

Assistive Technology

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Overview

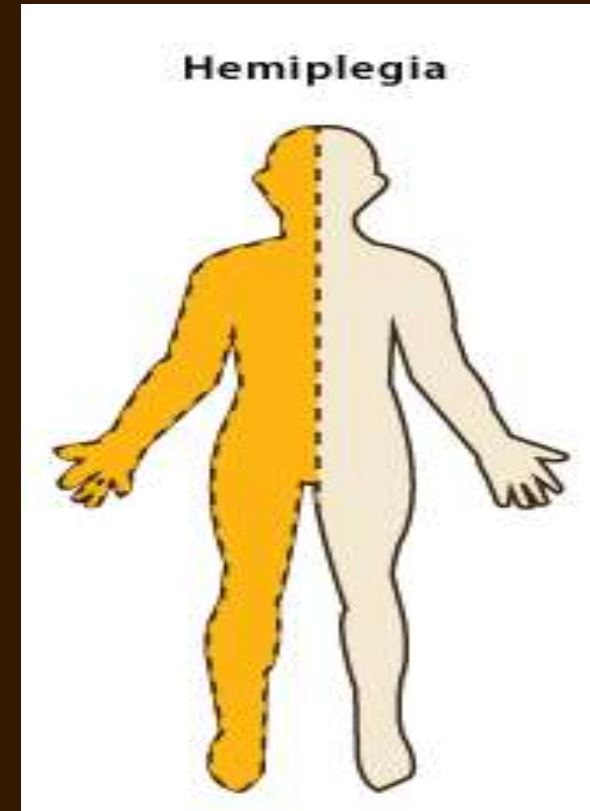
- Background
- Design Objectives
- Design Evolution
- FMEA
- Testing



Background

Client description:

- Male with Cerebral Palsy
 - Poor vision that cannot be further enhanced with optical aids
 - Paralysis of the left side of body
 - Limited balance
 - Muscle weakness
 - Insufficient dexterity
 - Cognitive disabilities



Affects one side of the body



Background: Gas Station Employment

Job Responsibilities	Design Objective
Clean restrooms, floors, and windows	Make handling cleaning supplies easier and lighter
Receive and organize stockroom shipments	Lifting heavy crates and stacking them safely and accurately
Maintain merchandise	Organizing merchandise to meet aesthetic standards

- Design cleaning cart incorporating all objectives and meeting job responsibilities



Needs Analysis: Everyday life

Shower Attachment

- Cannot start shower without aid of caretaker
- Inadequate balance, dexterity, and strength to engage mechanism

Lunchbox

- Cognitive disability: poor understanding of temporal scales
- Depleted energy: could no longer work



Shower Attachment

Shower Attachment

Initiate shower without caretaker assistance

Objective	Application
Safety	No additional danger or potential for injury
Usability	Little to no maintenance but functional
Durability	Long lifetime and corrosion resistant
Simplicity	No outside assistance necessary



Conceptual Designs: Shower Attachment

Advantages:

- Handle client could engage shower/tub transition
- Adjustable tightness
- Sturdy

Disadvantages:

- Size/Aesthetics
- Safety

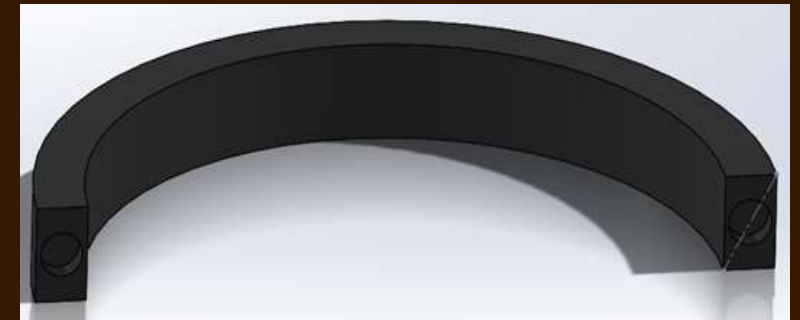
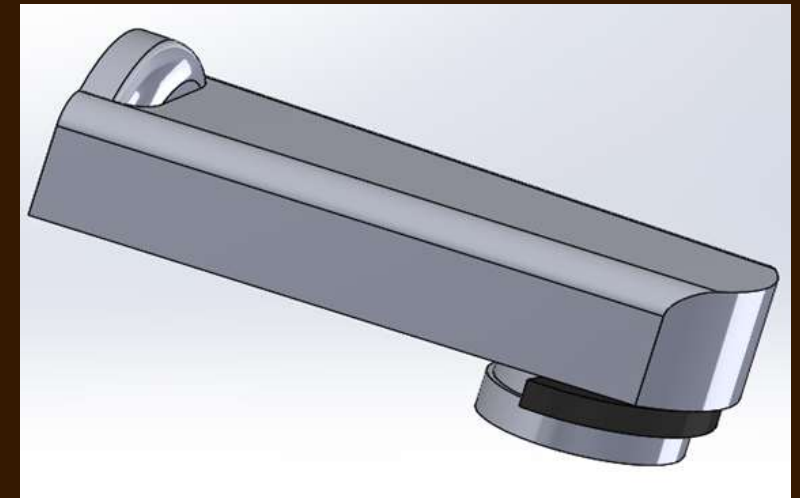


Final Design: Shower Attachment

- Printed with polylactic acid (PLA)
- Neodymium magnets epoxied
- Finish can match faucet

Features:

1. Safety
2. Easy installation
3. No maintenance
4. Economical
5. Client Independence



Lunchbox

Lunchbox

Provide sustenance at appropriate times



Objective	Application
Durability	Withstand worst case scenario
Utility	Restrict access to food
Reliability	Consistently unlock at the programmed time
Thermal Control	Keep food at appropriate temperatures



Conceptual Designs: Lunchbox

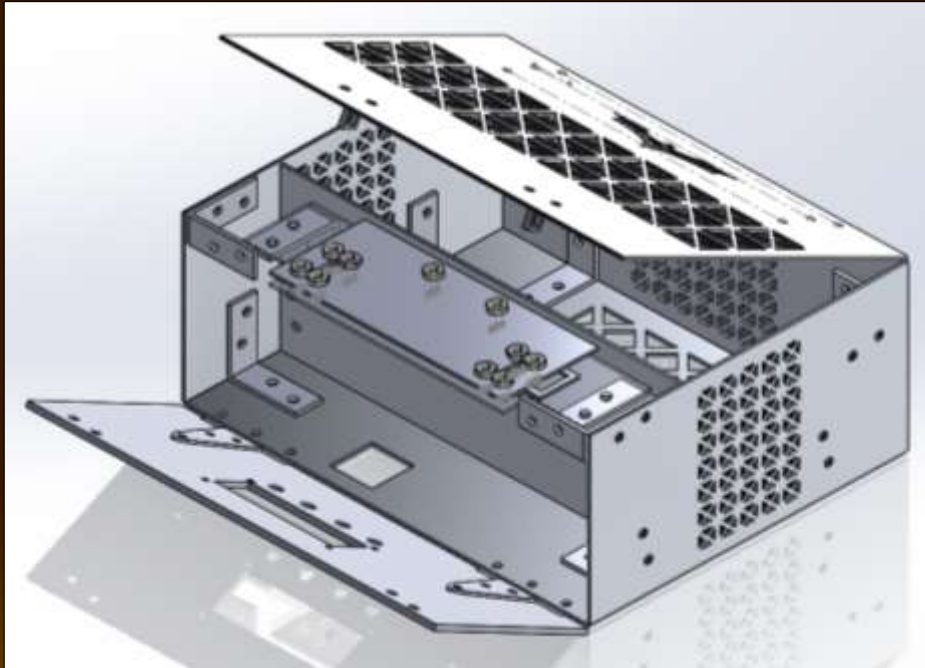
- Modify prefabricated lunchbox
- Advantages:
 - Expedite commercialization
 - Completed testing through CPSC and NSF
 - Proven design
- Disadvantages:
 - Circuit housing
 - Main compartment volume loss
 - Locking mechanism integration



Final Design: Lunchbox

Features:

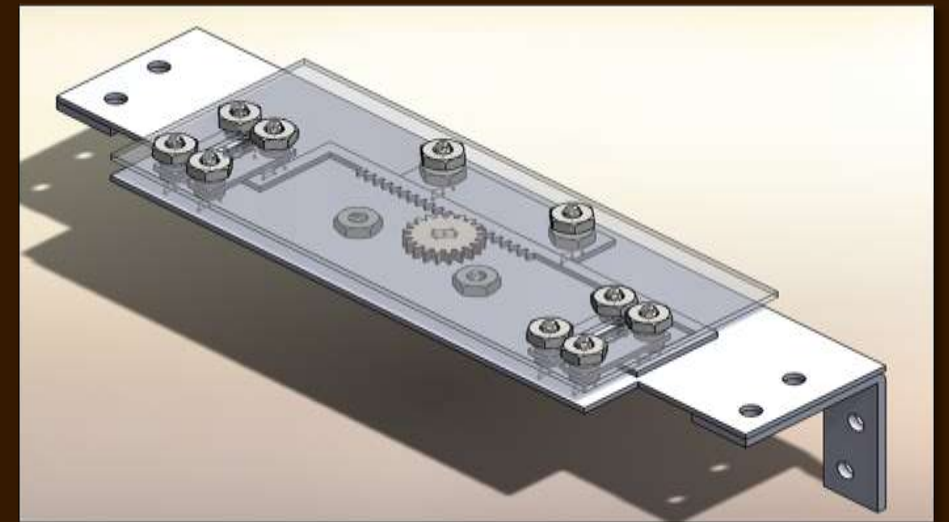
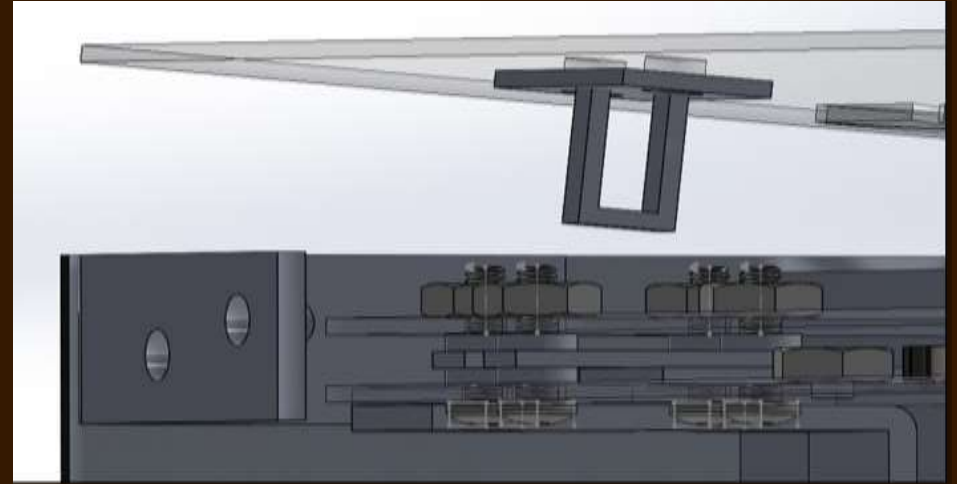
1. Lightweight - 1/16th inch 5051 aluminum plates with cut out trusses
2. Safety - Separate compartments for food and circuit



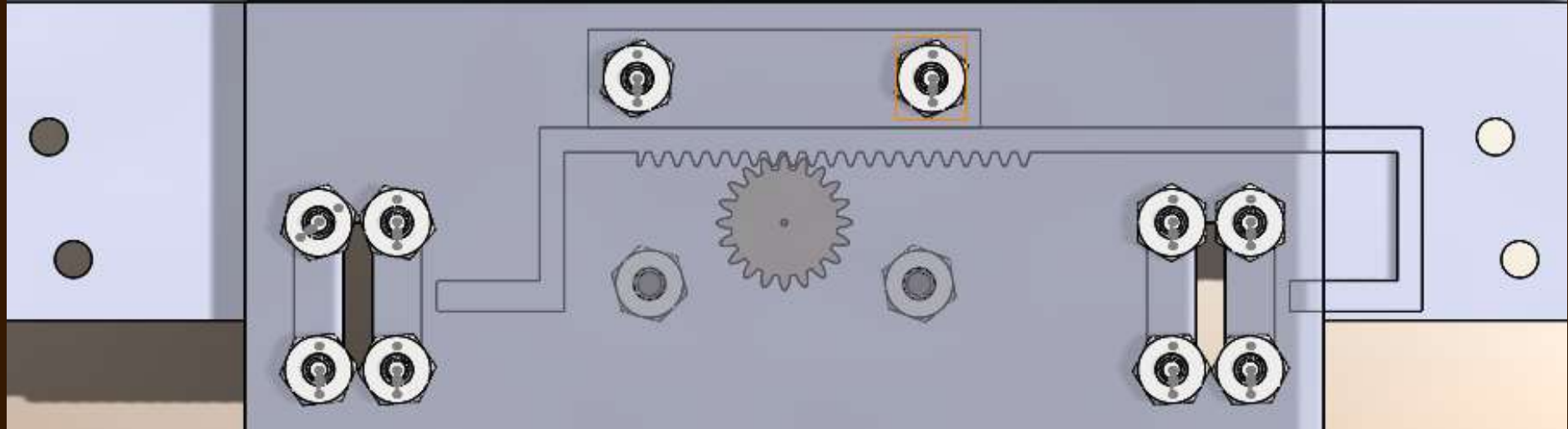
Lunchbox Locking Mechanism

Features:

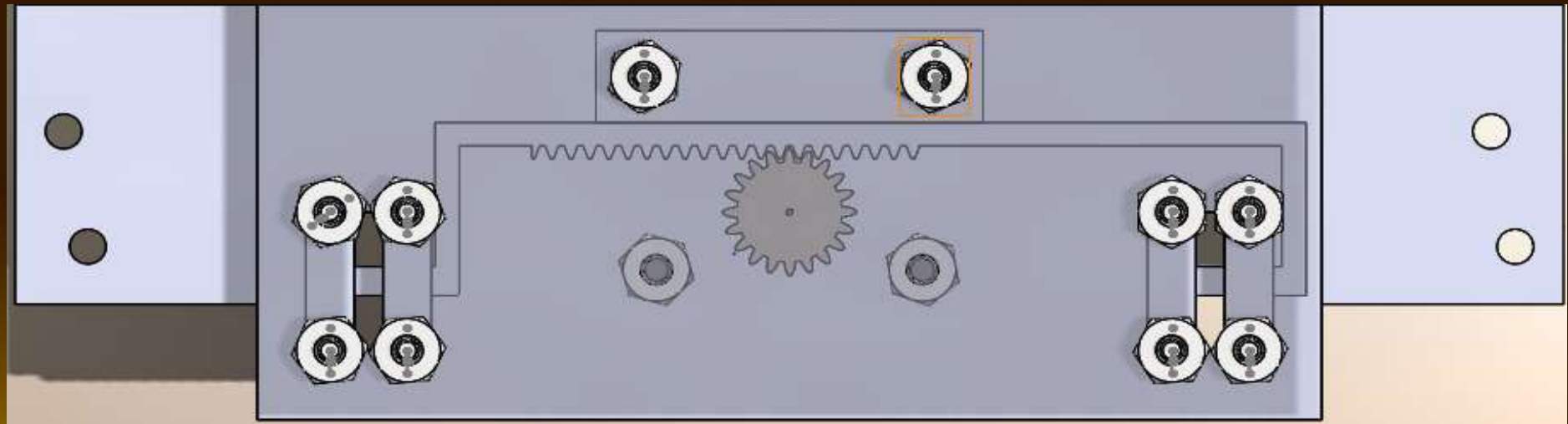
1. Sliding gear track
2. Gear is press fit onto to Servo motor shaft
3. Cut by water jet
4. 1/16" 5051 aluminum plates



Unlocked position



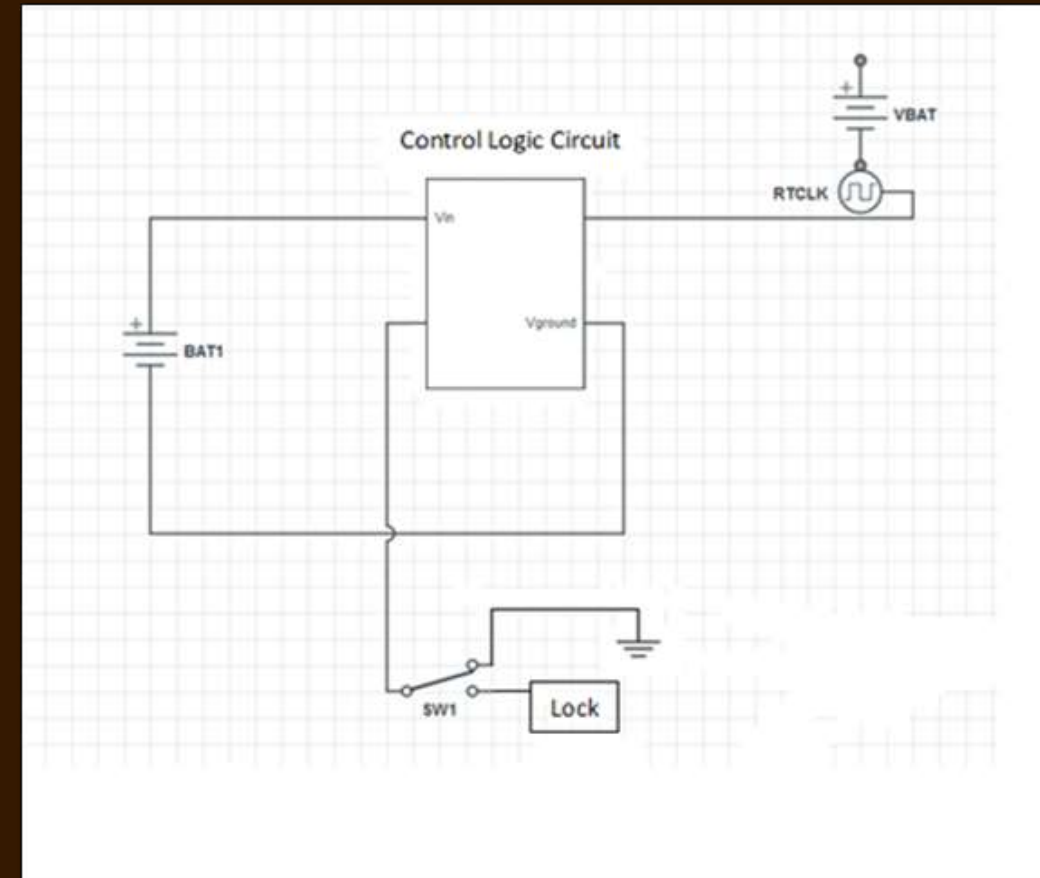
Locked position



Lunchbox Circuit

Features:

1. Simplistic - Four button integrated keypad and display for easy programming
2. Accurate - Incorporates a Real Time Clock to diminish uncertainty
3. Longevity - Rechargeable 12V Li-Ion battery



FMEA

Failure Modes and Effects Analysis

- Method used to determine failure methods of components in a system and their effects.
- Failure modes rated based on severity, occurrence, and detection.
 - Results in risk priority number.



FMEA: Shower Attachment

- Three potential failure modes:
 - Slip
 - Fracture
 - Permanent deformation
- Highest priority failure is slip
 - Effects: doesn't engage shower
 - Causes: Insufficient friction
 - Prevention: thicker outer shell on shower attachment



FMEA: Lunchbox Locking Mechanism

- Three potential failure modes:
 - Misalignment
 - Fracture
 - Immovable
- Highest priority failure is misalignment
 - Effects: lock will not engage/disengage
 - Causes: high impact
 - Prevention: 6 points of contact



FMEA: Lunchbox Circuit

- Three potential failure modes:
 - Short circuit
 - Open circuit
 - Loss of power
- Highest priority failure is short circuit
 - Effects: failure of LCD and circuit overheating
 - Causes: wire insulation erodes, improper grounding
 - Prevention: isolated circuit compartment



Testing: Slip

Testing parameters:

- Placed on shower faucet
- 30 days
- Assumed compressive force less than 2 lb_f

Results:

- No visible deformation
- Slips occurred, mitigated by increase in thickness
- Recommend rubber coating for commercial product



Testing: Drop and Impact

Testing Parameters:

- Simple drop from 3 ft and 6 ft
- No insulation
- 3ft : 35 drops
- 6ft : 1 drop

Results:

- 6ft
 - Visible impact point deformation
 - Locking mechanism shifted
- 3ft
 - Visible deformations between plate (misalignments)
 - Locking mechanism shifted after 21st drop



Testing: Circuit

Testing Parameters:

- System Testing
 - Compliance with locking and unlocking requirements
- Battery life
 - $(i_{Arduino} + i_{LCD})x = BC$
 - Arduino current (mA): $i_{Arduino}$
 - LCD current (mA): i_{LCD}
 - Battery life (hours): x
 - Max Battery capacity (mAh): BC

Results:

- Circuit and programming functions effectively during repeated use
- Battery life (x) in hours:

	3V Regulator (hours)	5V Regulator (hours)
Backlight On	80.4	76.3
Backlight Off	122.9	115.4



Safety

Shower Attachment

- No protrusion from faucet
- Physical injury

Lunchbox

- Circuit probability of fire
- Physical injury



Conclusion

- Main purpose
- Prototypes
- Legal & Risk



MECHANICAL

Questions



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