

Industrial Design Project III

Low Cost Washing Machine for the Low Income Groups

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(2013-15)

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Approval Sheet

Industrial Design Project III

Low cost washing machine for low income groups

by **Naman S. Varma**

M. Des. Industrial Design 2013-15

is approved as partial fulfilment of requirement of post-graduate degree in Industrial Design.

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all the principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/ data/ fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date:

Acknowledgement

I cannot but acknowledge the unquantifiable help God gave me throughout this project work, always showing up whenever I got to the end of my line. I wish to express my deep gratitude towards Prof Ramachandran my guide & Prof. Kumresan my co guide without whom none of this would have been possible. Very soft spoken and always helpful, I learnt a lot from them. The project and the report, would be incomplete without thanking all IDC staff. I also express my thanks to my friends and family for their support .

- Naman S Varma

Sr PD

Content

1. Introduction	1
2. Motivation of the project	2
3. Initial Design Brief	3
4. Scope of the project	4
5. History of washing machine.....	5-6
6. Vintage product study	7-10
7. Existing product study	11-12
8. Innovative product study	13-14
9. Product analysis	15-21
10. Component Study	22-23
11. User Research	24-27
12. Clothes weight data	28-29
13. User behavior with respect to the machine	30
14. Observation	31-32
15. Survey	33-34
16. Overall research analysis	35-37
17. Activity analysis	38
18. Brake down analysis of the process.....	39
19. User statistics for slum areas in chembur	40-41
20. User statistics for slum areas in worli	42-43
21. Summary of user statistic data of slum dweller	44-45
22. Design hypothesis	46
23. Final design brief	47
24. User mind mapping	48-49

Content

26. Ideations (phase 1).....	50-60
27. Rig testing	61-65
28. Ideations (phase 2).....	66-69
29. Feedback on the Project Progress	70
30. Changes in the Project	71
31. Concepts	72-79
32. Concept Evaluation	80
33. Concept Evaluation Without Considering Weightage	81
34. Concept Evaluation Considering the Weightage	82
35. Study Model 1	83
36. Study Model 2	84
37. Ideas of making the Flywheel Mechanism Work	85-87
38. Form exploration (Phase 1)	88-89
39. Form exploration (Phase 2)	90
40. Form exploration (Phase 3)	91
41. Form Evaluation- User Research	92
42. Anthropometric Considerations	93-95
43. Final Form Refinement	96
44. Final washing machine (CAD Model)	97-98
45. Final washing machine (About the Product)	99
46. Final washing machine Detailing (CAD Model)	100-102
47. Bill of Material	103
48. Final washing machine (Engineering Drawing)	104-111
49. Branding & Logo	112-113
50. Cost Estimation of Prototype	114
51. Future Scope & Possibilities	115
52. Conclusion	116
53. Reference	117

Introduction

The Need

People all over not only desire but also need clean clothes. We can hope to reduce the time, effort and resources needed to perform these tasks by understanding local customs, practices, and geography, we can hope to fill the void and modernize an age old process for people who need it the most.

[1]“When companies design products and services for the poor, they often think about making them as low-cost as possible. But whether you’re tapping a market opportunity or addressing a social need, it’s important to realize that people living in poverty value quality design. Quality design doesn’t mean that goods and services need to cost more.”- IDEO.

Motivation of the project

Over the past few years the Income levels of the people have gone up substantially and the wealth effect has spread across the population. The emphasis has changed from just price consideration to design, quality, and trends. The desire to look and feel good is also a guiding factor for customers while making their purchase decisions. Washing machine is no longer a luxury appliance and is gaining ground as a utilitarian product for the rapidly growing middle class and increasing younger population. With their evolving lifestyles, consumers are warming up to the idea of purchasing home appliances with advanced features.

Initial design brief

To design a washing machine for the low income groups for individual household.

- Low-cost.
- Easy to use and maintain.
- Low water consumption.
- Low space utilization.

Scope of the project

The Indian market situation provides with a user group which has been unattended to with regards to laundry devices.

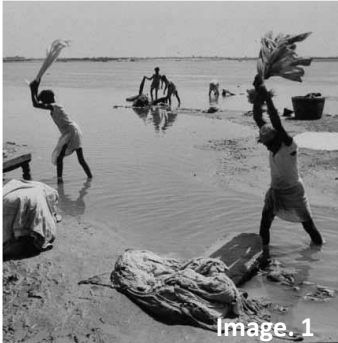
As a designer this gives an opportunity to produce a durable, simple, product as well as create jobs with an understanding of local materials and customs, to not only help the laundry process, but also affect the people.

Thus, designing a laundry device for a low income group user profile in the Indian market allows me to focus on solving life's daily problems for the people who need it the most.

OBJECTIVE :

- Study different scenarios in terms of domestic and commercial methods of washing clothes.
- Study further under each area, various socio economic sectors of people and activity mapping of their process of washing clothes.
- Understanding the difference in process/ steps in the various scenarios studied.
- Understanding of users in all dimensions of emotional, social, cultural and financial factors.
- Analyzing the observations, and finding insights from the same.

History of washing Machines



1400

In the early 1400's clothes were washed in the lake or river by beating the clothes on the stone in order to remove the dirt from them.



1797

A washboard was a tool designed for hand washing clothing. washboard is usually constructed with a rectangular wooden frame in which are mounted a series of ridges or corrugations for the clothing to be rubbed upon.



1851

The first hand powered washing machine with a drum was invented by James King. It was the 1st machine to use a drum and the concept was also patented



1861

The first clothes wringer was added to the washing machine. Wringer is an apparatus or machine for squeezing liquid out of the wet clothes, it consists of two rollers through which wet clothes can be squeezed.



1900's

Wooden wash tubs are replaced by metal tubs.

History of washing Machines



1907

Maytag Corporation began manufacturing a wooden-tub washing machine with a flywheel, still manually operated with a rotary handle.



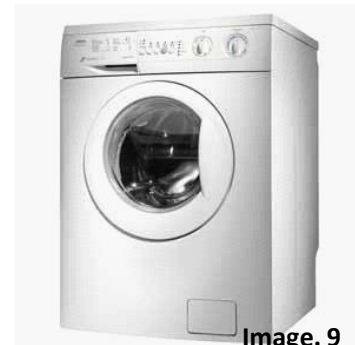
1908

The first electric washer was invented by Alva J. Fisher. This made the task of washing clothes easy.



1922

Maytag Corporation introduced the agitator system for moving the water around in the drum, rather than dragging the fabrics around in the water.



1947

The first top-loading automatic washing machines are introduced by the forerunner of the Whirlpool Corporation.

- 1911- Whirlpool Corporation, then called the Upton Machine Co. is founded in St. Joseph, Michigan and starts producing electric motor-driven wringer washers.
- 1915- The first electrical clothes dryers appear.
- 1930's- John W. Chamberlain of Bendix Aviation Corporation invents a machine that can wash, rinse, and extract water from clothes in a single operation.
- 1951- The first automatic washing machines are made in Europe. The first computer-controlled automatic washing machines appear.
- **Many technological advances follow. Among hundreds of systems tested, only two washing systems survive until this day: the agitator system and the tumbling system. Wash cycles and products are developed for new fabrics and a greater range of wash conditions**

Vintage Product Study

Washboard



A washboard was a tool designed for hand washing clothing. washboard is usually constructed with a rectangular wooden frame in which are mounted a series of ridges or corrugations for the clothing to be rubbed upon.



The washboard is made of wood. It has ridges and corrugations that helps in washing the clothes when they are scrubbed on it.



Step 1- The wash board is kept in a bucket or drum filled with water and detergent. Then the cloth that needs to be washed in dipped in the water.



Step 2- The cloth is manually scrubbed on the washboard to remove the dirt.



Step 3- after the dirt is removed by manually scrubbing, the cloth is then dipped in fresh water to remove the soapy water from it. Then the cloth is squeezed and put for drying on a clothes wire

Vintage Product Study

Metal wash tub with a wringer



Before 1900's only wooden wash tubs were used. Wooden wash tubs are replaced by metal tubs in 1900's. This particular machine had a metal tub with an attached wringer that helped in drying the clothes after they were washed by squeezing out water from them by putting them between two or more rollers.

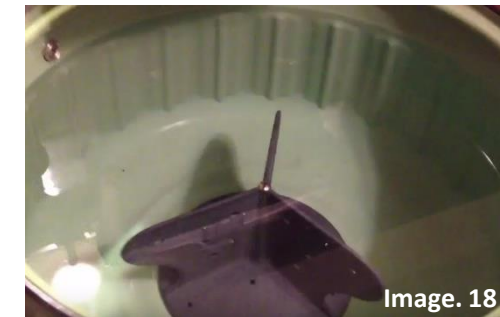
Tub:



Metal wash tub with wringer



The metal tub is filled with water and the detergent is added.



Pulsator inside the tub that helped in giving movement to the clothes inside the tub while they are washed for better cleaning.

Wringer:



The wringer consists of two or more rollers between which the clothes are passed in order to squeeze out all the water from it so that it can dry.



The washed cloth is passed between the rollers from one side.



The is removed from the other side after all the waters is squeezed out.

Vintage Product Study

Manually operated machine with a fly wheel



Image. 22

This is a wooden-tub washing machine with a flywheel, still manually operated with a rotary handle it also has a wringer attached.



Image. 22

Manually operated machine



Image. 23

The top lid of the wooden wash tub.



Image. 24

Flywheel is manually rotated which helps in washing the clothes inside the wooden tub.

Manually operated washing tub



Image. 25

This has a semi circular wooden washing tub with a swinging wooden part that has ridges or corrugation on it for the clothes to be rubbed upon for better cleaning.



Image. 26

The tub is filled with water and detergent then the clothes are soaked in the tub. After this the swinging wooden part is rubbed upon the clothes.



Image. 27

The swinging part has ridges on it which helps in the cleaning of clothes by removing dirt by the action of rubbing.

Vintage Product Study

Rapid Washer –Manual Hand Washing Machine



Image. 28

This non-electric washer uses minimal water and because of the agitation motion, less soap. The hand powered up and down plunger washer action uses the pushing and pulling of water through the clothes to get them clean without a lot of wear and tear on clothes or your hands. It has a plunger style funnel cone construction and it's durable.



Image. 29

Exploded view of the product



Image. 30

Rapid washer is a portable device. It can be used in any type of bucket or drum in which clothes are washed.



Image. 31

The bucket is filled with water and detergent, then the clothes are soaked into the water with the help of this rapid washer which helps in the cleaning the clothes.



Image. 32

Rapid washer while in use.

Existing Product Study



<http://tinyhouseblog.com/tiny-furnishings/tiny-washing-machine/>

This is a portable washing machine which enables you to use in places that don't have electricity. It is made of plastic with no mechanical parts, it is a hand powered washing machine. It can last a lifetime and requires no maintenance. Because this washing machine is so small, it's easy to store and move from one place to another.



<http://ibnlive.in.com/photogallery/7102.html>

Pedal operated washing machine.



<http://www.designwala.org/2011/12/designing-innovation-india-future-of-change-design-contest/>

Manual bucket washing machine which can be used by low income households to wash clothes efficiently without investing in an expensive washing machine that needs electricity to run.

Existing Product Study



Image. 36 <http://ecx.images-amazon.com/images/I/41HmxhuXG2L. SX342 .jpg>

Light weight yet sturdy manual clothes washer. Great for emergencies or everyday use. Great supplement to every day washing and cost saving. Excellent for Camping or boating trips. Uses less water and detergent than traditional washing methods.



Image. 37

https://www.engineeringforchange.org/news/2012/06/10/foot_powered_washing_machine_from_sketch_to_product.html

As a washing machine, this five-gallon bucket that spins on pieces of pipe. To operate it, the user straps two loops of rope onto his feet and moves his legs up and down. It's easy to make and easy to repair.



Image. 38

<http://inhabitat.com/human-powered-giradora-washer-needs-no-electricity-and-costs-only-40/>

This machine is a combination of a washer and spin-dryer that is powered by a foot pedal. The portable plastic tub can be filled with soap and water before a lid is placed on top, acting as a seat. Then, all the user needs to do is rest on the washer, and pump the spring-loaded foot pedal.

Innovative Product Study

Eco-laundry pillow



Image. 39

<http://www.trendhunter.com/trends/eco-friendly-laundry-pillow-detergent-free-washing>

Detergent free washing. The little ceramic marbles inside the wash pillow clean your clothes through movement instead of the traditional chemical way. Best of all, it's gentle enough to use on hand wash items, and at any temperature.

Orbital Washing Machine

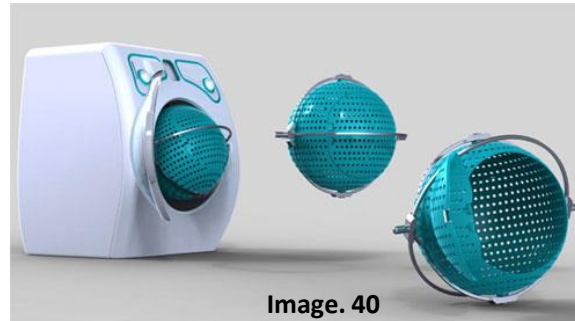


Image. 40

<http://www.designyourway.net/blog/inspiration/30-cool-high-tech-gadgets-to-give-your-home-a-futuristic-look/>

Orbital washing machine makes the washing process easy. With the incorporated basket one can load and unload the clothes in the washing machine easily. It has a innovative feature. The spherical drum is moving on two axes washing clothes better than the old washing machines that use only one axe.

Almighty Laundry washing machine



Image. 41

<http://fgadgets.com/future-gadgets/almighty-laundry-%E2%80%93-futuristic-washing-machine-by-won-suk-lee>

This machine tries to cut down a few steps in the washing process so that you can just load in a rack full of stale, stinky shirts and bring out a lineup of fresh no-ironing needed stack.

Innovative Product Study

Microwave washing machine



Image. 42

<http://www.trendhunter.com/trends/enee-microwave-washing-machine>

Microwave Washing Machine concept is a compact washer that uses microwave technology to not only wash clothes, but also to repair them. It has the ability to repair organic textile clothes by itself simply with the push of a button. Microwave Washing Machine is compact enough to fit in small, tight spaces.

Waterless Washing Machine



Image. 43

<http://www.trendhunter.com/trends/kai-onwave-waterless-washing-machine>

This washing system uses radical oxygen alongside the ultraviolet C-light to sanitize fabrics while they're being cleaned.

Crystal Ball Clothes-Washers



Image. 44

<http://www.trendhunter.com/trends/maglev-washing-machine>

This might just be the future for washing machines across the globe. Reducing the consumption of both water and washing liquid, it replaces the cylindrical drum with a spherical one that rotates around different axis by magnetic levitation.

The Hula Washer



Image. 45

<http://www.trendhunter.com/trends/hula-washer>

The Hula Washer takes advantage of a loophole. It presents the public with the opportunity to engage in eco-friendly practices with the benefit of becoming physically fit. This design requires you to insert your clothing, water and laundry detergent into a small opening in the big hollow ring. The power of your own gyrating movements will enable an intense spin cycle to spruce up your wardrobe and your physique.

Product Analysis

FRONT LOADING FULLY AUTOMATIC MACHINE:

BASICS

- A front loading washer consists of a drum that spins clothes with the help of an agitator.
- This setup is surrounded by a metal casing and controlled by a timer that cycles through the various portions of the wash, a regulator that stops the inflow of water and thermostat that regulates the temperature.
- A counterweight made of a concrete block typically, supports the entire drum and mechanism weight which is cantilever mounted.



Concrete counterweights



Drum



Counterweight supports at front of the drum as well



Entire mechanism is supported by springs on the top and a mount at the base

LOADING / UNLOADING

- On top loading washers, the door is placed above, which allows you to drop in a forgotten sock or fabric softener while the wash is in progress.
- Front loading washers feature doors that form a sealing wall at the front of the drum and hold in water, clothing and suds during a wash.
- For adequate sealing, the door in a front loader features a rubber gasket that forms a water tight barriers.

Image. 46- 49 reference : Author

Product Analysis

WATER CONSUMPTION:

- Front loaders only use enough water to fill the bottom half of the drum.
- Because the drum is horizontal, all clothes spend time on the bottom of the drum as they tumble.
- Top loaders, conversely, require enough water to fill the entire drum.

SPIN CYCLE:

- The clothes in a washer all require drying after the end of the cycle, but how much drying depends on the rate of spin the clothes are subjected to during the spin cycle of the wash.
- Top loading washers feature agitators that spin an average of 650 rpm.
- This pales in comparison to front loaders which can spin up to 1,000 rpm.



Slot to check the level of water



Side view of the machine

DETERGENT:

- Front loading washers require a high efficiency detergent, rather than the regular detergents.
- Because less water is used in a front load washer, normal detergent is often too powerful, creating too many suds for the washer to rinse off during the rinse cycle.
- The high efficiency detergent creates fewer suds and washes away completely at the end of a wash



Detergent drawers



Connections for control panel

Image. 50-53 reference : Author

Product Analysis

Construction of a front loading washing machine

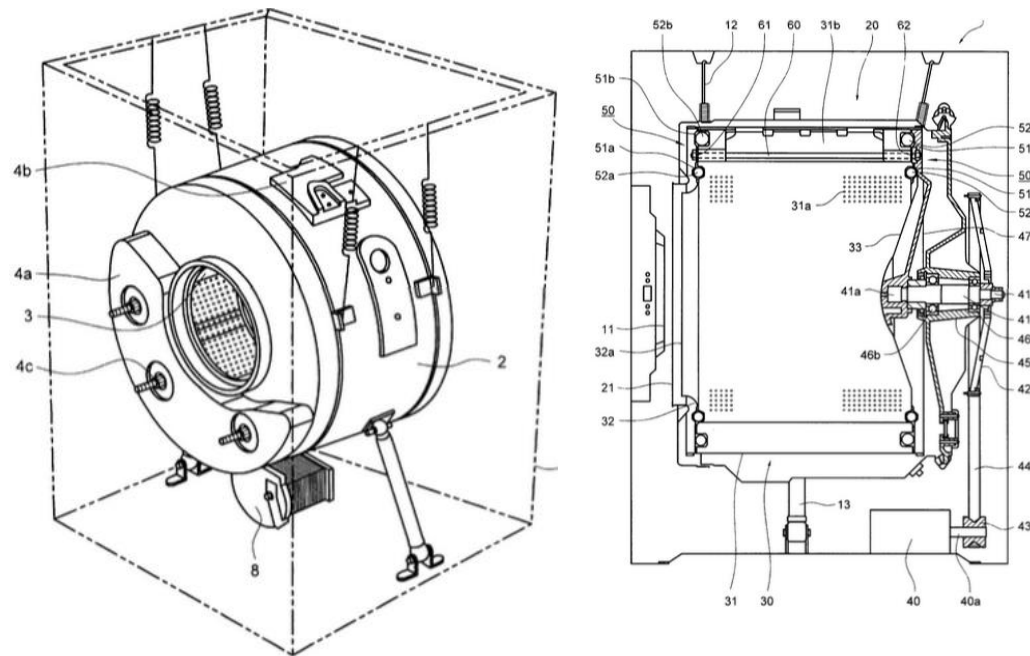


Image. 54

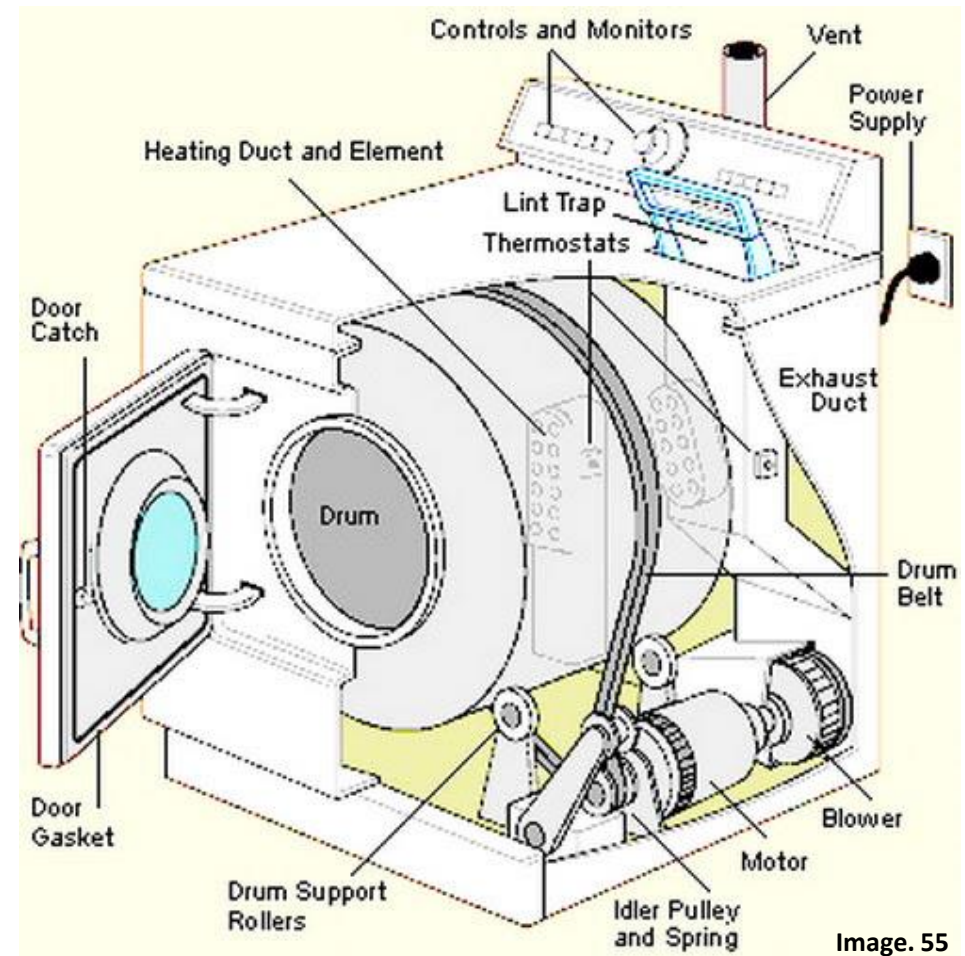


Image. 55

Product Analysis

TOP LOADING SEMI AUTOMACTIC MACHINE:

BASICS:

- A semi automatic washing machine, also known as a twin tub, has two sections a washtub in which laundry is agitated in soapy water and a spin dryer that is used for rinsing and water extraction.

FOR SETUP:

- The machine is positioned in front of the sink.
- The drain hose is hooked onto a faucet for water supply
- The washtub is filled with water and the machine is attached to the electricity supply.



Spin & wash tub

Image. 56

WASHING:

- Detergent is added to the water and the agitation system is briefly activated to dissolve this in the water.
- The laundry is placed in the washtub and the agitation system is again activated for the desired amount of time.

RINSING AND SPINNING:

- The washing is lifted from the washtub into the spinning drum. The suds are spun out of the washing and water is then poured on top of the load using the fill hose.
- This water rinses soap out of the clothes when the spinner is again activated. The process should be repeated until the water emerging from the drain hose contains no soap

Image. 56-61 reference : Author

- The load should then be spun until water ceases to emerge from the drain hose.



Image. 57

Connecting pipe to faucet, which will be placed in washer to fill the tub with water



Image. 58

Motor drive for spinning mechanism



Image. 59

Top loading action of semi automatics



Image. 60

Outlet pipe fixed to washer



Image. 61

Spinning drum

Product Analysis

WORKING:

- The pulsator moves in two directions
- Clockwise and anticlockwise
- Gear box helps in changing the speed
- Normal mode: pulsator moves in one direction for a short period of time, pauses for longer time for soaking action, resumes action in opposite direction.
- Strong / Heavy mode: pulsator moves in one direction for longer time, pauses for less time and resumes action in opposite direction.



Image. 62



Image. 63



Image. 64

Motor connected to a gearbox for reduction of gear ratio. The gear box is connected to pulsator via a belt pulley mechanism.

WASHER ONLY

- Works on a pulsator which is used for agitation
- Low duty machine
- Smaller in size
- Pulsator moves only in one direction
- Quality of wash is not great



Image. 65



Image. 66



Image. 67

Image. 62-67 reference : Author

Product Analysis

Construction of a top loading washing machine

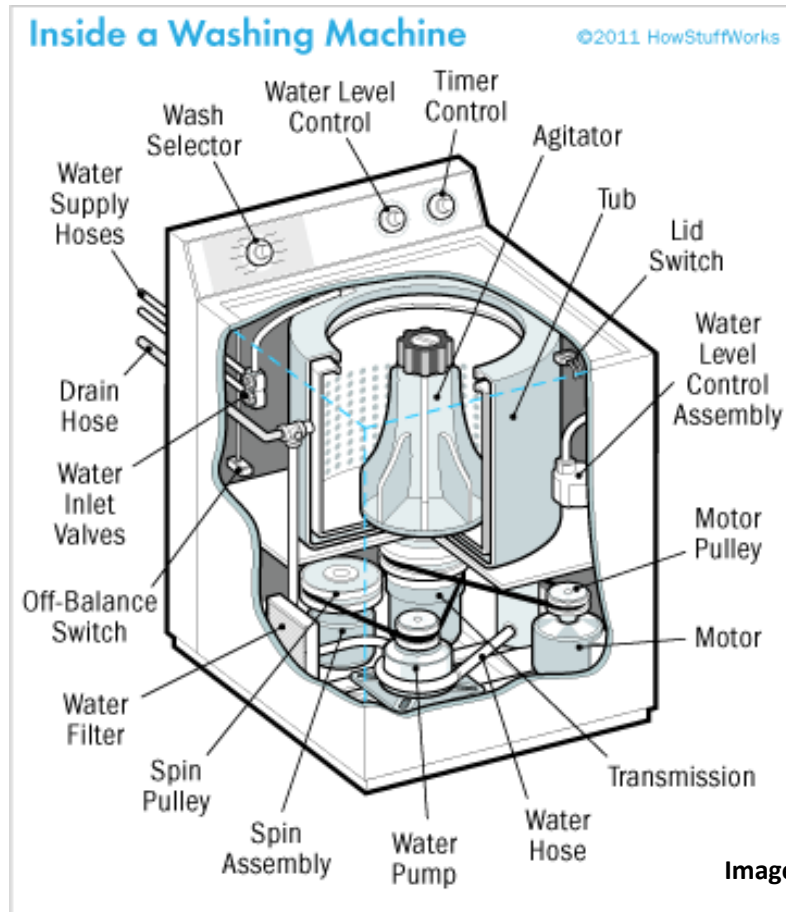


Image. 68

<http://s.hswstatic.com/gif/illustration-washer-repair-update-1a.gif>

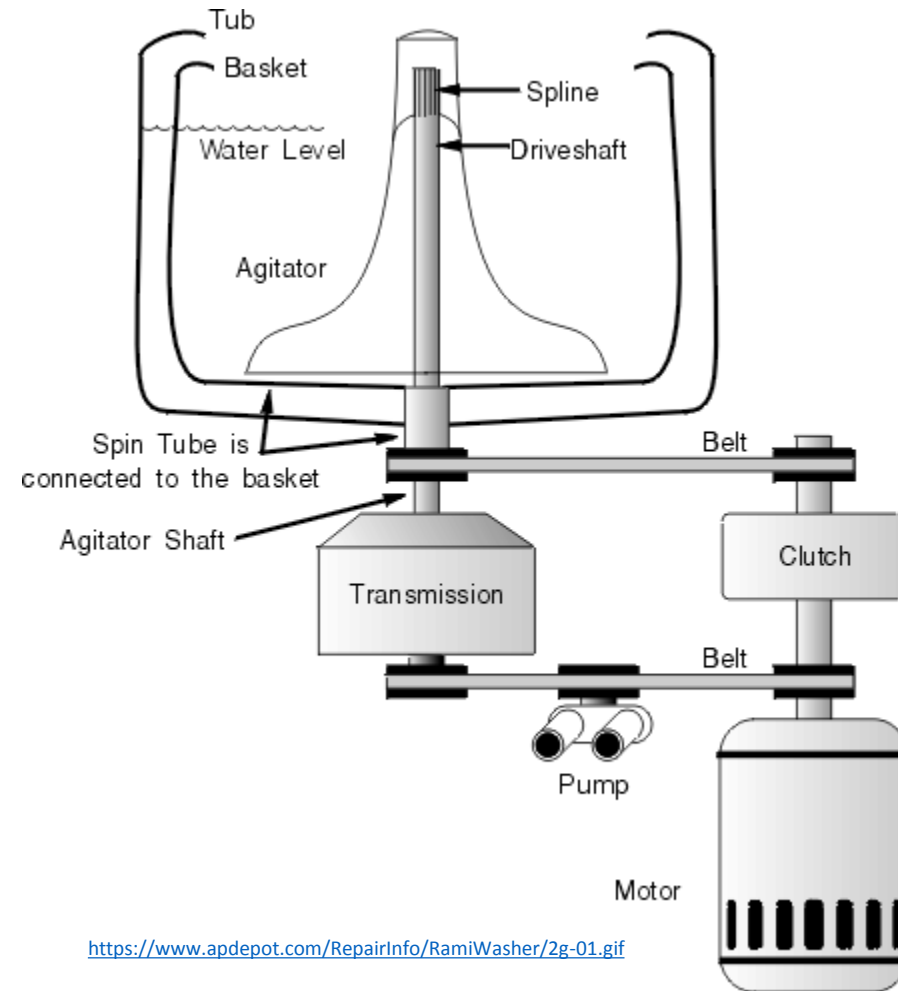


Image. 69

<https://www.apdepot.com/RepairInfo/RamiWasher/2g-01.gif>

Product Analysis

FEATURE BASED COMPARISON:

Feature	Semi automatics	Top loading agitator 	Top loading impeller 	Front loading
Capacity	4 – 8 kg	5.5 – 6 kg	5.5 – 10 kg	5 – 8 kg
Floor space req	Most (36" x 36")	Less (16" x 16")	Less (16" x 16")	More (16" x 18")
Wash quality	Average	Good	Good	Excellent
Delicate clothes (Wash quality)	Average	Get stretched	Good	Excellent
Wash cycle	Fastest	Fast	Fast	Slow
Hot wash	No	Few	Few	All
Portability	Yes	Yes	Yes	No
Water connection	Not needed	Required	Required	Required with some pressure
Water consumption	Less	More	More	Less

Component Study

PULSATOR (impeller type)

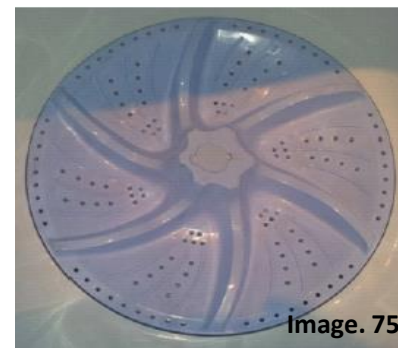
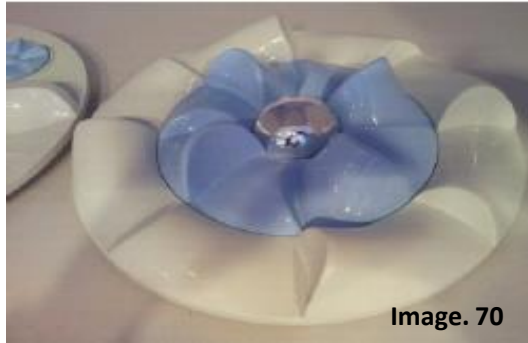


Image. 21-27 reference : Author

Component Study

CONTROL PANEL



LIDS

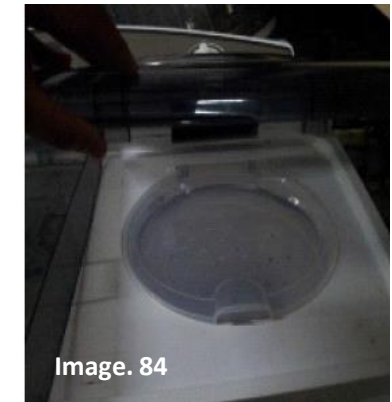
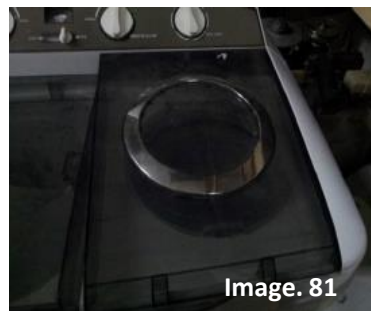


Image. 27-36 reference : Author

User Research

DOMESTIC WASHING SCENARIOS-LOW INCOME HOUSEHOLDS (CITY SLUMS)

USER GROUP CHARACTERISTICS:

- Low income
- Less supply of water (approximately 2 - 4 hours everyday)
- Timing of water supply may vary
- Electricity fluctuation
- Large families living in small houses
- Space constraints
- In large families the work may be distributed
- Accustomed to routine of performing daily household chores
- Orthodox thinking
- Not a very strong sense of concept of sharing
- Community style of living
- Lack of unity
- Storage of water in drums or big tubs with lids and is locked for safe keeping



Image. 85

65% Hand wash clothes
(as per user research)



Image. 86

35% Own washing machines
(as per user research)

Image. 85-86 reference : Author

User Research

HOW?

- Using a brush to scrub
- For rigid stains or extremely dirty clothes (children uniforms stained with mud), washing bats are used
- Tubs to soak clothes in
- Detergent (most commonly used: Ariel)
garment is stain free even though it may not be so.
- Manual rinsing is tiresome
- Washed and rinsed clothes are often placed on the bare ground due to lack of space (and probably not enough tubs)



Image. 87-92 reference : Author

User Research

HAND WASH

WHERE?

- Bathroom
- tiled porch outside the house
- On the ground/road

OBSERVATION:

- Washing clothes on the ground will not result in making them clean and germ free
- Since the ground cannot be cleaned by soap water.
- Wastage of water is incurred since the tap is always running through the entire process
- Strain is caused due to fatigue human activity done repeatedly over long periods of time
- Users tend to feel a personal satisfaction with hand washing
- This is because they can specifically concentrate on stained areas and scrub them well. This sometimes causes them to believe that the

Washing clothes in area outside the house, on the ground directly
In spite of having a machine, clothes are hand washed and machine is used only for spinning.

Washing clothes on steps outside house



Image. 93-96 reference : Author

User Research



Image. 97

Removing dried clothes of previous day from the clothes line and placing them on a chair

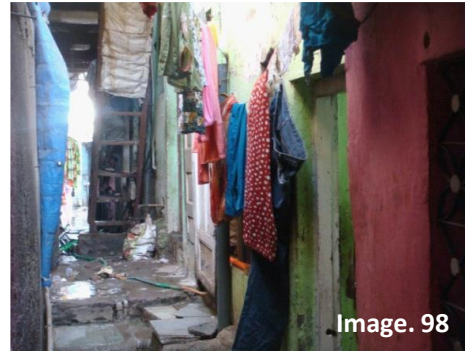


Image. 98

Clothes being hung to dry on clothes line in alley way, due to lack of proper space



Image. 99

Cleaning tub and filling it with water to begin process of washing clothes



Image. 100

Clothes are being washed in machine



Image. 101

Washing blankets

Image. 97-101 reference : Author

Clothes Weight Data

CLOTH WEIGHT CHARACTERISTICS

Measured	Cotton trouser (size 36)	500 gm
	Cotton shirt (full sleeves, size 42)	250 gm
Estimated	Sari	400 gm
	Salwar suit	600 – 750 gm
	Jeans / denims	650 -750 gm
	T shirts	200 gm
	Kurta pajama	600 gm
	Undergarments	200 gm
	Shorts	200 – 300 gm
	Bedsheet	400 gm (single, 750 – 100 gm(double)
	Bedcovers	1250 gm
	Curtains	1250 gm (full length)
Childs clothes	Shirt and pant	500 gm
	Undergarments, socks, handkerchief	400 gm

Source: Onida MIRC Electronics R & D

Clothes Weight Data

AVERAGE DAILY REQUIREMENT CALCULATION FOR A FAMILY OF 4 (2 ADULTS + 2 CHILDREN)

1 Adult Male	1 t shirt + shorts	450gm
	1 shirt + trousers	750 gm
	1 kurta pyjama	600 gm
	1 set of undergarments	200 gm
		= 2.25 kg (with 250 gm misc)

1 Adult Female	1 salwar suit	600gm
	1 sari (2 days)	350 gm
	1 night gown (2 days)	500 gm
	1 set of undergarments	200 gm
		= 1.75kg (with 250 gm misc)

1 Child	2 set shirts + pants	750 gm
	1 set of undergarments	150 gm
		= 1.1 kg (with 200 gm misc)

Therefore,

Family daily average = 5 – 5.5 kg

(Add on wt = 400 gm (towels, bed sheets etc)

Source: Onida MIRC Electronics R & D

User Behavior with Respect to the Machine

WHERE DO PEOPLE KEEP THEIR WASHING MACHINE?

- Inside/outside the house
- At entrance of the house
- In some houses, due to lack of space, machine is pushed under some table or other platform and is pulled out every time for use.
- Post machine rinsing and cleaning of clothes in fresh water happens outside the house (on porch or ground) or in the bathroom



HOW?

- If the machine is placed aptly as per length of pipe, then the pipe is put into the machine to fill it with water
- If the pipe does not stretch till the machine, then manually buckets/tubs of water are filled and emptied into the machine
- Detergent is added
- Machine is allowed to run its cycle
- Often washed clothes are removed from the machine and soaked once more into clean water for further cleaning
- These clothes are then either manually rinsed or put back in the machine for a spin cycle.



Image. 102-103 reference : Author

Observations

OBSERVATION:

- In one house, the outlet nozzle had a defect and a pipe could not be inserted into it. Hence, after the machine had run its cycle, the water would drain out from the open nozzle into the house directly. This requires unnecessary manual labor to clean the house there after using the machine.
- Often, households with large families, having semi automatic machines tend to wash the clothes by hand and use the machine only for spinning them.
- Due to space constraints inside the house, machines are placed outside the house.
- There is no sharing of ones own possession of the machine (not even amongst their own relatives)
- The machine users can't see the clothes being washed and specific stain areas being worked on. Thus, this leads them to believe that the machine doesn't wash well.
- Many users perceive that clothes coming from machine after wash are still soapy.
- So after machine wash they again wash the clothes with clean water and dry it manually.
- This not only increases manual labor, but causes excess (not required) water consumption.
- Some users, who own a washing machine, still prefer to wash their children's clothes by hand.



Image. 104 reference : Author

Machine is placed under a table and is pulled from there every time for use. This is due to lack of space in the house

Observations



Image. 105

Machine placed outside the house



Image. 106

Machine is placed on the upper level of the house. The outlet pipe is long enough for it to extend all the way outside the house to drain the gray water



Image. 107

Clothes are washed in the machine, rinsed again in clean water by hand, and then put in the machine again for a spinning cycle.



Image. 108

Image. 105-108 reference : Author

Survey

- If given an upgrade option between a hand washing station, special space dedicated to washing clothes, washing machine was given more preference.
- All users would want to own a machine.
- Effort applied is maximum while scrubbing the clothes to remove stains(either with a brush or in some cases with a bat) & squeezing out the water from the clothes.
- Users prefer hand wash over machine wash because they feel manual washing gives a better wash quality to their clothes as they can see the entire washing process that's done where as in the machine they are unable to see the washing process.
- They believe that machine cannot concentrate on all stains and areas on the garments.
- In spite of having a machine, most people still wash clothes by hand and only use the machine to spin clothes. For hand washing, all users would prefer any area where water comes with good force. Hence, they prefer bathroom, but they do not have 24 hours water supply, so they stored water in drums/buckets and then use that.
- Many times other house members are using the bathroom and hence clothes cannot be washed in the bathroom.
- Washing the clothes by hand would be a cost effective option which they would prefer.

During hand washing, there was excessive use of soap bars. Around 1 bar is consumed within 2 days for a family of 4 – 5 people.

Users that hand wash clothes, feel that a higher level of cleanliness is achieved with the use of more soap.

During machine wash, the force of water through the pipe is not heavy.

- Hence, many users prefer to fill buckets and empty them into the machine, since this can help them save time and also control the amount of water the machine uses.
- Many users had purchased their new machines, during exchange offers in the market.
- Such a locality (city slums) is a large community where people perform all activities such as washing clothes in the open.
- This is because of lack of space within each individual house.

Survey

Hence, any product/device/aid that they may use for the same needs to fit into this scenario.

Thus, such a product should give them comfort and an added sense of pride which will encourage them to use it in the public eye.

Houses which do not have attached toilets, use the system of Sulabh Shouchalya (common toilets)

- For this they either have to pay Rs2 or Rs5 every time that they wish to use the toilet.
- This would come up to Rs 11 to Rs 13 per day per user. In a family of 4 (average) it would be over Rs 40 each day. Hence, it is not affordable.
- Therefore, the users carry their own bucket of water whenever they need to use the toilet. This exempts them from paying for the same.
- However, if there was a way to get water supply in the toilets, without having to pay, all users will be ready to conserve water for the same.
- Hence, creating an awareness of water conservation, with an added incentive can be implemented in the product/aid.

Overall Research Analysis

BASED ON THE RESERACH FINDINGS, I DECIDED TO CHOOSE LOW INCOME HOUSEHOLDS

WHY WASHING MACHINE FOR LOW INCOME HOUSEHOLDS?

- The washing machine market in India is set for sustained growth over the long term, fuelled by favorable consumer demographics, availability of finance, and infrastructure development in rural areas.
- Several leading companies are now differentiating their products in areas of relevance to the changing aspirations and lifestyle of the consumers.
- Hence, the future of washing machine is on the verge of evolving from a mere utilitarian product to a truly energy efficient, well connected, and value added appliance.

UNDERSTANDING THE TARGET USER GROUP:

- The chosen User group has a monthly income ranging between Rs 6,000 to Rs 15,000
- Though most of India's population can afford a washing machine, only about 10% of all households own one.
- This is because all existing machines are dependant on electricity, space and permanent water supply to function well.
- Only about 20% of homes in major cities receive water 24 hours everyday. The rest of the homes receive water for a few hours everyday, or in some places only a few times every week.
- Washing clothes accounts to 22% of home water.
- Thus this creates a gap to be filled by introducing a machine which will consume as little water as possible without compromising on wash quality.
- A machine which will save space and is not dependent on running water to use.

Overall Research Analysis

WHAT THE USER WANTS?

- They need devices and systems to allow them to help themselves.
- They need quality products made of locally sourced materials and that are available at a low cost.
- Doing laundry manually is a time consuming and tiring task.
- The washer must ensure of water supply, soak clothes, scrub them by hand, wring the clothes out, carry the clothing back, and hang it out to dry.
- Often the clothes lose structural integrity due to these harsh washing habits.
- To design a laundry device that is not only functional, but also keeps the user in mind.

WHY DOING LAUNDRY IS AN ISSUE?

- Time consuming to fill water and entire process of washing drying
- Labor intensive due to heavy loads, bending, scrubbing, folding
- Resource reliant on water, bucketstubs and detergents / soap
- Damaging due to constant scrubbing and wringing. Hence, can ruin the fabric.
- Space dependent because hand washing requires sufficient space

Overall Research Analysis

CURRENT LAUNDRY CONDITIONS:

- ✓ Sufficient water
- Water supply for only 2 – 4 hours daily
- Most activities tend to be done with running water
- Storing of water for later use
- ✓ Cleaning sources
- Regular soap bar
- Sachets of detergents
- ✓ Agitation
- Scrubbing with a brush (manual)
- Scrubbing directly on the ground
- ✓ Drying
- Air drying on clothes line to extract excess moisture

➤ CHIEF CRITERIA:

PERFORMANCE CRITERIA:

- Odourless, spot stainless washing
- Agitate vs. over work clothing
- Uses motor less motion/ energy
- Cutting down on the time involved in the cleaning process

IDEAL LAUNDRY CONDITIONS:

- ✓ Sufficient water
- Dilutes the stain
- Best to pre treat the stain
- ✓ Cleaning sources
- Breaks the bonds between stain and the clothing
- ✓ Agitation
- Rubs the stain out
- Moves the clothe for flexing action
- ✓ Drying
- Extract excess moisture
- Ensures clean and fresh smell

COST CRITERIA:

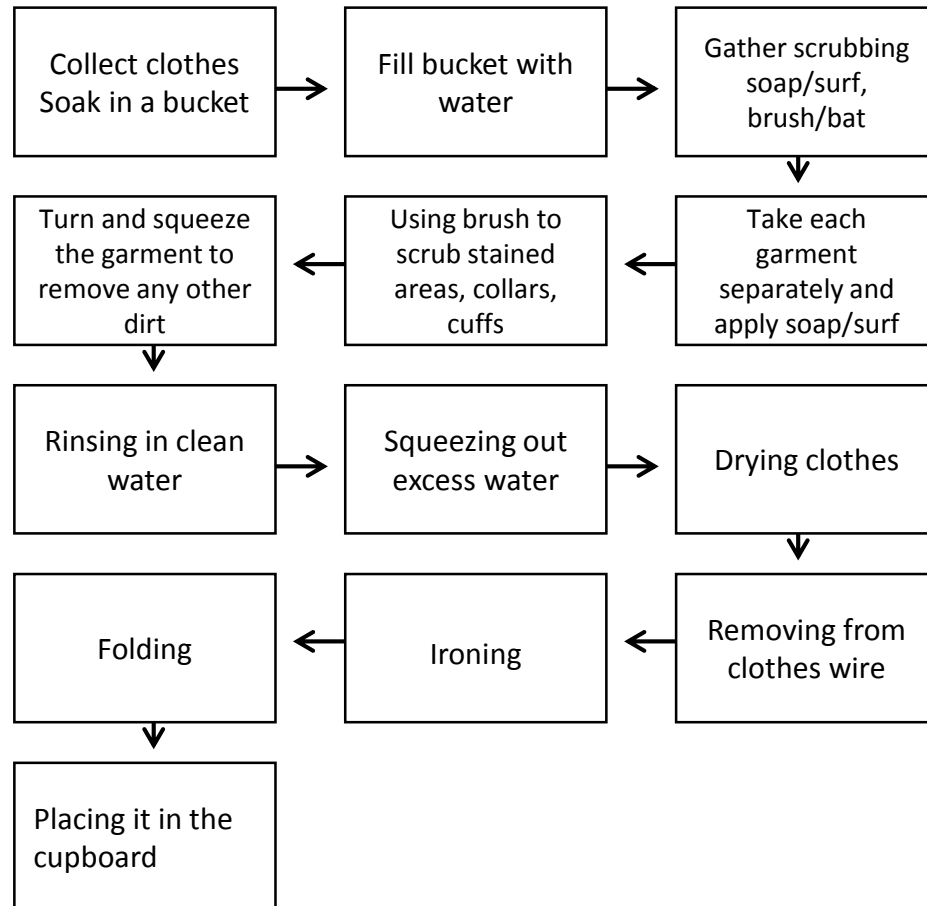
- Affordable to the user
- Not reliant on outside grants or aid
- Makeable locally, using repairable materials and parts

MARKET CRITERIA:

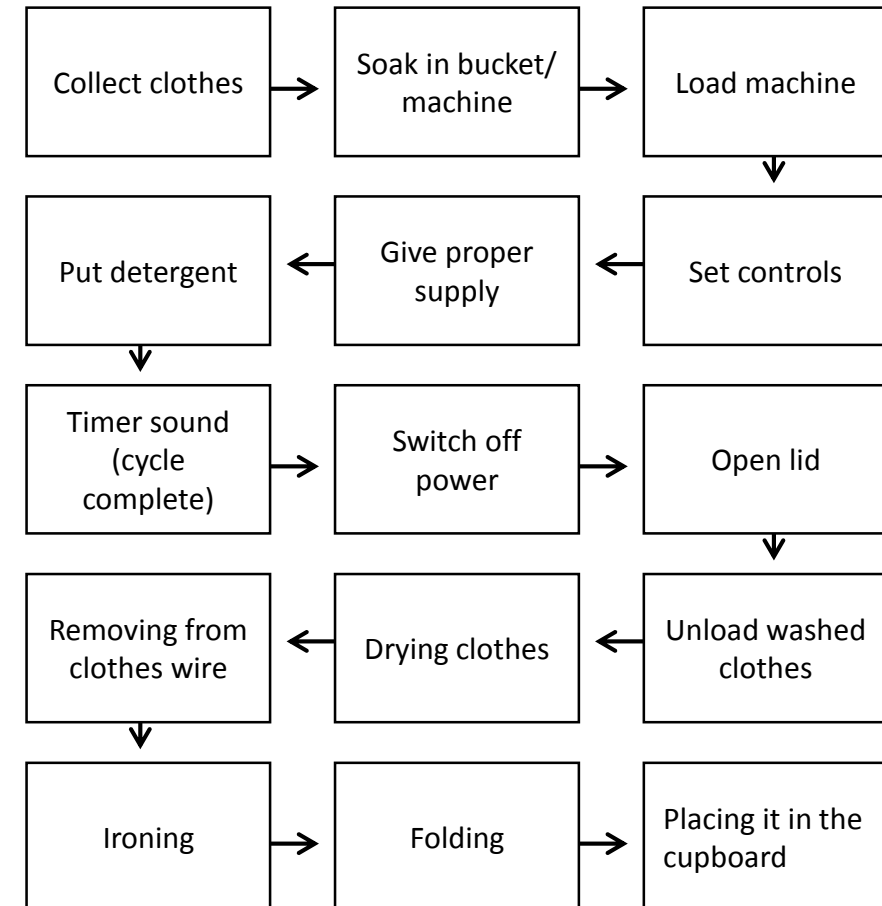
- People who desire washed clothing
- People who currently expend too much effort washing clothes
- Whole communities
- People without laundry devices

Activity Analysis

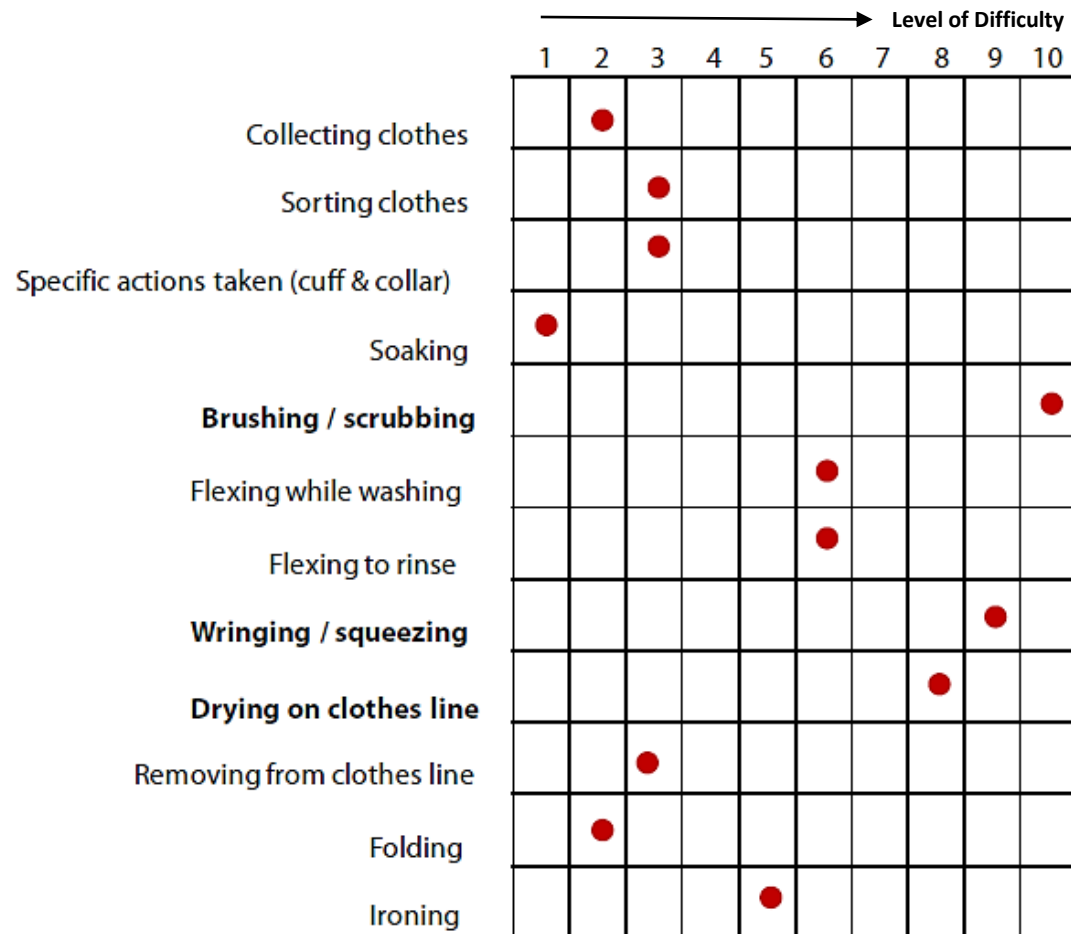
Washing clothes manually (by hand)



Washing clothes in a washing machine



Breakdown Analysis of the Process



MANUAL WASHING:

- Strenuous
- Manual fatigue
- Unhygienic
- Lack of space
- Process is not organized
- Consumption of water
- Unintentional water wastage
- Making it more than a mundane / routine task
- Enhance community style of living
- Ease of process
- Time consuming

MACHINE WASHING:

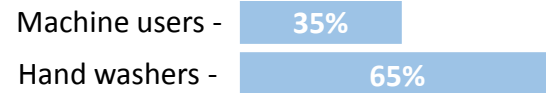
- Most users use machine only for spinning
- Speedy activity
- Saving space in homes where machine is placed
- Machine which offers optimum efficiency
- Common machine
- Tackle psychological issues of users regarding washing machine

User Statistic for Slum Areas in Chembur

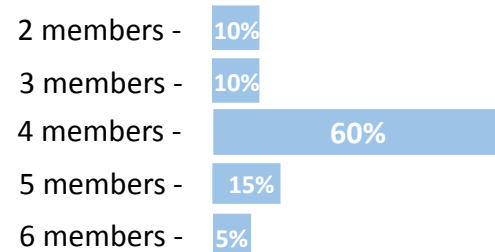
Target users- City slum dwellers.

Total no. of user- 20 users.

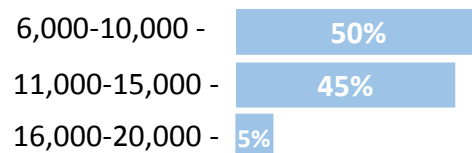
Users:



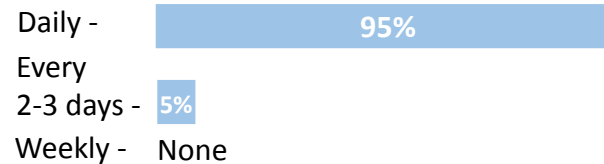
No. of members in the house:



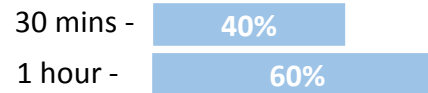
Family's monthly income:



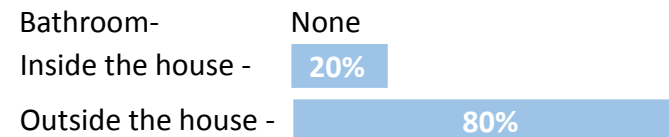
Frequency of washing clothes:



Time spend on washing:

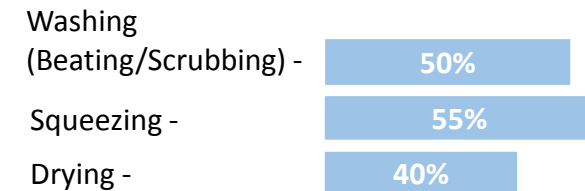


Where are the clothes washed:

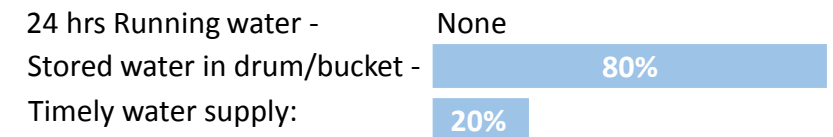


Most effort consuming activity:

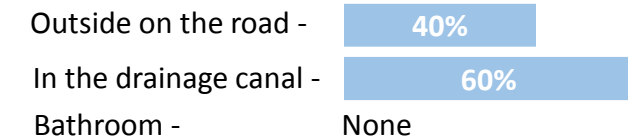
(Note - Since most of the users had selected more than 1 option in this category giving importance to all the selected options, the statistics of each option has been calculated individually.)



Water supply:



Drainage of grey water:



User Statistic for Slum Areas in Chembur

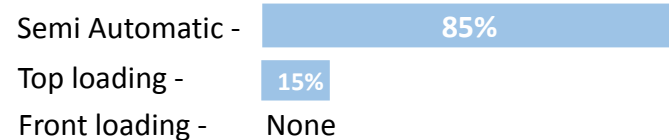
Target users- City slum dwellers.

Total no. of user- 20 users

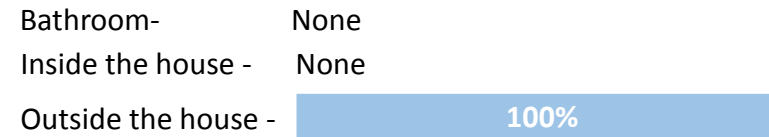
Total no. washing machine of user- 7 users

(**Note** - this statistics has been calculated only from the data collected by the 7 machine users out of the total no. of 20 users)

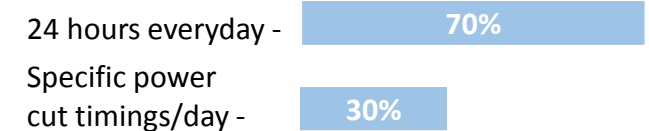
Type of machine owned:



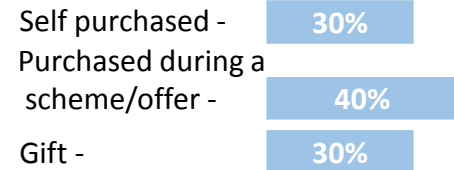
Placement of the machine:



Electricity supply:

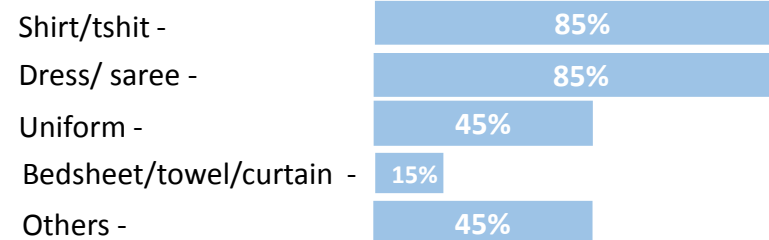


Purchase decision of the machine:



Types of clothes mainly washed in the machine :

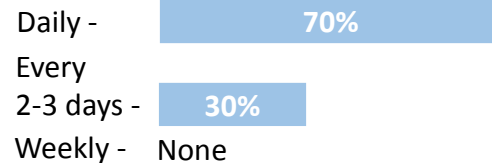
(**Note** - Since most of the users had selected more than 1 option in this category giving importance to all the selected options, the statistics of each option has been calculated individually.)



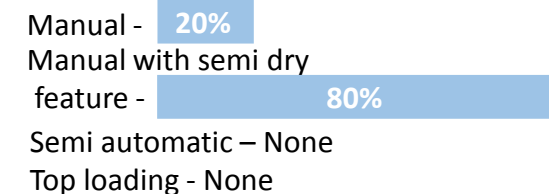
Machine user problems:

- Space constraints
- Affordability
- High maintenance
- Water wastage
- Hike in Electricity bill

Frequency of washing clothes in the machine:



Desired machine for both manual & machine washers:



User Statistic for Slum Areas in Worli

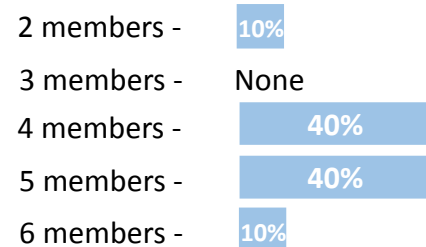
Target users- City slum dwellers.

Total no. of user- 10 users.

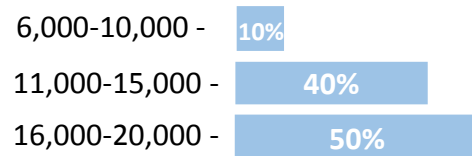
Users:



No. of members in the house:



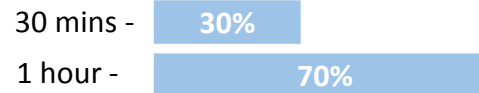
Family's monthly income:



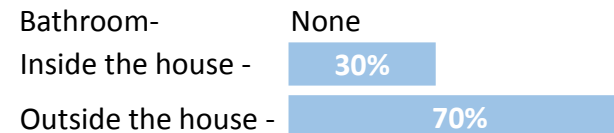
Frequency of washing clothes:



Time spend on washing:

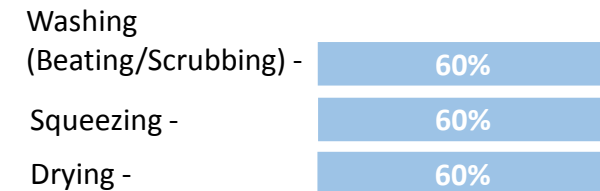


Where are the clothes washed:

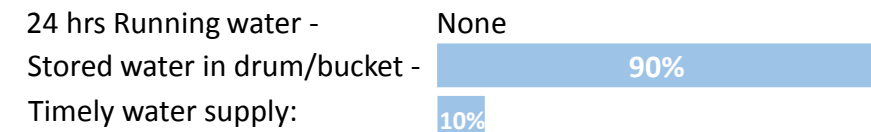


Most effort consuming activity:

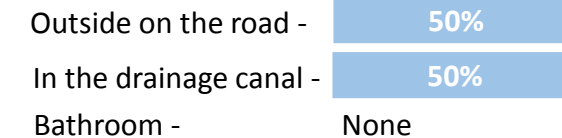
(**Note** - Since most of the users had selected more than 1 option in this category giving importance to all the selected options, the statistics of each option has been calculated individually.)



Water supply:



Drainage of grey water:



User Statistic for Slum Areas in Worli

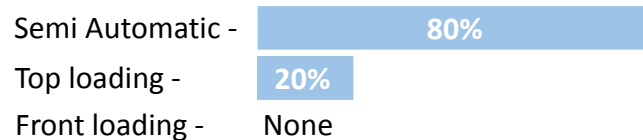
Target users- City slum dwellers.

Total no. of user- 10 users

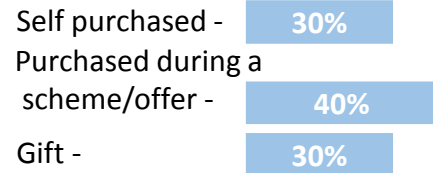
Total no. washing machine of user- 6 users

(**Note** - this statistics has been calculated only from the data collected by the 6 machine users out of the total no. of 10 users)

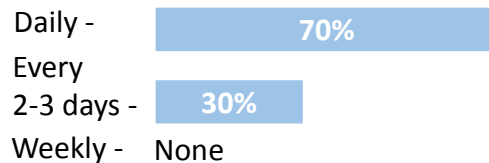
Type of machine owned:



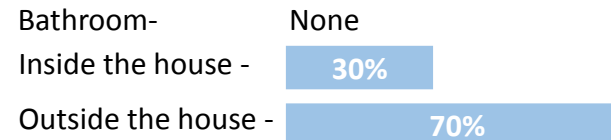
Purchase decision of the machine:



Frequency of washing clothes in the machine:

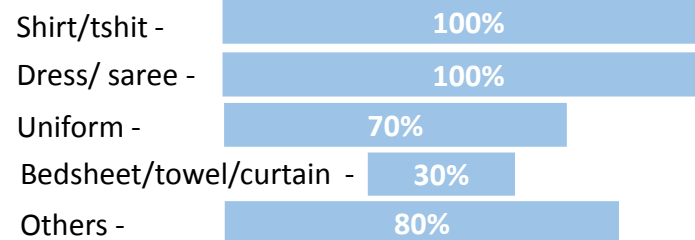


Placement of the machine:



Types of clothes mainly washed in the machine :

(**Note** - Since most of the users had selected more than 1 option in this category giving importance to all the selected options, the statistics of each option has been calculated individually.)



Electricity supply:

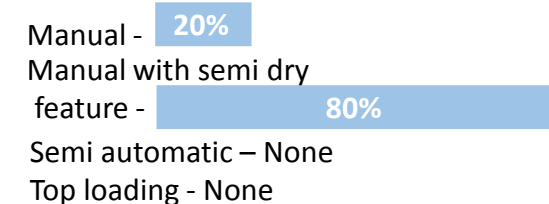
24 hours everyday with specific power cut timings/day -

100%

Machine user problems:

- Space constraints
- Affordability
- High maintenance
- Water wastage
- Hike in Electricity bill

Desired machine for both manual & machine washers:



Summary of the User Statistic Data of the Slum Dwellers

- **Target users-** city slum dwellers.
- **Total no. of user-** 30 users.
- **Income group-** 10,000 – 15,000
- **No. of members** - 5 to 6
- **Frequency of washing clothes-** daily
- **How is the washing done?** - mostly manually
- **Where is the washing done?** - in the small place outside the house
- **Time spend on washing-** 1 hour
- **Most effort consuming activities (in order of effort)** – squeezing, washing (scrubbing, beating), drying
- **No. of users who own a machine-** 13
- **Type of machine owned-** semi automatic
- **Types of clothes washed mainly-** shirt/tshirt, dress/saree, uniform, others
- **Quantity-** 6 kgs.
- **Placement of the machine-** outside the house
- **Water supply-** stored water in drums/buckets
- **Electricity supply-** irregular (24 hours with frequent powercuts)

Summary of the User Statistic Data of the Slum Dwellers

- **Non machine users main reason for not buying a machine-** space constraints, affordability, myths such as machine use leads to wastage or more water and hikes their electricity bill.
- **Machine user problems-** space constraints, high maintenance of the machine, wastage of water and electricity
- **Desired machine-** manual machine with semi dry feature.

Design Hypothesis

- Need for devices and systems to allow users to help themselves.
- Need for quality products made of locally sourced materials and available at a low cost.
- Doing laundry manually is a time consuming and tiring task.
- The washer must ensure of water supply, soak clothes, scrub them by hand, wring the clothes out, carry the clothing back, and hang it out to dry.
- Often the clothes lose structural integrity due to these harsh washing habits.
- To design a laundry device that is not only functional, but also keeps the user in mind.
- There is an unfair divide between laundry devices and services amongst people of various socio economic strata.
- Despite this difference, all people still desire and need clean clothes.
- We can only hope to reduce the time, effort and resources needed to perform these tasks.
- By understanding local customs, practices, and geography, try to fill the void and modernize an age old process for people who need it the most.

WHAT WILL BE DESIGNED?

- A device which will simplify process of washing clothes.
- It can be a machine or a washing device as well.

WHAT WILL BE ITS NATURE?

- The device will be easy to use, space conserving, water and electricity efficient.
- It will encourage people to use it and make the process of washing clothes more than just a mundane activity.
- It will be made for a specific user group (city slum dwellers), keeping in mind their behavioral, lifestyle and other aspects in mind.

WHO WILL IT BE FOR?

- The end user is a female living in a low income household.
- This household is situated in a city.
- Washing clothes is a part of her daily chores.
- Machine is not there since they cannot afford its buying cost and/or life cycle cost.
- Hand washing is done in uncomfortable spaces.

- Upliftment of the females of such houses. To help them understand and use machines/modern devices better.

WHY IS IT NEEDED?

- Hand wash – inadequate space, lack of hygiene, usage of water, time spent, manual fatigue caused.
- Machine wash – cannot afford a machine, difficulty of use, lack of trust on device, electricity consumption.
- It will do away with problems such as space, water and electricity
- It can also act as additional income source for people in that community.

Final Design Brief

To develop a Low cost washing machine or a cleaning device for the low income user group (city slums), which is portable, involves low water consumption, conserves space & is easy to maintain

ESSENTIALS:

- Stored water consumption
- Less power usage/Manual operation
- Space efficient
- Low affordability for low economic groups
- Portable
- Low cost operation

User Mind Mapping

Factors that affect washing clothes in a low income household:

- Economic
- Behavioural
- Lifestyle
- Cultural
- External
- Circumstantial
- Social
- Personal

ECONOMIC FACTORS:

- Cost effectiveness
- Low income
- Male working members
- Base of pyramid
- Low affordability
- Self sufficient environment
- Increase in standard of living
- Upliftment
- Low buying power
- Decision maker is male member of family
- Low power consumption

BEHAVIOURAL FACTORS:

- Mental blocks
- Old school techniques
- Orthodox
- Water consumption
- Unintentional wastage of water
- Apprehensions
- Machine needs to be supervised
- Time wastage
- Running water activities
- Routine

LIFESTYLE FACTORS:

- Extensive
- Time consuming
- Manual labor
- Large family strength
- Small children
- Mandatory tasks
- Distribution of chores
- Daily washing of clothes
- No attached toilets

CULTURAL FACTORS:

- Traditional methods
- Hand washing
- Personal satisfaction
- Kurtas and saris
- Household chores - female duties
- Stain prone
- Low ownership of garments
- Low acceptance towards new methods

EXTERNAL FACTORS:

- Social atmosphere
- Possession
- Peoples opinions
- Doing tasks the way everyone else does them
- Boastful
- Pride of ownership
- Community living
- Weather conditions
- Privacy

User Mind Mapping

CIRCUMSTANTIAL FACTORS:

- Limited water supply
 - Storing water
 - Faulty electrical connection
 - No judgment of consumption
 - Space constraints
 - Habitual
 - Accustomed over period of time
 - Reuse of grey water.
- Multiple tasks (multi tasking)
- Hygiene
 - Routine
 - Mundane nature of tasks
 - Stain removal
 - Urgency of certain type of garments (uniforms)
 - Fatigue
 - Seeing is believing

PERSONAL FACTORS:

- Visual interaction
- Cleanliness
- Intensive manual work
- Multiple tasks (multi tasking)
- Hygiene
- Routine
- Mundane nature of tasks
- Stain removal
- Urgency of certain type of garments (uniforms)
- Fatigue
- Seeing is believing

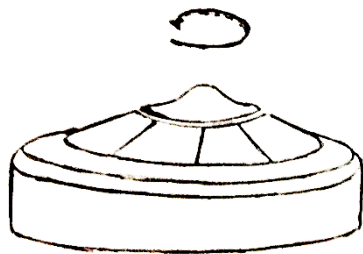
SOCIAL FACTORS:

- Pride
- Maintaining standards
- Competitive
- Involuntary sharing of things
- Unfriendly relations within community
- Open activity
- Task carried out in public eye
- Possessive

Ideations (Phase 1)

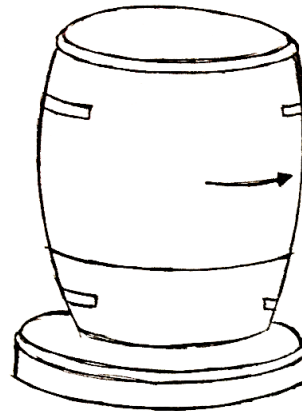
1) ABOUT:

- Power driven by hand or foot
- Angular loading unloading to enable. Handle or crank to rotate the base wheel (chain drive, belt drive, rope drive)

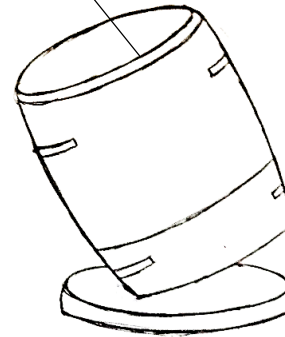


- Pulsator box contains gear box drive mechanism.
- This gear train rotates pulsator wheel in clock wise direction when base wheel rotates in anti clock wise and vice versa.
- The base wheel can be driven by hand or foot

Manually powered by hands or feet- mechanically driven machine

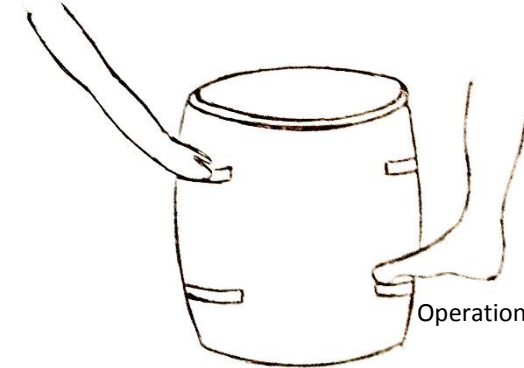


Tilting of machine for easy loading and unloading

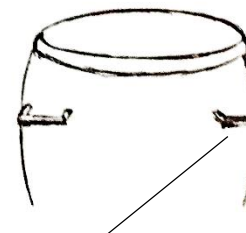


- Spin machine in displayed direction.
- It will retreat motion with speed reduction, causing agitation through pulsator.
- Repeat pulsator in the opposite direction (as displayed)

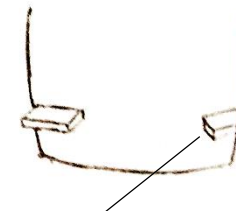
Hand operation



Operation by foot



Protrusions for hand operation

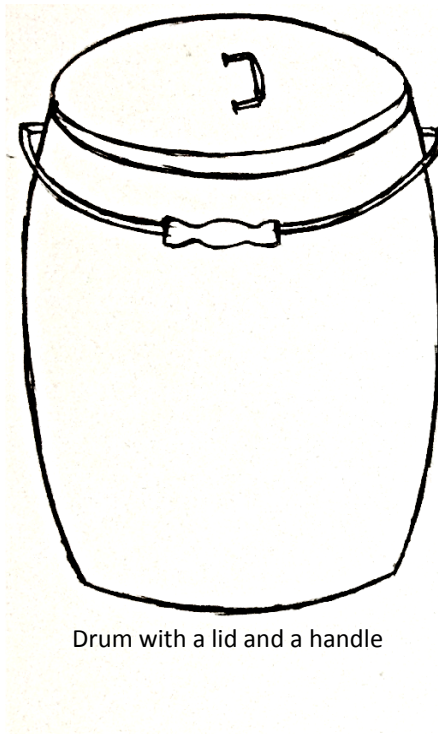


Protrusions for foot operation

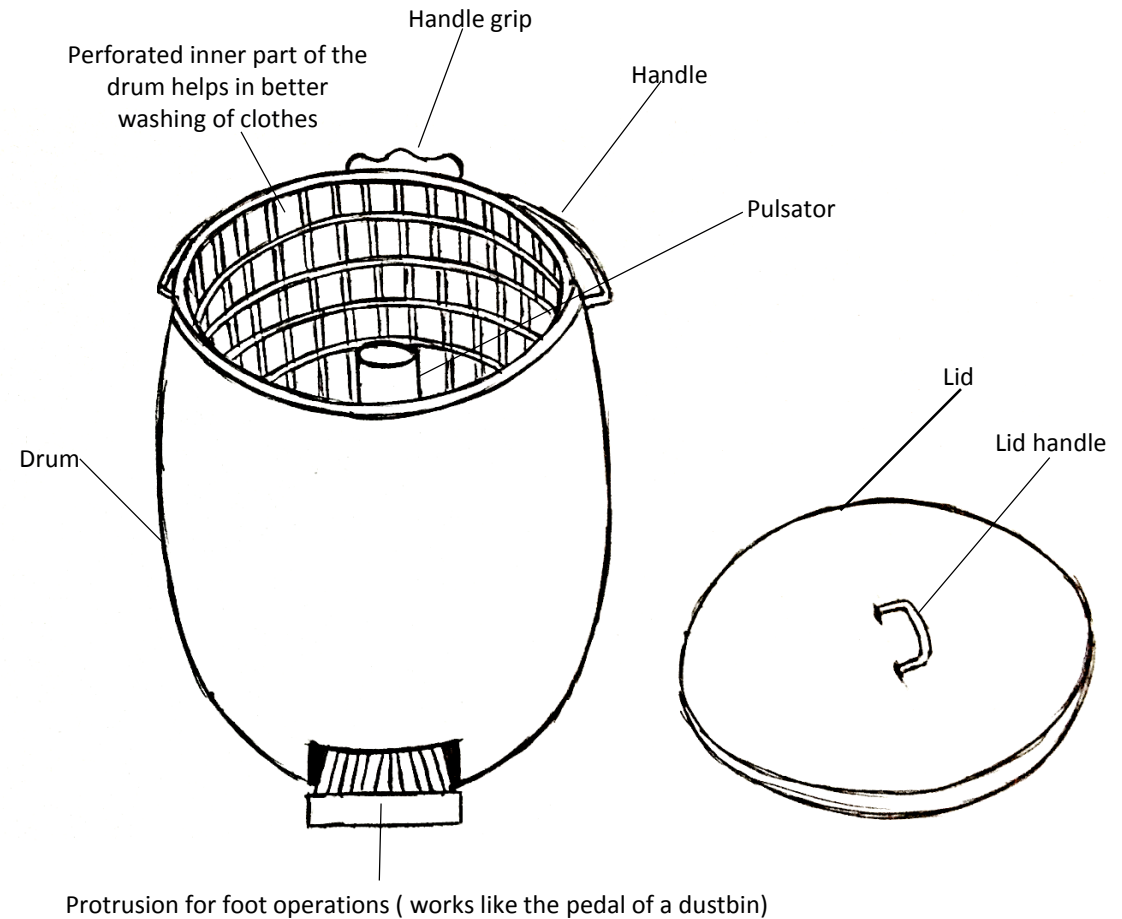
Ideations

2) ABOUT:

- Power driven by foot
- Easy working and can be easily carried and kept anywhere



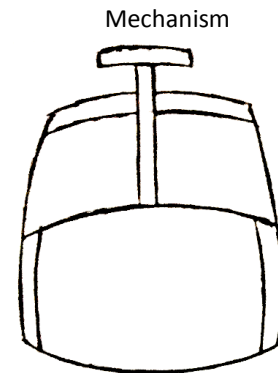
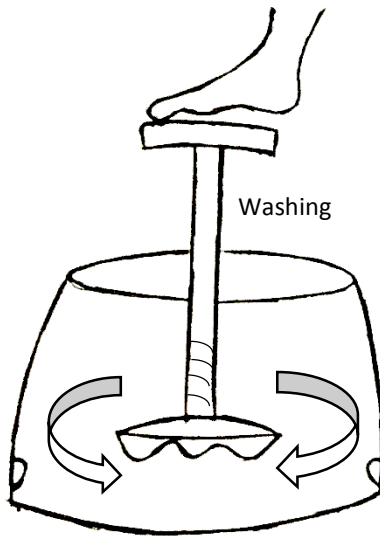
Drum with a lid and a handle



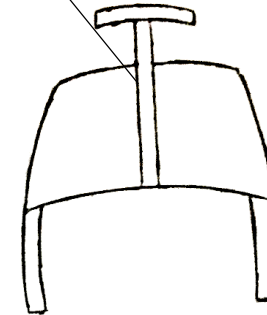
Ideations

3) ABOUT:

- Plunging or compressing mechanism used to remove excess water.
- The plunging action is done manually.



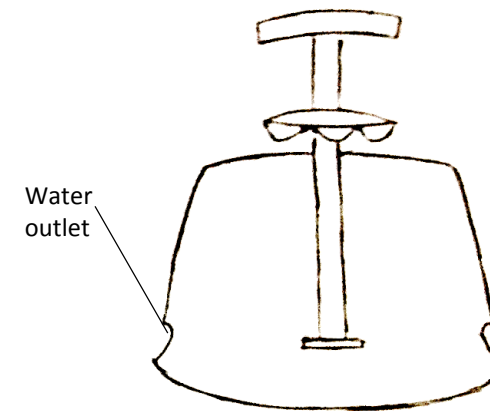
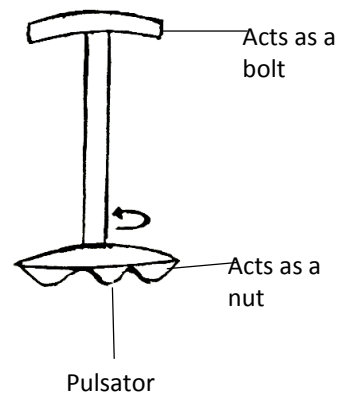
Shaft for compression



Detachable drum



- Foot pressure to move agitator into place.
- After the cycle the shaft retreats back upwards.
- Spinning is done by foot pressure, which will press the shaft into the drum and squeeze out the water from the outlets on the lower sides

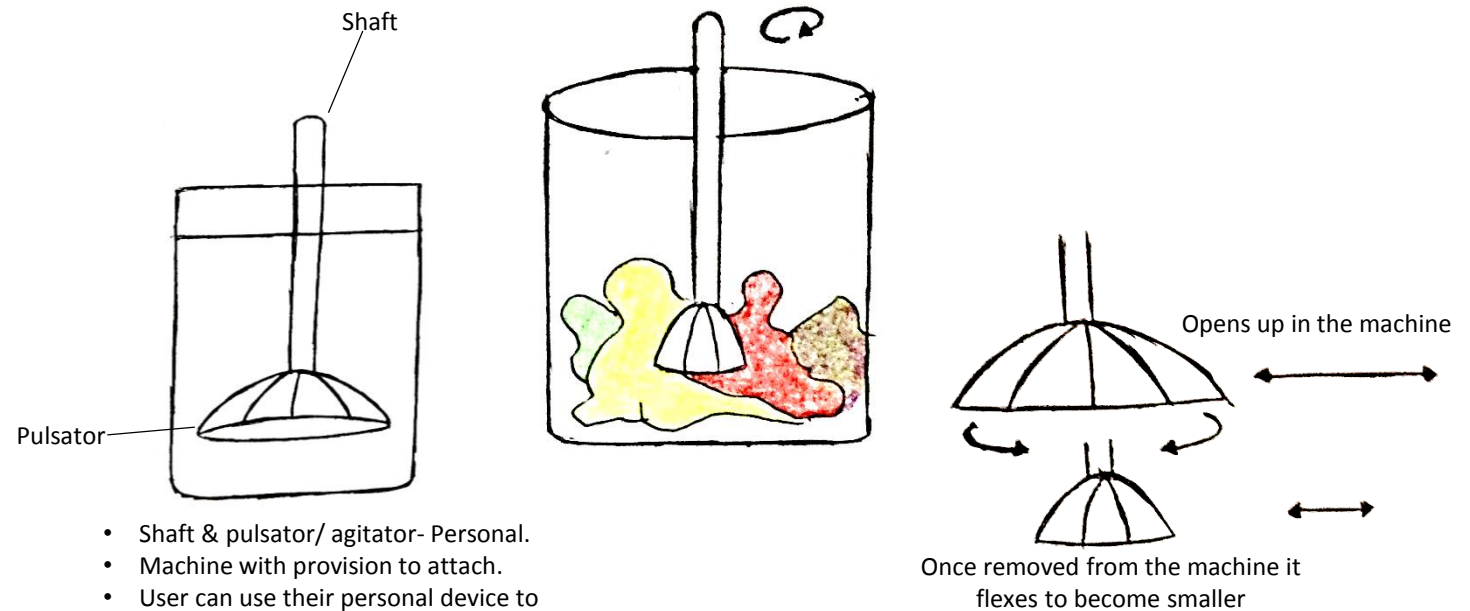


Pulsator moves up after the was cycle is over

Ideations

4) ABOUT:

- Removable pulsator which can be attached to be driven by motor
- Incase of no power availability, the pulsator can be driven manually



- Shaft & pulsator/ agitator- Personal.
- Machine with provision to attach.
- User can use their personal device to soak & agitate the clothes in a regular bucket.
- Once the user fixes the device into the machine, it will start running.

Ideations

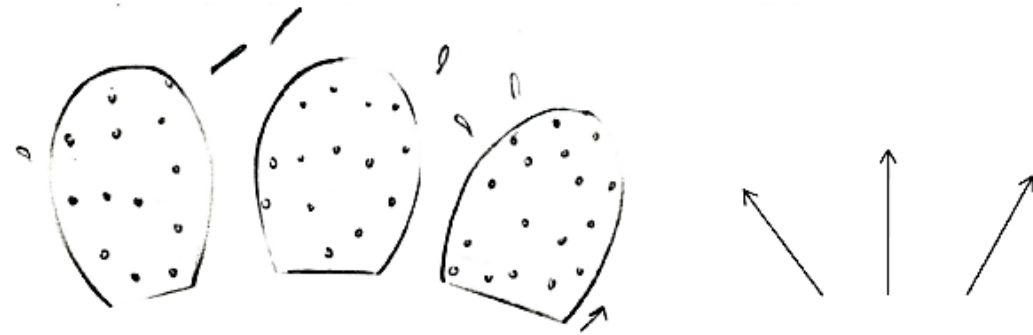
5) ABOUT:

- Various ways of spin drying clothes
- Different possibilities of powering a spin dryer

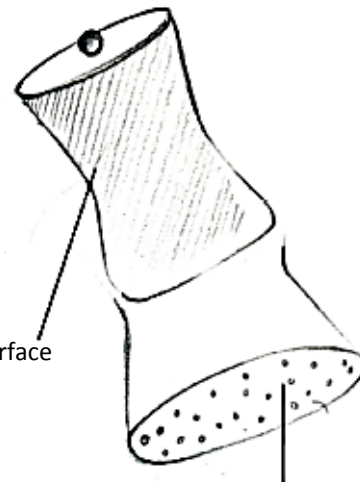
Spring mechanism for moving the spinning drum to throw all excess water through the pores.



Dual spring action

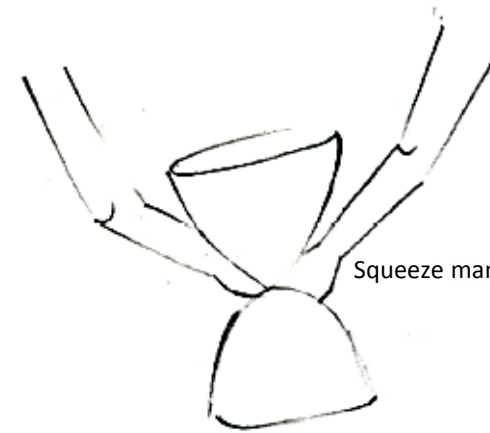


Rubber bag like device for individual use



Rubber/textured/corrugated surface

Pores at the base to release water

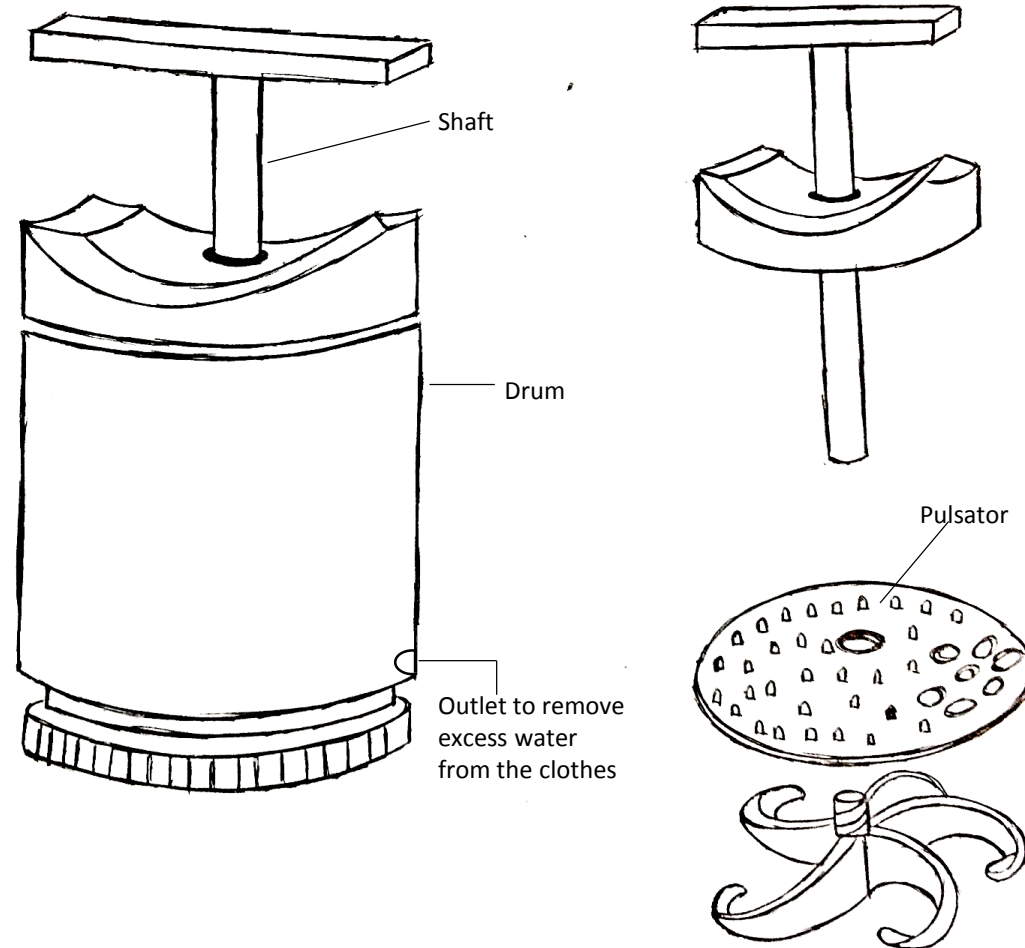


Squeeze manually

Ideations

6) ABOUT:

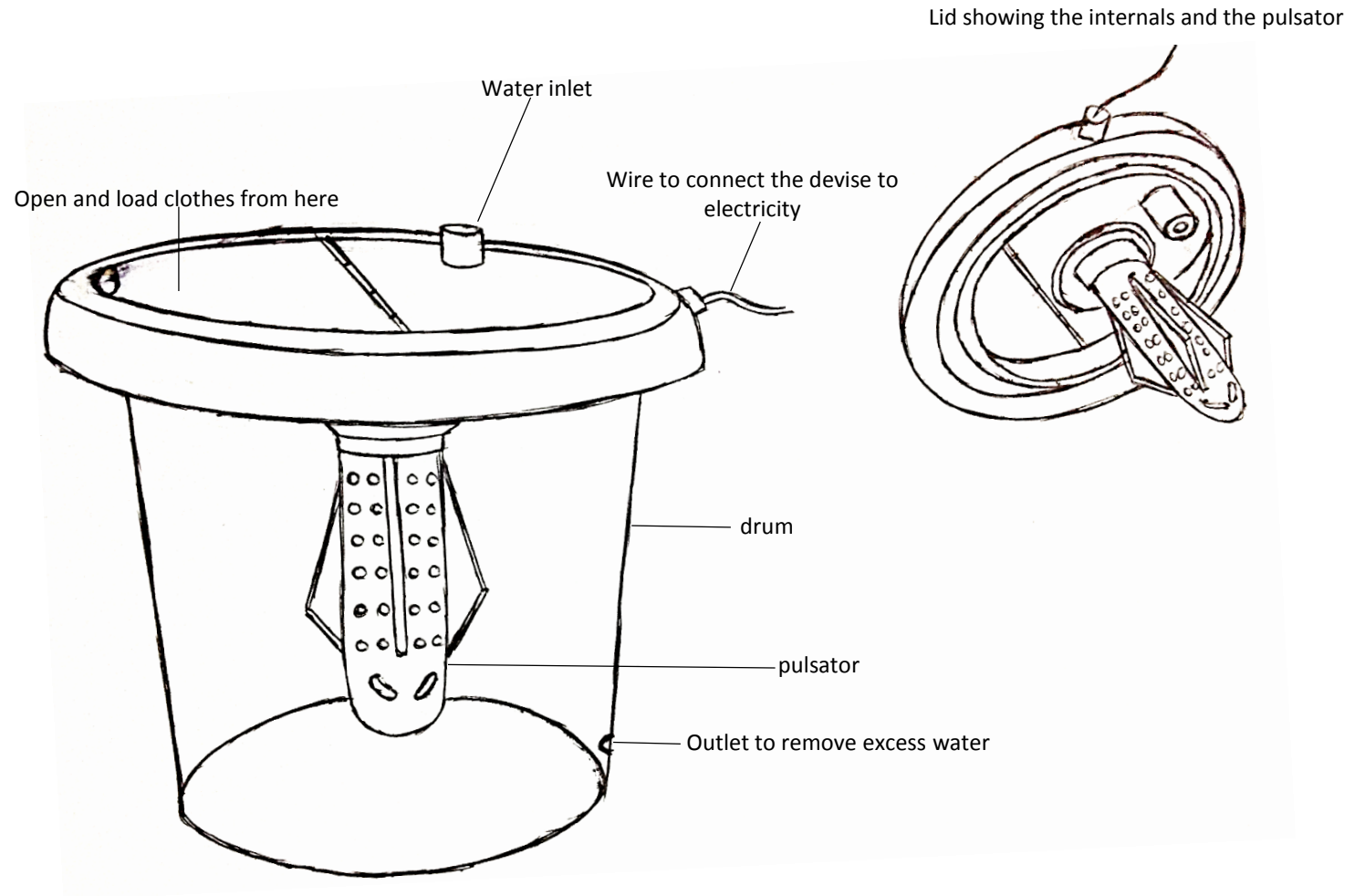
- Removable pulsator which can be attached and detached to the drum. Works on spring wound mechanism. The user has to put the clothes in the drum then rotate the shaft and leave it to complete its washing cycle. After completing the washing cycle the shaft can be pressed to remove water from the clothes.



Ideations

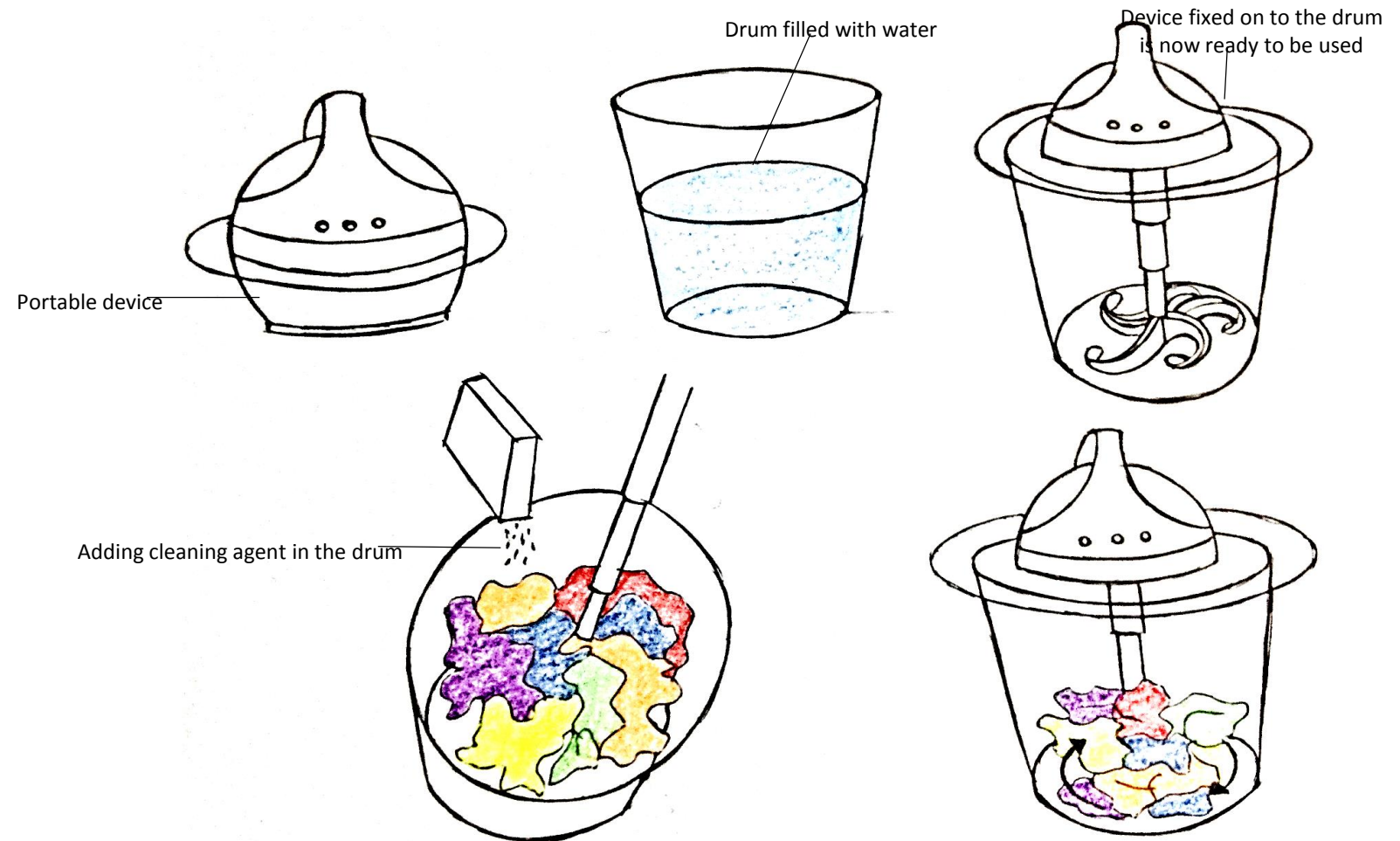
7) ABOUT:

- Top loading machine with motor and pulsator attached to the lid.
 - Works on electricity.
- The device can be used for washing clothes. After the device completes its washing cycle the excess water can be removed from the outlet and the machine can run again to help the clothes to dry better.



Ideations

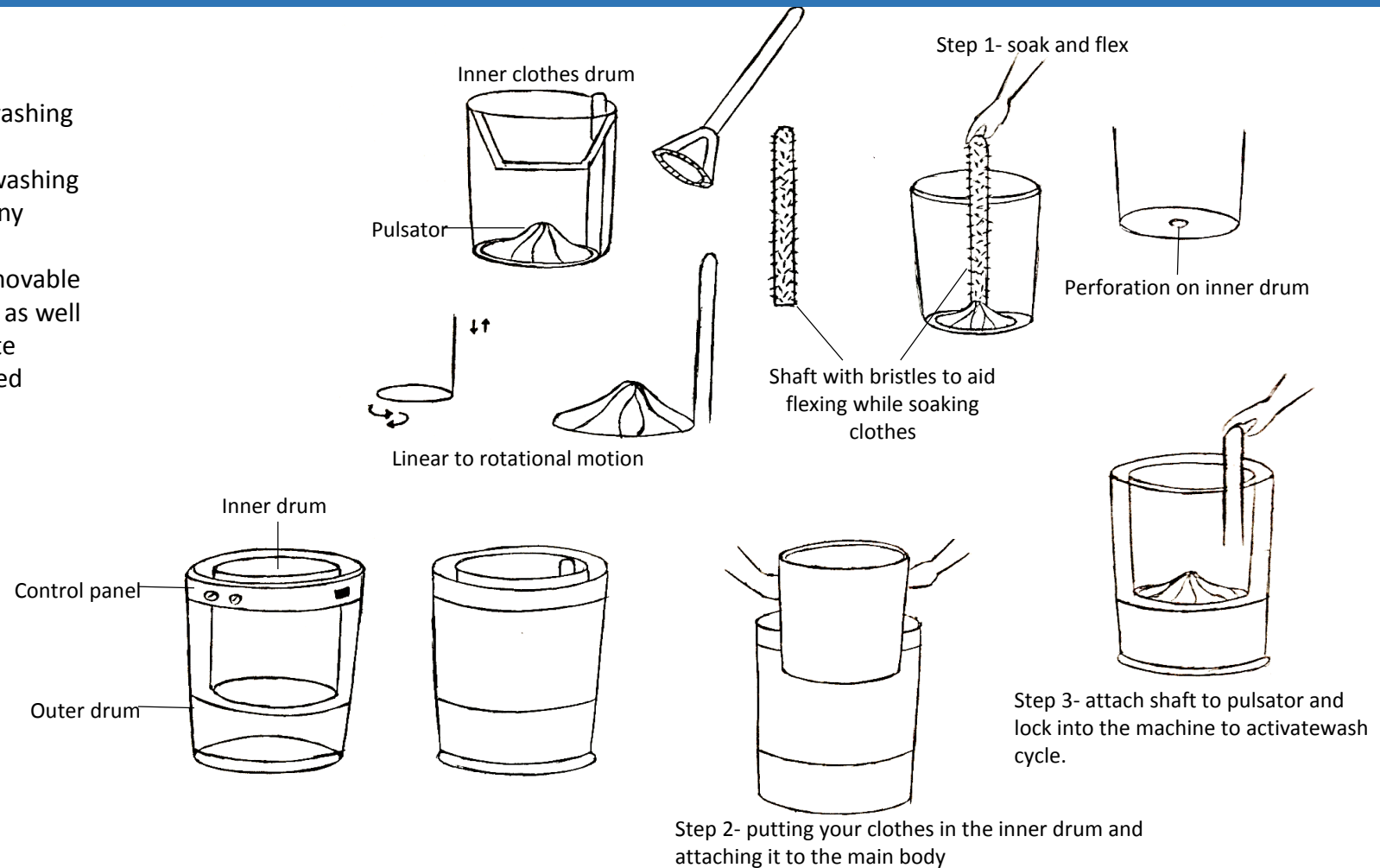
- 8) ABOUT:**
 Portable battery operated
 device for washing clothes.
 Has a telescopic plastic rod
 that is attached to the
 pulsator.
 Can be used on any drum.



Ideations

9) ABOUT:

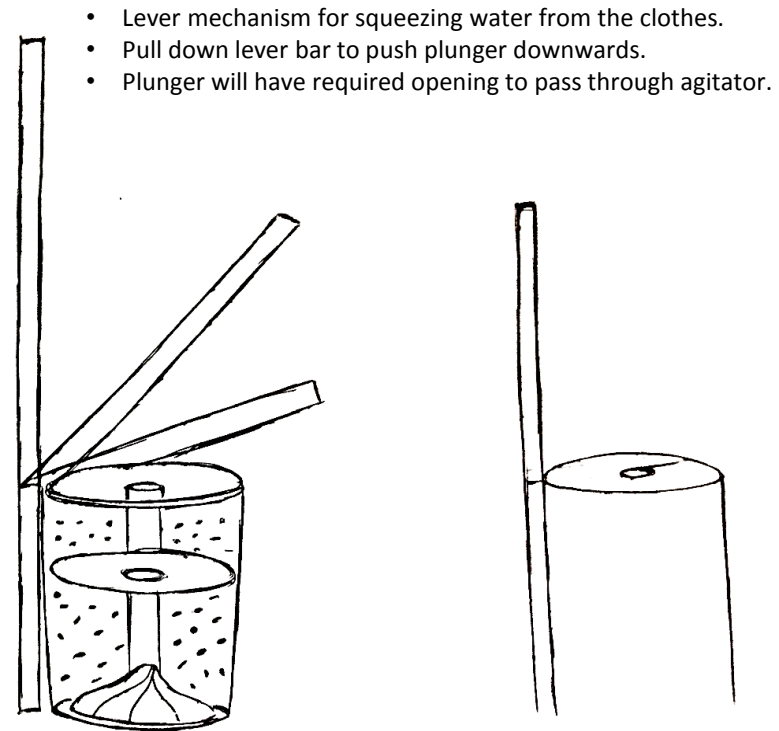
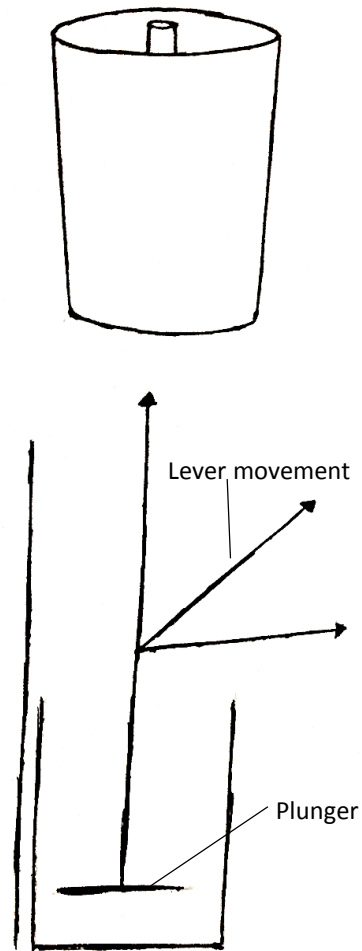
- Two drum concept
- Inner drum is used for washing and squeezing activity
- Outer drum is used for washing and later can be used as any regular storage drum
- Pulsator and shaft is removable and can be used manually as well
- Bristled brush to facilitate manual wash, when needed



Ideations

11) ABOUT:

- Structure for squeezing of water is kept at common location
- Inner perforated drum is taken to this spot and wet clothes are squeezed

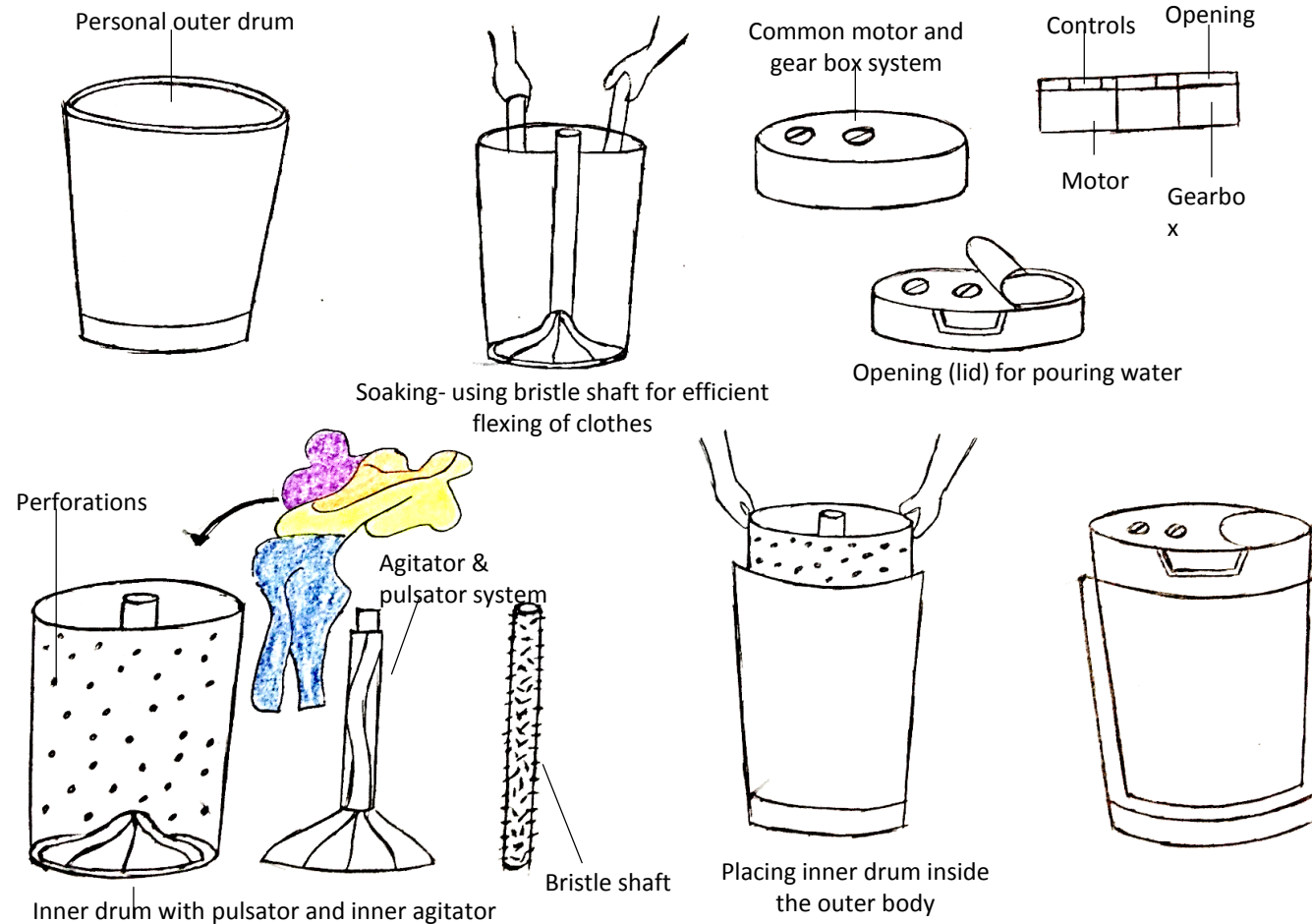


Perforated inner drum used for washing

Ideations

12) ABOUT:

- Refining previous concept further
- has a main outer body and drum
- has a inner working and perforated drum



Rig Testing

EXPERIMENTS FOR WASHING THREADED SHAFT ATTACHED TO PULSATOR

FINDINGS:

- Threaded shaft alone causes clothes to tangle

WHY?

- Small diameter
- Finer threads
- Rough surface

FURTHER SOLUTION:

- Smooth shaft larger in diameter

WHAT NEEDS TO BE VERIFIED?

- Whether shaft movement causes a problem to function of pulsator
- How much the pressure plate moves during wash cycle



Image. 109
Shaft attached to pulsator causing good water turbulence



Image. 111
End cap out on base of shaft for smooth rotation



Image. 112
Clothes begin to tangle around the threaded shaft

Image. 109-112 reference : Author

Rig Testing

PVC SMOOTH PIPE OF LARGER DIAMETER FIXED

FINDINGS:

- PVC smooth pipe of larger diameter stops the clothes from tangling around it
- However, the height upto which the pipe extends into the machine, limits the squeezing action by pressure plate

WHY?

- Large diameter
- No gaps at base of pulsator for clothes to get stuck into
- Smooth flushed surface
- The plate can move only upto the maximum height of shaft inside machine from base up

FURTHER SOLUTIONS:

- A smooth structure which is connected to pulsator without any openings or gaps left in between the connections
- A possible smooth and collapsible structure to achieve maximum distance covered by pressure plate

WHAT NEEDS TO BE VERIFIED?

- If smoother surface helps
- If increase in diameter avoids tangling



Image. 113



Image. 115

Clothes seen floating freely around the shaft. This shows that clothes don't tangle around a smooth surface with larger diameter

TESTING OF WHIRLPOOL WOBBLE MACHINE:

Which has a protruding smooth shaft rising from pulsator



Image. 114

Whirlpool machine with smooth freely moving tube was tested.

Clothes do not tangle around this tube

Image. 113-115 reference : Author

Rig Testing

PET BOTTLE ADDED AS A SLEEVE

FINDINGS:

- PET bottle cannot withstand the pressure applied from top
- Hence, it does not collapse but simply crushes

WHY?

- Flimsy material
- Not enough rigidity
- No spring loaded mechanism for collapsing

FURTHER SOLUTIONS:

- Use of a smooth rubber or silicon rubber tube which has collapsible properties

PET Bottle is added as a sleeve at base of shaft to check for tangling and collapsible nature

WHAT NEEDS TO BE VERIFIED?

- Whether adding a smooth sleeve stops tangling
- Whether a plastic sleeve can collapse when pressure is applied from top



PET bottle crushes with the pressure

Image. 116 reference : Author

Rig Testing

RUBBER BELLOWS FIXED TO SHAFT TO ALLOW FOR COLLAPSING

FINDINGS:

- Bellows are not smooth enough surfaces
- The behaviour of clothes moving in wash cycle in this set up, shows that this would work well with a silicone rubber tube due the properties it holds

WHY?

- Not smooth enough
- Sharp grooves

FURTHER SOLUTIONS:

- A smooth, flushed with the pulsator kind of telescopic spring loaded silicone rubber struture to be used

WHAT NEEDS TO BE VERIFIED?

- Whether a rubber /silicon tube will work as collapsible sleeve
- However, rubber bellows are not extremely smooth being slightly greased, however a silicone tube would work in this case.



Image. 117

Assembly



Image. 118

Turbulence created due to bellows



Image. 119

Image. 117-119 reference : Author

Rig Testing

EXPERIMENT FOR SIMULTANEOUS WASH AND SQUEEZE PRESSURE DISK IS ATTACHED

FINDINGS:

- Power supply needs to be controlled via gearbox
- When pulsator and disk both rotate in same direction, it allows for more efficient squeezing of clothes between the two

WHY?

- Works smoothly
- Pressure applied by the disk is sufficient to achieve more than 50% efficiency of water removal

FURTHER SOLUTIONS:

- A pressure disk having the negative contour of pulsator ribs should be designed
- Since this will enable a minimum quantity of clothes to be squeezed

WHAT NEEDS TO BE VERIFIED?

- Whether simultaneous rotation of pulsator and disk helps with squeezing



Image. 120



Image. 121



Image. 122

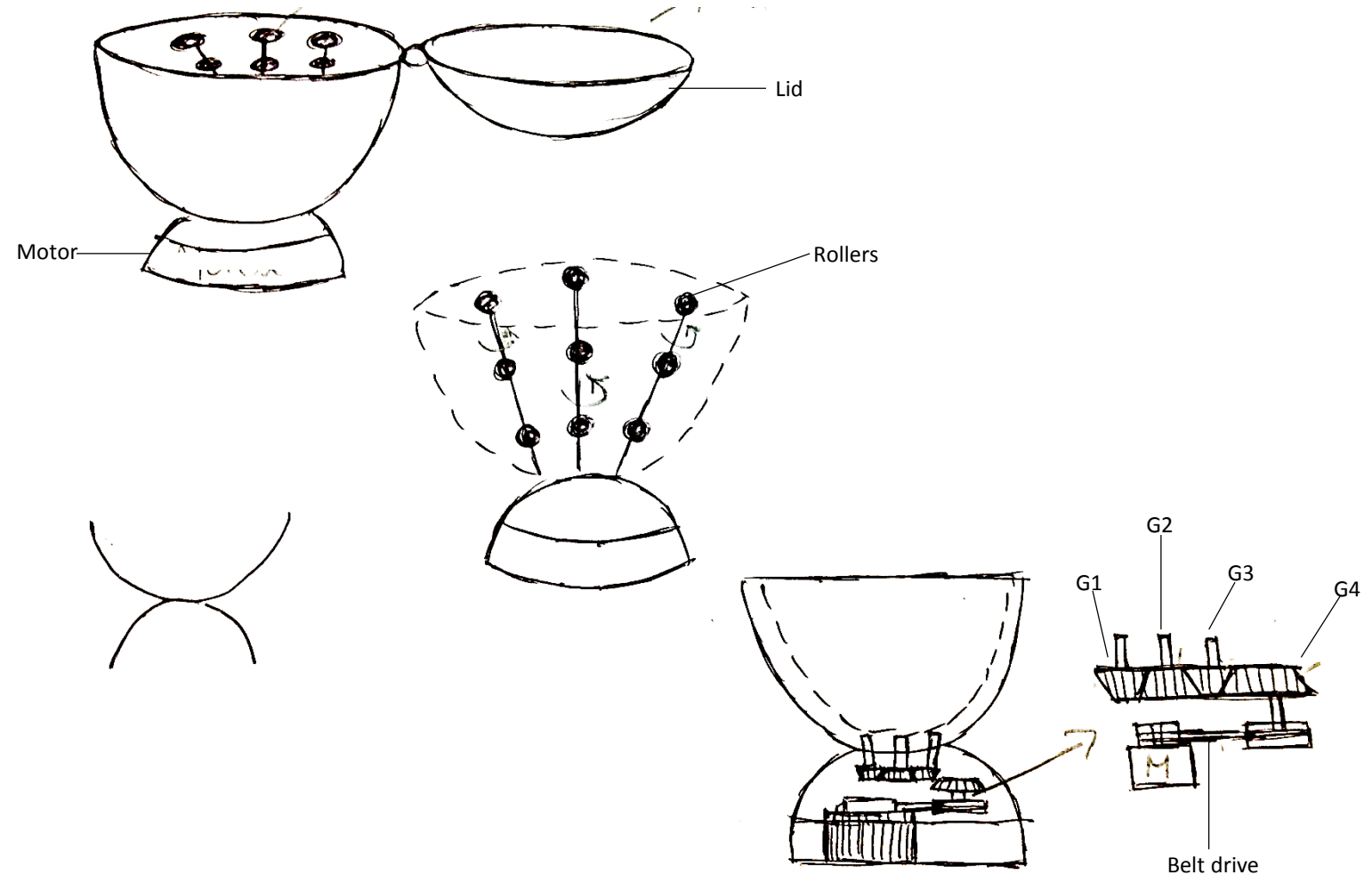
Both pulsator and disk rotate in same direction. Hence clothes get sandwiched between the two

Image. 120-122 reference : Author

Ideations (Phase 2)

12) ABOUT:

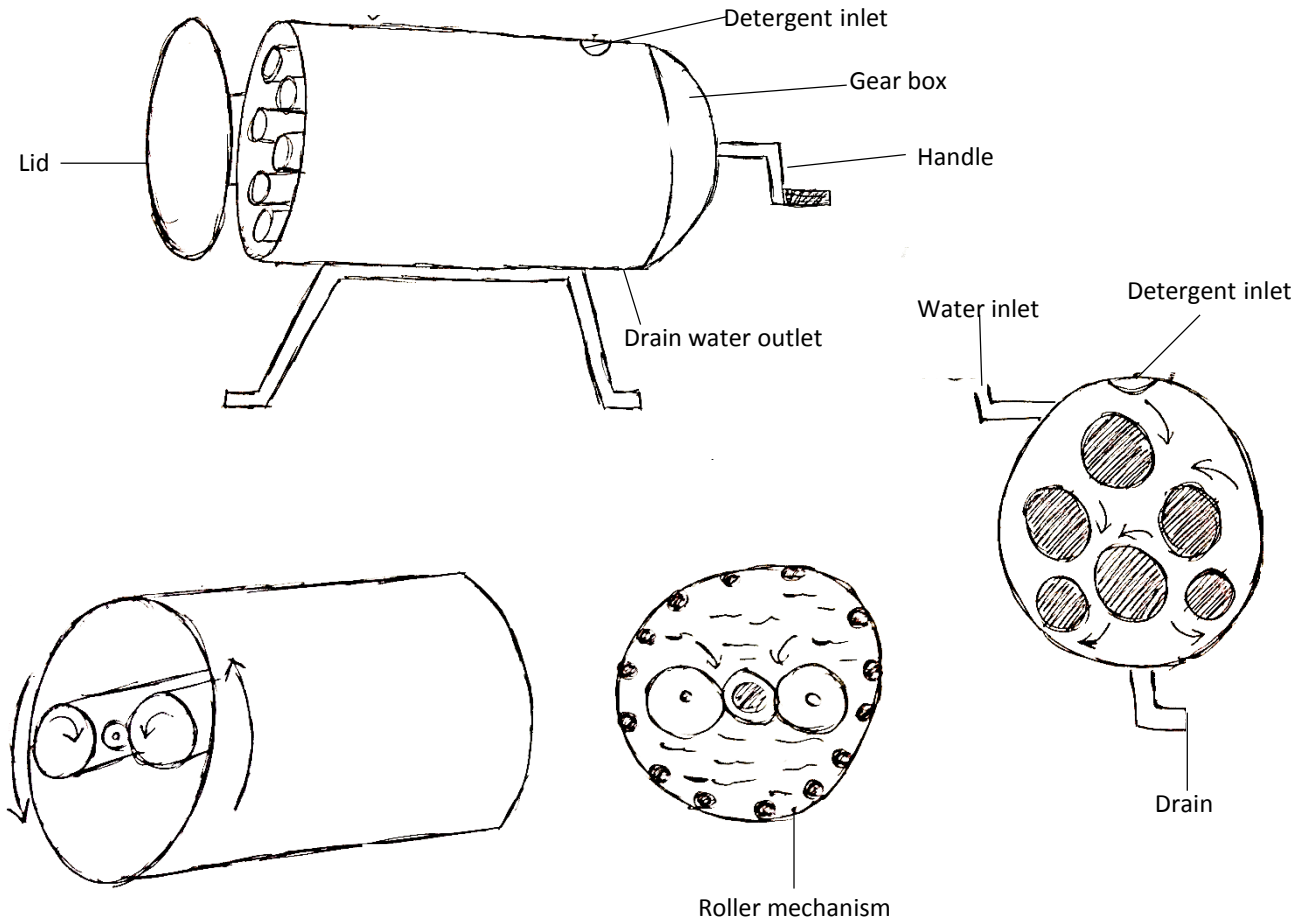
- Is an oval shaped machine consisting of rollers inside which gives the clothes movement while its washed
- Works on a belt drive mechanism.



Ideations

13) ABOUT:

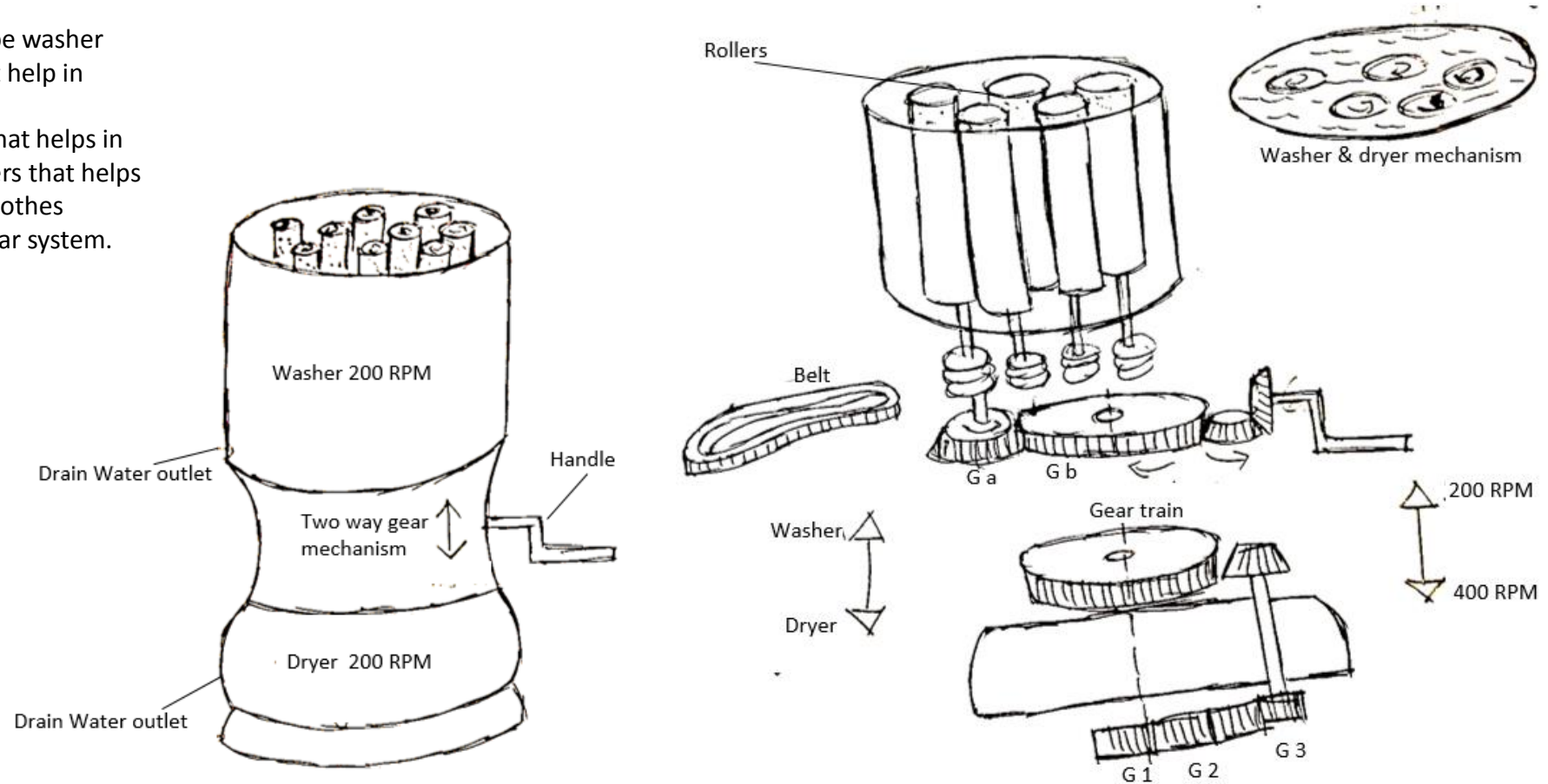
- Is a horizontal type washer
- has rollers that help in washing clothes
- Has a handle that helps in rotating the rollers that helps in washing the clothes



Ideations

14) ABOUT:

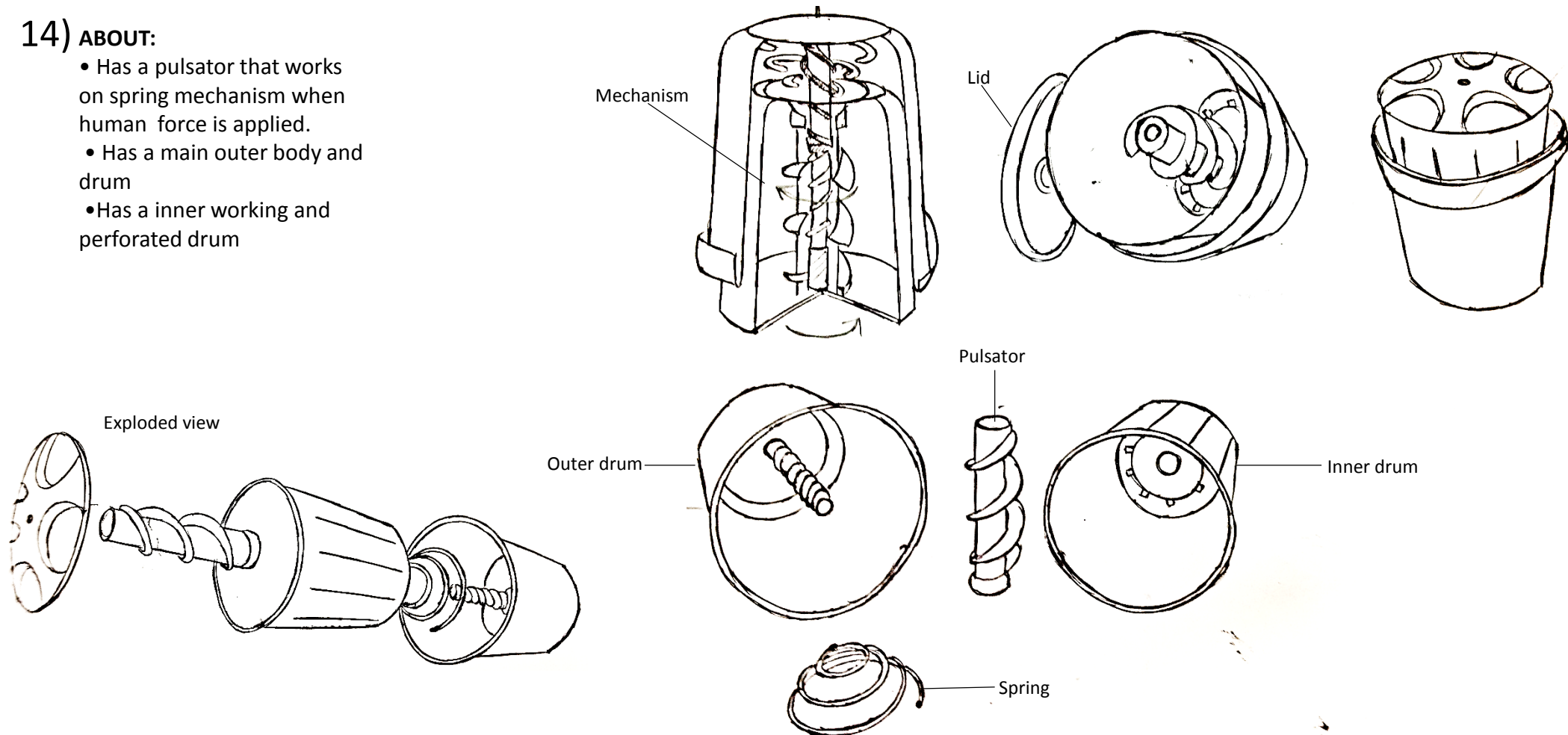
- Is a vertical type washer
 - has rollers that help in washing clothes
 - Has a handle that helps in rotating the rollers that helps in washing the clothes
- It has a 2 way gear system.



Ideations

14) ABOUT:

- Has a pulsator that works on spring mechanism when human force is applied.
- Has a main outer body and drum
- Has a inner working and perforated drum



Feedback on the Project Progress

When an evaluation check was done on the project evolution during the stage1 jury, many conclusions were drawn which changed the path of the project significantly, The ideations that were done did not seem very feasible and had no reflection of the literature study. The whole idea of making the product extremely low cost and simple was getting lost.

The jury suggested that I should fix one mechanism that fits the user requirement and design around it.

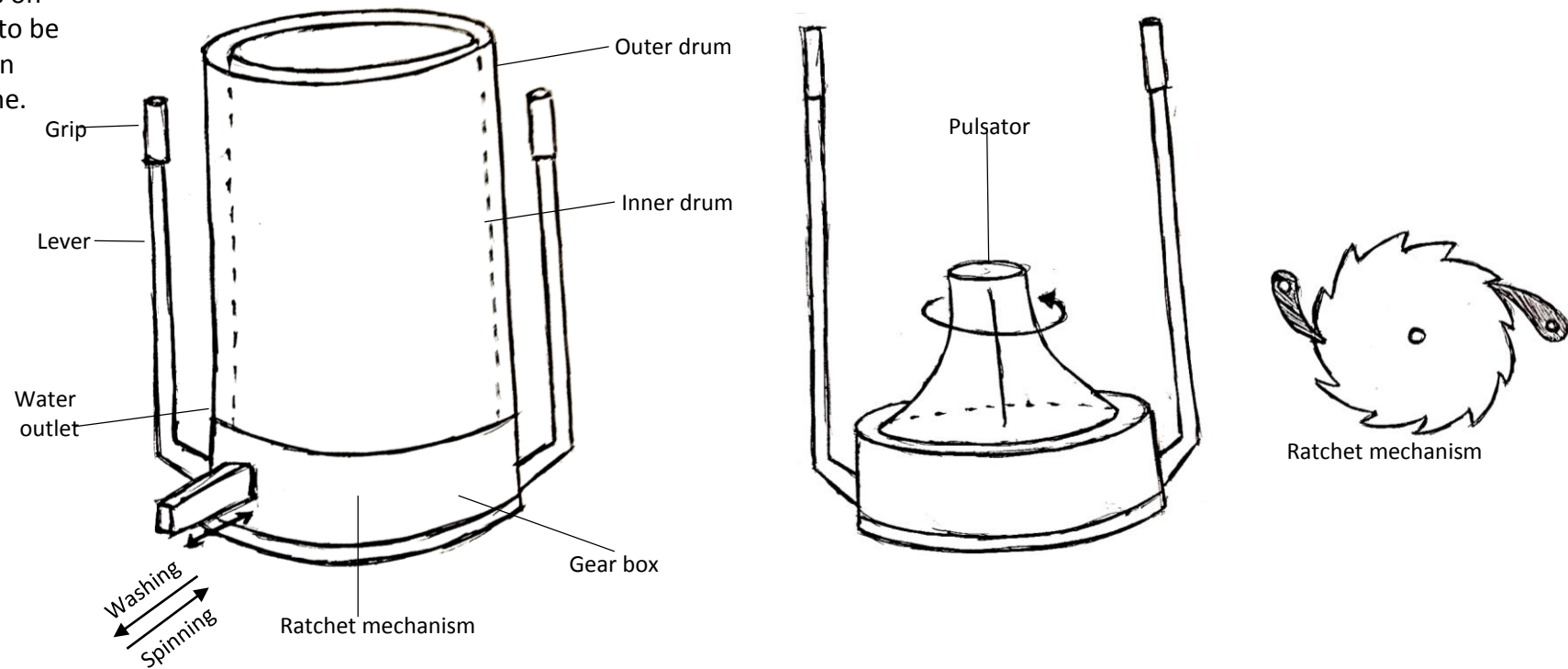
Changes in the Project

After having a discussion with my guide and other faculty members, new concepts were made from which 3 concepts were shortlisted & evaluated, after which one mechanism was finalized and different ways of making the mechanism work was explored. The parts & detailing of the product was done. The design element was brought in during this phase. Several form designs were tried to enhance the richness of the structure while making it more stable. Joining details were added in a way that it contributed to the aesthetic value of the product.

Concept 1

ABOUT:

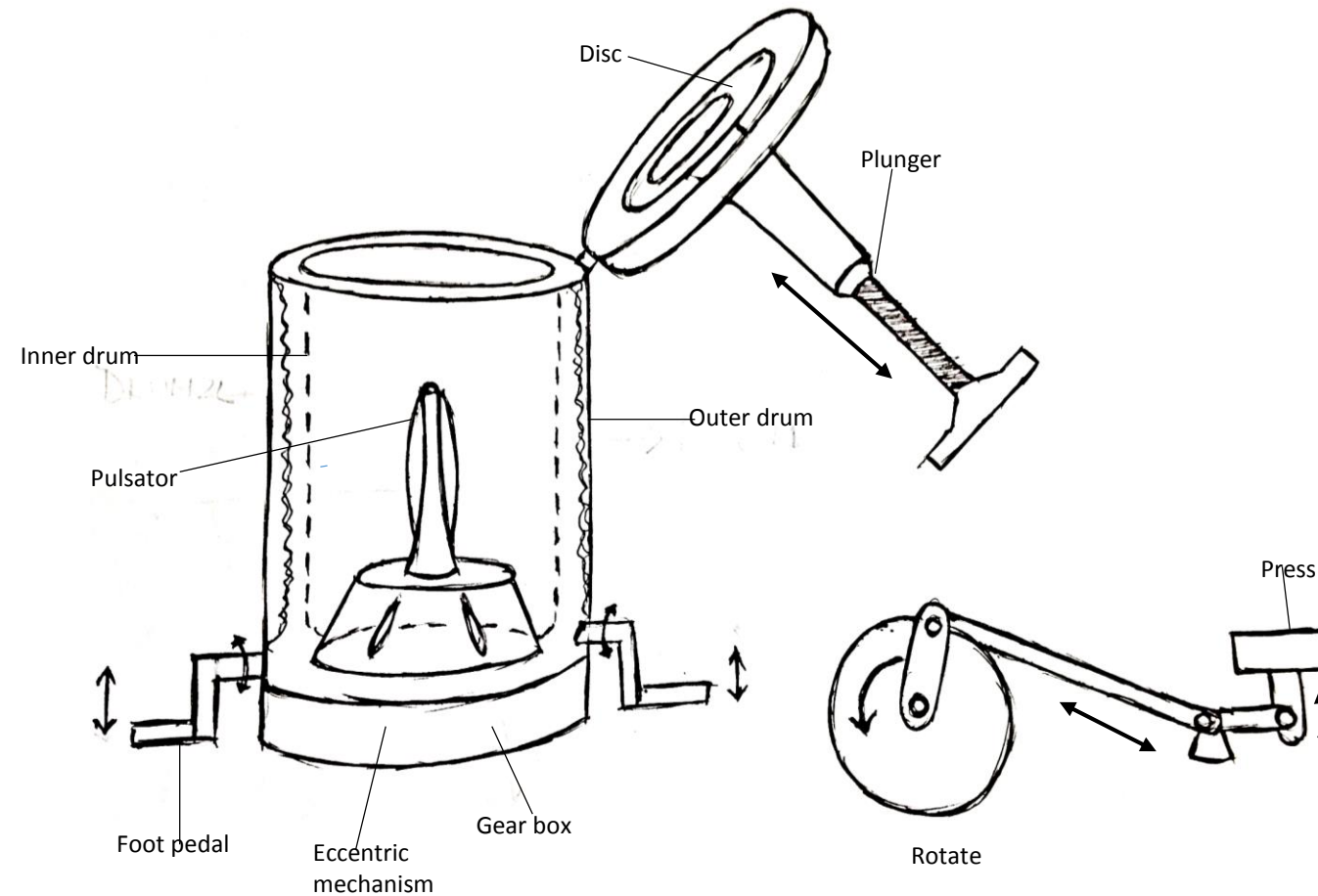
- Is an cylindrical shaped machine consisting of two drums. It has two levers on either sides that needs to be pushed back and forth in order to run the machine.
- Works on ratchet mechanism.



Concept 2

ABOUT:

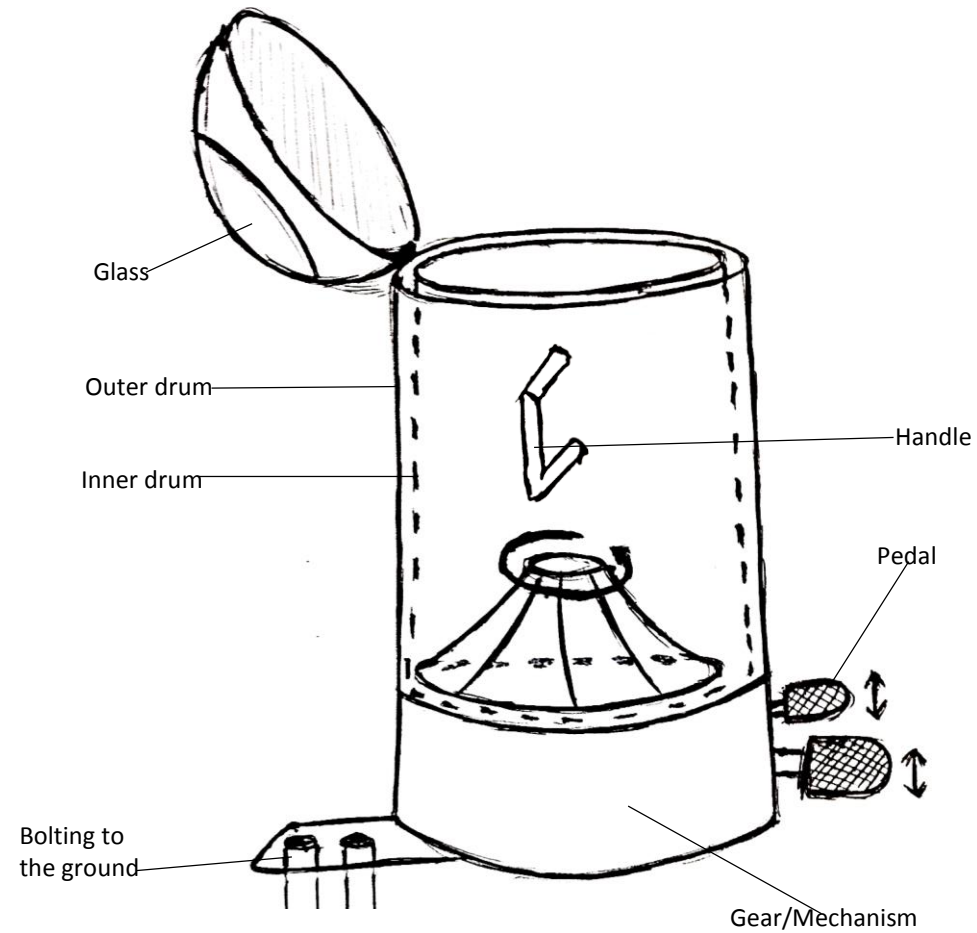
- Is a pedal operated machine with a vertical drum.
- Has an inner drum and a outer drum.
- Has an agitator type of pulsator.
- Has a plunger attached to the lid of the machine that can be pressed to remove the excess water out of the clothes after the washing cycle in complete .



Concept 3

ABOUT:

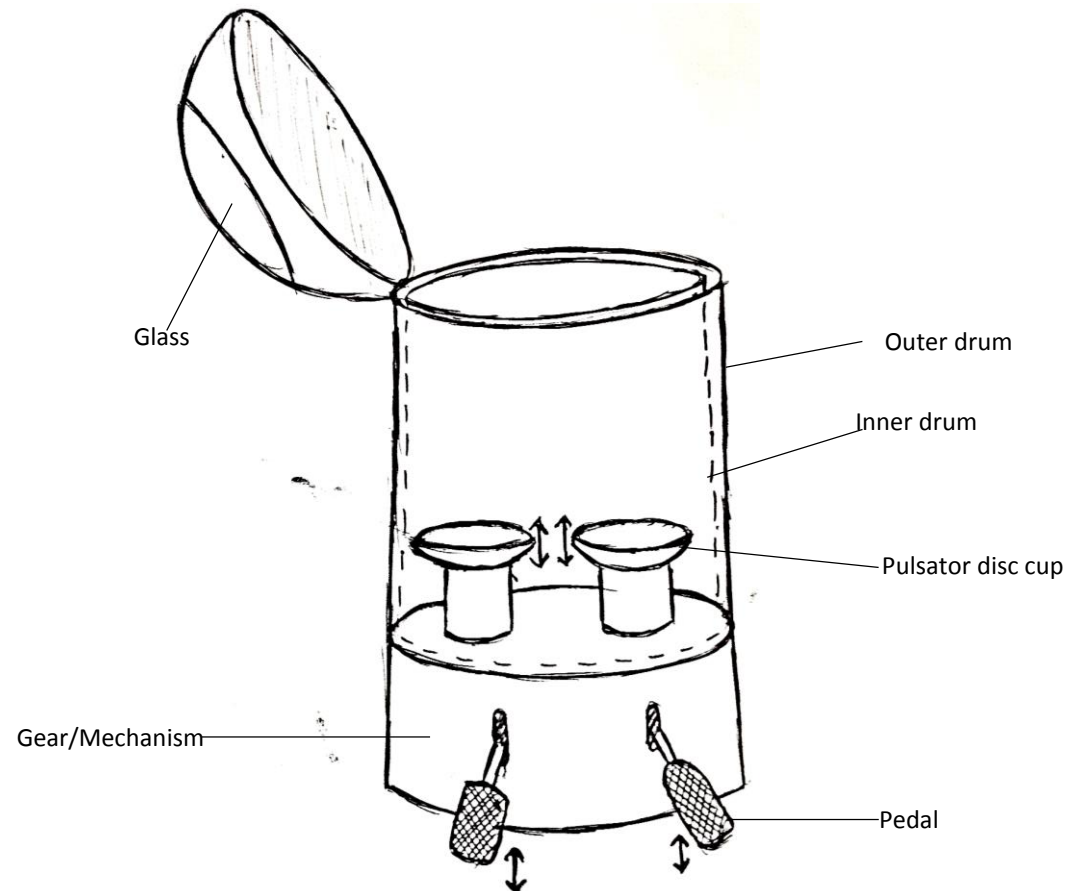
- Is a vertical type drum.
- Is pedal operated. The pedal helps in rotating the pulsator that helps in washing the clothes
- Has a handle that helps in holding the drum while using the pedal. In rotating the rollers that helps in washing the clothes.



Concept 4

ABOUT:

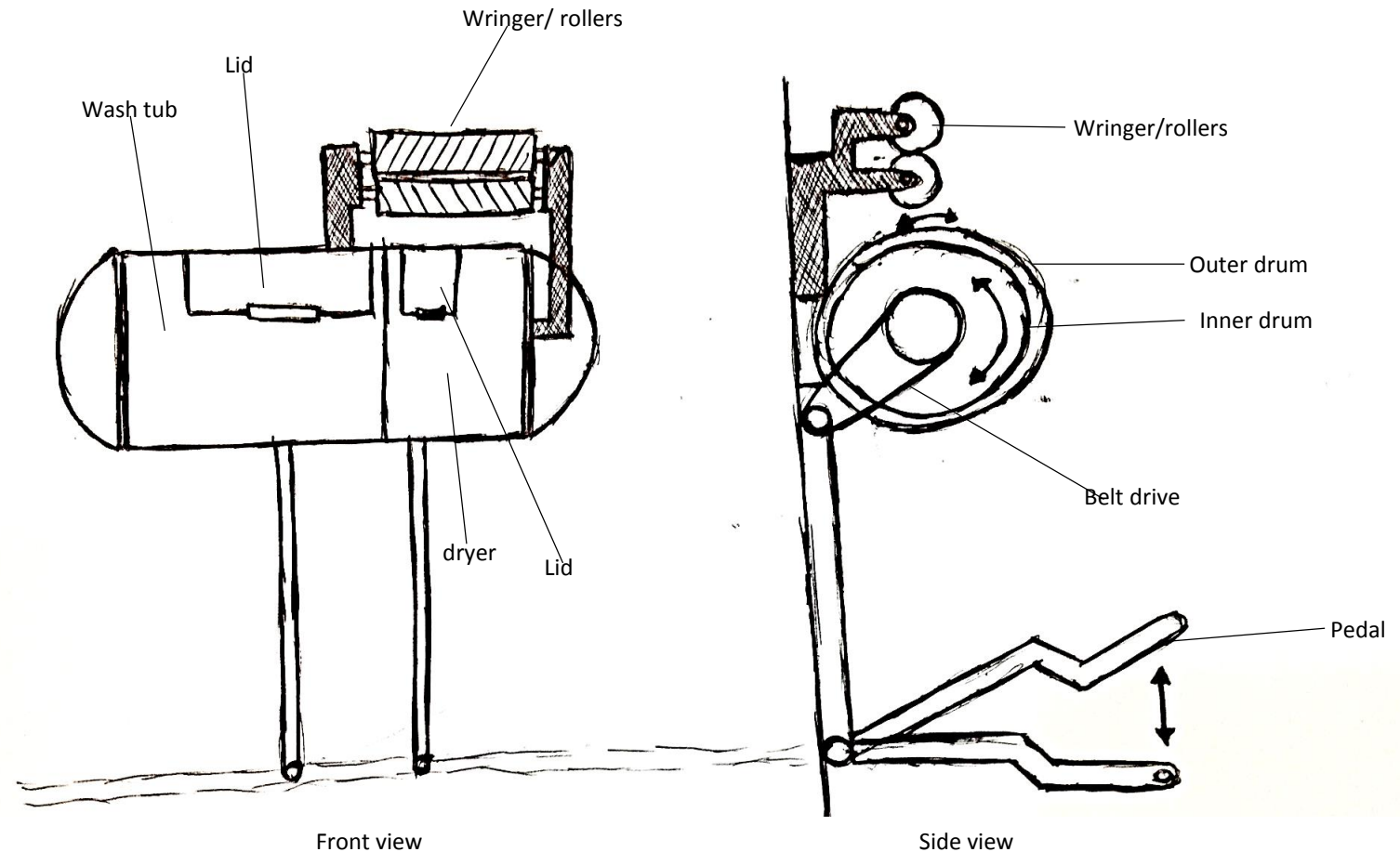
- Is a vertical type washer
 - Has two pulsator disc cups that help in washing clothes by bouncing which results in giving a drop action to the clothes.
 - Has a handle that helps in rotating the rollers that helps in washing the clothes
- It has a 2 way gear system.



Concept 5

ABOUT:

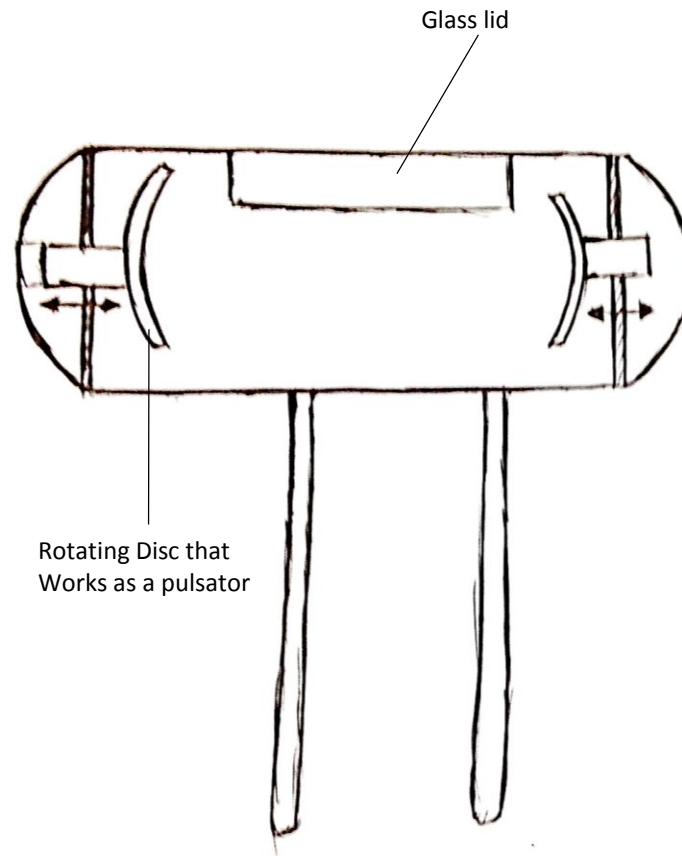
- Is a pedal operated wall mounter washer that runs on belt drive.
- Has an additional wringer/rollers that help in drying clothes after the drying cycle is complete.
- Has two separate drums for washing and drying.



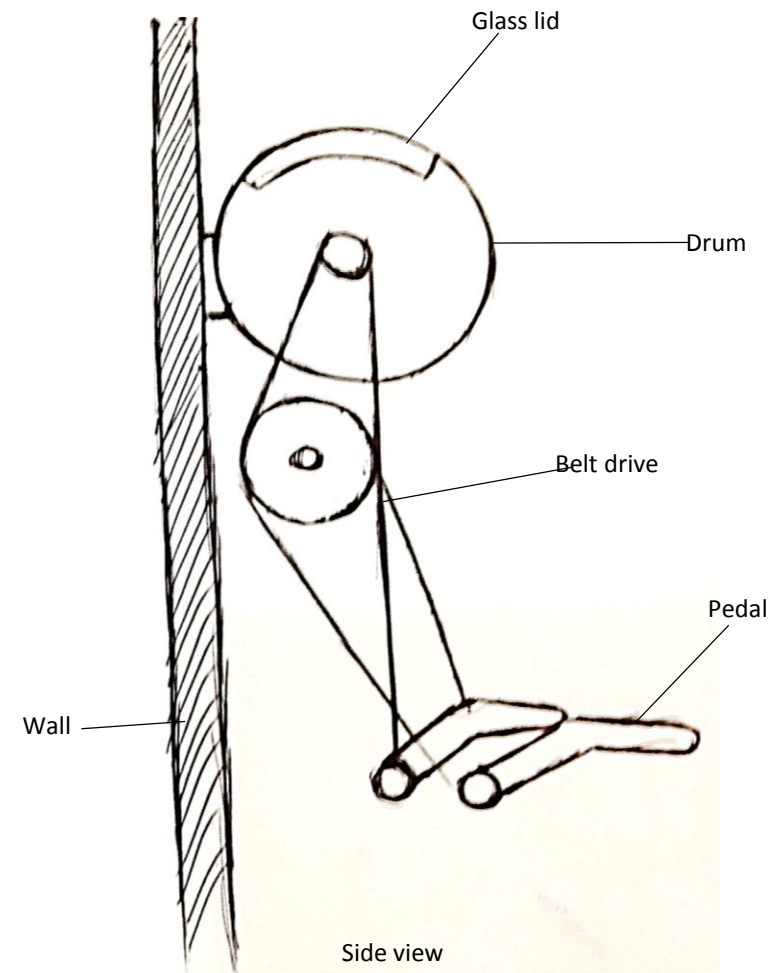
Concept 6

ABOUT:

- Has a horizontal wall mounted drum.
- Has a drum and two disc like cups inside the drum on either side that act as a pulsator. The pulsator cleans the clothes by pick and drop action along with rotation.
- This machine is pedal operated.



Front view

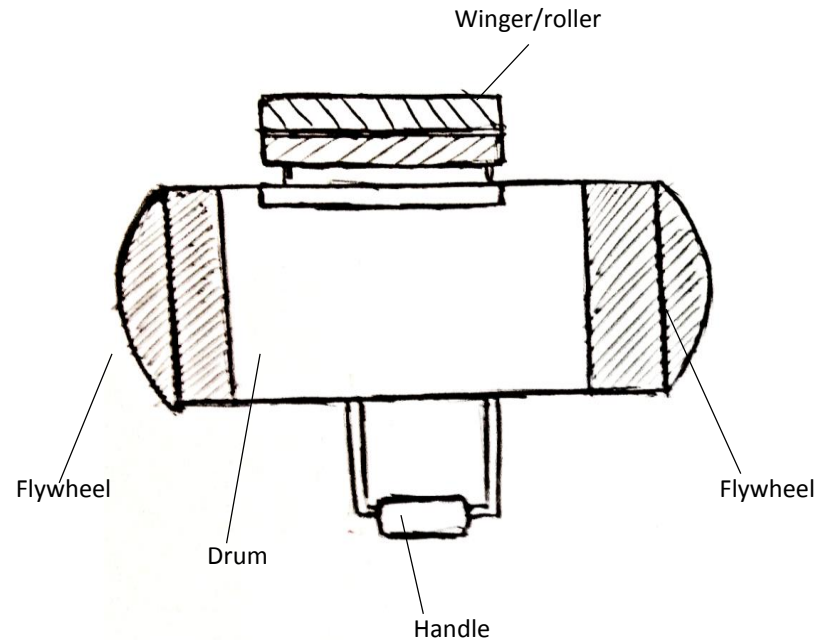


Side view

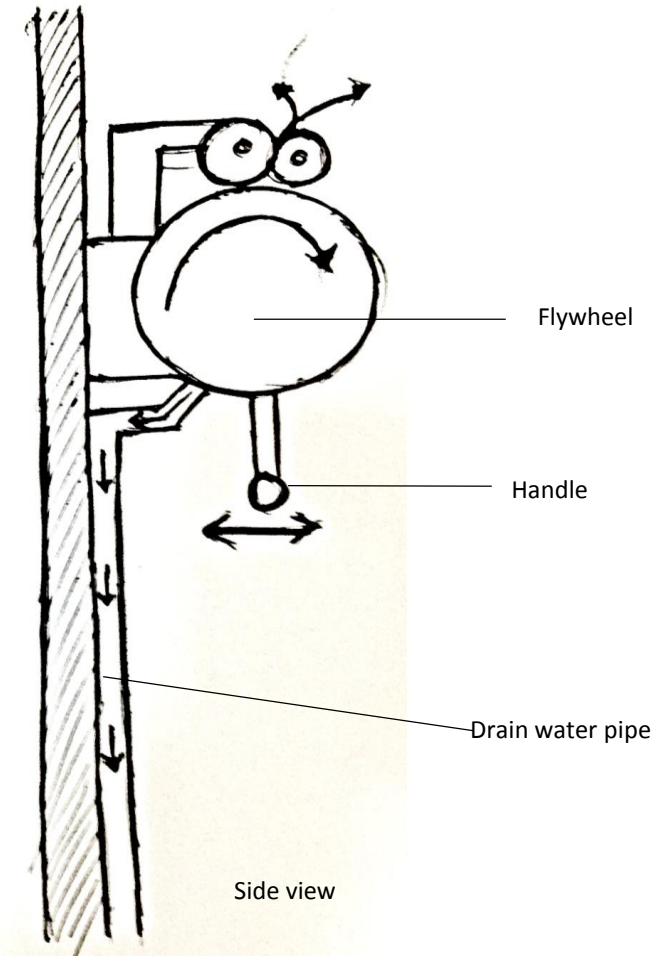
Concept 7

ABOUT:

- Is a horizontal wall mounted type washer
- Has a inner drum and a outer drum. The inner drum has perforations that help in cleaning the clothes better. This machine uses the drop action for cleaning the clothes
- Has a handle that needs to be pushed to rotate the drum. The drum is attached to the fly wheel.



Front view

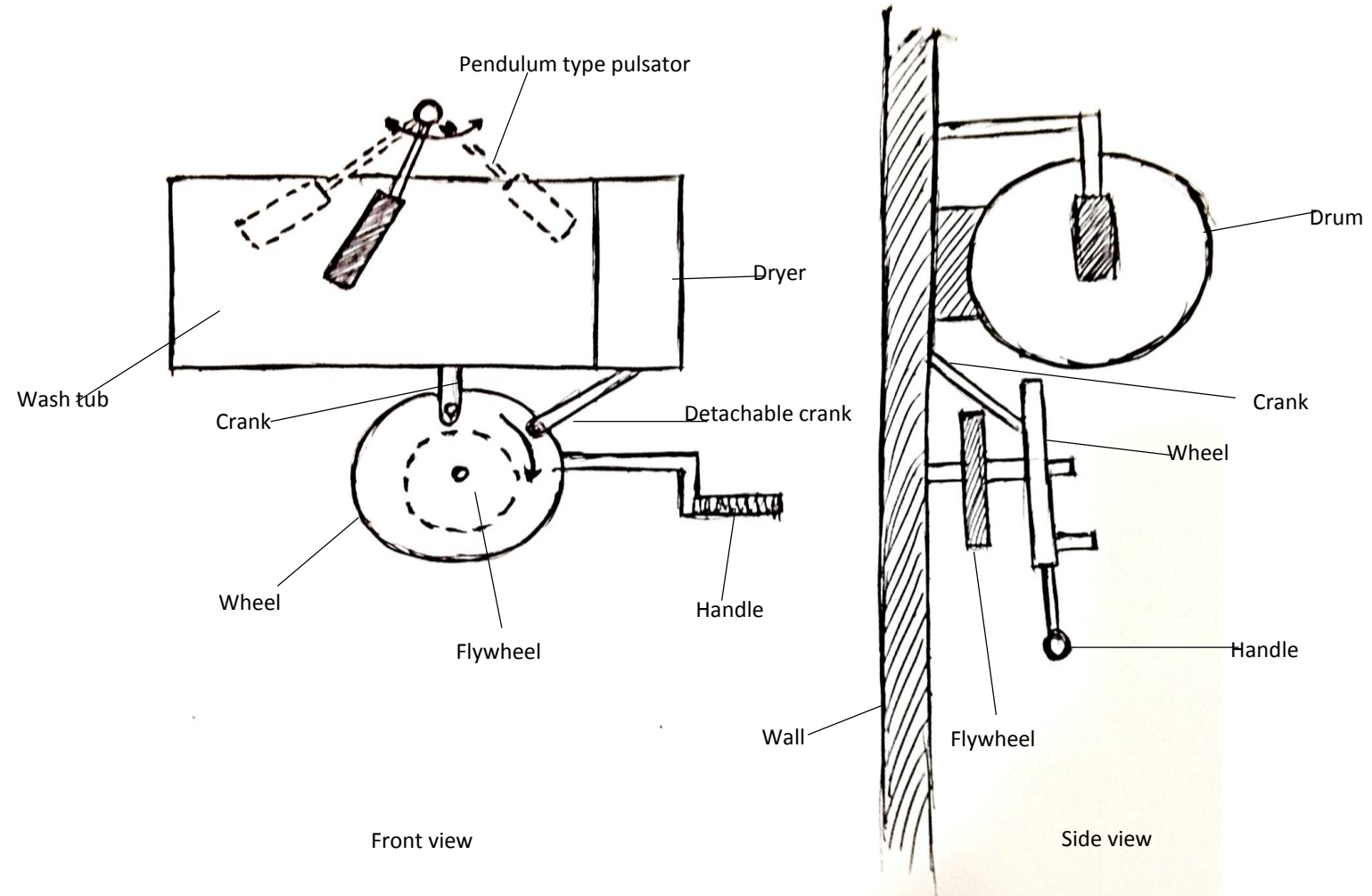


Side view

Concept 8

ABOUT:

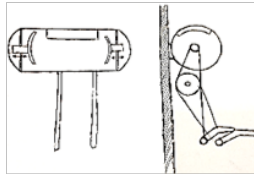
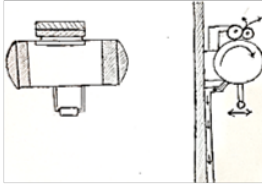
- Is a horizontal type wall mounted washer. It has two different compartments for washing and drying.
- Has a pendulum type pulsator that help in washing clothes
- Has a handle that is attached to the flywheel that helps in rotating the drum.



Concept Evaluation

8 concepts were generated and after discussing all the above 8 concepts with my guide, 3 concepts were mutually shortlisted by us and evaluated on parameters such as floor space, efforts required for washing, time consumed, portability, water consumption, user friendly, drying & affordability. After which study models were made to get a better understanding of the concepts.

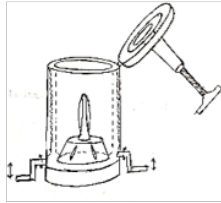
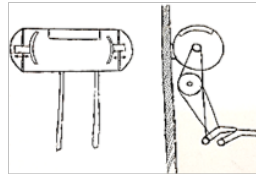
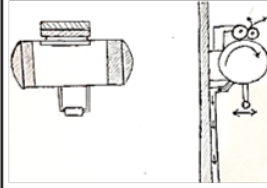
Concept Evaluation Without Considering Weightage

Parameters	Concept 2 	Concept 6 	Concept 7 	Overall weightage per category out of 3 (3 being very important & 1 being the least important)
Floor space	3	9	12	3
Effort required for washing	6	9	12	3
Time consumed	3	3	3	1
Portability	9	6	12	3
Water consumption	4	6	6	2
User friendly	6	6	8	2
Drying	6	8	8	2
Affordability (cost)	12	6	9	3
Total Score	49	53	70	

Evaluating Scale:

Poor = 1
 Average = 2
 Good = 3
 Very good = 4
 Excellent = 5

Concept Evaluation Considering the Weightage

Parameters	Concept 2 	Concept 6 	Concept 7 	Overall weightage per category out of 3 (3 being very important & 1 being the least important)
Floor space	3	9	12	3
Effort required for washing	6	9	12	3
Time consumed	3	3	3	1
Portability	9	6	12	3
Water consumption	4	6	6	2
User friendly	6	6	8	2
Drying	6	8	8	2
Affordability (cost)	12	6	9	3
Total Score	49	53	70	

Weightage Scale:

Least important = 1
 Important = 2
 Very important = 3

Evaluating Scale:

Poor = 1
 Average = 2
 Good = 3
 Very good = 4
 Excellent = 5

Study Model 1

After concept evaluation was done, study models were made of the two highest scoring concepts to get a better understanding of the working of the concepts.

1. Concept 6 study model:

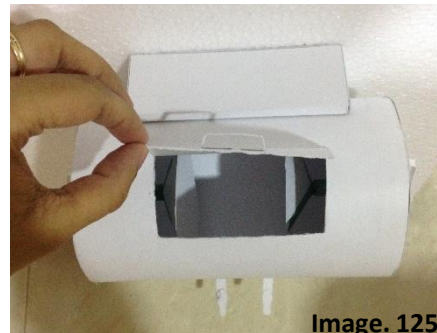
This study model is made using chart paper. Concept 6 has a drum and two disc like cups inside the drum on either side that act as a pulsator. The pulsator cleans the clothes by pick and drop action along with rotation. The pulsator is operated through the pedal that runs on belt drive. The machine has two handle on either side that makes it easy for the user to hold and operate the pedals.



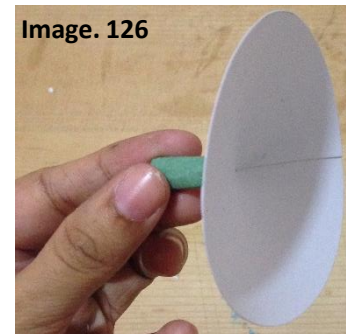
Concept 6 study model



Giving a clear view of the handle and the pedal



Giving a clear view of the pulsator disc inside the drum



Pulsator disc



Pulsator disc on both sides inside the drum

Pros:

- Wall mounted
- Cleans the clothes using pick and drop action

Cons:

- Pedal operated
- The user will have to hold the handle in order to use the pedal
- User might get tired in the process of washing clothes
- Lot of human effort required
- Complex mechanism

Image. 123-127 reference : Author

Study Model 2

1. Concept 7 study model:

This study model is made using chart paper and straw. Concept 7 has an inner drum and an outer drum. The inner drum has perforations that help in cleaning the clothes better. This machine uses the drop action for cleaning the clothes. It has a handle that needs to be pushed to rotate the drum. The drum is attached to the flywheel. The flywheel stores the energy input and evenly distributes it. Making the product extremely user friendly in terms of the efforts required to use the machine.



Concept 7 study model



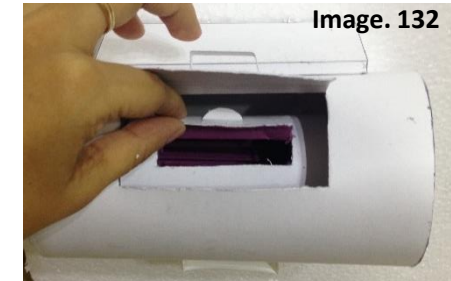
Giving a clear view of the handle



Drum is attached to the flywheel



Inner drum



Perforations inside the inner drum

Pros:

- Wall mounted
- Cleans the clothes using drop action
- Uses flywheel
- Less human effort required
- Inner drum has perforations inside to ensure better cleaning.
- Simple mechanism

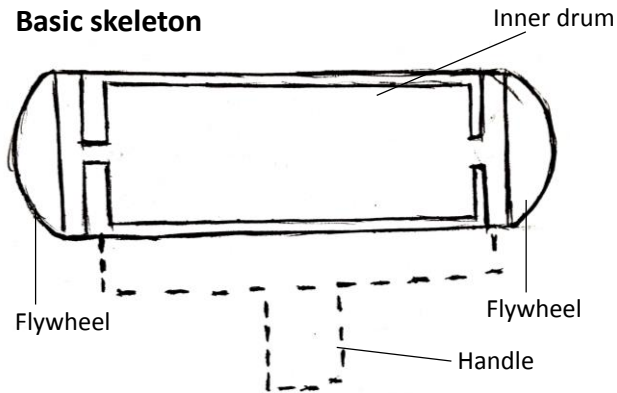
Cons:

- None

Conclusion: Since concept 7 has more pros than cons and it also fits all the user requirement, the concept was finalized.

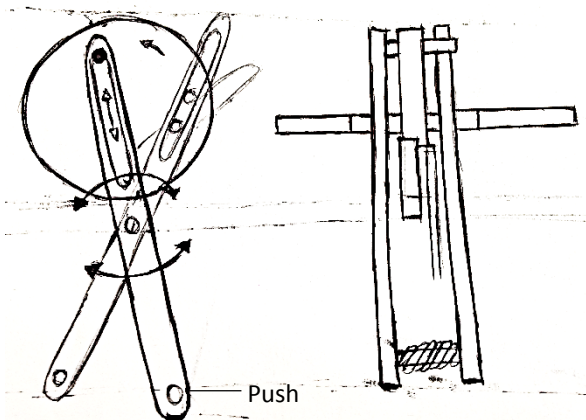
Image. 128-132 reference : Author

Ideas of making the Flywheel Mechanism Work



This was the basic skeleton of the product around which different mechanisms were made in order to find the mechanism that meets the need of the project i.e. low cost, easy to use & maintain.

1) Quick Return Mechanism

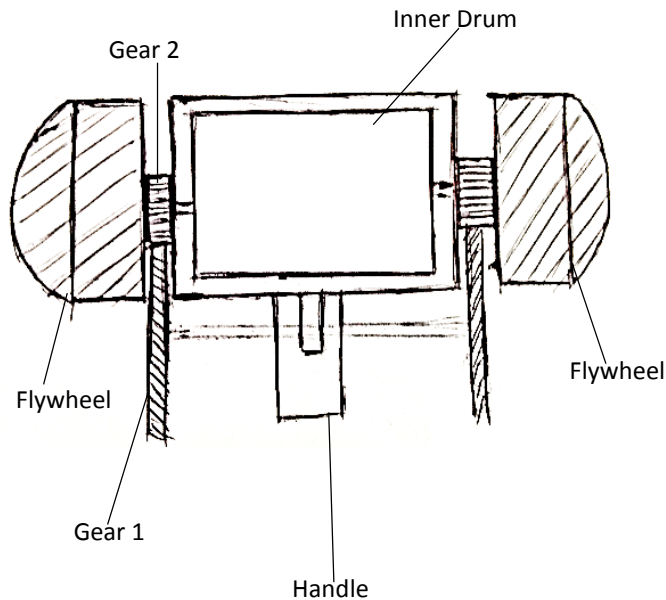


The quick return mechanism has a wheel and a crank. The crank is pivoted at the center. The crank has a slot on the side from which a plunger of the wheel is fixed. The plunger is placed close to the circumference of the wheel. The center of the wheel & the center of the pivoted crank are on the same horizontal plane. The other side of the crank has a handle which needs to be pushed back and forth in order to rotate to rotate the wheel. The wheel is directly connected to the inner drum of the machine because of which the drum rotates. This mechanism:

- Is expensive.
- Has a complicated mechanism.
- Is noisy.
- Is high on maintenance – because of friction between the plunger and crank, it requires regular oiling and repairs.

Ideas of making the Flywheel Mechanism Work

2) One Directional Push Gear Train Mechanism

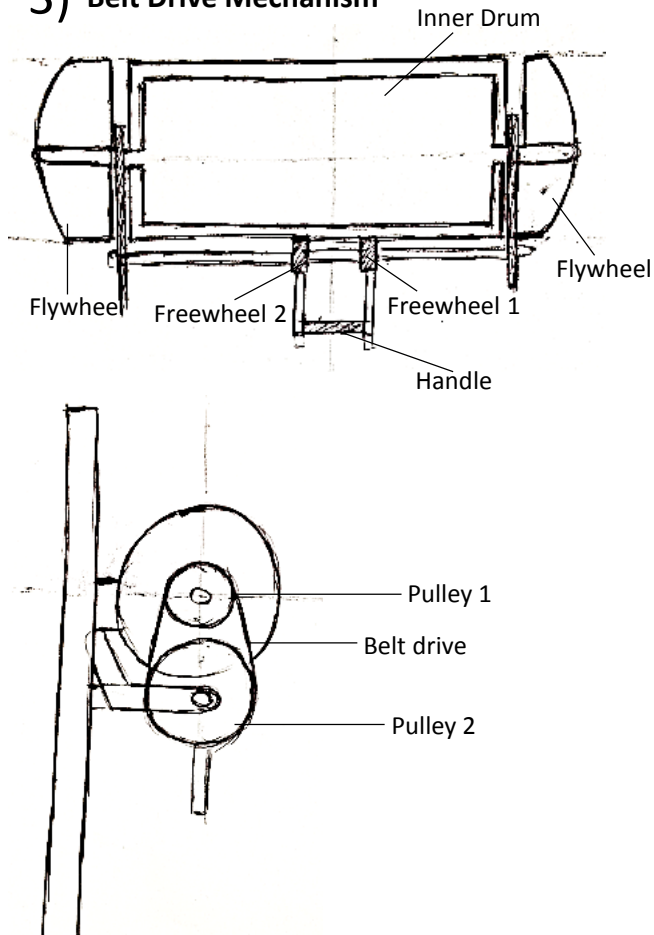


This mechanism consists of two gears i.e. gear 1 and gear 2. Gear 2 is smaller than gear 1. Gear 2 is fit on to the shaft coming out from the inner drum. The flywheels are fit at the end of the shaft i.e. Gear 2 is placed between the outer drum & the flywheel. Gear 1 is mounted on a separate shaft. Gear 1 & gear 2 are engaged. The shaft the gear 1 is mounted on consists of two freewheels that are placed at the center of the shaft. The distance between two freewheels is the exact distance of two fists join together. The handle is fit on to the freewheel. So, when the handle is pushed the freewheel rotates because of which the shaft rotates causing gear 1 to rotate as well. Since gear 1 & gear 2 are engaged gear 2 also rotates causing the inner drum to rotate. This mechanism:

- Is noisy
- Requires more human effort than any other mechanism
- Complex mechanism
- Expensive- because specially designed gears have to fit in order to make the machine work.

Ideas of making the Flywheel Mechanism Work

3) Belt Drive Mechanism



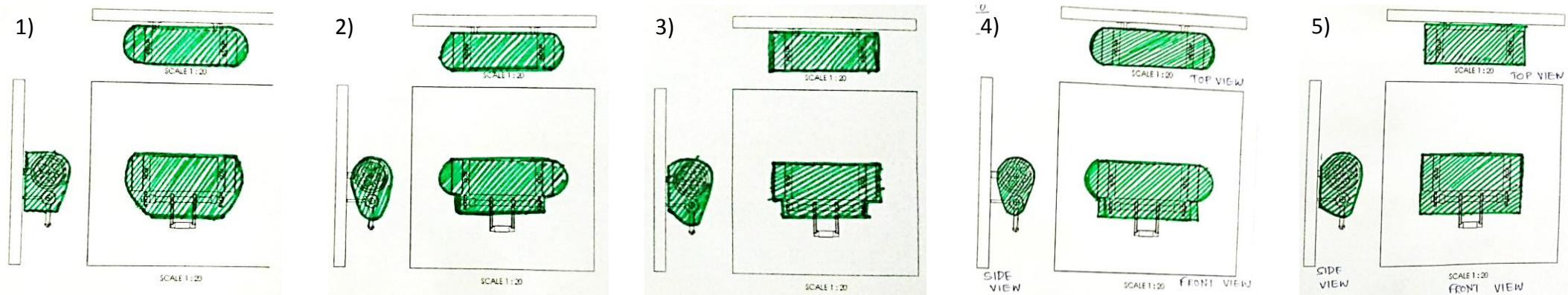
This mechanism consists of two pulleys i.e. pulley 1 and pulley 2. In this mechanism we have replaced the gears from the previous mechanism to pulley because for gear to gear contact a bigger diameter was required which occupied a lot of space. So in order to save the access space required for the gears, the gears were replaced by pulleys.. Also the gears cause a lot of noise so to avoid the noise caused rubber belt is used. This mechanism:

- Noiseless
- Compact
- Easy mechanism
- Low cost as compared to the other mechanism.

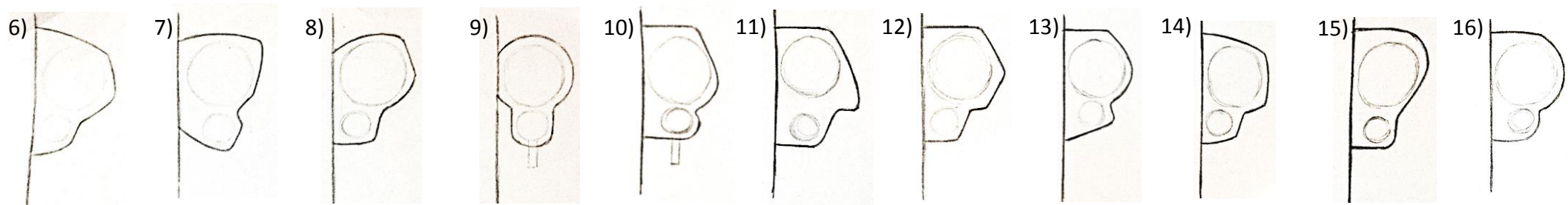
Conclusion: Since Belt Drive Mechanism fits all the project requirement, this mechanism was finalized.

Form exploration (Phase 1)

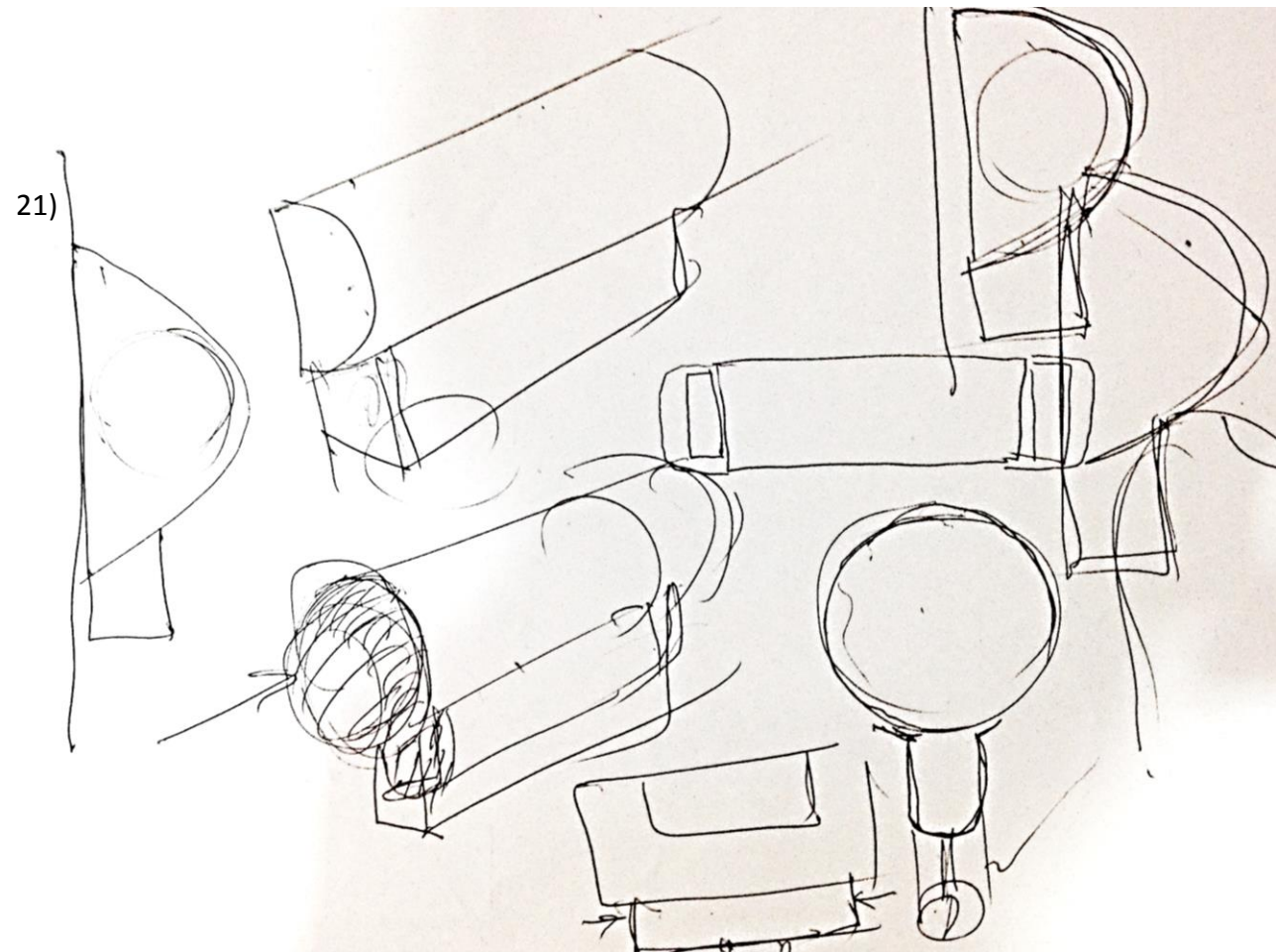
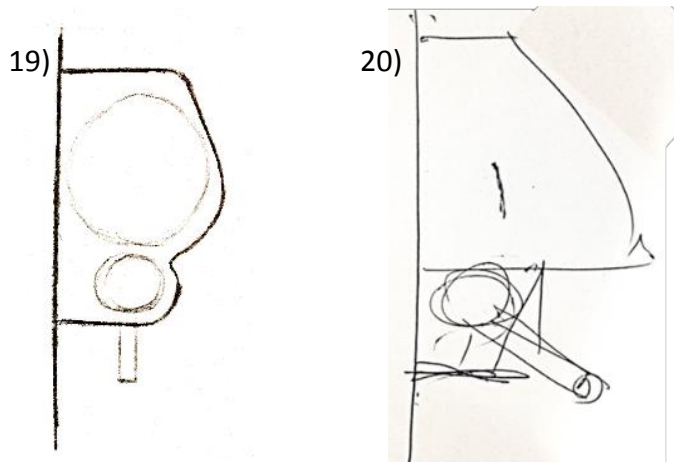
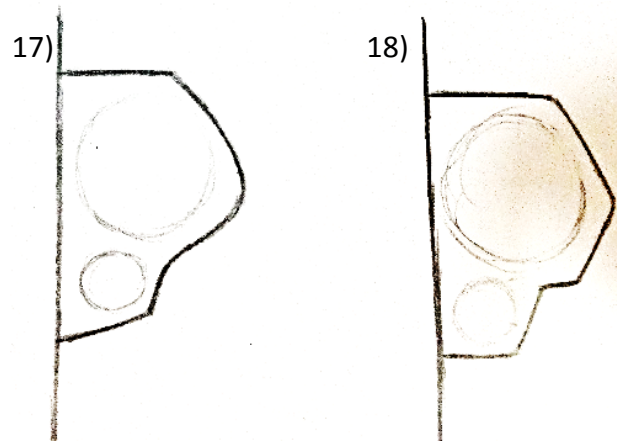
After finalizing the concept and mechanism various form designs were explored in order to increase the aesthetic value of the product by making it look simple but elegant.



Initially I took a print out of the skeleton of the machine and designed forms around it in top view, side view & front view to get a better understanding of how the form will look. However this did not give me much clarity, so I moved to exploring forms only by making the side view so that it'll help me getting an idea of how the product will look and also help me in making the CAD model.

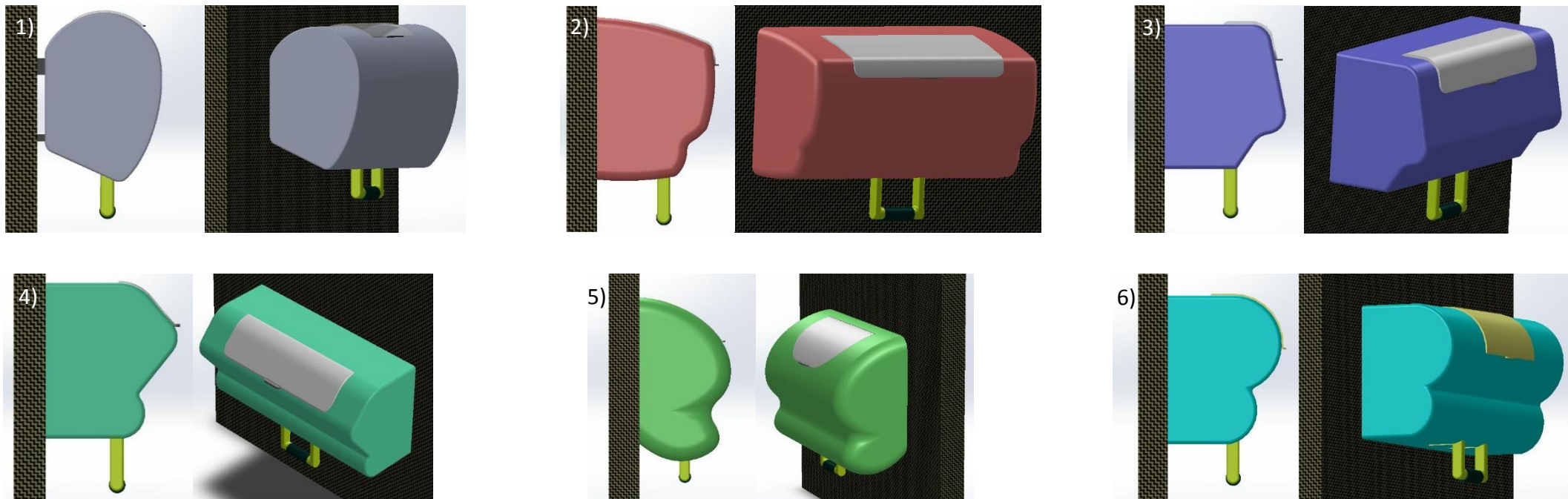


Form exploration (Phase 1)



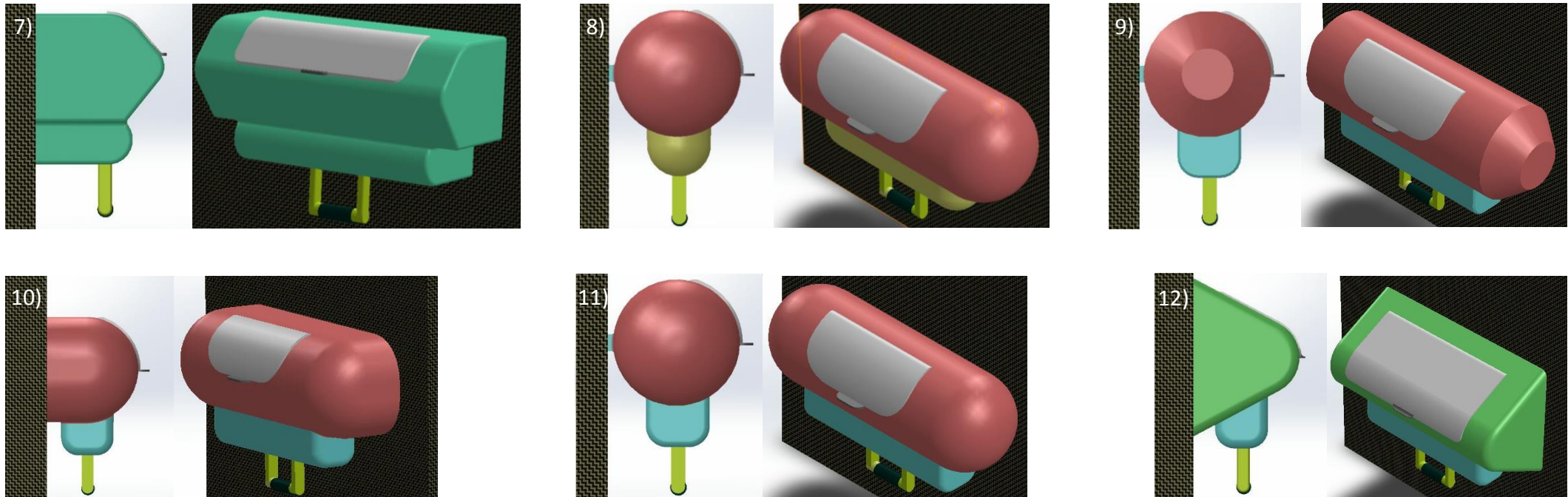
Form exploration (Phase 2)

After finalizing the concept and mechanism various form designs were made on paper. To get a better understanding of the machine in 3D forms design was done on solid works. CAD models were made and this made it possible to see the different views of the form designed and select 1 particular form from it.



Forms in phase 2 appeared to be slightly boxy and bulky hence more form were made in order to make the product look more elegant than bulky by adding more curves and cuts to the form.

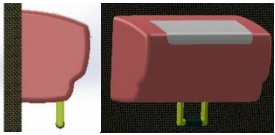
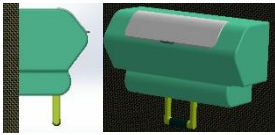
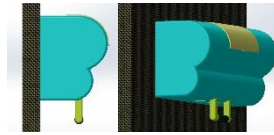
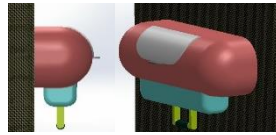
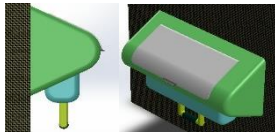
Form exploration (Phase 3)



In phase 3 an attempt was made to make the product look more elegant than bulky by adding more curves and cuts to the form after which 5 forms were shortlisted and user research & evaluation was done to get a better understanding of what kind of form does the user prefer.

Form Evaluation- User Research

To get a better understanding of what kind of form the users prefer, the shortlisted forms were shown to the users and according to their feedback and liking the final form was selected.

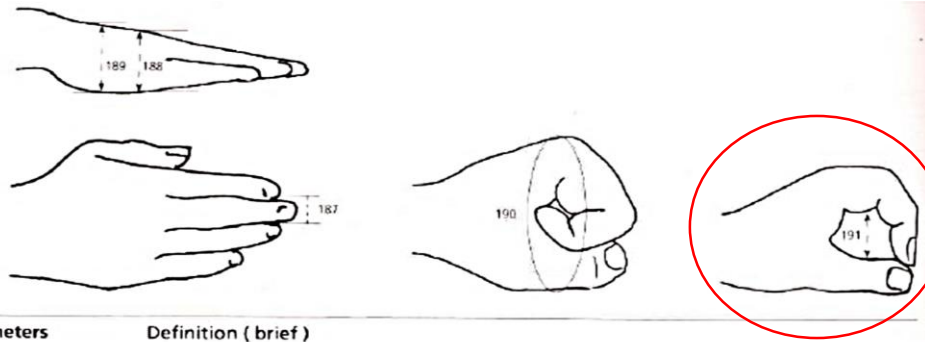
Shortlisted forms	Form 2	Form 7	Form 6	Form 10	Form 12
Looks	 2	 2	 2	 3	 4
Visual space	1	2	1	3	4
User Feedback	Looks very bulky. Seem like the form is coming on to us. Will occupy a lot of space.	Very bulky. Looks like an AC.	Looks very huge . Will occupy a lot of space.	Looks nice. The round corners will lead to wastage of space as the machine can not be placed in the corner or in between two shelves.	Looks nice. Can be placed in the corners and between two shelves. Will occupy less space.
Total score	3	4	3	6	8

Evaluating Scale:

Poor = 1
Average = 2
Good = 3
Very good = 4
Excellent = 5

Conclusion: Since form no. 12 was given the maximum number of points by the users and after having a discussion with my guide this form was finalized after which refining and detailing was done on it.

Anthropometric Considerations

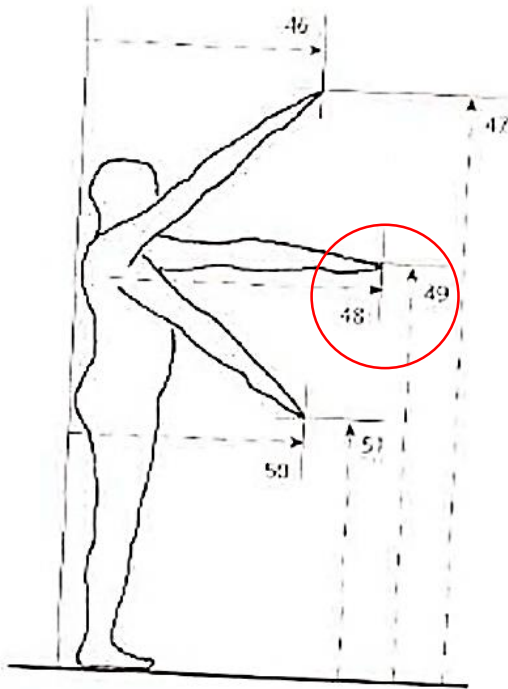


R.No.	Parameters	Definition (brief)
187	Finger-tip breadth	Maximum distance across the lateral surfaces of the tip of the middle finger.
188	Hand depth at metacarpal	Maximum thickness between the dorsal and the palmar surfaces of the palm, across the knuckle of the middle finger, where it joins the palm.
189	Hand depth, at thumb base	Maximum thickness of the palm, on the fleshy pad at the base of the thumb.
190	Fist circumference	Maximum circumference of the fist, wherever found, encompassing the knuckles of the middle finger and the thumb.
191	Grip inside diameter, maximum	Maximum inside grip diameter, measured by sliding the hand down a graduated cone until the tips of the thumb and the middle finger remain touched to each other.

R.No.	Parameters		Min	Percentiles					Max	Mean	±SD	Ratio
				5th	25th	50th	75th	95th				
187	Finger-tip breadth	Male	13	13	14	15	16	17	20	16	1	0.01
		Female	10	11	12	12	13	15	16	13	1	0.01
		Combined	10	12	13	14	15	17	20	15	2	0.01
188	Hand depth at metacarpal	Male	15	18	21	24	27	31	39	25	4	0.02
		Female	17	17	20	23	25	29	37	24	4	0.02
		Combined	15	18	21	23	26	31	39	25	4	0.02
189	Hand depth at thumb base	Male	26	34	37	40	44	50	65	42	5	0.03
		Female	29	30	34	37	38	43	44	37	4	0.02
		Combined	26	34	37	40	43	50	65	41	5	0.03
190	Fist circumference	Male	220	240	252	264	279	294	373	266	19	0.16
		Female	200	205	219	229	237	249	250	227	13	0.15
		Combined	200	219	247	259	275	294	373	260	23	0.16
191	Grip inside diameter, maximum	Male	39	42	46	49	51	56	60	50	4	0.03
		Female	39	40	42	46	49	52	57	47	5	0.03
		Combined	39	41	46	49	51	56	60	49	4	0.03

Grip inside diameter was considered in order to design the handle for the washing machine : 47mm

Anthropometric Considerations

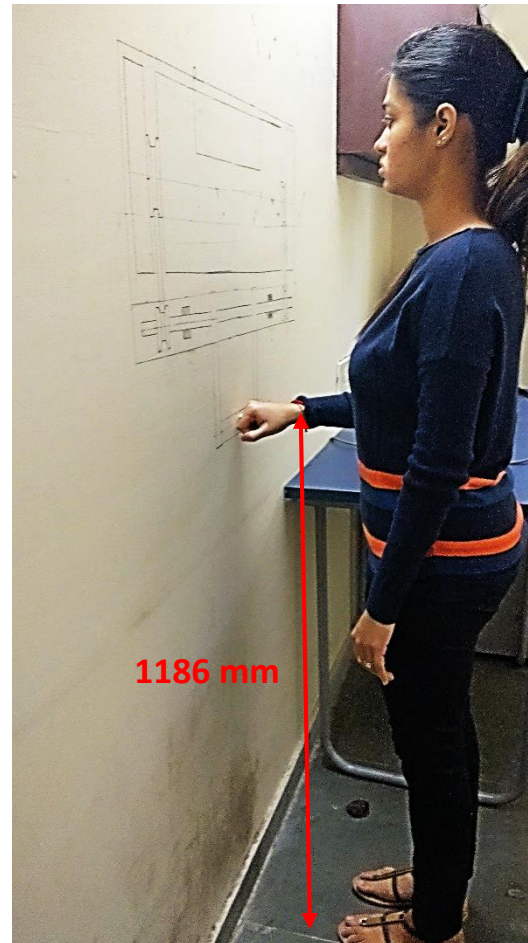
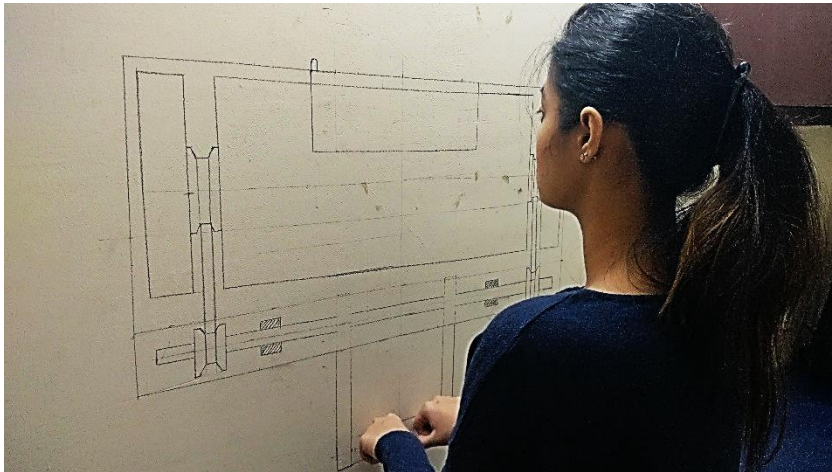
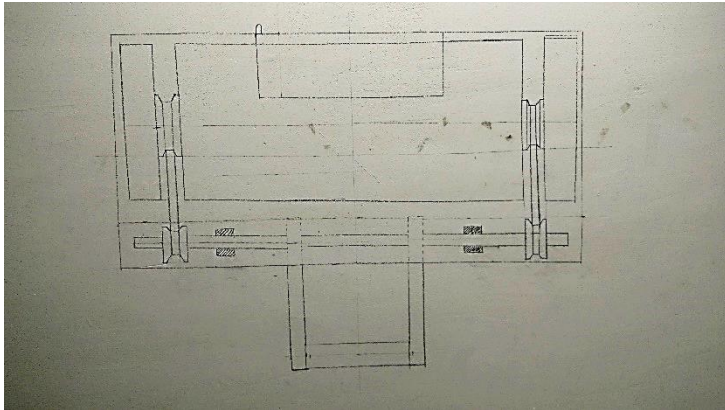


R.No.	Parameters	Definition (brief)
46 - 51		Standing in erect posture, forward comfortable arm reaches from back and heights from floor.
52		Standing in erect posture, forward comfortable mid position grasp reach length from back.

R.No.	Parameters		Min	Percentiles					Max	Mean	±SD	Ratio
				5th	25th	50th	75th	95th				
46	Upper position length	Male	390	469	559	629	689	799	940	632	100	0.38
		Female	350	399	539	629	689	809	880	613	109	0.4
		Combined	350	459	559	629	689	799	940	628	102	0.39
47	Upper position height	Male	1575	1659	1799	1869	1949	2064	2220	1874	118	1.14
		Female	1290	1519	1659	1759	1849	1949	2060	1747	135	1.14
		Combined	1290	1624	1769	1849	1929	2059	2220	1848	132	1.14
48	Mid position length (Forward arm reach)	Male	589	749	809	849	879	939	1050	847	64	0.51
		Female	600	704	759	799	844	919	980	803	64	0.53
		Combined	589	729	799	839	874	939	1050	837	67	0.52
49	Mid position height	Male	1090	1229	1309	1369	1409	1509	1841	1363	89	0.83
		Female	1070	1139	1209	1279	1329	1439	1540	1278	89	0.83
		Combined	1070	1179	1279	1349	1399	1489	1841	1345	95	0.83

Mid position height was considered in order to design to decide the placement of the machine on the wall from the ground level : 1278mm

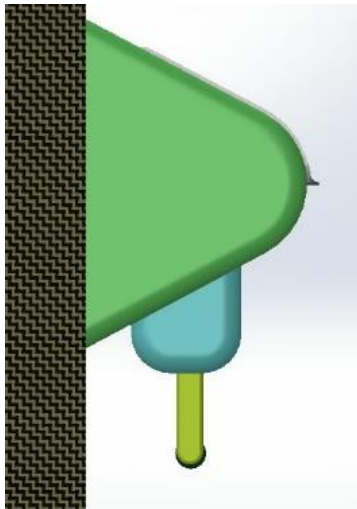
Anthropometric Considerations



To get a better understanding of the product dimensions and the anthropometric considerations I drew a 1:1 size model on the wall. This gave a visual understanding of how the actual product will be. Also it gave me the idea of how much space on the wall will the machine occupy and at what height should it be placed above the ground level. I also drew the inner mechanism of the washing machine. This helped me in figuring out the exact placement of the part in the machine & With the help of this very small changes were made in the dimensions of the product.

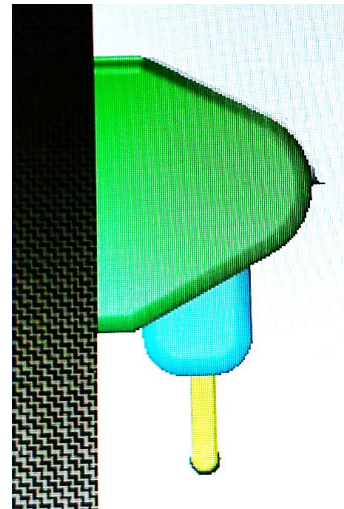
Final Form Refinement

After finalizing the form and having a discussion with my guide it was mutually decided the chosen form would need further refinement. The refinement had 3 stages wherein changes were made at every stage and stage 3 was selected as the final form of the product. The final form was made with anthropometric consideration.



Stage 1

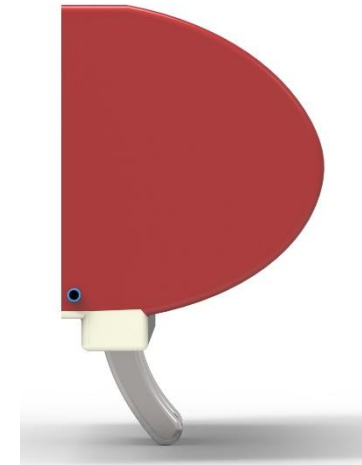
Stage 1 was the initial form. It was realized the upper and lower corner are stretched to far which was not required because the internal mechanism did not occupy that much space. So we thought of making changes in the form.



Stage 2

In stage 2 the corners of the upper and bottom end were trimmed and flattened. After flattening the end the form looked slightly strange. So further changes were made in the form.

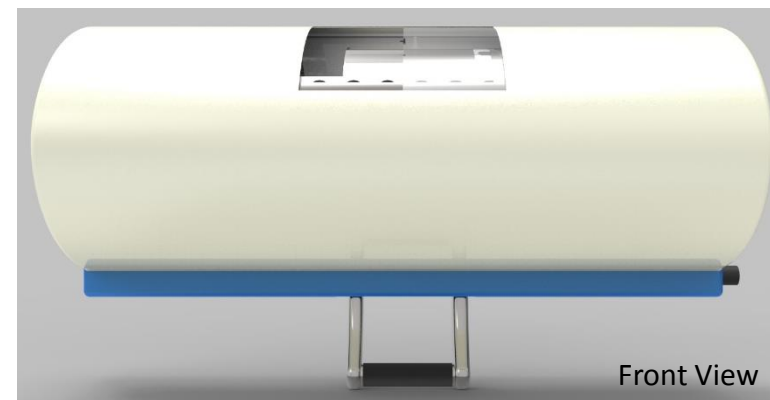
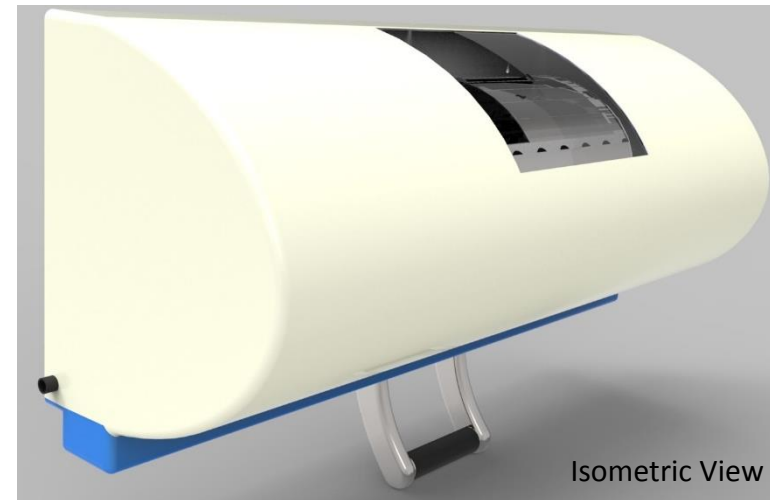
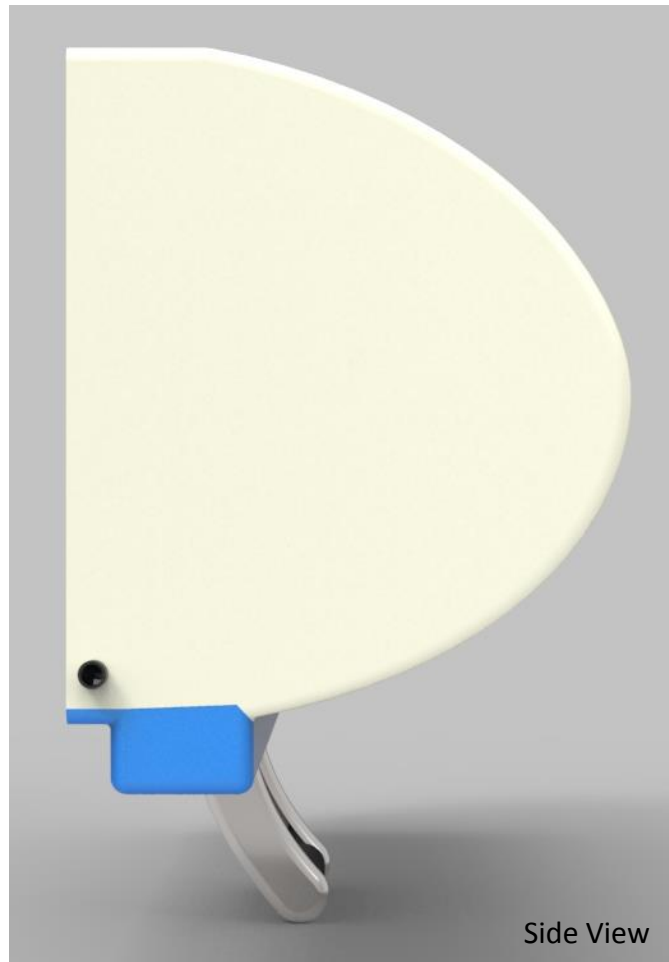
Final form



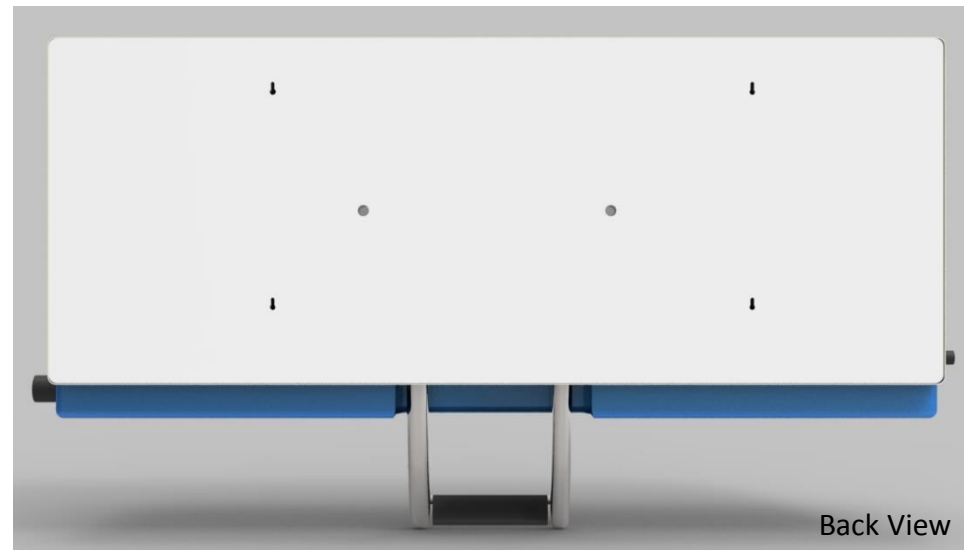
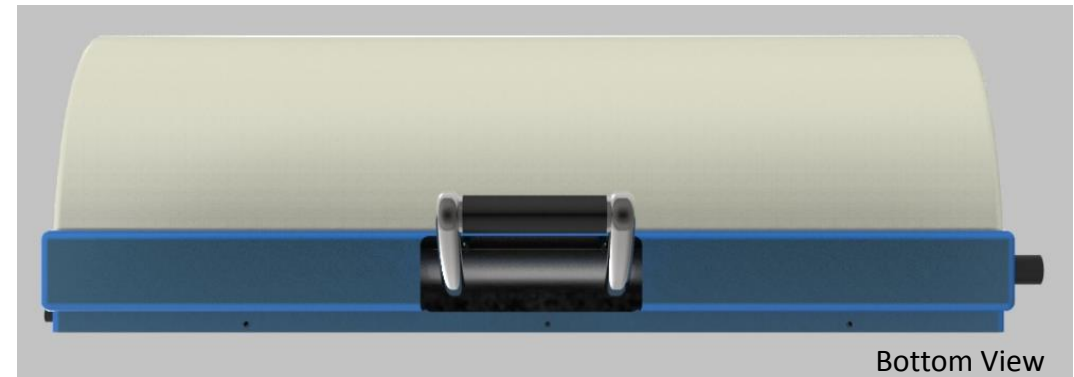
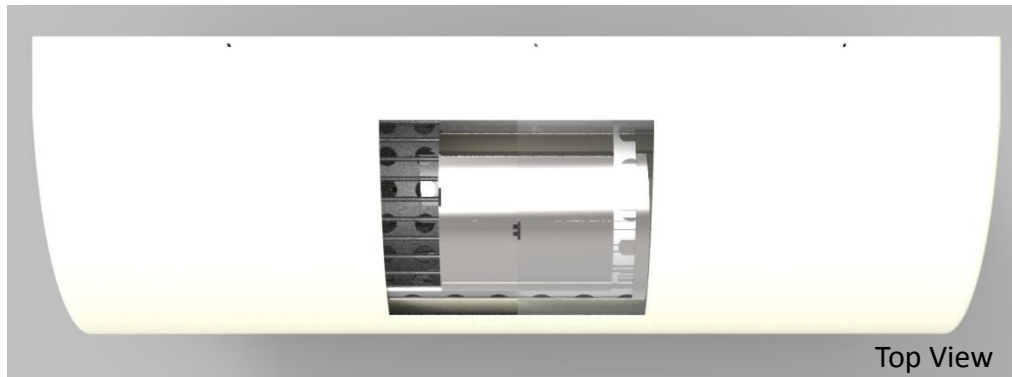
Stage 3

In stage 3 the corners of the upper and bottom end were kept flat and the body was given an angle/curve to increase its aesthetic value. This form perfectly fit the need of the project of looking simple but elegant. Hence this for was finalized.

Final washing machine (CAD Model)



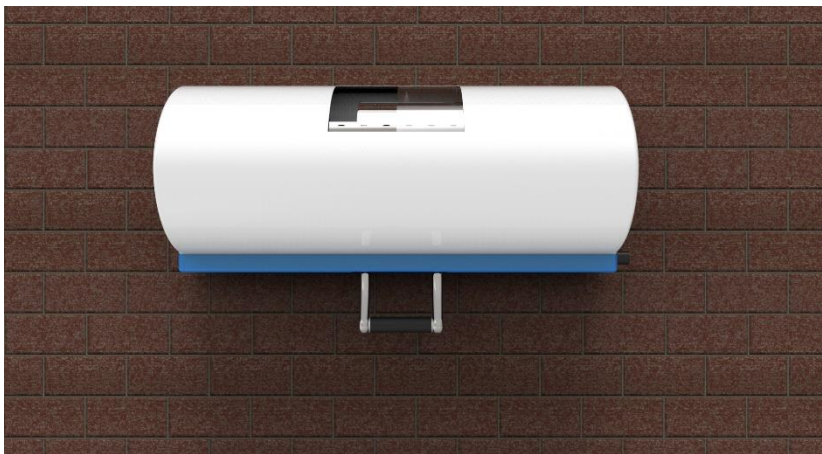
Final washing machine (CAD Model)



Final washing machine (About the Product)

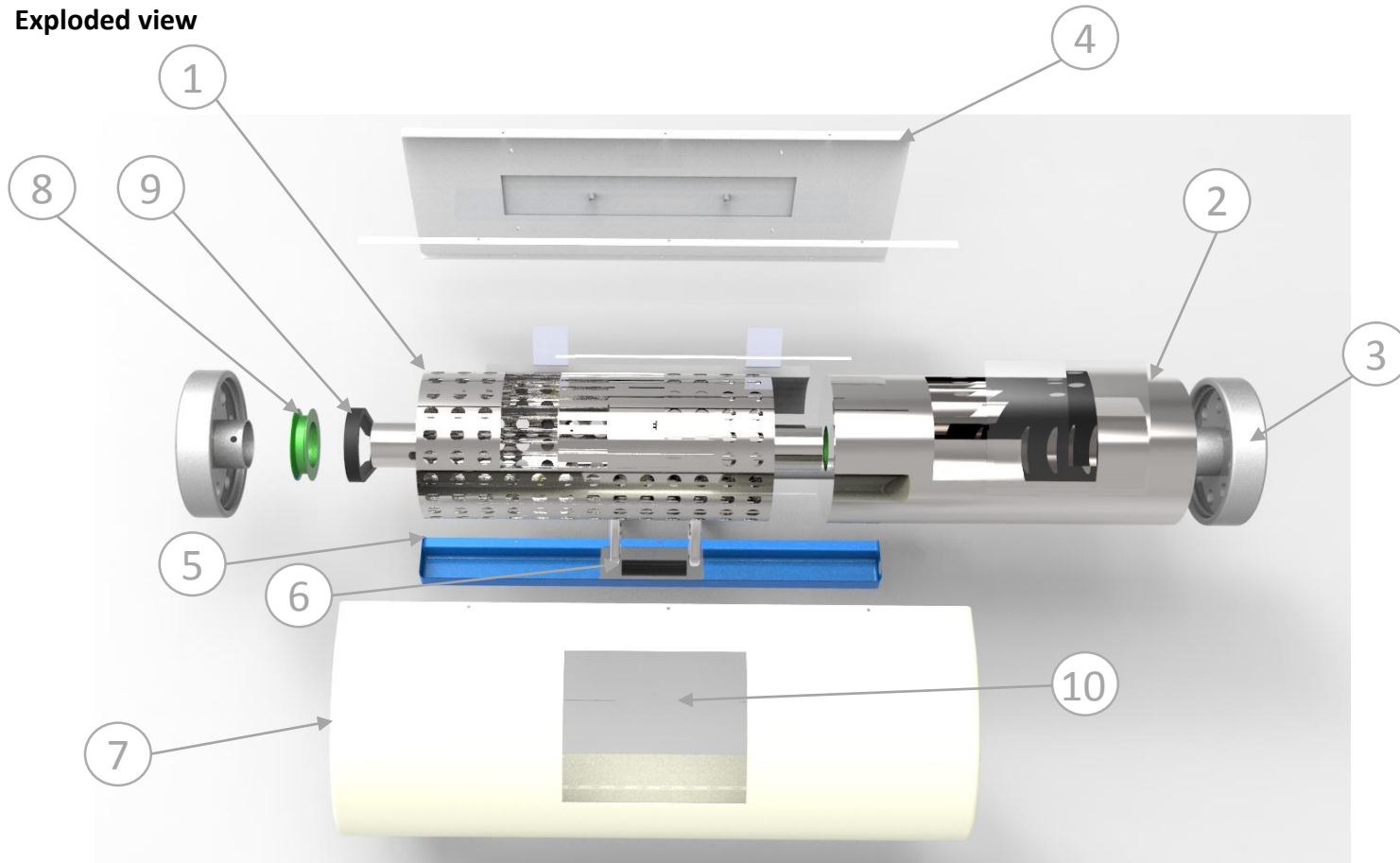


This product is a low cost washing machine for low income groups. It is wall mounted & it is manually operated. It has a handle that needs to be pushed back a forth in order to making the machine work. This machine has a capacity of 6kg. This machine has a transparent lid needs to be opened to load and unload the clothes. This washing machine has two drums. Both inner and outer drums are made of stainless steel. The inner drum has perforations which helps in better cleaning of the clothes. The drum is placed horizontally and gives a drop action to the clothes while they are washed, works as a front load washing machine. It has two flywheel on either side of the machine that cause the rotation when the handle is pushed. The flywheels store the energy input and distributes it evenly. This makes the machine extremely user friendly in terms of the effort required. This machine uses the belt drive mechanism which makes it extremely low cost, noise free, compact, simple to use/operate. This machine completely fits the needs of the users and looks simple but elegant.



Final washing machine Detailing (CAD Model)

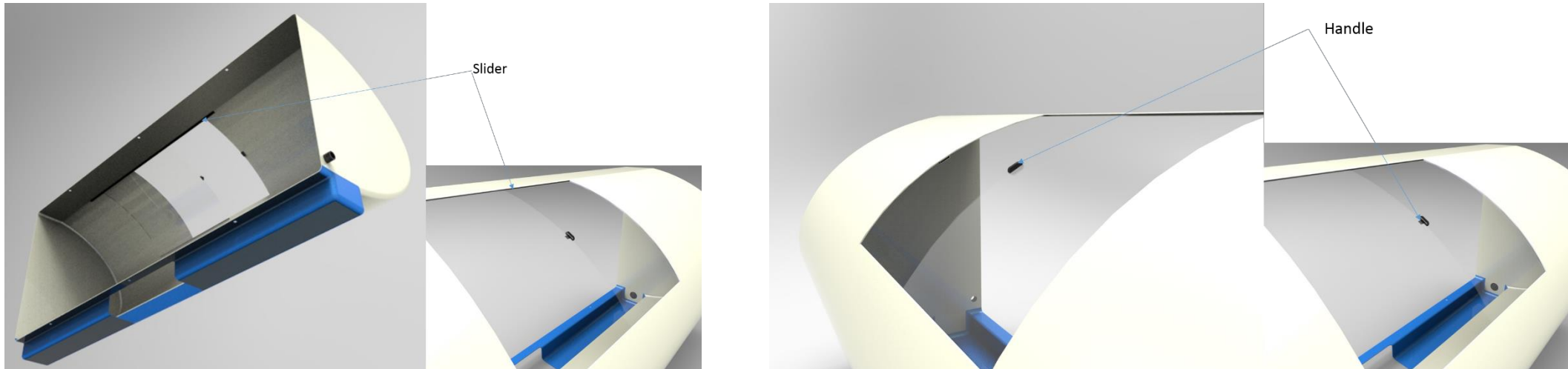
Exploded view



Item no.	Part Name
1	Inner Drum
2	Outer Drum
3	Flywheel
4	Back Cover
5	Shaft
6	Handle
7	Body
8	Pulley
9	Belt
10	Lid

Final washing machine Detailing (CAD Model)

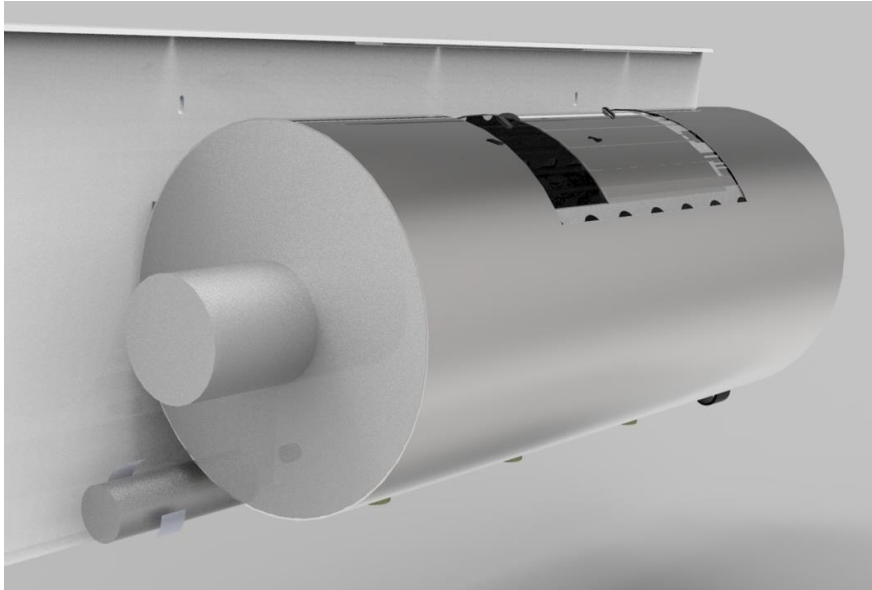
Lid Details



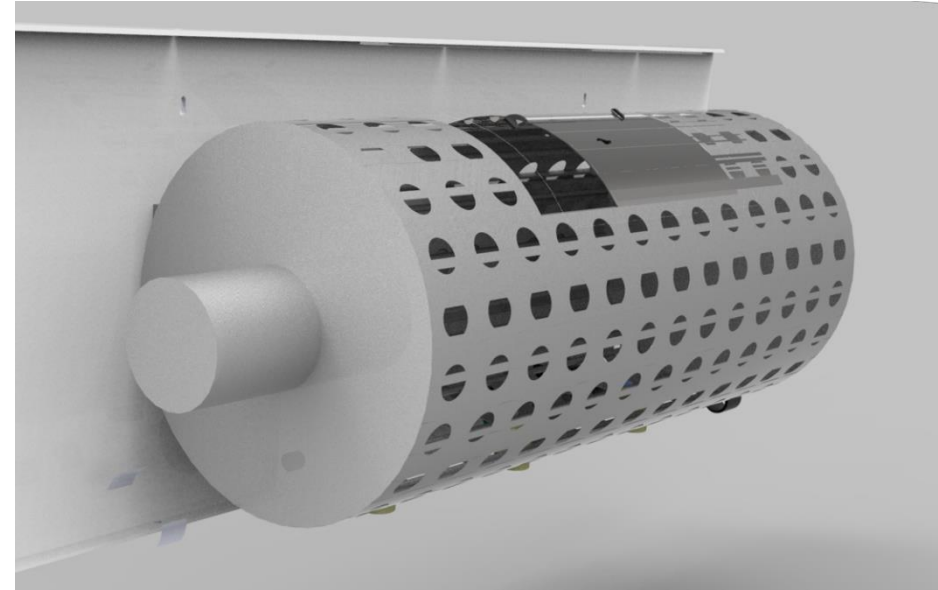
The washing machine has a lid on the body. The lid is made of acrylic and enables the user to see the washing process while the machine is in use. The user is required to open the lid of the washing machine in order to load and unload clothes from the drum. The lid has a small handle on it which makes it easy to open and close the lid.

Final washing machine Detailing (CAD Model)

Drums



Outer Drum



Inner Drum

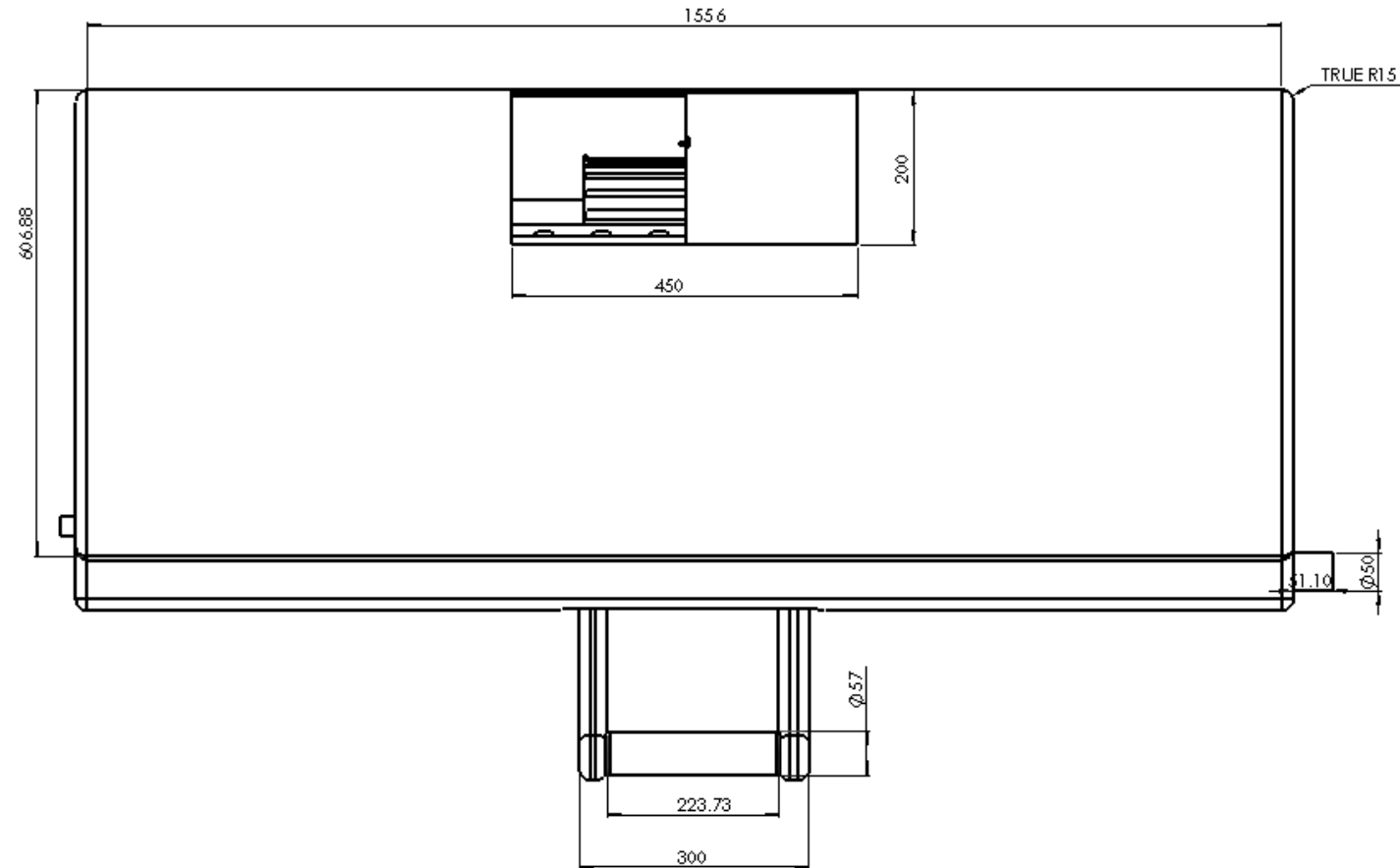
The washing machine has two drums. Inner & outer drum. Both inner and outer drums are made of stainless steel. The inner drum has perforations that help in better cleaning of the clothes. The drums are placed horizontally and gives a drop action to the clothes while they are washed, works as a front load washing machine.

Bill of Material

Item no.	Part Name	Material	Qty.
1	Inner Drum	Stainless Steel	1
2	Outer Drum	Stainless Steel	1
3	Flywheel	Cast Iron	2
4	Back Cover	Steel	1
5	Shaft	Steel	1
6	Handle	Steel	1
7	Lid	Acrylic	1
8	Body	Polypropylene (PP)	1
9	Pulley	Cast Iron	2
10	Belt	Rubber	2

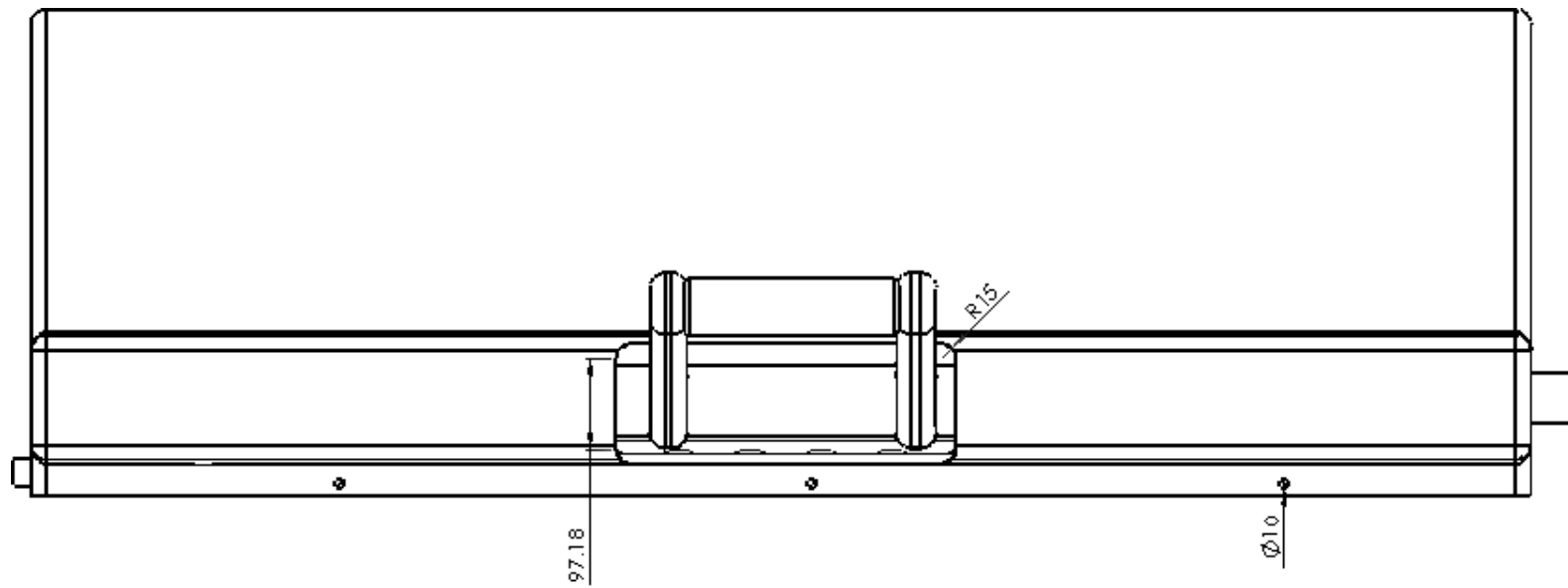
Final washing machine (Engineering Drawing)

Front view Dimensions



Final washing machine (Engineering Drawing)

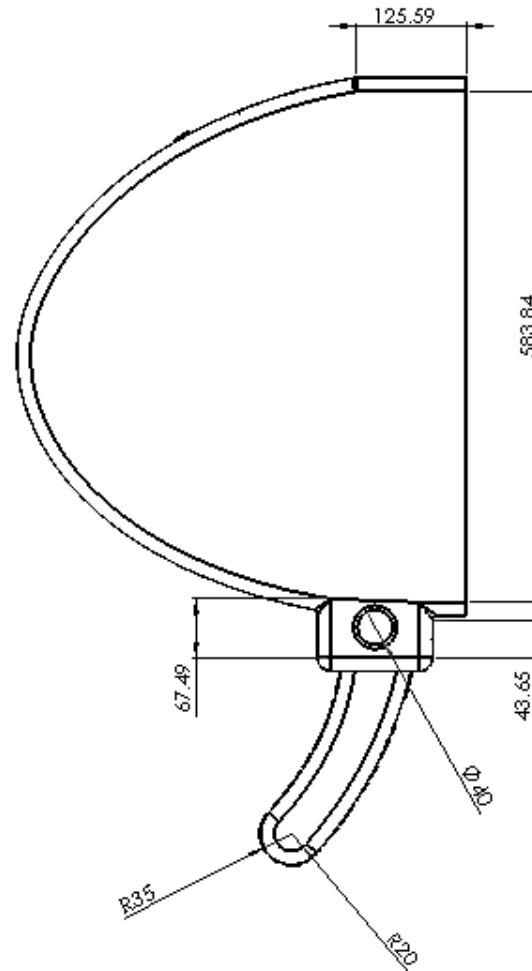
Bottom view Dimensions



SCALE 1 : 5

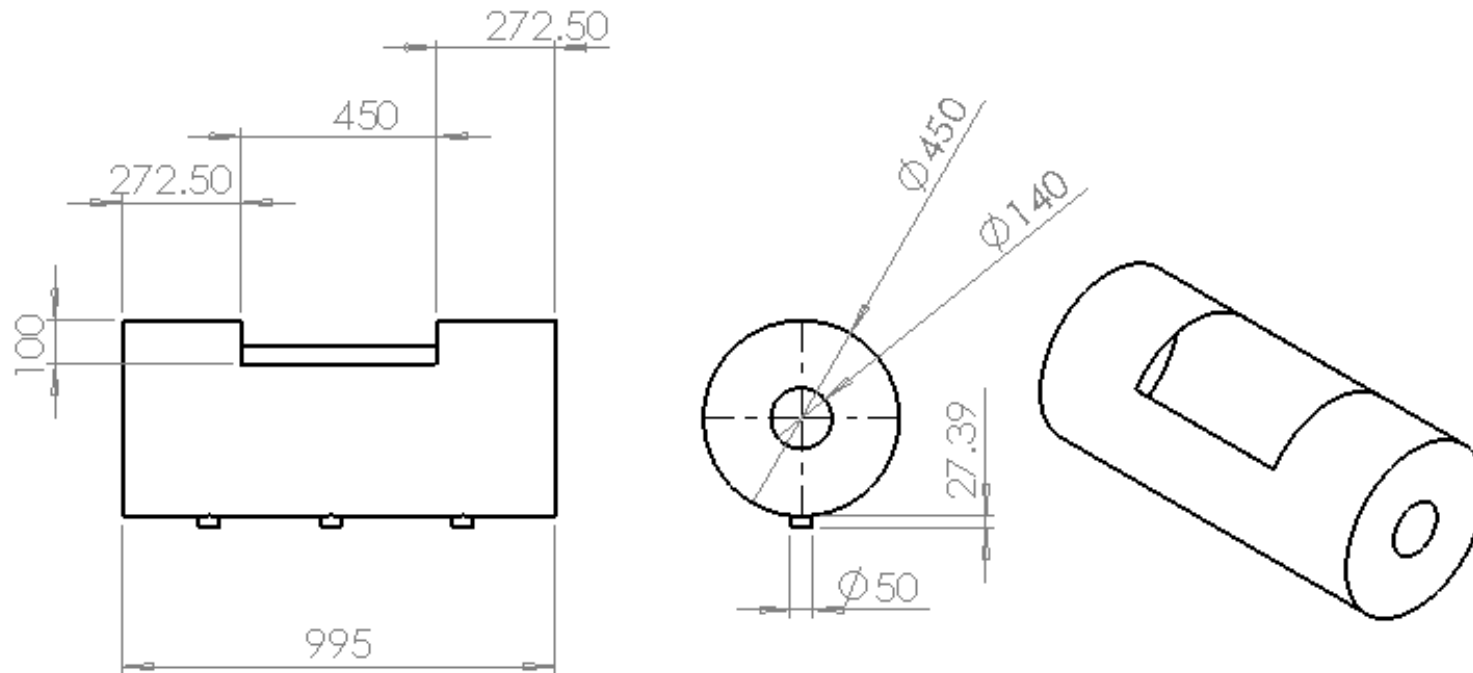
Final washing machine (Engineering Drawing)

Side view Dimensions



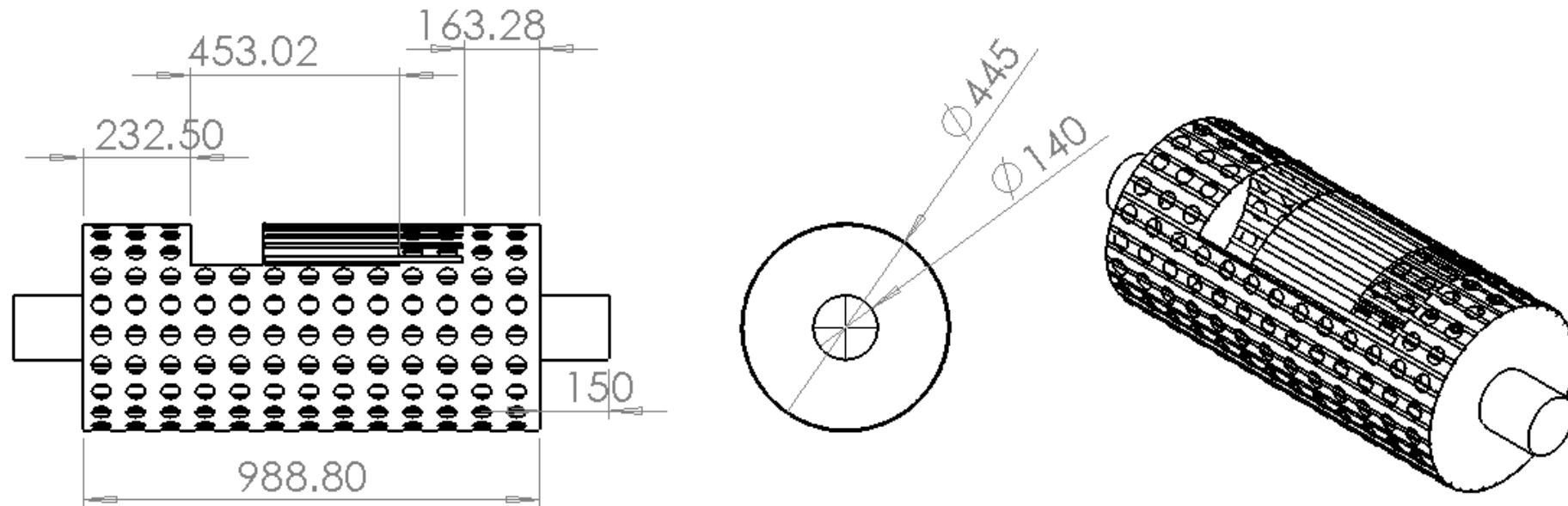
Final washing machine (Engineering Drawing)

Outer drum



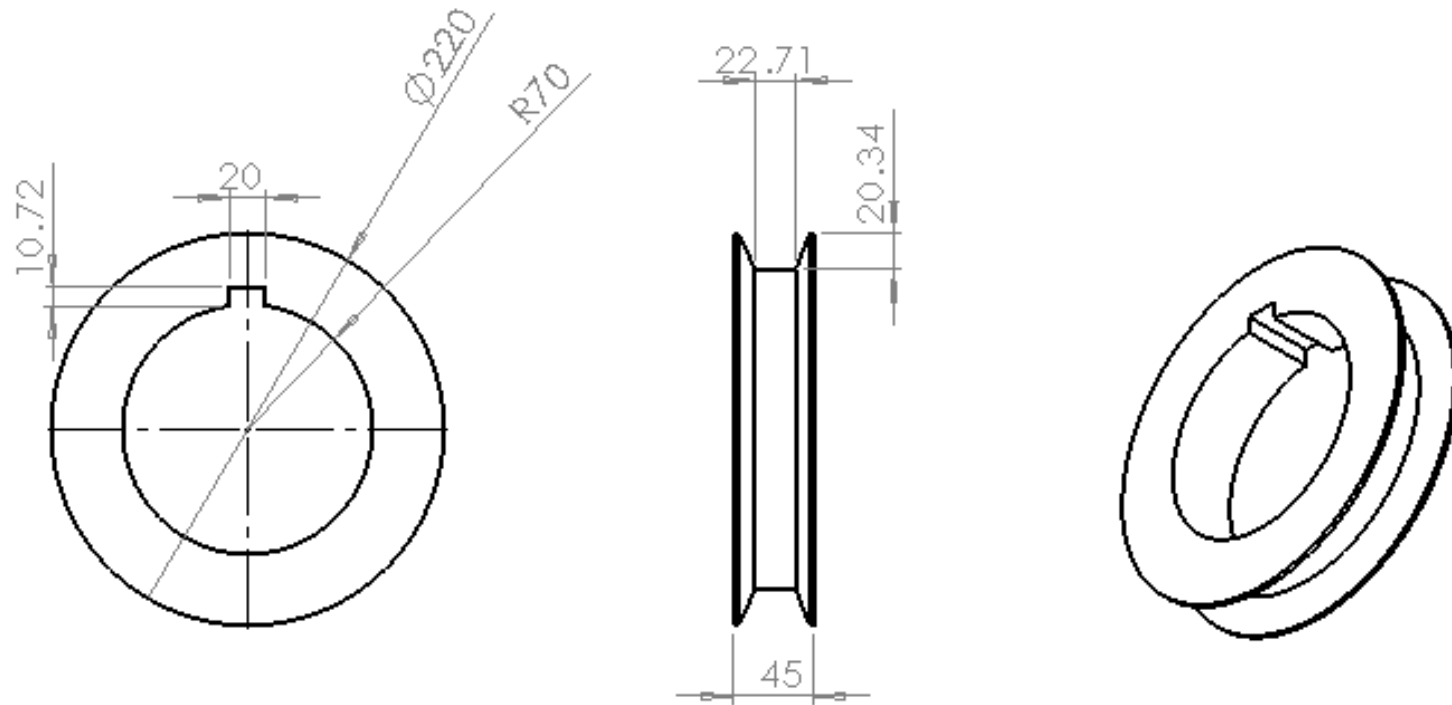
Final washing machine (Engineering Drawing)

Inner drum



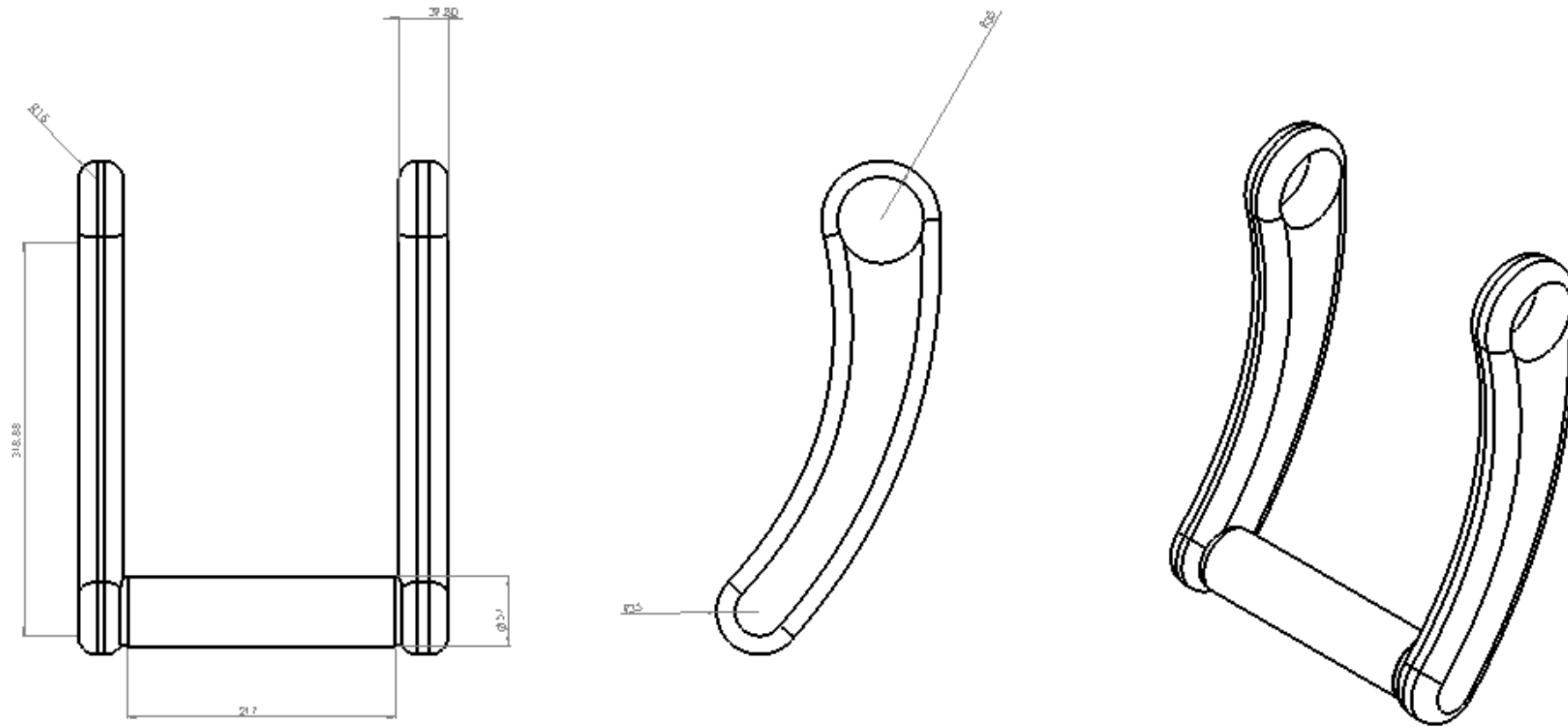
Final washing machine (Engineering Drawing)

Pulley



Final washing machine (Engineering Drawing)

Handle



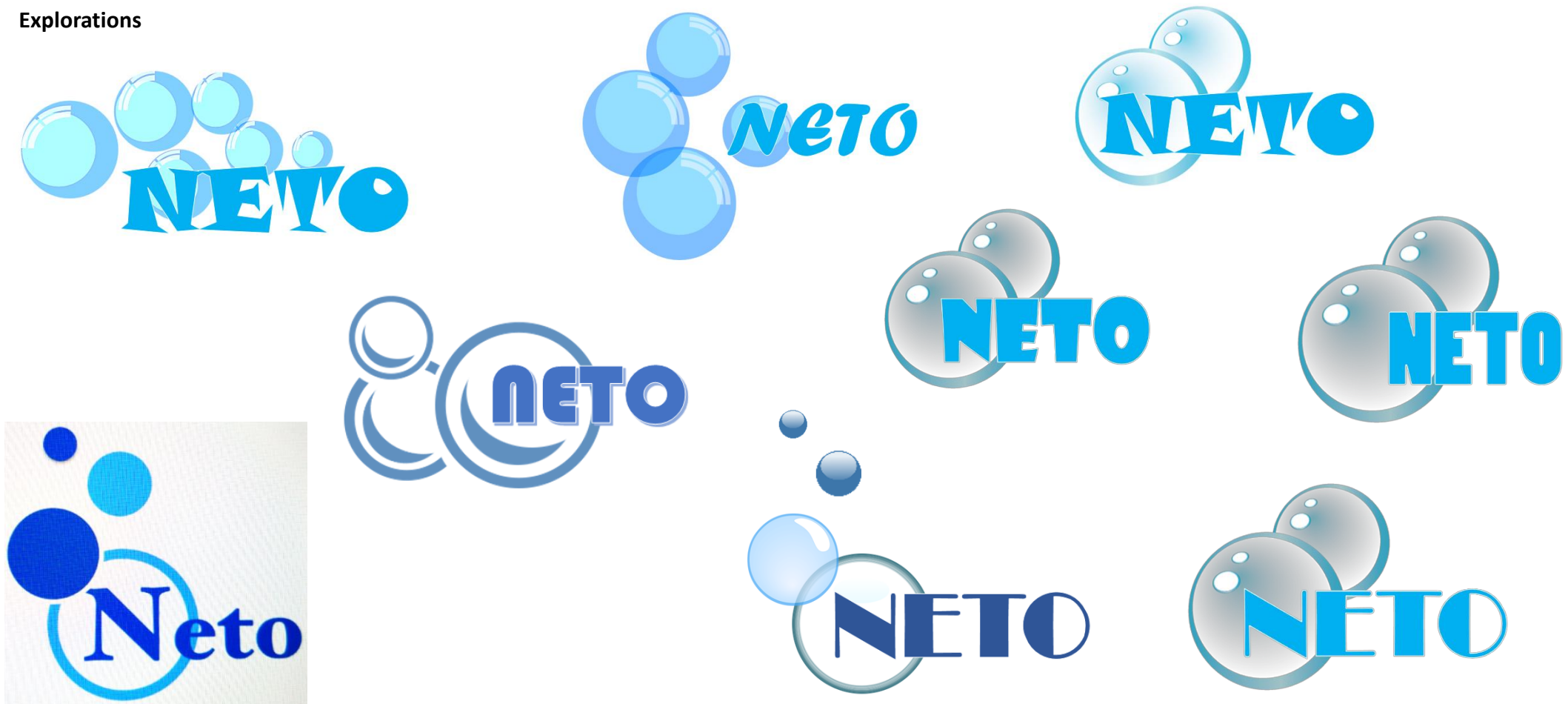
Final washing machine (Engineering Drawing)

Shaft



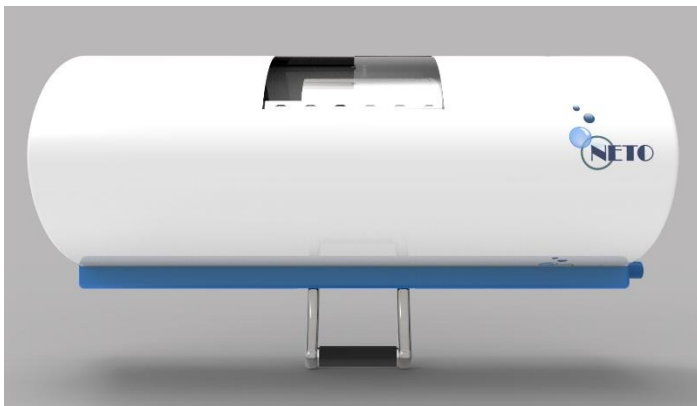
Branding & Logo

Explorations



Branding & Logo

Final Logo



Philosophy:

This washing machine is called "NETO". The name NETO is Spanish word that means clean and fresh. Since the product I've designed is a washing machine and its sole purpose is to provide clean and fresh clothes, the name NETO seemed apt for it. The design philosophy of the logo is derived from the functionality of the machine. Circle is chosen they depict the visual identity of the detergent bubbles. The amalgamation of the bubble and the product name gives the perfect combination of the washing machine's identity. The energetic blue colour is used for the logo in order to give the washing machine an identity of purity, cleanliness, freshness & playfulness.

Cost Estimation of Prototype

Material/Part	Quantity	Cost (Rs)
Stainless steel Sheet/ Inner and outer drum	6 feet*8 feet	~ 4000
Cast iron / Pulley and flywheel	4 each	~ 1000
Steel/Back cover, shaft and handle	1 each	~ 1500
PP/ Body	1	~ 500
Rubber/Belt	1	~ 200
Transportation	-	~ 200
Labor cost	-	~ 1000
10% Overhead cost (Elec., Tool, etc.)	-	~ 500
Total		~ 8900

Note - Estimated price of 1 prototype is **8900/-** (Including 10% overhead costs). The price of the machine will reduce when it is mass produced.

Future Scope & Possibilities

This washing machine is currently designed for the low income groups that do not have regular water & power supply, hence it is manually operated. This machine runs on belt drive mechanism. There is a possibility of fitting a motor in the machine in order to make it power driven. The users can easily attach a motor to the machine if and when required. Eg. User having regular water and power supply or user looking for a low cost washing machine.

Conclusion

The project followed a formal design methodology and proposed a design intervention in a challenging area of providing a Low-cost washing machine for the low income groups.

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.

Model will be presented in the jury.

Refrence

[1] http://patterns.ideo.com/issue/quality_design_for_the_poor/
<http://www.futureshop.ca/en-CA/research/laundry-buying-guide/rc8602.aspx>
<http://www.scribd.com/doc/22761142/The-Survey-Report-on-Washing-Machine-Market-in-India>
<http://info.shine.com/Industry-Information/Consumer-Durables/902.aspx>
<http://www.slideshare.net/rsm/a-complex-view-of-laundry>
<http://www.slideshare.net/keerthana777/top-washing-machine-brands-in-india>
<http://www.wringerhand.com/>
<http://www.apartmenttherapy.com/the-laundry-pod-international-141324#comments>
<http://www.cleanairgarden.com/portable-washing-machine.html>
http://www.ehow.com/info_10043792_agitator-washing-machine-vs-nonagitator.html
<http://www.walmart.com/ip/Honey-Can-Do-Three-Bag-Mesh-Rolling-Hamper/15641335>
<http://lifeandtimes.com/laundromat-by-the-snoori-bros-looks-at-a-dying-nyc-institution>
<http://vimeo.com/41938940>
<http://eliotcoven.wix.com/dev-world-laundry>
<http://freshome.com/2007/07/31/detergentless-haier-wash20-washing-machine/>

Book Reference :

- Indian Anthropometric dimensions, Author: DebkumarChakrabarti, 2011