JIVAN JAR : A WATER PURIFYING JAR FOR SURVIVAL SITUATIONS

PRODUCT DESIGN PROJECT II

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Design Project 2

Jivan Jar

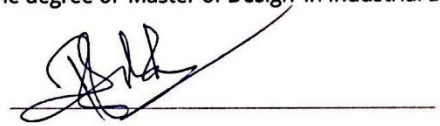
A Water Purifying Jar For Survival Situations

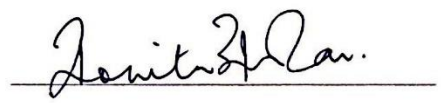
Trivikram | 136130013

guide : Prof. Sandesh

APPROVAL SHEET

The project titled '**Jivan Jar** – A water purifying jar for survival situations' by Trivikram Annamalai, is approved for the partial fulfillment of the requirement for the degree of 'Master of Design' in Industrial Design.

Guide 

Chairperson 

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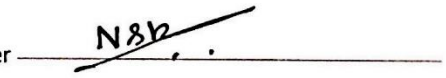
External Examiner 

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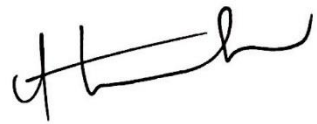

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During the course of the project, I have received many valuable inputs and insights from my friends Debasish, Anulal, Sohini, Tushar, Baisam, Omkar, Riken and others which have been of great value to me. I would like to thank them for their support and encouragement and thus helping me complete this project.

ABSTRACT

The area of work dealt in this project is providing Drinking Water for survival of people during natural disaster and emergency situations. Under this area, a product has been developed which would be a do it yourself quickly deployable device that provides pure water to the needy.

In India, quick relief during disasters and emergencies is often hindered due to lack of quick deployable solutions, which gives rise to the need for design intervention that would help solve this problem.

Rain water harvesting was the initial focus in order to utilize the benefit of using rain water which was later modified into designing a device for handling water crisis during emergency or disaster situations. Hence a device was designed which would quickly provide pure water using the flood waters or any other contaminated source of water.

CONTENTS

'We don't even know how strong we are until we are forced to bring that hidden strength forward. In times of tragedy, of war, of necessity, people do amazing things. The human capacity for survival and renewal is awesome'

–Isabel Allende

INTRODUCTION

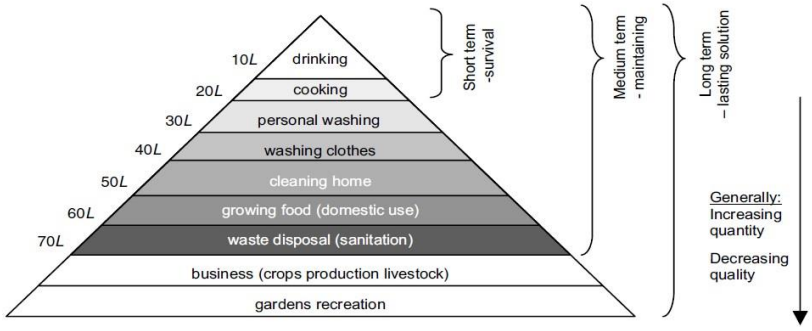


Figure 1 : WHO standards of water usage quantities

Source :www.lboro.ac.uk/wedc

THE NEED

The World Health Organization (W.H.O) prescribes that a human being must normally consume 3 liters of pure water per day to stay healthy, people are often found in scenarios where this quantity of water becomes scarce and are put in a situation of life and death.

Human survival depends primarily on water, food and shelter, Water is essential for good healthâand life. Up to 60 percent of an adults body weight and about 74 percent of a newborns body weight is water, making it the largest single substance in the human body.

Scenarios like floods, earthquakes, tsunamis, landslides and other natural calamities cut out the access of clean drinking water, Scenarios were one goes on trekking or other adventure trips and runs out of drinking water, leads to grave danger of dehydration and consecutive health deterioration to the lives of people involved. It is this particular situation which lead to the need to make a device which would help collect surrounding water, purify and make it consumable for the user in need.

MOTIVATION OF THE PROJECT

Picture 1 : Man in search of drinking water during Assam floods in 2014

Source : http://indiatoday.intoday.in/gallery/assam-flood-northeast-havoc-rains-india/5/12873.html

People struggle on daily basis to get access of clean drinking water, where the irony is there is ample amount of water which can solve the water shortage issues, for instance drinking water in the form of rain is one source which is not exploited to the fullest as yet.

According to Azad India foundation report -It is estimated that by 2020, India will become a water-stressed nation. Nearly 50% of villages still done have any source of protected drinking water. 85% of domestic supply comes from ground water, 1,95,813 villages have water affected by chemical contamination. On daily basis Indian women walk long distances to collect water, often from polluted sources.

The picture alongside shows a person walking in flood waters searching for drinking water, although there is rain, one is unable to collect it and although there is flood waters all around, one is not able to consume it sighting its purity, instances such as these highlighted the need to make a design intervention that would help people reap in the benefits of rain water harvesting, which acted as the motivation of the project.

INITIAL DESIGN BRIEF

INITIAL DESIGN BRIEF

To design a Rain Water Harvesting device with following key points-

- Device should be Small and Portable
- Can be easily cleaned
- Easily deployable, Do-it-yourself approach
- Feasible for a Large scale manufacturing
- Has value added features
- Easy repair and maintenance
- Device must be Durable
- Easy storage and use of water

SCOPE OF THE PROJECT

The device designed will cater to the need of providing clean drinking water to people stuck in situations where there is presence of water in form of rains or stagnant dirty water.

The device is meant for individual use or a small group of people (around 20-30) which can be easily carried by a person and deployed with minimal cognitive load

Features not addressed are:

- Device is not meant for a large community system [Population not in excess of 100 people during a worst case scenario]

- Device is not meant for purifying toxic industrial wastes

TIMELINE OF THE PROJECT

PHASE 0	PHASE 1	PHASE 2	PHASE 3	FINAL CONCEPT
				
JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
Design Brief	Ideations	Concepts	Refinement	Final Product
To make a rain water harvesting device for survival conditions	To collect rain water using various kinds of collectors	To collect and store rain water during survival conditions	To collect and store rain water and purify flood waters during survival conditions	To collect and purify flood waters during survival sitations
	Storage of water not addressed	Limited to rain water collection	Inclusion of purifier Individual use	Inclusion of purifier For more than one person

DESIGN DIRECTIONS

After finalizing on the design brief, the various possible approaches or design directions to proceed in the project were jotted down, of which the 3 most prominent directions were :

- Usage of local methods
- Industrial approach of mass production
- Domestic, Household methods

Of the above stated design directions, the industrial approach of mass production was taken up, with an intention of taking up a design challenge that would cater to a larger audience

DESIGN PROCESS

DESIGN PROCESS FOLLOWED

After the conception of the project area, the following steps were used to come up with a feasible end product :

Understanding of the project area :

Brief discussions with the guide were held where the area of work was focused down to a refined area, in that regard ample research on the water problems, situations across the world were studied to increase the knowledge base about the project area.

User details, material choices, ergonomics, existing products data, etc were collected and collated, which was later on used in making a mind map, which immensely helped understanding intricacies of the project and opened avenues for new opportunities.

During the study and data collection understanding the pros and cons of rain water harvesting was a important aspect of the project progress.

Advantages of rain water harvesting :

- Makes use of a natural resource and reduces flooding, storm water runoff, erosion, and contamination of surface water with pesticides, sediment, metals, and fertilizers
- Reduces the need for imported water
- Excellent source of water for landscape irrigation, with no chemicals such as fluoride and chlorine, and no dissolved salts and minerals from the soil
- Promotes both water and energy conservation
- No filtration system required for landscape irrigation

Dis advantages of rain water harvesting :

- Limited and uncertain local rainfall
- Can be costly to install ,The payback period varies depending on the size of storage and complexity of the system
- Can take considerable amount of time to "pay for itself"
- Requires some technical skills to install and provide regular maintenance
- If not installed correctly, may attract mosquitoes (i.e.; West Nile Disease and other waterborne illnesses)
- Certain roof types may seep chemicals, pesticides, and other pollutants into the water that can harm the plants

With the repository of knowledge base obtained, a detailed product study was done which gave rise to many interesting findings from innovations across the world especially from the developing countries like latin America, Africa and India, these findings were made into clusters according to the certain relationships they gave rise to, couple of concepts particularly stood out as being very feasible and interesting namely the polythene bag concept and the wall mountable storage concepts were similar to what was being thought of initially in the design brief.

Tackling the initial obstacles :

The biggest challenge in the project was coming up with a solution that would cater to the water needs of the rural India all year round, but as the rain seasons are usually for 4-6 months across the question arises as to what happens to the product at other times when there is less or no rainfall.

During those times of less or no rainfall, the product could be used for other purposes like performing other important works which the rural India would welcome, for instance a cloth drier, solar water heater, etc could be incorporated in the product or a foldable options needs to be present which would fold into a small device occupying less space.

Obtaining statistics about rainfall pattern:

In order to understand where and when the product can be deployed to collect the rainfall, a thorough study on the rain patterns across India were collected over the last 100 years, this data gave an understanding as to how much water can be expected to be collected by the device if in case the only source of water during an emergency situation is rainfall.

Choosing the target users :

based on the knowledge repository, the target users chosen were

- Temporary dwellers of rural India, slums, make-shift camps
- Household usage
- Disaster management

Proposal of design brief :

based on the insights obtained from the data collection, a preliminary design brief was made, to get clarity of project structure.

Finding the design directions :

- Having a industrial product (large scale manufacturing)
- Domestic (household) approach
- Local methods (product made using locally available materials)

Classification of the project area :

Based on the design directions the classifications made were broadly of two types :

System Level permanent installation of the solution

Temporary (on the move) products for population on the move, like camps, troops, slums, etc.

Due to constraints like duration of project and resources available, the temporary (on the move) classification was chosen.

Idea generation :

After the design directions and classifications were finalized, ideas were generated catering to individual components of the product. Inspiration were drawn from objects in nature and by doing a parallel product study.

Refinement of design brief :

At every stage of the project a new interesting avenue opened up, which improved the functionality and feasibility of the product Âbut also meant the design brief had to be modified many times.

Concept generation:

After the ideas were made, the best of the ideas were taken together and structured in a manner that would give an end to end workable concept.

Finalizing the concept :

After the concepts are generated, a detailed concept evaluation is made over the most important features that is needed in the product and how each concept fare over the other. The winning concept is then finalized.

Mock-up phase :

In order to understand the look and feel of the product, many mock ups were built and to understand the working of the components of the device a functional prototype were made.

Detailing of the product :

Before making the functional prototype a preliminary detailing of the product was made, which highlighted the flaws in the design, this lead to a more refined detailing in the further stages of the project.

Material consideration :

The device had to manufactured in large scale, which necessarily calls for a very highly refined material usage and manufacturing usage, the insights of which were obtained in the detailing of the product phase.

The proposed material in High density polyethylene (H.D.P.E) as they are durable, lightweight, dishwasher-safe, and BPA-free

The proposed manufacturing process is injection molded parts, the prototype would be made using vacuum forming process.

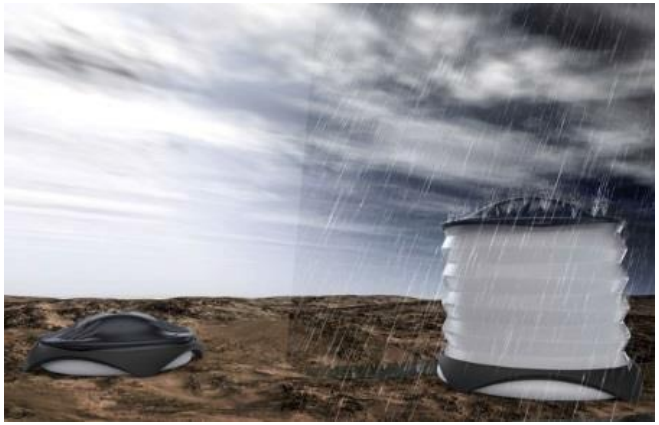
User feedback and refinements :

After the device is made it is deployed in a simulated environment where the users interact with the product and refinements are madany, based on the feedback obtained from the users.

PARALLEL PRODUCT STUDY

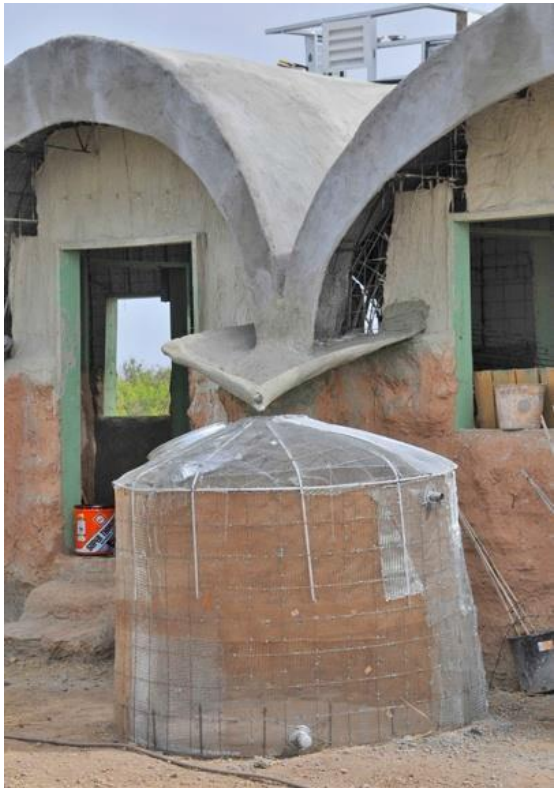
Picture 2 :Tent that collects water and the supporting rods help transfer water when in need

Source :campingsurvivalblog.com



Picture 3 :A device that uses bellow concept, grows upwards as the rain water starts filling it up

Source :anglerz.com



Pictures 4 and 5 : A simple change in the architecture to collect the rain water and transfer it to storage unit

Source trendvee.com and annesley.wordpress.com

Picture 6 : A vertical storage unit for saving space in houses

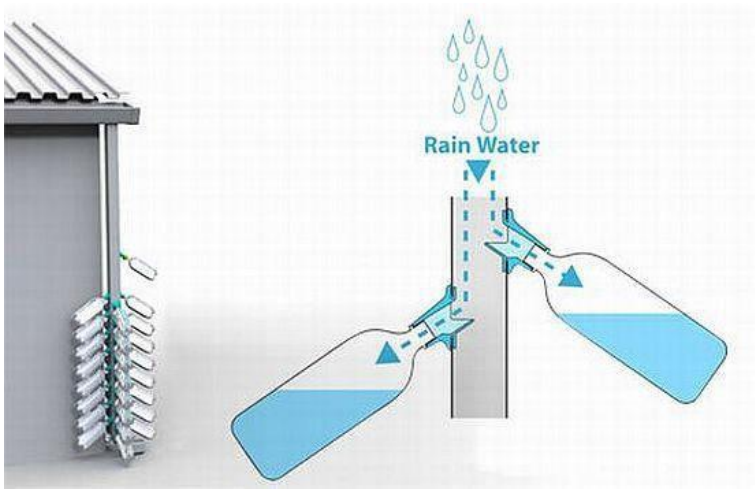
Source :harvesting.com.br

Picture 7 : Bob water bag for storing harvested water without building a storage unit, the bag can be folded when not in use

Source :www.samsamwater.com

Picture 8 : A concept architecture of solar powered lampposts which also collect rain water

Source :www.khoahoc.com.vn



Picture 9 : A concept which collects the rain water directly in bottles for ready to use applications

Source :lasmonedasdejudas.wordpress.com

Picture 10: A do-it-yourself rain saucer device that collects rain water and filters it.

Source :survivalbackpack.us

Picture 11 : A water bag installed in public spaces like parks for storing rain water and also act as a seating for passers by

Source : www.fastcoexist.com

Picture 14 : A public lamp post which collects rain water, purifies it and serves it at the base for passers by

Source :www.treehugger.com

Picture 15 : An award winning concept of using rain water efficiently for gardening purposes

Source :gadzetomania.pl

Pictures 16 and 17 : Lifestraw water purifier which filters out unclean water and gives pure water instantly

Source :www.gizmag.com
thisisiamthis.wordpress.com

INFERENCES FROM PARALLEL PRODUCT STUDY

The research on various products available related to rain water harvesting and other devices used during disasters gave an over view of possibilities with the area chosen for the project.

Few insights obtained from the study are as listed below :

- Understanding about value propositions of the products
- Form explorations
- Material and manufacturing process usage
- Integration of technology
- Value addition of product by using suitable features

The knowledge got from doing the product study gave an opportunity to leap frog from where the benchmark was already being set instead of re-inventing the wheel yet again.

STATISTICS ABOUT RAINFALL

In order to be equipped with data on when, where and how much of rain fall happens in India, various statistics were referred to about the rainfall pattern found in India, the most reliable data were obtained from NSSO [National Sample Survey Organization]

The regions in India which are most flood prone are Ganga Basin, Brahmaputra and Barak Basins, Central India and Deccan Rivers Basin, making a product that would cater to the drinking water needs of people living in these areas would be very beneficial.

According to which the annual rainfall pattern is :

Annual rainfall in India
[Rainfall in mm]

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
(1901-2003)	20.3	24.6	32.0	39.8	61.9	163.4	286.7	255.3	171.8	78.4	30.7	17.9	1182.8

Calculations were made on the data obtained from NSSO about what would be the volume of water collected for a given amount of rainfall and collector area is prescribed for a device

Volume of rain water harvested = Area of collector X height of rain

Rainfall per year in Rajasthan = 313 mm /year

Rainfall per year in Amroati = 1100 mm /year

Rainfall per year in Mumbai = 2010 mm /year

Taking the average rainfall data of Amroati,

Volume of rain collected in Amroati = 1100 litres for 1 sq metre area

Considering Amroati, number of rainy days = 186

1 device collects = 1100 /186 = 5.91 litres of water per day for 1 sq metre collector area

From the calculations made, it was safely assumed that for a region which receives close to 1000 mm of rainfall per year, one could expect little more than 5 litres of water, hence with this data explorations were made with a collector area of 1 sq meter area.

Data From NSSO (National Sample Survey Organization) *Indian Standard* Code Of Basic Requirements For Water Supply, Drainage And Sanitation
(*Fourth Revision)*Udc 625 I/.3 : 006.76

PHASE 0

JULY

Design Brief

To make a rain water harvesting device for survival conditions

PHASE 1

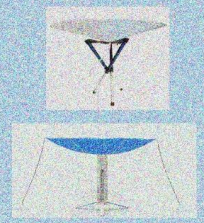
AUGUST

Ideations

To collect rain water using various kinds of collectors

Storage of water not addressed

PHASE 2



SEPTEMBER

Concepts

To collect and store rain water during survival conditions

Limited to rain water collection

PHASE 3

OCTOBER

Refinement

To collect and store rain water and purify flood waters during survival conditions

Inclusion of purifier

Individual use

FINAL CONCEPT

NOVEMBER

Final Product

To collect and purify flood waters during survival sitations

Inclusion of purifier

For more than one person

DESIGN BRIEF

Based on the research and analysis done the problem area of providing clean water during survival conditions was narrowed down to a precise design brief.

DESIGN BRIEF :

A water purifying device to be used in survival situations, with the following features -

- Gives clean potable water
- Is small and portable
- Easy to deploy
- Has value added features
- Easy to repair and maintain
- For people in survival disaster management trekking conditions, with difficult access to drinking water

TARGET USERS

The target users were primarily the people of rural India who are in need of water, but a system level change to the permanent dwellers on rural India would mean a government intervention, large initial investment and would invariably need more time to look into various details which is not favored in the project period.

Hence the focus was shifted from a system level change to a product level solution which radically changed the quantity of water that can be collected by the design solution, and thereby the target users were changed from those who can use the water on daily basis to those who need the precious water for their survival.

People stuck in floods due to heavy rainfall, landslides, or other temporary camps of disaster management sites, trekking in forests, etc

IDEATIONS

Based on the analysis done on the parallel product study, target users and refined design brief, ideations were made taking into consideration of the various possible creative solutions.

Ideations first started with sketching ideas that were anything under the sky, without ruling out any concept as impossible. These ideas were later refined more and more based on logical reasoning and feasibility aspects.

Inspirations were taken from nature, the forms and mechanisms replicating instances in nature were considered, inspirations were also taken from unique characters of animals and reptiles, for instance the dew collecting desert beetle.

More refined ideations were made after many iterations, which very evidently started taking the form of being a more wholesome product with many feasible aspects.

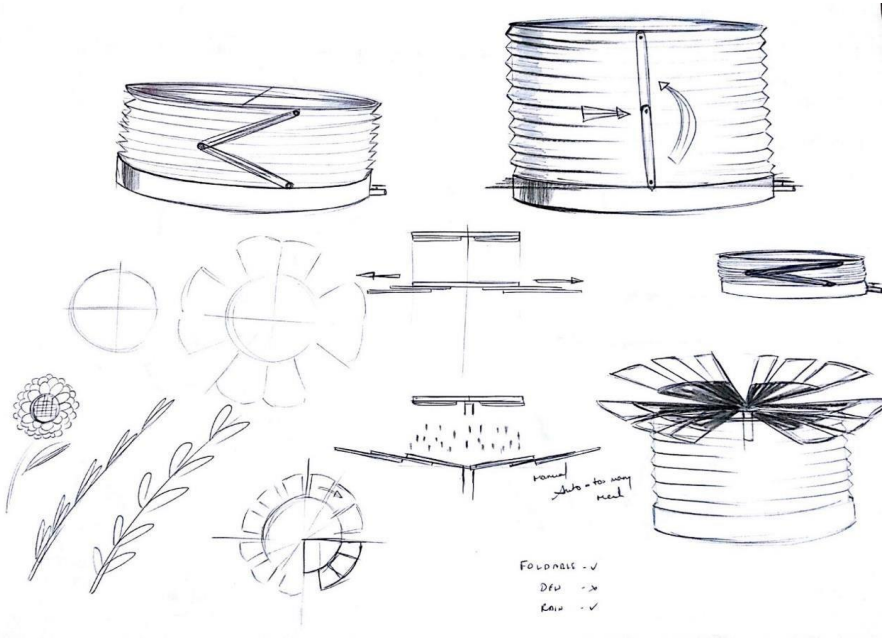


Figure 2 :Sketches depicting the usage of locally available materials and ideas inspired from opening of flower petals

Source : Author

USAGE OF BELLOWS TO COLLECT WATER

Ideations along side shows inspiration drawn from nature to evolve a feasible concept, the idea of leaves of touch me not plant folding into a thin strip when touched paved way to a concept of using folded bellows to store water which opens into a bigger structure when used to hold water and folds into a thin space saving structure when not in use, a similar treatment was given to the collector unit, where a foldable unit was used Âthe strips of plates would slide upon each other to form a small area and upon up to substantial sizes during rain thereby increasing the surface area. This idea is explained in the figure 2.

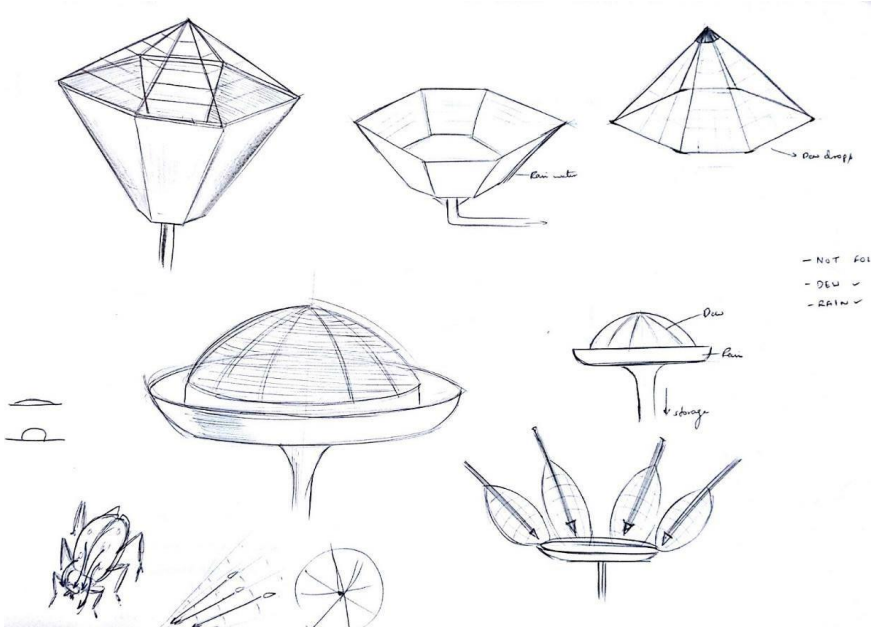


Figure 3 . Sketches showing the possibility of collecting dew drops and rain water

Source : Author

DEVICE FOR COLLECTING DEW DROPS

A beetle in African deserts are known to collect dew drops from the humid air over night and survive by drinking them, this idea inspired into a concept that uses a conical structure with thin elements to capture dew water and collect them down to a vessel from which the water can be later used for consumption.

This idea was not taken forward in later explorations as the climatic condition in most parts of India wouldn't be suitable for collecting dew water.

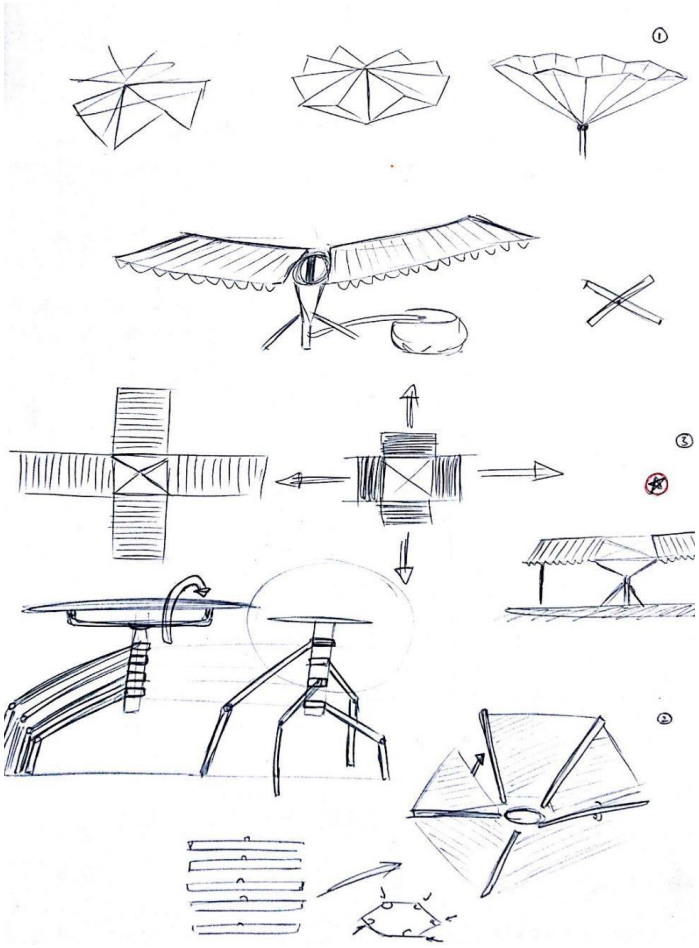


Figure 4 : Sketches exploring the value add ons apart from being a rain water harvesting device

Source : Author

EXPLORATIONS OF COLLECTOR UNIT

The bigger the collector area Âbetter quantity of water is collected in lesser time. In that regard a lot of explorations was done to find ways of collecting large quantities of water using collector devices which would fold back into a smaller unit when not in use. The figure alongside shows few of the explorations that was done in that regard to find the most suitable way of collecting rain water.

Locally, the most easiest way to achieve this would be by using a saree Âby tying a saree along its four ends and collecting the water from the centre, other option which was much more feasible was that of using an umbrella as it is more strong , is foldable , come in various sizes and is low cost.

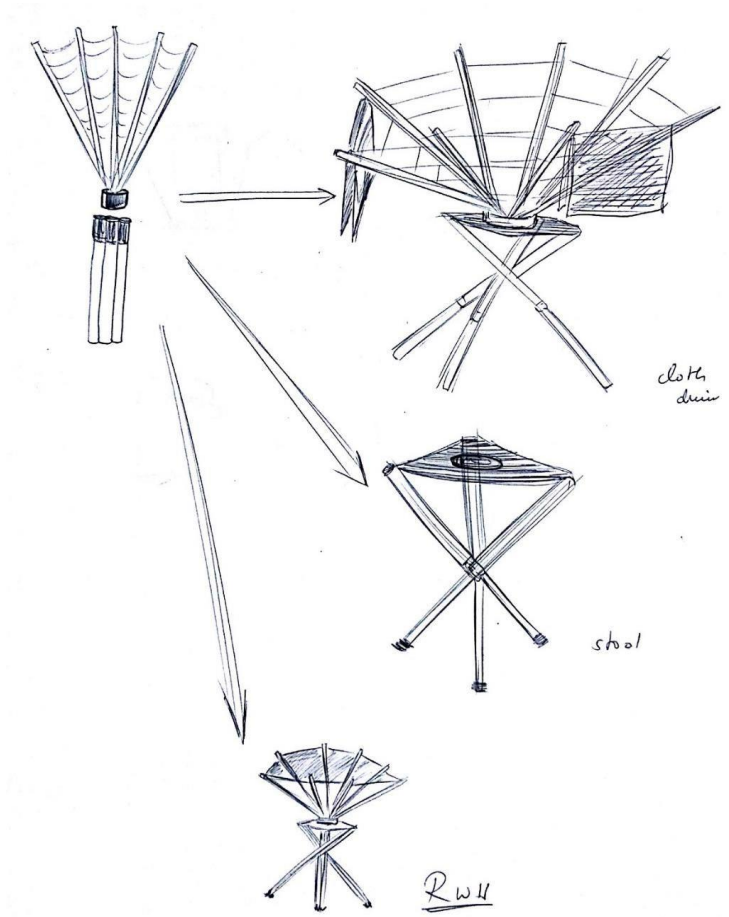


Figure 5 : Sketches exploring the value add ons apart from being a rain water harvesting device

Source : Author

ADD ON FEATURES OF THE DEVICE

More the features a product is able to address the better it is for the user, in this regard another problem that was found during field visits were the lack of facilities to dry up wet clothes in viilages, currently they mostly dry heir clothes on grass patches on plain fields which is not a very efficient option, hence an idea was made to build a device that would primarily act as a rain water harvesting device but also act as other devices like :

- A cloth drier
- A stool

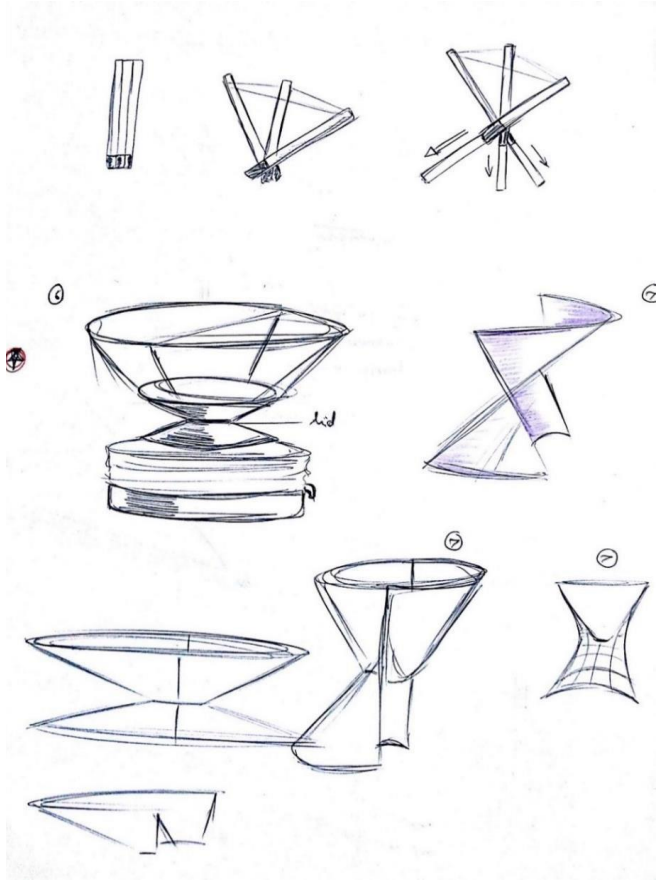


Figure 6 : Sketches exploring the ideas of modularity and portable solutions

Source : Author

EXPLORATIONS ON MODULARITY

For ease in large scale manufacturability and transportation, modularity is used as a very imperative concept, explorations were made in modularity for rain water harvesting looking at possibilities of using one or two parts which could be repeatedly used in order to make a structure that would collect and store water effectively.

The problem sighted in modular options were the storage of these units when not in use and the feasibility in making a leak-proof concept.

PHASE 0

JULY

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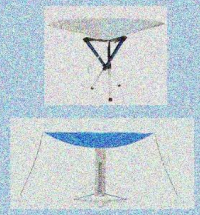
PHASE 2



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FINAL CONCEPT

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Final Product

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For more than one person

IDEA 1

Picture 18: Paper Mock up of the model

Source : Author

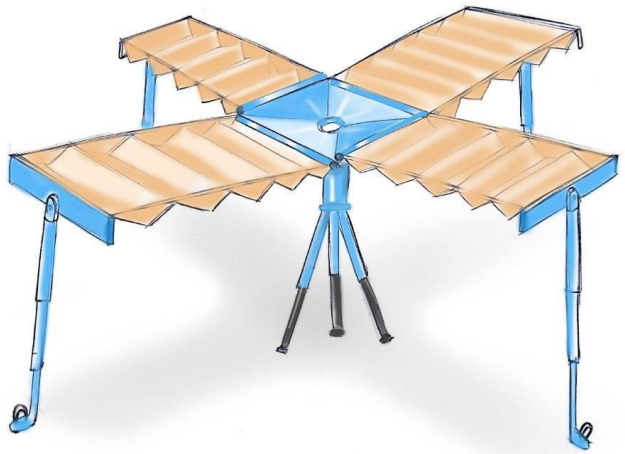


Figure 7 , *Source : Author*

Figure 6 : The rendering shows the idea of opening flaps on 4 directions to increase surface area thereby be able to collect more water in a short span of time. When not in use the entire structure would fold back/ collapse into a small portable device.

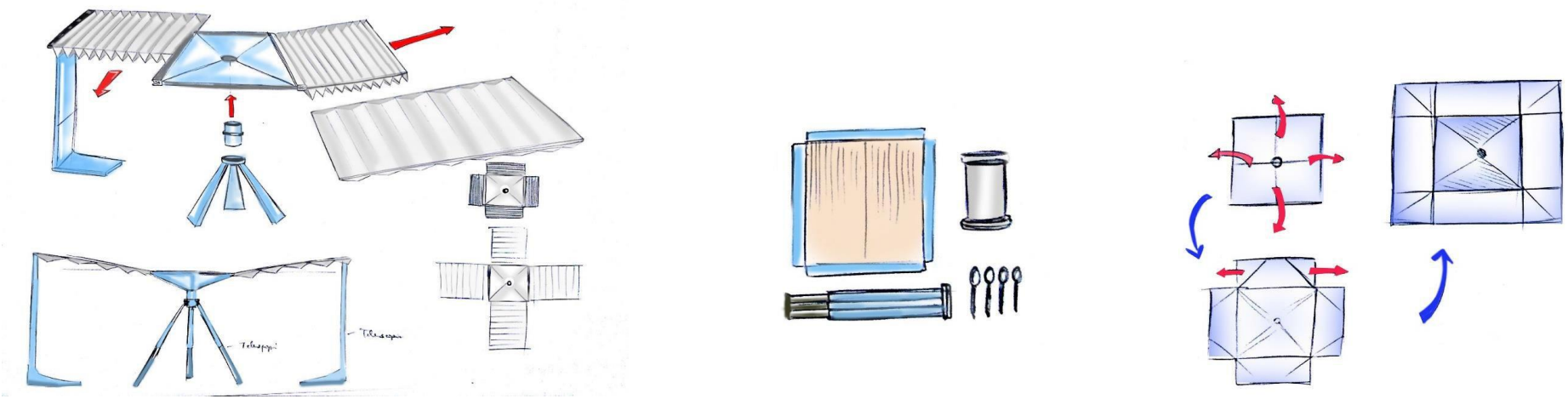


Figure 8 : Renderings showing the usage method of the device- a DIY approach

Source : Author

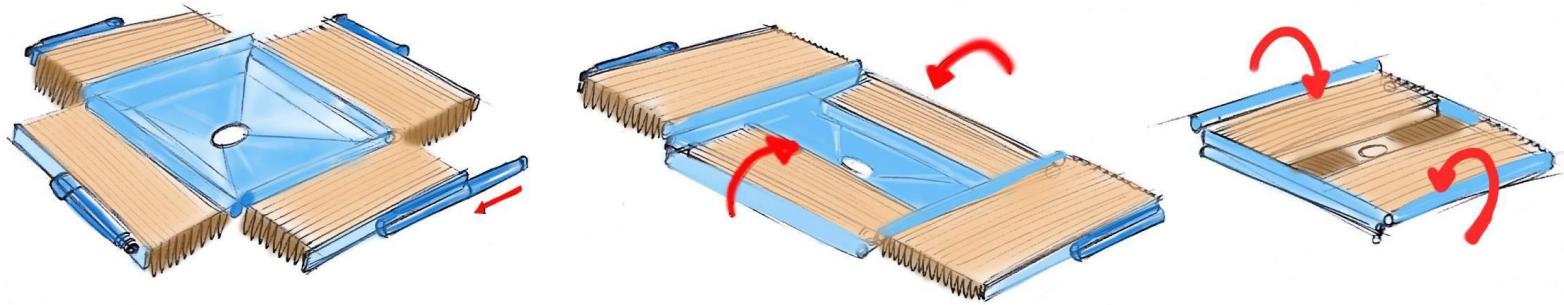
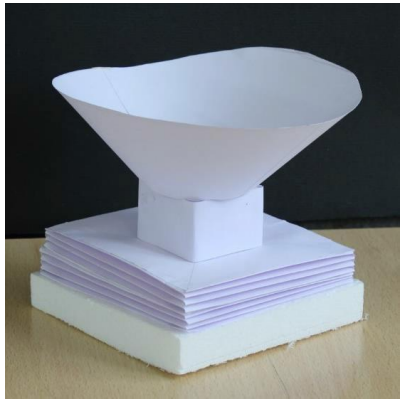


Figure 9 : Renderings showing the folding of the flaps into a compact form

Source : Author

IDEA 2



Picture 19: Paper Mock up of the model

Source : Author

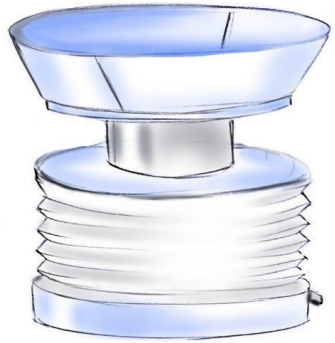


Figure 10 , *Source : Author*

Figure 9 : An idea which employs bellows to store water, when the rain falls on the collector it gets funneled into the bellows, as the level of water rises, it would push the air balloon upwards thereby the entire structure with the collector rises up slowly until a threshold point is reached.

By using the arrangement, space can be saved as the device folds into a very small equipment when not in use

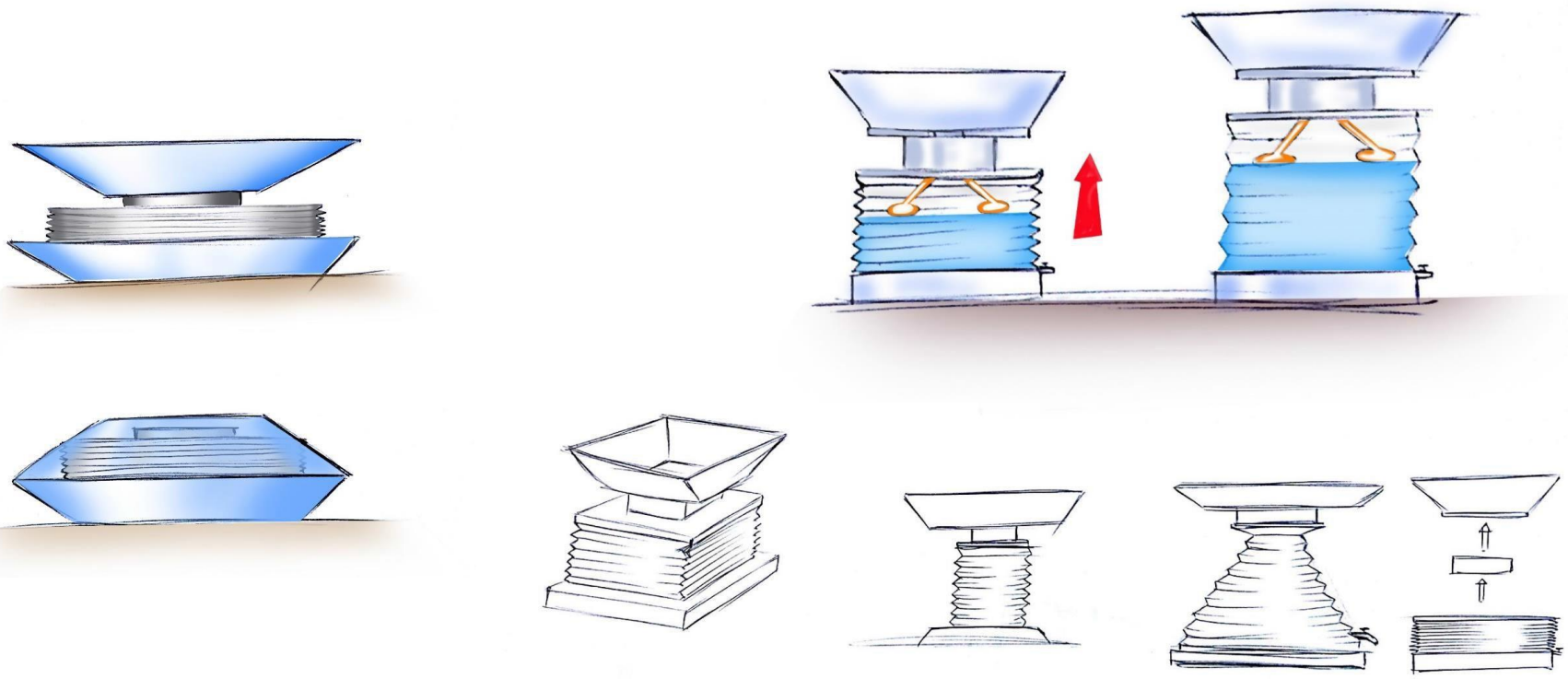
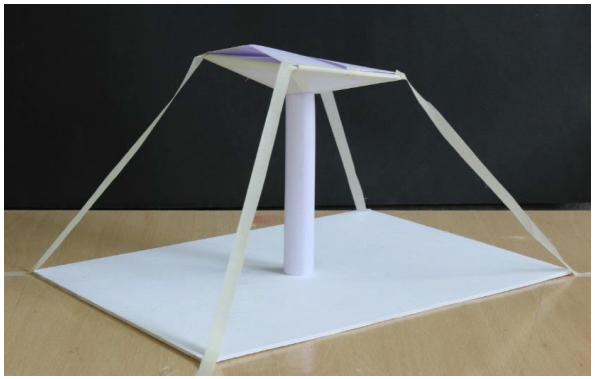


Figure 11 : Sketches showing the working of device

Source : Author

IDEA 3



Picture 20 : Paper Mock up of the model

Source : Author

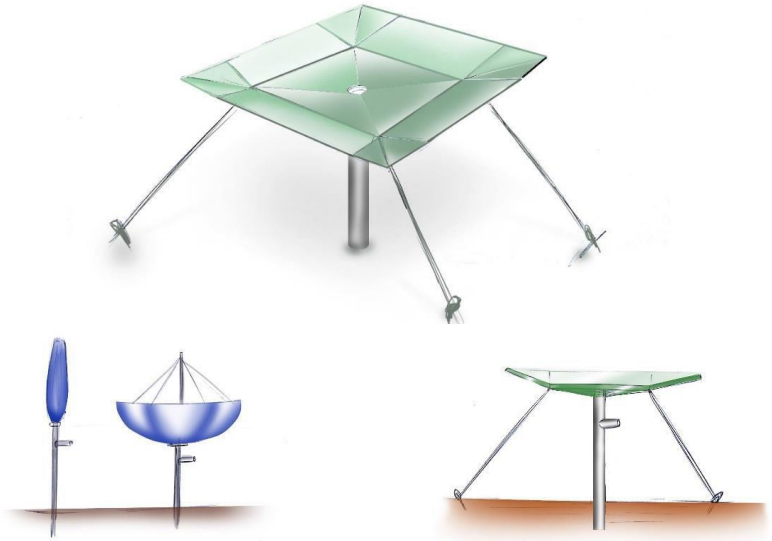


Figure 12 : Rendering of the Idea 3

Source : Author

An Idea which uses a simple rod to fix the structure on to ground and use a foldable collector to collect water. Hooks and ropes are used in order to fix the device on to the ground more strongly to withstand winds and rainfall.

PHASE 0

JULY

Design Brief

To make a rain water harvesting device for survival conditions

PHASE 1

AUGUST

Ideations

To collect rain water using various kinds of collectors

Storage of water not addressed

PHASE 2

SEPTEMBER

Concepts

To collect and store rain water during survival conditions

Limited to rain water collection

PHASE 3

OCTOBER

Refinement

To collect and store rain water and purify flood waters during survival conditions

Inclusion of purifier

Individual use

FINAL CONCEPT

NOVEMBER

Final Product

To collect and purify flood waters during survival sitations

Inclusion of purifier

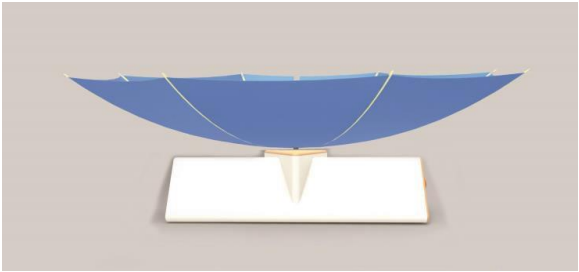
For more than one person

CONCEPTS

Based on the ideations done, three end to end concepts were made which included the primary features that evolved during the ideation phase , some of the features are design of the collector unit, storage of the device, stability issues, deploy ability of the device, base stand and storage of the collected water.

Concept 1

Concept 2



Concept 3

Figure 13 : Renderings of the 3 concepts developed using cues from previous ideas

Source : Author

CONCEPT 1

Figure 14 : Renderings of concept 1

Source : Author

Picture 21 : mock up model of the concept

Source : Author

A quickly deployable tripod stand inspired device, where in the tripod design was inspired from a collapsible seat. The device primarily has a collector which wraps around the tripod stand and is wound using a plastic tube, when needed the stand is quickly deployed and the collector unit along with the plastic tube is attached to the stand.

The advantages of the product is the fact that the deployment time is very less and the design is less complex, hence reducing the cognitive load to the user, on the downside the product lacks the sturdiness during rains and winds, also the device does not provide an in-built option for water storage.

From the manufacturing point of view the product has minimal complexities as major part of consideration is the stand and its joineries.

Figure 15 : Pictures showing the packing and deployment steps involved in the concept

Source : Author

CONCEPT 2

Figure 16 : Renderings of concept 2

Source : Author

A concept with in built rain water storage unit, a collector in the form of an umbrella and option for additional water storage. The device is extremely compact and portable where all the separate unit fall into a compact structure.

The device has possibility of storing extra water gives an edge to the product in terms of value addition and on the downside it employs far too many moving parts making the manufacturing of the product extremely cumbersome.

The collector here is an umbrella, hence it facilitates the option of fastening the collector on to the ground firmly for stability during rains and winds. The detailed working data about the product are given in the consecutive pages.

Figure 15 : Pictures showing the packing and deployment steps involved in the concept

Source : Author

Concept 2 was further explored in terms of adding more value to the product, In that regard the concept was looked beyond a product that would collect and store rain water.

- Opportunities were seen for the product to become into a temporary structure providing shelter to the user during rain
- If the external body was made of suitable material, it could be used for boiling rain water using the firewood one finds around
- Also an option was thought of to add bottles that would collect rain water as the rain water is collected in the device

After the explorations were made, the individual components were detailed out to check the feasibility of the concept in terms of manufacturability.

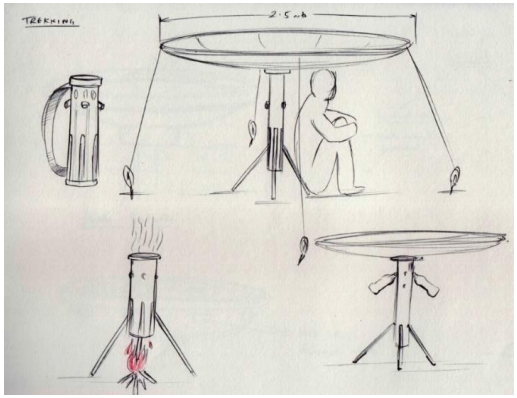


Figure 17 : Explorations of concept 2

Source : Author

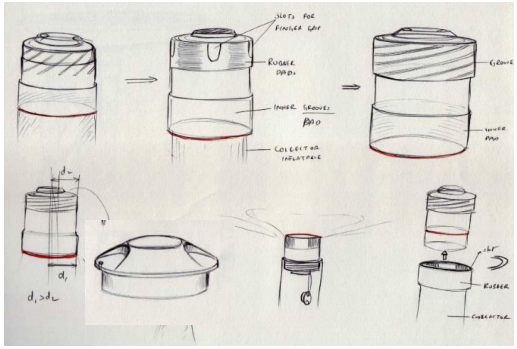


Figure 18 : Detailing of concept 2

Source : Author

Figure 19 : Rendering showing the steps involved in deploying the device

Source : Author

Picture 22 : Functional prototype of the product

Source : Author

Figure 20 : The device is designed to be 45 cms tall, which can fit into a travelling bag

Source : Author

Parameters		
Compactness/Portability	7	8
Storage of water	4	8
Deployability	8	7
Material Usage	8	6
Stability	7	9
Ease of cleaning	8	6
TOTAL	42	44

PHASE 0

JULY

Design Brief

To make a rain water harvesting device for survival conditions

PHASE 1

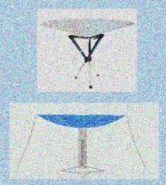
AUGUST

Ideations

To collect rain water using various kinds of collectors

Storage of water not addressed

PHASE 2



SEPTEMBER

Concepts

To collect and store rain water during survival conditions

Limited to rain water collection

PHASE 3

OCTOBER

Refinement

To collect and store rain water and purify flood waters during survival conditions

Inclusion of purifier

Individual use

FINAL CONCEPT

NOVEMBER

Final Product

To collect and purify flood waters during survival sitations

Inclusion of purifier

For more than one person

CONCEPT 3

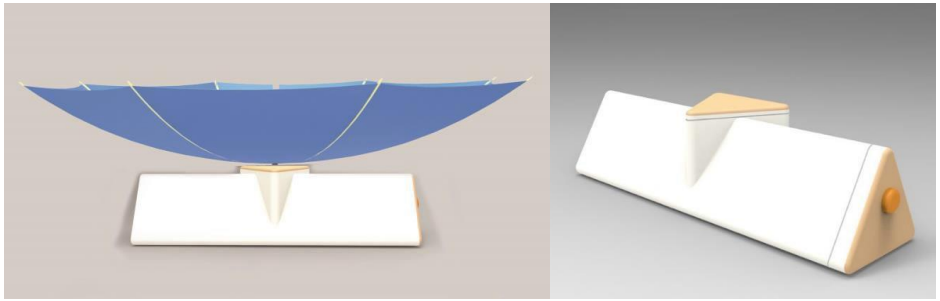


Figure 21 : Renderings of concept 3

Source : Author

Concept 3: A simplified concept with in built water storage unit and a water purifier, based on the analysis of the previous concepts one common feature that had to be taken care of was the need to reduce the complexity of the product and reduce the number of moving parts involved, in that regard the concept 2 was modified by making the device lie horizontally on a flat ground.

By doing this small change the number of individual parts involved in the device were bought done to bare minimum, otherwise the concept is similar to the concept 2.

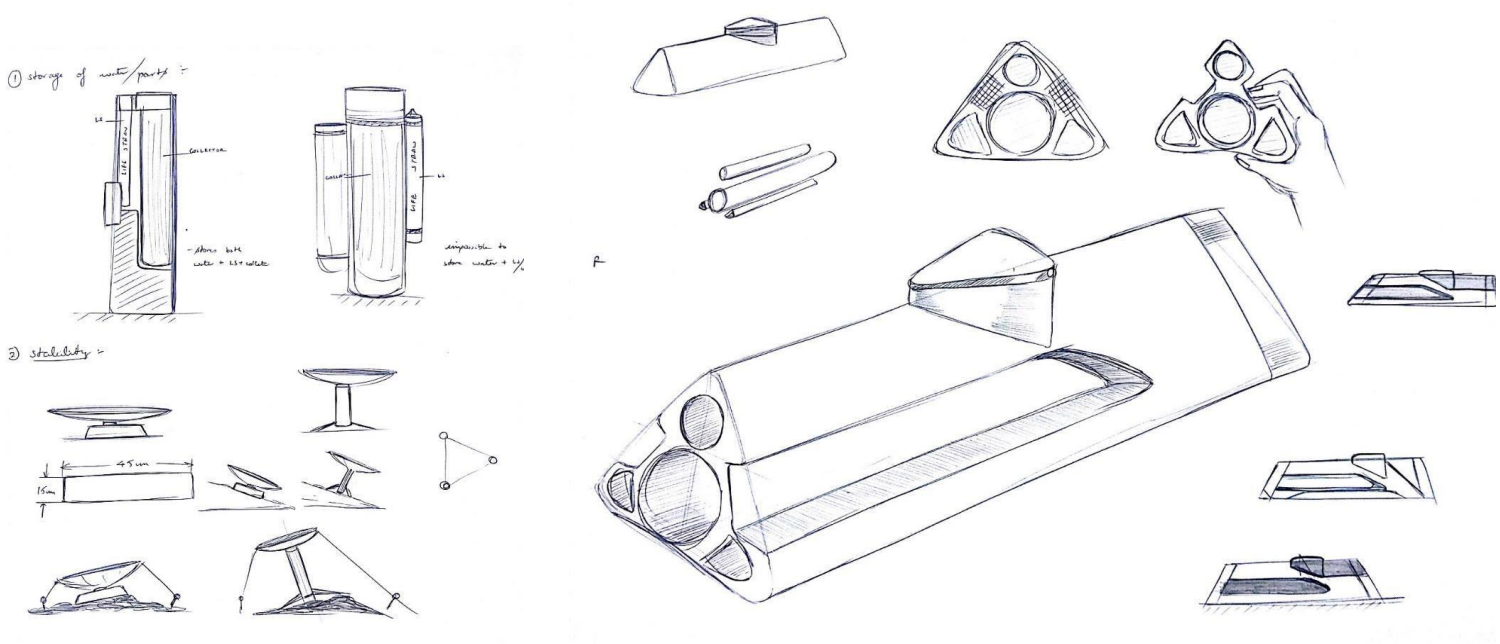


Figure 22 : Explorations of concept 3

Source : Author

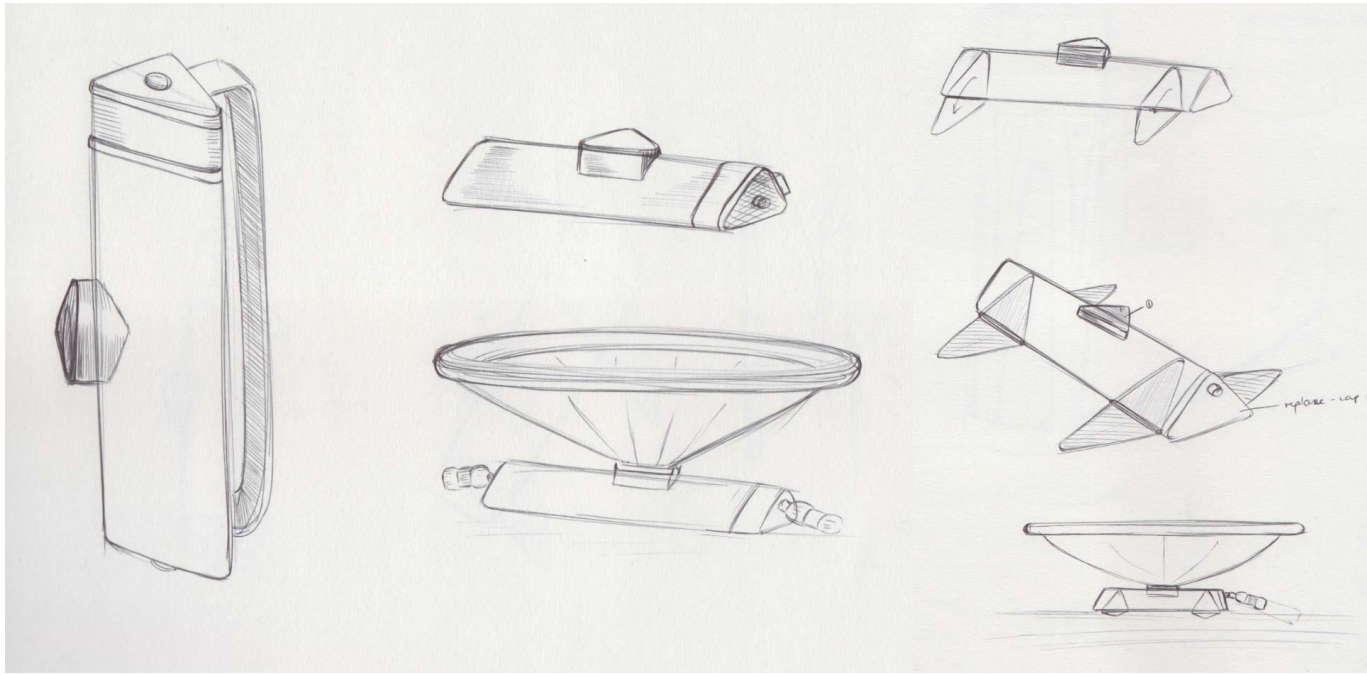


Figure 23 : Explorations of concept 3

Source : Author

PRODUCT DETAILING

Once the concepts were made, the detailing of the product were done as to what would be the individual parts , how the internal parts will be configured and which materials- manufacturing process to be made use of

Body

ABS - acrylonitrile butadiene styrene

High impact strength

With UV stabilizers, itsuitable for outdoor applications

Non-Toxic food safe

Transparent indicator

PMMA (polymethyl-methacrylate)

High strength

Excellent outdoor properties weather resistant

Very good optical properties

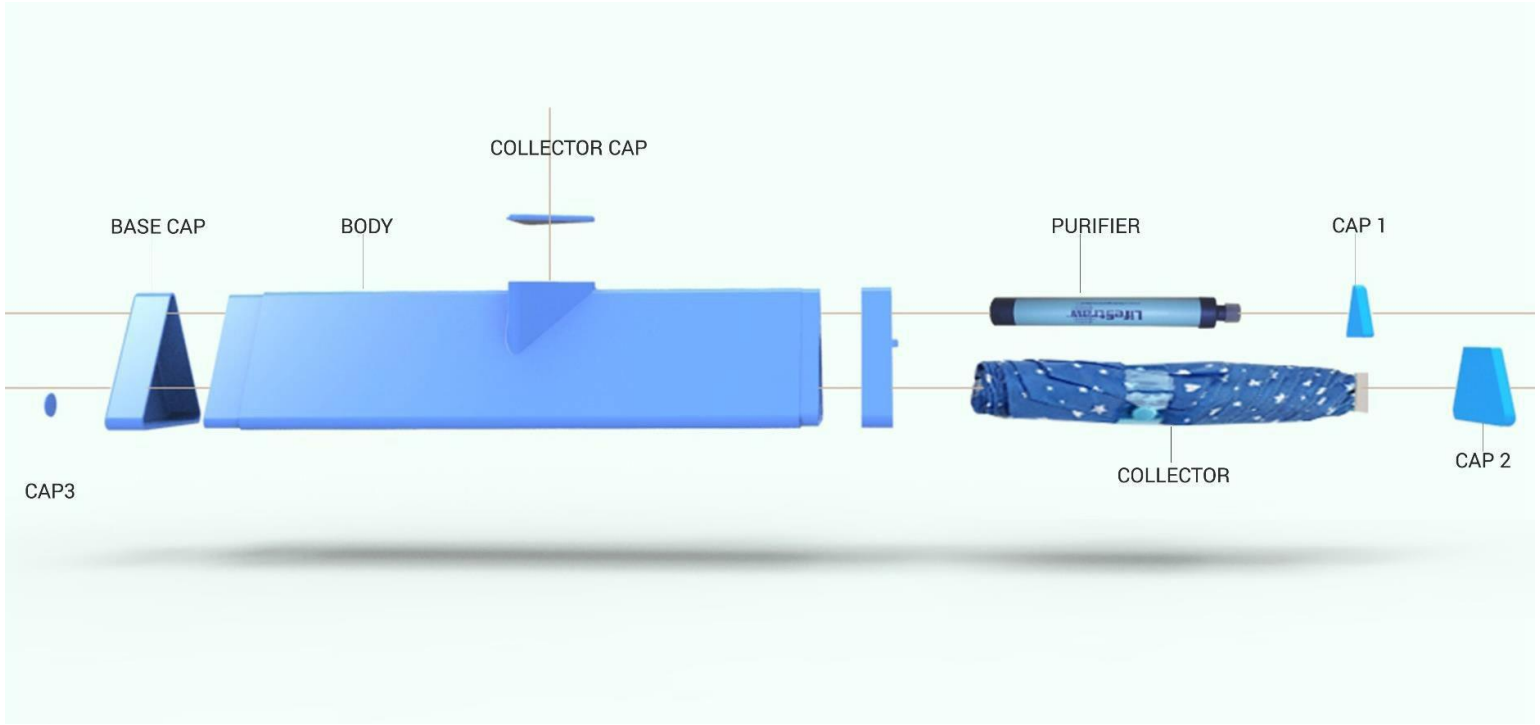
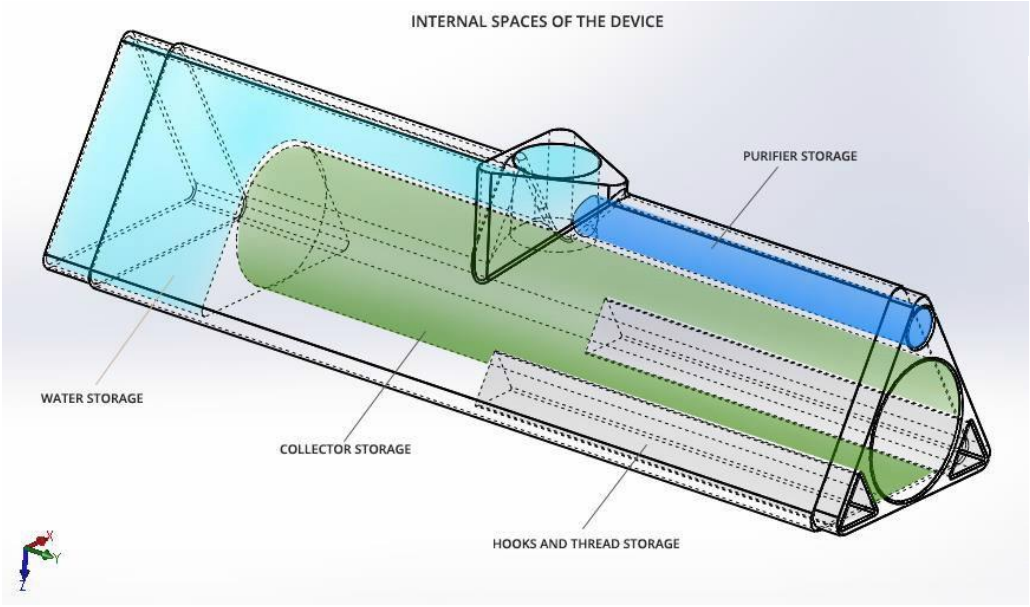
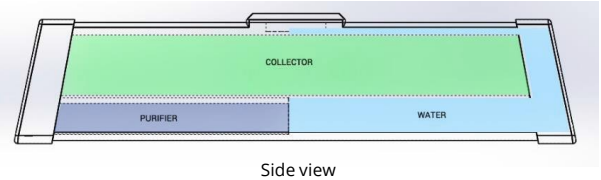


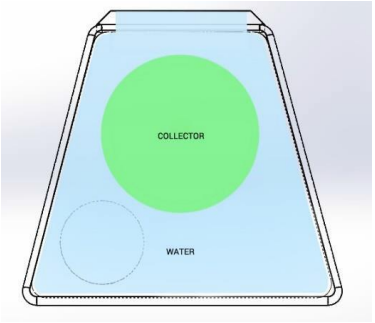
Figure 24 : Exploded view of concept 3

Source : Author





Side view



Cross sectional view

Figure 25 : Rendering showing the internal spaces of the device

Source : Author

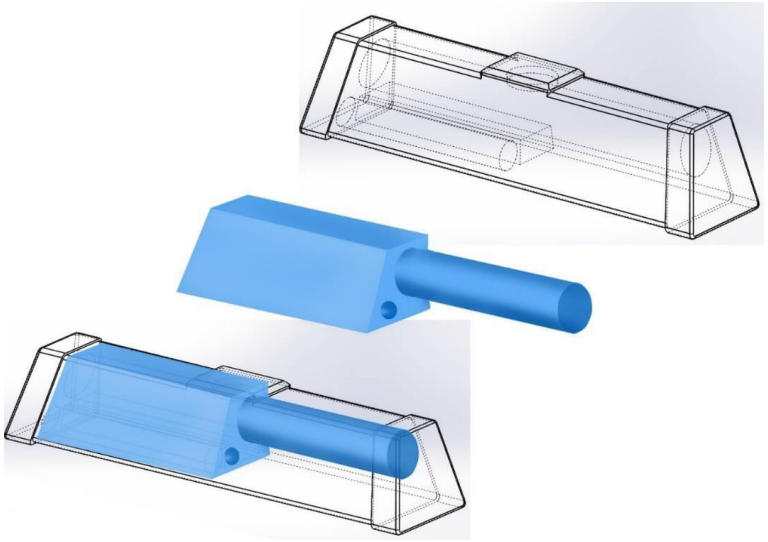


Figure 26 : Rendering showing the internal consoles of the device

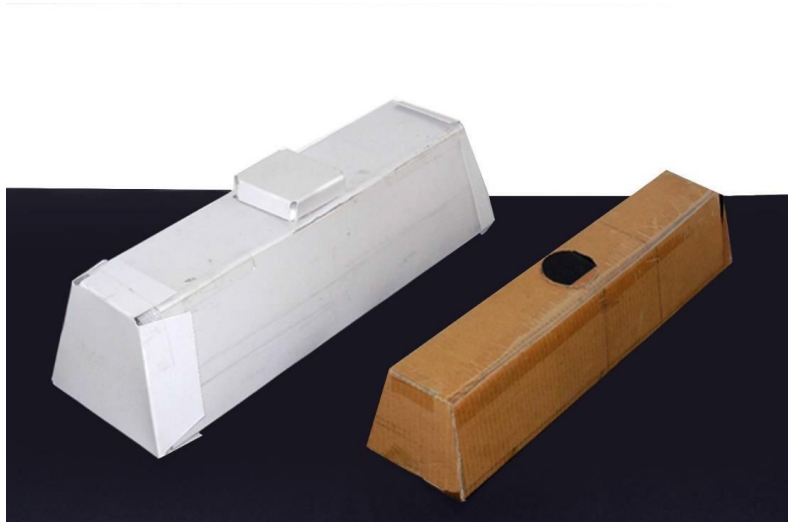
Source : Author

INTERNAL STRUCTURE OF THE PRODUCT

In order to keep the device leak proof, an idea of using a console in the device was thought of, where in - the external body of the device acts as one unit which houses a second console in it. The second console will be used for storing the collector (umbrella), lifestraw and other survival aids like threads, hooks, knife, lighter, etc. whereas the first console which is also the external body houses the water collected. These two parts are joined using waterproof joineries.

The lifestraw which is stored in the second console will have its end in contact with water, hence that portion of the console is left open Âto make this portion leak-proof silicon rubber is used at the rim of the lifestraw and the console. The feasibility of this idea can be validated after making an actual prototype.

MOCK UPS



Picture 23 : Mock ups of concept 3

Source : Author

Picture 24 : Size of the product is compatible to be kept in a trekking bag

Source : Author

USER TESTING

Picture 25 : user testing of the Mock ups, in order to understand the user interaction with the product

Source : Author

Before venturing into the form explorations of the product a comprehensive study was made on how the user interacts with the device, in order to understand as to where and how the user holds the product thereby design the grip area accordingly and add consecutive design elements.

Hence two mock ups were made of different sizes and tested on different users, after explaining them about the product, its features and usage. Photo documentation was done along with the user feedback on how to improvise the overall functioning of the product these were later on used to develop the form and refinement of the product.

MOCK UP TESTING WITH WEIGHT SIMULATION :

Understanding the user interaction in terms of testing with mock up models were important as it gave a very good in sight on the visual size and simulating with the actual weight of the product gave the feel of the product. By making various kinds of people hold the product one could understand the most comfortable positions of holding the device and thereby design the form/gripping areas based on the findings.

To get a realistic data in this regard an ergonomic consideration was made on the users where the target users were of 95^{th} , 50^{th} and 5^{th} percentile. Insights and opinions about the improvement on the products functionality were asked to the users, which would be later on incorporated in the final design, few of the most important areas pointed out was to change the form to a more rounded cylindrical form

Picture 26 : Mock ups with 1 liter of water in it for weight simulation

Source : Author

Picture 27 : user testing of the Mock ups, with weight simulation (1 liter of water was placed in the mock up)
Source : Author

INFERENCES FROM THE USER STUDY

After testing the mock up device with and without weights, a thorough understanding about the product usage was obtained in terms of how the person holds/grips the device while drinking the water from it.

Using the data from photo documentation one could map the areas where the user feels most comfortable to hold the device, this came in handy during the form explorations.

The feedback given by the user during the interaction with the product was also immensely useful in refining the product and making it more effective.

FORM EXPLORATIONS

Figure 27 : Rendering showing the physical size of the device, When held by the user

Source : Author

After the product detailing, the device was given the treatment of Form explorations. The keywords chosen in this regard were hard, strong and rugged, the forms were explored to bring about the above mentioned expressions.

Also the form was made in such a way that it would reduce the cognitive load on the user and be as self explanatory as possible.

Other considerations made during form explorations were the ease of manufacturability and stack ability for space saving.

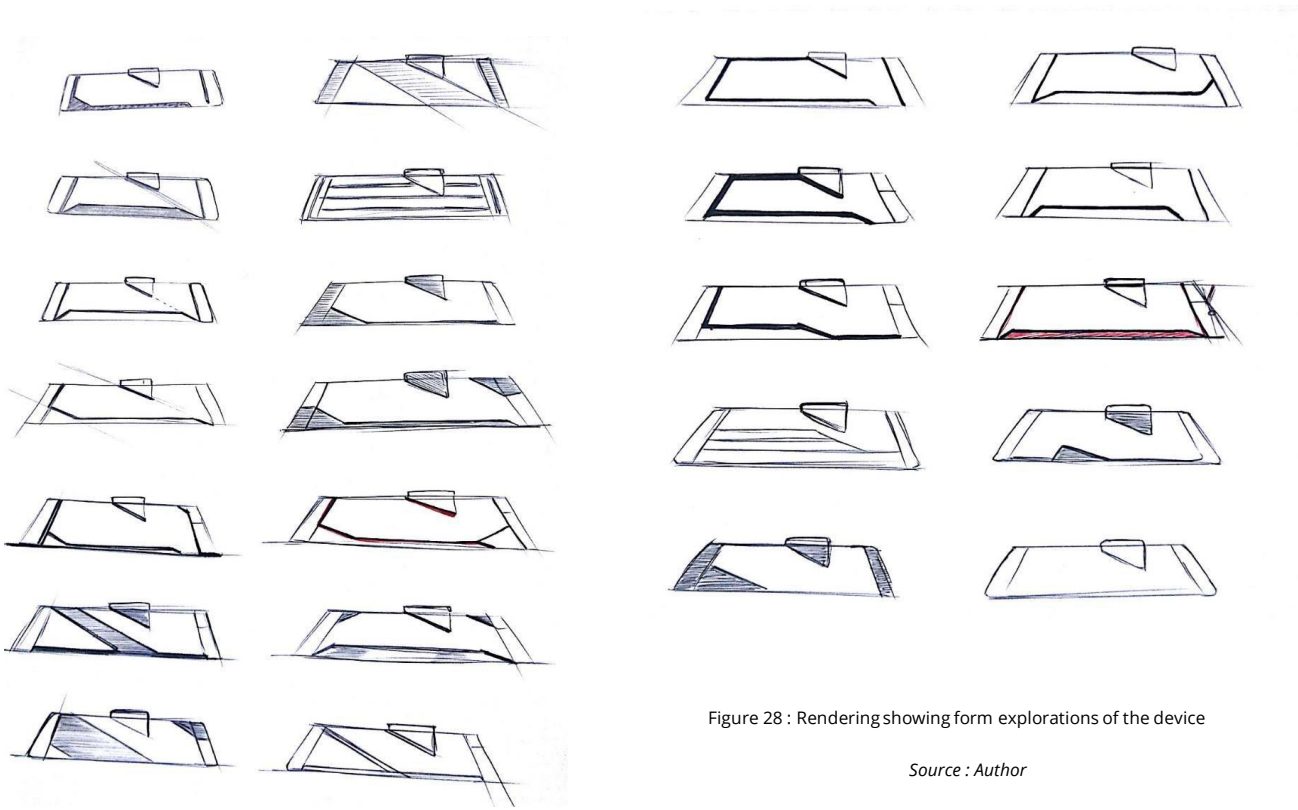


Figure 28 : Rendering showing form explorations of the device

Source : Author

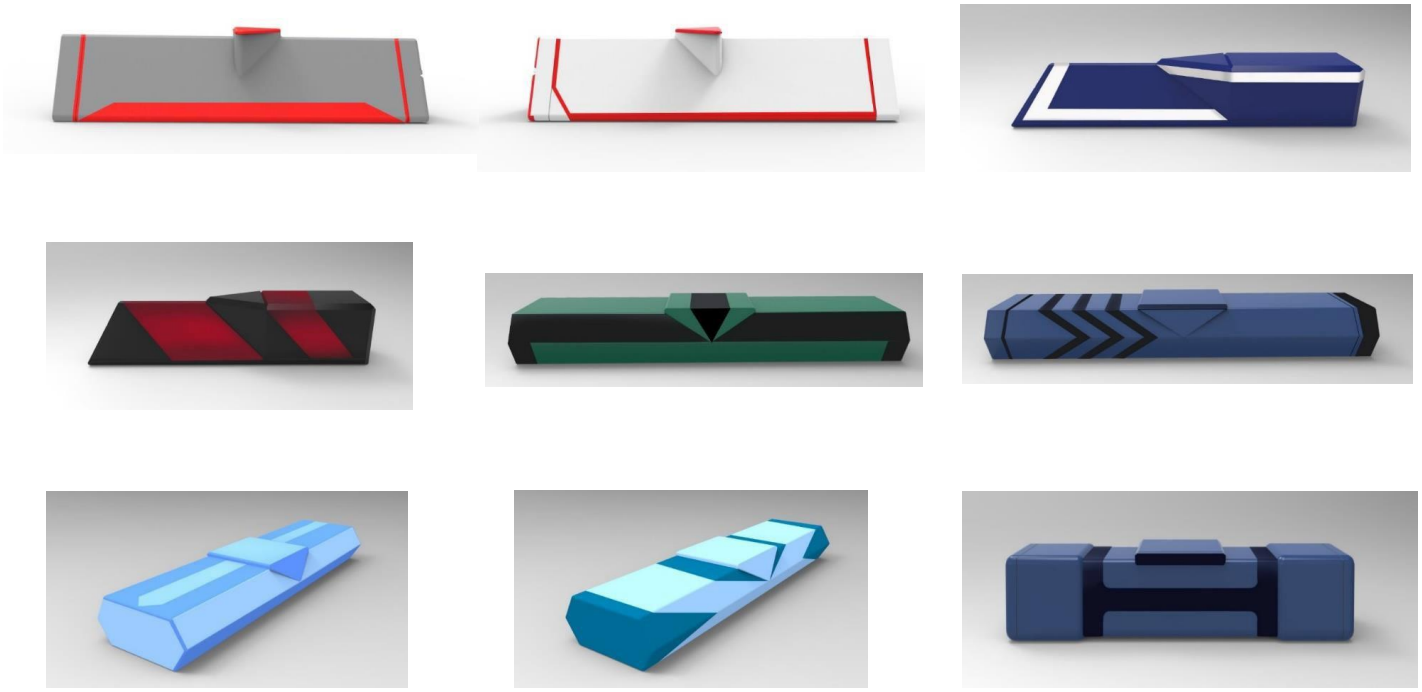


Figure 29 : Rendering showing form explorations of the device

Source : Author

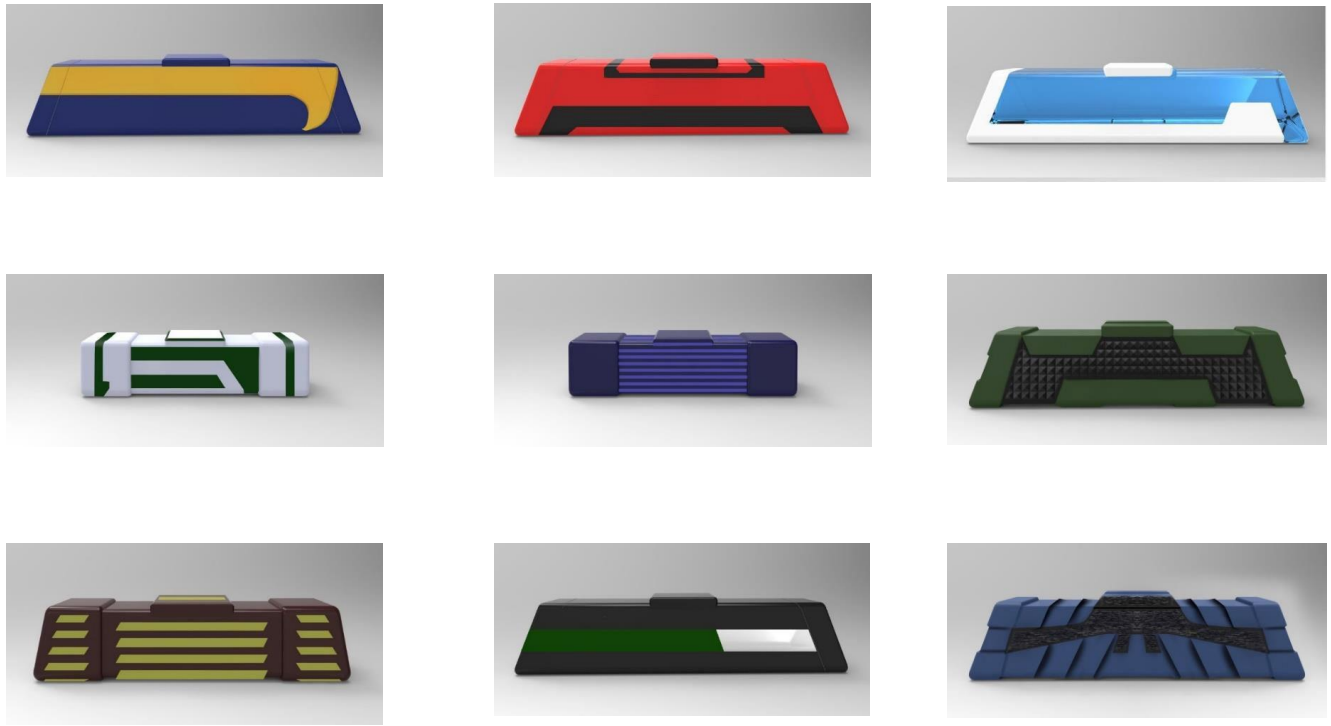


Figure 30 : Rendering showing form explorations of the device

Source : Author

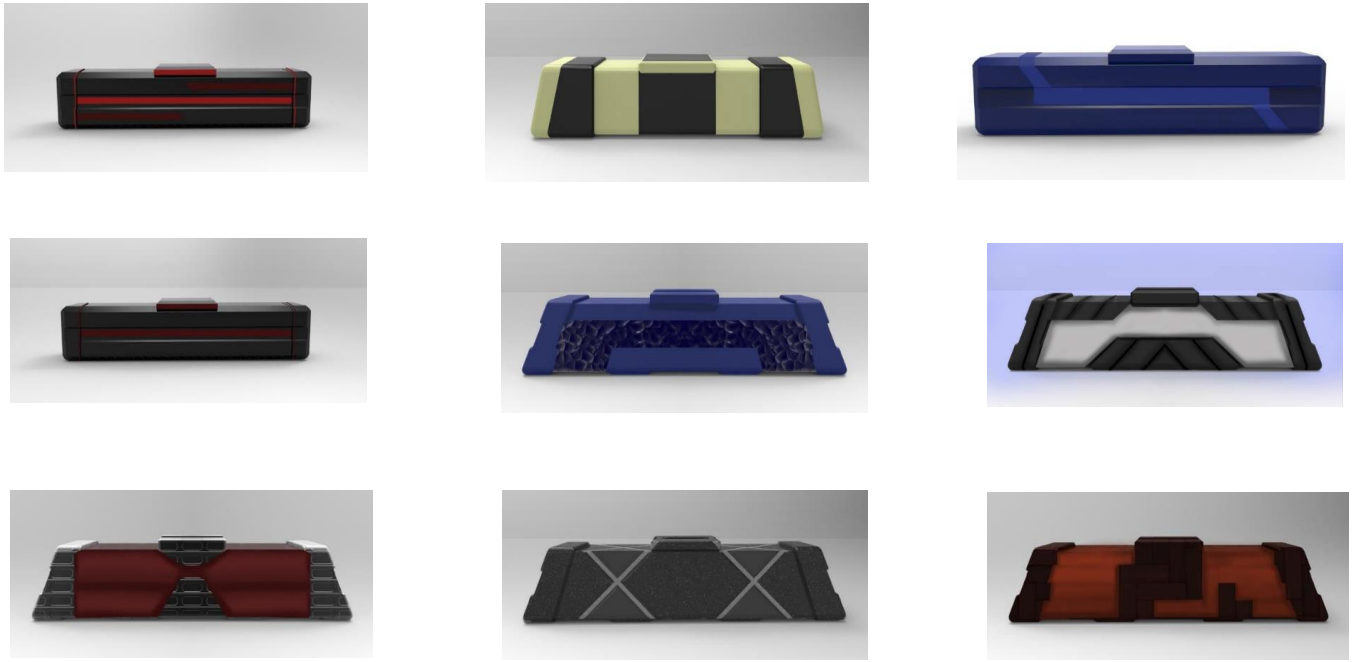


Figure 31 : Rendering showing form explorations of the device

Source : Author

After various form explorations were made, 3 of them were selected on this basis of visual appeal, the justification they made to the key words chosen, the usability and manufacturability point of view.

The selected forms are shown along side in the figure, the second form shows the usage of transparent material in order to show the quality and quantity of water that was present in the device, thereby removing the need for the user to authenticate the same frequently.

The visual appeal of the product had to match the contexts of both being used as an survival product and a product used by the youth for trekking.

Figure 32 : Final selected 3 form explorations

Source : Author

PRODUCT USAGE SCENARIOS

To understand the intricacies of the product usage, all the possible product usage scenarios were thought off that would point out every important activity involved in the user interaction with the product.

The possible scenarios based on whether the device will be used during floods or trekking are as follows :

Scenario 1 : During Floods Presence of Rain only
Scenario 2 : During Floods Presence of Rain and Flood water
Scenario 3 : During Floods Presence of Flood water only
Scenario 4 : During Trekking - Presence of Rain only
Scenario 5 : During Trekking - Presence of Rain and Flood water
Scenario 6 : During Trekking - Presence of Flood water only

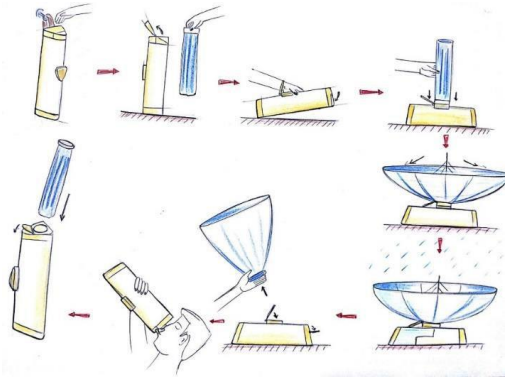


Figure 33 : Scenario 1 : During floods, Presence of rain water Âno surrounding flood water

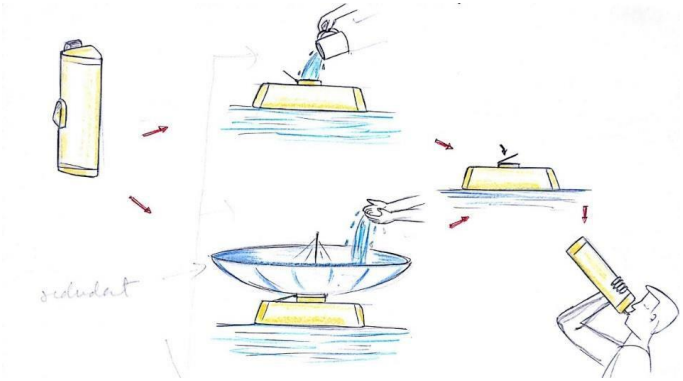


Figure 34 : Scenario 2 : During floods, Presence of rain water and surrounding flood water

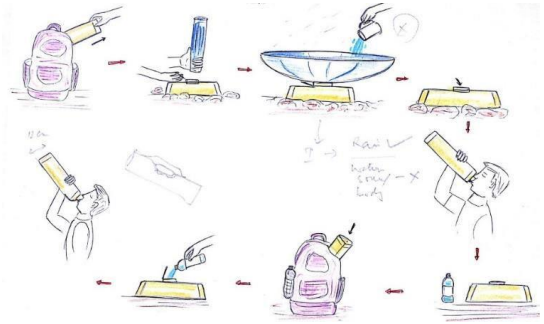


Figure 35 : Scenario 3 : During floods, no rain water Âonly surrounding flood water

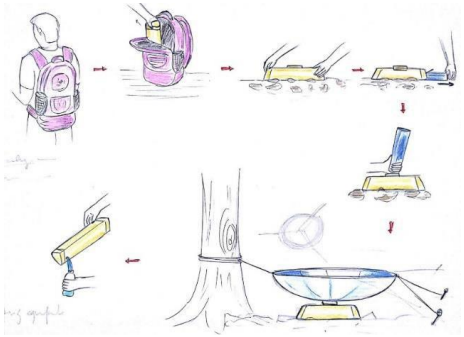


Figure 36 : Scenario 5 : During trekking, Presence of rain water and surrounding flood water

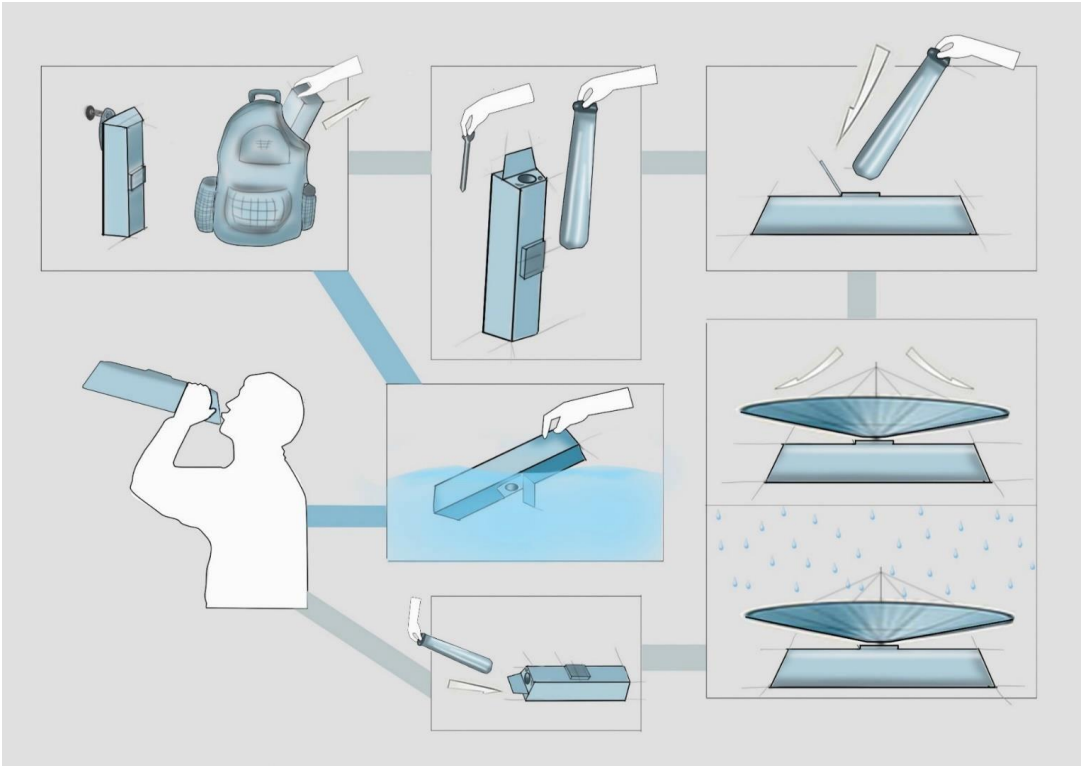


Figure 37 : Refined and Simplified activity analysis showing the product usage during rain and floods

Source : Author

FEEDBACK ON THE PROJECT PROGRESS (Stage 3)

When an evaluation check was done on the project evolution during the stage 3, many conclusions were drawn which changed the path of the project significantly,

- The **product positioning** was still very weak, the questions about who would use it and why would they use it, kept surfacing time and again, a thoroughly justifiable answer was still non- existent.

- The concept 3 was chosen to be the final product, but when presented in front of the expert panel a common feedback got was that the product did not look well defined as such with severe **lack of value proposition** it held to the user, it looked more like using a lifestraw and covering it forcibly with a box.

- The effectiveness of using a umbrella to collect the rain fall was under doubt, as calling rain fall as a source of water during survival situations was not very viable, considering the fact that **rainfall is extremely un-dependable.**

CHANGES IN THE PROJECT (POST STAGE 3)

When a critical analysis was done on the prominence of the project, it was felt that the product was severely deficient in its value proposition, hence a major change had to be done to make the need for the product more profound. It was at this point the idea of using the potential of Lifestraw to provide pure water to more than one person unlike its present usage status.

Hence, the idea of incorporating the **need to collect rain water directly was side-lined** and focus was given more to using the **product as a survival device** to provide water from surrounding water to the needy.

POTENTIAL OF THE LIFESTRAW PURIFIER

LifeStraw is a water filter designed by Lifestraw S.A. in Switzerland to be used by one person to filter water so that they may safely drink it. It filters a maximum of 1000 litres of water, enough for one person for one year. It removes almost all of waterborne bacteria , protozoa and parasites. The cost of the product is about ₹750, which could be further reduced when subsidized by the government and bought in wholesale.

DRAWBACKS OF THE EXISTING LIFESTRAW

The reason why Lifestraw as a product is very efficient and low cost, but still failed to reach the masses is :

- One needs to **find a source of water** to be able to purify and consume it using Lifestraw then a bottle was integrated with the lifestraw, so that one could carry around which ever water they find.
- The user doesn't prefer to **carry around dirty water** all the time in the water bottle
- The product is ideally meant for individual use, as the bottle **tip needs to be kept sterile**

GENERATION OF NEW CONCEPT

A new concept was developed **based on the drawbacks of the exiting Lifestraw device**, the new product was designed to address the following features :

- Would be a **portable** water purifier that would be deployed during survival situations
- Would **use the existing technology** of Lifestraw and use it as the water purification unit
- The product could be **operated individually**
- The product would cater to the **needs of a small group** of people, which would comprise of 40-50 people
- The product would visually provide **less cognitive load** on the user
- The product would have high importance given to **usability issues**

VALIDATION OF THE CONCEPT :

The promising idea of using lifestraw as an integral part of a water purifier for quick purification and catering to more than one person was conceived and immediately a quick test rig was built to test if the concept was feasible.

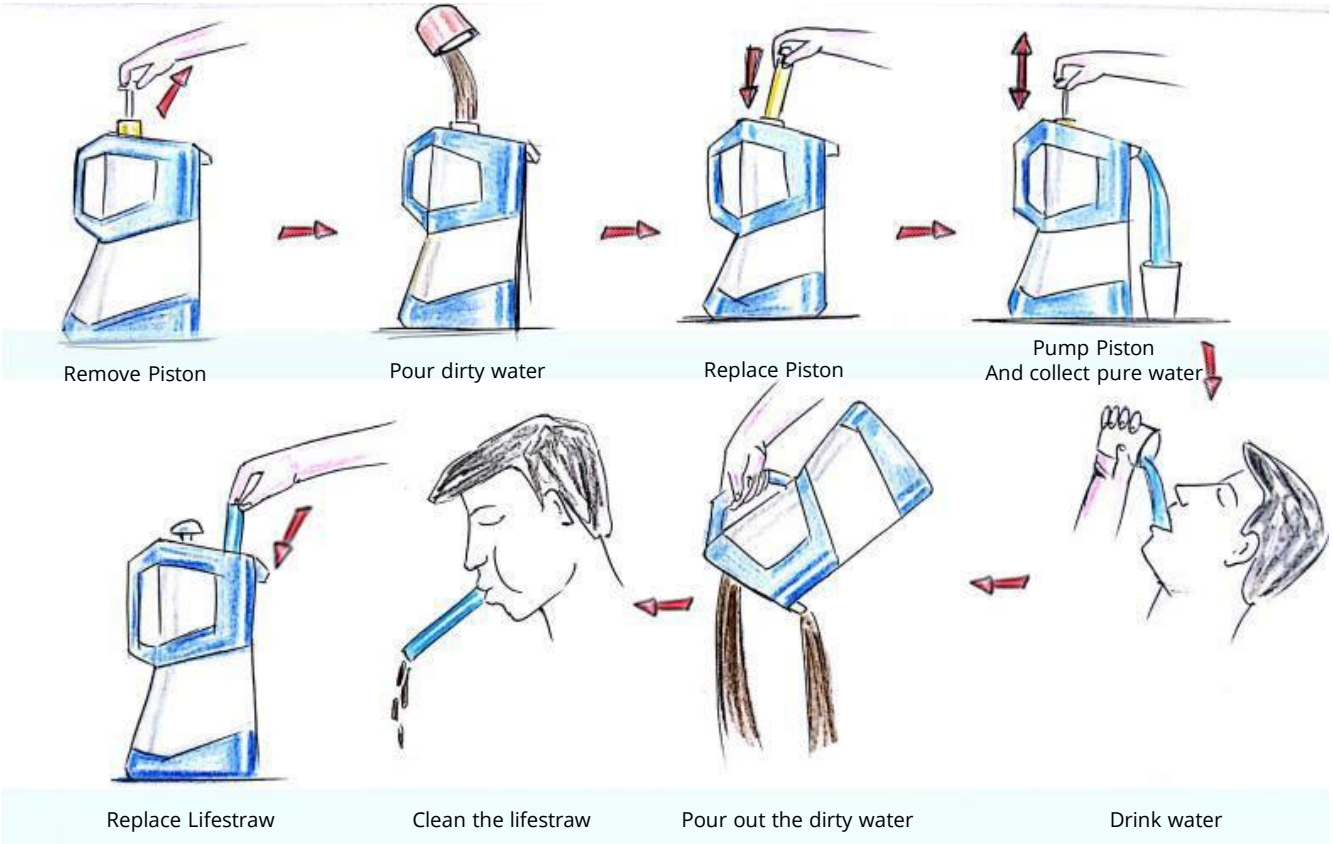
Lifestraw needs negative pressure to suck in the dirty water - purify through the fibers and give out the pure water, the new product design did this in a slightly different way, a positive pressure was given at the other end of the straw thereby forcibly pushing the dirty water into the straw and making the pure water flow out of the other end, this positive pressure was given using a piston of a pressure garden sprayer.

As expected the rig worked, with a promising amount of water being pumped out. Hence further development of the product was carried on.

Picture 28: A quick test rig that was done using life straw to test the validity of the concept

Source : Author

ACTIVITY ANALYSIS



FORM EXPLORATIONS

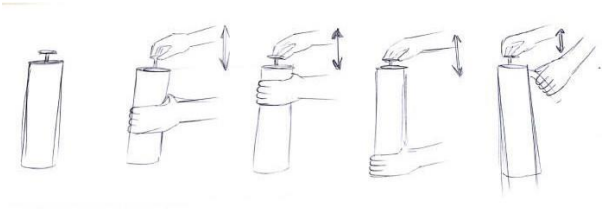
Once the concept was validated using a test rig, the process of form explorations was started based on certain parameters.

The product is to be used in survival conditions, hence there were constraints on the form, usage of color, materials, texture etc. to be considered for effective product usage during survival scenarios.

The keywords chosen in context here were strong and rugged.

The following parameters were considered for form explorations :

- Visual stability of the product
- Usage of handle and grip
- Cognitive load on the user
- Manufacturability
- Ergonomic considerations
- User interaction with product
- Visual appeal



Picture : various positions of holding the device

Source : Author

WEIGHTAGE GIVEN TO PARAMETERS:

The functionality aspects of the product was of utmost importance when compared to the form and other visual appeal strictures, in that regard the hierarchy of importance to the product was :

1. Usability of the product
2. Manufacturability
3. Form and visual appeal

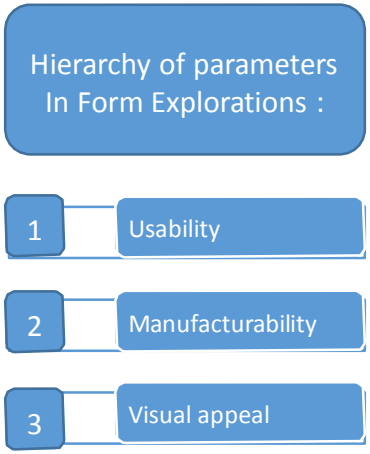
Usability of the product :

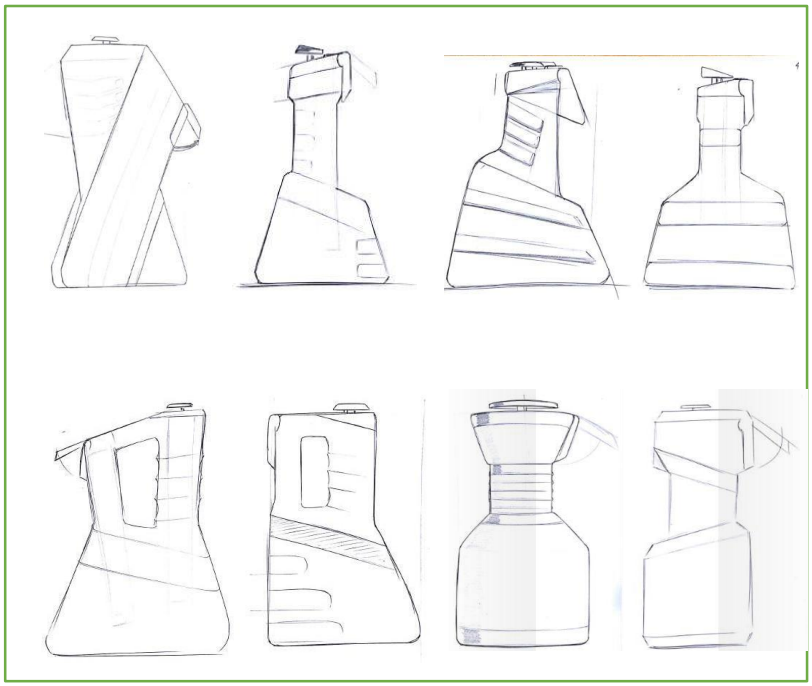
The way user would interact with the product was considered was the primary factor in positioning features like the handle/grip of the product, in that regard users were asked to state the most preferred place of holding the device, which turned out to be the region just below the top cap/piston.

Evolving the final set of forms :

After exploring numerous possibilities the final set of 3 forms were evolved based on the following factors :

- The side of the product with the spout was kept flat, as water would be collected from that side and having a protruding surface would **hinder efficient collection of water**
- The idea of having a **movable spout** was dropped, as movable parts in a product makes the element weak, design complex and further increase costs
- A **broader base** was provided in order to increase the stability of the product- both visually and from Centre of gravity point of view
- Sufficient height and width were provided in order to safely **accommodate both the piston and the lifestraw**

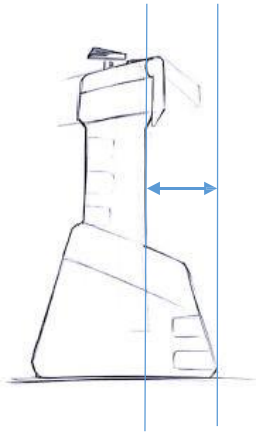


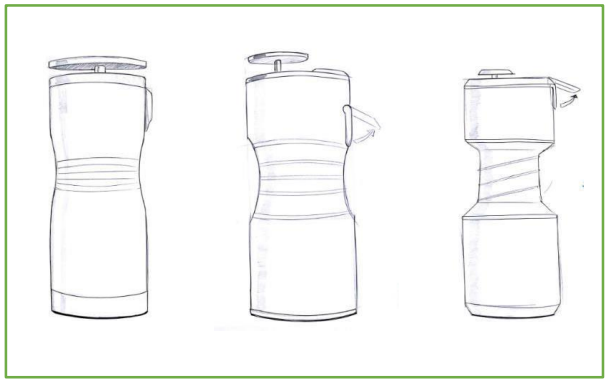


CHUNK 1

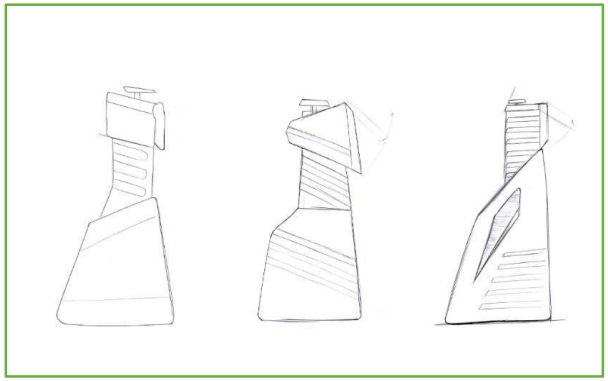
FORM EXPLORATIONS : CHUNK 1

The sketches alongside shows the first set of form explorations, the main issue with all these explorations were that of the spout coming with in the range of the body, hence **obstructing the water collection** as shown in the figure below





CHUNK 2



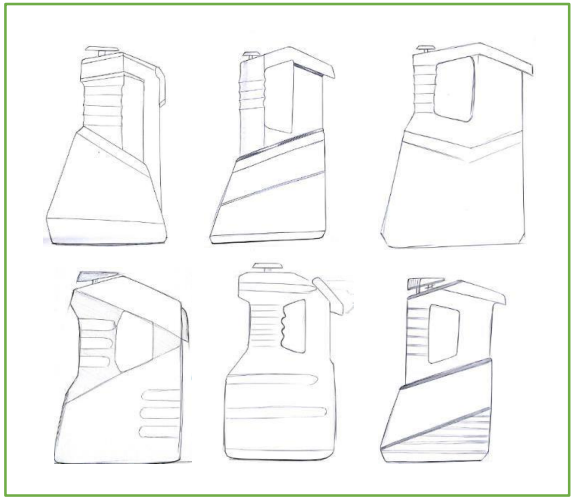
CHUNK 3

FORM EXPLORATIONS : CHUNK 2

These explorations were done keeping in mind a minimalistic approach, where in the form resembles the base shape of a cylinder, the issues that cropped with these forms were the **lack of visual stability** of the product

FORM EXPLORATIONS : CHUNK 3

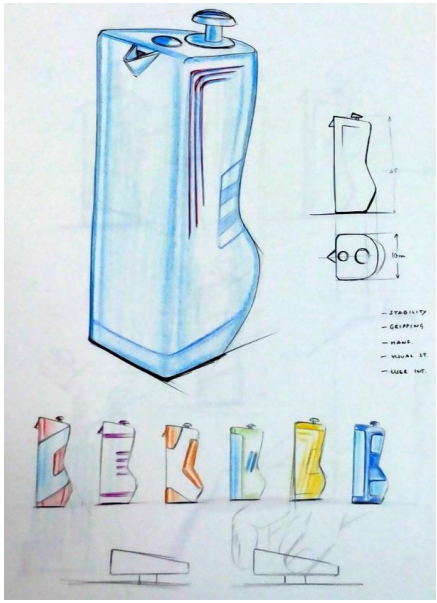
These explorations concentrated more on the stability of the product with a wider base area and narrower top, but the issue cropped up in the **usability factor**, where in the user was not able to understand where to grip the product comfortably

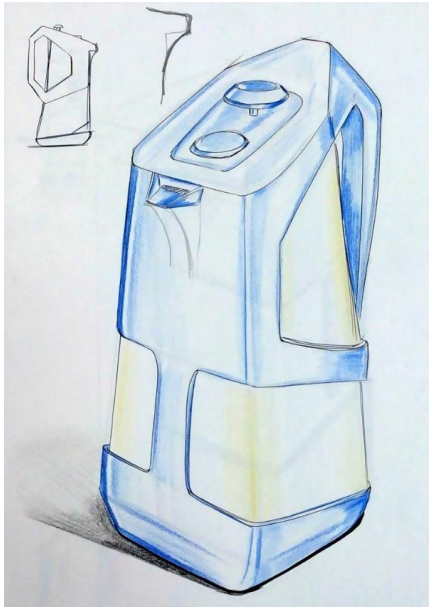


CHUNK 4

FORM EXPLORATIONS : CHUNK 4

These final set of explorations were more refined in terms of having better **visual stability**, **usability factors, presence of an obvious handle** and more **quantity of water storage**, hence the final form were derived primary from the features got from these set of explorations.





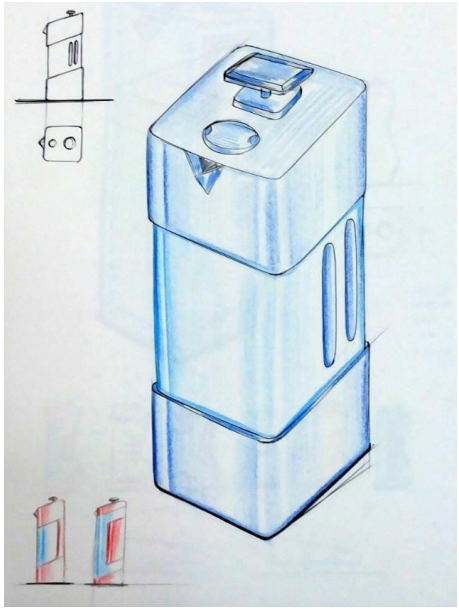


Figure 38 : Final 3 forms chosen from the explorations

Source : Author

Picture 29: Thermocole Mock up of the forms

Source : Author

MOCK UP TESTING

After the forms were finalized, quick models were made using thermocole, to visualize the product and test it on users to get their feedback for further refinement. Here importance was given more to the physical shape of the product and not the visual appeal.

Based on the feedback got from the users the refinement of ergonomics of the product was done considering the important parameters like twist in the wrist and stress on the user while using the product.

A small thermocole block of 10 cm in height and width was given to the users to check the gripping by 5^{th} and 95^{th} percentile user, once the size of the product was approved , the actual 1:1 scale models were made using thermocole.

Picture 30: Mock up of the forms being tested with the users
Source : Author

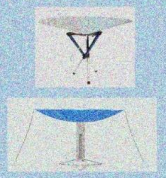
Picture 31: Thermocole Mock up of the forms being tested by the users

Source : Author

INFERENCES DRAWN FROM THE USER FEEDBACK

When all the three forms were tested on the users, who were asked to simulate the process of pumping the piston and collecting water, both in standing and sitting postures - the feedback obtained pointed out that the form shown alongside in the picture was the most preferred, because of the following reasons :

- The form had affordance of a jar, hence the user was easily able to relate to it as a product that is used for holding water
- The form had a visual stability unlike the other 2 forms
- The chosen form gave more opportunities for better gripping of the product- which was provided because of the inclusion of the handle, the feature that was lacking in other two forms
- The form was physically bigger which made storage of large quantity of water possible, instead of refilling often

PHASE 0	PHASE 1	PHASE 2	PHASE 3	FINAL CONCEPT
				
JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
Design Brief	Ideations	Concepts	Refinement	Final Product
To make a rain water harvesting device for survival conditions	To collect rain water using various kinds of collectors	To collect and store rain water during survival conditions	To collect and store rain water and purify flood waters during survival conditions	To collect and purify flood waters during survival sitations
	Storage of water not addressed	Limited to rain water collection	Inclusion of purifier Individual use	Inclusion of purifier For more than one person

FINAL CONCEPT

Figure 39: Final form chosen

Source : Author

CHOOSING THE FINAL FORM :

Amongst the three final forms that were short listed- one of them was chosen to be taken forward to the prototype stage because of the following reasons :

- The user feedback of the 3 test mock-ups proved that, the users preferred using a form which they **could easily related to** a device that would hold water hence the Jar inspired form was considered
- The form needed to be **visually stable and strong**, which was considerably lesser in the other two forms
- The product had to be **firmly gripped for efficient pumping**, which the users preferred to achieve by holding the handle rather than holding the neck of the product
- Because the form was very similar to the existing jar designs, the users **intuitively knew what to do** and were comfortable in using it rather than an alien looking form

FINAL PRODUCT

After finalizing the form, the product was rendered using software and analyzed as a 3-d product, after finalizing on the detailing dimensions were used to make an actual working prototype which would act instrumental in validating the working of the concept.

The color scheme chosen were shades of blue and grey, as they were apt to the usage in survival conditions and are neutral colors which are liked by both genders

Figure 40 : Rendering of the final form

Source : Author

FINAL PROTOTYPE

KEY FINDINGS

Few of the things that were discovered / learnt during the course of the project were :

- Understanding the scenario of product usage needs to be as clear as possible for expecting effective outcome
- The need for the product and where it will be placed in the market should be well defined
- Periodic User feedback at different stages of the project is a important check to be sure the project is moving in the right direction
- One must not shy away from changing the project direction drastically if the new direction holds a better value to the user
- Understanding about the weather and climatic patterns helped in justifying the product better

CONCLUSIONS

The project followed a formal design methodology and proposed a design intervention in a challenging area of providing drinking water to victims stuck in survival conditions.

Even though many of the preliminary concepts failed, it was possible to refine and look for directions that took the final concept to a substantial level of feasibility. Validation by making the concept work in real life scenario would be the formal way of culminating the project.

Future scope of the project would be to come up with even more innovative solutions which would cater to the needs of people with following points :

- Include other value added features.
- Refinements and up gradation after actual field testing
- Low cost options of purification

BIBLIOGRAPHY

- Per Mollerup, 2001, *Collapsibles,* Thames and Hudson
- Handle Ergonomics <http://mpatkin.org/ergonomics/handle_checklist.htm> as seen on 12//11/14
- Working of Lifestraw <http://science.howstuffworks.com/environmental/green-tech/remediation/lifestraw1.htm> as seen on 10/11/14
- Silicon Rubber Ring <http://www.indiamart.com/adityapolymers-vasai/air-tight-and-leak-proof-silicone-rubber-ring.html> as seen on 10/11/14
- Statistics on Rainfall <http://wheretherainfalls.org/india/> as seen on 16/10/14
- Self Sufficiency <http://www.mitraniketan.org/mitraniketan/self-sufficiency-new> as seen on 16/10/14
- Data on Indian Rainfalls <http://www.economist.com/node/14401149> as seen on 14/9/14
- Strategies of Rain water harvesting <http://www.slideshare.net/D5Z/o3a339> as seen on 16/10/14
- Tank Module <http://www.rainxchange.com/products/aquablox.php> as seen on 16/9/14
- Annual Rainfall pattern <http://www.mapsofindia.com/maps/india/annualrainfall.htm> as seen on 16/9/14
- Flood prone areas of India <http://www.mapsofindia.com/top-ten/geography/india-flood.html> as seen on 12/11/14
- Working of pressure pump <www.hydropac.com/HTML/howpumps.html> as seen as 12/11/14