



TEAM SPARTA

GROUP 4

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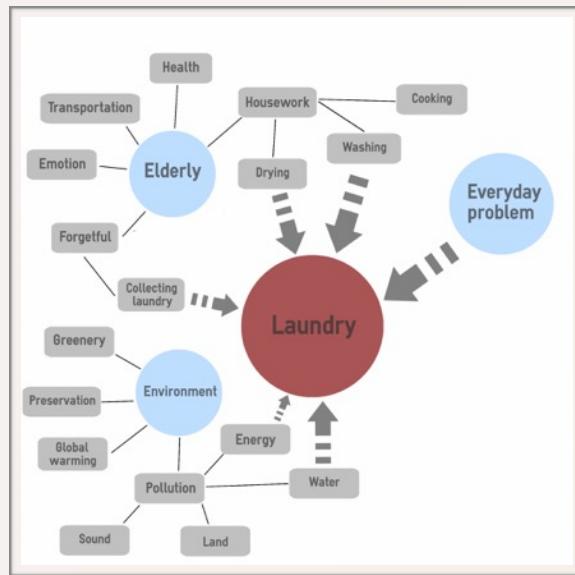
PROBLEM SCOPING

Our process to determine the topic of interest

BRAINSTORMING



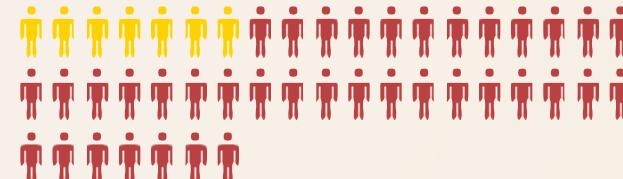
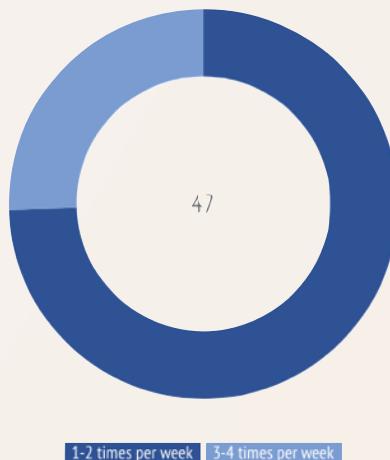
RATIONALE



Through brainstorming, we narrowed down our ideas to: Environment, Elderly and Everyday problems.

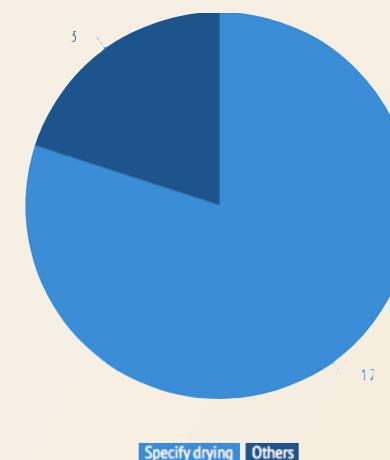
Based on the rationale and the result of mind mapping, we realized that laundry was an issue central to all ideas.

Frequency of doing laundry

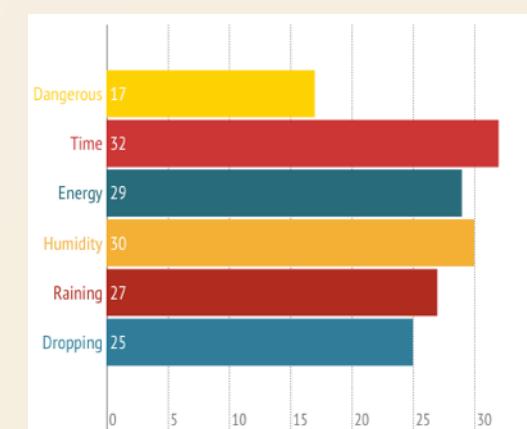


Laundry is not a problem Laundry is a problem

Troublesome steps

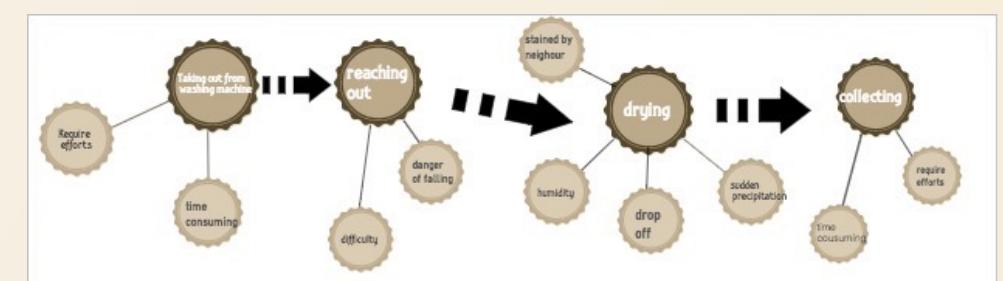


Problems of drying

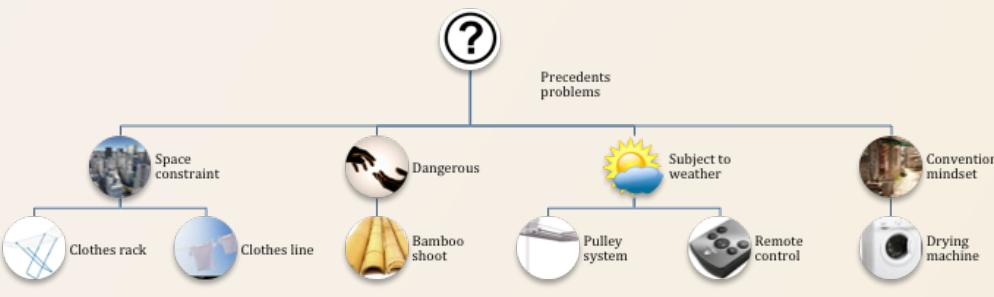


SURVEY

PROCESS FLOW



PRECEDENT ANALYSIS



PROBLEMSCOPING

We identify the main problem faced by people to be hanging of laundry.

Hereon, we will analyze existing laundry hanging process and design, framing our problem to a statement.

PROBLEM STATEMENT

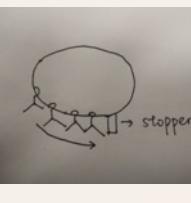
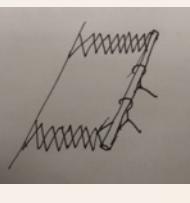
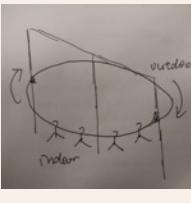
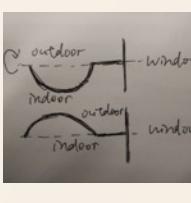
Drying laundry takes too much time and effort, while engendering safety issues. Its existing solutions are not radial enough hence frustrating people in everyday life

2 IDEATION

Idea generation and selection

- Based on the design brief and strategy, we came up with a number of solutions that can resolve laundry problem to different extents. We adopted the method of Pugh Chart to select from them the best solution in a reasonable and clear manner.

PUGH CHART

Description	Hostel clothes rack	EZ Hi-Dry	Slanted rack + collapsible hanger	Rotating circular loop + collapsible hanger	Retractable clothes rack outside window	Rotating circular loop attached to window grill	Rotating half-moon loop attached to window grill
Sketch							
Identity	Current Solution	Current Solution	Design 1	Design 2	Design 3	Design 4	Design 5
Reduce steps	0	+	+	0	+	+	+
Simplify steps	0	+	+	+	+	+	+
Save efforts	0	+	+	+	+	+	+
Low cost	0	0	-	0	-	-	-
Not engender safety issues	0	0	0	-	-	-	-
Ease of installation	0	0	-	-	-	-	-
Intuitive use	0	+	+	-	+	-	-
Space	0	0	0	+	+	+	+
Not create new problems	0	+	+	-	-	-	-
Total	0	5	3	-1	1	-1	

Though the scoring difference is quite obvious, we still have to take a closer look at the chart. Among the criteria, there are some that are actually more crucial. For example, **safety issues** are always a major concern, and we would never compromise the commercial potential by designing a product that cannot cater to **low cost** and **ease of installation**.

In light of all the factors, we settled down on the idea of **collapsible hanger** designed with a slanted rack.

DESIGN BRIEF

1) Goals & Vision:

- To design a product fundamentally different from the existing solutions without creating new problems.
- We hope to simplify the current way of drying clothes by looking into its multiple steps, in order to enhance the overall laundry experience, through which we can convey an attitude of "simpler life, better world".

2) Target audience & scope of project

- People who do laundry (everyone)
- High-rise buildings in urban areas

3) Analysis of precedents/functions/activities

Same methods -> not radical enough

4) Requirements

- Solving the primary problems quoted by the survey:
 - Reduce human labor (energy + time)
 - Minimize safety hazards
- Solution should address problems in a creative way
- The solution will not occupy much space
- An additional aim to simplify procedures

5) Constraints

- Time: 7 weeks
- Budget: \$300

6) Deliverables/Deadlines

- Oral presentation -> Week 7 and 13
- Poster -> Week 7 and 13
- Video -> Week 9
- Portfolio, prototype -> Week 13

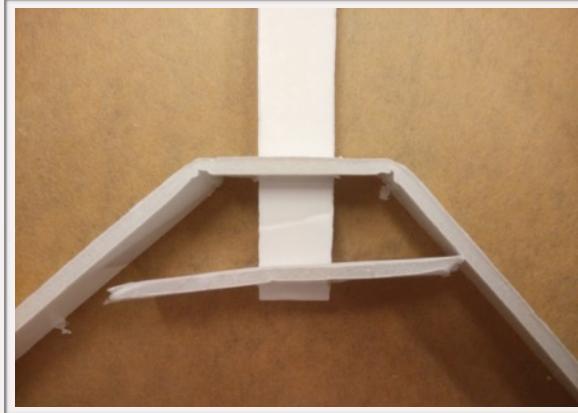
DESIGN STRATEGY

Use a combination of simple mechanism and automation to simplify the procedures of drying clothes by eliminating troublesome steps.

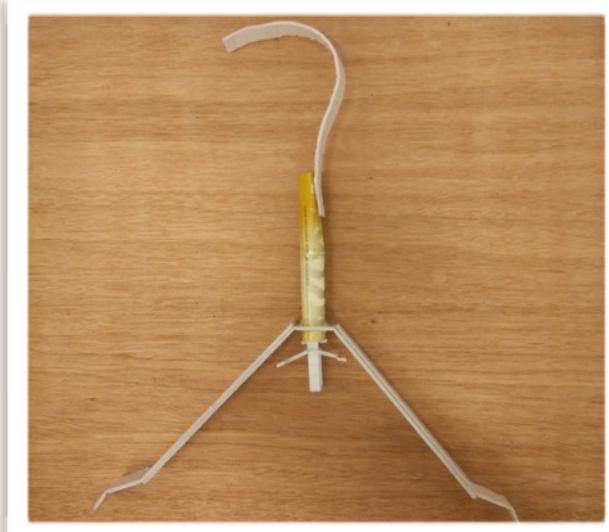
PROGRESSION CARDBOARD



- First rough cardboard prototype
 - Shows how to realize collapsing by a lifting plate



<normal view>



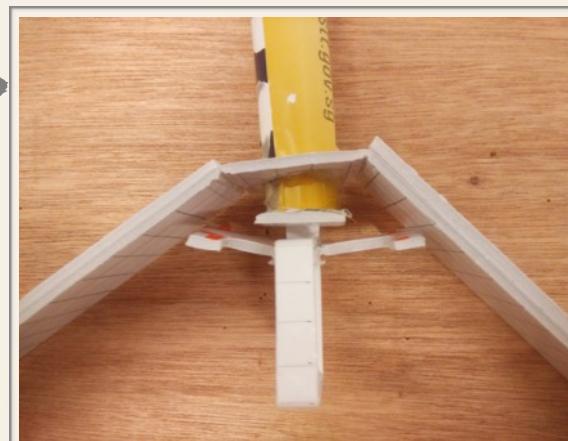
- Second cardboard prototype
 - More detailed mechanism that explains the process of auto dropping

GUIDING QUESTIONS

-  How to perform auto-collection by only one click without generating extra high costs?
 -  How to trigger a domino effect among multiple hangers?
 -  How to resume the apparatus after using it?
 -  How to retain the basic functions of precedents while adding on with fundamentally different design?

3 PROTOTYPE DEVELOPMENT

Come to our final design through multiple prototypes

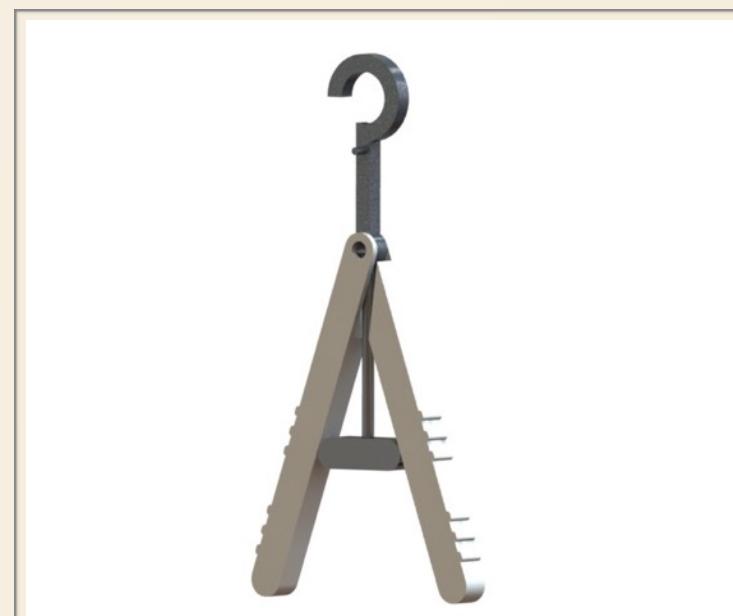


A photograph showing two black, modern-style coat hooks mounted on a light-colored wall. Each hook consists of a vertical rectangular bar with a curved horizontal arm extending from its side.

<connection>



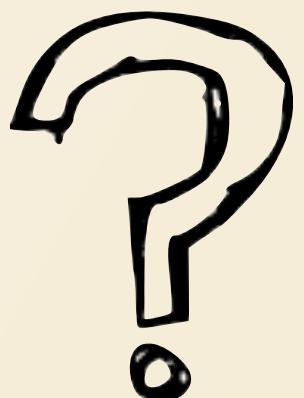
<normal view>



<collapsed view>

Conclusion

The process of preliminary prototyping using simple cardboard technique and 3D modeling gives us a chance to try out some ideas and also makes us clearer about how our final prototype would be like. At this point, we have solved the first guiding question and touched on the rest of the question. Having these results in mind, we need further proof from calculations and experiments, in order to finalize the design.

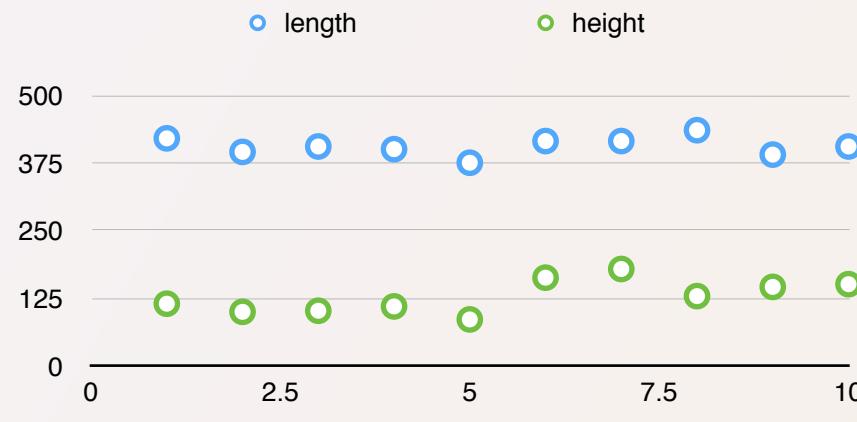


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PRELIMINARY STUDY

General dimensions

We measured the size of 10 different kinds of hanger in order to find the average size for our hanger.



Our hanger size:
LENGTH: 350-420mm HEIGHT: 100-250mm

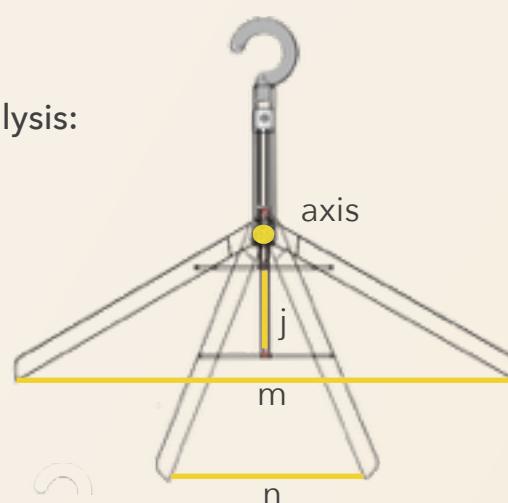
Dimensions of legs and lifting plate

Declaration of variables:

Length of the legs: l
 Height of the legs when they are open: h
 Height of the legs when they are closed: p
 Distance between two ends when they are open: m
 Distance between two ends when they are closed: n
 Length of the lifting plate: d
 Distance between axis and lifting plate while legs are open: $k=20\text{mm}$
 Adjustable range of the height of lifting plate: $j=100\text{mm}$
 Smallest shirt collar: $s=170\text{mm}$

Requirements and analysis:

$100\text{mm} < h < 250\text{mm}$
 $350\text{mm} < m < 420\text{mm}$
 $n > 170\text{mm}$
 $m = 2(l^2 - h^2)^{1/2}$
 $d/m = 20/h$
 $d/n = (20 + 100)/p$



Results (final dimension):

$l=200\text{mm}$
 $h=195\text{mm}$
 $p=295\text{mm}$
 $m=372\text{mm}$
 $n=165\text{mm}$
 $d=70\text{mm}$

Weight capacity

- Due to the equality of impulse and change in momentum, increase the mass can increase the force of pressing the button.
- The weight of the clothes can exert a downward force on the two legs therefore make it easier to collapse.

The maximum weight:

- The maximum force that can be applied to the hanger: $F_{\max}=8\text{N}$
- The heaviest jacket in general: $F_{\text{need}}=5\text{N}$
- $F_{\max} > F_{\text{need}}$
- Our hanger can carry almost all kinds of clothes.



Calculations in preparation for actual fabrication

Collision speed study

Calculations and analysis:

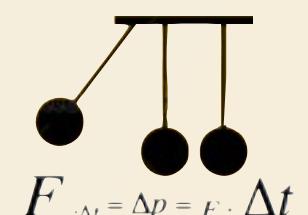
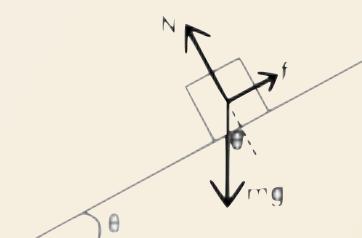
$$\begin{aligned} \text{impulse} &= \text{change in momentum} \\ F_t &= mv \\ \text{calculate the acceleration} \\ ma &= mg\sin x - umg\cos x \\ a &= g\sin x - ug\cos x \\ 2al &= v^2 - 0^2 \\ v &= (2al)^{1/2} = [2l(g\sin x - ug\cos x)]^{1/2} \\ F_t &= M[2l(g\sin x - ug\cos x)]^{1/2} \\ \text{substitute in our actual values:} \\ 0.6 \cdot 0.3 &= [2 \cdot 0.075 \cdot 0.5 \cdot 9.8 \cdot (\sin x - 0.5 \cos x)]^{1/2} \\ x(\text{min}) &= 30 \text{ degrees} \\ \text{therefore } x &= 30 \text{ degrees is the minimum angle for our rack} \end{aligned}$$

M is the net mass for a hanger, when we add some clothes on it, the total mass will increase so it will become easier to press the button and trigger the collision.



Preparation (Tests and measurement):

Force required to press the button: $F = 0.6\text{N}$
 Average time interval during collision: $t = 0.3\text{s}$
 Mass of a hanger: $m = 0.075\text{kg}$
 Friction coefficient between rack and hanger: $u = 0.3 \sim 0.5$
 The distance between the last hanger and the end of the rack: $l = 0.5\text{m}$
 Angle we want to calculate: x

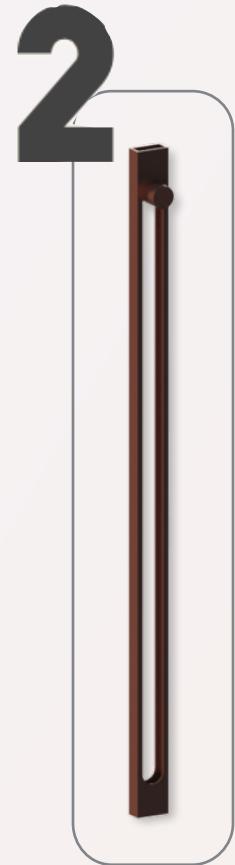
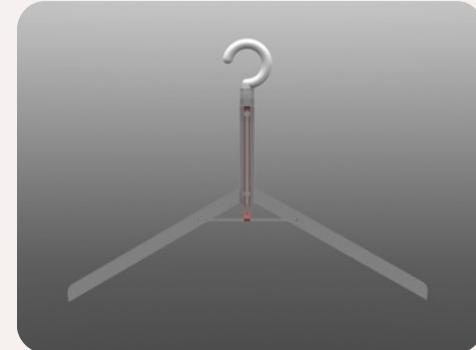


$$F \cdot \Delta t = \Delta p = F \cdot \Delta t$$



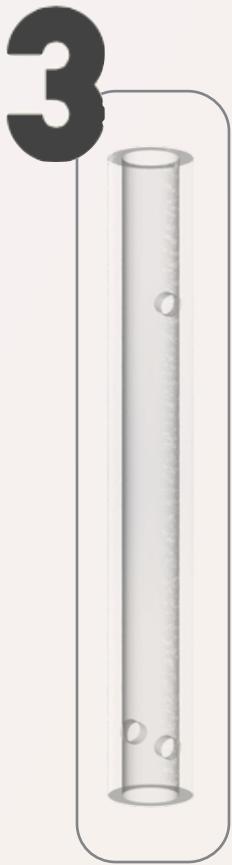
<major components>

HOOK
3D printed



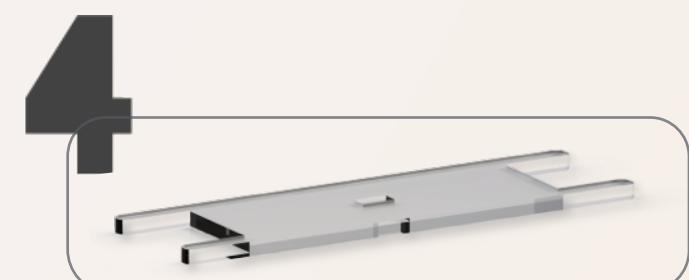
INNERSHAFT

Bronze
Key component
Attached to lifting plate



OUTERTUBE

Transparent glass
Clearly show the mechanism
Connect all components



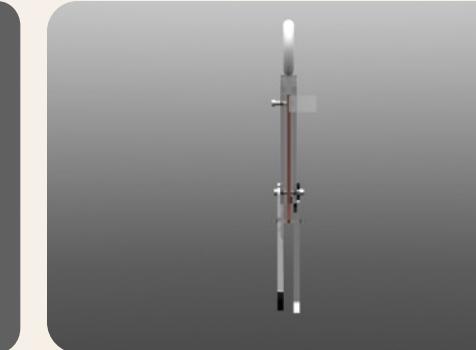
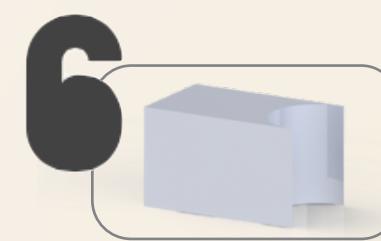
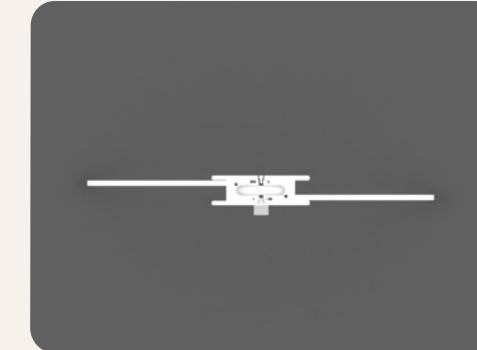
LIFTINGPLATE

Laser-cut 3mm acrylic
Guide the two legs



LEG

Laser-cut 3mm acrylic
Sustain the clothes



<front view>
<top view>
<side view>



<multiple hangers>

5 FINAL DESIGN - "CHANGE"

An everyday solution to an everyday problem

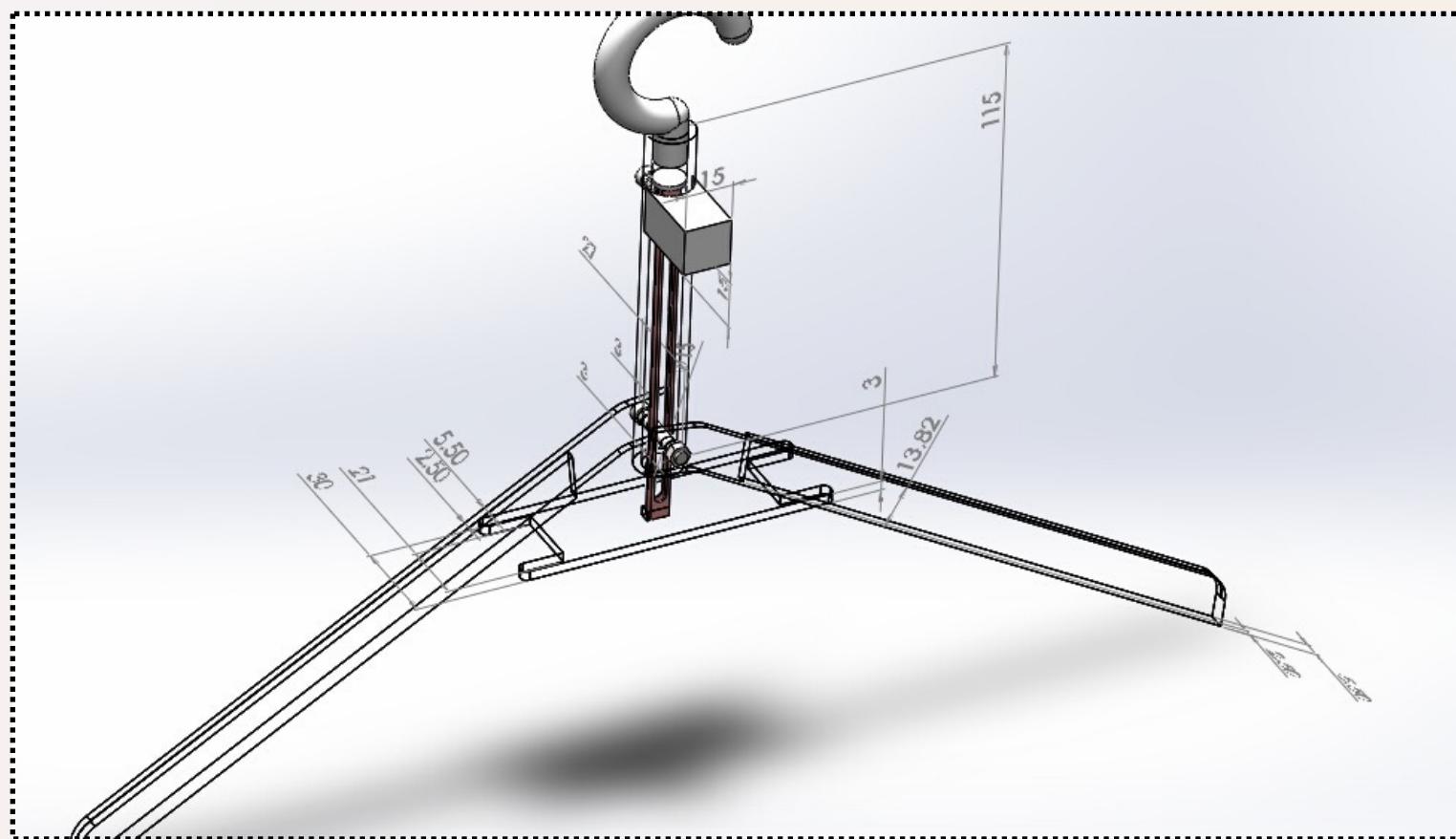
CHANGE is a revolutionary hanger design. Harnessing the power of gravity through automation, it allows clothes to slide off easily to accumulate into a centralised basket. Utilising principles similar to the domino effect, the mechanism within CHANGE lets clothes collection be achieved with the simple press of a button, saving much time and effort.



CHANGE
AN EVERYDAY PROBLEM GETS AN EVERYDAY SOLUTION

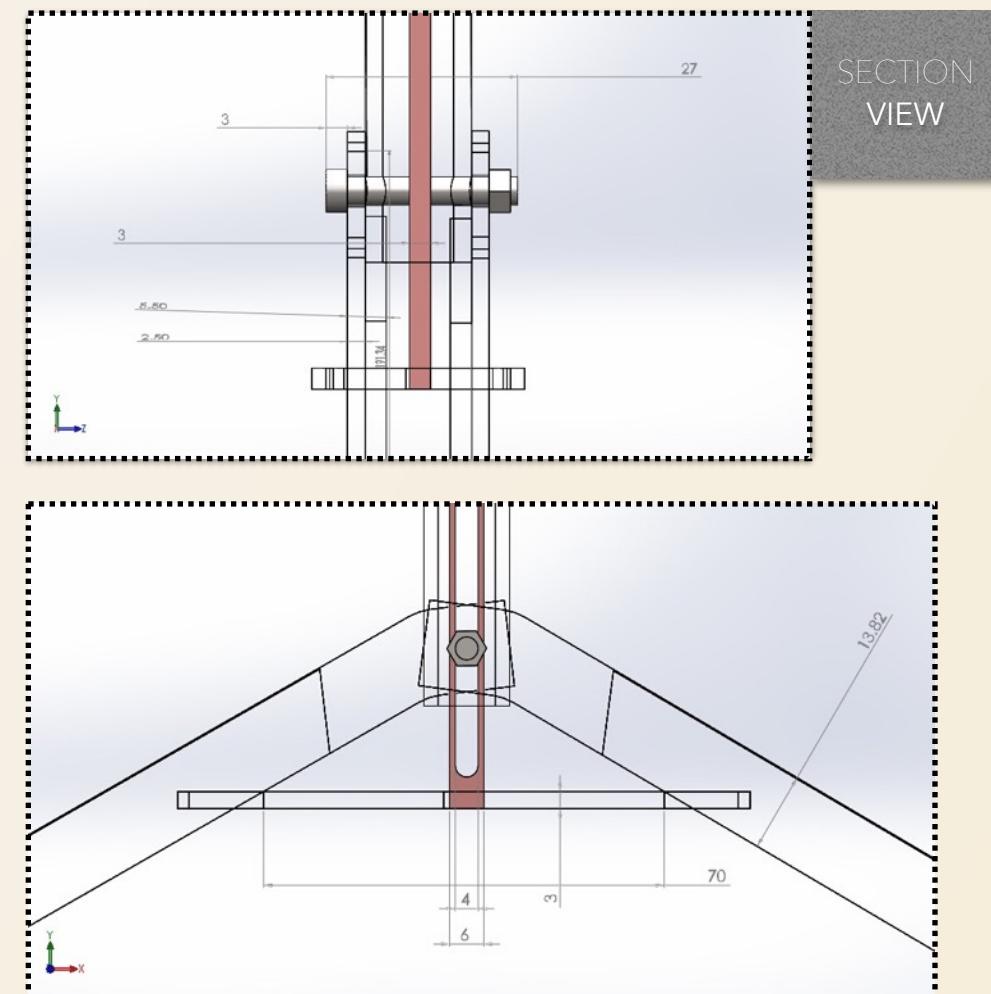
6 DIMENSIONS

Technical drawings

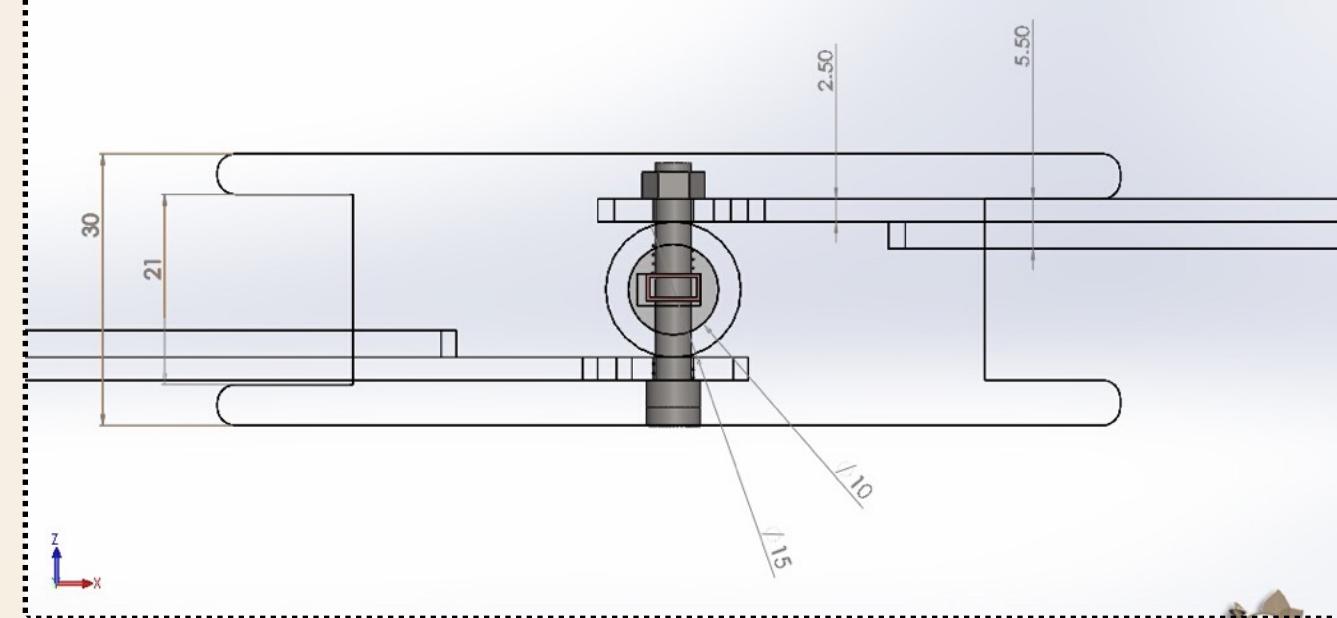
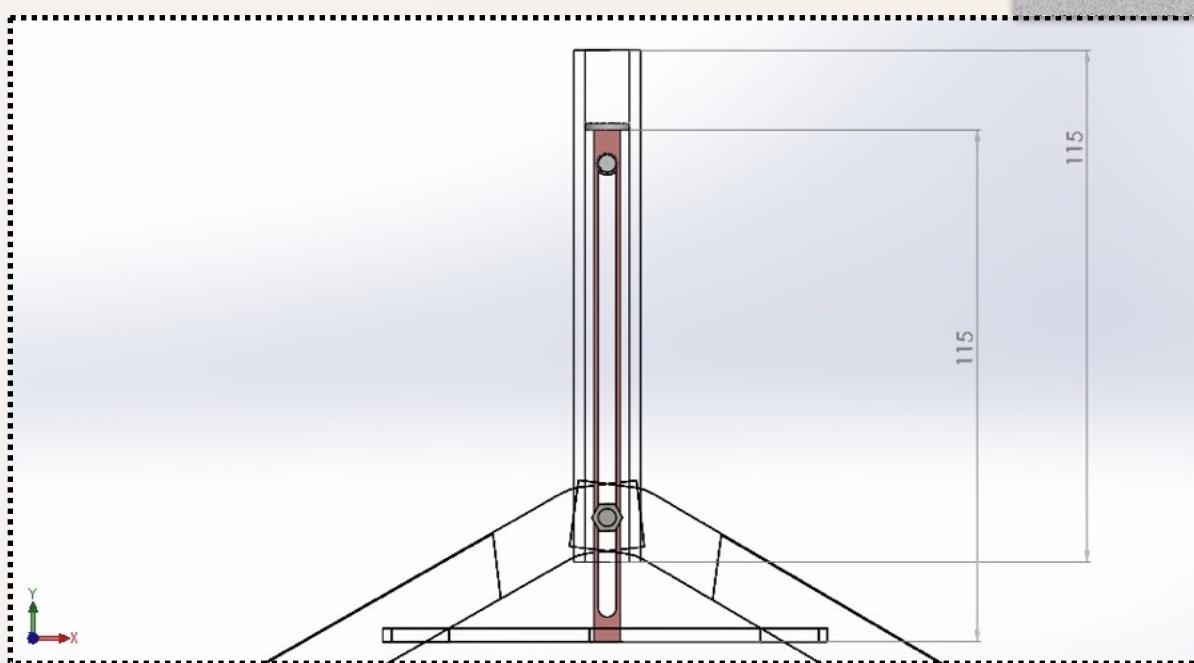


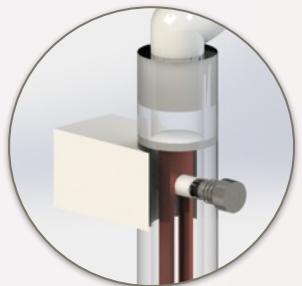
TUBES

LIFTING PLATE

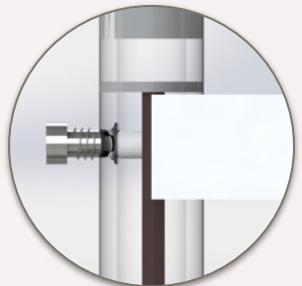


SECTION VIEW





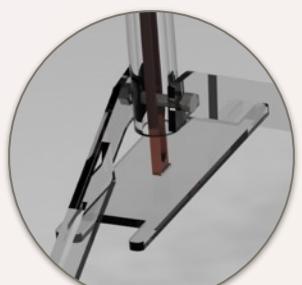
By manually pressing on the steel button outside the tube, it will push in the white button.



The white button is initially lying on the hole in the outer tube.



The inner shaft together with the spring and white button will drop due to gravity.



The two legs are loosely connected to outer tube. Once the lifting plate drops together with the inner tube, two legs will collapse.

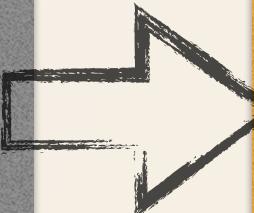


7 MECHANISM

Decisions and underlying purposes

PROBLEMS ENCOUNTERED

- Not enough weight to make two legs to drop
- Button cannot resume after pressing it
- Legs slide out of the lifting plate
- Spring faces too much friction which prevents it from dropping
- Triggering mechanism is not accurate enough



SOLUTIONS ADOPTED

- Make the two legs made of 3mm acrylic double-layer
- Attach a spring to the button
- Modify the lifting plate to "H" shape be able to guide the two legs
- Adjust the length and orientation of the spring
- Replace the rod with a rectangular one

DESIGN INSPIRATION



Influenced by the **Butterfly Corkscrew**, where the auger is screwed into the center of the cork and the raised lever arms are pulled down to extract the cork cleanly, our hanger works on the based on similar principles. By pushing the plate down, the hanger's legs slide down accordingly, and by pushing the plate up, the legs go up appropriately.

To open the **umbrella**, one simply presses a button and the rider will unlatch from its bottom latch, prompting an automatic, smooth and swift expansion of the wings till it reaches the top rider latch. To keep the umbrella, one presses the same button to release the rider from the top rider latch and pulls the rider till it latches onto the bottom rider latch. Our hanger works on the same principle, where with a simple press of a button, the screw will unlatch from the hole in the tube, and the shaft will drop. By pushing the plate up, the shaft will raise and the screw will latch into the tube's hole again.



Motivated by the **domino effect**, our hangers slide down the tilted rack and the block attached to the hangers' back will trigger the other hangers, allowing the hanged clothes to easily drop and collect into a basket.

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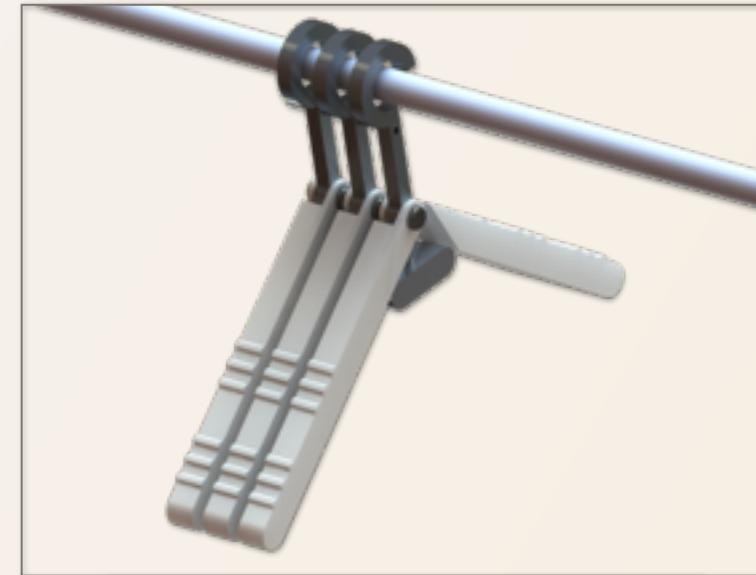
USER EXPERIENCE

Laundry experience with "CHANGE"

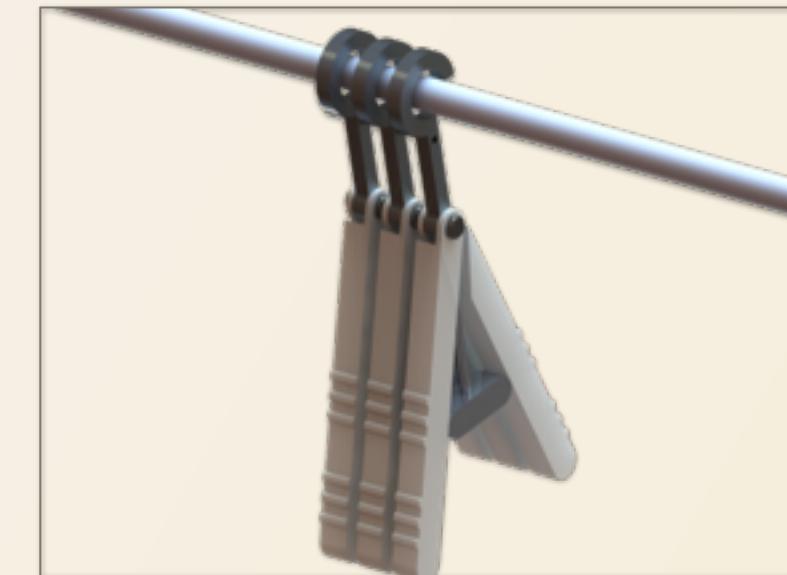
We believe in the power that a simple change has in life. It may be trivial, with respect to each day of life. However the **cumulative impact** is more than enough to convey an attitude. It all starts from the awesome user experience.



The rack gets slanted.

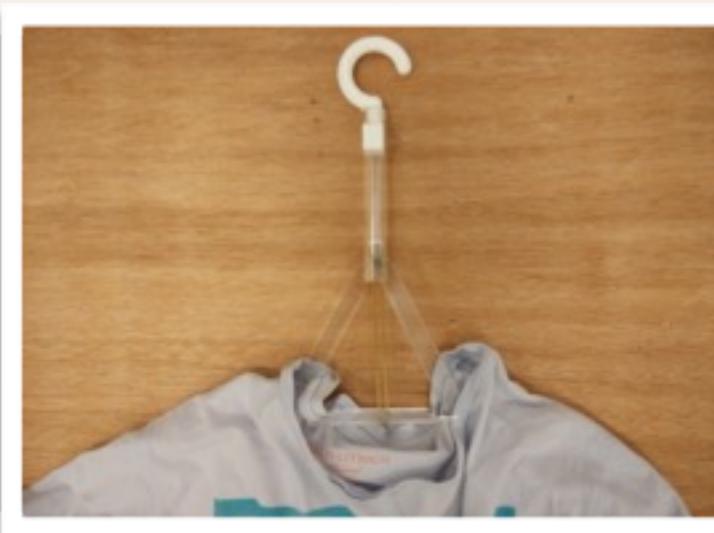


Hangers slide down and get close to each other.



Hangers trigger each other to collapse.

Hanging Process



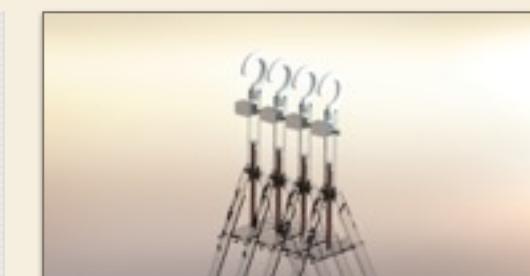
Collecting Process

▼ 90 seconds

Average time required for collecting laundry.

▲ 3 seconds

Time required using "CHANGE".
It's simply amazing.



We inadvertently stretch the collar of clothes when we hang clothes using normal hangers. The collar would become loose and bigger after repetitive stretching. With "CHANGE" you can simply put on the clothes when the hanger is in collapsed state and then resume the hanger. This design prevents cumulative damage done to clothes.

IT'S SIMPLY AMAZING

Things we feel proud of about "CHANGE"

With the help of CHANGE, **time and energy** can be saved from users' daily lives. Though this time and energy saved seems minimal each day, over many days and years, the accumulated amount will be great. As time is money, and one only has 24 hours a day, why not use the time for greater things?

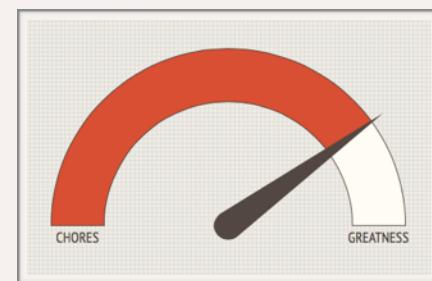


CHANGE is in line with the vision of a **new lifestyle** where everything is automated and simplified with just a simple press of a button. With a button pressed to trigger the rack to tilt, CHANGE collects together and automatically activates each other, prompting a swift collection of clothes into a basket.



CHANGE is **environmentally friendly**. The pressing of the button to tilt the rack and CHANGE to open and close its legs are purely mechanical and do not involve any sources of chemical energy. Hence, it is energy efficient.

CONVENIENCE



LIFESTYLE

CORE COMPETENCE

INNOVATION

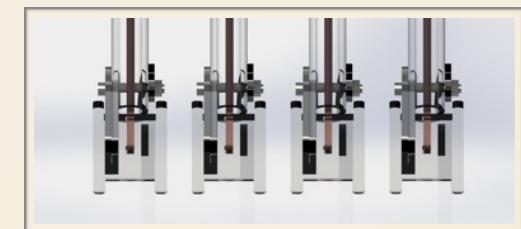
LOW COST



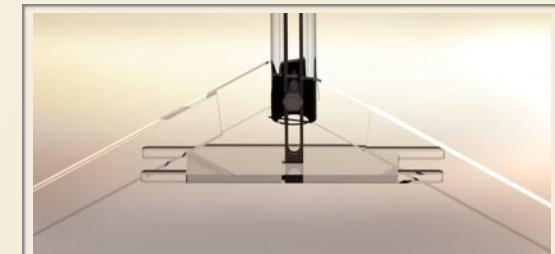
INSTALLATION

CHANGE is **easy to install**. It just requires the replacement of current cheap hangers and to allow current ceiling racks to be able to tilt, other than its present ability to ascend and descend. This tilting feature can be easily added on to current HDB flat's ceiling rack designs.

CHANGE is a novel and unique product that sets itself apart from the others. This is because CHANGE sets out with the aim to simplify the procedures of drying clothes, through reducing the step of collecting clothes. This makes it **fundamentally different** from the other hangers.

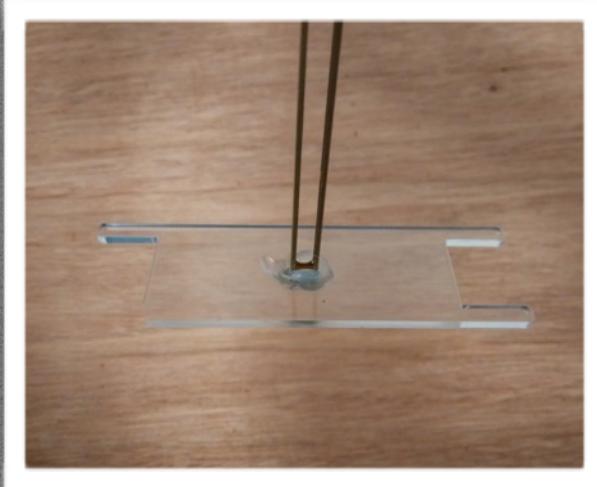


CHANGE is economical. At a mass production cost of less than **S\$1** a piece, CHANGE offers increased utility at minimal cost.



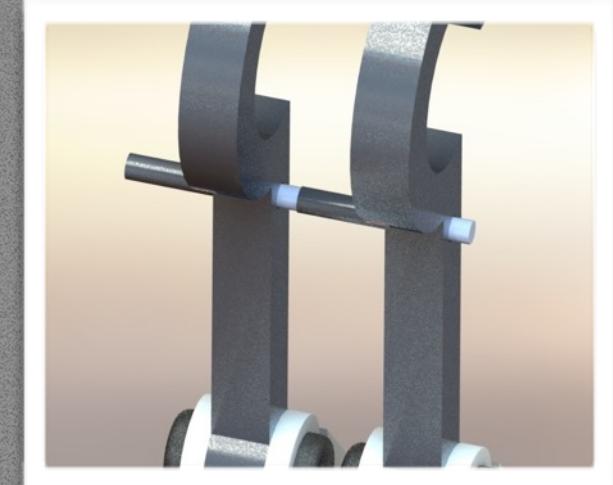
1

Due to cost constraint and ease of fabrication, we adopted acrylic as a major material. We can replace acrylic boards with more robust material.



4

The accuracy of domino effect can be improved through use of more sophisticated mechanisms.



2

The shape of the hanger can be modified so that multiple hangers can be easily carried.

3

For now users still need to manually resume the hangers. Further automation can be developed.

10 FUTURE EXTENSIONS

Room for further refinement and enhancement

ADD-ON FEATURES

The simplicity of our design makes it possible to be applied into any household. Meanwhile, a lot of existing solutions can be added on it.



Sensor that can detect change in moisture, in order to automatically trigger collection.



Remote control to command the tilting of the clothes rack.



A mobile application to give commands to the laundry system anywhere, anytime.



Mechanism to realize **auto-folding** when clothes drop off.

