad**



Fig. 5.4
Spluga Stool By
Achille and Pier Giacomo
Castiglioni

5.3 Image Board

The adjacent image board shows designs of bar stools by world's renowned designers like Ron Arad, Eileen Gray, Alvar Aalto etc.

knock - down BAR STOOL in bamboo



Fig. 5.5
Sarapis Chair by
Philip Starck

5.3 Image Board

The adjacent image board shows designs of bar stools by world's renowned designers like Philip Starck, Eileen Gray, Karim Rashid etc.



Fig. 5.6
Bar Stool
By Eileen Gray



Fig. 5.7
Kant Stool
By Karim Rashid

5.3 Image Board

The adjacent image board shows designs of bar stools in bamboo. These are available in countries like Thailand, China Brazil etc



knock - down BAR STOOL in bamboo



5.3 Image Board

The adjacent image board shows designs of bar stools in bamboo. These are available in countries like Thailand, China Brazil etc



knock - down BAR STOOL in bamboo



6.0 Existing knock-down furniture and fittings



knock - down BAR STOOL in bamboo



6.1 Introduction

Knock down furniture, also known as 'Flat Pack' or RTA (Ready To Assemble) was created to solve fundamental problem of shipping the furniture. The transport cost was relatively much higher than the production cost. According to IKEA, this concept was invented by Swedish draughtsperson 'Gillis Lundgren' who in order to fit a table in the boot of his car, broke the legs and reassembled it at home. He took this idea to IKEA who later on build a business around it.

IKEA is a pioneering company in this type of furniture.

The Indian companies that manufacture Knock Down fittings are Ebbco Fittings, Aries International etc. Both have offices in Mumbai. Their showrooms were visited to find out the possibility of using their fittings for bar stool.

Companies manufacturing Knock Down (KD) fitting for bamboo are not available, but some of the common fittings used for wood were tried. This was mainly to test the behavior of bamboo. Bamboo tends to split vertically when nailed perpendicular to the direction of fibers. It was found that for the Manga variety of bamboo (nearly solid),if holes are drilled with drilling machine and not hammered, the splitting problem could be avoided.





6.2 Image Board

The adjacent image board shows various types of Knock down furniture available in different material like wood, metal as well as combinations of materials. The Knock Down feature is incorporated either by using removable joining fixture or notch fitting.



knock - down BAR STOOL in bamboo



6.2 Image Board

The adjacent image board shows various types of Knock down furniture available in different materials like wood, metal and combinations of materials. The Knock Down feature is incorporated either by using removable joining fixture or notch fitting.



knock - down BAR STOOL in bamboo

6.2 Image Board

This image board shows different types of Knock down furniture manufactured by IKEA. Peculiarity of IKEA furniture is that complete furniture could be assembled using only one Allen key.



knock - down BAR STOOL in bamboo



7.0

User Survey and interview



knock - down BAR STOOL in bamboo



The bar stool users were interviewed to know more about their personal experiences with the bar stool in various types of pubs and bars.

The users selected were of three types

- a. people who are regular pub visitors
- b. people who have visited and used bar stool only once
- c. people who have used bar stools few times.

Users with different nationality were also included which consists of Indian, American and Dutch and Norwegian.

The user group consists of age - 20 to 45 with a good gender mix.

Following summary could be given from these user interviews-

- a. People prefer to sit on the bar stool, near the bar counter if they are alone. This helps them in making new acquaintances and they can chat with people more easily.
- b. People prefer to sit on the more comfortable lounge area if they are with their partners or friends.
- c. People have never used a bar stool which is without the backrest for more than 20-30 minutes.
- d. People prefer swivel type bar stools since getting in and out is more easier
- e. Barstool with a backrest is preferred since it is more comfortable than barstool without backrest.





- f. Many times the barstools are not stable enough and they tend to topple with shift in the loading pattern.
- g. People who visit the pubs regularly tend to personalize their space and like to sit in a particular place
- h. The floor is very dark and it's difficult to find belongings like keys of money if someone drops it mistakenly.



knock - down BAR STOOL in bamboo



8.0

Sitting and dimensional aspects.



knock - down BAR STOOL in bamboo

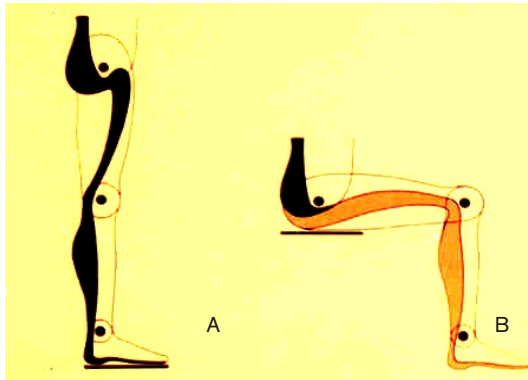


Fig. 8.1
A - Muscles in standing posture
B - Muscles in sitting posture

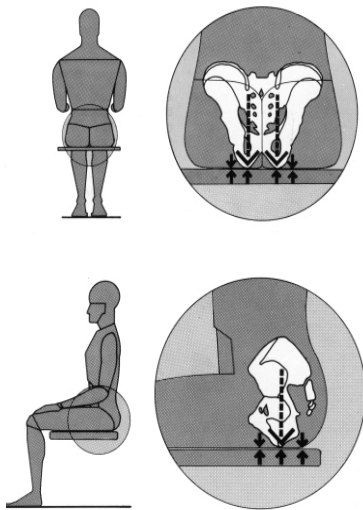


Fig. 8.2
Ischial Tuberosities

8.1 Need for sitting

Along with the anthropometric data it is important to know how human anatomy works and what exactly happens with respect to biomechanics during standing and sitting postures.

Standing posture

When we stand, our body is held in an upright position by means of static muscular effort. This is the reason why we feel tired after standing for a long time. (Figure 8.1A) One tries to relax the muscles by shifting the body weight on the alternate legs.

Sitting posture

Whereas in sitting, the muscles responsible for keeping the ankle, knees and hip joint rigid are considerably relaxed (Figure 7.1B). This reduces the fatigue on the muscle and we are much comfortable compared to standing.

In sitting posture, about 75% of total body weight is supported on only 4sq inches of these tuberosities (Figure 8.2). This means, a heavy load is distributed over a smaller area. Due to this, very high compressive stresses are exerted on the bottom part of buttocks while sitting. This causes fatigue and discomfort leading to need of constant change in postures.

The tuberosities form a two point support system, which with the help of seat alone cannot give sufficient stability to body. The feet and back and hand support together with contact to other surfaces impart stability to body.

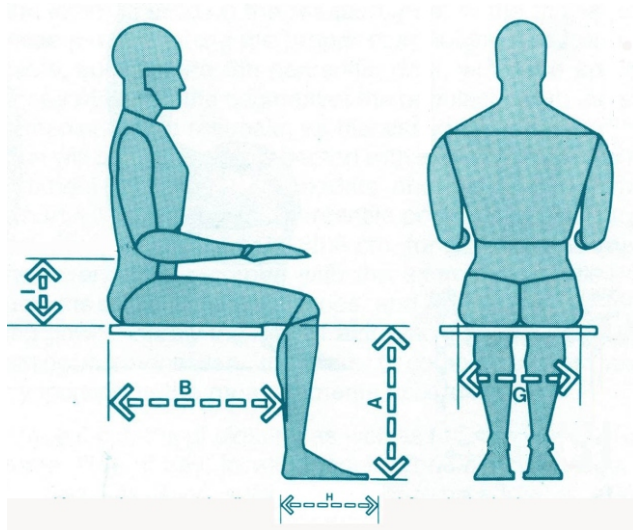


Fig. 8.3
Anthropometric
dimensions
required for bar
stool

8.2 Anthropometric dimensions for Barstool Design

It is important to know the basic anthropometric dimensions for designing a bar stool. Important dimension include Popliteal height, Buttock-popliteal length, distance till lower lumbar, hip breadth and foot length.

Amongst 5th, 50th and 95th percentile, which measurement is considered can be seen in Figure 8.4. It also shows all the dimensions from 5th to 95th percentile, both male and female.

		5 th percentile			50 th percentile			95 th percentile		
		Male	Female	Combined	Male	Female	Combined	Male	Female	Combined
A	Popliteal	380	365	374	425	399	419	471	441	466
B	Buttock - Popliteal length	399	384	394	455	439	451	512	494	509
I	Lower lumbar	72	66	72	101	95	100	156	189	159
G	Hip breadth	272	259	269	331	314	326	405	429	406
H	Foot length	227	207	215	248	227	244	274	249	271

Fig. 8.4
Data on
anthropometric
dimensions for
various
percentiles.



9.0

Product Brief



knock - down BAR STool in bamboo



The main objective of the project is to develop a new product for KONBAC which will solve the issues related to transport and shipping.

The product - A Bar Stool will have following features

- a. Main material for the bar stool would be full bamboo.
- b. The joints will be of Knock Down nature.. Use of metal for the joinery or structural stability.
- c. Use of other materials like cane, steel, bamboo strips or weaving for seat design.
- d. The stool will have features like swivel seat (360 or 180 degree rotation) and provision for fixing to the floor.

The product aims at one time assembly at showroom or customer's end.

The immediate target market for the product will be Wine Bars proposal by Indage group of wines.

The target audience is theme pubs /bars of resorts or restaurants, for example 'Tropical Bar' of Taj Land Ends, Mumbai.



knock - down BAR STOOL in bamboo



10.0 Ideation and Concept generation



knock - down BAR STool in bamboo

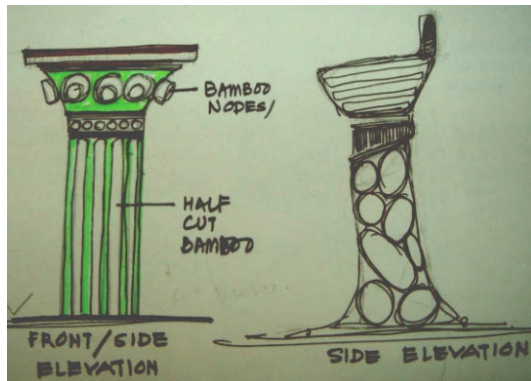


Fig. 10.1

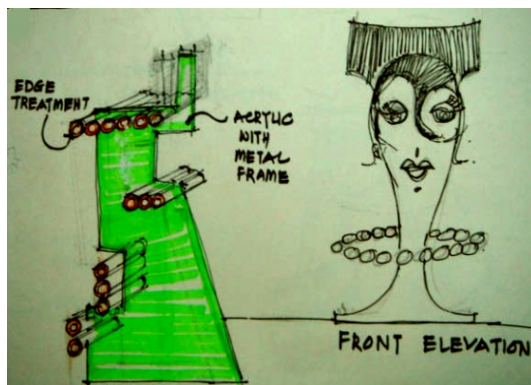


Fig. 10.2

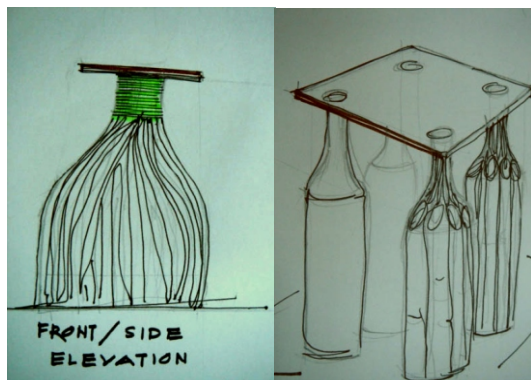


Fig. 10.3

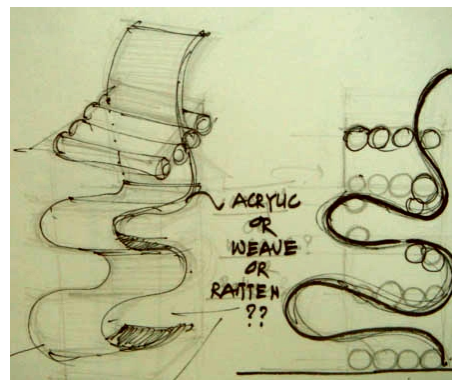


Fig. 10.4

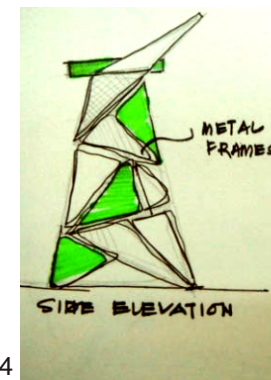


Fig. 10.5

Various ideas for bar stool were generated by considering as well as not considering the material constraint. Various metaphors were used like 'bottle stool', 'flower stool' etc. There was a theme of illusion based on people's world after having couple of drinks. There was 'bird' metaphor relating to mind of people that they have after having few drinks.

The images shows various idea sketches developed for bar stool. Use of other materials like metal, acrylic along with bamboo was also thought of. This could be seen from some of the sketches below showing molded acrylic and metal frames with weaving (Figure 10.4 and 10.5)

Knots in bamboo was used as an element for one of the designs (Figure 10.1). Bottle idea was also thought of and methods of expressing 'bottleness' in bamboo was explored (Figure 10.3)

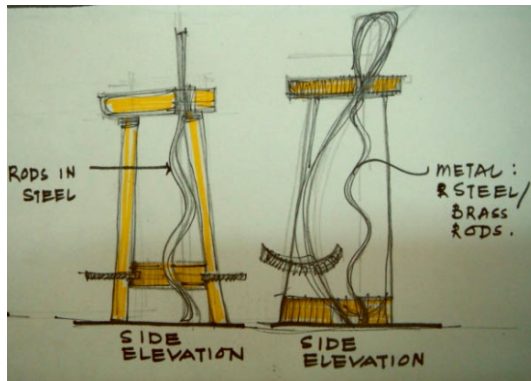


Fig. 10.6

For the theme of illusion, different elements in metal and acrylic were used along the periphery of simple bamboo core. This can be seen from Figure 10.6 and 10.7

Peanut stool can be seen in Figure 10.8 and 10.9. It shows two options - giving the form of peanut by bamboo weaving (10.8) and orienting bamboo elements from a central vertical member giving the form of peanut shell (10.9).

Bringing out beauty of bamboo when seen as circles in cross section was one of the ideas and could be seen in Figure 10.10 and 10.11

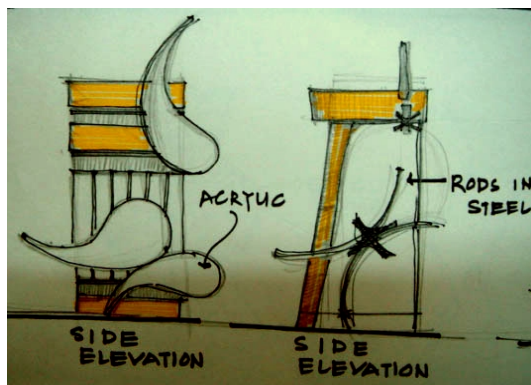


Fig. 10.7

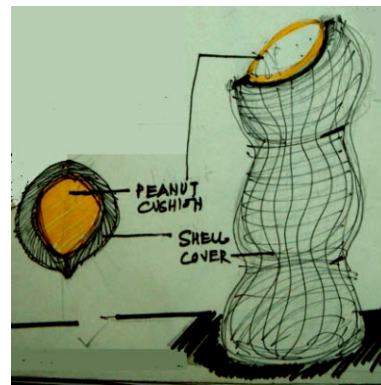


Fig. 10.8

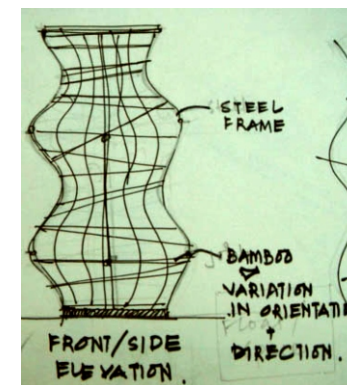


Fig. 10.9

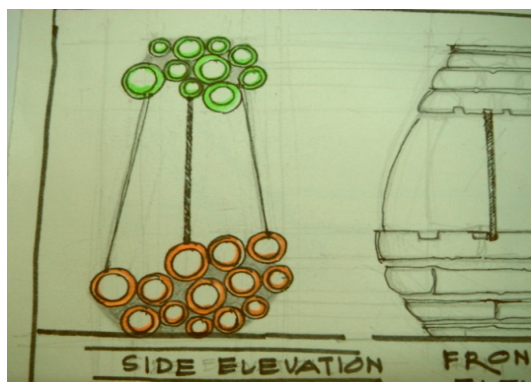


Fig. 10.10

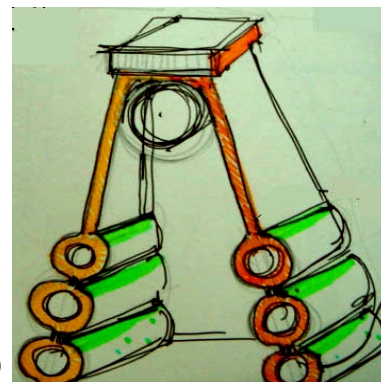


Fig. 10.11



Fig. 10.12

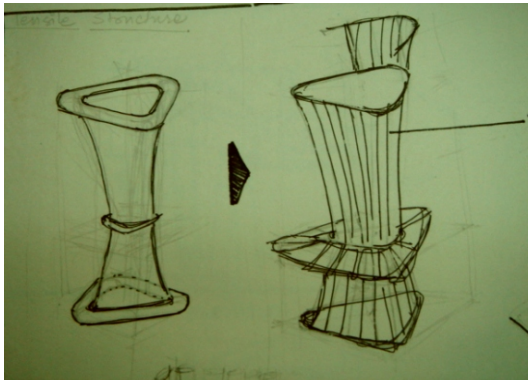


Fig. 10.13

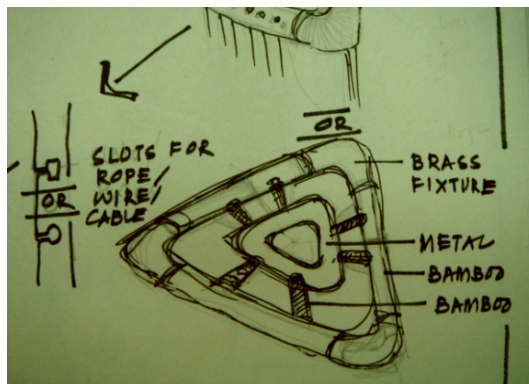


Fig. 10.14

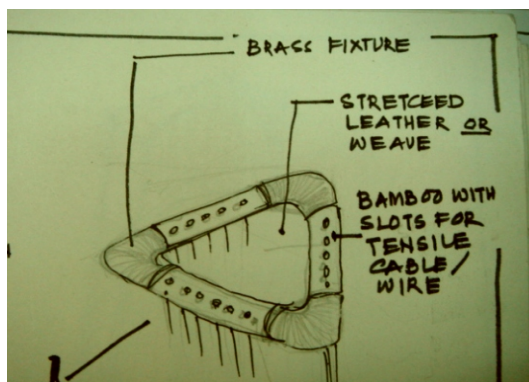


Fig. 10.15

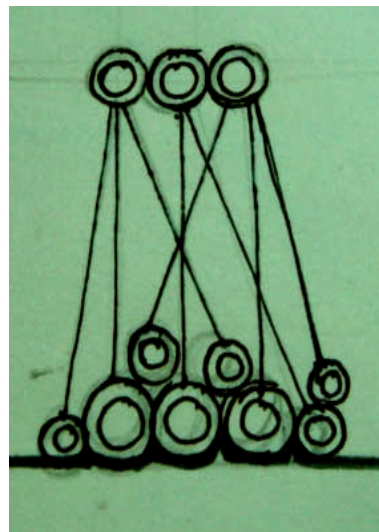


Fig. 10.16

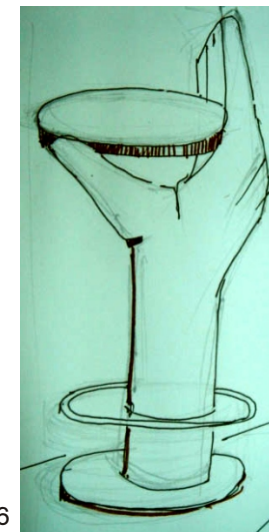


Fig. 10.17

Use of tensile members like rope or wire was focus for one of the ideas as shown in Figure 10.13, 10.14 and 10.15. Stretched cloth or leather is used for seat. Rope is stretched between two triangular bamboo frames.

Idea shown in Figure 10.6 is nothing but variation of ideas shown in Figure 10.10 and 10.11.

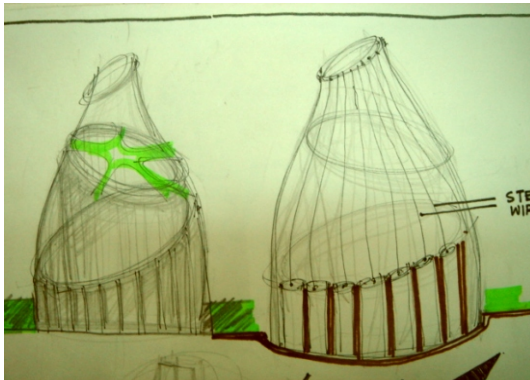


Fig. 10.18

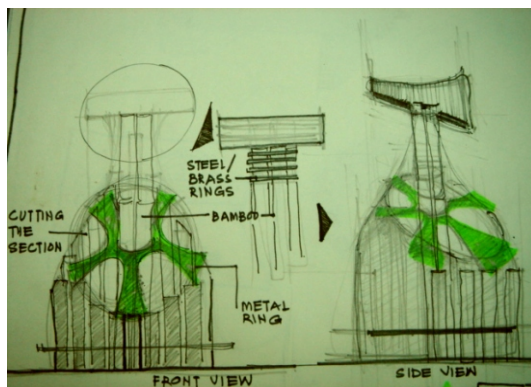


Fig. 10.19

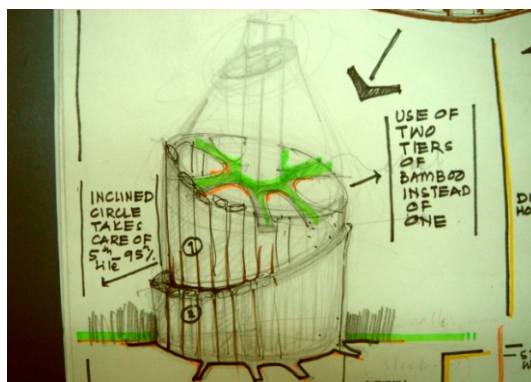


Fig. 10.20

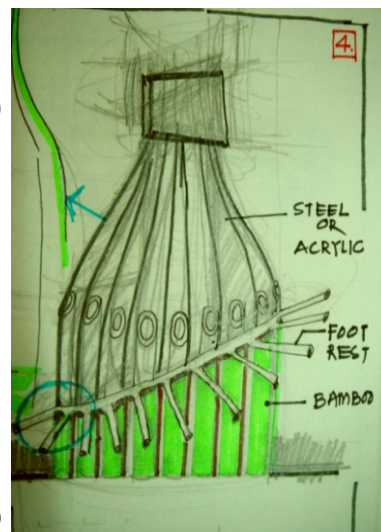


Fig. 10.21

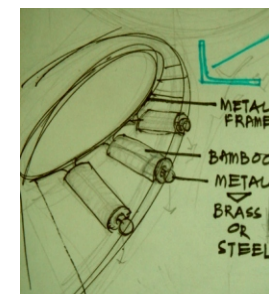


Fig. 10.22

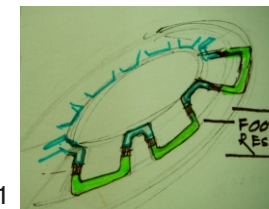


Fig. 10.23

The idea of taking bottle as a metaphor (Ref: Figure 10.3) was developed further since it had potential and offered challenges with respect to expression in Bamboo. The process could be seen in Figure 10.18 to Figure 10.21

The bottle was build around the central bamboo core. Use of materials like steel wire, metal plate joining the center to peripheral bamboo was explored.

The circular base consists of series of bamboo joined together, which also forms the area for the footrest. The upper part is made up with steel wire. Solid half filled base and transparent top part resembles the liquid filled bottle.(Figure 10.18 and 10.21)

Details for the footrest could be seen in Figure 10.22 and 10.23



11.0 Concept Development



knock - down BAR STOOL in bamboo



Fig. 11.1
1:1 scale model in
filecard

For developing this concept further, two approaches were taken which would be explained further.....

A Approach One

In this approach, the emphasis was on explorations of formal aspect of barstool. 1:1 scale model in card board gave first feel of the height and volume that the bar stool will occupy.

Small mock up models were made to understand the optimization of form without losing the expression. Using steel rod with bamboo was considered. Various forms were tried focusing on a single line that will express bottle. This was similar to the Abstraction exercises that we did earlier.

As seen in Fig. 11.2 and 11.3, spiral forms were made using copper pipe, simulating the steel rod in actual product. Fig.11.4 shows another option of the same idea.



Fig. 11.2



Fig. 11.3



Fig. 11.4

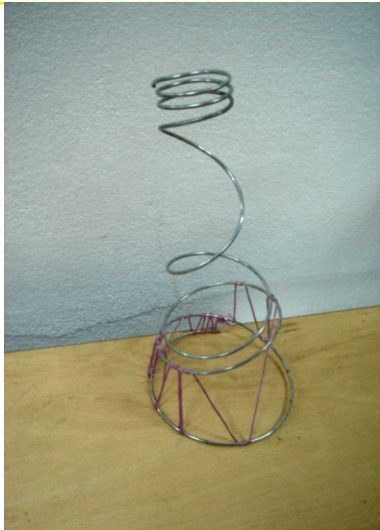


Fig. 11.5



Fig. 11.6

Possibility of combining bamboo or cane weave with the steel member was tried (Figure 11.6).

B Approach Two

In the second approach, idea was to work on the main support system of bamboo and later on look into possibilities of combining work done in first approach

This type of approach was very useful because I could clearly understand the role of 'Bone and Skin' in a product.

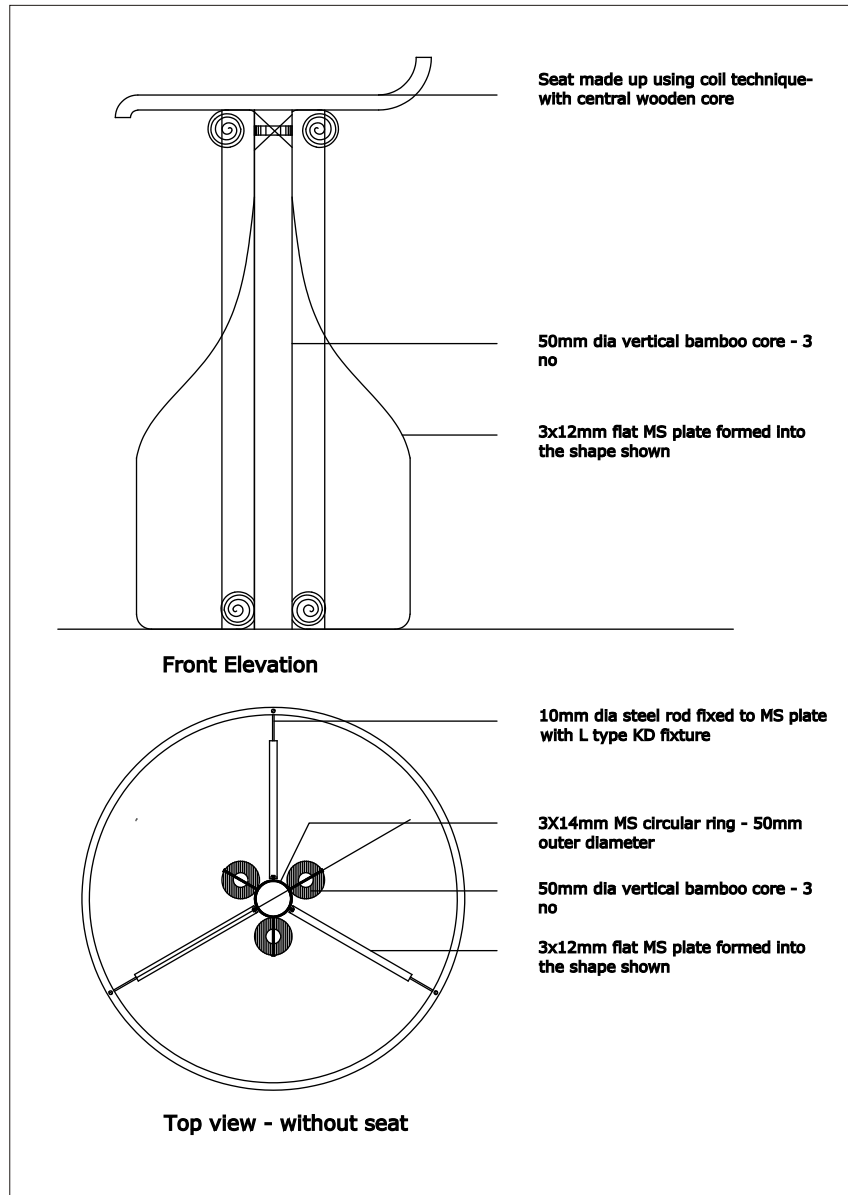
The methodology in this approach consists of simultaneous working on drawing and making it in the workshop. Since bamboo was completely new material for me, actual working with it was the only solution to understand the problems and advantages of bamboo.

Developing Knock Down joints was also a challenge and it needed lot of experimentation.

I will explain the development of design with respect to seat, footrest and the main load bearing structure. During this process various joints and details were worked out. The process was developmental and one concept led to another.

Design was mainly focused on the fact that it should be feasible to be manufactured at KONBACK.

All the help with respect to supplying material i.e. Kanak and Manga bamboo required for making prototypes was given by KONBAC.



11.1 Concept I

This concept consists of using three vertical bamboo members having 40mm diameter each. They were fixed at an angle of 120 degree around MS ring or a bamboo piece of 50 mm diameter .(as seen in Fig.11.8) Alternating with these three members there are three MS flat members bent in the profile shown in drawing. The profile of these members catches the profile of a bottle(Fig.11.8) Main drawback of the design was rotary movement of the bamboo members along the joint since both were circular.

Fixtures seen in the image are standard Knock Down fixtures manufactured and supplied by Ebco fittings in Mumbai. Detail of the fixture will be shown in following page.



Fig. 11.7
Drawing
showing
concept I

Fig. 11.8
First
experimental
prototype





Fig. 11.9
Knock Down
Fixture



Fig. 11.10
Knock Down
Fixture



Fig. 11.11



Fig. 11.12

Figure 11.9 shows two type of Knock Down fixtures

- MS screw with MS stud.
- MS screw with Brass head and Nylon stud

This type of fixture is used to joint two parts. The stud is fixed in one part and the other part gets joined to it with the help of screw. Due to the stud, wear and tear due to repeated use is avoided. Removing and refixing of parts become possible.

Figure 11.10 shows another type of fixture. It consists of a steel pipe with two screws on both ends. This is used for joining two parts sideways.

Both the fixtures were used and tested for bamboo and the result was positive.(Figure 11.12)

These fitting were supplied by two companies in India

1. Ebco Fittings
2. Aries International



Fig.
11.13(a)
Seat
using coil
technique



Fig.
11.13(b)
Seat
using coil
technique



Fig.
11.13(c)
Seat
using coil
technique



Fig.
11.13(d)
Seat with
plastic
mould

Simultaneously, design for seat was also developed. From the viewpoint of finding new applications of existing techniques, one prototype was developed. Figure 11.13-a,b&c

The technique used is known as 'coil technique' which is developed in IDC by Prof. Rao. This involve taking long strips of bamboo and tightly coiling it around the central circular wooden or metal piece. The desired profile is obtained by using the mould (Figure 11.13d). Styrene mould was prepared and a seat was made using this method.

Drawback of the design was that it was not structurally very strong by itself. It required support at the base which was offered by three MS flat members in the design.

For this technique, skilled labour is required which KONBAC does not have at the moment.



Fig. 11.14(a)
Joinery for bamboo



Fig. 11.14(b)
Joinery for bamboo

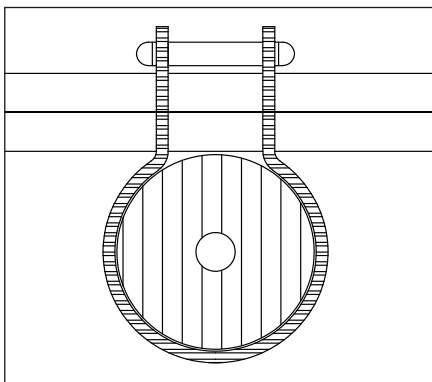


Fig. 11.15
footrest joinery

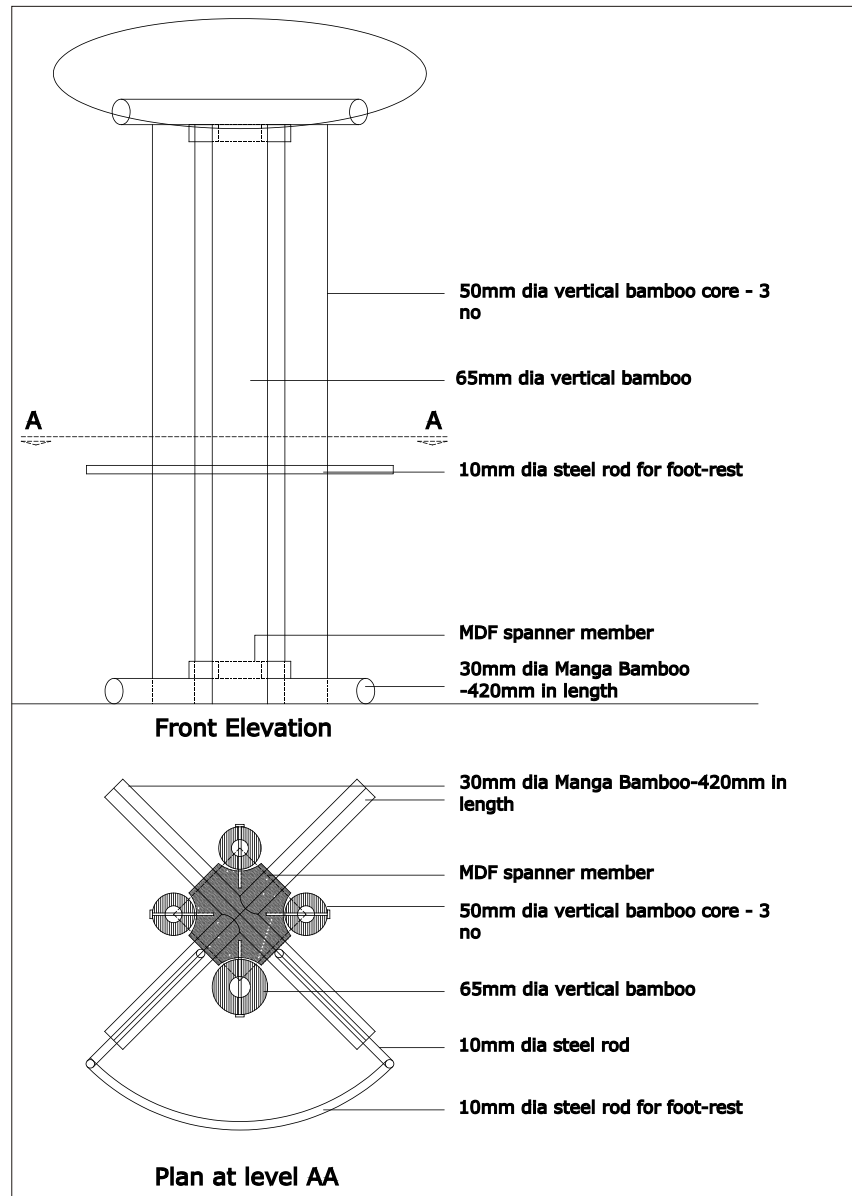
Footrest design consists of a circular ring in steel pipe which is fixed on three radial members.

The detail for joining three horizontal bamboo to each other and joining circular pipe to those three members required designing.

As shown in figure 11.4- a&b, wooden member was used in the center to join three circular bamboo sections. Wooden member has a square cross section and is press fitted in the central hollow part of bamboo. This could be tightened by MS screws if required.

Instead of wood, a precast metal member can also be used.

Figure 11.5 shows fixing of circular pipe to the horizontal bamboo members



11.2 Concept II

This concept was based on eliminating the problems that exist in Concept I.

Combination of four bamboo instead of three was tried out. Use of two bamboo fixed to form '+' were used as horizontal members in between four vertical members.

Wooden member in the shape as shown in figure 11.16 and 11.17 was made and fixed using knock down fixtures shown earlier. Shape of this member along with the '+' shaped member at the bottom reduced the rotational movement happening in Concept I



Fig. 11.16
Drawing
showing
concept II

Fig. 11.17
Second
experimental
prototype



Fig. 11.18
Detail
showing
wooden
fitting



Fig. 11.19
Base
detail



Fig.
11.20a
Cross
member
joinery I

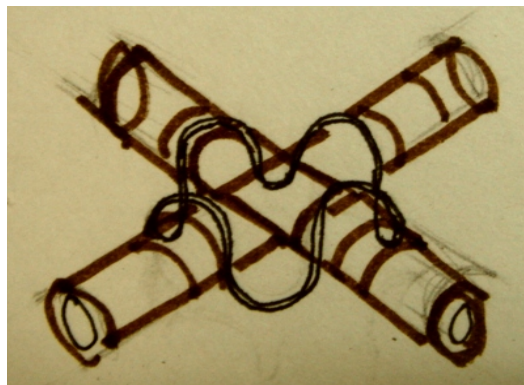


Fig. 11.2b
Cross
member
joinery II

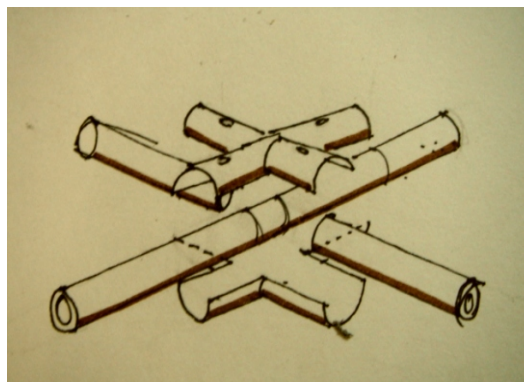


Fig. 11.20c
Cross
member
joinery III

Images in 11.18 and 11.19 shows detail at the base of the barstool.

Three details are shown for joining two bamboo members in '+' fashion
Fig 11.20b & 11.20c : using metal fixture as shown in the image for holding parts together



Fig. 11.21
seat profile
in
thermacol

Another design for the seat was developed. Profile of seat was cut in thermacol and tested with users to find comfortable seat profile and cross section. (Figure 11.21.)

The development can be seen from Fig.11.21 to 11.23.

The seat prototype in cane was also tested with user. It has few drawbacks with respect to the seat profile in front area and change is the shape of woven cross section. Fig.11.24a&b shows the structural members inside the seat on which the weaving is done. Fig. 11.25 shows correction required in the shape of the cane members to get desired cross section



Fig. 11.22
Profile in
bamboo

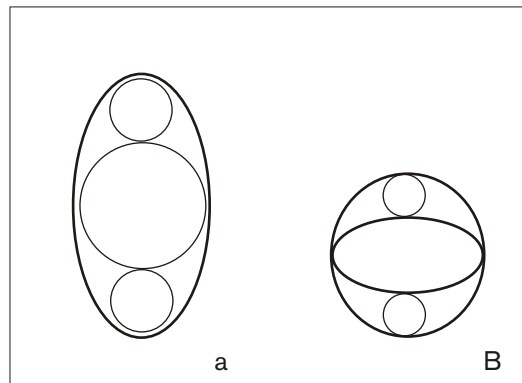


Fig. 11.25
a: existing
cross
section
b: desired
cross
section



Fig.11.24b



Fig. 11.23
Seat in
Cane

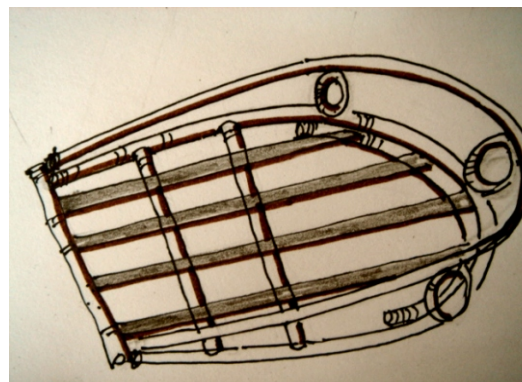


Fig. 11.24a
Cane
structure
inside
woven part

11.3 Concept III : Final Concept

In the third concept, the concern was design for knock down ability. The objective was to avoid need for drilling holes in bamboo for fixing.

What shapes and forms can be used to hold bamboo together???'Circle' was one of the solutions.

Circular rings were used to hold the four pieces together. The cross member present in between four members prevent them from coming closer.

The ring exerts inward pressure and cross member exerts outward pressure resulting in stabilization of joint. Images here shows use of plastic ring.



Fig. 11.26
Detail near
the seat



Fig. 11.27
Detail at
the base



Fig. 11.28
Third
experimental
prototype



knock - down BAR STOOL in bamboo

Plastic rings were replaced by MS rings in this prototype. At the base, a bamboo cross member is sandwiched between two MS rings. The top ring has a smaller circle joined to it which acts as a spacer member keeping four vertical bamboo apart.

Since bamboo show slight variation in diameter, this type of detail can accommodate those variations.

This concept resolves most of the issues. KONBAC can procure these metal fixtures from outside agencies in Mumbai or Goa.

Fig 11.31b shows the number of components present in barstool.



Fig. 11.29
Detail near
the seat



Fig. 11.30
Detail at
the base



Fig. 11.31a
Fourth
experimental
prototype

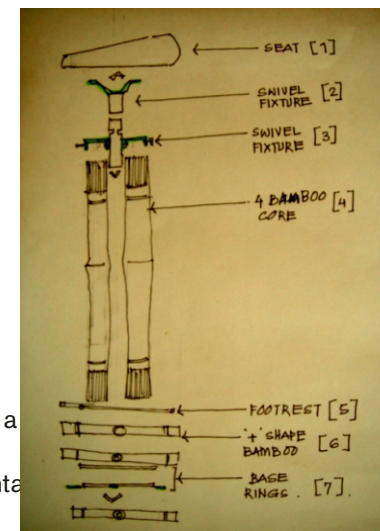


Fig.
11.31b

knock - down BAR STOOL in bamboo

Various methods and techniques to add to the richness of bamboo were thought and tried out. The treatment includes using Pyrography to enhance the joints and graphic pattern around the nuts and bolts as shown in fig. 11.32



Fig. 11.32
Pyrography

Instead of removing full skin of bamboo which KONBAC is practicing currently, only the bottom and top part of skin could be removed and rest should be left as it is; along with the central knot as shown in Fig 11.33. The fixtures will be fixed at the top and bottom part of bamboo only, so removing skin will allow slight moderation of the bamboo diameter.

Fixing steel or brass ring around the knot as shown in fig. 11.34 and 11.35 will also add to the beauty of bamboo. If Knot is to be removed then such fixture will make it more aesthetical. The rough texture of bamboo after removing the knot along with the smooth texture of rest of the skin creates interesting detail.

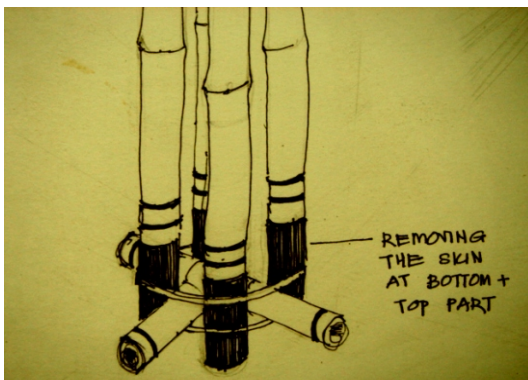


Fig. 11.33



Fig. 11.34

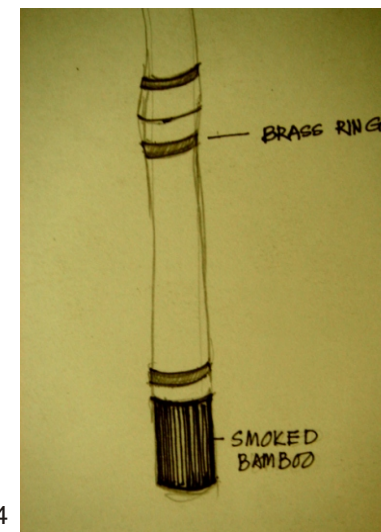


Fig. 11.35

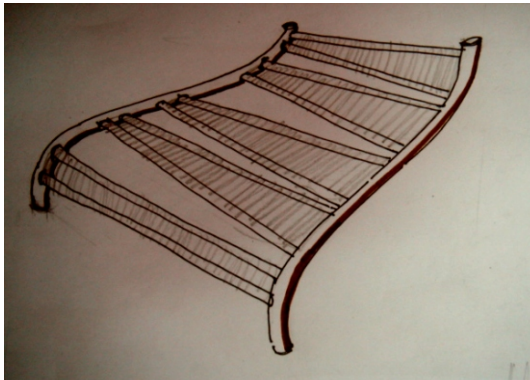


Fig. 11.36
Option I

Apart from cane seat shown earlier, various other options for seat were also designed. Adjacent images show different designs for seat using full bamboo, bamboo strips and combining bamboo with metal also.

Fig 11.36 : Use of steel pipe for the edge and flat bamboo strips fixed in unparallel fashion with a weaving done on alternate strips.



Fig. 11.37
Option II

Fig 11.37 : Use of full bamboo at the edges with cross woven strips for sitting area.

Fig 11.38 : Combination of full bamboo and cane mat for seat

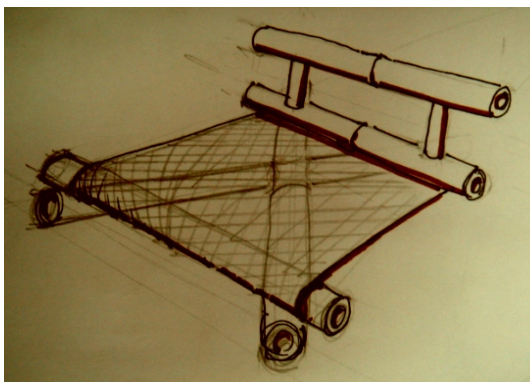


Fig. 11.38
Option III

Fig 11.39 : Use of full bamboo at the edges with bamboo strips

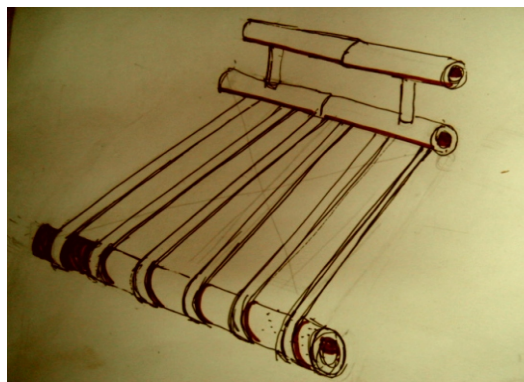


Fig. 11.39
Option V

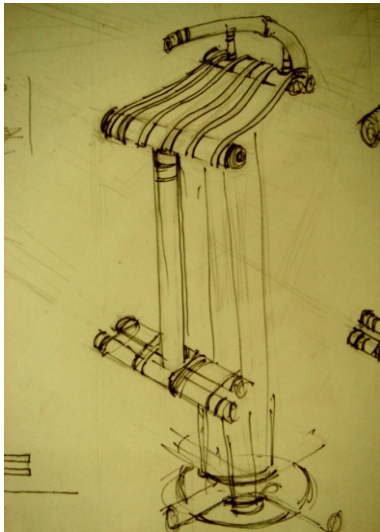


Fig. 11.40
Option VI

Fig 11.40 : Using bamboo with brass plates for sta and possibility of combining seat with the footrest for swivel type of barstool

Fig 11.41 : another option of combining footrest with the seat. Supports on the side gives clear space for footrest.

Fig 11.42 : Using variable bamboo diameter to take care of profile curve

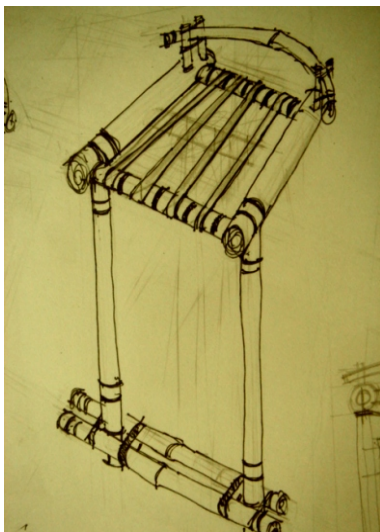


Fig. 11.41
Option VII

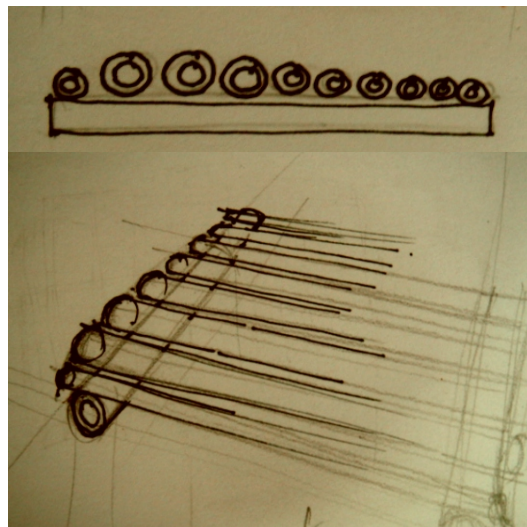


Fig. 11.42
Option VIII

knock - down BAR STOOL in bamboo

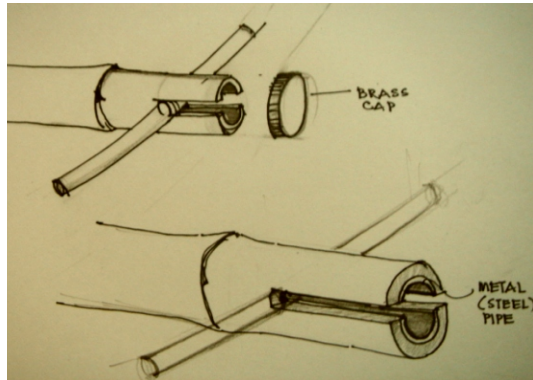


Fig. 11.43
Detail for
footrest

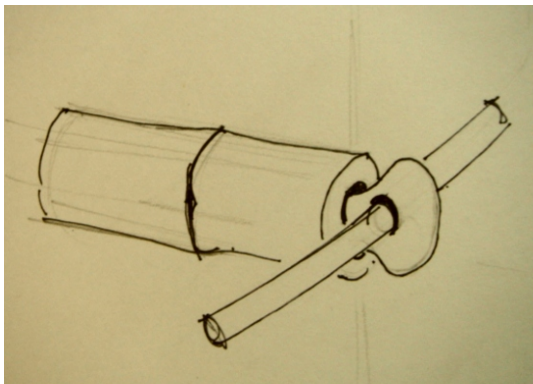


Fig. 11.44
Detail for
footrest



Fig. 11.45
Detail for
swivel seat



Fig. 11.46
Detail for
swivel seat

11.4 Other details

Detailing for fixing of footrest and swivel joint was done.

Fig 11.43 shows fixing details of a steel rod for footrest with the horizontal bamboo members.

Fig 11.44 shows use of intermediate wooden fixing member having spherical head. The steel rod for the footrest is passed from the spherical head of the wooden part

Fig 11.45 and 11.46 : typical detail used for rotating or swivel type of chairs. This type of detail can be easily accommodated the in final concept

The cross sectional drawing as shown in fig. 11.47 explains the fixing detail of bamboo with the swivel fitting.



11.5 Further work

Further work is being done in developing the final concept.

I will be working on detailing with respect to colour and finish of bamboo.

Formal attributed will be incorporated in the design.

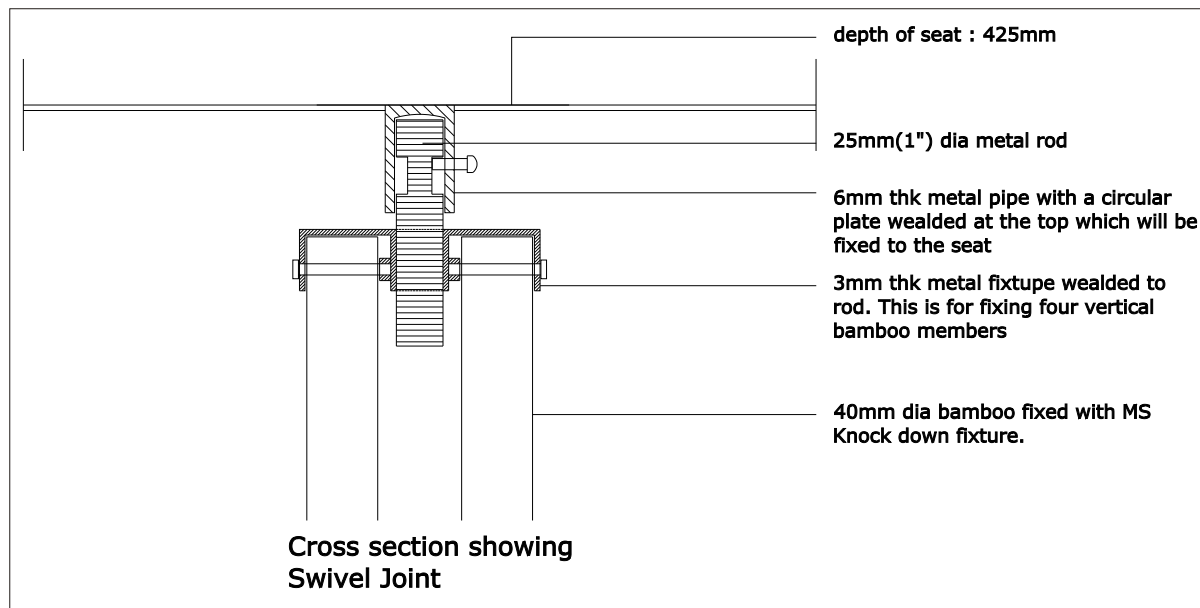


Fig. 11.47
Detail for
swivel seat





12.0 Appendix



knock - down BAR STOOL in bamboo



12.0 Bibliography



knock - down BAR STOOL in bamboo



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Final Design



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First
Prototype

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Final
Prototype

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Seat Detail

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knock - down BAR STOOL in bamboo



1



2



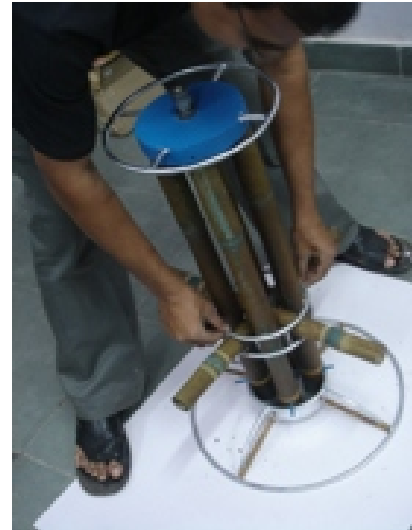
3



6



7



8



11



9



10

Assembly Sequence

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