THINK!
DESIGN

D'source Project

Open Design School

MoE's Innovation Cell

Design of Solar Powered Pesticide Sprayer

Design Thinking & Innovation Case Study

Section: C4, Week 4

Design Thinking & Innovation (DT&I)

Section: C4.0

Week 4

Design Thinking & Innovation (DT&I)

Prof. Ravi Poovaiah
IDC School of Design, IIT Bombay

DT&I Case Study

C4 Design of Solar Powered Pesticide Sprayer

Module C4:

THINK!
DESIGN

C4.1

Design of Solar Powered Pesticide Sprayer

THINK!
DESIGN

Project-3

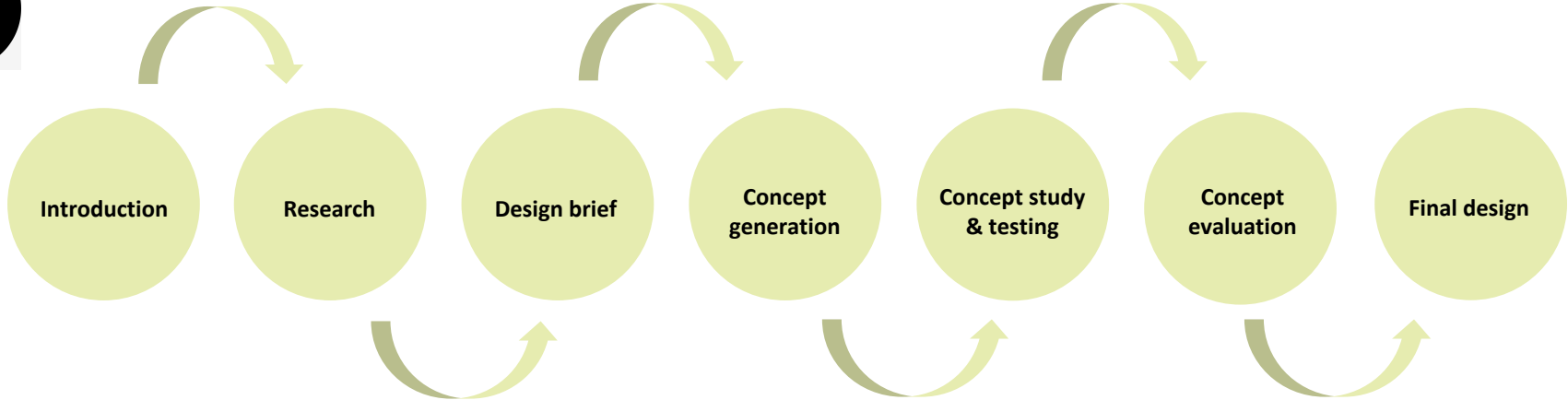
Project - 3

Design of solar powered pesticide sprayer for agricultural use

Ajit Dhebe – 206130008
Guide - Prof: Avinash Shende

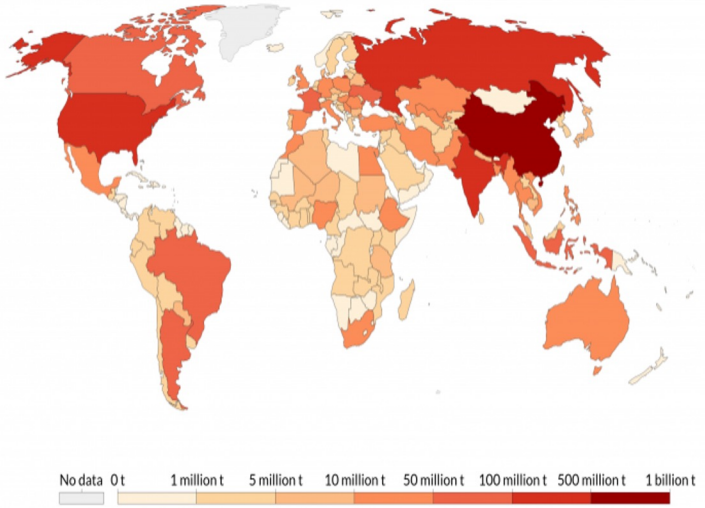
IDC
IIT Bombay

Content


Introduction
Research
Design brief
Concept generation
Concept study & testing
Concept evaluation
Final design

Agricultural in India

Agriculture is demographically the broadest economic sector of India. As per 2018 survey India ranks second worldwide in farm outputs & ranks first in the world with highest net cropped area followed by US and China.



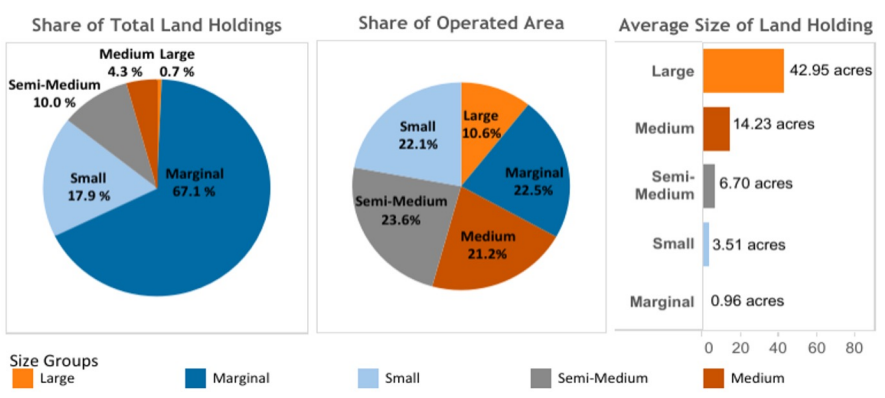
Cereal production 2018 world wide

Landholding statistics

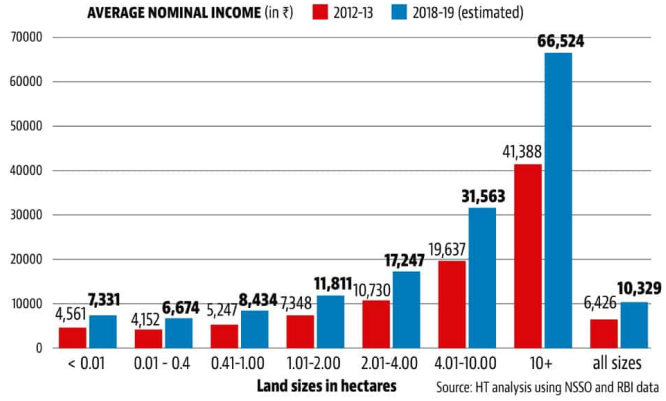
India has a total geographical area of about 329 million hectares, out of which 160 million hectares (45%) of land is suitable for growing crops.

100 million farmers
160 million hectare land

Landholding statistics



Average nominal income as per land sizes



Observation from the Secondary Research of statistics

- In comparison to marginal farmers, small & medium land holding farmers owning sizable amount of land (3 to 7 acres) but still fall into the small income group and hence cant afford a expensive farming equipment's such as advance HTP or orchard sprayer.

- Small farmers with less land can use the current sprayers with comfort but for a big land it becomes hassle. This gives the opportunity to design a sprayer for a small and semi medium land holding farmers.

Pesticide spray machine

Sprayer is a device used in agriculture used to spray liquids like water, insecticides, and pesticides in agriculture. They are also used to spray herbicides and fertilizers to crops in agriculture.

Agricultural sprayers have components like spray nozzle, liquid tank, sprayer pump, pressure regulator, valves and fluid plumbing and some sprayers have spray gun.

Various types of sprayers suitable for small to large lands, viz.

- Knapsack Sprayer
- Portable Power Sprayer
- Knapsack Power Sprayer
- Mist Dust Sprayer
- HTP Sprayers
- Orchard Sprayers

Observation from Secondary Research of Pesticide spray machine

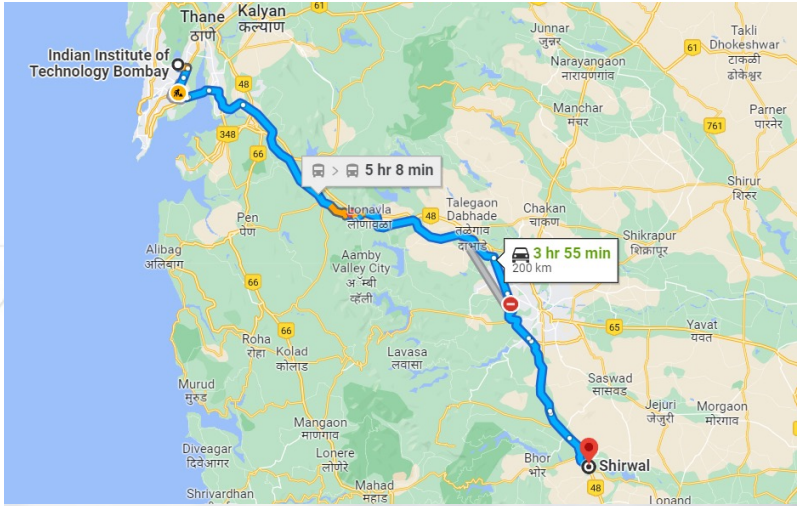
Most of the farmers use manual and battery powered knapsack spray for the farming which they need to carry on a back throughout the large field to spray the pesticides.

Problems in current pesticide sprayer are:

1) Majority of the small & semi medium farmers who own around 1 to 10 acres of land prefer knapsack sprayer.
2) This knapsack sprayer is difficult to use for long period of time as it is heavy with 16 to 18 liters solution & needs to be carried on the back over a large fields which results into back, neck, shoulder and arm pain.
3) Difficult to load and unload for a single person due to very heavy weight, often require two persons.
4) There are vibrations & heat problem while using petrol power sprayer.
5) Uneven spray of pesticides due to the hand pump mechanism.
6) Farmer exposed to harmful pesticides while spraying.

Primary Research - Field visit 1

Location: Shirwal, Satara



Purpose of field visit

- To understand geographical and social conditions of the farmer.
- To collect first hand information of how different crops are protected (from pests, fungus etc.) in farming.
- To get direct experience of the activities that are carried around for effectively applying pesticides over a crops.
- To interact with local people & discuss problems they faced during entire process of pesticide use.

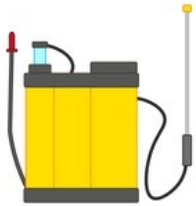
Field visit: 1

Questionnaire – 4 parts

- Demographic data

- Farming related questions

- Questions related to pesticide use in farming

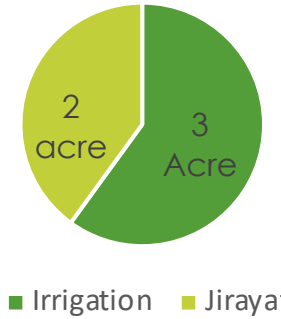


- Questions related to pesticide sprayer machine

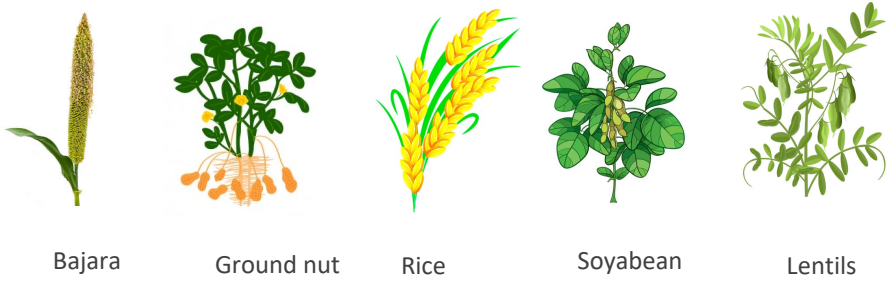
Meeting with the farmers

Field visit: 1

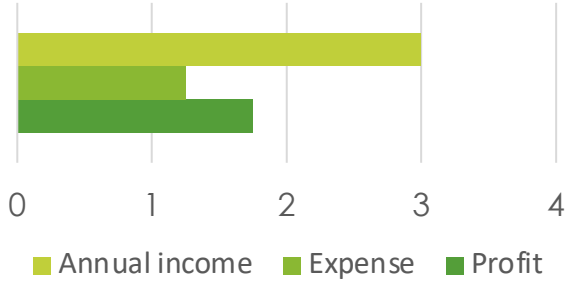
Land



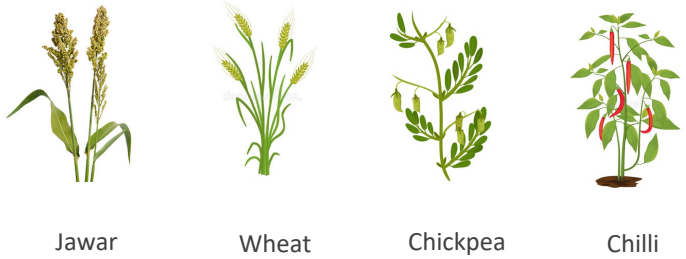
Kharif crops



Annual income (Lacs)



Rabi crops



Components

Removable nozzles

Charger

Belt hooks

Belt

https://www.moglix.com/neptune-16l-12v-yellow-2-in-1-battery-operated-knapsack-garden-sprayer

Field visit: 1

Demonstration

Step 4

- Fil the tank with water using a nearby **waster source** with vessel through given filter to avoid foreign particle from damaging the pump.

Step 5

- Shake the tank well or spray the solution into the tank itself using the nozzle until it gets mixed properly.

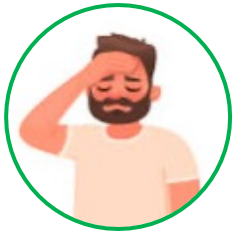
Step 6

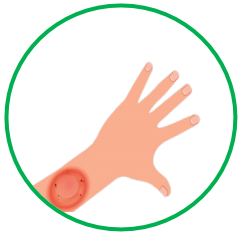
- Load the tank on your body, ask for help if available while loading

Field visit: 1

- Generally farmers prefer to spray the pesticides when there is a less wind to avoid coming in contact with chemicals.
- Due to the chemicals, they face coughing, sneezing, headache, skin issues etc.

Flow bending due to the wind





Key insights

Physical strength

- Person with only certain **physical strength** is able to perform the task of spraying efficiently as it requires walking of **4 km distance** with a weight of around **20 kg** for more than **4 hours** for a **1 acre** land.
- Women, younger, older or weak person would not be an ideal candidate to perform such tasks.

✓

✓

✗

✗

Key insights

Ergonomic issues

- Spraying the pesticide using the knapsack sprayer for Long term is **difficult** & causes pain in **both shoulders**, **back** & **arm**.

Design brief

Design a solar pesticide sprayer for agricultural use in India:

Objective of the product are:

- Affordable to the majority of small & semi medium farmers.
- Easy to maneuver between crop alleys sizes.
- Comparatively effortless & comfortable to use than the existing knapsack sprayer.
- Solar powered automatic spray to reduce human efforts.
- Feasible to tackles the electricity & battery drain issue thus reducing the labor waiting period for charging the battery.
- Multifunctional with additional product value for farmers to increase the frequent use of the device.
- Able to manufacture, maintain & repair at local level.

Design direction

Possible design direction

- Shifting all the weight from back and putting it on single frame of wheel to push forward.
- Farmer will lead the way while spraying on crops & tank will follow him on the wheel.
- More effective way to carry weight on back & shoulder which will reduce human efforts.

1

Pushing the tank

2

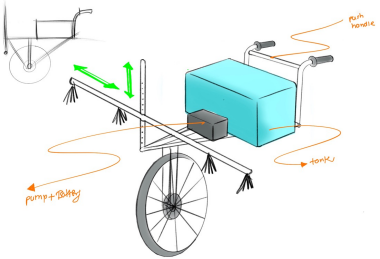
Make tank follow user

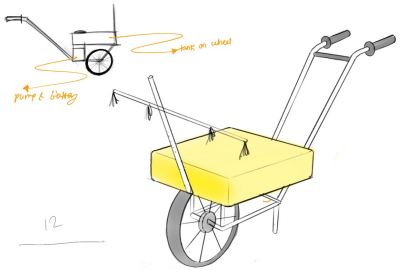
3

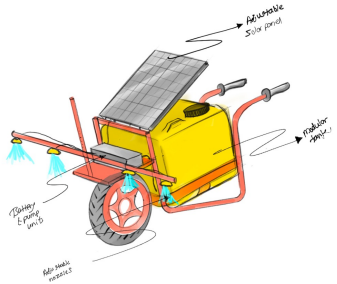
More effective way to carry on body

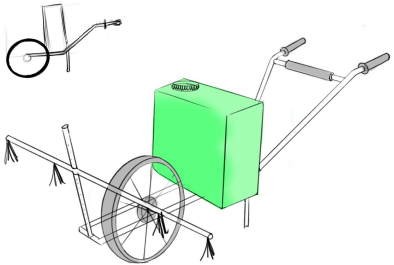
Concepts

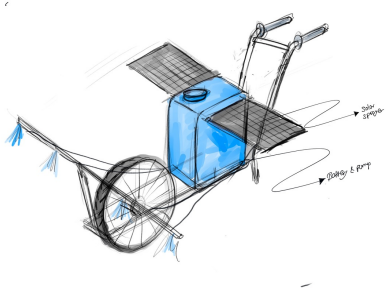
Push type concepts : Ideations

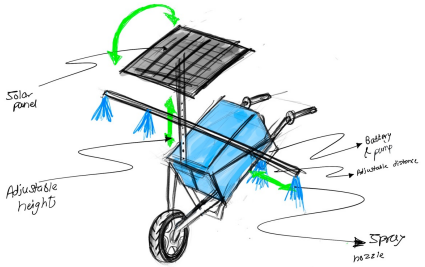






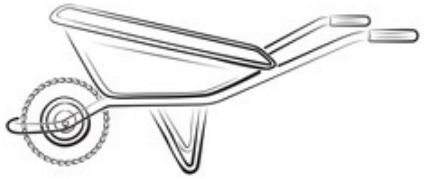






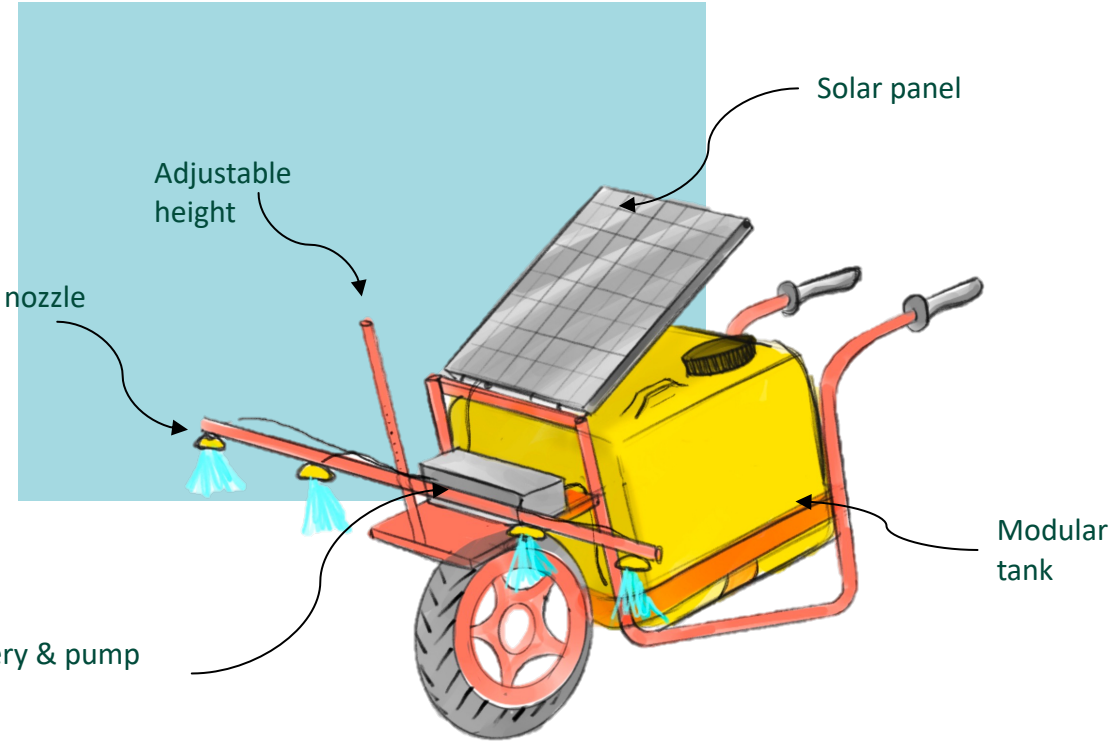
ideations

Push type concepts : Ideations



Inspiration

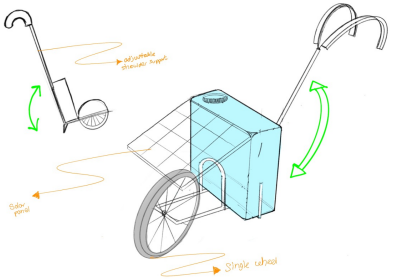
Modular components

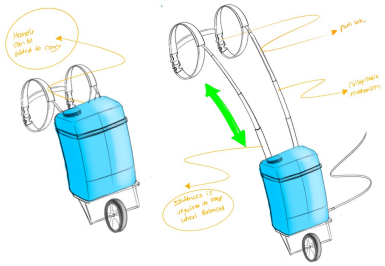


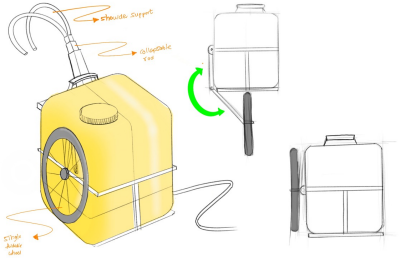
Source: Author

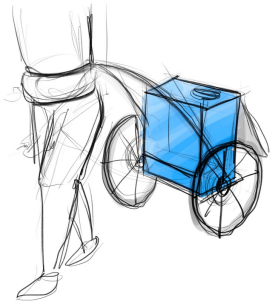
Concepts

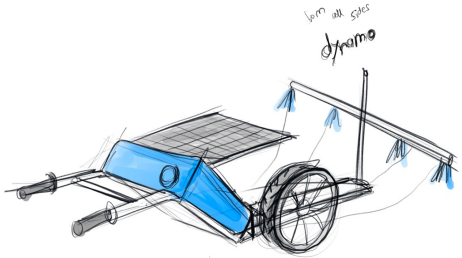
Pull type Concepts: Ideations

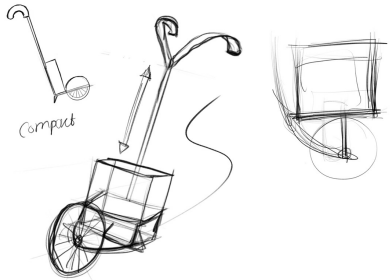








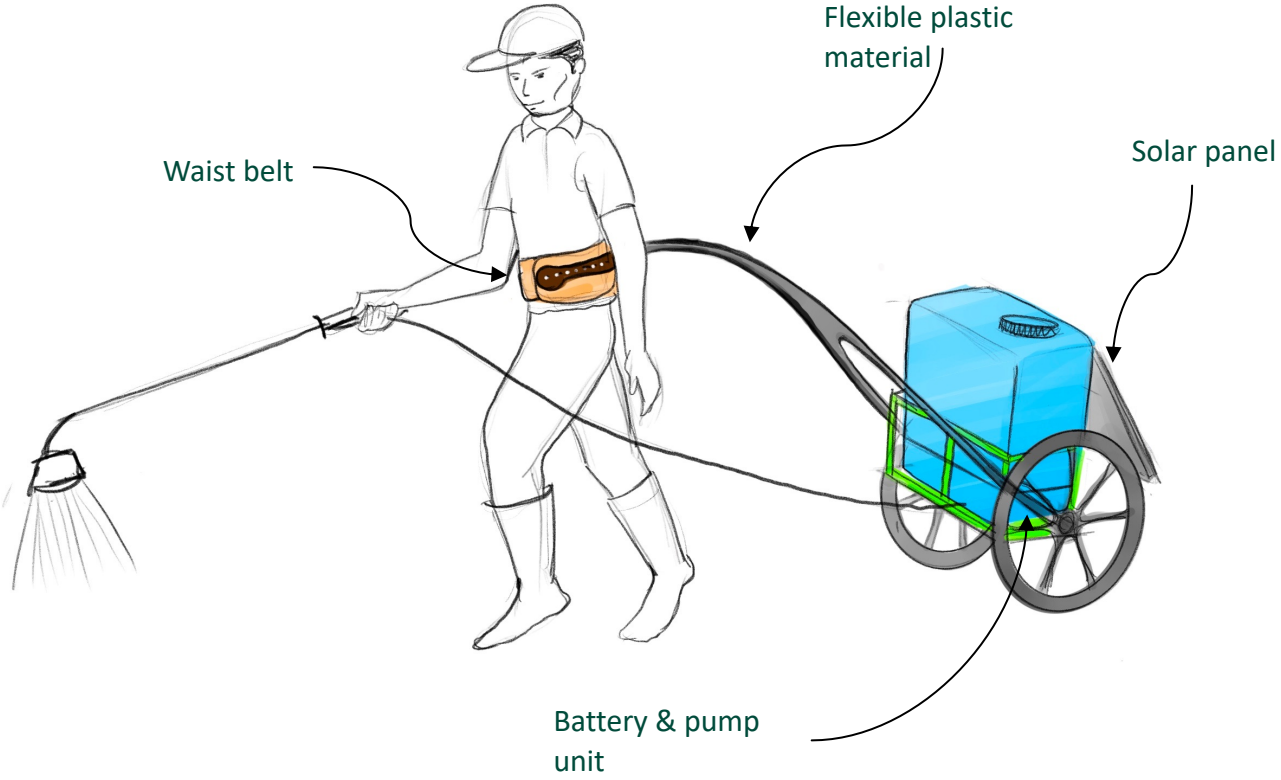




ideations

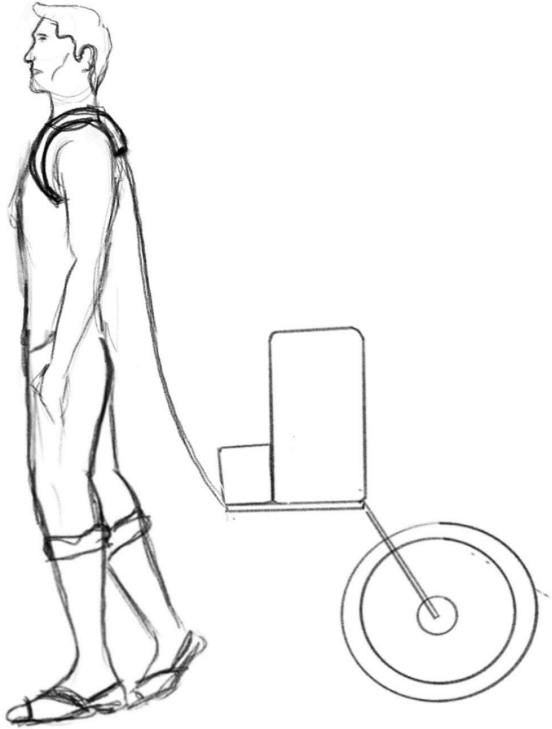
Pull type Concepts: Ideations

Inspiration

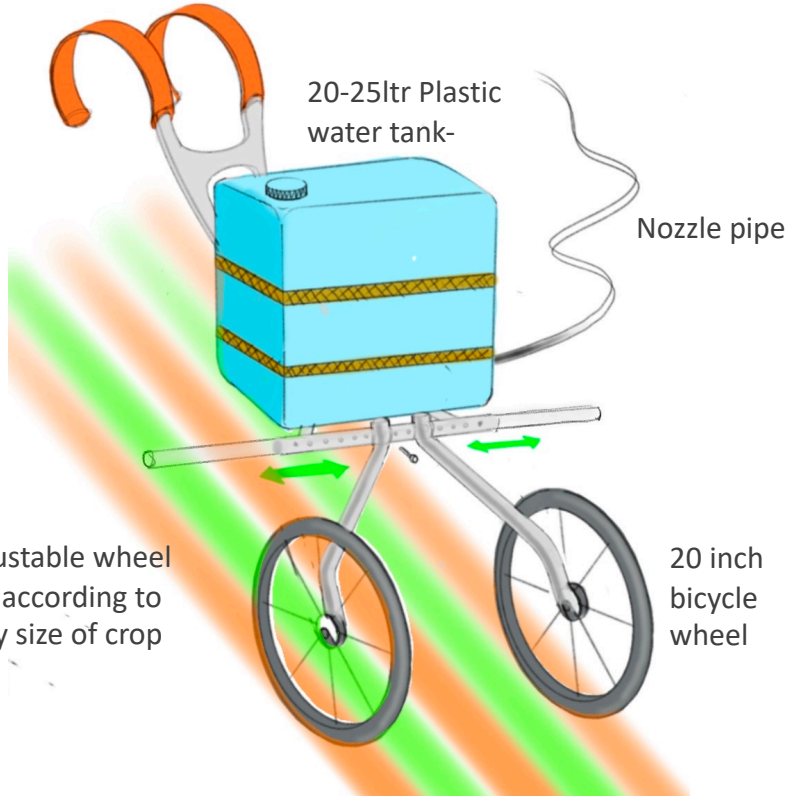


Concepts

Pull type Concepts: Ideations

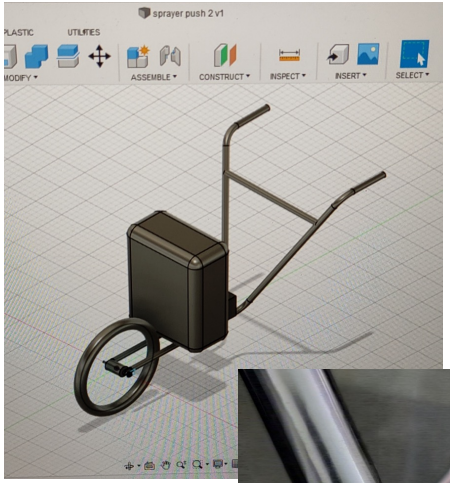


Free hands for operating the nozzlec



WIP

Cad model



Alignment

Welding

Dia: 25 mm

Thickness 1 mm

Pipe failure

Testing

Mock-up

Mock-up study

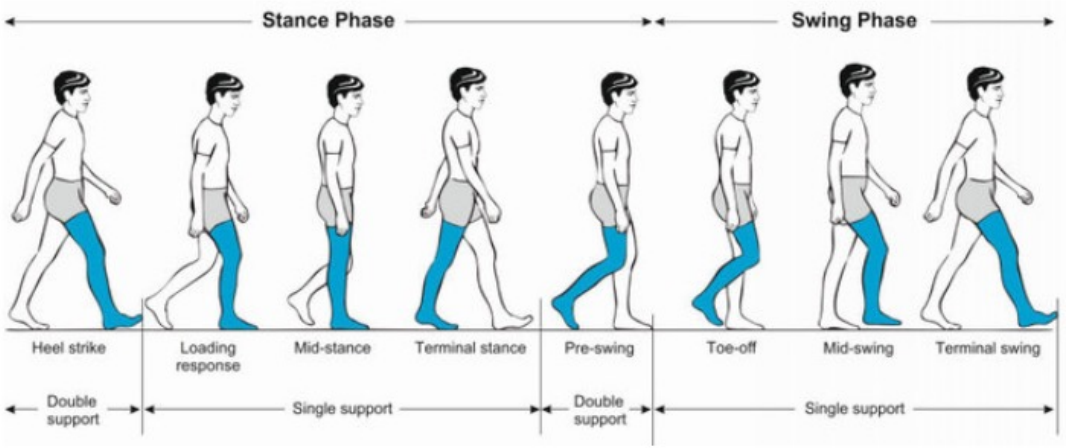
Mock-up

Anthropometric measurement

Average Indian height

	Men	Women
India	163.4 cm (5 ft 4½ in)	151.9 cm (5 ft 0 in)
India	163.7 cm (5 ft 4½ *in*)	152 cm (5 ft 0 in)

https://en.wikipedia.org/wiki/Average_human_height_by_country

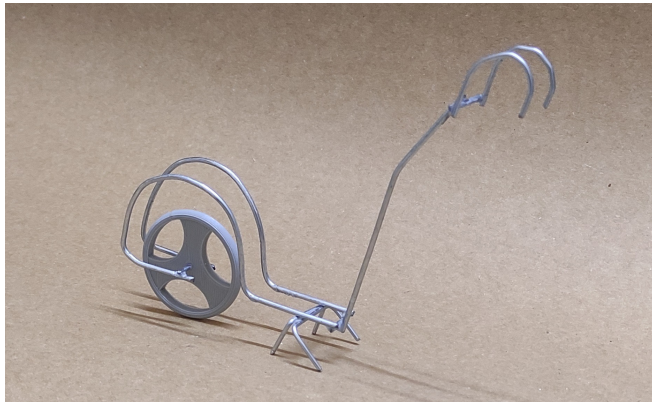


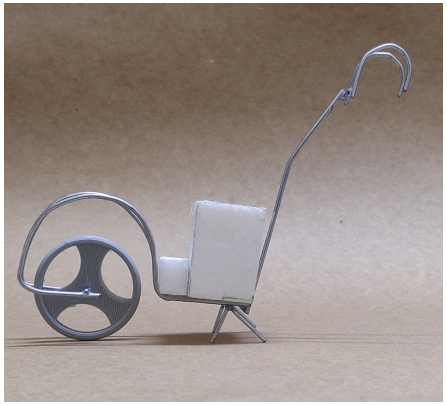
GAIT cycle and phases

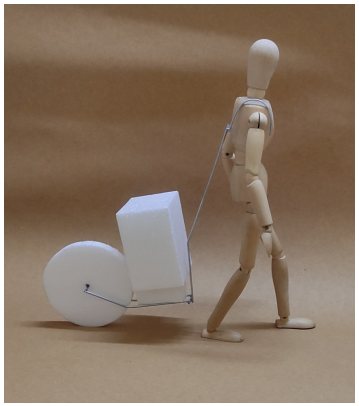
Mock-up

Wire mock-up: 2

Scale - 1:12







Mock-up

Mock-up : 3 development

Testing

Mock-up : 3 - User testing

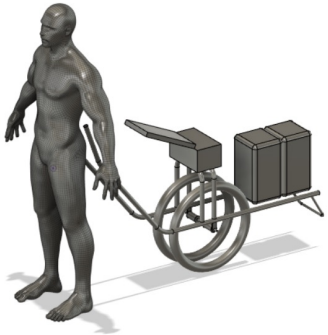
Evaluation

Evaluation result

Concept	Overall comfort in walking	Loading & unloading	Load carrying capacity	Manoeuvrability	Simplicity	Compactness	Cost	Protection against chemicals
	2	2	2	4	3	4	3	2
	3	4	4	3	3	2	2	2
	3	3	4	2	2	2	2	3
	4	4	4	3	3	2	2	3

Combining the Mock-up 3 and 4

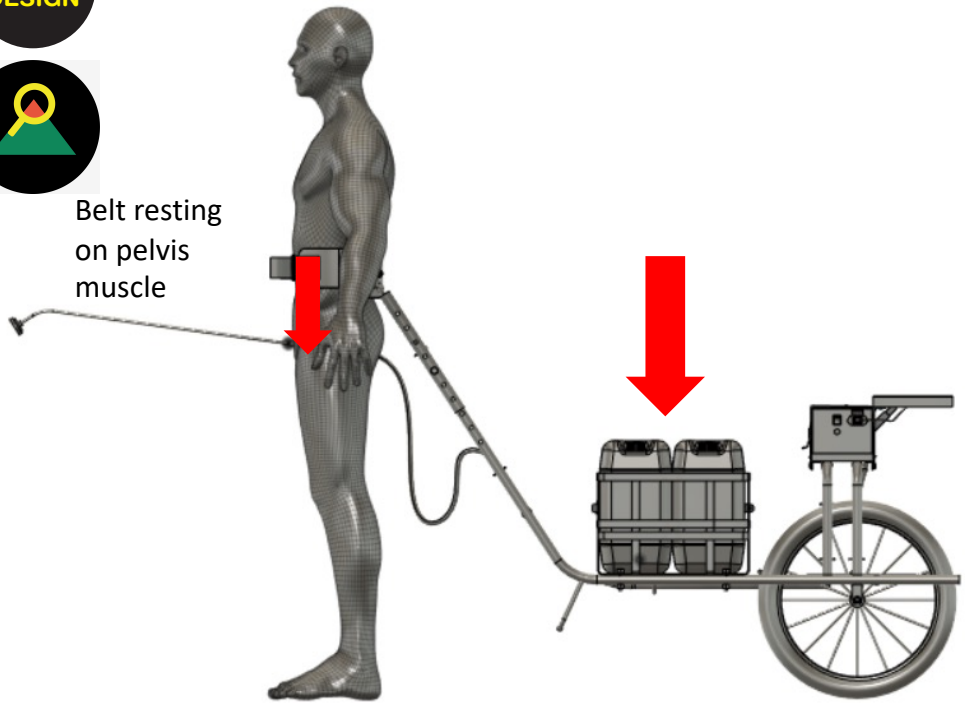
- Distributed load among waist and ground.
- Tank near body



- Two wheels for better stability.
- Two connecting pipe rods.
- Reduced water sloshing.
- Lighter tanks.

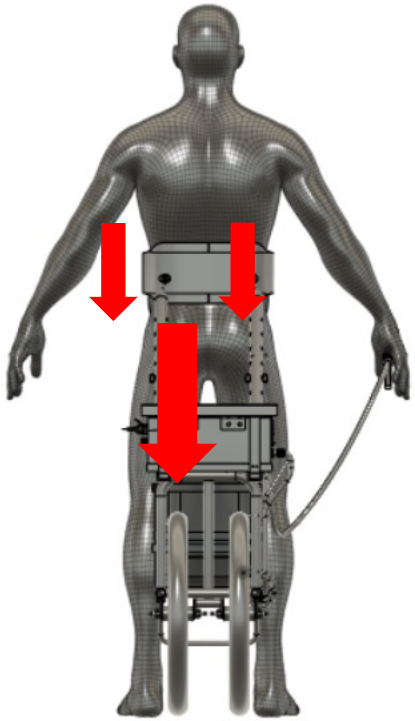
Revised design

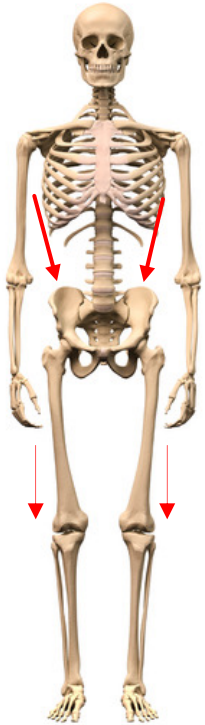
Belt resting on pelvis muscle



Distributed load on ground

Load distribution on bigger muscle and bone group





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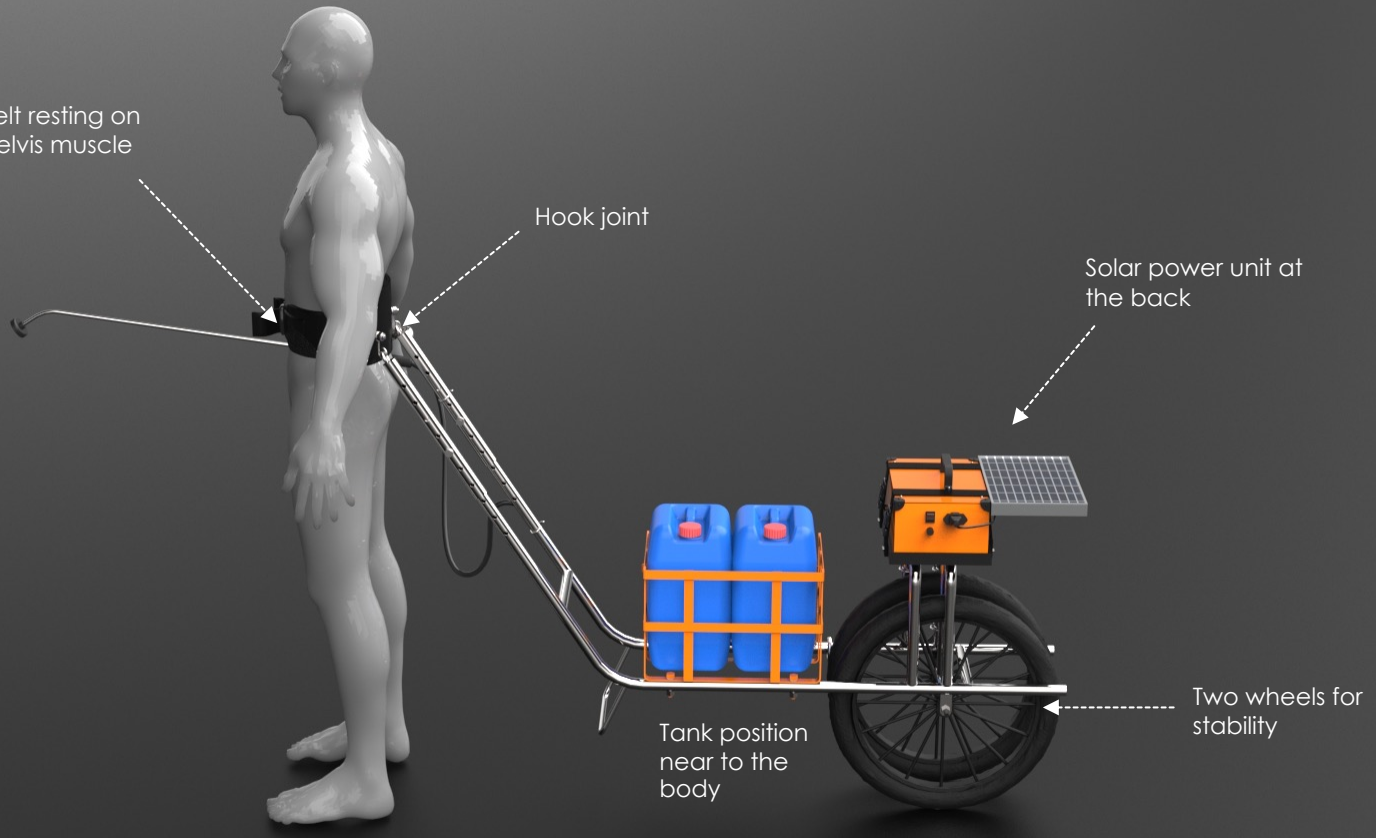


C4.1-035

Cost estimation

Material cost Rs: 5000 /-

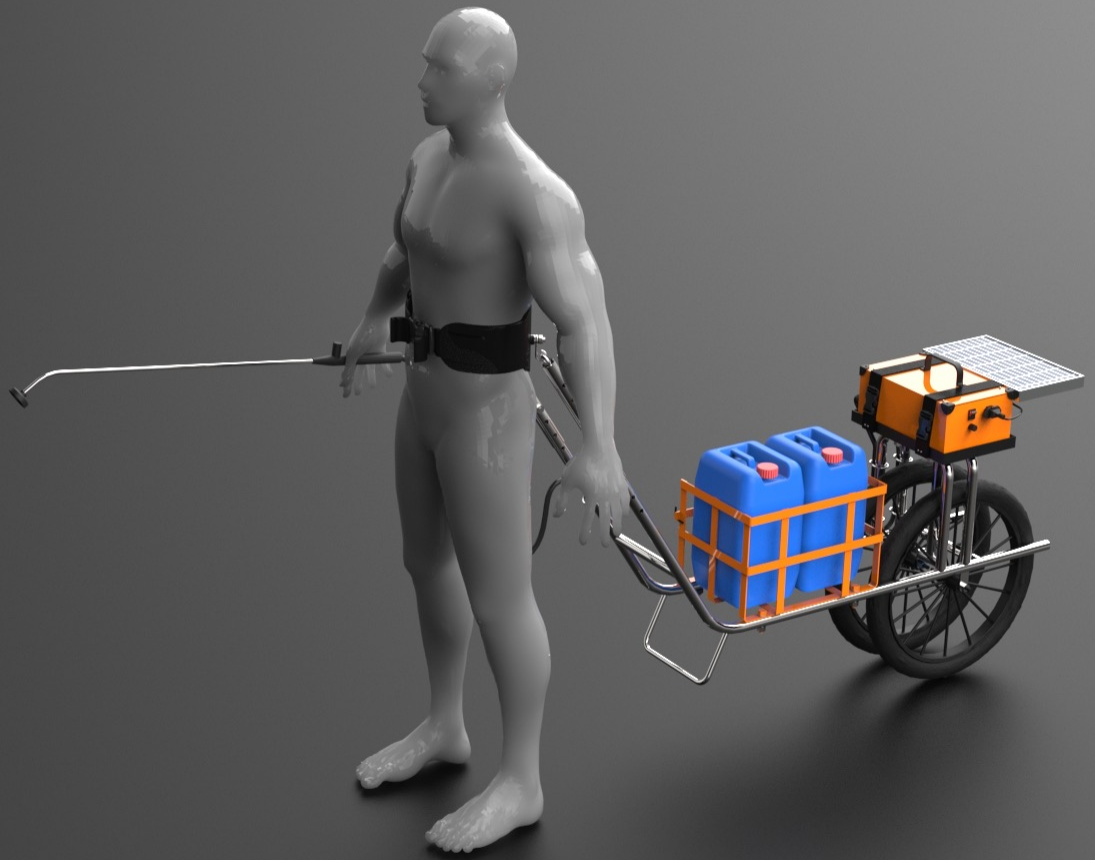
Material	Cost (Rs)
Tank	80/-
Stainless steel pipe	570/-
Valve	250/-
Belt	400/-
pump	400/-
Battery	800/-
Solar panel	700/-
Charger	200/-
Pipe, nozzle etc.	250/-
Tank Filter/ funnel	50/-
Wheel with rim	1200/-
Nut bolts	100/-

Objective check

- **Affordable** to the majority of small & semi medium farmers.
- **Easy to maneuver** between crop alleys sizes.
- Comparatively **effortless & comfortable to u**se than the existing knapsack sprayer.
- **Solar powered** automatic spray to reduce human efforts.
- **Multifunctional** with additional product value for farmers to increase the frequent use of the device.
- Able to **manufacture**, **maintain & repair at local level**.

Thank you

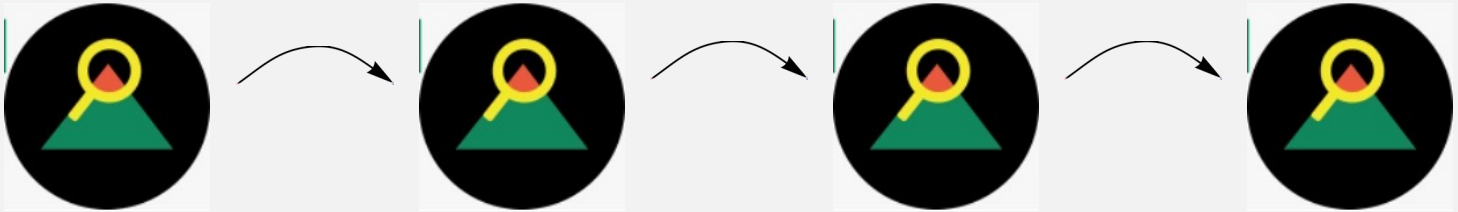
THINK!
DESIGN



Thanks for Listening

DT&I Case Study
Section: C4
Week 4

DT&I Case Study – Week 1-4:



Week 1

> Jellow Communicator (CD + IxD)

Week 2

> Smaran for the Elderly (PD + IxD)

Week 3

> Learning Culture through Stories (CD + IxD)

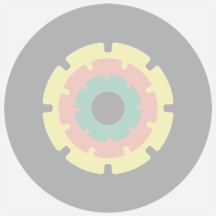
Week 4

> Solar Powered Pesticide Sprayer (PD)

DT&I Course – Week 4:

DT&I
Process
(20%)

> Secondary Research Part 2
> Understanding Users

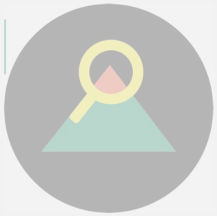


DT&I
Tools
(20%)

> User Participant Mapping

DT&I
Project
(50%)

> Secondary Research
> User Mappings



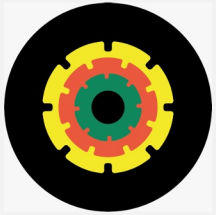
DT&I
Case Study
(10%)

> Case Study Project 'PD Project'

DT&I Course – Week 5:

DT&I Process
(20%)

> Primary Research
> Conversations
> Questionnaires
> User Narratives



DT&I Tools
(20%)

> Contextual Inquiry

DT&I Project
(50%)

> Primary Research
> Contextual Inquiry

DT&I Case Study
(10%)

> Case Study Project using Contextual Inquiry' – 'Smart Control for Bedroom'

THINK!
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Supporting Organizations:

D’source

D’source Project

Open Design School

MoE’s Innovation Cell

Credits:

Content:

Prof. Ravi Poovaiah

D'source Project

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Credits:

Mentor for Case Study Project:
Prof. Avinash Shende
Student:
Ajit Dhebe

Credits:

Camera & Editing:
Santosh Sonawane

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Credits:

Think Design Animation:
Rajiv Sarkar

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Credits:

Graphic Icons:
Shweta Pathare

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