Internship at Uravu

Wayanad

Final Report

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Contents

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2013-15 Batch
1st year | MDes Product design
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Completion certificate

uravu
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Date..25/6/14..

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This is to certify that Mr.Manu Revi Poovakkat, MDes Product Design, Industrial Design Centre IIT Bombay has done his Summer Internship for a period of one month (from 12th of May till 13th of June) and has assisted in the following projects/fields:

1. **Solar Workstation**
2. **Redesign of Bamboo Pen**
3. **Accessories**
4. **Furniture design**

Mr. Manu Revi Poovakkat has been found to be keen in conceptual and technological explorations and their respective mock-ups and has succeeded in formulating new ideas and concepts. His conduct has been good throughout the internship period and we wish him all the success for his future endeavors.

URAVU THRIKKAIPETTA WAYANAD SCIENCE & TECHNOLOGY STUDY CENTRE

For URAVU

President

Acknowledgement

I would like to extend my thanks to Prof. B. K. Chakravarthy, the HOD , Industrial Design Center, IIT Bombay for giving me the permission to proceed with my internship in Uravu.

This internship would not have had its true meaning without the guidance I received from Prof. A G Rao.

I am grateful to Uravu, Mr. Baburaj (President), T. Shivaraj (founder, President), Mr.Manoj (Manager) and the staff there , especially Mr.Thomas, Mr.Rakesh, Mr.Balan, Mr.Lenin, for supporting, encouraging and appreciating my work and helping me adjust into the dissimilar environment of Uravu.

Lastly, I would like to thank my parents and my classmates, especially Gautham R Varma, Anulal V S and Isaac Junior for providing me with mental support and discussing my work from time to time.

I am grateful to all those people who wished me well and helped me make my days at Uravu most memorable one.

1

Uravu
Wayanad

Fig.1: *Uravu entrance ; source:Author*

Wayanad is one of the fourteen districts in Kerala, situated about three hours from Calicut which is the nearest city. Wayanad has its headquarters in Kalpetta. It is also the least populated district in Kerala.

Wayanad is set high on the Western Ghats with altitudes ranging from 700 to 2100m.

About Uravu

'Uravu', set in the heart of woods on the Western ghats in Kerala among the misty mountain range and lush green backdrop, is an organization of international recognition acclaimed for promising a new path for many who missed out on their opportunities to live.

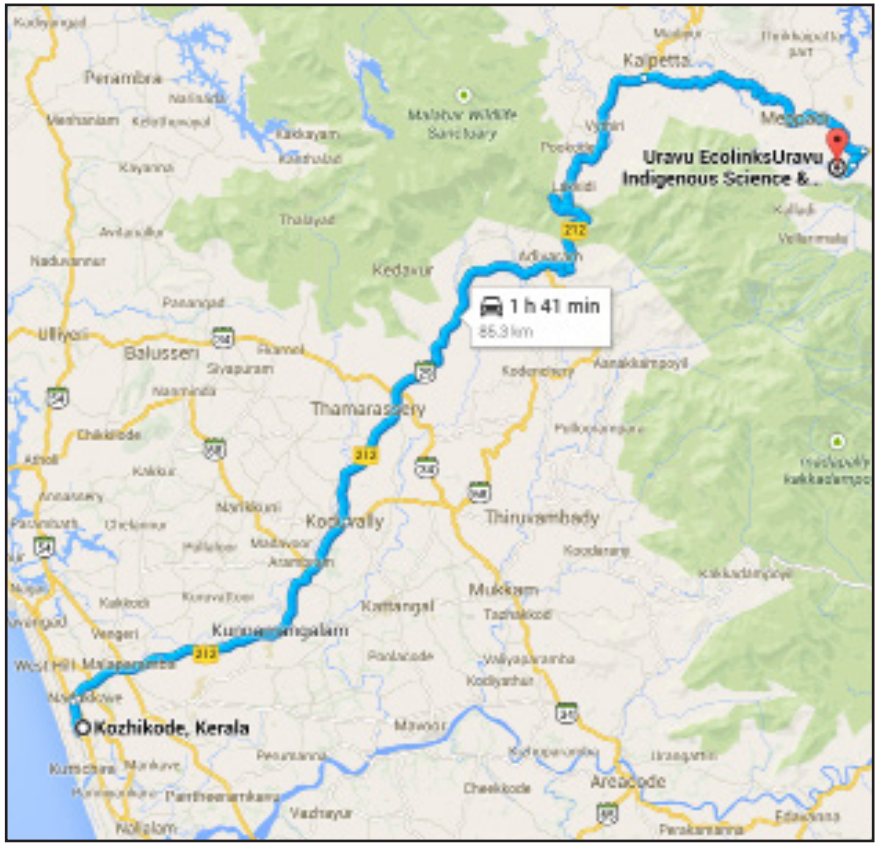
Uravu [Fig 1] is a non-governmental organization registered under the Indian Trusts Act. Uravu works with people, governments and private businesses as a development partner. It is an institution in the making

Uravu is currently focused on bamboo-centered products and services and believes in sustainability in every aspect it throws light on. Uravu implements integrated, end-to-end programs in the bamboo sector, which include providing skill training in bam-

boo processing, establishing micro enterprises, marketing of bamboo handicraft, cultivation of bamboo and promotion of eco-tourism.

Uravu is located in Thrikkaipetta village in Wayanad district.

How to reach Uravu



Uravu is nearly 87 kms from the nearest railwaystation - Kozhikode, from where bus services are available at regular intervals. Nearest airport is Calicut International Airport which is about 107 kms from uravu. From Karnataka side uravu is reachable via road from Mysore which comes to about 143 kms.

2

Bamboo
The green gold

Fig.2: *Bamboo at Uravu; source : Author*

Bamboo, essentially, is a grass. It is one of the fastest growing plants and its vertical growth depends on the geographical locations. In the Mediterranean regions bamboo grows only to a limited height of about 1-1.5 feet, whereas, in the equatorial regions, they would grow to its full potential, up to height of about 20-25 feet.

There exist more than 1250 varieties of bamboo across the world, out of which 136 are identified in India and 28 among them in Kerala. Uravu got a wonderful nursery which houses a good veriety of this wonderful plant [Fig.2].

Growth Pattern

During the early stages, the growth is less and is more confined beneath the ground at root level. From the middle of second year, shoots start coming out and roots propagate beneath the ground. In the subsequent years, more and more shoots sprout up. By fourth and fifth year onwards harvesting of the matured bamboo begins and the same can be continued from then on. Patterns start showing on the bamboo once its matured enough to be harvested. To make it easier for the on-site workers, colour coding is done, with respect

to each year, to the shoots that come up.

Identifying different types of Bamboo

Natural methods for identifying different types of bamboo are:

- By observing the development of the Sheath
- The forms and patterns on the leaves

Types of Growth of Bamboo

Monopodial - Bamboo grows individually, where different shoots sprout at a certain distance from each other.

Sympodial - Bamboo grows as a bunch and shoots sprout close to each other

Bamboo Varieties Used for Construction

Guadua augustifolia [Fig 3]

- A bamboo variety from Columbia
- Monopodial
- Non- Bendable
- Diameter same for first 15m and then tapers to top
- One thorn at a node
- Used singularly or can be bolted together, as per need
- Lifespan of about 70 years
- 15% more BTU than other fuel woods (alternative fuel)

Fig.3: *Guadua augustifolia*


Fig.4: *Bambusa bambos*

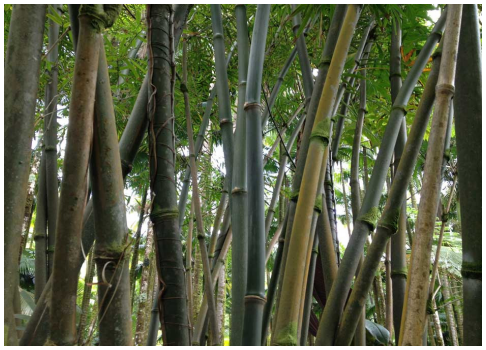


Fig.5: *Dendrocalamus strictus*


Fig.6: *Dendrocalamus brandisii*

Bambusa bambos [Fig.4]

- ♦Native of Kerala Ghat
- ♦Sympodial- difficult to harvest
- ♦Structural strength- almost double as of Guadua
- ♦Thorny
- ♦Pruning technique while growing- for easy harvesting
- ♦Pruning - if not done, results in wastage of immature bamboo as the whole bunch is harvested

Dendrocalamus strictus [Fig.5]

- ♦A tropical genus; similar to Bambusa genus
- ♦Best for cantilever structures
- ♦Attains a height of 30ft
- ♦Also used in furniture
- ♦Variants exist within Kerala, in different districts
- ♦Comparatively thin cross section of 3-4cm

Dendrocalamus brandisii [Fig.6]

- ♦Native of Southeast Asia - wet evergreen tropical forests
- ♦Also known as velvet leaf bamboo
- ♦Lifespan of 60 years
- ♦Thornless
- ♦Sympodial, but less branches- hence easy to harvest
- ♦Used for pillars and roofing
- ♦Also used in handicrafts

Dendrocalamus giganteus [Fig.7]

- ♦World's thickest bamboo but not the strongest
- ♦Will reach heights up to 46m
- ♦Pillars can be made out by splitting this bamboo and filling concrete within
- ♦Lifespan of 100 years

Fig.7: *Dendrocalamus giganteus*

Bambusa balcooa [Fig.8]

- ♦Indian origin
- ♦Strongest, thorn less
- ♦Called a semi solid bamboo as the cavity within is comparatively small
- ♦Inner wall thickness of 4-6 cm

Fig.8: *Bambusa balcooa*

Bambusa nutans [Fig.9]

- ♦Grows at altitudes between 500-1500m
- ♦Thrives on moist hill slopes and flat uplands
- ♦Commonly found in the North East, Orissa and Bengal
- ♦Thorn less
- ♦Strong bamboo used for scaffolding
- ♦Sympodial growth, but still can be cut out individually with skill
- ♦Used for creating ladder, pillars etc

Fig.9: *Bambusa nutans*

Fig.10: *Schizostachyum dullooa*

Fig.11: *Rostretta*

Fig.12: *Dendrocalamus sikkimensis*

Schizostachyum dullooa [Fig.10]

- ♦Grows up to an altitude of 1200 m
- ♦Found in the North-eastern region of India
- ♦Thorn less
- ♦Sympodial
- ♦Thin cross section
- ♦Grows straight without bends
- ♦30 ft in height
- ♦Comparatively less strong

Rostretta [Fig.11]

- ♦25 ft in height
- ♦3-4 cm wide cross section
- ♦Used in furniture making too
- ♦Easy to harvest
- ♦Inner section is comparatively small

Dendrocalamus sikkimensis [Fig.12]

- ♦Similar to Brandisii but shorter and thinner
- ♦40 ft in height
- ♦Branches are normally orange in colour
- ♦Used in pillars as strength is more
- ♦Immature ones used in weaving too

Burmese bamboo [Fig.13]

- ♦Just below Dendrocalamus giganteus in height, width and strength
- ♦Used in pillars

Siamensis [Fig.14]

- ♦Hollow
- ♦Bendable
- ♦Used more in furniture
- ♦20 ft in height
- ♦Bends sideways while growing

Melocanna baccifera [Fig.15]

- ♦25 ft in height
- ♦Grows in tropical region
- ♦Monopodial - one metre between successive shoots
- ♦Thorn less
- ♦3-4 cm wide

Dendrocalamus longispathus

- ♦Glaucous green when young, grayish-green on maturity
- ♦Grows straight
- ♦Distribution: Thailand, Malaysia, Bangladesh and India
- ♦Thorn less: good for construction
- ♦Requires shade to grow
- ♦Grows up to 50ft in height and 1.5 to 2 inch wide

Fig.13: *Burmese bamboo*

Fig.14: *Siamensis*

Fig.15: *Melocanna baccifera*

Fig.16: *Thyrsostachys oliveri*

Fig.17: *Bambusa Tulda*

Thyrsostachys oliveri [Fig.16]

- Distribution: Thailand, China, India
- Needs less space to grow
- Thick sympodial
- Tough to harvest
- 2-3 cm width

Unidentified Species

- Soft and lush green
- Thickness of 3-4 cm
- Has lots of branches
- Big hole inside
- Hollow, but used in roofing

Bambusa Tuldal [Fig.17]

- Similar to balcoa
- Medium diameter hole inside
- Branches at base
- Sympodial

Pseudoxytenanthera ritchii

- No hole and bendable
- 2-3 cm wide and 20 ft height
- Suitable for furniture

Palida [Fig.18]

- ♦Grows straight
- ♦2 inch wide and big hole

Dendrocalamus membranaceus [Fig.19]

- ♦Used for construction
- ♦Grows up to 60ft tall
- ♦Bigger hole
- ♦Used for making ladders

Dendrocalamus Asper

- ♦Native to Southeast Asia
- ♦Used for heavy construction
- ♦Shoots are consumable

Bamboo Used for Ornamentations

- ♦Buddha bamboo [Fig.20](Bambusa Vulgaris Wamin)
- ♦Bambusa multiplex

  Can be used for making pens

- ♦Bush Bamboo
- ♦Golden Bamboo
- ♦Creeper Bamboo
- ♦Bambusa multiplex vangata (it has white striations on its leaves)
- ♦Chinese Bamboo (Phyllostachis Bambusoides)
- ♦Bambusa vulgaris- Green
- ♦Bambusa vulgaris- Yellow

Fig.18: *Palida*

Fig.19: *Dendrocalamus membraneceus*

Fig.20: *Buddha bamboo*

Fig.21: *Black bamboo*

♦Black Bamboo[Fig21]

Bamboos Used for weaving

♦Ochalndra Travancorica

♦Ochalndra Scriptorla

Used for making pens and jewellery

♦Schisostachium Bedomi

Need shade to grow

Cultivation techniques at Uravu

♦Growing seeds

♦Hormonal Process

A small hole is made on a bamboo stem. A mix containing 7gm Naphthalic acid, 100ml alcohol and 900ml water is made. This mix is added to 9L water and poured inside the bamboo through the hole till brim. Then it is wrapped up with plastic and buried in ground. Shade is provided. New bamboo shoots grow from the nodes.

♦Replanting from a bunch after taking one plant (with root and shoot) out.

3

Unit visits

As part of getting familiarised and understanding the different stakeholders associated with Uravu a visit was done to the different units that work under / obtain guidance from Uravu. The micro enterprise units were established under the Rashtriya Sam Vikas Yojana (RSVY) programme, providing employment in bamboo craft to rural people [*http://www.hindu.com/2005/11/09/stories/2005110912410300.htm*].

The visit encompassed Bhavm Mural Arts, Niravu, Soubhagya and Unarvu. These units laid out pictures of achievement, struggle, stagnation and hopes that people live with as they continue to be part of the craft industry in Kerala. These following are the short glimpses into the lives of many who help constitute the fragile craft sector in and around Uravu.

Fig.22: *craft products at Niravu; source:Author*

Niravu

A self-help group run by women, Niravu has been creating variety of craft products such a The Rainmaker, phone stands, pen stands etc.[Fig.22] for more than nine years. The products created are as per the requirement / orders which are delegated from Uravu. Employees at Niravu receive their income based on the

number of products that they deliver to Uravu. The unit is still not self-sustained even after being in operation for a decade. Even though there are opportunities for them to attract craft orders on their own, such a potential has not been realized and they still depend heavily on Uravu.

Bhavm Mural Arts

This unit showcased a successful story of creating a steady market for craft products. The unit focuses on mural art works. Dendrocalamus Gigantus variety of bamboo is used to create mural paintings [Fig.23(top)]. Bhavm are no longer under Uravu, and require assistance only regarding raw material and guidance. The mural paintings from Bhavm were done on walls, canvas, and on all things that had utilitarian value. They progressed in a way where they utilized the technical knowledge about bamboo along with their creativity to create a niche sustainable market that nourishes craft and creativity.

Soubhagya

Another self-help group run by women, situated in Parathode. The unit has adequate machinery in terms of sander, grinder etc. The workers are paid a fixed salary per month. Their output is also based on the orders delegated from Uravu. Training for the workers are imparted from Uravu and their working hours are from 9am to 5 pm every day. The transporting of products / raw materials in between Uravu and Soubhagya are through public transport buses or via hired goods vehicle.

Self-sustainability has not been achieved by the unit

Fig.23: *Bamboo murals at Bhavm(top);Book of spices design at Soubhagya(bottom); source:Author*

Fig.24: *Bamboo jewellery designs at Unarvu; source:Author*

even after being operational for about 5-7 years. Soubhagya is still heavily dependent on Uravu. They still have not attained the level to ensure quality check and to manufacture totally finished final products. Semi-finished goods are transported back to Uravu for the final steps and quality check. The members have the skill to work with bamboo, but are not able to explore additional products owing to the lack of time. Most of the members are housewives and mothers.

Unarvu

Another self-help group run by women situated in Moorikkappu, Vengappally. Unarvu showcases a story in which the bamboo craft training imparted to them were put to use in accessory design, creating earrings, necklaces and other jewellery for women [Fig.24]. They faced difficulties to own a working space and hence registered their self-help group as a society and built a space using a loan. They devised a strategy of employing only married and settled down women who belong to the nearby villages, thus ensuring that there were no fallouts once the members were trained.

After breaking even to a certain extent, they even started to source raw material on their own without the assistance from Uravu. They use minimal machinery for the production. Students and Interns specializing in accessory design provide their valuable input in jewellery design. Unarvu is also active in conducting exhibitions across India.

4

Bamboo as a material

Bamboo in the pure and natural form is less resistant to the biological degrading organisms. The large amount of starch content present in bamboo attracts the degrading organisms like fungi, termites, and becomes the food for these organisms which are generally called Borers. The average natural durability of bamboo is less than 2 years. However if stored with care, the untreated bamboo may last up-to 4-7 years that too very rare. Bamboo is also known to be rich in silica, but the entire silica content is present in the outer layer. Even though it has minor amount of waxes, resins and tannins, but none of these have enough toxicity to improve its natural durability.

Compared to timber, bamboo has a low natural durability, hence few chemical treatment methods are used to improve the durability of the bamboo columns. The treated bamboo are completely safe from the borers and the durability increases many folds.

Bamboo Treatments used in Uravu

1. Gas pressure impregnation

The bamboo columns are placed in a pressure chamber and the air inside the chamber is sucked out. With the help of a vacuum pump, the chamber is then pressurised with vacuum. The chamber then slowly filled with the treatment chemical (Borax and boric acid powder) and pressure is applied to a predefined value of 16kg/cm2 . Due to this pressure the chemical gets pushed into even the small pores in the bamboo and the entire bamboo column gets soaked in chemical. For a 100 litre of water , 3 kg of boric acid powder and 2.5 kg of borax is used as the chemical . The entire pressurised chamber is kept untouched for a day and the columns are removed from the chamber the next day[Fig.25 (top)]. The treated bamboo's are then dried, and used for further manufacturing processes.

2. Hot dipping

The fresh cut branchless column with punctured nodal walls are weighed down and boiled in a container with chemical solution (Boric and Borax powder) [Fig.25]. The minimum process time is 4 hours. The treatment is done for splitter and small diameter bamboo in small quantity.

Fig.25: *Gas pressure impregnation(top);Hot dipping(bottom); source:Author*

5

World Environment Day

June 5th is World Environment Day. As a patron of green movements, the environment day was well celebrated at Uravu. A gathering was called for, to remind and remember the ecological imbalance faced by earth at present and how we, as humans, are responsible to change or rather slow down its course as it has reached an extent where it seems the catastrophes are irreversible.

It was also said that, at Uravu, Environment day is not just for a day. It is a social responsibility every human has to carry with him through out his life for the sake of the planet and for the sake of the future generation.

The Environment day was celebrated in the nearby schools also. There were rallies by the students pledging themselves to be a part of this social cause. Bamboo shoots were planted at Uravu as well as in the school.

There was also a performance by a student trainee, Mr. Vibhu, who made beautiful musical instruments with bamboo.

6

Uravu Ecolinks

Fig.26: *Bamboo house at Uravu ecolinks; source: Author*

Uravu has come up with novel solutions to housing problem at wayanad, especially how to tackle uneven terrain in a sustainable way. We had a chance to visit the housing project and to understand how this is undertaken.

The main structure [Fig.26] rest over a base made of palm pillars containing concrete [Fig. 27]. Main structure that houses the bedroom is has wall made out of mud plaster (mud+sand+lime+1-2% cement) on the inside as this does not come into contact with water and the outside wall is lined with bamboo strips (Dendrocalamus Giganteus). Each structure has an attached bathroom which is lined using ferrocement due to the constant exposure to water.Interesting part of eco links structure is its butterfly roof, the 2 flaps of which are held together by ropes to prevent it from transferring excess weight to the pillars. The roofs are lined by 2 layers of bamboo (Dendrocalamus brandisii) mats, chicken mesh and 2 layers of ferrocement. Bambusa bamboo forms the pillar structure, while Dendrocalamus brandisii is used for beams.

A single kitchen is built to service the whole housing structures which are solar powered and sensor lightings are provided in the pathways to reduce power consumption.Water management is one issue when it comes to housing and the way its

Fig.27: *Palm and concrete base for construction; source: Author*

managed is what makes eco links stand out of the rest. Water from reservoir is fed into a fresh water tank, which goes directly into shower, wash basin and kitchen. This water is then fed into a grey water treatment tank and then to grey water tank. This treated water is fed into the flush system which is again send for water treatment and finally into the landscape. This process ensures safety of ground water at the same time ensuring proper water supply to respective areas.

7

The book of spices

Fig.28: *Book of spices designed at Uravu; source: Author*

:About the book

The Book of Spices [Fig.28] is a unique product made in the Uravu Kalpetta Bamboo Cluster, which has won much appreciation on account of the perfect match of innovative concept and utility value as a gift product. The Book is basically a box in the form of a book that can hold samples of spices (and for that matter many other items such as dry fruits, chocolate etc.) and be sold as a gift/memento. Uravu has been using the Book filled with organic spices as a memento of Wayanad.

The present form of the Book comprises of front and back covers made of bamboo veneer board (8.25 X 5.25 inch) size. The inner portion of the back cover holds a rectangular frame made of giant bamboo reapers of 6 mm thickness which functions as the box. There are partitions (4 to 9) in the box made of thin strips of bamboo, which acts as a container for spices.

How is it made

Earlier Uravu was making the book covers by joining and gluing together 4 strips of giant bamboo longitudinally, using fevicol. The glued planks are then pressed but keeping stones on top.

Issue faced with current design

Under hot and cold climates in India as well as abroad, the strips displayed a tendency to gradually bend or warp as shown in Fig.29. This appears mainly do to presence of moisture in the bamboo due to non uniform drying process.

Fig.29: *Warping issue seen at extreme temperature; source: Author*

Methods tried so far

- A cross-stitch with thinner bamboo strips were placed on the inner side of the front cover, taking out a groove on the board and inserting a strip of bamboo. This could not prevent warping to the required extend.

- A certain type of Bamboo Veneer boards (4 mm thick altogether with 0.5mm bamboo veneer sheets pasted on both sides of a 3 mm wooden ply board) were used [Fig.30]. Scarcity and weightage period to procure the raw material made it a difficult choice of replacement, even though it helped in mitigating the problem to a certain extend.

Fig.30: *Book of spices made of Bamboo veneer boards; source: Author*

- Hand-made slivers of D. giganteus (around 0.5 mm- I mm thickness) were pasted on both sides of a mechanically hot-pressed industrial board (of 3 mm thickness) [Fig.31]. The process involved taking slivers of uniform thickness which were glued uniformly on both sides of the board followed by application of uniform pressure on the board to fasten the slivers without air blotches. Even though this could prevent warping, Uravu faced the following issues in this regard:

  ♦Hand slivering combined with rotary sanders had to be used as machines were not able to provide the required uniform thickness (0.5 - 1 mm). This required proper training and skilled labour.

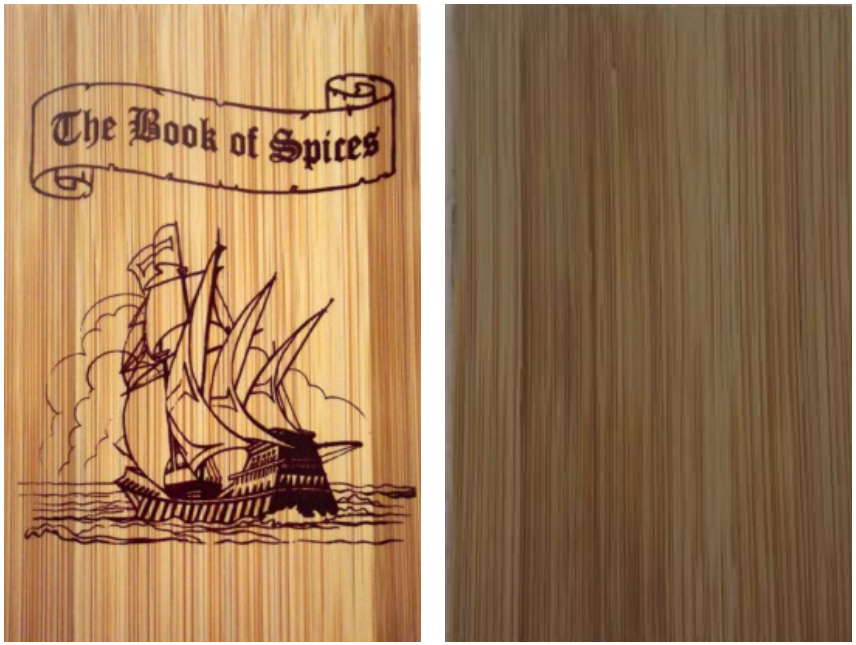


Fig.31: *Cover constructed using bamboo slivers; source: Author*

♦Glues had to be applied in a uniform manner which required proper training and skilled labour.

♦Lack of hot press system.

Solutions suggested to prevent warping

1. Redesigning book of spice

After a brainstorming session, suggestions were put to redesign the book of spices. It was observed that warping was localized to only the front side, as the back side had its strength coming from the box like wood structure attached to it. Question was, why not bring in a similar structure to the opening flap where warping is observed. To an extend this could solve the problem, but at the same time gave rise to some issues like :

♦Training artisans to the new designs

♦The whole philosophy of opening a book to its starting page becomes non existent.

♦Need for extra raw materials.

♦Cuts had to be more precise due to existence of male and female pieces locking together.

These issues led us into leaving behind the idea of redesigning book of spices and we started looking for new solutions to counter warping.

2. Into the world of adhesive

Absence of a hot press and cold press being the only choice, made us look into various options when it came to the choice of adhesive while laying out bamboo strips. We approached various organizations having prior experience in bamboo ply, one among

which was Bamboo Corporation, Nallalam and got insights into adhesives like Starke D3, Blue coat D3 and Henkel food grade which could be directly used. They also suggested using Urea Formaldehyde combined with Ammonium Chloride catalyst. As most of the above adhesives could not be locally procured, we contacted the local manufacturer of urea formaldehyde - Poly Formalin Pvt Ltd and paid a visit at their factory to arrange for test samples as well as to understand ways of adhesive application. Following actions were suggested to prevent warping :

- ♦ Using 65% Urea Formaldehyde resin with catalyst formic acid(both of which could be locally procured)
- ♦ Mixing clay powder or starch with the adhesive to enhance bonding.
- ♦ Bamboo strips should be placed in a cross fashion to counter warping.
- ♦ Application of adhesive should not be too much or too less, preferably one layer of uniform thickness.
- ♦ Application of uniform pressure over the planks.


Bamboo
bottle

8

Bamboo bottle

for trek enthusiasts

Wayanad, exclusively called as the “Green Paradise” of Kerala, is nestled among the mountains of the Western Ghats. It is a trekkers delight and they account for much of the tourist inflow at Wayanad. This has its own adverse effects as, the once untouched forest land has now become a victim of plastic abuse. This is mainly attributed to the use of mineral water bottles, most of which gets dumped into the forest land. Even after adopting measures like recycling and restricting the use of plastic bottles inside the forest premises, the situation hasn’t changed much.

Its a common practise followed by explorers and trekkers to survive with what they get from the environment, so as to reduce the carry load. Water, being trekkers best friend for survival, is often carried and refilled from springs and other water bodies, which are often trusted for their purity. A water bottle thus becomes an indispensable object for explorer population and given the fact that a sustainable option is still missing in this section made us look for options to fill this gap by using locally available materials. Thus came the idea of bamboo bottle for trek enthusiasts.

Current market scenario or similar products

Current market does not offer bamboo bottle in its purest form. A bamboo bottle marketed by Uravu comes in the form of a normal wine bottle with bamboo strands weaved over it. While researching on other similar players in the market, we came across an interesting product in the name of Bamboo bottle, manufactured by Bamboo Bottle Company based in California [Fig.32].

Bamboo bottle

The bottle is basically a glass storage unit for water, with a bamboo covering. The top and bottom portion are made of food-grade BPA free plastic. Bamboo here is used mainly for style, strength and insulation purpose.

Locally made bamboo storage units for water and oil, even though functionally exemplary, had limitations that they could not be mass produced and required materials that were scarcely available. We started exploring how a product could be brought out totally out of bamboo.

Fig.32: *Bamboo bottle designed by bamboo bottle company; source: Author*

Design brief

To design a water bottle that could cater to the needs of a trek enthusiast, which could easily be carried along with the luggage, at the same time provide enough and reliable storage space for water. The bottle should be easily manufacturable under the given circumstance with locally procurable materials.Additional features should include:

- ♦It should not spill water, as the terrain of travel is extremely demanding and often results in jerks and fall.
- ♦Bamboo should not under any circumstance affect the quality of water.

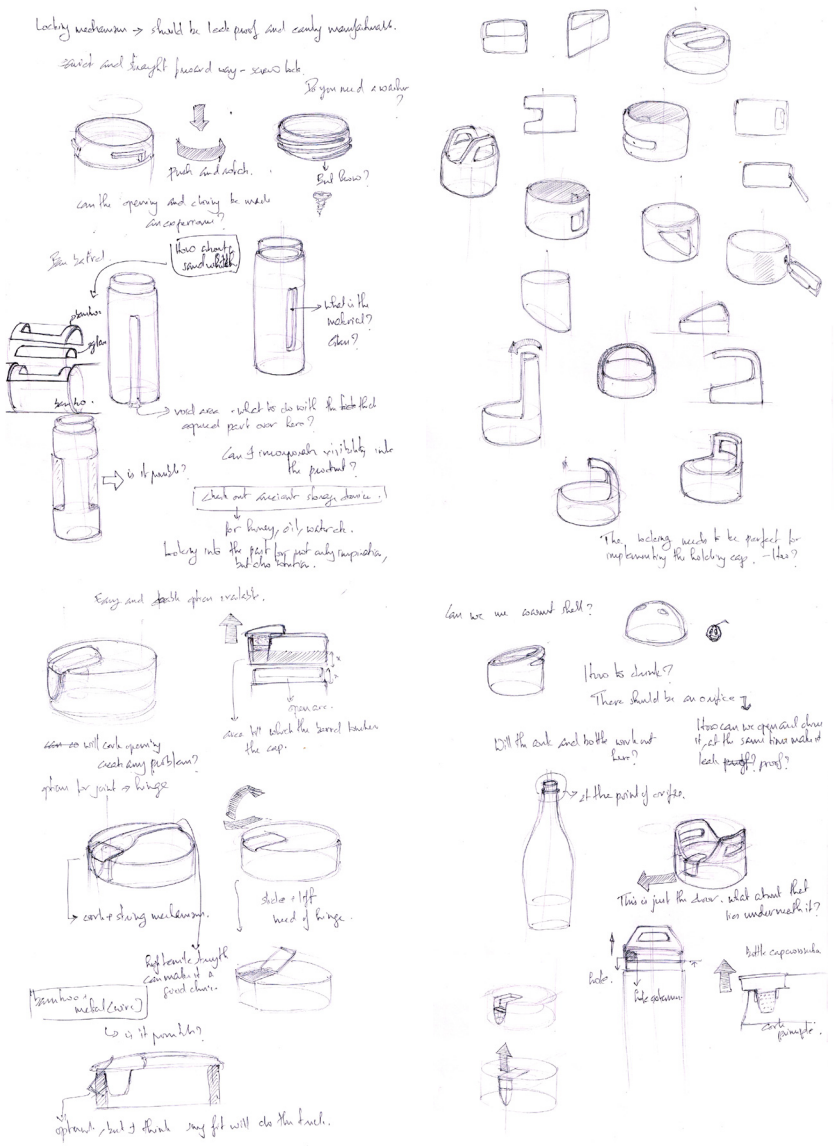


Fig.33: *Body, Cap and Lock mechanism ideations; source : Author*

Ideation

Initial ideations were done on paper [Fig.33], to explore the overall form of the bottle.

Body

Body was chosen to go with the shape of bamboo, i.e cylindrical, and not much exploration was done as this made easier to manufacture. Extra effort needed to be spent only on selecting the bamboo of right thickness and sanding the exterior.

Cap

Explorations on the cap mainly dealt with how to make it attach to a loop (for easy carrying of bottle) and on shapes that could make the accessibility to water easy (while drinking or filling).

Locking mechanism

While exploring the cap and the body of the bottle, this was one question that kept on lingering - how to join both together? Will the material be able to manipulate easily to bring about common locking mechanisms like threads, push and rotate etc?What came was bit challenging. No wonder Bamboo bottle company resorted to glass and plastic to design the storage area.

Conceptualization

Final concept that went to prototyping had a cylindrical body. The cap was given a half slanting profile to aid in drinking process, at the same time a loop area was also given so as to aid in hanging the bottle as well as opening it. Cork was thought about as the ideal and easy solution to locking

mechanism, but the idea was put to rest as corks of the required dimensions could not be procured. The next option was to try rubber washer with rubber tube along the closing section. to give leak proof snug fit. Snug fit was chosen as this did not require craft precision of a slide lock mechanism as well as threading, which did not go well with bamboo due to its structure.

Prototyping

Body

Body was chosen from bamboo shoots having around 2.5 - 3 inch cross section and sections were taken between the nodes to reduce the weight of the body. This is cleaned from inside and sanded on the outside to give a uniform finish and texture.Cross sections are also sanded making it even and smooth on both sides. The bottom side is closed using wood cut in a circular shape and stuck using food grade glue.

Cap

A v-shape cut was first made on the bamboo, followed by cutting out a rectangular section which formed the loop to handle the cap [Fig.34(top)]. The cut out portions were sanded to form the required shape(shown in the figure).This is then closed in the top portion by cutting out a similar profile in wood and sticking with food grade glue. An opening(-closed by cork) was also given over here to get direct access to water without opening the bottle.

Fig.34: *Finishing the cap(top);Final bottle(bottom); source : Author*

Connecting element

Rather than making the cap lock with the body, a connecting element was used, to counter the shape varying thickness of bamboo. The connecting element eliminates the problem of using continuous bamboo for the same bottle cap and body. The connecting element uses a section of bamboo which is sanded at both ends to be snug fit into the cap and body. The connecting element is to be permanently fixed to the cap end the other end is to be snug fit onto the body.

Challenges faced

- ♦Leak proofing the cap-body system. This gave us a very hard time.
- ♦Shearing of bamboo along the vertical lines
- ♦Cover for cap had to be precisely cut to make it leak proof on the top side.
- ♦Fungus when bamboo is unused for a long time
- ♦Shrinkage and expansion at extreme conditions.

Tensegrity

9

Tensegrity
explorations

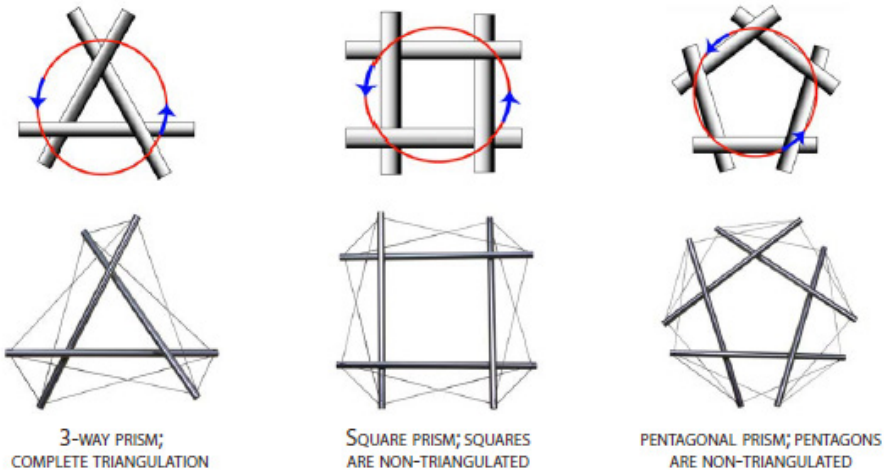


Fig.35: *Weaving patterns and corresponsing tensegrity links; ref: Tensegrity,weaving and binary world - Kenneth Snelson*

Uravu as an NGO aspire to get into furniture sector and is still in their starting stages of design and manufacture of bamboo furniture. This gave us complete freedom to look out for opportunities in design and come up with furniture that could be easily manufactured with available resources and limited skillset.

I was always fascinated about how bamboo is going to fare in combination with material other than wood. Many options were looked upon - metal, plastic,stone, but all these were either difficult to manufacture locally or limited number of artisans with right skill set made it difficult to venture into this area. Thanks to Gautham, as he introduced me to the concept of Tensegrity, which opened up a new array of opportunities. This took me to the world of Kenneth Snelson and Buckminster Fuller who came up with the concept of Tensegrity. As Snelson quotes:

"Tensegrity describes a closed structural system composed of a set of three or more elongate compression struts within a network of tension tendons, the combined parts mutually supportive in such a way that the struts do not touch one another, but press outwardly against nodal points in the tension

network to form a firm, triangulated(to make it firm), prestressed, tension and compression unit."

Snelson's works and his journey into the world of floating compression (ref: *Kenneth Snelson Art and Ideas*) were the source of inspiration to try and come out with similar structures which could be applied to furniture design. Snelson's paper on *tensegrity and weaving* gave a new insight into the concept of tensegrity and its relation to weaving, which he mentions as the mother of tensegrity.

World of tension and compression

Explorations were started of with making scale models with the helps of struts made of bamboo sticks and rubber band [Fig.36(top)] strands forming the tension members. First task was to make a stable 3-way prism. Initial phases gave outputs which were flaccid, which was mainly attributed to the tension member which is elastic and we resorted to materials which were less elastic like badminton racket strings as shown in Fig.36(bottom). These gave bit more insight into making the structure stable and firm and the importance of triangulation for firmness in tensegrity structures. Getting the right shape required a bit more iterations which was followed by trying it out in curved struts. As the mathematical side was not explored much (except for the geometrical side), much of the constructions were mainly on trial and error by changing the length of tension members. This was followed by explorations done on curved struts, which were c-shaped.

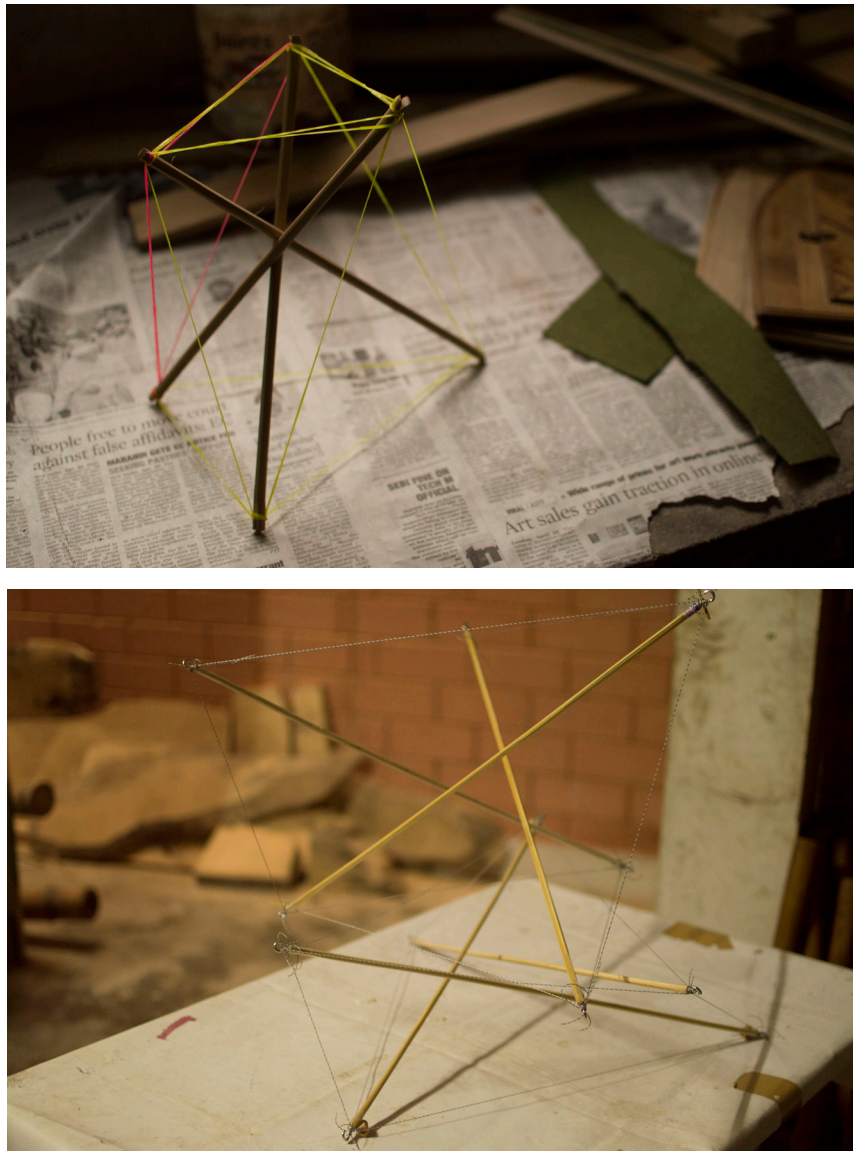


Fig.36: *3-way prism using bamboo sticks and rubber-band(top);Tensegrity structures connected together(bottom); source: author*

Fig.37: *3-way prism using stool(top);Strength check of stool(bottom); source : author*

Tensegrity and furniture design

Choices had to be made regarding the tension members and what type of bamboo has to be used, as the furniture should not only be stable and firm but also withstand the weight of the person using it. Lathi was chosen as it was stronger than the rest with shoots that were not hollow. This aided in easy drilling without breaking the bamboo struts. Nylon strings were chosen as compression members due to very low elasticity and very high strength, moreover, these were easily available in the local market.

1. 3-way prism stool

First task was to scale up the 3-way prism structure. 3 Struts (with 2 holes drilled on both sides for vertical and loop cords respectively) were placed in a triangular weaving pattern and tied together at the crossing point so that they don't slide from each other when tension members act on it. Loop cords were connected using a single member to form a triangular loop. It was made sure that loop members were loosely tied so that they could be easily manipulated later while adjusting the tension. Once the loop cords were tied on both sides, 3 vertical cords were tied. This was followed by cutting the strings at the crossing point so that the tension members start acting on the struts. Now the vertical cords were adjusted so as to give the prism structure the required height at the same time making sure the loop cords were in tension so that the struts won't touch each other. After certain trial and error adjustments of cords and checking string tensions at regular intervals by listening to the vibration sounds, a proper 3 way prism was made. A seating was given by attaching a triangular jute cloathing with pockets to attach to

the struts [Fig.37(top)].

Next step was to check the strength of the structure [Fig.37(bottom)]. People were asked to sit, stand and even throw the structure. The structure showed enormous strength and did not crumble under the test conditions. This was followed by adding a proper seating area made out of jute with the help of local artisan. It was a triangular piece with pockets that could go into the struts. The whole structure was again tested under adverse conditions.

2. Pentagonal prism chair

Pentagonal prism followed a similar process as 3 way prism, except that struts were placed in a pentagonal weave pattern [Fig.38(top)]. Once the loop cords and vertical cords were adjusted to the required height to make it a proper pentagonal prism, we experimented with the length of the cords - increasing on one side and decreasing on the opposite two, which gave rise to a slanting chair like structure [Fig.38(bottom)]. Cords were put in tight tension at the final position with small bamboo sticks hammered to the holes to prevent sliding of strings when weights are applied. This also went through strength tests and fared well.

3. Structure out of 7-shaped struts

Once regular tensegrity structures were experimented, questions were raised on what would happen if certain compression and tension members are interchanged. This gave rise to the idea of using 7-shaped struts. 2 bamboo struts were bolted together and tied to reinforce the strength, forming a 7 shaped structure [Fig.39-1]. 2 such structures formed

Fig.38: *Pentagonal prism before application of tension(top) and after(bottom); source : author*

the compression members, while cotton ropes were used to to form the tension members. This became bit more challenging as the structure was devoid of one compression member and two tension members. Triangulation was also absent due to the missing compression element. The final structure [Fig.39-2]thus developed was stable and strong, but had one end that retraced to its position when changed(similar to a spring action), while others remained in their position - which could be attributed to the excess of a compression element compared to the tension strings.

Fig.39: *Clockwise from top-left 1. 7-shaped struts, 2. tensegrity structure 3. Cotton rope as tension member, 4.Join area of struts; source : Author*

Conclusion

The learnings at IDC had a great infuence on how we looked into the issues put up at Uravu. It helped in identifying the role design had to play within the context at the same time looking out for different realms to explore. We were able to try out different concepts with the available medium and expertise.

The internship was a platform for us to get an inside view of working of craft sector and the problems they faced. It also helped us is in understanding a new material in which we never had prior hands- on experience. We understood how a material could be used in its own various forms and how it affects the entire design. We also learnt the practical difficulties and constraints while working with bamboo.

Uravu, is of-course, a good place to learn about bamboo as well as a good environment to discover yourself. It is definitely a great place to get closer to nature. We have also recommended in idealizing a plan to attract more interns, by promising challenging work environment in the areas of their expertise.

References

Uravu <http://www.uravu.net> as seen on 04.07.2014

World Environment Day logo <http://http://i1.ytimg.com/vi/zkr5Axl1v0k/maxresdefault.jpg> as seen on 06.07.2014

Tensegrity definition < http://www.kennethsnelson.net/faqs/faq.htm> as seen on 08-07-2014

Fig 35 <Tensegrity, weaving and binary world:Kenneth Snelson:Page 16> as on 08-07-2014

Fig 3 <http://www.byronbamboo.com.au/media/images/content/thumb/TAW_048.JPG-page191.jpg> as on 08-07-2014 as on 08-07-2014

Fig 4 <http://indiabiodiversity.org/biodiv/observations/3547e0bc-a4d2-47f4-ba8f-ab5361e8f5da/1-Photo1437_gall.jpg> as on 08-07-2014

Fig 5 <http://www.htbg.com/Poaceae/GRAM-011-1-11-014/images/Dendrocalamus-strictus-(3).jpg> as on 08-07-2014

Fig 6 <http://bamboowa.com.au/wp-content/uploads/2010/09/dendrocalamus-brandisii-var-black-21.jpg> as on 08-07-2014

Fig 7 <http://pics.davesgarden.com/pics/2007/05/29/RWhiz/7f5c0a.jpg> as on 08-07-2014

Fig 8 <http://www.flowersofindia.net/catalog/slides/Balcooa%20Bamboo.jpg> as on 08-07-2014

Fig 9 <http://www.abssocal.org/TropicalPics/Dasper.jpg> as on 08-07-2014

Fig 10 <http://www.asianflora.com/Poaceae/Schizostachyum_funghomii2.jpg> as on 08-07-2014

Fig 12 <http://bamboonursery.com/wp-content/uploads/2012/03/Dendrocalamus-sikkimensis-philippine.jpg> as on 08-07-2014

Fig 13 <http://3.bp.blogspot.com/-6nfSWkwCh10/TzSvQVrbpII/AAAAAAAAAII/bOOQN6tplsI/s640/timber+bamboo.jpg> as on 08-07-2014

Fig 14 <http://www.byronbamboo.com.au/media/images/content/thumb/DSC01653.JPG-page181.jpg> as on 08-07-2014

Fig 15 <http://2.bp.blogspot.com/-9W7pJm6KMaQ/TZMBvSCE4NI/AAAAAAAAEsc/LSy3cKuQs1U/s640/DSCN8004.JPG> as on 08-07-2014

Fig 16 <http://1.bp.blogspot.com/_AVtPHjahRG4/SlWZFSOgRbI/AAAAAAAAAmY/BPNxFaMR95Q/s400/P1000316.JPG> as on 08-07-2014

Fig 17 <http://plantjdx.com/bambusa_tulda.jpg> as on 08-07-2014

Fig 18 <http://www.byronbamboo.com.au/media/images> as on 08-07-2014

Fig 19 <http://www.thepeaceofbamboo.com.au/photos/gallery/Dendrocalamus_asper28.jpg> as on 08-07-2014

Fig 20 <http://www.byronbamboo.com.au/media/images/content/thumb/TAW_048.JPG-page191.jpg> as on 08-07-2014

Fig 21 <http://www.hardytropicals.org/images/blog/black_bamboo2.jpg> as on 08-07-2014

Fig 32 < http://www.metromountainsg.com/_/rsrc/1315335321513/bamboo/bamboo_bottle4.jpg> as on 08-07-2014

Bibliography

Kenneth Snelson. Tensegrity, weaving and the binary world. web publication 08-07-2014< http://kennethsnelson.net/tensegrity/>

Eleanor Heartney. Kenneth Snelson Art and Ideas . web publication:Kenneth Snelson . 2013

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