

Design Review 2

Arthritis Kitchen Assistive Device

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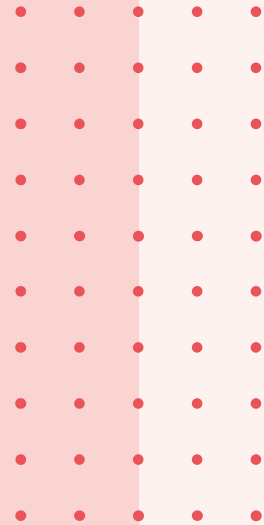
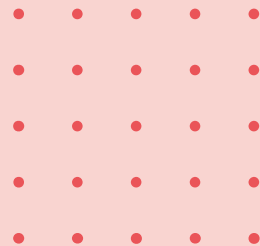


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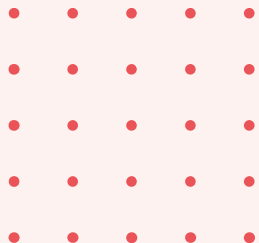
Additional Details

About our process so far

01.

Project Summary

Design Review 1 until now





(Again...) The Everyday Struggle

- 20% of adults in the U.S. have arthritis
- Low motor strength & precision in fingers makes opening jars, cutting food, or holding utensils difficult
- Causes frustration, reliance on caregivers, and a decreased quality of life
- A solution could help people regain independence in the kitchen

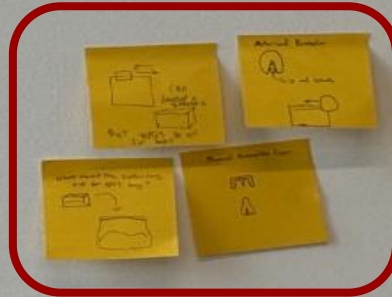
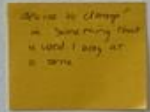


A Change in Perspective

- Previous ideas of a jar opening device had large market competition
- Broke away from initial brainstorming and reiterated ideation process with Post-It style group brainstorming session
- Decided to address arthritis assistance for pinch-to-close resealable quart-size freezer bags

Reusable
sliding
"Ziploc" tab

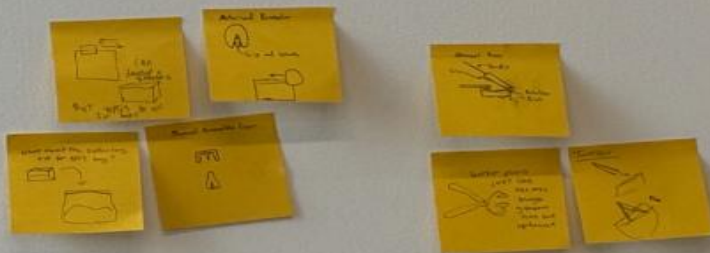
Using magnets
to wedge/pry
zipper teeth



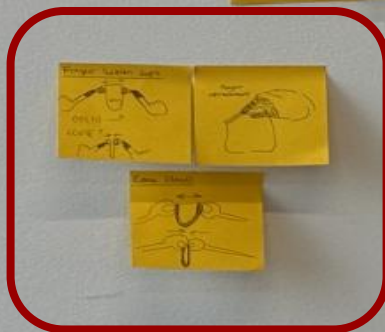
Handheld
clamp/pliers that
wedge/pry
zipper teeth

Countertop
devices that also
wedge/pry teeth!

Effort to change
in "hand ring" that
is used today at
a service



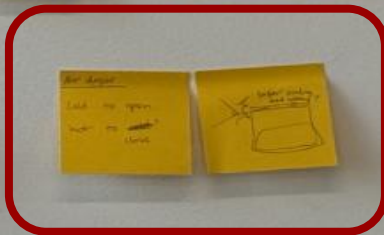
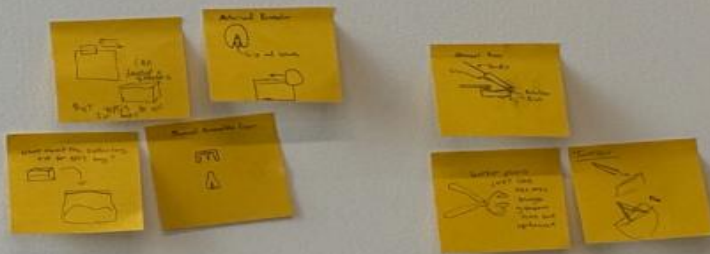
Hand/finger
gloves idea



Use blunt
extension to
wedge open



Effect of change
in "material" that
is used to bag it
is small



Using physics to alter
material properties of bag
(laser cutting, heating and
cooling the bag)



Waste to Energy
in "Waste to Energy"
is used 1 day at
a time.



Roller press
mechanism

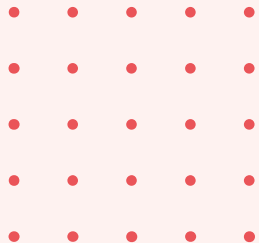


Moving Forward with a New Idea

Changes to our User Inputs

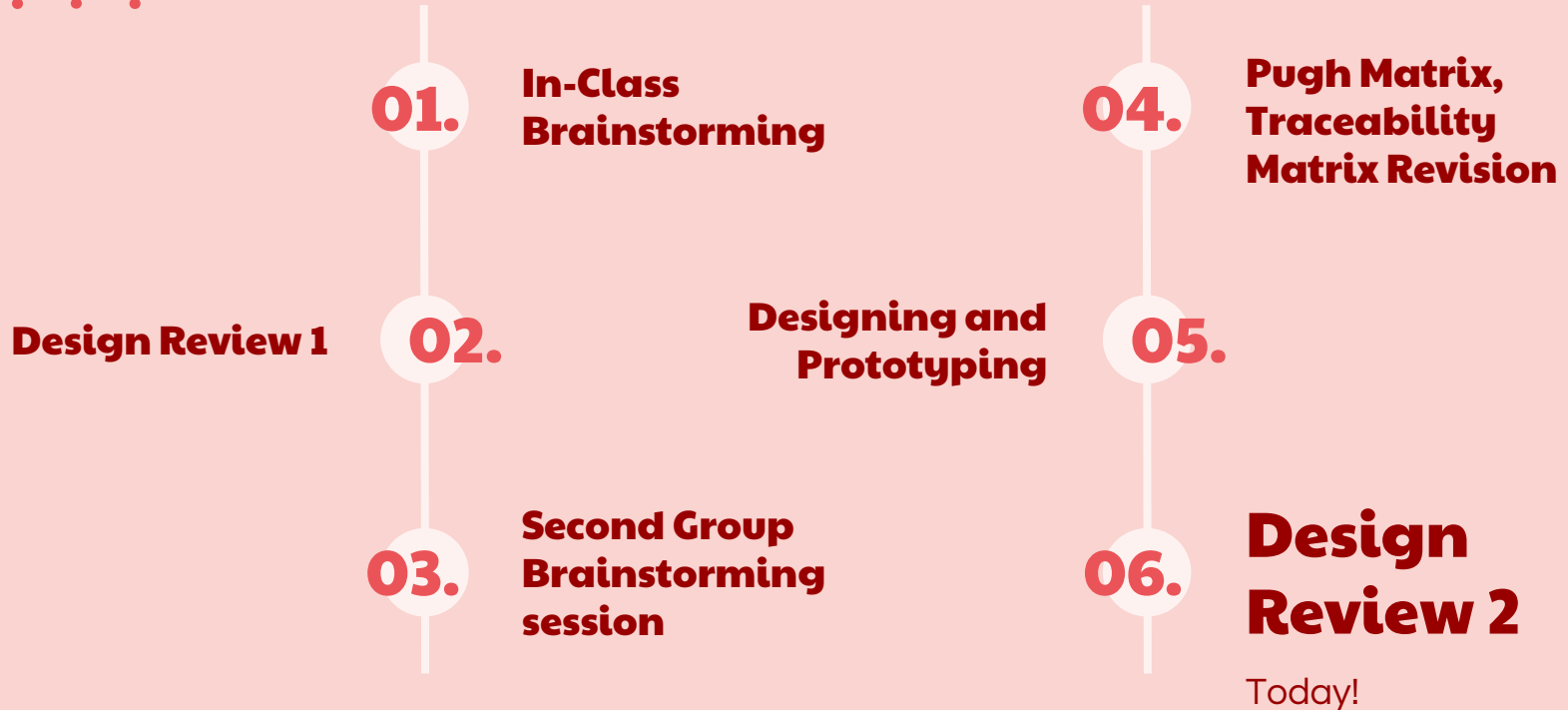
- Device must align the two sides of pinch-to-close bag ridges
- Device must successfully open and close bags fully (no leakage)
- The bag must remain functional after device use
- Device must withstand frequent use / durability
- Device cannot contain toxic materials or mechanisms, and cannot allow cross contamination

From our Weighted Pugh Matrix, we found the three strongest options: (1). Slide across magnetic device, (2). Attachable slider tab, (3). Partial hand exoskeleton





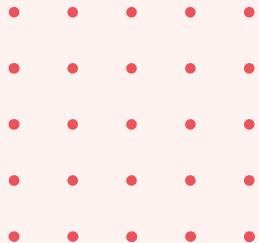
Summary Timeline



02.

Customer Description

Who do we design for?

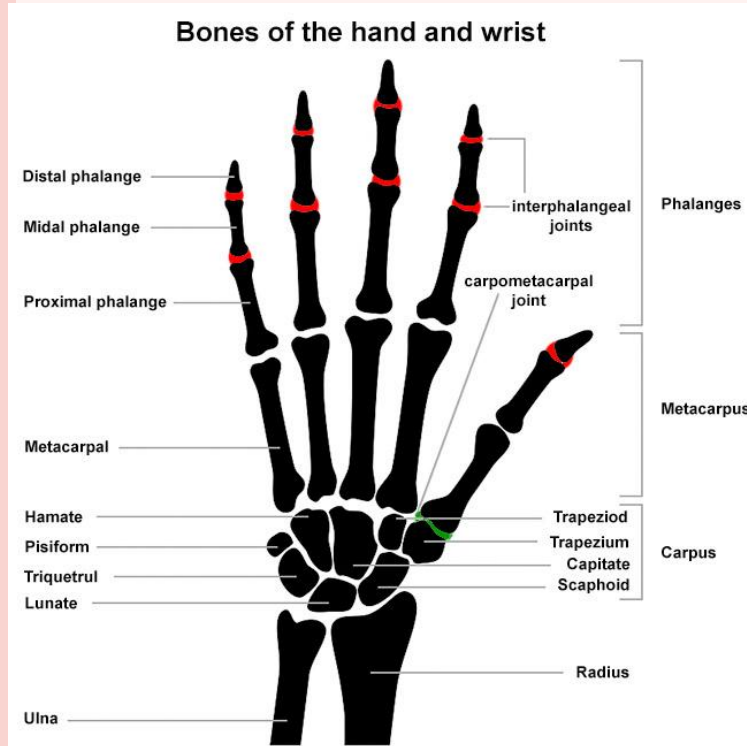
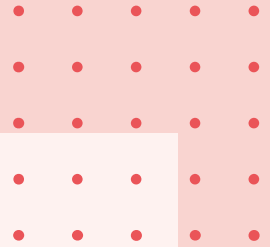




This product is specifically designed for...

- Adults with arthritis (of any age/sex) whose arthritis specifically reduces motor strength and precision in their fingers (osteoarthritis, rheumatoid/inflammatory arthritis)
- Adults with limited motor strength and precision in their fingertips caused by related musculoskeletal disorders (e.g., lupus, fibromyalgia)

These are the particular joints affected in arthritis patients!



- **Red:** interphalangeal joints (both osteo and rheumatoid arthritis)
- **Green:** basal joint (in basal thumb osteoarthritis)

Source: Hospital for Special Surgery
(https://www.hss.edu/conditions_assistive-devices-for-the-hand-small-joint-protection.asp)



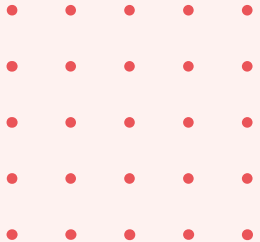
This product is not intended for but may also help...

- Individuals who have short-term limited motor strength and precision in their fingers caused by some type of traumatic force injury
- Individuals with limited motor function from wearing a splint or brace on their hands
- Children under the age of 10

03.

Design Process

Considerations and
Prototypes



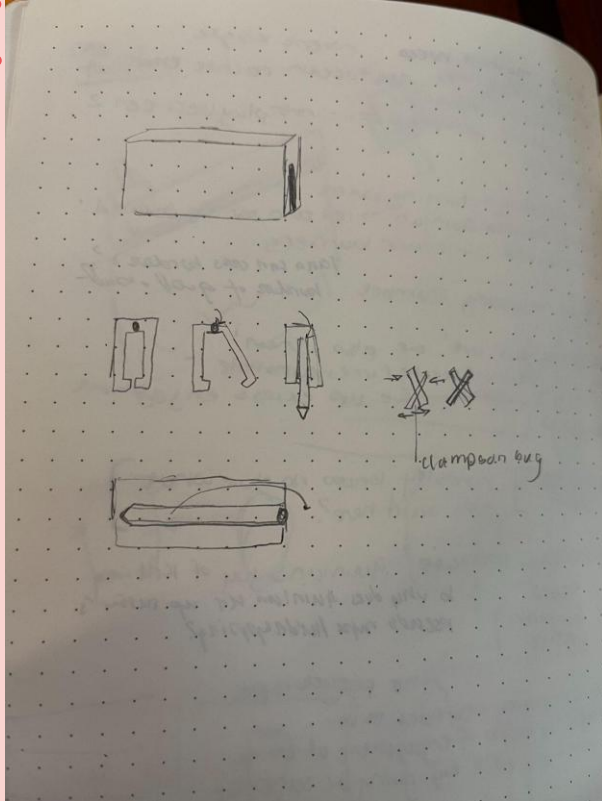
Creating a portable, durable, and comfortable device

Design Considerations (TM - Design Inputs)

- Users must be able to clamp for 1 minute without pain
 - Device must align the two ridges on either side of the bag
 - Device will be mainly 3D printed, with metal parts to enable rotation and other movements
 - Device must clamp with enough force to lift a bag (90% filled with water) of a surface
 - Device must function after submerged in soap and water
1. How do we design two separate mechanisms (open and close bags)
 2. How does the user choose the function (open vs. close)
 3. How does the device change between selecting functions?



Concepts and Sketches - Round 1

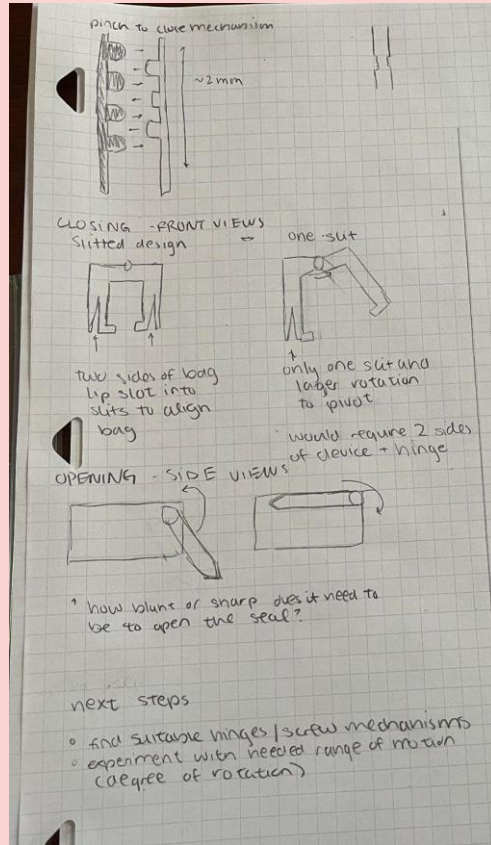


← Side view of opening and closing mechanisms

← Top view with stored opening extension

Initial issue: the opening extension storage area within the device would leave no room for the hinge closing mechanism

Concepts and Sketches - Round 2



← Pinch-to-close bag closing zipper

← Side view of closing mechanisms with 1 and 2 slits to hold the bag in place

← Side view of opening mechanism rotation and storage

Concepts and Sketches - Round 2



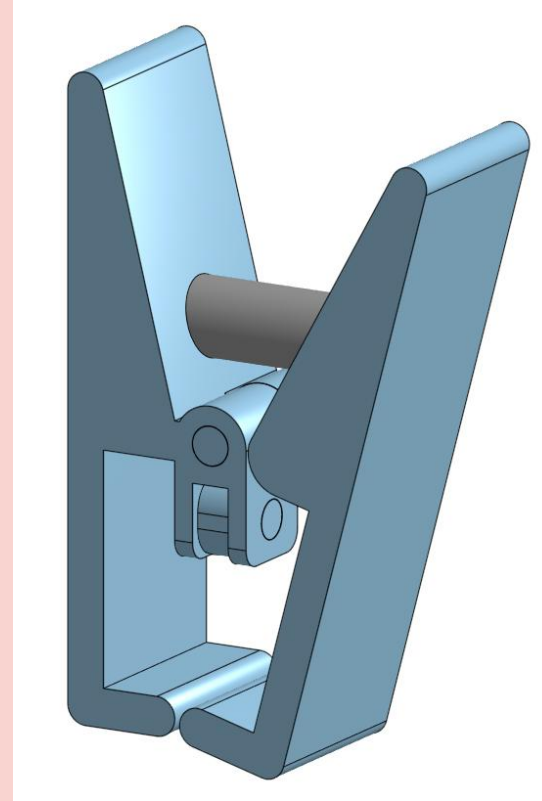
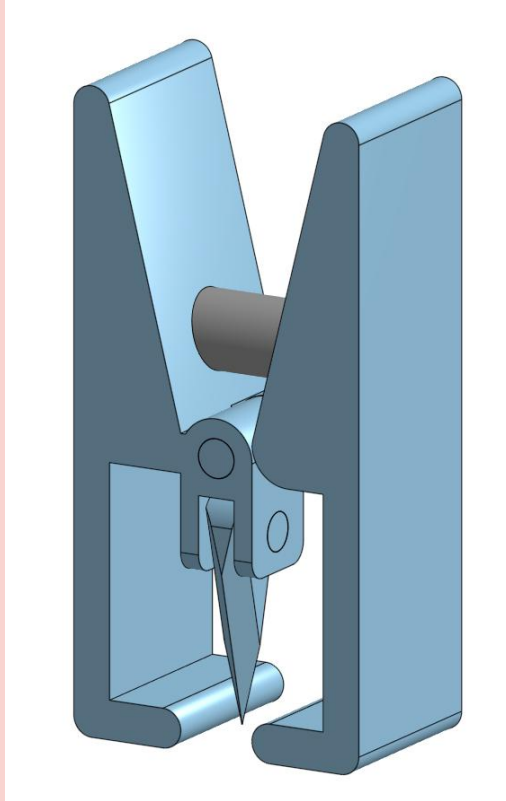
How do the opening and closing mechanism work together and interact?

- On opposite sides of the device
- On the same side of the device

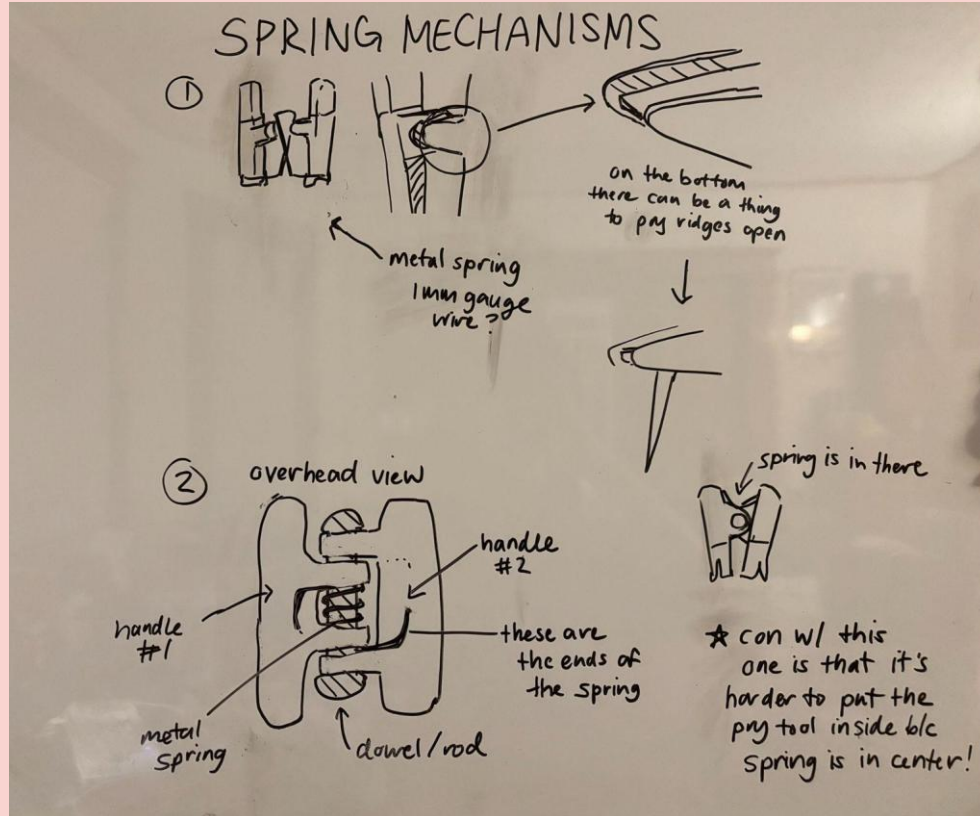
Next:

CAD the opening and closing mechanism separately

CAD Prototyping



Potential Spring Mechanisms





Next Steps

1. Find suitable screw / hinge mechanism
 - a. User's applied force doesn't break it
 - b. Necessary force for bag opening
 - c. Degree of rotation
 - d. Requires testing different available hinge mechanisms
1. Integrate manufactured parts into 3D printed parts
2. Decide on how opening and closing mechanisms will interact
 - a. Switching between modes
3. Create comfortable grip material



Manufacturing and Risk Analysis

Currently, design would be built from:

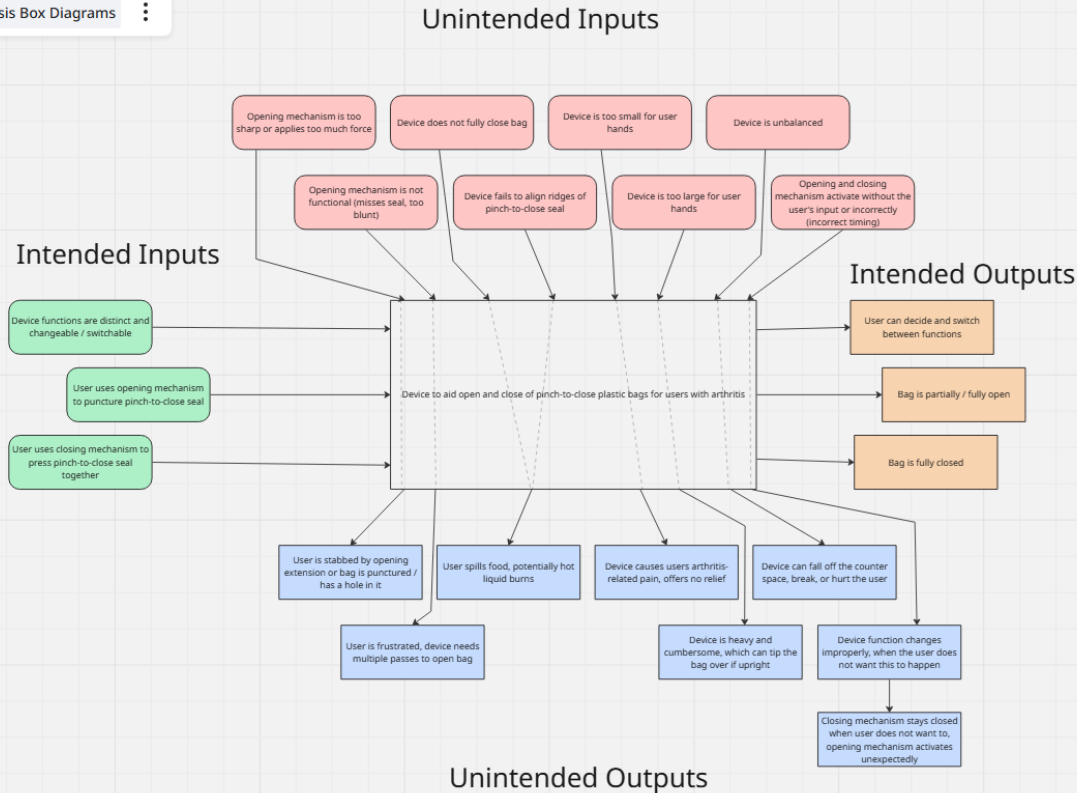
1. 5 3D printed parts
 2. 1 manufactured mechanical parts
 3. Soft material for comfortable use
- Small parts may be difficult to manufacture
 - Would find alternate plastic manufacturing for scale-up
 - Soft materials like rubber or silicone may be hard to cast

Risk Analysis Considerations

- How does low grip strength change our design?
- What if the opening/closing mechanisms are incorrectly timed?
- Does the manufacturing of the device (small pieces) pose a threat?
- How can we design a device to mitigate risks and hazards?

Preliminary Risk Analysis

Analysis Box Diagrams



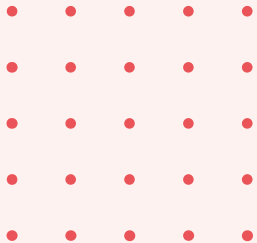
Preliminary Risk Analysis

Item Number	Function	Risk Analysis							Risk Control			
	Functional Output	HAZARD (Potential cause of Hazard)	Hazardous Situation	HARM (Potential adverse effect)	Cause	SEVERITY	OCCURRENCE	RPN	RISK MITIGATION	SEVERITY	OCCURRENCE	RPN
Description		Description of why the product will not perform conform specs		Description of resulting injury, damage					The way by which the risk is reduced/eliminated			
1	Bag is not fully open	Device fails to open bag, open extension fails	Bag contains living-saving medication	User fails to take medication, other pathologies may effect (dementia, pain killers, seizures, allergies)	Opening mechanism puncture is not sharp enough	5	1	5	Extension tip is made more sharp, utilize angle of extension	3	1	3
2	Bag is not fully closed	Hot food or liquid within open bag	Hot substances fall or spill onto user	Burn injuries, now necessary clean-up	Closing mechanism has low force or small surface area coverage	3	3	9	Add ridges to align bag, only release device from bag when closed	3	2	6
3	Sharp open mechanism	Extension is sharp enough to hurt user	Device slips or user falls onto device	Device could puncture or bruise user, requiring stitches	Device relies on extension's sharpness to open bag	2	3	6	Extension has rounded tip	1	3	3
4	Device too small	Size is difficult for the user to grasp	User drops device or needs more force to grasp device	Any above hazards (dropping bag or device), further damage or joints	Device designed to be too small for users' hands	3	4	12	Device has large surface area for hands	3	2	6
5	Device too large	Weight is cumbersome	device's weight causes bag to tip or fall, user must carry heavy device	Any above hazards (dropping bag or device)	Included mechanisms too heavy for usage	3	4	12	Optimize mechanism functions and weight	3	2	6
6	Device not stable	Device cannot stand on itself, imbalanced	Device falls off of counter tops	Bag or device may fall off counter or tip over, falls on user	Device weight was not distributed well, sides are not level	3	4	12	Device weight is balanced and level	3	2	6
7	3D print shatters	Hinges or plastic detach if dropped	Metal or plastic is ingested by user or pets	Fragment causes blockage requiring surgery	Interfaces between metal and plastic parts not strong enough	4	2	8	Make 3D printing tolerances and interface with plastic smaller	4	1	4
8	Device cannot maintain open or closed conformation	Spring hinge suddenly snaps shut	Device hinge could close on user's finger or fly out of their hands	Device could puncture or bruise user, requiring stitches	Metal spring is not securely attached to body of device	2	3	6	Ensure that spring weight is small enough as to not cause major injury to user - add protective shell around spring	2	1	2

04.

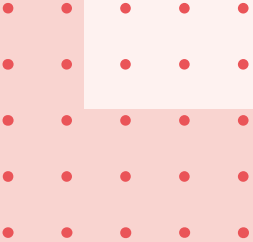
Additional Details

Design challenges thus far,
team working, and more!





Challenges our team has had

- Narrowing down design ideas
 - Determining materials to be used for prototype
 - Modeling prototype using CAD before fully fleshing out design mechanisms (ex: hinge)
- 



Thank you!

For more information, please visit
our website:
<https://sites.tufts.edu/pinkteam/>



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images by Freepik

Resources

Sketches and Photos taken by team members

FMEA:

https://docs.google.com/spreadsheets/d/1fl_S67U2SdzYPrb_oq3l0V3jAs-UQXb8j5eHPAatM00/edit?usp=sharing

Fault Tree Analysis:

https://miro.com/app/board/uXjVIND5yF0=/?share_link_id=585797283521

Box Diagram:

https://miro.com/app/board/uXjVIMOjcao=/?share_link_id=406720729428

