IDC School of Design
अभिकल्प विद्यालय

Project 3

Designing sustainable constructable toys in bamboo for Pre-School (kids aged 3 to 6 years)

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Stage 0

28 Jan 2022

Area of Work

Research

Key insights

Initial design brief

Stage 1

9th Mar 2022

Data Collection

(Detailed research on selected fiber)

key insights

revised d b

possible design directions

ideations

Stage 1.1

28th Apr 2022

Concepts

Evaluations

selected concepts

mock up's

Study

Field Validation

Stage Pre-final

7th June 2022

Pre-Jury- user review,

prototype development

16th June 2022

Report submission

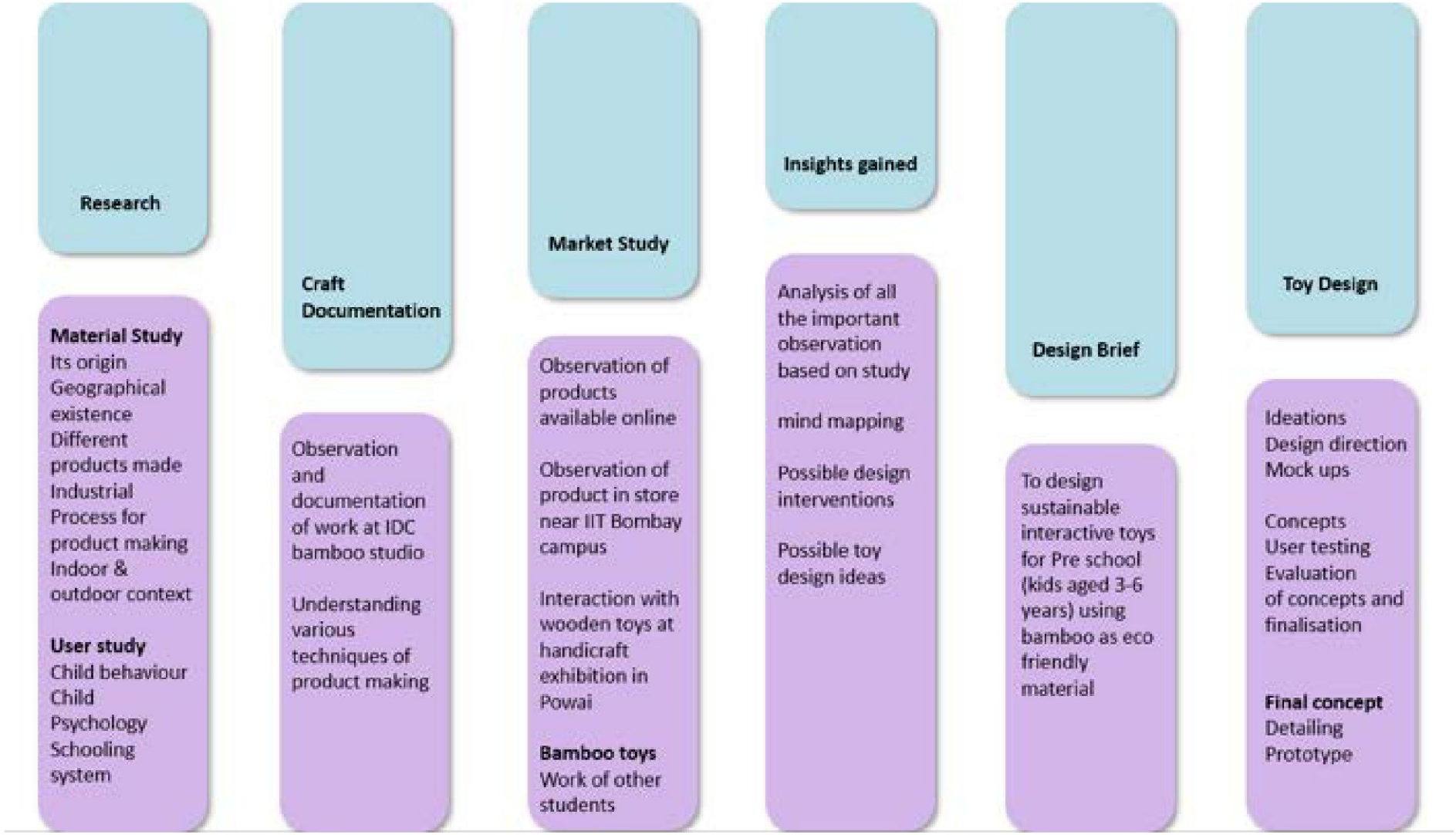
Stage final

27th & 28th June 2022

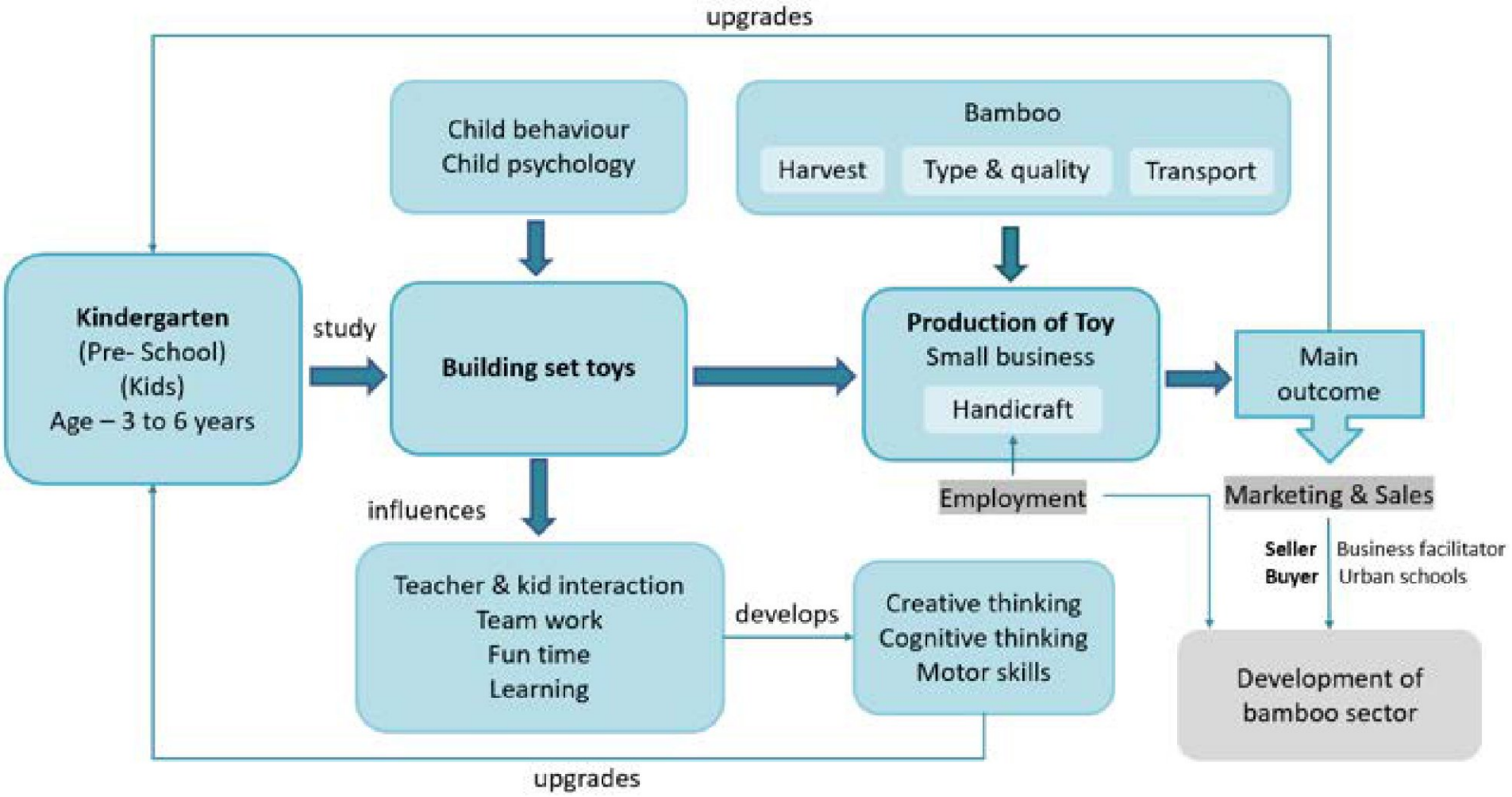
Final jury

2. METHODOLOGY & CONCEPTUAL FRAMEWORK

Methodology



Conceptual framework



3. INRODUCTION

Toys are essential part of a child's overall development. They are fun entertainment tools that engages them and help them develop fine motor skills, build communication, think creatively, build imagination and definitely have fun time playing. Play is one of the areas where children develop creativity.

The project is about sustainable and eco-friendly toy design for Pre-school kids, aged 3 to 6 years for kindergarten (Pre-school). Various ideas were explored and executed in Bamboo material. Mock ups helped in understanding the design details and thereby evolving the design.

The aim of the project is to provide engaging entertainment to kids while developing motor skills and creative thinking through eco-friendly toys for pre-schools. Therefore, it was important to understand school system, toys used by them and interaction of kids with the toys. For this a field visit to IIT-B KG school was conducted to observe the kids play and interact with toy. Conversation with teachers also helped understand the requirement.

Further design process was followed to finalize the Toy design. The final prototype will be majorly executed in bamboo with the combination of wood and stainless steel at few places.

4. LITERATURE STUDY OF BAMBOO AND ITS PRODUCTS

Bamboos are a **diverse group of evergreen perennial flowering plants.** They are very tall and native to tropical and sub-tropical regions of east and southeast Asia.

Why Bamboo?

- Largest grass on the planet
- Fast growth rate. Typically reaches to full height in 12 months and achieves full maturity in 5 to 7 years
- Strong as concrete and good strength to weight ratio as steel. Good tensile and compression strength
- Durable
- Economic in terms of material cost
- Sustainable
- Studio facility is available at IDC with expertise access

4.1. GEOGRAPHICAL STUDY OF MATERIAL AND ITS PRODUCTS

Bamboo is most commonly grown in **Asia, Australia, North America, South America, and Africa**. The region where most bamboo is grown worldwide for commercial purposes is in Southeast Asia, especially in

China

https://fsi.nic.in/isfr2017/isfr-bamboo-resource-of-the-country-2017.pdf

https://www.researchgate.net/figure/Global-Natural-Bamboo-Habitat-Source-National-Geographic-1980_fig1_333531438

Fig. 1. *Global habitat of Bamboo*

Indian habitat of bamboo

More than 50% of the bamboo species occur in Eastern India- Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and West Bengal. Other areas rich in bamboo are the A&N Islands, Chhattisgarh, Madhya Pradesh and the Western Ghats.

https://fsi.nic.in/isfr2017/isfr-bamboo-resource-of-the-country-2017.pdf

https://nbm.nic.in/Bamboo-Species

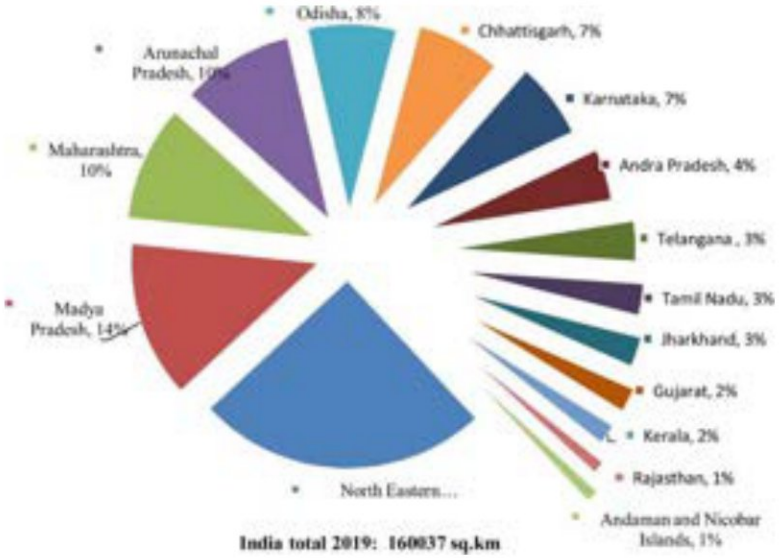
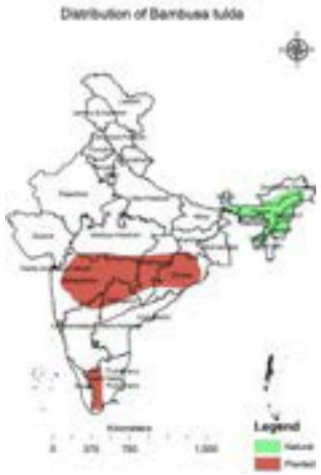


Fig. 2. *Indian habitat of Bamboo*

Species of bamboo in India

Bambusa Tulda



Location: Assam, Tripura

Use: For all range of products

Bambusa Bambos

Location: eastern and southern region

Use: Construction, ladders, Furniture, Paper/pulp, edible shoots, leaf as fodder

Bambusa Balcooa

Location: eastern and southern region

Use: construction, ladders, Agarbatti sticks, **edible shoots**, paper

Bambusa Polymorpha

Location: Assam, Tripura

Use: mats, furniture, handicrafts, paper pulp, **edible shoots** with a distinctly sweet taste

Bambusa Nutans

Location: North East

Use: baskets, fences, roofs and roof tiles, paper, for **treating inflammation, ulcers and wounds**

North east India and bamboo

Bamboo is an integral part of North east people. Different region and tribes have different and unique artistic style of bamboo craft.

1) Arunachal Pradesh

61% forest area is covered with bamboo plantation. There are **26** major tribes and 10 subtribes.

Arunachal Pradesh has highly diverse craft in terms of **style, pattern, ornamentation** of the products. They have Artistic masterpieces

https://ignca.gov.in/divisionss/janapada-sampada/northeastern-regional-centre/introduction-bamboo-and-cane-culture-of-arunachal-pradesh/

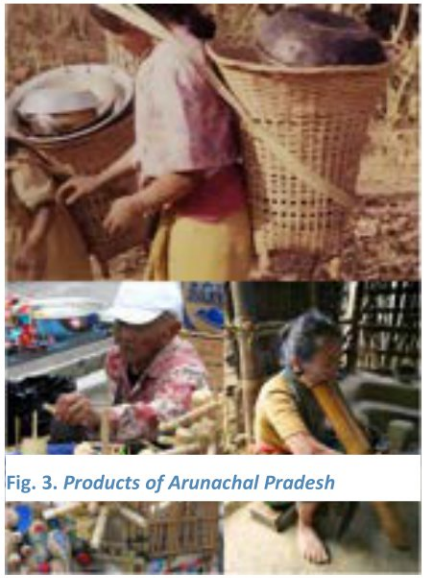


Fig. 3. *Products of Arunachal Pradesh*

2) Assam

Assam is rich in bamboo resources. There are 51 species of bamboo grown.

Bamboo is an Integral part of their lifestyle and economy.

The most attractive product of them is the Bamboo/Leaf Head-gear-**Japi** or Chhata which is used as conventional umbrella during rainy season.

Fig. 4. *Products of Assam*

https://assam.gov.in/citizen/428#:~:text=Bamboo%20base%20craft%20is%20now,on%20commercial%20scale

3) Meghalaya

This state is rich in rainfall. Most popular product here is special type of umbrella called **"Kurup"** in local language and is crafted by Khasi tribe. The artistic baskets are known as meghum khoks locally which is used to store day to day items. The men of the household usually weave the bamboo baskets
https://ignca.gov.in/en/divisionss/janapada-sampada/northeastern-regional-centre/bamboo-and-cane-culture-of-meghalaya/

Fig. 5. *Products of Meghalaya*

4) Manipur

Traditional bamboo craft is highly influenced by their lifestyle.

Manipuri has unique styles of weaving, which they use in varieties of baskets.

They also make wind musical instruments out of bamboo.

Fig. 6. *Products of Manipur*

http://www.craftclustersofindia.in/site/index.aspx?Clid=298

5) Mizoram

Mizoram is the prime producer of Bamboo in India. Women are engaged in weaving and men in bamboo crafts.

Most popular product is basket used for various purposes of storing grains and other items like ornaments. They do artistic carving on bamboo. Women wear head ornament made in bamboo and decorated with feather.

Fig. 7. *Products of Mizoram*

https://aizawl.nic.in/handicraft-2/#:~:text=The%20state%20of%20Mizoram%20has,well%20as%20weaves%20shawls%20too.

6) Nagaland

Naga people are very productive in making bamboo products from bamboo cot to bamboo coffin. They feel pride in flaunting their most popular basket.They make other products like furniture and building architecture

Fig. 8. *Products of Nagaland*

https://ignca.gov.in/en/divisionss/janapada-sampada/northeastern-regional-centre/bamboo-and-cane-culture-of-nagaland/

7) Tripura

Their weaving design, pattern, and style make them unique from the rest of the states.

Bamboo **matting** is the most popular product over here

Experiments with bamboo root by **sculpture carving**

https://tripuratourism.gov.in/art-crafts

Fig. 9. *Products of Tripura*

7) Sikkim

Sikkim is India's first organic state dedicated to organic farming.

Bamboo is grown abundantly in Sikkim but not everywhere. Impressive and eye-catching products made which, consist of beer-mugs, piras, mugs, tumblers, etc. Men do bamboo craft here.

Fig. 10. *Products of Sikkim*

http://sikkimcrafts.gov.in/canebamboocraft.html#:~:text=Cane%20and%20bamboo%20craft%20is,new%20designs%20and%20improved%20technologies.

Insights gained

Very common area of bamboo craft found in all the states is the Kitchen including tools, storage boxes, baskets for multiple activities.

Open basket

Spatula & containers

Carry basket

Big Storage

Trays

Umbrella

Most of the products are used to store grains and food items like collecting vegetation in the field, drying grains in the sun, serving food, cooking food and storing food.

Product categories observed

There is huge range of products that are made using bamboo in different ways. It includes use of whole bamboo, bamboo strips (patti), weaving and sculpting. And based on study and observation, below is the categorisation of products made out of bamboo.

Hat & carry basket

Kitchen tools & storage

Paddy harvesting

Toys

Home decor

Local smoking object

Musical instruments

Home & construction

Furniture & interior

Sculptures

4.2. INDUSTRIAL PROCESSING OF BAMBOO

Cultivation of bamboo, cutting and transportation to various sites.

Bamboo is cut into length and split into parts for further processing.

Bamboo is cut into strips of various length and width as per requirement.

Node is removed and then yellow and green skin is removed by stripping.

It then undergoes steaming process for insect treatment.

After steaming process, entire lot of bamboo strips are kept for air drying.

Strip planning as per requirement and then sorting in grades is done.

Hot pressing and gluing of strips is done to convert into sheets.

https://www.esshelf.com/what-is-the-manufacturing-process-of-bamboo-timber/

https://www.researchgate.net/figure/Manufacturing-process-a-Original-bamboo-b-cut-off-c-original-bamboo-strips-d_fig1_333028818

4.3. PRODUCT MAKING PROCESS

Basket making process

Raw material is cut into lengths using cutting knife.

Cut pieces are then split into thin patti for basket making

Patti's are arranged in a circular manner one above other to create base

A thinner patti is used to weave by interlocking alternate thick patti base

The process of alternate interlocking is repeated

A thick stick is inserted at the base for support

Then again weaving process continues

Now the basket has started to take shape

In some cases, coloured patti are added for design & pattern

Rim is created by twisting and interlocking the left over and the basket is ready

https://www.dsource.in/about/bamboo-basketry-bengaluru/making-process#:~:text=Weaving%20is%20done%20by%20arranging,mixing%20color%20powder%20and%20water

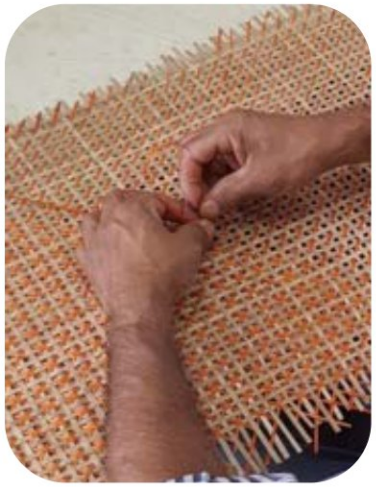
Pattern weaving at IDC school of design

At IDC, we have the facility and expertise. Rudrapal sir showed how weaving is done and how various patterns can be created using different styles.

The strips seen in the image were colour dyed in the studio. Before start the weaving process, the strip size is checked and corrected using strip sizer.

Coloured strips (patti) are immersed in water to soften it in order to weave patterns. This makes the material flexible for intricate weaving between the grind.

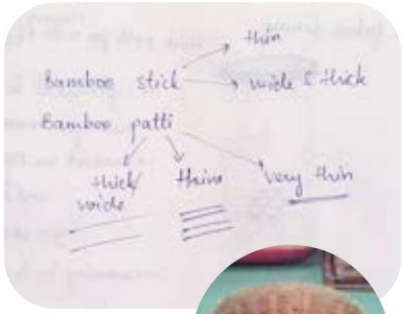
Bamboo strip is inserted into the gap through one hand and pulled from beneath using other hand

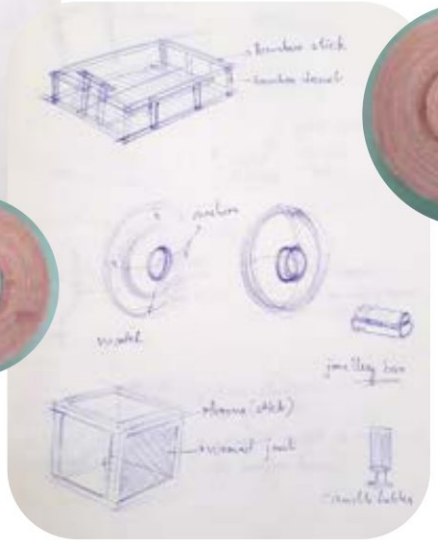


It is then pulled up and inserted again in the next gap and the process continues

Once that strip length gets over, another strip is interlocked and the weaving continues.

Understanding existing product





Sticks used for making lampshade and tray. Sticks are bind together using cane thin patti and more structural support is provided by wider sticks

Existing products in the studio were studied and documented.

Wide **strip** is used here. Bent and glued together with fevicol to give it a form

Ex: wall clock and lampshade

4.4. TOOLS AND MACHINERY USED

Tools

Tools used for cutting, splitting, scrapping, piercing, weaving, sanding activities. Below is the tool kit designed at IDC

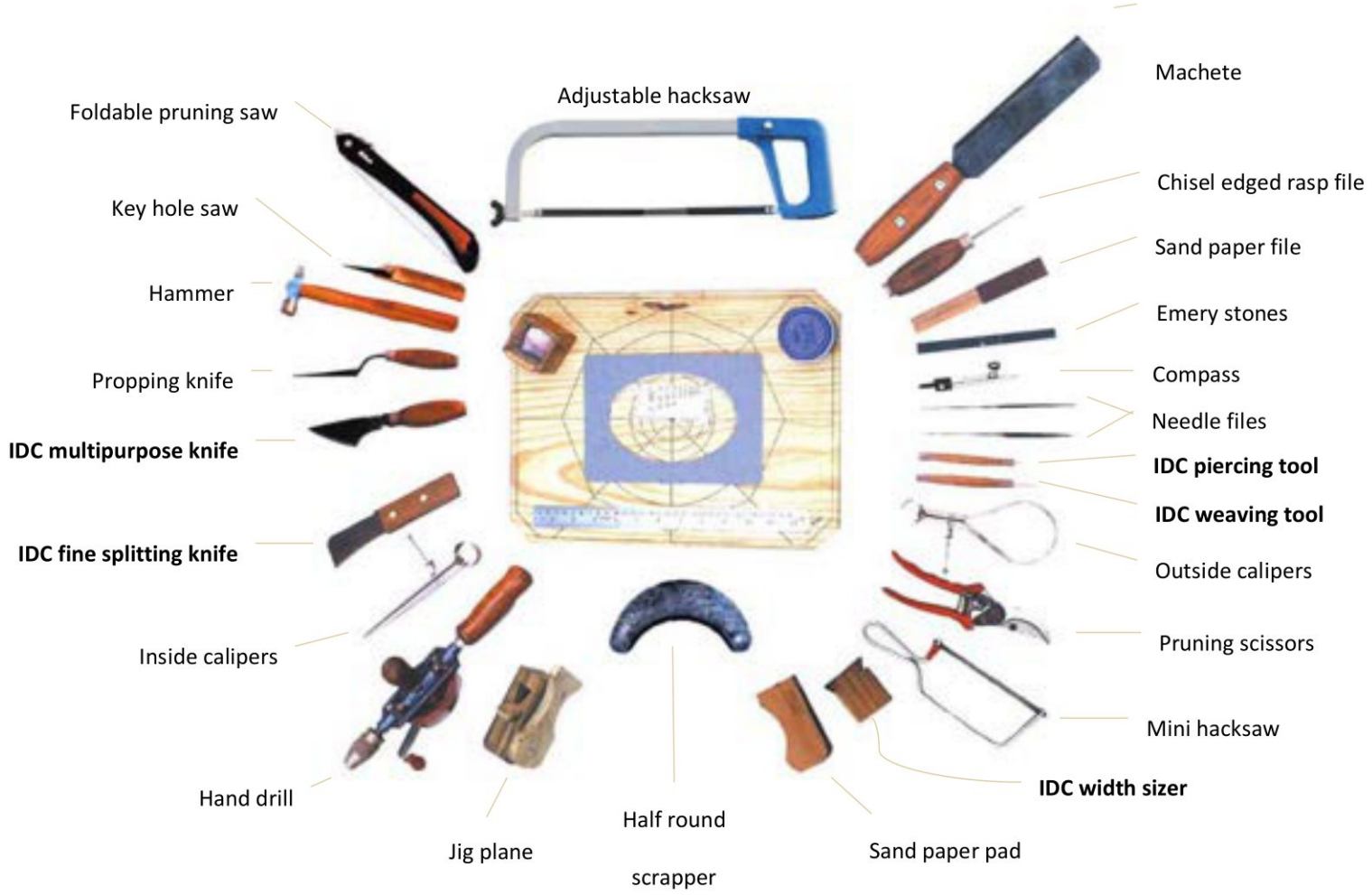
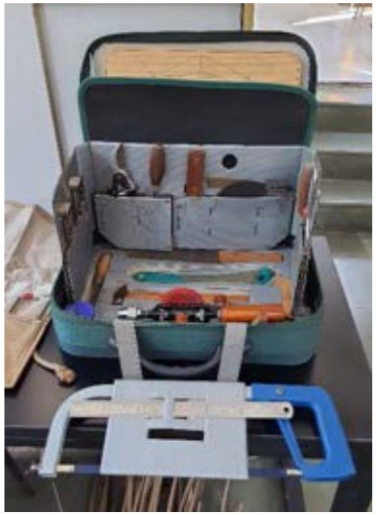
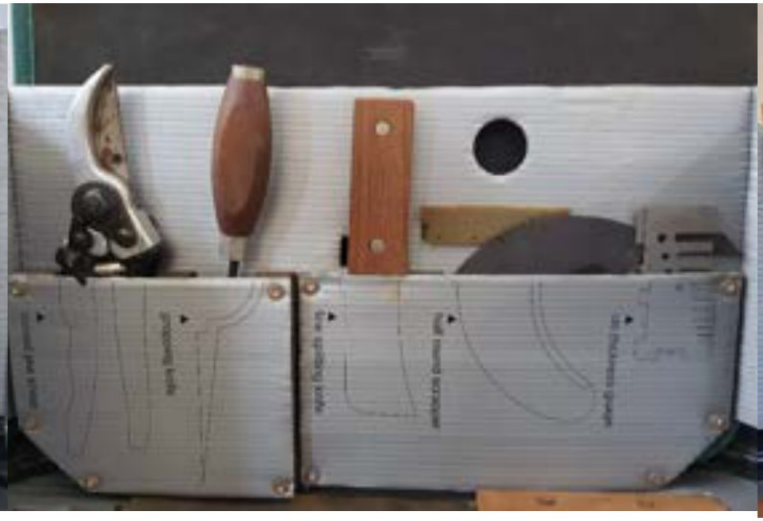


Fig. 11. Bamboo *tool kit*

http://www.agrao.in/images/Articles/OnBambooToolsDesignEtc-IndianExperience.pdf

Below are the images of the tool kit studied at IDC






Machinery

Splitting machine

Hand operated machine which splits the slivers into parts

Width sizer

Hand operated machine which helps in sizing the bamboo strip in equal width

Thickness sizer

Hand operated machine to even thickness of bamboo strip by pulling it under the blade

I.D.C. sander

Hand operated grinder which helps in finishing bamboo strip, basket rims and surfaces

Strip curling machine

Hand operated machine which helps in curling the thin strip of bamboo

Hand vice

Hand operated vice to fasten the bamboo for cutting with hacksaw

Moulds and fixtures

For giving certain form to the weaving, wooden moulds are created and weaving is done surrounding the mould giving it the shape it required.

There are Split moulds - Collapsible moulds developed at IDC for making baskets









http://www.agrao.in/images/Articles/OnBambooToolsDesignEtc-IndianExperience.pdf

4.5. PRODUCT MAKING SKILLS AND TECHNIQUES

There are various organisation working towards development of handicraft sector. Below are some of the leading institutes and organisation.

https://nbm.nic.in/Home

http://www.idc.iitb.ac.in/about/studios-bamboo.html

https://www.nid.edu/research_&_developments/center-for-bamboo-initiatives/detail

https://www.uravu.in/

5. MARKET STUDY OF BAMBOO PRODUCTS

5.1. EXISTING BAMBOO PRODUCTS IN MARKET

Indoor products

Furniture

Interior

Lighting

Storage

Kitchen storage

Home decor

Utility products

Organiser

cookware

Lifestyle accessories

Outdoor products

Garden lighting & decor

Open bathroom

Garden fountain

Shade at IIT-B campus

Fig. 12. *Bamboo house in Assam*

https://www.thebetterindia.com/233052/assam-floods-bamboo-homes-viral-survive-traditional-technology-sustainable-architecture-disaster-safe-social-india-ana79/

Green village Bali

Green Village is not a collection of individual houses, but a living community of globally connected individuals who care about Nature and appreciate its magnificence.
Our **bamboo villas** and houses are purposefully built towards a **sustainable future** for you, your lifestyle.

Fig. 13. *Green village in Bali*

https://greenvillagebali.com/

5.2. INSIGHT GAINED

Indoor

Various products were studied and it was found out that indoor products made using bamboo has better shelf life than outdoor products. Also, it requires less maintenance and there is scope design intervention which will further be explored.

Outdoor

There are various factors affecting the life of bamboo as a material.

Exposed to sunlight – discoloration over prolonged time

Climate – rainy season – deteriorate

Preventive measures by wax coating material and chemically treating for better water resistance

Structural damage due to rot has to be replaced since it cannot be repaired.

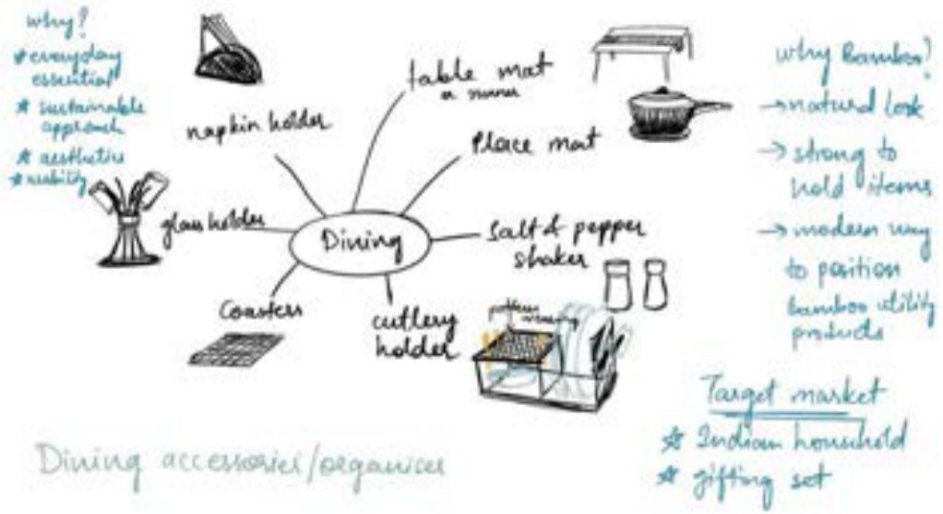
6. PROJECT AREA FINALIZATION

6.1. BRAINSTORMING IDEAS

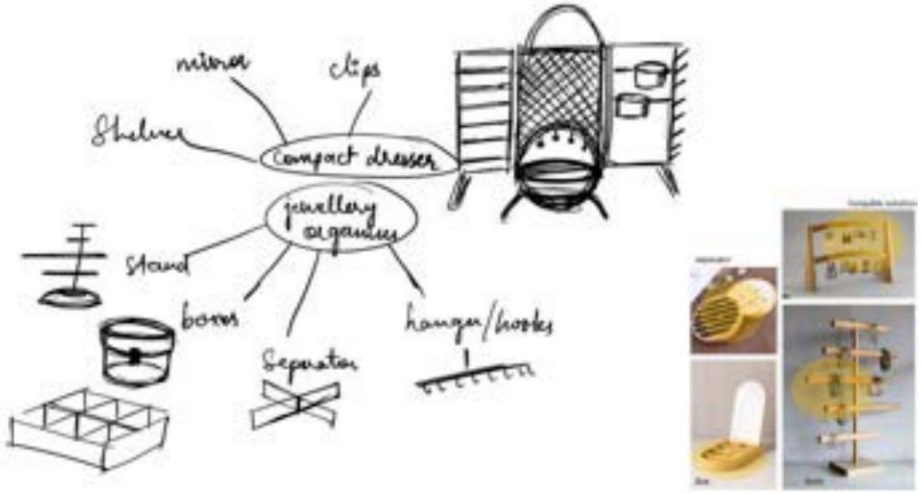
Fig. 14. *Brainstorming ideas*

Idea 1 - Indoor light and garden light

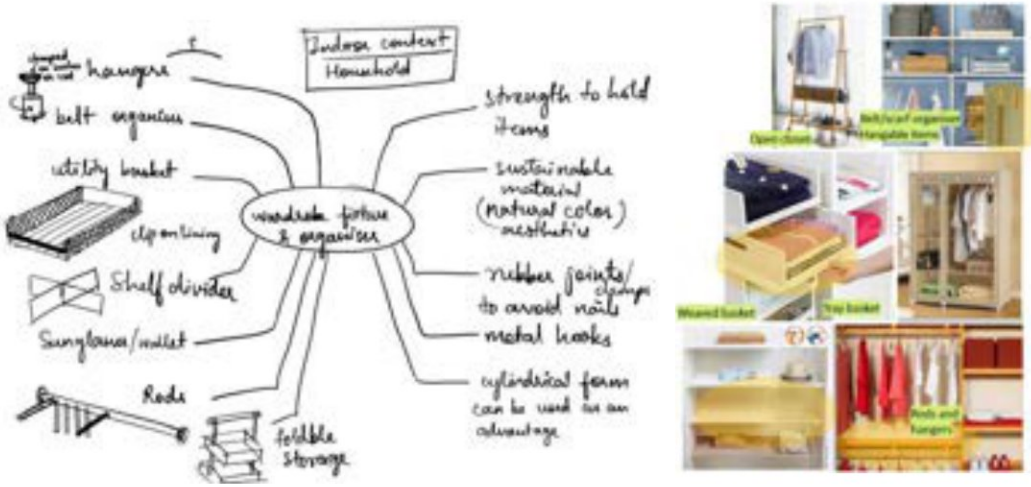
Idea 2 - Bamboo dining accessories



Idea 3 - Jewellery organiser cum dresser unit



Idea 4 - Multipurpose wardrobe organiser



Idea 5 – Toy or kids' vehicle

6.2. FINALISATION OF DESIGN AREA

Discussed with my guide for various possibilities and scope of design. Understanding the length and breadth of P3 requirements along with system level study, Toy design topic was finalised for further exploration in design.

Further it will be explored based on research, user study and requirements for possible design interventions.

7. LITERATURE STUDY OF TOYS

7.1. WHAT IS A TOY?

A toy is an item that is used primarily by children. Playing with toys can be an enjoyable means of training young children for life experiences.

7.2. WHAT DO THEY DO?

Every toy has a different focus but all the toys essentially help in entertaining and providing joy to the kid. Apart from these toys may have different focus. Some aim at developing motor skills, some just for fun and engagement and some have targeted learning

Entertain

Skill development

Educate

Engage interactively

7.3. WHY IS TOY DESIGN REQUIRED?

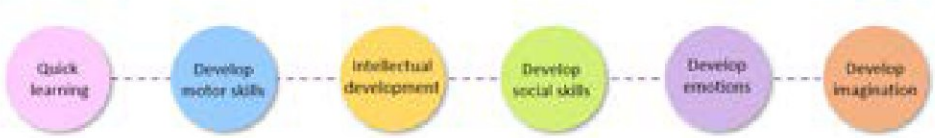
There are many toys in the market manufactured in plastic which after a period of time are discarded and end up in the landfill adding to global warming. There is need for more sustainable and eco-friendly toys.

The project explores on various possibilities to make toys more interactive while providing creative freedom to kids to explore various objects and experience on their own.

7.4. LEARNING AID TOYS

Play is the best way to start learning for kids

Educational toys (sometimes called "instructive toys") are **objects of play, generally designed for children, which are expected to stimulate learning**. They are often intended to meet an educational purpose such as helping a child develop a particular skill or teaching a child about a particular subject.



7.5. MOTOR SKILL DEVELOPMENT

A motor skill is a function that involves specific movements of the body's muscles to perform a certain task.

1. Hand eye coordination

2. Balance and coordination

3. Patterning

4. Core muscle

5. Bilateral coordination

Activities involving both side of body movement. There are three types of it.

Symmetrical integration

Asymmetrical integration

Reciprocal integration

6. Crossing midline

7. Back to front activities

7.6. TOY CATEGORISATION

7.6.1. BASED ON ACTIVITY

Toys are categorised based on various activities kids perform like solving puzzle, building block, playing music so musical toys, pretend and play and therefore there are doll housed and kids to plays with, ride on toys which are large size toys where kids can sit on and play.

Even in these categories, there are huge range of toys with different intellectual level to cater to different age group.

Fig. 15. *Categories of toys*

7.6.2. BASED ON TYPE OF TOY

Small toys - Hand held toys

Structural unit for playful activities

https://www.kidslovewhat.com/best-unique-wooden-toys-for-kids/

There are varied sizes of toys and both have different function and purpose. There are mainly two types, small hand-held toys which are comparatively smaller in size and as name suggests hand held, it can be easily grabbed by kids and played independently.

There are even larger structural unit. They require more space in house and are mostly preferred in play schools are society play room. Basically, at a shared facility where more kids have access to the play unit.

https://www.cdc.gov/ncbddd/childdevelopment/positiveparenting/toddlers.html#:~:text=Developmental%20milestones%20are%20things%20most,of%20themselves%20and%20their%20surroundings.

7.6.3. BASED ON AGE OF CHILDREN

Toddlers (1-3 year old)

At this age toddlers are mostly engaged with learning to speak, move, imitate.

Learnings to kids
Interaction with objects (Object movement)
Hand eye coordination
Develop a healthy curiosity
Observe actions and imitate
Memorising and sorting

Kindergarten (3-5 year old)

At this age kids start to interact with other kids, go out to play in garden and start learning alphabets and. There is learning with playfulness. Kids like messy play in sand or mud, pretend play with puppets or outdoor play with plenty of running, tumbling and rolling. Make time for creative and artistic play

Learnings to kids

Observe, memorise colour, shape, size, Identify and sort, Balance the object, learn about the object, Hand eye coordination, develop a healthy curiosity and imagination, learn to scribble, write and colour

School aged (6-12 year old)

At this age kids school education starts and they learn to form words, sentences, solve problems, do quizzes, play games with friends, involved in various outdoor art, dance, music & sport activities. They love to spend time playing with friends and are fascinated by remote control toys, action figures and board games

Learnings to kids

Brainstorming, Problem solving, Math and science challenges/ fun learning, Building imagination, Super hero story building, Team work, Creative thinking

Teenager (13-19 year old)

At this age kids start using their intelligence with logic and relate things to their experience. They also experience a lot of new things mentally and physically at school and home. They are more inclined towards brain teaser games and sci-fi stuff. This is the crucial age as they are more focused on studies for future career.

Learnings to teenagers

Brainstorming, Complex problem/puzzle solving, Math and science challenges, Super hero story building, Team work, Creative

7.6.4. BASED ON GENDER

Toys preferred by girls

Likings – soft colours like pink, purple, Pretend and play, dolls are absolute favourite

Fig. 16. *Example of toys for girls*

Toys preferred by boys

Likings – bold colours like red, blue, black action figures, Pretend and play, imaginary stories

Fig. 17. *Example of toys for boys*

Toys preferred by both

Likings – mixtures of colours, building blocks, Pretend and play, imaginary stories, sports

Fig. 18. *Example of toys for both*

These toys are suitable for both boy and girl. There are multiple colours used in such toys to avoid gender bias as understood by society.

8. RESEARCH

8.1. MARKET STUDY

8.1.1. EXISTING TOYS IN MARKET

Here are few references of the existing toys found on online store to understand and analyse what exists and where the gap lies.

Most of the popular toys found online were made of plastic. Also, because they are affordable and so can reach larger audience.

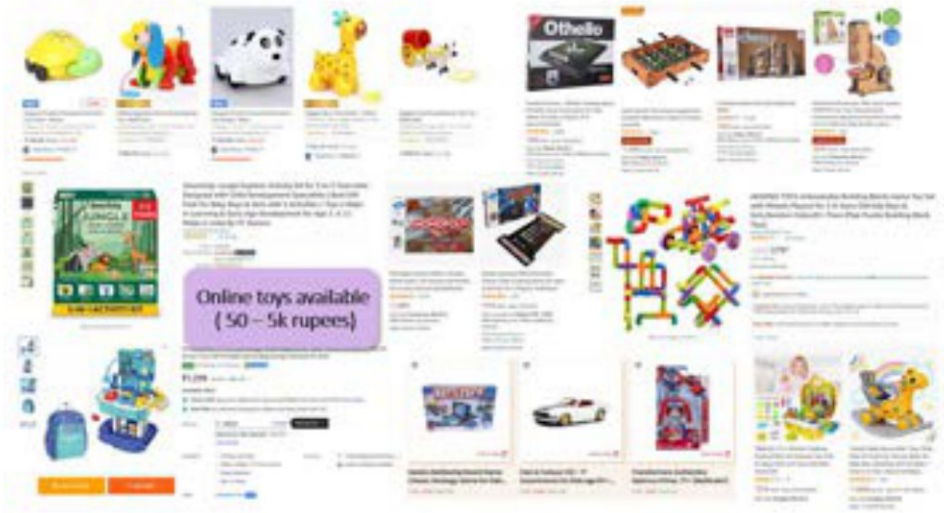
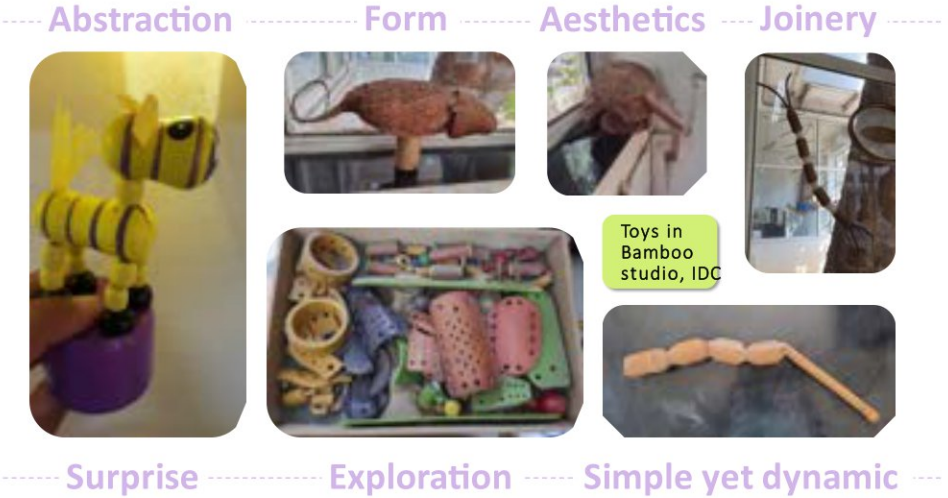
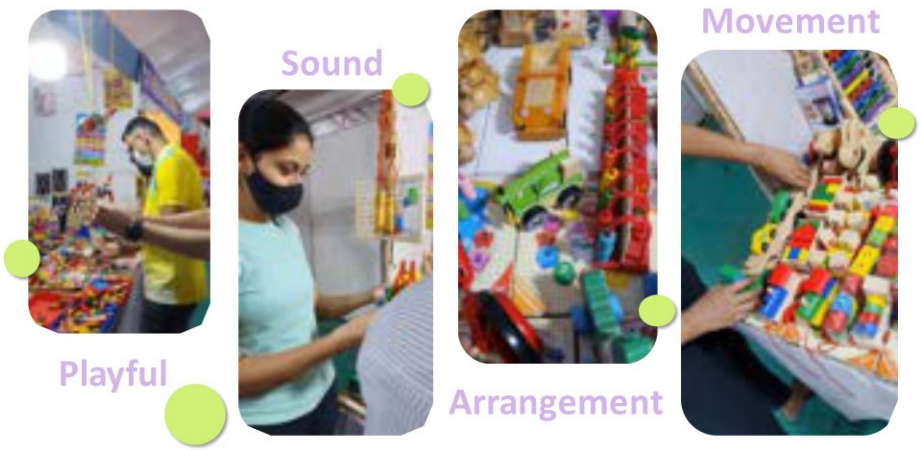


Fig. 19. *Example of toys existing online*

An exhibition near IIT Bombay main gate was visited where channapatana wooden toys were exhibited. There were variety of toys for both fun & educational. Below are the images of earlier work of students at IDC. Some keywords were derived from the observation for exploration.





Store visit in Powai, Mumbai

Most of the toys found so far were plastic toys. Wooden toys were not available at general toy shop. There are specific handicraft exhibitions or shops selling wooden toys.

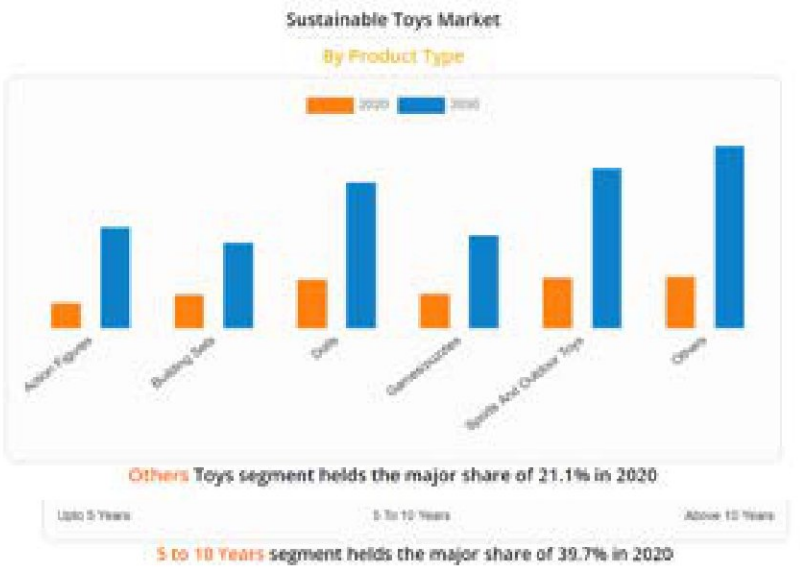
8.1.2. EXISTING BAMBOO TOYS IN MARKET

Below are few images referring to work of students done in this area.

There is potential for bamboo toys but very less work has been done.

Fig. 20. *Examples of existing work done*

8.1.3. MARKET TREND OF SUSTAINABLE TOYS



Sustainable toys in the building set sector is expected to rise in the coming years by 2030.

https://www.alliedmarketresearch.com/sustainable-toys-market-A13868

Below is the direct data on STEM toys from https://www.fatherly.com/love-money/harsh0truths-about-stem-toys

What are the best educational toys for kids?

If you want to go STEM, Dr. Lee recommends lower-tech versions, such as Legos and K'Nex. "Choose things that involve building or creating. Look for toys that are interactive, involve open-ended solutions and encourage collaboration. Those are the building blocks of STEM."

Toys Marketed as STEM-Oriented are Expensive

Toy manufacturers that differentiate their toys as being specialized for STEM can charge more for that specialization. Moreover, if a toy is app-enabled, uses artificial intelligence or is otherwise integrated to the internet or the cloud, manufacturers will ask a premium price for the cutting-edge tech.

But there are plenty of toys and activities that help children learn concepts of mathematics and engineering. A good set of wooden blocks is a perfect example of a no-smart STEM toy rarely marketed as STEM. And not only are they more affordable than many high-tech STEM toys, but you also are never, ever, required to charge them or charge their batteries.

STEM Toys Are More About Employment Than Learning

A study by industry group The Toy Association found that 76 percent of parents wanted their child to end up in a STEM-related field as an engineer, doctor, web developer, or scientist. Additionally, parents felt that kids should be on their career path by five-and-a-half-year-old. Finally, nine out of 10 parents said that it was important for their kids to develop STEM skills.

These insights are incredibly problematic considering that childhood play should be about fun exploration more than it should be about career development. In fact, it's highly unlikely that a child could even be oriented towards any career by preschool age.

Considering that so many STEM toys aim to teach kids coding, it's clear that parents and toymakers are looking at career development rather than pure, imaginative, open-ended play. That's not only unhelpful for kids, but it's also simply impossible.

STEM Toys Are Built for Parents, Not Kids

Given that STEM Toys are geared for career development, the target of the toys isn't necessarily children, despite the grinning kids on the packaging. Parents should remember that toys should be about fun and exploration. Open-ended and creative toys are often far more engaging than toys with a pedagogical purpose.

That doesn't mean that open-ended creative toys can't lead to learning. They absolutely can. And it also doesn't mean that STEM toys can't be incredibly fun for kids. The trick is to put the child first. Education comes with play when a kid is engaged and happy.

https://www.fatherly.com/love-money/harsh0truths-about-stem-toys

https://health.clevelandclinic.org/why-your-child-doesnt-need-stem-toys-to-be-a-stem-star/

8.2. TOY GUIDELINE AND INDIAN SAFETY STANDARDS

Press Information Bureau
Government of India
Ministry of Commerce & Industry

12 DEC 2020 12:15PM by PIB Delhi

Handicraft and GI Toys exempted from Quality Control Order

Taking steps towards the Prime Minister's vision of making India a global manufacturing hub for sale & exports of toys, Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry has devised a comprehensive action plan with steps being taken to boost production & sale of indigenous toys across the country. Quality Control order has been issued by the Department for standardization and quality adherence of Toys. The order will come into effect from 1st January, 2021. This order aims to bring forward the synergized efforts of the GoI, states and the stakeholders to promote 'Toors up for toys' vision keeping quality standards of the indigenous toys as the priority.

Now, as a part of the initiatives being taken to provide impetus to the marginal, small and micro toy production units in the country, DPIIT has released Toys (Quality Control) Second Amendment Order, 2020. It exempts goods manufactured & sold by artisans registered with Development Commissioner (Handicrafts) from use of Standard Mark under licence from Bureau of Indian Standards, as per Scheme-I of Schedule-II of BIS(Conformity Assessment)Regulations,2018.

The Amendment Order 2020, also exempts products registered as Geographical Indications from following Indian Toy Standards & compulsory use of Standard Mark licence from Bureau as per Scheme-I of Schedule-II of BIS(CA)Regulations,2018. The Gazette notification issued by the department says that "nothing in this Order shall apply to goods or articles manufactured and sold by Registered proprietor and Authorised user of a product registered as Geographical Indication by the Registrar of Geographical Indications, Office of Controller General of Patents, Designs and Trademarks (CGPDTM)"

Goods or articles	Indian Standard	Title of Indian Standard
(1)	(2)	(3)
Toys	IS 9873 (Part 1) : 2018	Safety of Toys Part 1 Safety Aspects Related to Mechanical and Physical Properties.
	IS 9873 (Part 2) : 2017	Safety of Toys Part 2 Flammability.
	IS 9873 (Part 3) : 2017	Safety Requirements for Toys Part 3 Migration of Certain Elements.
	IS 9873 (Part 4) : 2017	Safety of Toys Part 4 Swings, Slides and Similar Activity Toys for Indoor and Outdoor Family Domestic Use.
	IS 9873 (Part 7) : 2017	Safety of Toys Part 7 Requirements and Test Methods for Finger Paints.
	IS 9873 (Part 9) : 2017	Safety of Toys Part 9 Certain Phthalates Esters in Toys and Children's Products.
	IS 15644: 2006	Safety of Electric Toys.

https://pib.gov.in/Pressreleaseshare.aspx?PRID=1680181 https://www.bis.gov.in/wp-content/uploads/2020/03/Toy_QC_order.pdf

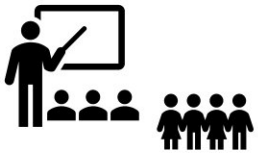
8.3. PRIMARY USER STUDY

8.3.1. DEFINE USER PROFILE

Target user

Kids age 3 to 6 year

Studying in Pre-school LKG & UKG class



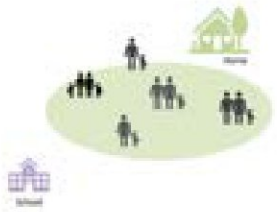
Target customer

Urban Pre-Schools catering to kids of

higher SES (Socio economic status) communities

Target community

Higher SES Families with young children



User Persona

Name: Navya
Age: 5 years
Education: UKG
School: KG School,
IIT Bombay campus

- Navya is a very curious and enthusiastic kid.
- She lives with her parents in the IIT Bombay residential apartment on the hill side.
- She loves to live in her own imaginary world and play long hours.
- She even drags her mother and sister while playing to accompany her

8.3.2. FIELD STUDY - PRE SCHOOL (KINDERGARTEN) VISIT

IIT Bombay KG School

Fig. 21. *Map of IIT Bombay KG school*

Principle in charge at IIT KG School

Ms. Lata P. Jagdeesh

"We have activity-based program which helps each child to grow emotionally, socially and intellectually"

"At this developing age they readily absorb what we teach them with curiosity so it is our responsibility to be sensitive with our teaching methods"

She helped with arranging the play time for each class for our study

Classroom indoor playtime setup

All the study desk and chairs are moved aside and kept along the wall to make space at the centre of room for kids to play freely. Kids play in groups with building blocks and other toys as seen in the image above.

Classroom indoor play setup for outdoor play session

This is a common space near the entrance gate of the school building for outdoor playing setup done indoors.

Fig. 22. *Children playing in school premises*

Lower LKG – A section

Age: 3 years

Total number of students: 11

Duration of playtime: 10 minutes

Toys

There were basic shapes building blocks. They help develop motor skills and colour identification. It is a wooden building block set painted with bright colours.

My observations

Kids were arranging them in line, stacking to make a building. When teacher see a kid sitting ideal, they instruct and encourage kids to play.

Lower KG – B section

Age of kids: 4 years

Total number of kids playing: 13

Toys

Arrange and match the block. There were 2 types of blocks here, one with numeric print and other with graphics representing the count on it. So, the kid has to look out for numbers arrange as in number system.

Different groups take different set of toys and start playing. Here is a simple puzzle set which kids figure out on their own and solve it.

There are sorting toys where kids identify the shape or colour and sort them accordingly.

There is teacher and kids interaction to check what they are doing, to encourage them, to appreciate them, to correct them from time to time.

All the groups are involved in playing with different set. Once the group has finished playing with the set, they interchange the toys among themselves and then play with another set. This way they are involved in team activity and also get to learn different things.

Lower KG – D section

Age: 4-5 years

Total number of kids playing: 9

Kids were given with box of beads and threads and the teacher asked them to arrange beads in alternate colour and make a design using yellow and green colour.

Some kids would do as instructed and some would procure whatever colour they could grab and make a design with that.

Lowe LKG – C section

Age: 4-5 years

Total number of kids playing: 13

Puzzle toy, kids solve the puzzle and move on to the next one. There are multiple figures of puzzle, the slots are cut in the wood and in that they have to arrange the pieces to complete the entire image. All made in wood.

All the toys seen so far have used bright colours.

Here is another toy of sorting or arranging in order. This type of toy basically involves stacking the blocks in ascending or descending order. Sometimes teacher has to guide or correct them. Sometimes they also do the counting while stacking blocks.

Upper KG

Age: 5-6 years

Total number of kids playing: 11

Arrange them order. They have numeric train arrangement pieces and alphabet train arrangement pieces. Again they play in groups and there is academic learning involved in fun way.

Teacher helps them in correcting if they go wrong or if kids ask for help.

Art and craft room

There is a separate art and craft classroom where all the art and craft related activities are held. Kids sit in a group and teacher instructs them to fold, cut, paste the paper step by step. There is also a assistant who would help kids with the activity

Painting session

Kids are given freedom to explore and be creative. Sometime teacher instructs them as to what to paint and sometimes they are on their own.

Movie screening

There is movie/ cartoon screening occasionally on festival. This is to teach them about our festivals and culture

Environment science

Various environment science related knowledge is displayed on wall through chart papers for visual learning. Topics like flower, fruits, vegetables, domestic animals, wild animals, birds, insects, helpers in society etc are covered under this subject.

Science day

Various science activities are also planned every year to teach them about science in real world. Teachers also involve kids to perform the activity for making it interactive and fun to learn.

8.3.3. INSIGHTS GAINED

What is the learning?

Social lesson – interactions with others, talking, communicating, making friends, maintaining friendship, social etiquettes

Visual learning – image memory-based learning through charts and graphical puzzles

Making connections – they try to connect dots through their visual memory and recognize symbols, numbers, objects and solve problems

My inferences

Most of the toys were wooden toys with 2D visual graphics printed flat pieces.

Their toys are basically categorised as Recognising colour and objects, puzzle solving – animal, fruits, GK, match the pieces, arrangement in alphabetical order, numbers in ascending order, arrangement of coloured blocks as per teachers' instruction, sorting of different shape blocks

Building block – Lego style – overall development

Behaviour learning – greeting adults, thank you, sorry, keep things at their place after play

Team work & coordination

Insights from teacher

Ms. Sarita Mishra

Teacher at IITB KG School

Kids get bored from playing with same puzzle toy after they have accomplished the task

Variety of toys will be helpful

They get bored of solving the same puzzle everyday so they need variety

They like to play with puzzle and creative building blocks

At school the focus is to educate basics of primary education along with etiquette and general knowledge with more play and little learning since they are new to this setup

We make them work in Team for better learning

They like small puzzle then bigger one as they lose interest in sometime

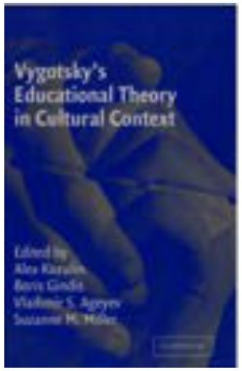
Addition of spelling learning element in the toys can help them form words of the object they playing with

Allowing movement while playing will be helpful like puzzle on 2 different wall to make them move

8.3.4. EDUCATION SYSTEM STUDY

Vygotsky's education theory

Vygotsky's theory **revolves around the idea that social interaction is central to learning**. This means the assumption must be made that all societies are the same, which is incorrect. Vygotsky emphasized the concept of instructional scaffolding, which allows the learned to build connections based on social interactions. 11-Jul-2020



Learning through social interaction

https://www.youtube.com/watch?v=8I2hrSRbmHE

https://books.google.co.in/books?hl=en&lr=&id=mfCHutwHT-cC&oi=fnd&pg=PR11&dq=lev+vygotsky+education+theory&ots=uisOo9o-qB&sig=qd94ueXrUyemMBIZEuaKKw1yUUE#v=onepage&q&f=false

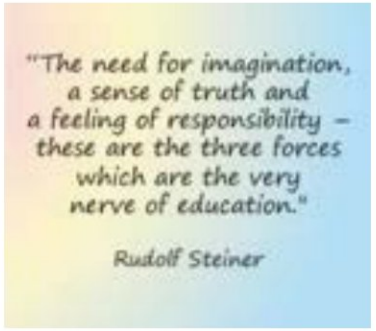
Waldorf education philosophy

Waldorf education, also known as Steiner education, is based on the educational philosophy of Rudolf Steiner, the founder of anthroposophy.

It focuses on experiential learning through own discovery and experiments.

https://www.waldorfeducation.org/waldorf-education

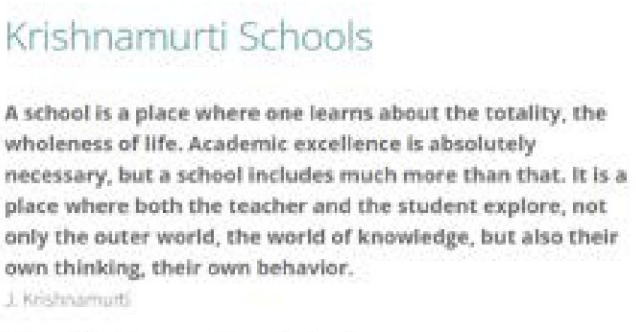
https://www.youtube.com/watch?v=xVhXhvxewdI

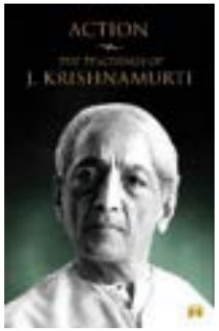


Toys used at Waldorf school includes all wooden toys. All the toys at Waldorf are designed and manufactured by Sarah's company

https://www.youtube.com/watch?v=6BYg-LbqdD0

J. Krishnamurthy philosophy of education





https://jkrishnamurti.org/schools

https://www.youtube.com/watch?v=O_qNesMOf-Y

My Inferences through reading

"There is no academic pressure of exams, children learn on their own pace as per their own schedule. There is no rigid timetable or curriculum followed"

Azim Premji foundation

Towards a just, equitable, humane and sustainable society

Azim Premji Foundation is a not-for profit organisation that has been working since 2000 with the elementary education system in rural government schools.

8.3.5. CHILD PSHYCOLOGY AND BEHAVIOUR

Positive Education for Young Children: Effects of a Positive Psychology Intervention for Preschool Children on Subjective Well Being and Learning Behaviors

Anat Shoshani[1] and Michelle Slone[2]

[1]Baruch Ivcher School of Psychology, Interdisciplinary Center Herzliya, Herzliya, Israel
[2]School of Psychological Sciences, Tel Aviv University, Tel Aviv, Israel

https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01866/full

• Examination of the effects of a positive psychology intervention. **A positive psychology intervention (PPI) was defined in accordance with Sin and Lyubomirsky's (2009) article as a psychological intervention (training, exercise, therapy) primarily aimed at raising positive feelings, positive cognitions or positive behavior as opposed to interventions aiming to reduce symptoms,** problems or disorders. The intervention should have been explicitly developed in line with the theoretical tradition of positive psychology (usually reported in the introduction section of an article).

Essential Influences

Child psychology encompasses a wide range of topics, from the genetic influences on behavior to the social pressures on development. The following are just some of the major subjects that are essential to the study of child psychology:[1]

- Cognitive development
- Environmental influences
- Gender Roles
- Genetics
- Language
- Personality development
- Prenatal development
- Social Growth
- Sexual Development

https://www.verywellmind.com/what-is-child-psychology-2795067

learned about it. This "natural pedagogy" (Csibra, 2010; Csibra and Gergely, 2009) becomes more sophisticated in the sensitivity of preschoolers to implicit pedagogical guides in adult speech directed to them (Butler and Markman, 2012a,b, 2014). Young children rely so much on what they learn from others that they become astute, by the preschool years, in distinguishing adult speakers who are likely to provide them with reliable information from those who are not (Harris, 2012; Jaswal, 2010; Koenig and Doebel, 2013). This connection of relationships and social interactions to cognitive development is consistent with how the brain develops and how the mind grows, and is a theme throughout this chapter.

https://www.ncbi.nlm.nih.gov/books/NBK310550/

Understanding Causal Inference

Children's intuitive understanding of causal inference has long been recognized as a fundamental component of conceptual development. Young children, although not explicitly or consciously experimenting with causality, can experience observations and learning that allow them to conclude that a particular variable X causes (or prevents) an effect Y. Recent advances in the field have documented the ways young children can implicitly use the statistics of

Learning begins prenatally, and children are not only "ready to learn" but already actively learning from the time they are born. From birth, children's minds are active and inquisitive, and early thinking is insightful and complex. Many of the foundations of sophisticated forms of learning, including those important to academic success, are established in the earliest years of life.

Development and early learning can be supported continuously as a child develops, and early knowledge and skills inform and influence future learning. When adults understand how the mind develops, what progress children make in their cognitive abilities, and how active inquiry and learning are children's natural inclination, they can foster cognitive growth by supporting children's active engagement with new experiences and providing developmentally appropriate stimulation of new learning through responsive, secure, and sustained caregiving relationships.

https://www.ncbi.nlm.nih.gov/books/NBK310550/

8.4. INSIGHTS GAINED

8.4.1. PROBLEM IDENTIFICATION

1. Need for Variety in toy. Should be flexible enough to build with imagination and learn
2. puzzle but non repetitive to reduce the boredom
3. creative building blocks for new discovery every time they play
4. More focus on play
5. Allowing movement through toy activity
6. All toys were flat, opportunity to make in 3D space
7. Toy should build curiosity to keep them engaging

8.4.2. FINDING DESIGN OPPORTUNITIES

	Building block	Puzzles	Sorting	Patterning	arrangement	Insights gained	Opportunity
Toy description	Basic shape blocks	• A-Z puzzle • 1-10 puzzle • Animal puzzle • GK based	• Colour sorting • Shape sorting • Small big	• Beads	• Ascending/ descending order different size rings	All toys were flat toys except building block GK based toys were very few. They mostly learnt via charts	• Create 3D space toys • teach them GK in fun way
Teacher's involvement	No initial instruction. Later if sitting ideal for a long time	Correcting when wrong and help if any kid asks Appreciates kids	very less, only when they do it wrong	instructs for pattern Ex: Alternate colour formation	instruction based Ex: Arrange the rings in increasing size	There was some kind of involvement at different stages for engagement with toys	• initial introduction by teacher • Play cards for teachers
Understanding level	Very adaptive	problem solving	high	medium	high		• Play cards for children
Kids excitement level	High	High	Medium	Less	Medium	Kids spend more time with Toys that excite them the most teacher creates competitiveness "who will so it fast"	• challenge based exercises
Kids Engagement time	10 mins	10 min	2 - 5 min	5 min	2 - 5 min		• to increase engagement time

	Building block	Puzzles	Sorting	Patterning	arrangement	Insights gained	Opportunity
Toy description	Basic shape blocks	• A-Z puzzle • 1-10 puzzle • Animal puzzle • GK based	• Colour sorting • Shape sorting • Small big	• Beads	• Ascending/ descending order different size rings	All toys were flat toys except building block GK based toys were very few. They mostly learnt via charts	• Create 3D space toys • teach them GK in fun way
Motor skill development	hand eye coordination, balance	YES	YES	YES	YES	All toys were intended for same	
Cognitive thinking	YES	YES	YES	YES	YES		
Creative freedom	YES	NO	NO	Slightly	NO	Only building block gave them freedom to construct in their own way	• Create puzzle based construction set
Creative thinking	low	NO	NO	Slightly	NO		• enhance creative thinking
Kids team work	BOTH	YES	BOTH	NO	BOTH		• cater to all
Safe	curved edges	YES	YES	YES	YES		

- Apart from motor skills and education syllabus they also learn socializing, behavioral etiquettes like greeting adults, thank you, sorry, keep things at their place after play
- All the toys were wooden toys and manufactured by “Vardh aman I.Q. Toys Pvt. Ltd”
- "Vardhaman I.Q. Toys Pvt. Ltd", are among the prominent Manufacturers and Exporter of wide range of Puzzles Toy, Cognitive Games, Motor Skill Toys, Language And Arithmetic Toys and much more

9. DESIGN PROCESS

9.1. INITIAL DESIGN BRIEF

To design sustainable and interactive constructable toy set using bamboo as an eco-friendly material for preschool kids, aged 3-6 years targeting urban Kindergarten to enable and develop the following among the kids,

- Creative freedom
- Creative thinking
- Cognitive thinking
- Motor skills
- General knowledge
- Team work

Need of the project

The study and research show that there is need for more sustainable and eco-friendly toys

Motivation

The motivation was to go eco-friendly and spread awareness about the sustainability amongst the people

Target market

Toy industry

Target user

Kids age 3 to 6 year, studying in Pre-school LKG & UKG class

Target customer

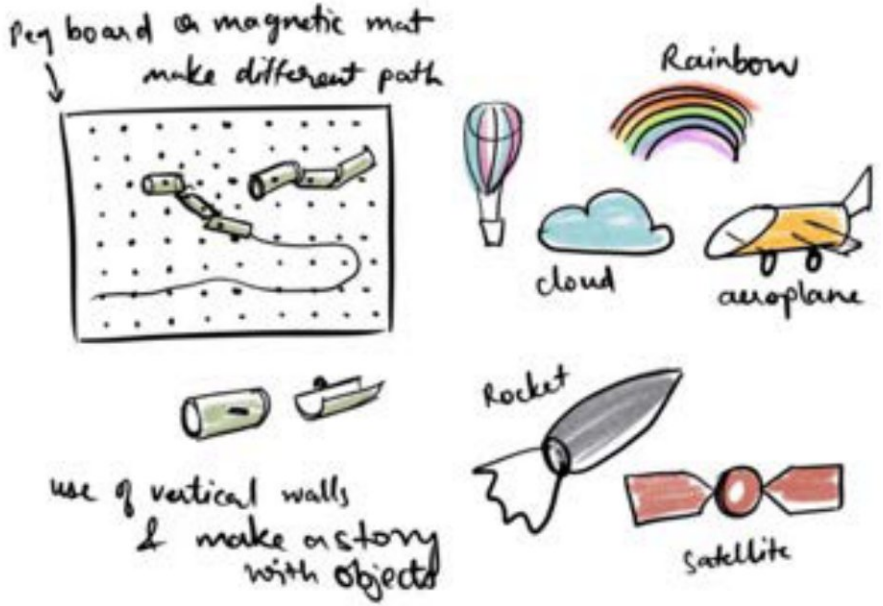
Urban Pre-Schools catering to kids of

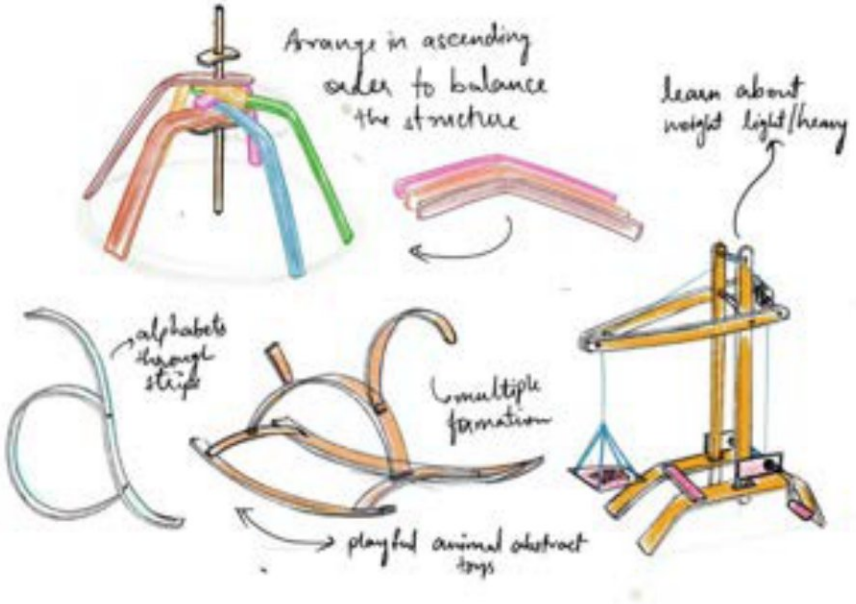
higher SES (Socio economic status) communities

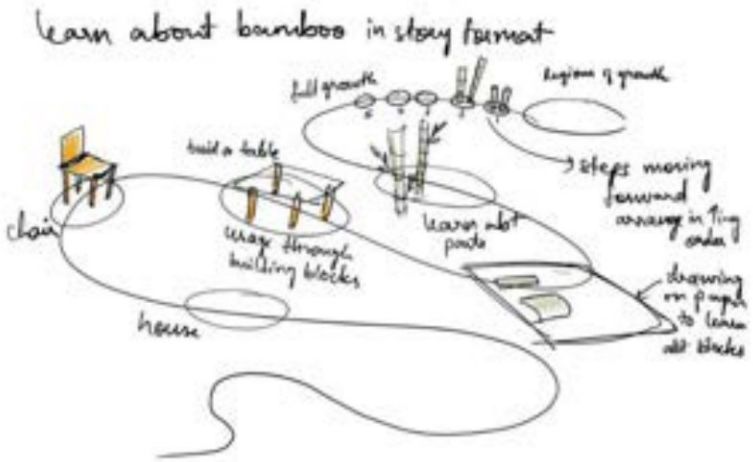
Target community

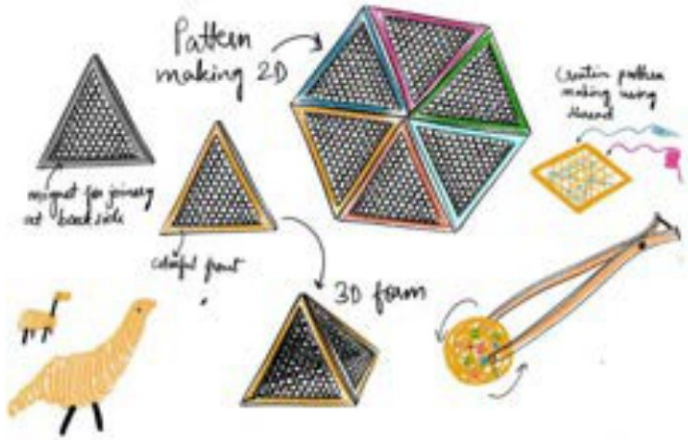
Higher SES Families with young children

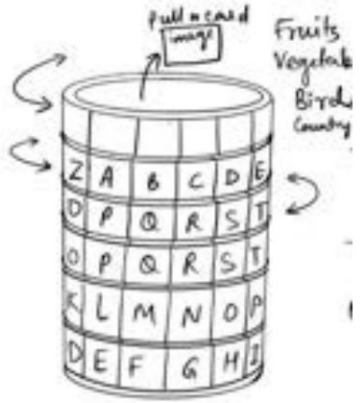
9.2. INITIAL DESIGN IDEATIONS

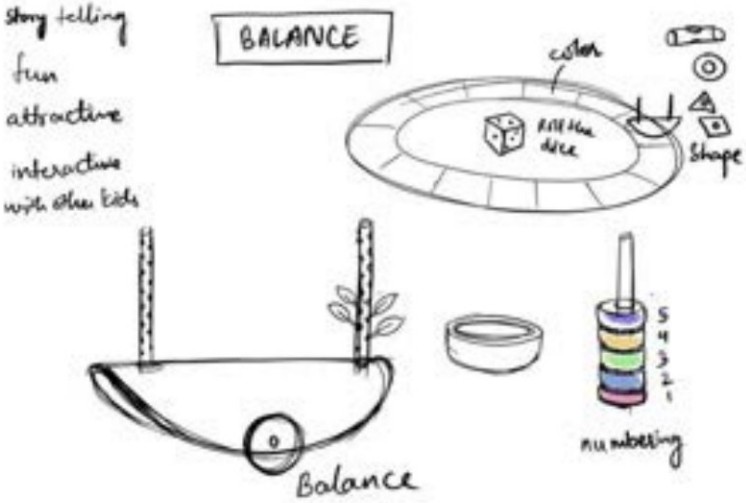


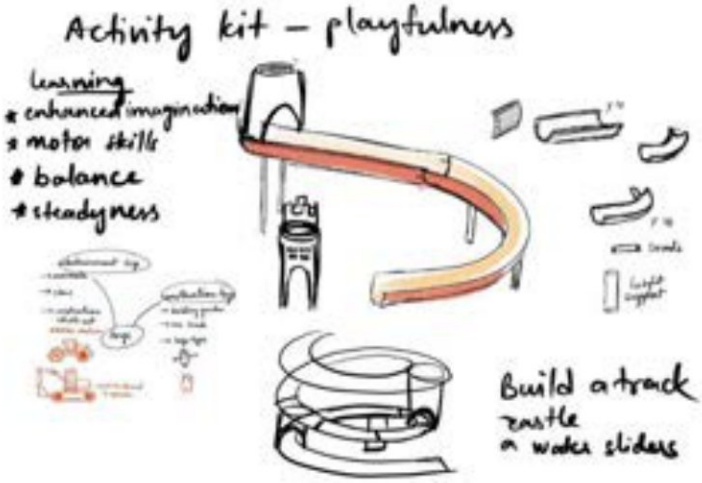



Learn about bamboo in story format
Full growth
Beginning growth
steps moving forward arranging in ling order
build a table
chair
learn abt parts
house
drawing on graph to learn add blocks


Pattern making 2D
3D form

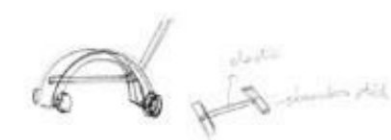

Fruits
Vegetab
Bird
Z A B C D E
D P Q R S T
O P Q R S T
K L M N O P
D E F G H I


Story telling
fun
attractive
interactive
with other kids
BALANCE
color
Shape
Balance
numbering

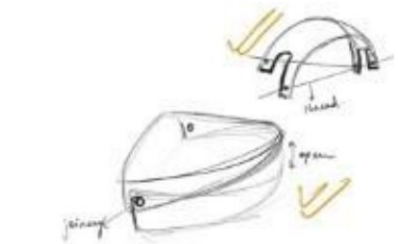

Activity kit – playfulness
Learning
* enhanced imagination
* motor skills
* balance
* steadyness
Build a track
castle
a water slides

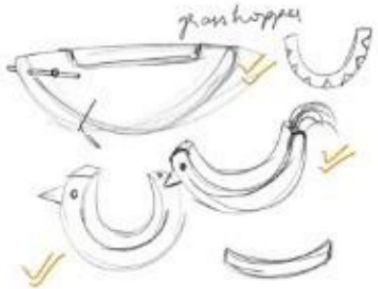

swaing board


Panda
Cat
Rhino
goat
DEER
Characteristic
thin body
long legs
mini tail
head
body
hand
tail
eye
ear




abstract form

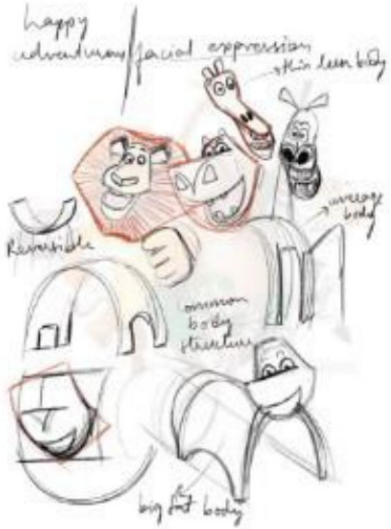



grasshopper


crab
fish
starfish
octopus
jellyfish


DOMESTIC AND PET ANIMALS
COW
CAT
SHEEP
GOAT
CAMEL
DONKEY
HORSE
DOG
BUFFALO


Water animals


happy
facial expression
Reversible
common body structure
big feet body

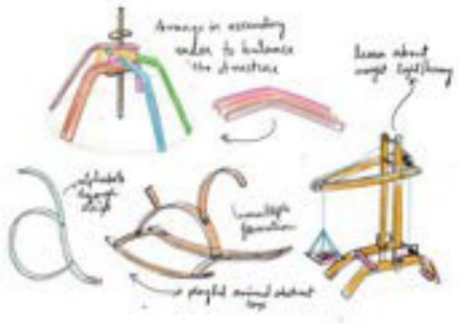
9.3. DESIGN DIRECTIONS

9.3.1. DESIGN DIRECTION 1

To use whole bamboo cut in different ways to make playful building block toys (3-5 years age)

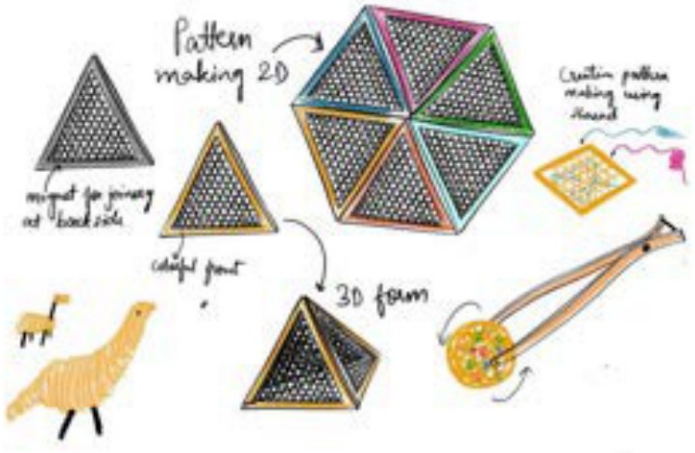
9.3.2. DESIGN DIRECTION 2

To use bamboo Strip (slats) to make Playful interactive toys for kids (3-5 years age)



9.3.3. DESIGN DIRECTION 3

To use patti coiling method along with weaving technique to make fun toys for kids (3-5 years age)



9.3.4. DISCUSSION, ANALYSIS AND CATEGORISATION OF IDEAS

After discussion with guide and feedback from stage one presentation, it was finalised that I should start with exploration on the actual material in order to understand the properties and technicalities of working with bamboo, thereby

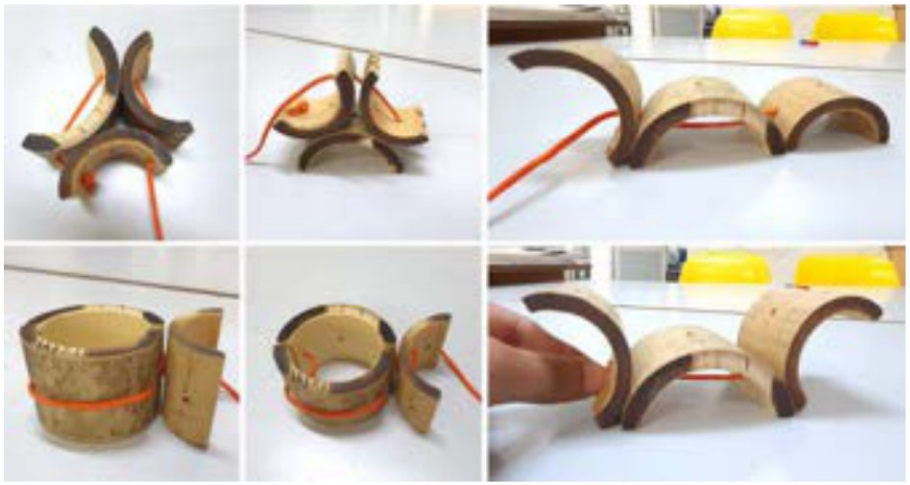
understanding the safety aspects for the kids. This will also lead to understand what is possible and what is not? What is safe and what is not? What is suitable for the context and what is not?

So, I started with various exploration on the material – Bamboo.

9.4. IDEA EXPLORATIONS

Bamboo split in half and various parts cut. These were then arranged for various exploration. Here I have arranged them in line in different orientation, grouped together and stacked with balancing the blocks

Further, 5mm diameter holes were drilled for more exploration. Here I have used nylon thread to connect the parts.



Arranging the blocks over the line. Below image shows the line drawing and the blocks placed over it.

Abstract animal formation

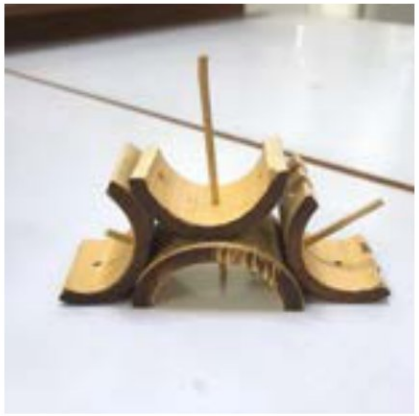
Further, more types of sections were cut. The thought was to use the curved section of bamboo as body of animal. Bamboo sticks were made and used as connecting elements for head and body of animal which acts as neck of the animal. The formation below is the abstract version.

Later, size of the curved sections were changed and small section was cut through centre of each end to form 4 legs of the animal.

More forms were explored for the head and tail as shown below

Orientation of the blocks were changed and explored again. Different length of sticks were used to connect the pieces.






The assembled blocks were given character by doodling over the image and visualisation.



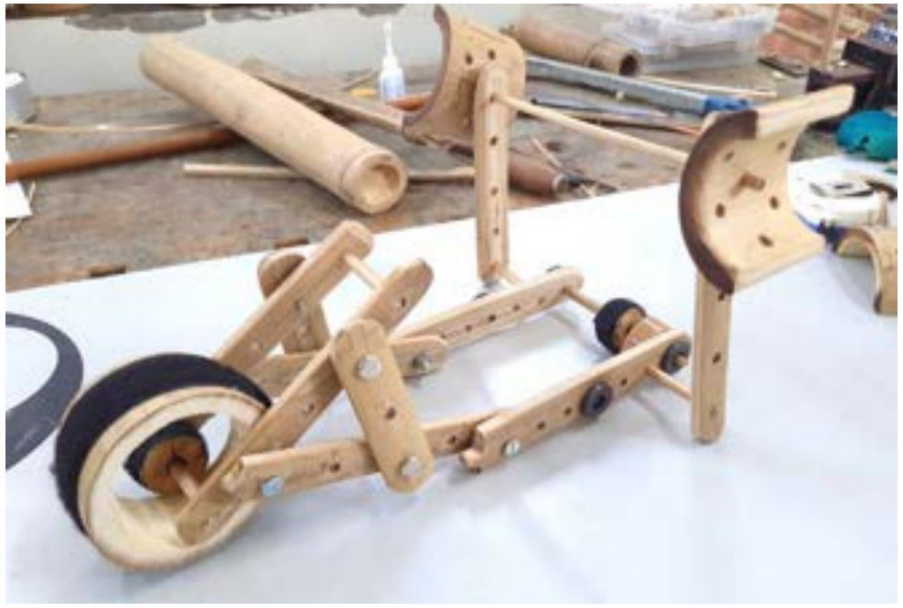

Animal formation – approach 2

To use curved body upside down and use 4 dowels as 4 legs of animal. For the neck a longer dowel stick is used with magnet on the tip for attaching the head which also has a small magnet embedded.

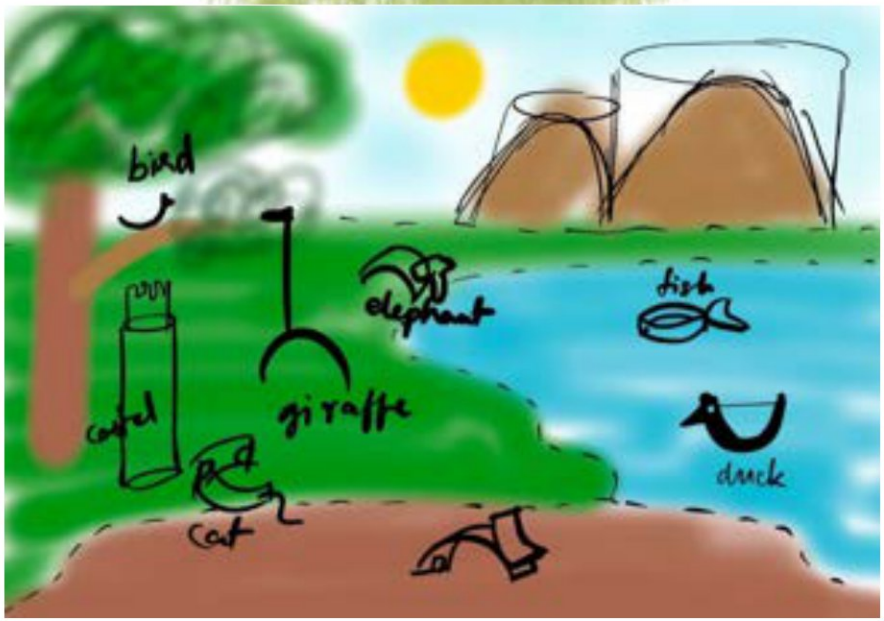
Freedom to using same element in different orientation and build stuff. It gives kid creative freedom to explore

Mechanical building style

Rivets and screws were used for connection



Scenario building and fantasy world



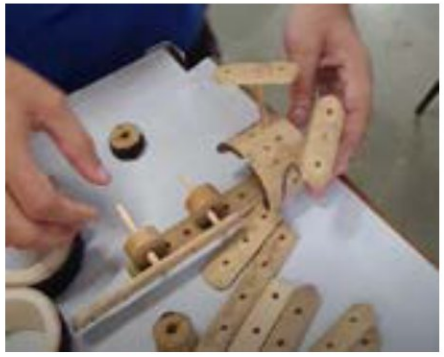
Ideas testing

Insights gained

There is need to Standardise the parts. Holes and cutting should be uniform in each block. A manual will help give clue where and how to start – few examples

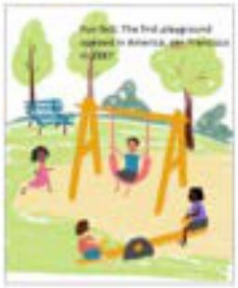
Found magnet as an interesting addition

valcro was also explored to see interesting joinery which turned out to be as expected but could not withstand multiple structure building



9.5. CONCEPT GENERATION

9.5.1. CONCEPT 1



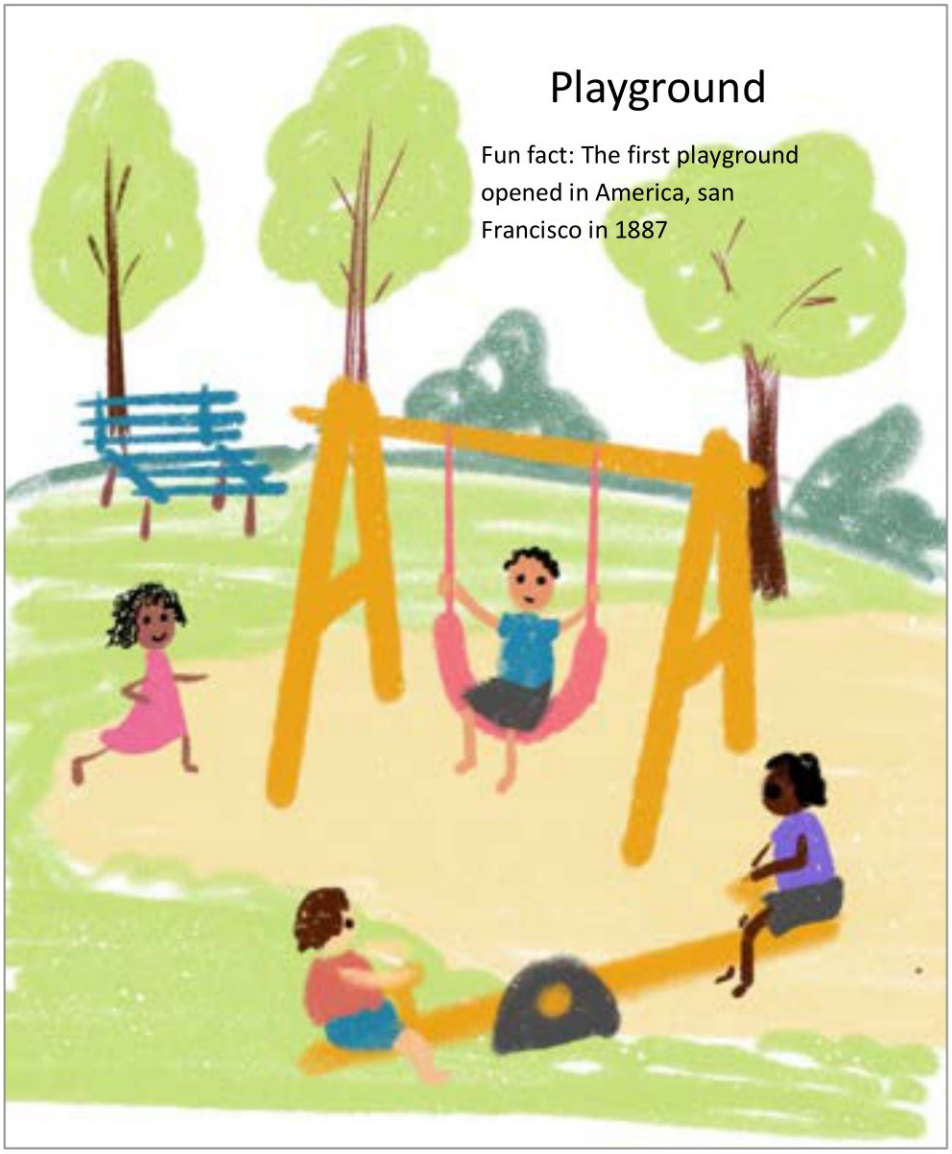
Theme play card-based construction set

- Design a constructable play card-based toy set to discover various objects by assembling different parts.
- Different parts can be assembled with the help of embedded magnet or bamboo dowel.
- Different kind of pieces will be similar and interchangeable so that kids are not confused.
- For better recognition elements will be colour coded.
- There will be set of play cards with various scenario images to give them direction to construct objects with fun fact that teacher can read out.
- There could be various activities with Cards to bring the competitiveness among groups. Example, pick a card and construct the object. Whoever does it fast will win the prize
- Construction does not limit to the cards it comes with. They can create many more objects and imaginary characters beyond this.

Aim

- The toy aims at gender neutrality that doesn't tell a girl to play with doll or a boy to play with truck.
- It gives equal creative freedom to both to explore the world without any bias with the help of cards on their own and discover objects and animals and learn about them and the environment.
- This will help them develop motor skills, cognitive thinking, enhance creative thinking
- With they will also learn about different objects and scenario they are put in

Mock-up of concept 1



9.5.2. CONCEPT 2

Story telling constructable set

- Designing Panchatantra theme based constructable toy set
- A puzzle toy in which different animal figures will be first assembled by kids with the help of colour coded parts.
- Different parts can be assembled with the help of embedded magnet and bamboo dowel to construct animals based on story card.
- There will be set of stories illustrated cards which will help teacher narrate and kids to build the scenario along the story line
- The story will be narrated by teacher and assembled animals will be used as puppets for visual interaction. Kids can also set up the scenario according to the story and play.

Aim

- This will enable kids to create animal figures and hence develop motor skills with team work
- Story narration will help them learn about the event and gain moral value lessons
- Apart from fixed set of cards, kids can use their imagination for their own fantasy world and play with toys.

Panchatantra stories – 40 stories

https://parenting.firstcry.com/articles/top-10-short-stories-of-panchatantra-for-kids/

One day crocodile swam through the river upto the tree and asked monkey for food as he was hungry. Monkey offered him rose apple. Crocodile thanked him and asked ig he could visit again. Crocodile and money became good friends. Crocodile told his monkey about his wife. Knowing this monkey sent many rose apples for his wife. Crocodile's wife ate those delicious apples and thought to herself "if monkey eats this sweet fruit, then his flesh must also be sweet". So, she pretended to be sick and asked crocodile to bring his friend's heart if he wanted to save her life. He wanted to save his friends also and his wife also. But what could he do? So, he invited monkey to his house. Monkey took ride on crocodile. In between crocodile stated to drown in water

and monkey asked him to which he said that his wife Is sick and wants to eat your heart. Monkey cleverly said that he would be willing to give his life to save his wife but he has forgotten his heart on tree. Fool crocodile believed him and brought him back to tree and monkey escaped to save his life.

Moral of the story: Choose your friends wisely

Be clever in decision making

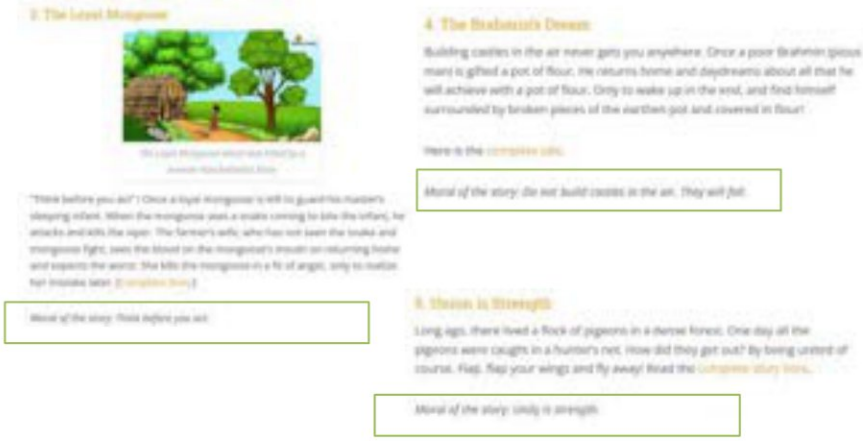
2. The Stork and the Crab

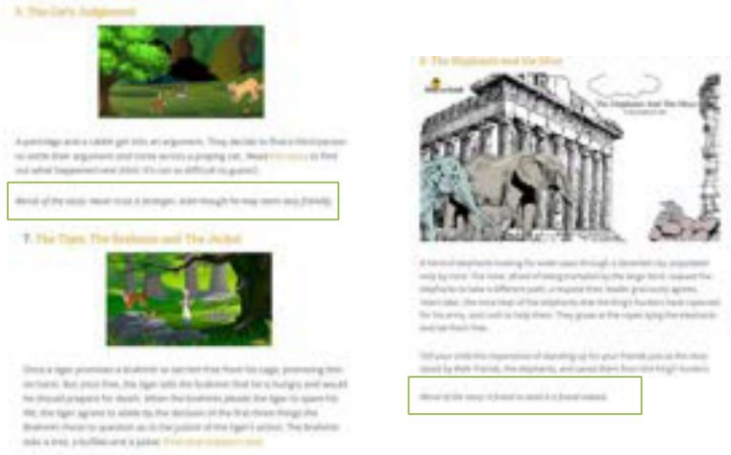
Once upon a time, there lived a stork by the side of tank. There were plenty of fish so hea had full meal everytime. As he grew older, he became weak to catch fishes. So, he thought of a plan. He stood sad near the tank. Looking at him fishes and crabs came near him to ask what happened. Stork said that soon this land will be used by humans to grow crop and everyone will die. Everyone got scared and wanted to save life. Stork offered to help them and said that I can carry few of you each time near a bigger tank and everyone agreed. So, every time he would carry few fishes and then eat them on the way. AT last, only crab was left. While he was carrying crab, the crab asked where he was taking him as he could only see rocky land and fish skeleton. He understood that he will be killed so he dug his sharp claws into storks' neck and dragged him to take back to the tank and thus he saved his life.

Moral of the story: A sharp mind is the greatest strength

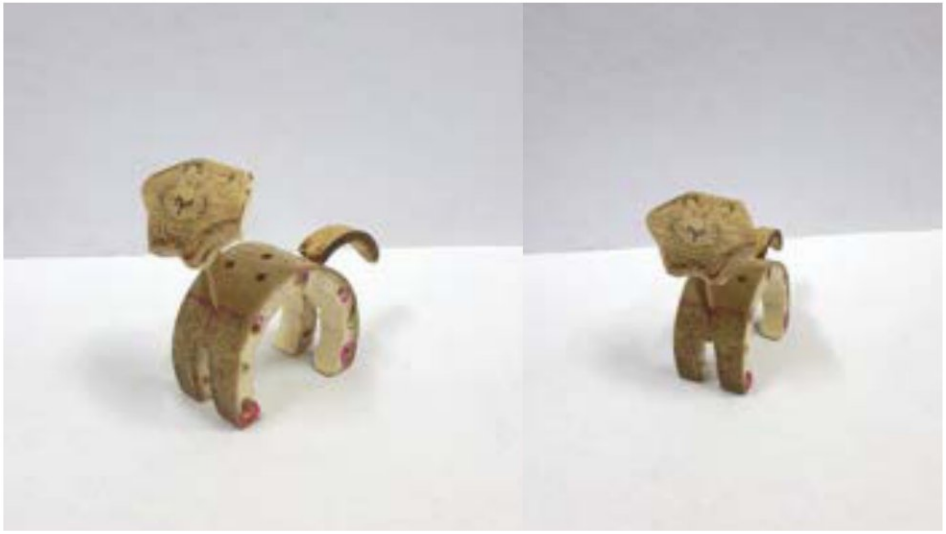
https://www.tell-a-tale.com/10-short-panchatantra-stories-must-read-4-6-year-old-kids/2/

And there are many more stories





Mock-up of concept 2



9.5.3. CONCEPT 3

Mechanical Constructable set

- To design a constructable automobile set with all the gears and hardware
- Different parts can assemble based on instruction manual to construct movable vehicle

Aim

- The aim is to enable kids to construct mechanically movable vehicles and hence develop motor skills with individual or team work.
- To give them freedom to construct vehicle of their own.
- To develop creative thinking

Mock-up of concept 3

9.6. CONCEPT EVALUATION

9.6.1. USER TESTING

User 1

Name: Mishti

Parent: Mr. Neeranjan

Age: 7 years

Study: 2nd class

Location: IDC, bamboo studio

In the beginning she checked all the pieces and was confused. I joined her and told her how to play and showed her different parts and how she can use them. she could recognise screws but was not aware of how to use them, so I taught her that.

She started building thing as per her visual memory of objects and things seen earlier.

Few parts had magnet attached. She didn't know the function of magnet so taught her that and then she was able to assemble parts with magnet on it.

She seemed happy after constructing an animal figure and showed that to her father present in the same room.

Then she also made a comb and showed it to her father. She had feeling of achievement.

She was happy to learn. And later we started playing together and in a team it got better. She had something in mind which she told me and then I was adding to it and we continued constructing stuff together.

Team work generates more ideas and enables us to play more. Here in context of school, a child can play with classmates, teachers and in home context they can play with parents, siblings or their friends.

User 2

Parent: Mr & Mrs. Biswal

Kid 1: Navya 5 year (UKG)

Kid 2: Shreya 9 year (3rd class)

Location: User home, IITB campus

Younger kid was very enthusiastic to play with the set.

grabbed most of the pieces and left very little for her elder sister

She used same type of blocks for one construction – **grouping similar elements**

And used sticks to build the structure in vertical direction.

As per her, it is a toy stand. She used screws to fill the holes. So, here the screws are not used as intended

The elder kid was playing with her mother. Here she changed the base of the above structure and was trying to balance by adding or removing the screws.

Fig. 23. *various creations by her*

Fig. 24. Various creations by her

She brought her own toys (fig.25) and started to build referring to it. To her it was a moving dog when asked why it has wheel. She said that its her animal and she will make it whatever way she likes.

Through this conversation, I realised that kids have their own imaginary world and they play in that world.

Fig. 25. *Playing piano with the arrangement*

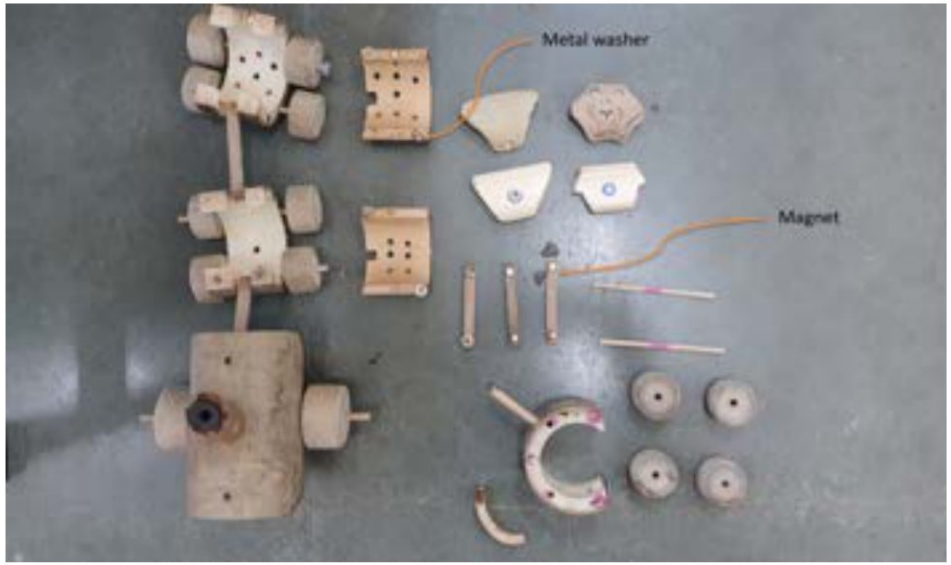
She arranged the sticks in line and started singing song and playing xylophone once and another time piano with her fingers.

It was very new to me observing kids enjoy in their own way. Nobody told her what to do and yet she was enjoying her moment as can be seen from the image.

Every kid has their own imagination and this set will give them that freedom to do whatever they like.

9.6.2. ANALYSIS

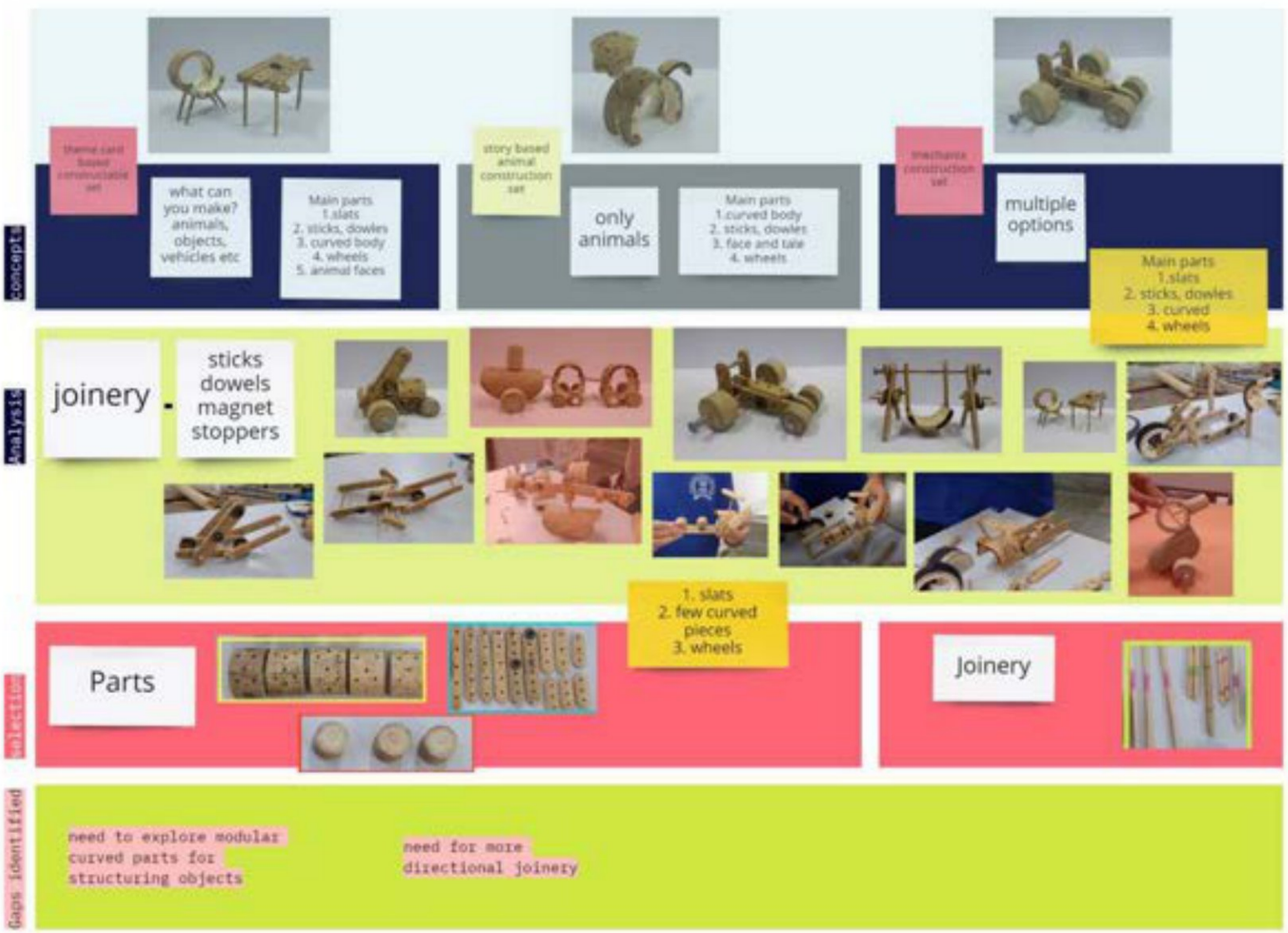
Insights gained from user testing. Below are various parts which will be further evaluated.

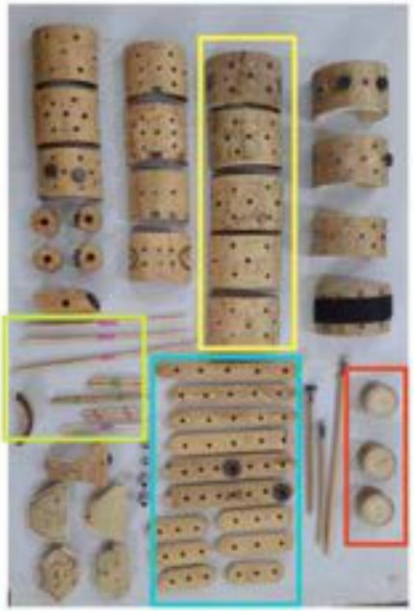


Comparison of three concepts

	Concept 1 Theme card based constructable set	Concept 2 Story telling constructable set	Concept 3 Mechanical constructable set
Learning	creative freedom to both to explore the world without any bias with the help of cards on their own and discover objects and animals and learn about them and the environment	learn about the event and gain moral value lessons	enable kids to construct mechanically movable vehicles and hence develop motor skills with individual or team work
Level of understanding	Play cards to help them guide visually to construct the object	illustrated story cards for narration and animal figure construction	instruction manual for few automobile structure Other exploration based on imagination
Kids Engagement	interaction with card and construction elements both	less interaction Only while constructing the animal figure	Deep engagement with construction because of mechanscal parts
Teacher involvement	less	more	less
Motor skill development	less than concept 3	less than concept 1	high
Cognitive thinking	yes	yes	yes
Creative thinking	high	low	high
Teacher involvement	less	more	less
Kids team work	yes	less	more
Alignment with school curriculum	All round GK	Moral lessons	Directional GK
Industrialization/craftsmanship	more craftsmanship than concept 3 due to some animal figures	more detailed craftsmanship	less craftsmanship because of simple elements

Parts analysis

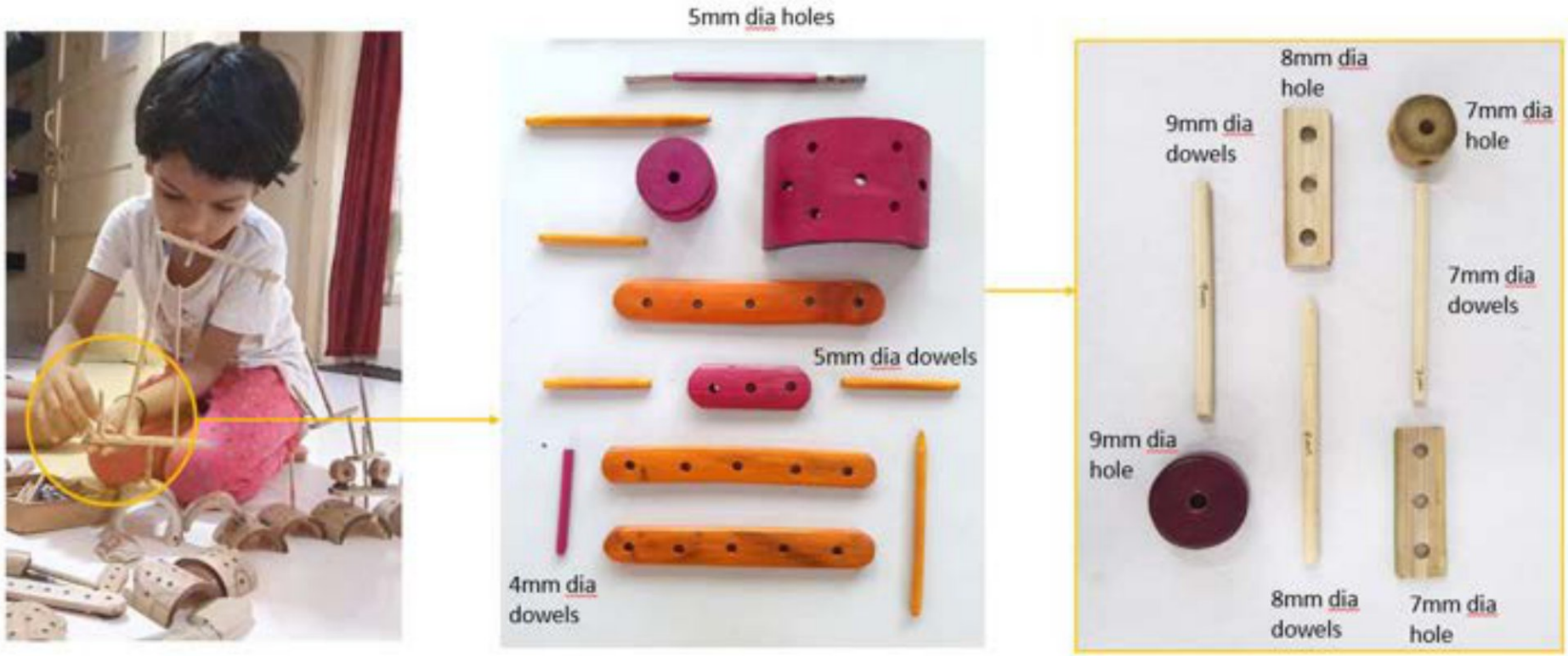




Size analysis

Initial dimensions

Revised dimensions

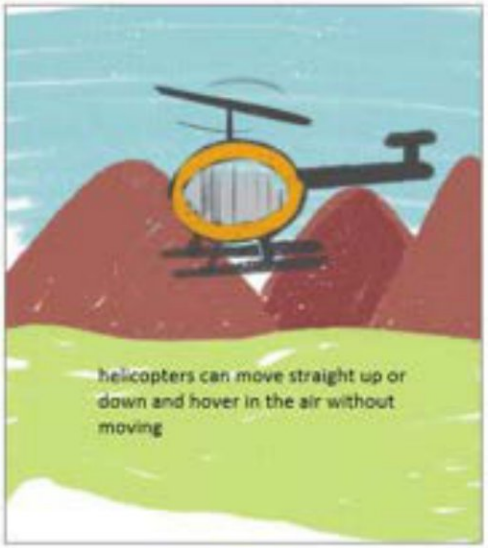


Concept selection

Elements from two concepts were derived. From concept 1, play cards were adapted but only for the teacher since we are trying to enable experiential exploration through toys. And from concept 3, mechanical constructable set is entirely picked with further revision on joinery.

Concept 1 – **play card** based construction set

Cards for **teachers only** to help/guide kids if they feel clueless in the beginning



Concept 3- **Mechanical** Constructable set

Gives kids creative freedom to build anything

Enable kids to think creatively & encourages experiential learning

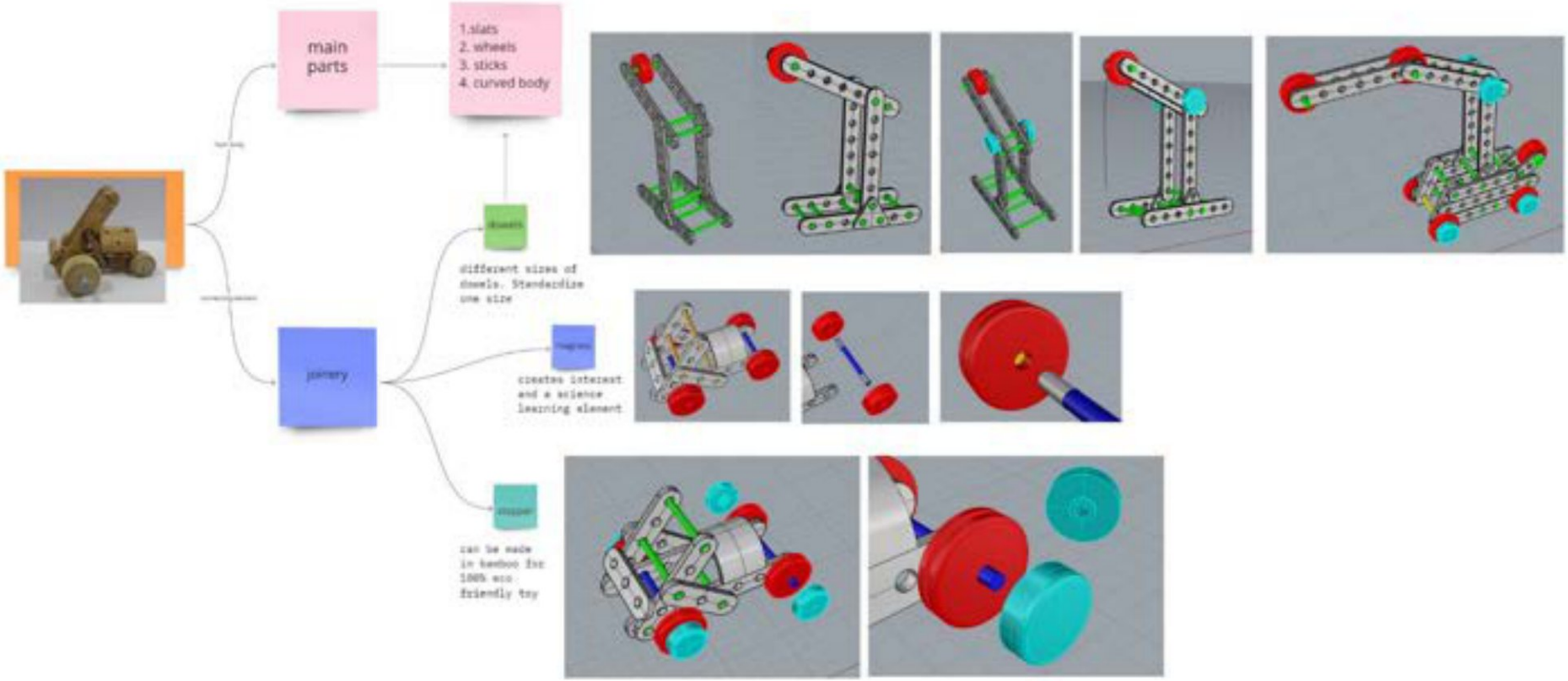
Modular Constructable set

- **To design a constructable toy set with modular parts for various exploration by kids** to develop creative thinking, cognitive thinking and motor skill proving them with all the creative freedom
- **Different parts can assemble to construct different objects and figures** through their memory or imagination
- The **cards provided with the set are only for teachers** to help them with the education. They can help kids if they are clueless and it **acts as an achievement card** by showing it to kids once they have constructed that object

Fig. 26. *Modular parts*

9.7.1. EXPLORATION IN PARTS

There are two things in the entire set of toys. One is the main part that is the modular units and another one is the connector, the joinery.



Modular unit exploration

Various cuts and section were given and explored for different formation of the structure. Images below show various parts and assembly of it. Dowels were fixed in some parts for joining two parts together.

In some cases a single part also acts a joinery and modular unit both.

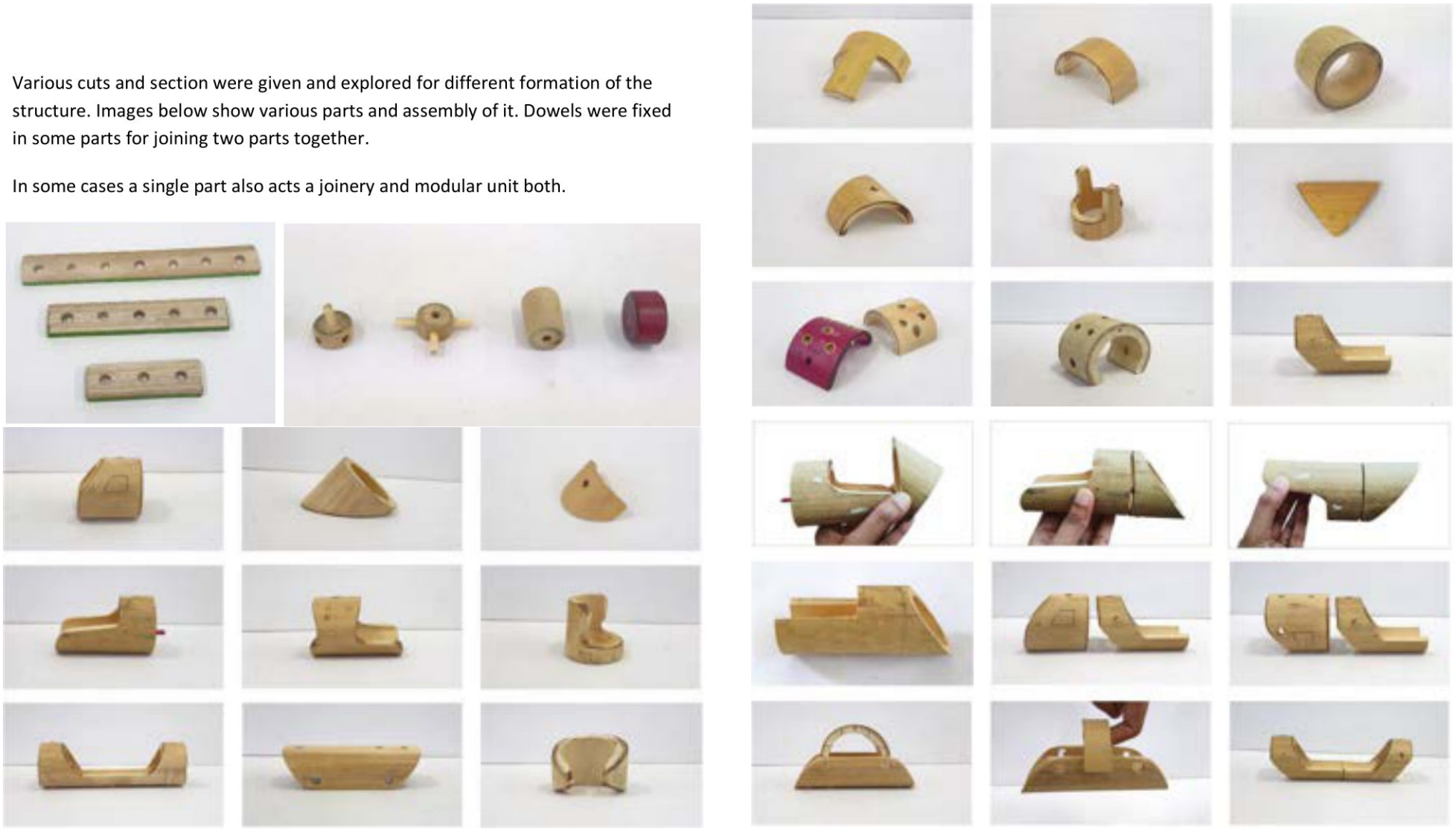


Fig. 27. *Modular units and its combinations*

9.7.2. EXPLORATION IN JOINERY

1. Initial Magnetic joinery

Magnets were added in few holes of the slats and the cylindrical blocks as shown in the image below. There are ring magnets and button magnets. For the counter attachment of the parts, ends of the stick are secured with rivets. And even in smaller size slats on the right side of the image, rivets are embedded.

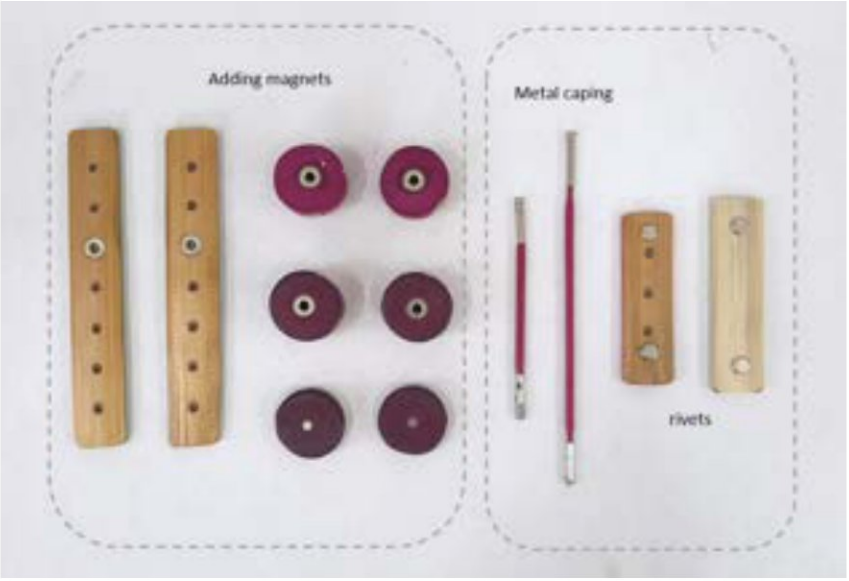
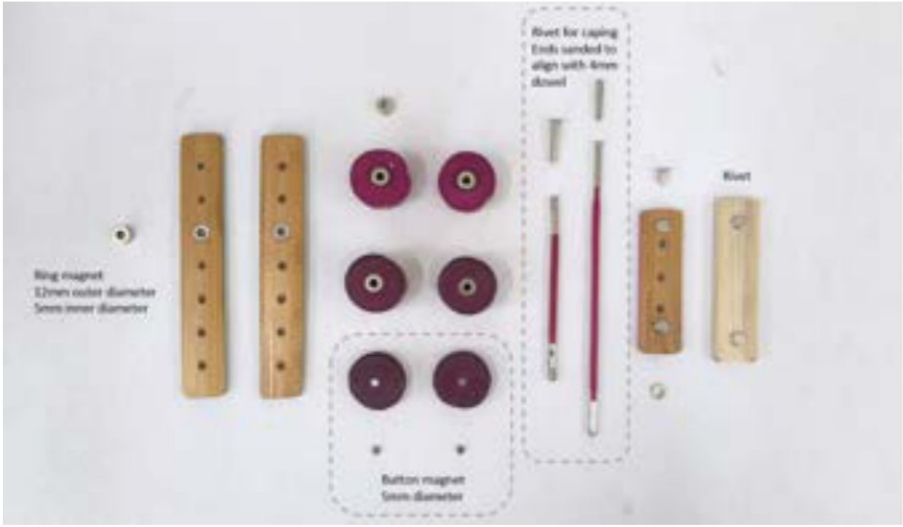


Fig. 28. *magnet and metal fixture fitting*



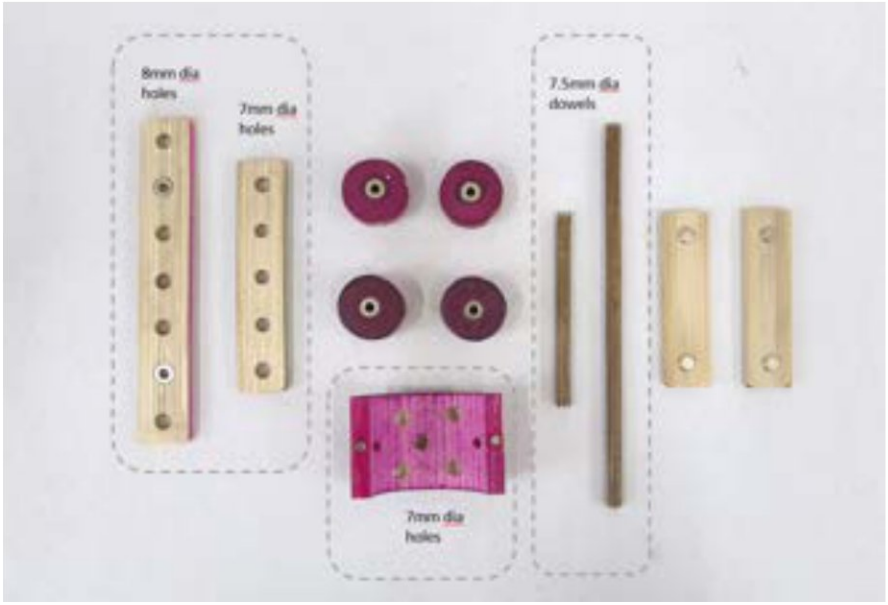
Above image shows the magnets and rivets used for the fixture. Rivets used for the sticks were sanded on the edge to align with the surface of sticks.

Fig. 29. *Possible construction*

Above are 2 examples of the construction using magnetic attachment.

Revised magnetic joinery

Size of holes were revised and so were the rivet ends on the sticks.



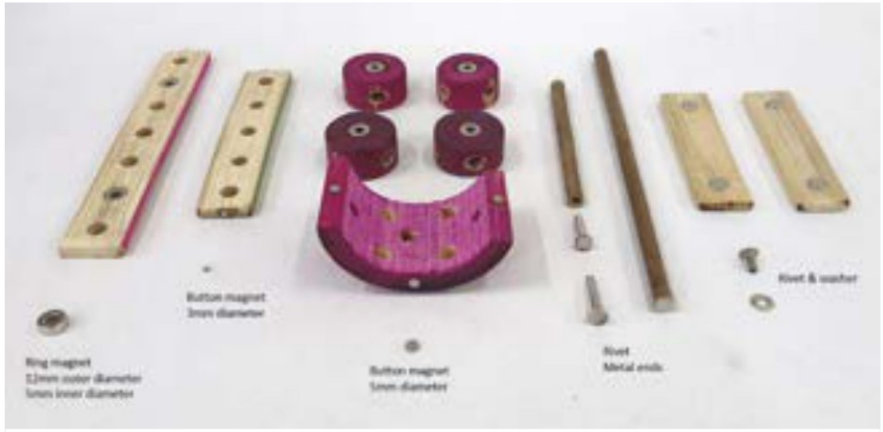


Fig. 30. *magnet and metal fixture fitting*

Objects constructed using the joinery

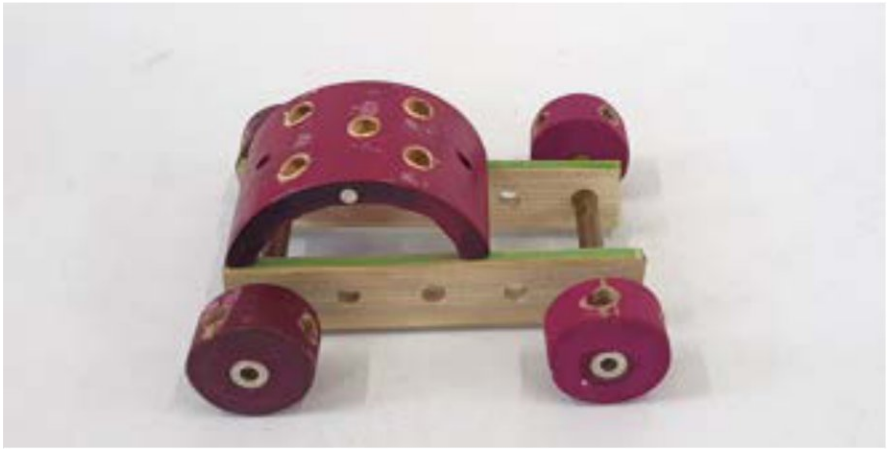
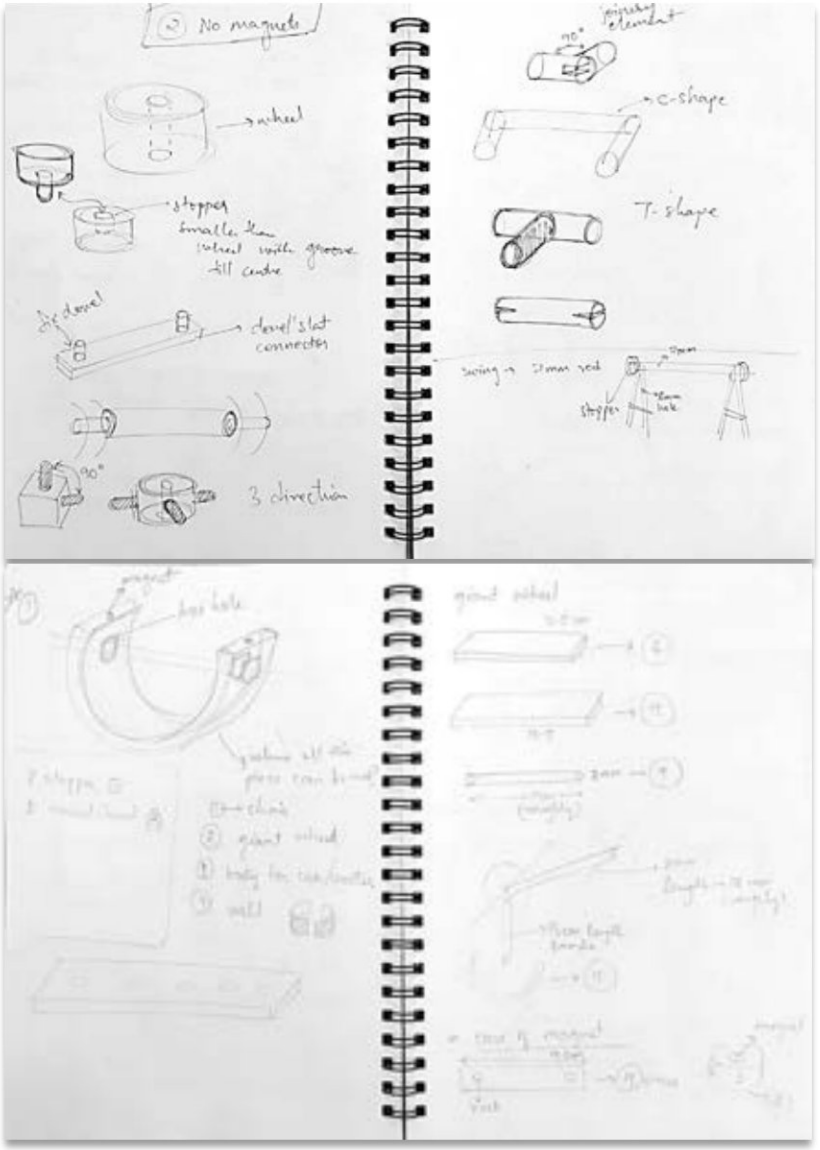


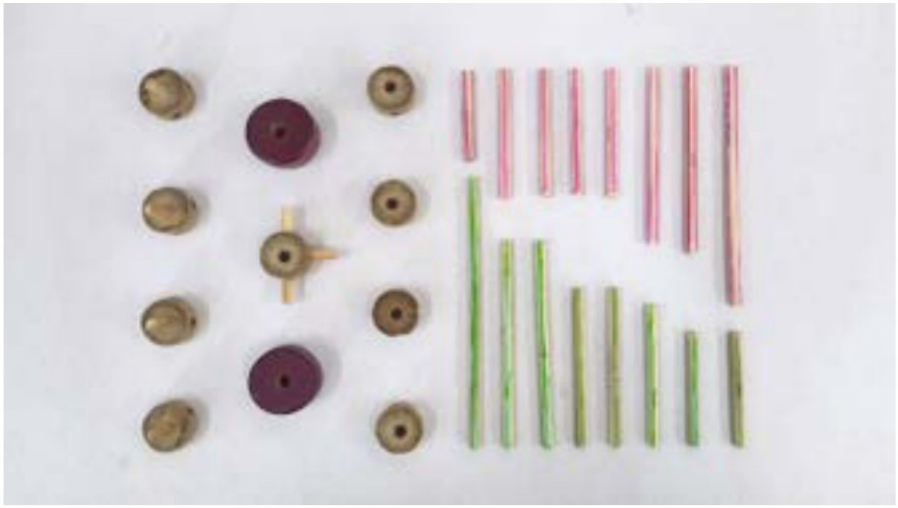
Fig. 31. *Possible construction*

2. Non - Magnetic dowel joinery



Below are the dowel joineries. The idea was to use the same component in different ways and not just as joinery. For example, the 2nd component in Fig.32 below can act as scooter seat and also as stopper at places. The 3rd component in Fig.32 below can act as handle for scooter and also as a joinery for 3 directional growths of object.

Fig. 32. *Connecting joinery*

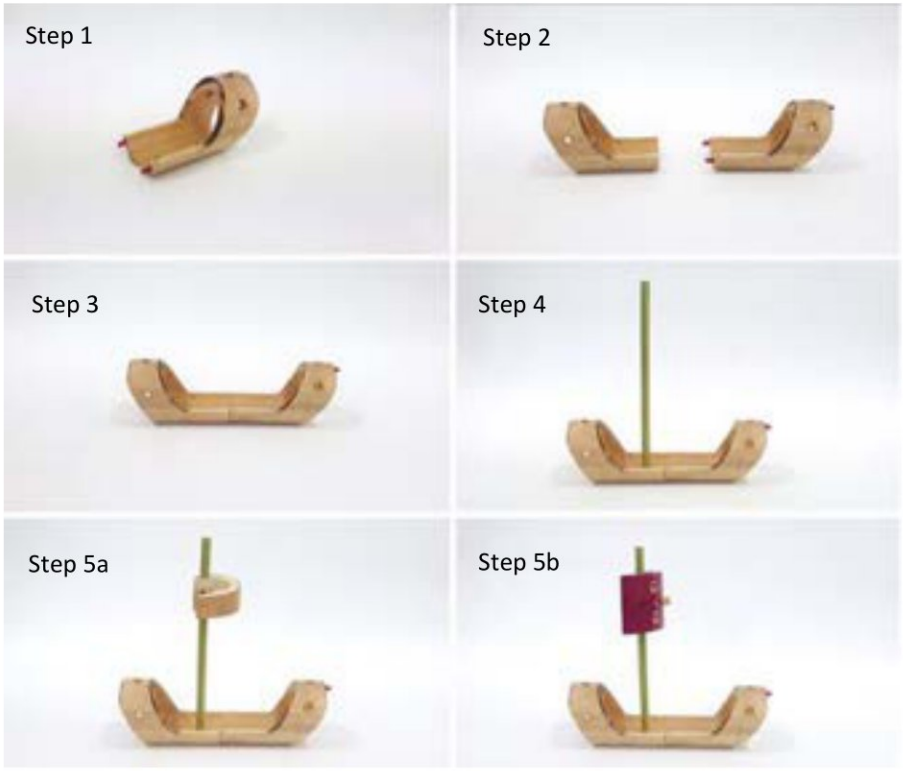


Also, the combination of these so-called connectors with the dowels can increase the possibility of using it in different ways. So, various combination can cater to different requirement in the construction of an object.

Below is the example of one such construction using connectors and other units

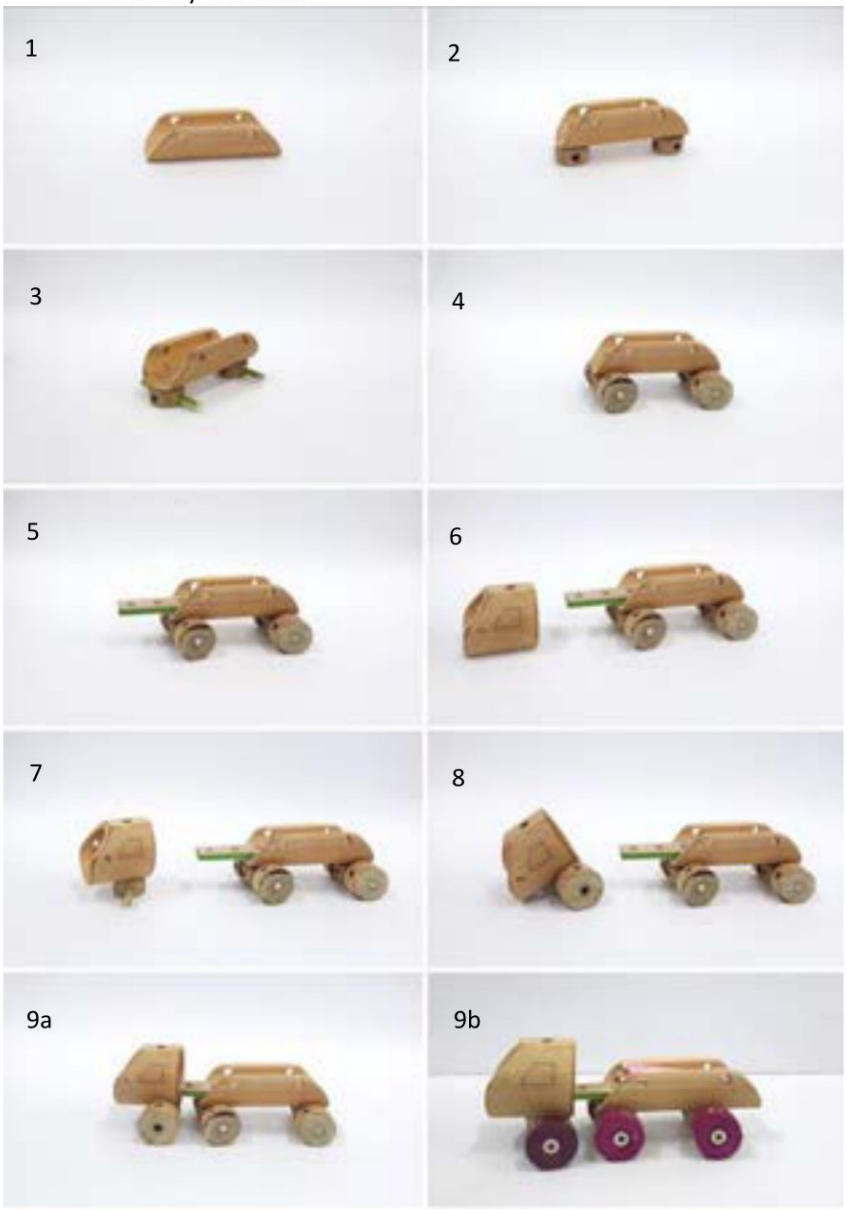
9.7.3. ASSEMBLY OF TOY FIGURES

Assembly of boat



There is small dowel connector in the modular part. This a male female dowel joinery. And for rest of the structure, a long stick, stopper and c section part is used.

Assembly of a truck



Here are more assembled figures

A scooter

Swing

Fig. 33. *Various construction using components*

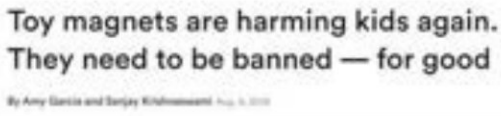
Fig. 34. *Various construction using components*

Crane machine

Giant wheel

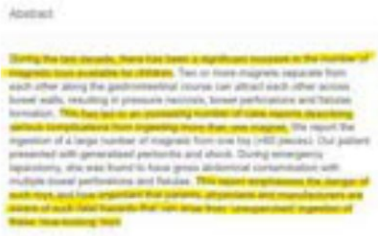
9.7.4. DESIGN EVALUATION

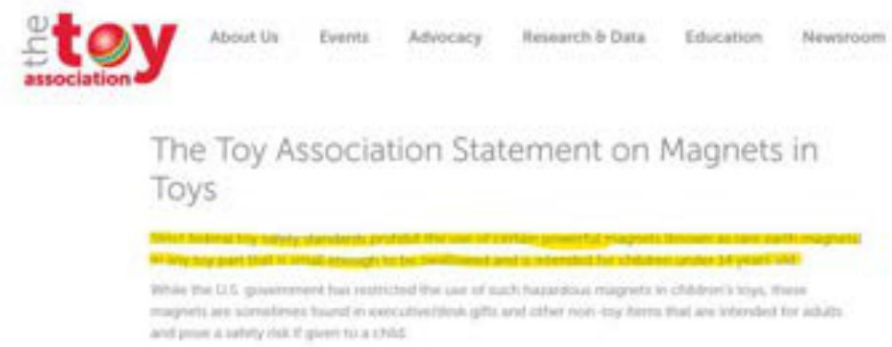
Since two different joineries were explored, the one that is safe and easy to use should be taken forward and detailed out for the final design. It was found out that magnets are dangerous for kids and there it was discarded.


Toy magnets are harming kids again.
They need to be banned — for good


How dangerous a toy can be? The magnetic effect

https://www.researchgate.net/publication/274372178_How_dangerous_a_toy_can_be_The_magnetic_effect




the toy association
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The Toy Association Statement on Magnets in Toys

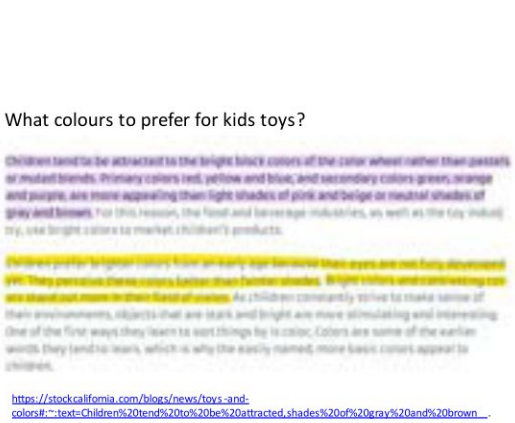
https://www.researchgate.net/publication/274372178_How_dangerous_a_toy_can_be_The_magnetic_effect https://www.toyassociation.org/PressRoom2/IndustryStatements/ToySafety/statement-on-magnets.aspx

9.7.5. SELECTION OF MODULAR UNITS

Blue highlighted ones are the selected units

9.7.6. COLOURING METHODS AND SELECTION

Colour selection

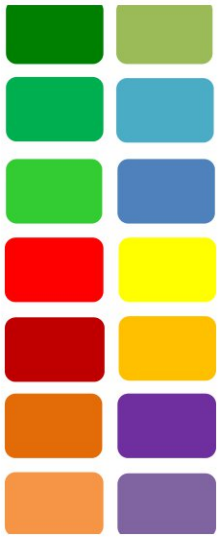


What colours to prefer for kids toys?

Children tend to be attracted to the bright block colors of the color wheel rather than pastels or muted blends. Primary colors red, yellow and blue, and secondary colors green, orange and purple, are more appealing than light shades of pink and beige or neutral shades of gray and brown. For this reason, the food and beverage industries, as well as the toy industry, use bright colors to market children's products.

Children prefer to ignore colors from an early age because their eyes are not fully developed yet. They perceive these colors better than human shades. Bright colors and contrasting hues are stand out more in their field of vision. As children constantly strive to make sense of their environments, objects that are stark and bright are more stimulating and interesting. One of the first ways they learn to sort things by is color. Colors are some of the earliest words they tend to learn, which is why the easily named, more basic colors appeal to children.

https://stockcalifornia.com/blogs/news/toys-and-colors#:~:text=Children%20tend%20to%20be%20attracted,shades%20of%20gray%20and%20brown .



Gender neutral colours

Toys and gender: Pretty in pink and boisterous in blue?

Children's perception of gender appropriate colors can be easily manipulated

Date: January 4, 2018

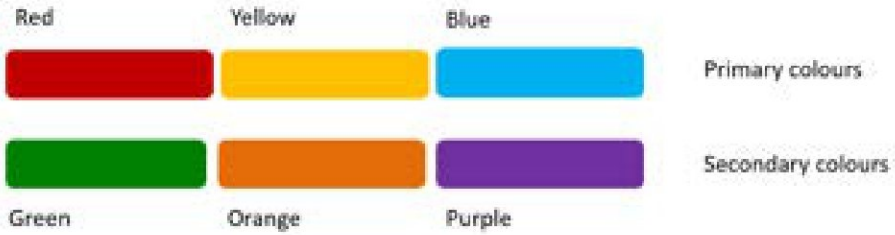
Source: Springer

Summary: Researchers urge toymakers and parents avoid gender-labeling toys, remove color divides, and manufacture toys for both boys and girls in a wide range of colors. New research shows how easily preschoolers' ideas about what is appropriate for their gender is manipulated.

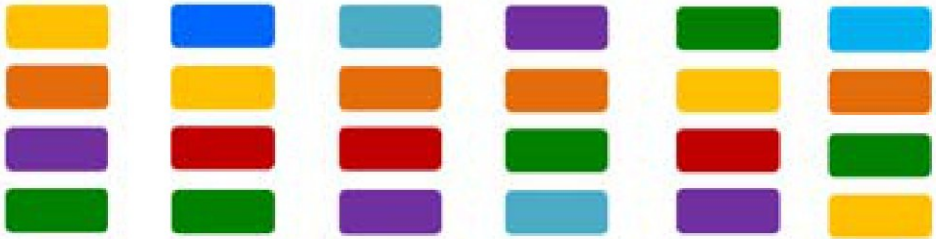
Two researchers from the University of Hong Kong suggest that toymakers and parents avoid gender-labeling toys, remove colour divides, and manufacture toys for both boys and girls in a wide range of colours. Su Ping Yeung and Wang Ivy Wong's study is published in Springer's journal Sex Roles, and shows how easily preschoolers' ideas about what is appropriate for their gender is manipulated. Their study is also the first to show that a boy's preference for blue and a girl's liking of pink is not just a Western construct, but is also a phenomenon in urban Asian societies.

https://www.sciencedaily.com/releases/2018/01/180104120331.htm

Colour selection



Different combination of colours



The plan is to use all the bright primary and secondary colours for the final prototype.

Colouring methods

Lac work

Lac is a natural resinous material used to make bangles in Rajasthan and Gujarat states of India. This method is used in turn able forms which have cylindrical surfaces.

Adding the finishing touches

http://blog.directcreate.com/the-splendid-legacy-of-wood-and-lac-work-from-gujarat/

The lac material is heated and rolled with a wooden base over the flat surface. And then a thin layer of resin is rolled on the cylindrical surfaces of the object being coloured.

Engraving on bamboo surface

There are two methods for engraving. One is to use the pyrography pen and other one is laser engraving.

Pyrography pen was used in the studio to experiment and experience the look. Various designs and patterns are possible but it is time consuming and the print is not the same everywhere since it is hand engraved.

Natural colour dying method

In this method the entire section of bamboo is emersed in the boiling-coloured water and is heated for an hour so that the bamboo soaks in the colour. After its done, the parts are removed from the contained and spread aside to dry completely.

At IDC, we did the setup for dying the toys parts.

A big steel container was half filled with water and preheated with a lid covering the container. We have to keep more water as half of it would evaporate during the process.

Turmeric was used for yellow colour. It was weighed on the weighing machine. For 2.5 litre water, we used 25-gram turmeric in the boiling water.

Fig. 36. *Process of dying with turmeric*

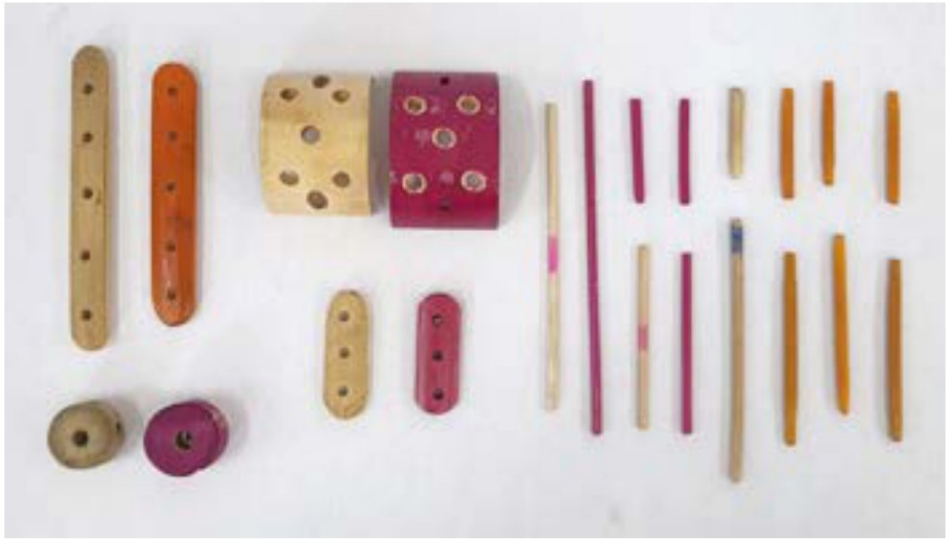
After dying some parts in yellow colour, alta was used for pink colour dying for other parts.

Fig. 35. *Process of dying with alta*

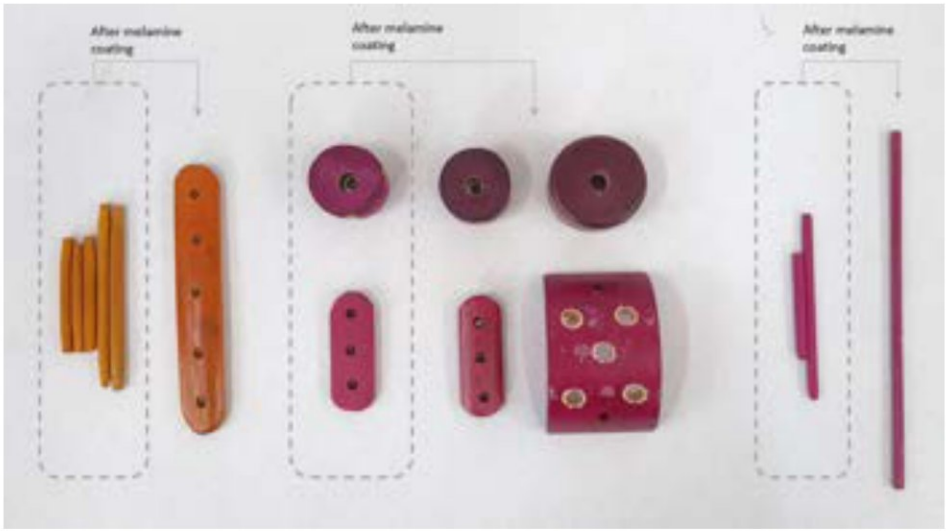
All the parts were removed and kept aside for drying

Left all the dyed parts overnight for air drying.

Here is the before and after look of various parts



And this is after melamine coating over the surfaces of various parts.



Wood Staining method

This method involves staining the surfaces of the wood. The colours remain on the surface only and is then sealed with a coating of sealant.

Varnishes/ sealants

Linseed Oil and Tung Oil

Tung and Linseed Oil are the more durable oils for protecting wooden toys. Penetrating "drying oils" polymerize, leaving a durable yet matte finish. They do change the color of the wood, with tung oil producing the darkest color change, followed by linseed, then hemp, then walnut. 30-Nov-2021

Non-Toxic Sealants for Wooden Toys (Clear & Stains)

- Natural Penetrating Oils. Linseed Oil and Tung Oil. ...
- Shellac. Shellac is a natural resin that comes from a beetle mixed into alcohol. ...
- Natural Wax Finish. ...
- Danish Soap Finish. ...
- Non-Toxic Synthetic Sealant.

9.8. CONCEPT EVALUATION & FEEDBACK

After pre jury stage presentation, I received the feedback to think critically on the dowel joinery as it might loosen up after multiple usage and to think of various material consideration for connectors so that we can industrialize the product to some extent.

So, the design details have to be evaluated on various aspects

1. Ease of Usability
2. Re usability
3. Durability

As of now solutions have been figured out for not loosening the dowel over repetitive usage. And also, for dowel joinery in modular units, stainless steel is being considered.

The edges, holes and corners can be heat pressed for better finishing.

9.9. FINAL DESIGN

After finalising various elements of the design, evaluating, discussion with guide and feedback from other faculty, here is the final design.

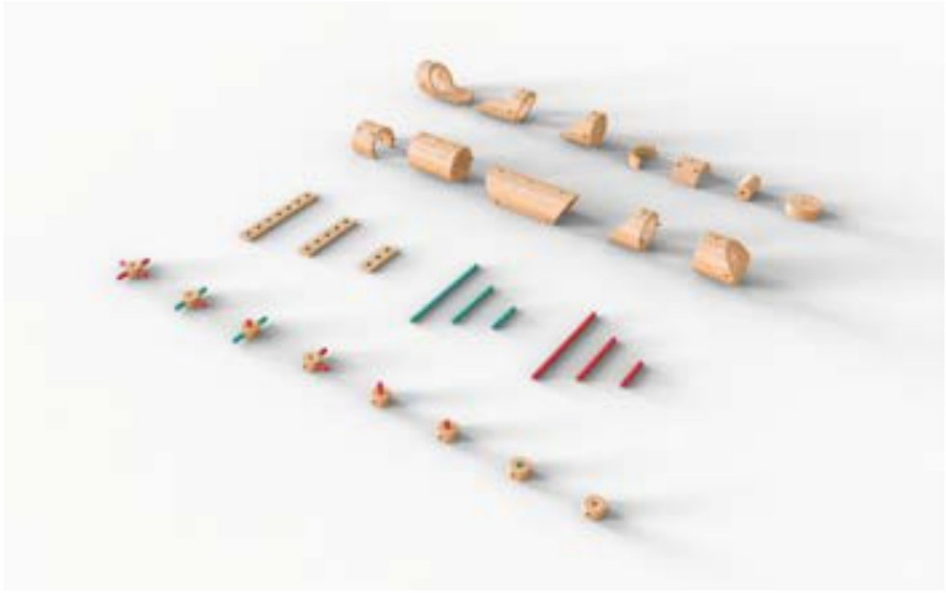
9.9.1. FINAL DESIGN BRIEF

To design sustainable and interactive constructable toy set using bamboo as an eco-friendly material for preschool kids, aged 3-6 years targeting urban Kindergarten to enable and develop the following among the kids,

- Creative freedom
- Creative thinking
- Cognitive thinking
- Motor skills
- General knowledge
- Team work

9.9.2. FINAL PARTS IN THE SET

All the parts in the set. This includes curved parts, flat parts, different lengths of dowel sticks and connecting dowel joinery.



Modular units in the set

Flat slats of three different lengths, that is 17.5 cm, 12.5 cm and 7.5 cm as shown below.

Curved Modular units

Flat modular units

Connecting dowels

Dowel joinery

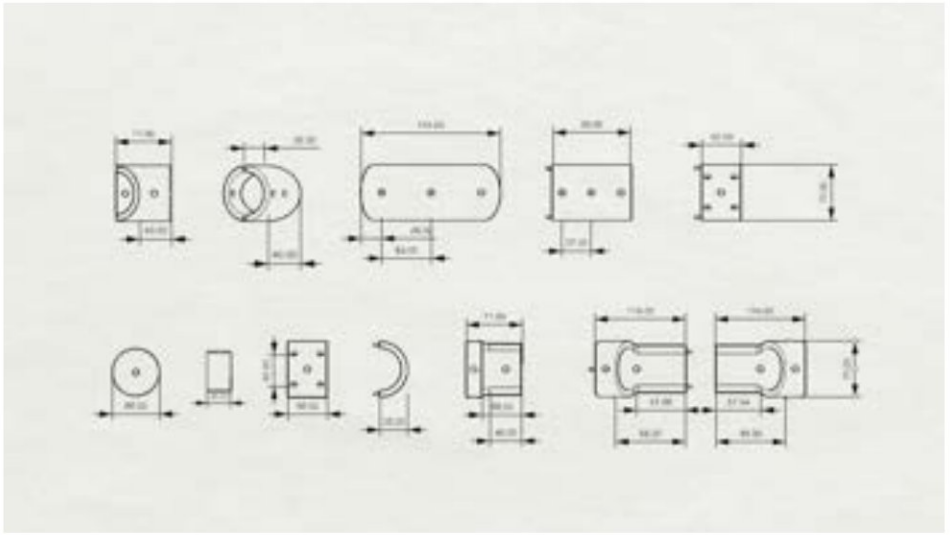
Cards for teacher

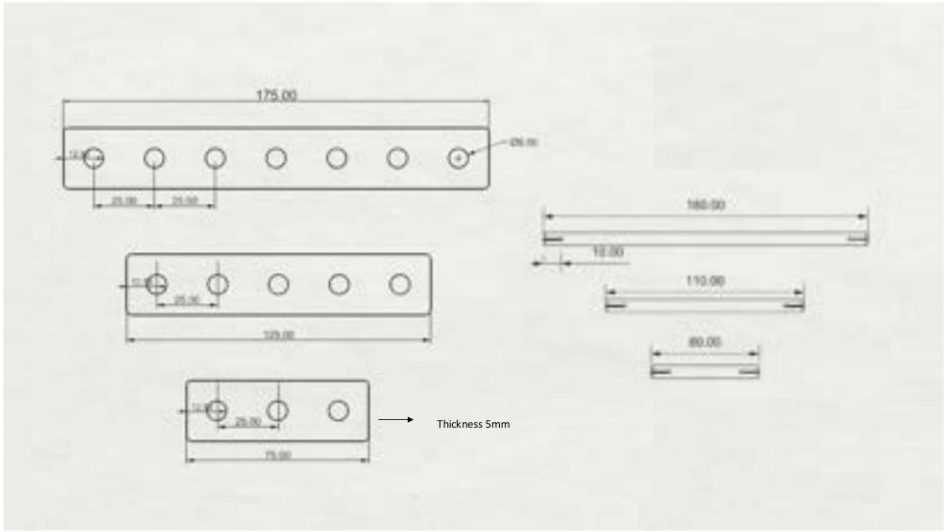
The **cards provided with the set are only for teachers** to help them with the education. They can help kids if they are clueless and it **acts as an achievement card** by showing it to kids once they have constructed that object

School scenario

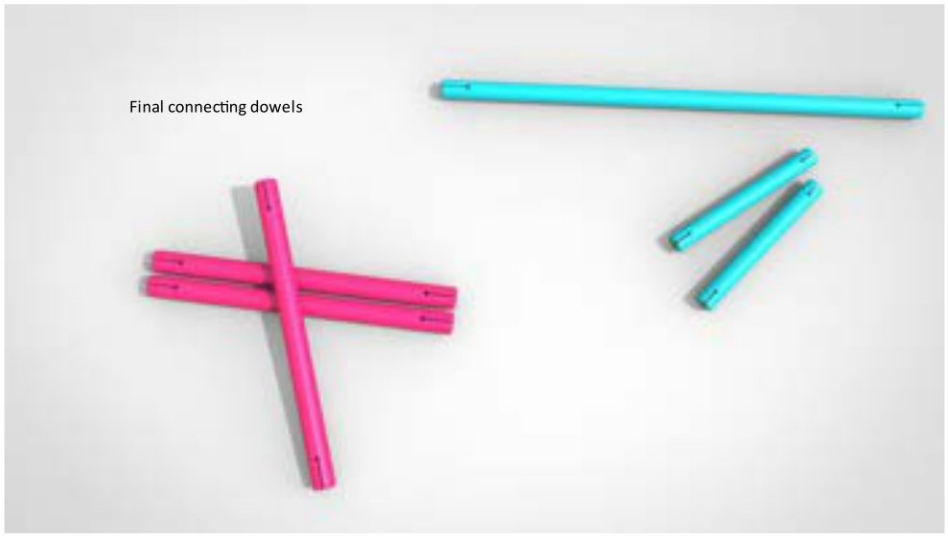
9.9.3. DESIGN DETAILS

Detailed drawings





For better fixation of dowel sticks with the main body (curved parts and flat parts), a slit is provided at both the ends with a small hole. This kind of details provides a spring action and ease to insert or remove the stick from the holes provided in various parts.



Same detail is also provided in the dowel connectors as shown below.

9.9.4. MATERIAL & MANUFACTURING DETAILS

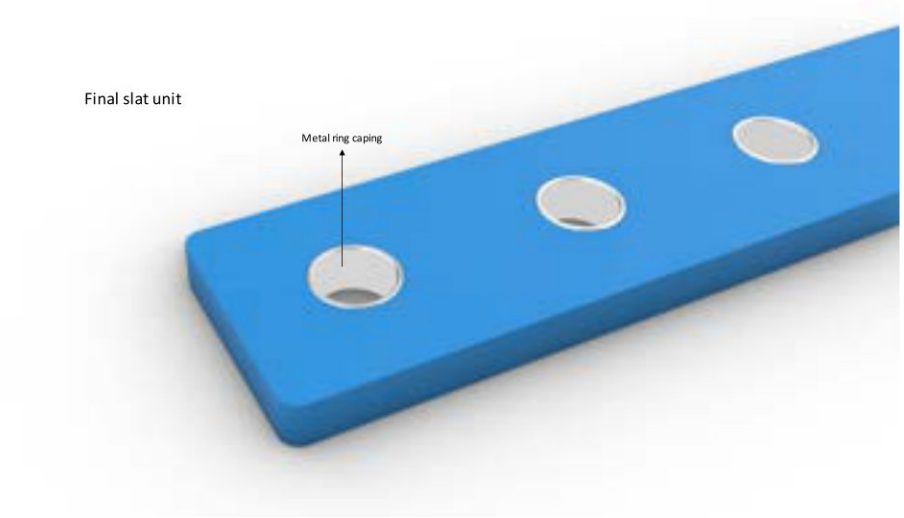
For all the curved parts and slats bamboo is the primary material.

For wheels and connectors wood is being considered

And for dowel joinery as shown in below image, stainless steel/brass rod of 3mm diameter is being considered

For the wheels, one side of the hole can be sealed with metal capping as shown in image above.

The edges, holes and corners can be heat pressed for better finishing or can be capped with stainless steel or brass as shown below.



9.9.5. FINAL COLOURS AND METHODS

For final prototype, few parts will be dyed in organic colours.

I have used all the organic colours like turmeric for yellow colour, Alta (made from betel leaves) for reddish pink colour, orange was made from the combination of turmeric and alta. Only bluish green colour was artificial colour as I couldn't procure an organic one.

Below are different parts dyed and left for air drying naturally.

The slats will be only be stained on side surfaces. The plan was so but couldn't achieve that as the material had variation in the look and so all the slat parts were dyed in chai to give it even looking finish.

Here are the final dried parts with all the bright colours.

1. Scooter

2. Truck

3. Racing car

4. Helicopter

5. Swing

6. Bench

7. Giant wheel

8. Creature

9. Crane machine

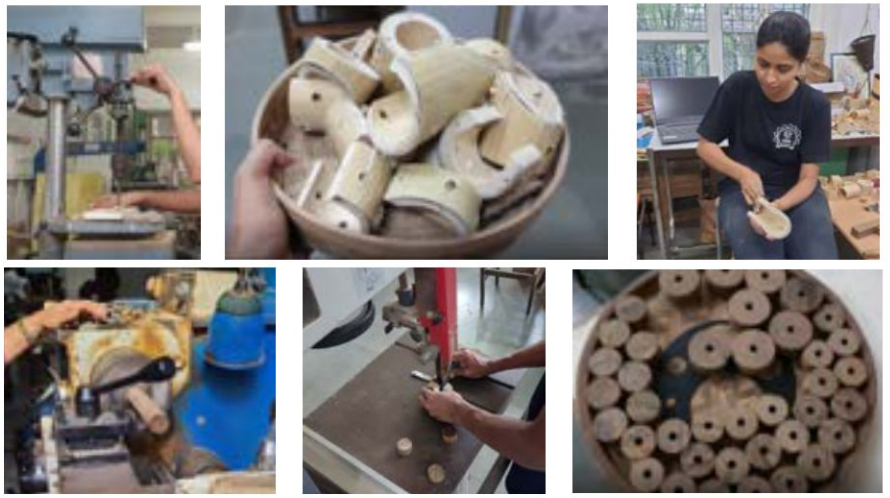
10. Table chair

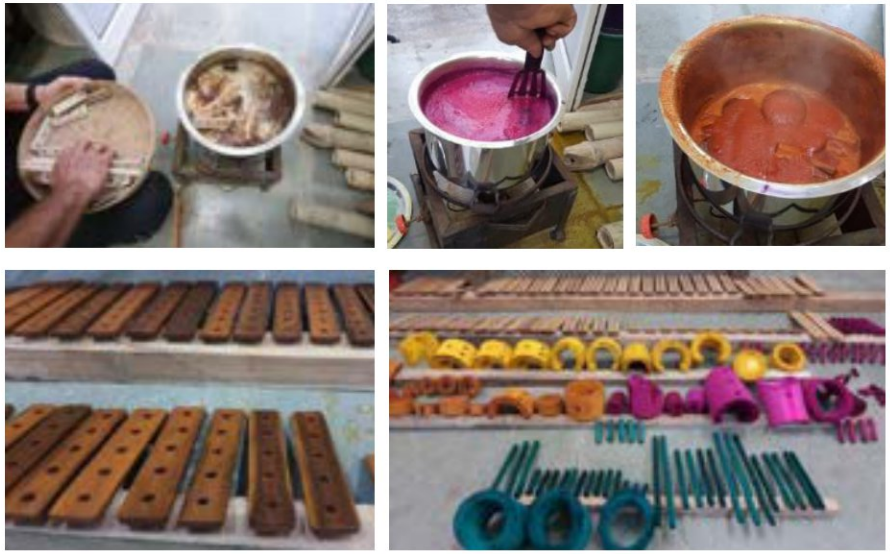
11. well

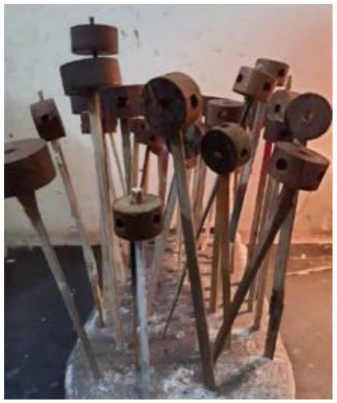
12. Tractor

9.9.7. FINAL DESIGN PROTOTYPE

Making of final prototype







After all the making process, finally the parts were ready for kids to play with. It can be assembled in various ways to explore creative mind.

Below are some examples of constructed objects

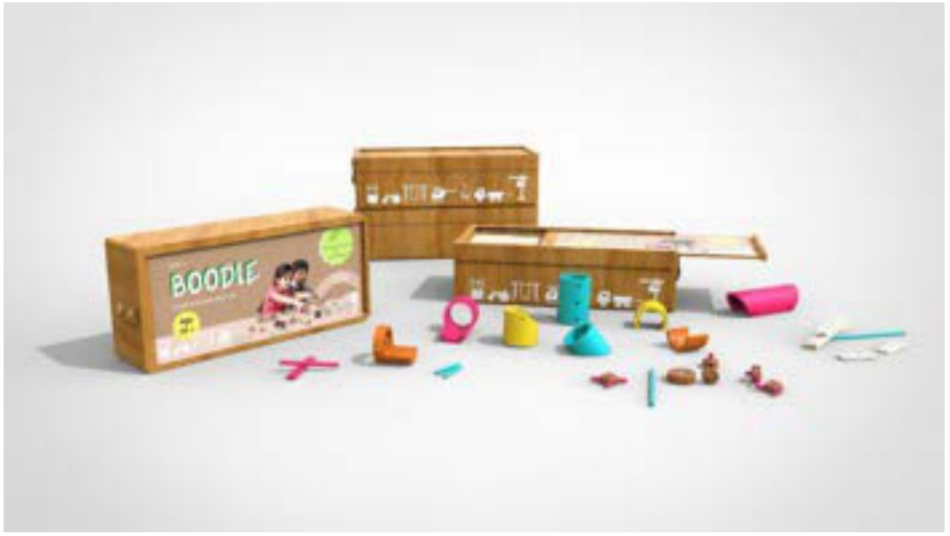
1. Truck

2. Table & chair

3. Imaginary animal figure

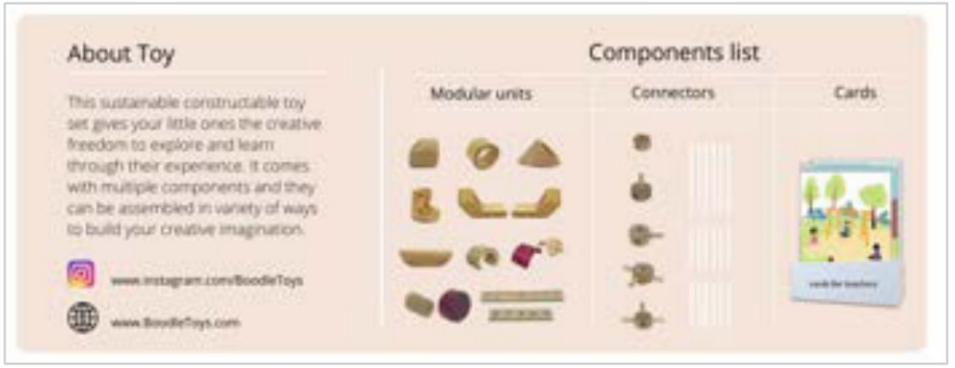
9.9.8. PACKAGING

Below is the visualisation of the packaging. Since these toys will be used by kids in preschool, it has to be sturdy considering that the box will open and close on a daily basis. Therefore, wooden box is a good option for packing. The design a cuboidal, easy to carry, stackable and easy to store.

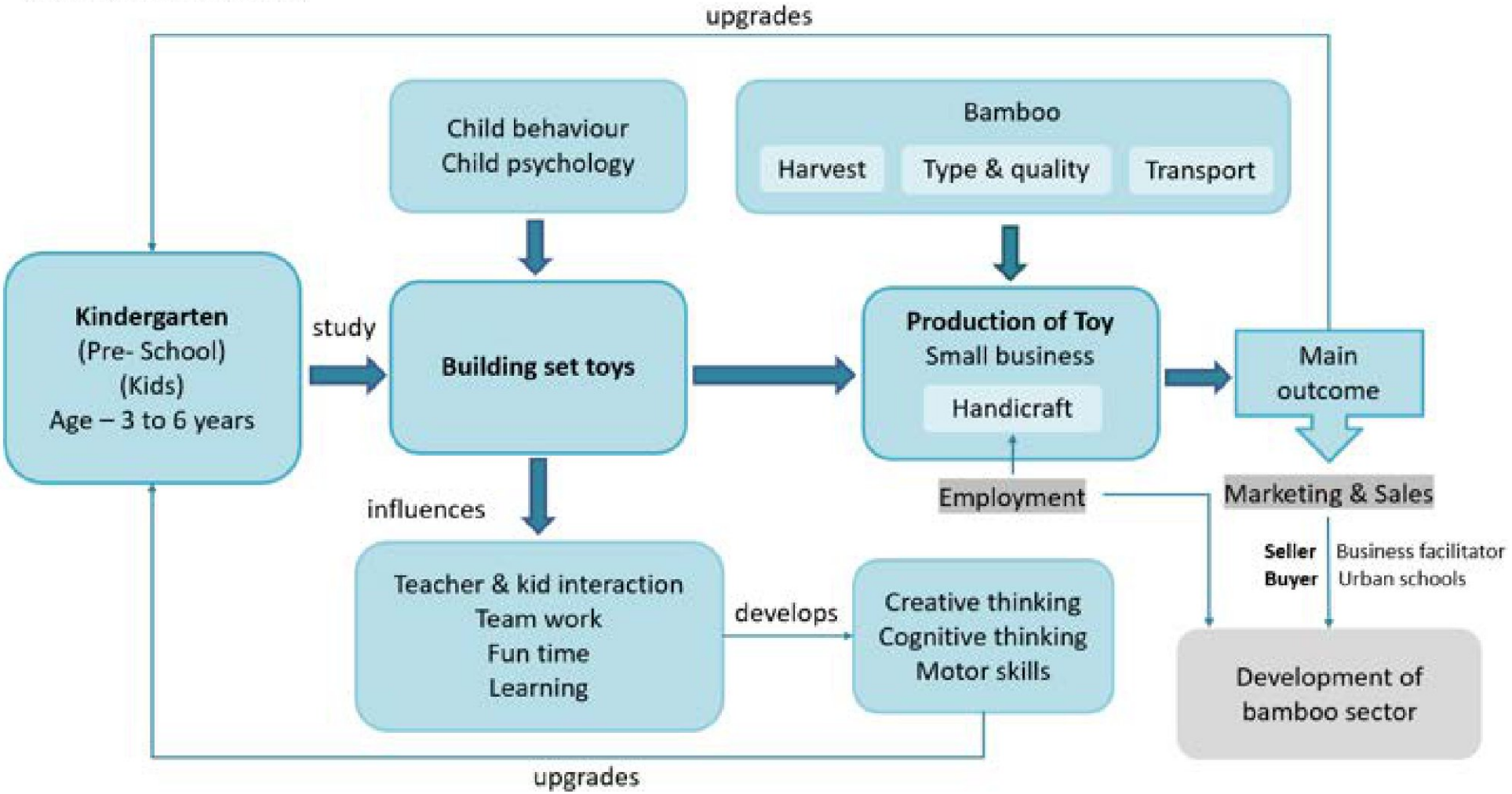


On the top surface of the box goes the label which shares basic details of the toys.

Details on the side surfaces of the box.



Conceptual framework



9.10. FEEDBACK

The jury appreciated the work and I got positive feedback.

Although the concept is good but there is a need to rethink on the age group that is considered for this project. Since I was covering a range of age group, there can be segregations of parts based on a single age as the way a 3 year kid would deal with certain part is different from a 4 year, 5 year and 6 year old. So, there is a need to set levels which can cater to specific age, thereby modifying parts for extra friendliness.

There was lack in finishing of the final prototype. The existing prototype was made with the available machinery, tools and skills at the workshop in a limited time.

However, I got positive feedback that such handcrafted work also calls for development of tools which can ease the process of making. More curves can be provided with right tools and machinery to make it more child friendly.

Next, for my final prototype, I had used sagwan wood which was available at the workshop for the making of wheels as it was getting difficult to turn the solid bamboo on turning wheel and get a uniform size. And for this, the feedback I received was that Sagwan wood might not be the right material as it is not as sustainable as bamboo. We need to think critically on all the aspects when it comes to sustainability and it's a great learning for me. We can find out methods to use bamboo for the development of wheels as well. I was also suggested to visit Chivar toy industry, look at how people work there and take my design forward for future development of the product.

For the colouring methods, I had used all the organic colours like turmeric for yellow colour, Alta (made from betel leaves) for reddish pink colour, orange was made from the combination of turmeric and alta. Only bluish green colour was artificial colour as I couldn't procure an organic one.

The feedback I got was to look for more plant extracted organic colours and also few parts can be left as it is for the natural colour and feel of bamboo. There can be experiments with just staining few surfaces and leaving some surfaces exposed. I tried this with the slats in the pre-final models.

I was appreciated for the test and trial approach of the project and the concept overall. Prof. B.K. chakravarty sir also liked the magnet concept in the earlier versions of the design and advised to not discard certain concept just because of our limited knowledge of industrial manufacturing process, rather we should dig deep and make it possible as there are various technology driven industrial process

And lastly, testing in actual scenario with school kids would help a lot to understand the practicality of the design. Feedback from school teacher would also benefit the evolution of design.

Although I had this in mind but due to unavailability of teachers, it couldn't happen.

I am thankful for such insightful feedback. It was a great learning experience for me and yet more to learn and explore.

9.11. REFERENCES

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