# *Eye Drop Assistant*

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**Client:** Dr. Beth Martin

**Advisor:** Prof. Tracy Jane Puccinelli

February 9th, 2024

# Overview

- Client Description
- Problem Statement
- Design Constraints
- Competing Designs
- Project Impact
- Summary of Previous Work
- Future Goals
- Packaging, Labeling, and Instructions
- Budget


Figure 1: Team Picture

# Client Description

- Dr. Beth Martin, PhD, MS, RPh
  - **Pharmacy Practice** & Translational Research Division
  - Assistant Dean for Teaching & Learning at UW Pharmacy School
  - Clinical practice setting is Oakwood Village University Woods Retirement Community


Figure 2: UW-Madison School of Pharmacy [1]

# Problem Statement

The eye drop bottle is difficult to use, especially for those with reduced dexterity, therefore the team proposes an eye drop assistant that ensures the release of a consistent dose of medication, allows for proper eye drop technique, and improves the ease of administration by decreasing the necessary manual force applied to the bottle.

# Design Constraints

- Awaiting IRB approval
  - Patient feedback is a strong testing result
- Materials
  - Injection molding capabilities
- Anatomy
  - Differing anatomical measurements such as nose bridge size and eyelid pocket distance from different points on face

# Competing Designs: In Market

- Droppy Eye Drop Dispenser
  - Advantage: Mechanical Leverage
  - Drawback: Does not allow for proper eye drop technique, assembly required
- GentleDrop Eye Drop Guide
  - Advantage: Stability
  - Drawback: does not ensure one drop


Figure 3: Droppy Eye Drop Device [2]


Figure 4: Gentle Eye Drop Device [3]

# Patents

- Bandolier Cartridge
  - Advantage: Eyelid retracting legs
  - Drawback: Contamination, improper technique
- Eye Drop Applicator
  - Advantage: Single drop
  - Drawback: Contamination

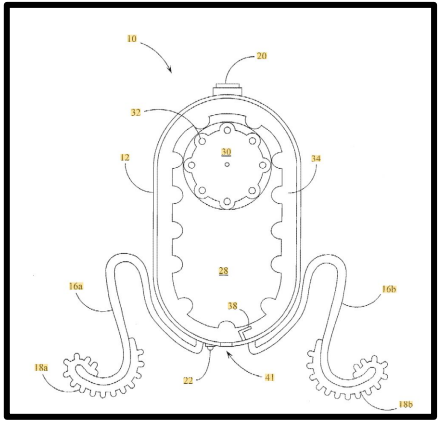



Figure 5: Bandolier Cartridge [4]

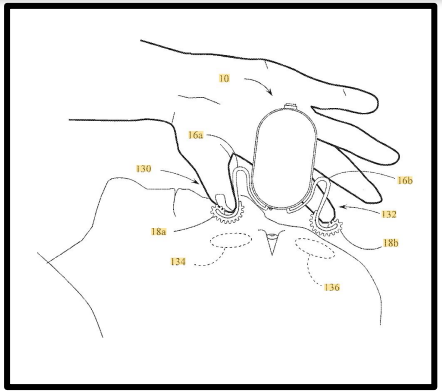



Figure 6: Bandolier Cartridge [4]

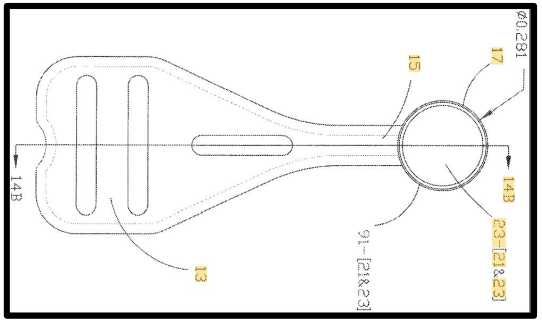



Figure 7: Eye Drop Applicator [5]

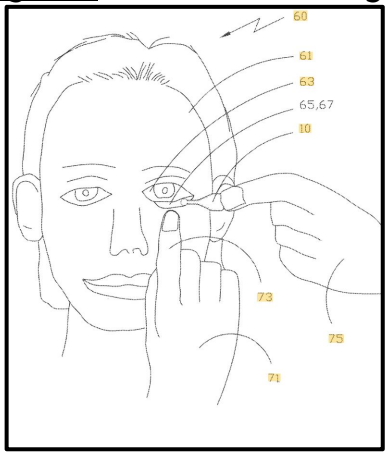



Figure 8: Eye Drop Applicator [5]

# Project Impact

- Improves patient adherence to prescriptions
  - Improved therapeutic outcomes
- Optimizes use of medication supply
  - Reduces the amount of solution released from bottle, therefore reducing eye drop waste
- Current competing designs lack
  - Mechanical advantage
  - Proper eye drop technique

# Final Prototypes

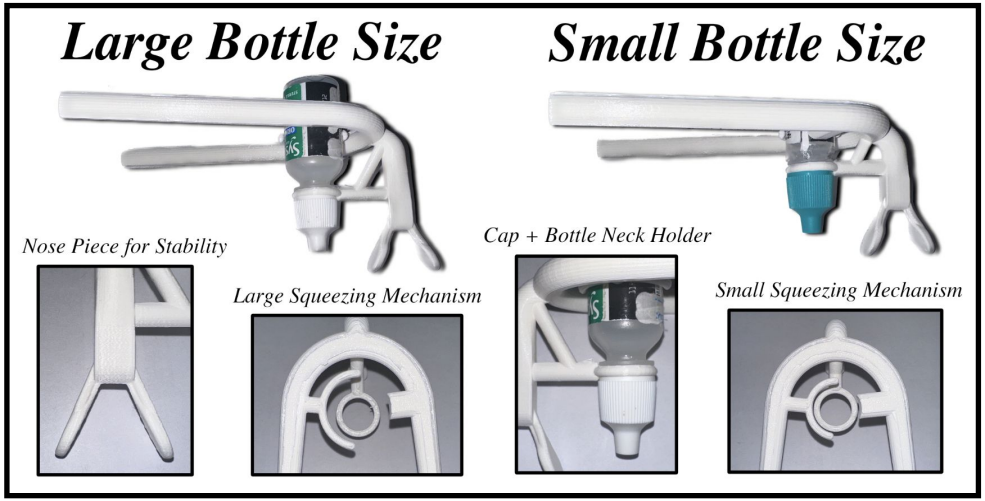



Figure 9: Breakdown of final prototypes highlighting key features, including the nose bridge stability

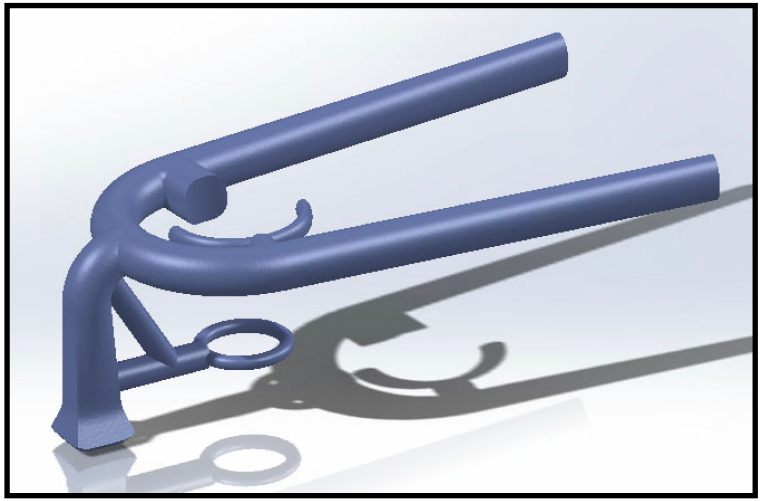
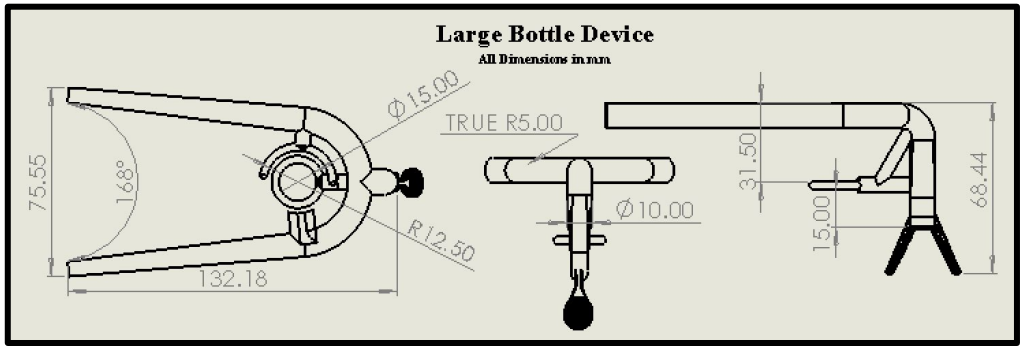
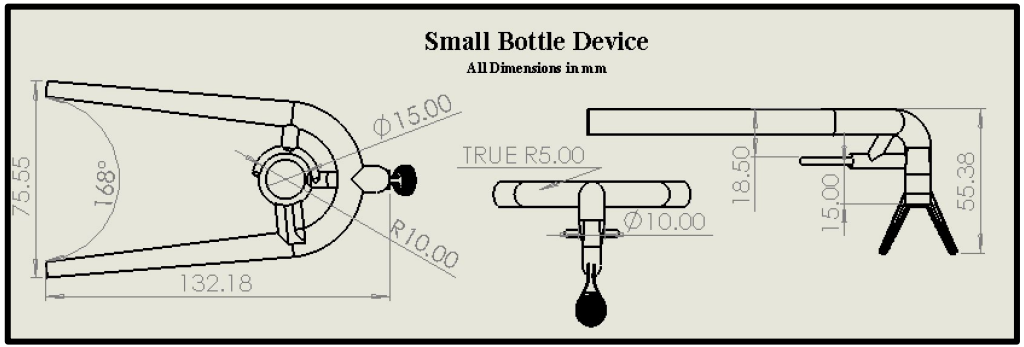


Figure 10: Final large bottle prototype featuring the platform for stability placed above the brow bone

# Final Prototypes - Nose Bridge Stability



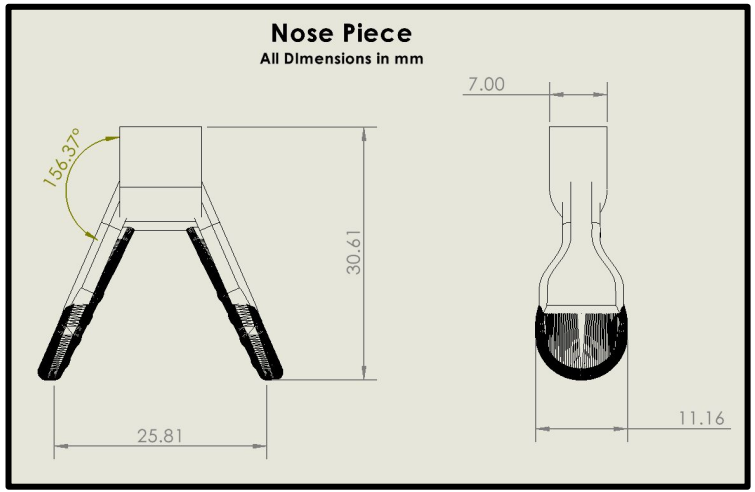
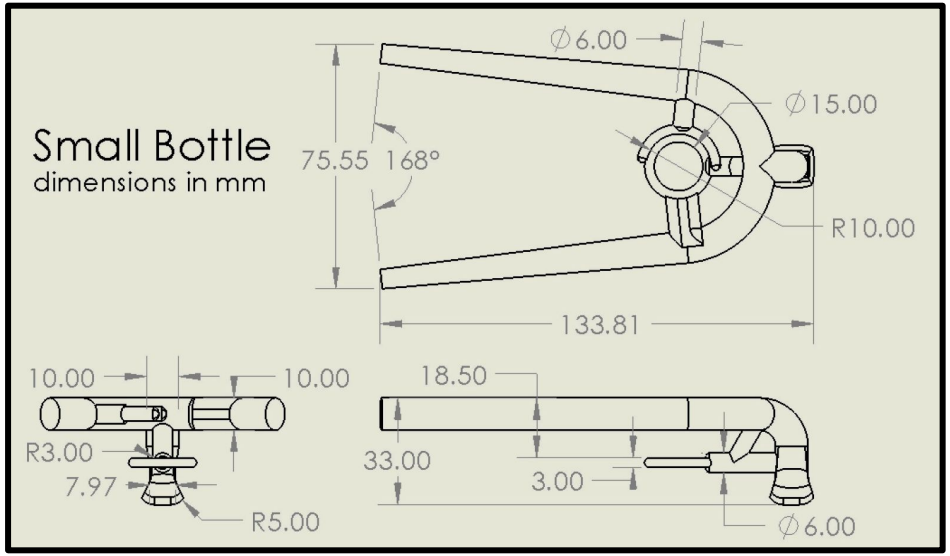




Figure 11: Dimensioned SolidWorks drawings of prototype featuring the nose piece for stability

# Final Prototypes - Platform for Stability



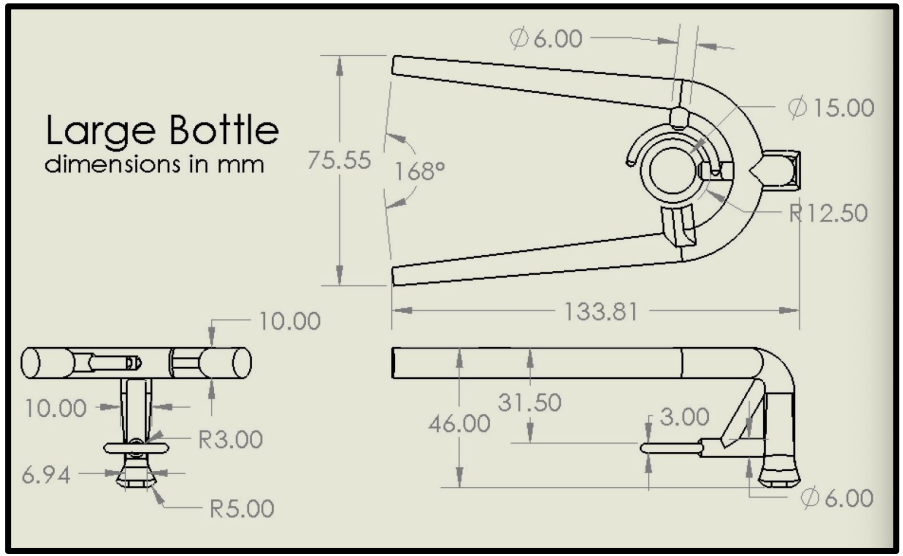




Figure 12: Dimensioned SolidWorks drawings of prototype featuring the platform for stability

# Final Prototype Limitations

- Nose Bridge Prototype
  - Doesn’t accommodate anatomical differences
  - Nose bridge attachment breaking
  - Head must be tipped back fully for use
- Eyebrow Platform Prototype
  - Platform is not secure to the face, i.e. could slip
  - Less intuitive than nose bridge
- Overall
  - Limited to round shaped bottles

# Final Prototype Advantages

- Nose Bridge Prototype
  - Fully secures the device
  - Produces a precise drop location
- Eyebrow Platform Prototype
  - Allows for patient preference
    - Dominant hand can be used on both sides of face
    - Platform can be placed based on different anatomy
  - May be easier to use while looking in a mirror

# Previous Testing and Results

- Single drop test
  - Concluded that drop size decreased with use of device
- Precision Test
  - Concluded that use of the device allowed for more precision of drop location
  - However, this was done with the nose bridge rest
- Squeeze Force Test
  - Concluded that the amount of force required to use the device is within the range for a majority of patients with dexterity issues

# Lessons Learned

- Time management
  - Set realistic goals and deadlines
- Testing methods
  - Not all tests will produce useful results
  - Conceptual tests give different results than human tests
- Team work
  - Divide and conquer
  - Everyone utilize their strengths

# Future Goals

| Task | Jan | Feb | | | | March | | | | | April | | | | May | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 2 | 9 | 16 | 23 | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 1 | 3 |
| **Project R&D** | | | | | | | | | | x | | | | | | |
| Research | | | | | | | | | | x | | | | | | |
| Prototyping | | | | | | | | | | x | | | | | | |
| Packaging | | | | | | | | | | x | | | | | | |
| Injection Molding | | | | | | | | | | x | | | | | | |
| **Testing** | | | | | | | | | | x | | | | | | |
| IRB User Preference | | | | | | | | | | x | | | | | | |
| IRB Addendum | | | | | | | | | | x | | | | | | |
| IRB Accuracy | | | | | | | | | | x | | | | | | |
| Fatigue Testing | | | | | | | | | | x | | | | | | |
| **Deliverables** | | | | | | | | | | x | | | | | | |
| Prelim Deliverables | | | | | | | | | | x | | | | | | |
| Executive Summary | | | | | | | | | | x | | | | | | |
| Final Deliverables | | | | | | | | | | x | | | | | | |
| **Shark Tank** | | | | | | | | | | x | | | | | | |
| Presentation Draft | | | | | | | | | | x | | | | | | |

| Task | Jan | Feb | | | | March | | | | | April | | | | May | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 2 | 9 | 16 | 23 | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 1 | 3 |
| **Project R&D** | | | | | | | | | | | | | | | | |
| Research | | | | | | | | | | | | | | | | |
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| **Shark Tank** | | | | | | | | | | | | | | | | |
| Presentation Draft | | | | | | | | | | x | | | | | | |

## IRB User Preference:

- Made recruitment flyer
- In pre-review process of addressing comments
- Dr. Martin will return in a couple weeks and we will join her on a clinic day at Oakwood Village University Woods retirement community
- Survey will include both prototypes to compare preferences

| Task | Jan | Feb | | | | March | | | | | April | | | | May | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 2 | 9 | 16 | 23 | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 1 | 3 |
| **Project R&D** | | | | | | | | | | x | | | | | | |
| R | | | | | | | | | | x | | | | | | |
| R | | | | | | | | | | x | | | | | | |
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| D | | | | | | | | | | x | | | | | | |
| R | | | | | | | | | | x | | | | | | |
| R | | | | | | | | | | x | | | | | | |
| R | | | | | | | | | | x | | | | | | |
| **Shark Tank** | | | | | | | | | | x | | | | | | |
| Presentation Draft | | | | | | | | | | x | | | | | | |

**IRB Addendum:**

- Make edits to original IRB to include study participant's administering eye drops into their eyes
- Should be much quicker process than first IRB because majority of it will be duplicated

| Task | Jan | Feb | | | | March | | | | | April | | | | May | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 2 | 9 | 16 | 23 | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 1 | 3 |
| **Project R&D** | | | | | | | | | | x | | | | | | |
| Research | | | | | | | | | | x | | | | | | |
| Prototyping | | | | | | | | | | x | | | | | | |
| Packaging | | | | | | | | | | x | | | | | | |
| Injection Molding | | | | | | | | | | x | | | | | | |
| **Testing** | | | | | | | | | | x | | | | | | |
| IRB User Preference | | | | | | | | | | x | | | | | | |
| IRB Addendum | | | | | | | | | | x | | | | | | |
| IRB Accuracy | | | | | | | | | | x | | | | | | |
| Fatigue Testing | | | | | | | | | | x | | | | | | |
| **Deliverables** | | | | | | | | | | | | | | | | |
| Prelim Deliverables | | | | | | | | | | x | | | | | | |
| Executive Summary | | | | | | | | | | x | | | | | | |
| Final Deliverables | | | | | | | | | | x | | | | | | |
| **Shark Tank** | | | | | | | | | | x | | | | | | |
| Presentation Draft | | | | | | | | | | x | | | | | | |

**IRB Accuracy:**

- Dr. Martin will supply lubricating eye drops for participant's to administer
- Ultimate test of feasibility and necessary for users to like using the eye drop assistant device compared to only the eye drop bottle

| Task | Jan | Feb | | | | March | | | | | April | | | | May | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 26 | 2 | 9 | 16 | 23 | 1 | 8 | 15 | 22 | 29 | 5 | 12 | 19 | 26 | 1 | 3 |
| **Project R&D** | | | | | | | | | | x | | | | | | |
| Research | | | | | | | | | | x | | | | | | |
| Prototyping | | | | | | | | | | | | | | | | |
| Packaging | | | | | | | | | | | | | | | | |
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| **Testing** | | | | | | | | | | | | | | | | |
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| Prelim Deliverables | | | | | | | | | | | | | | | | |
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| Final Deliverables | | | | | | | | | | x | | | | | | |
| **Shark Tank** | | | | | | | | | | x | | | | | | |
| Presentation Draft | | | | | | | | | | x | | | | | | |

**Fatigue Testing:**

- Want to determine how many compression cycles of the device handles it takes for the device to break
- Highly dependent on material choice
- Need to ensure that device is durable enough

# Fabrication Next Steps

- Injection Molding
  - Move toward mass production
  - Received expert opinion on properties of materials and design
    - Polypropylene (PP) is the ideal material
    - Make design modular to simplify mold
  - Moldex3D FEA Interface
    - Simulated 3 point bending test with a material
  - WID injection mold prototype
    - Complete mechanical testing

Figure 13: Injection Molding Part and Mold [6]

# Packaging

- Mono Carton
  - Environment, Fabrication
  - Durability
- Clamshell
  - Size, Shape, Visibility
  - Fabrication
- Additional Research
  - ISO + ASTM Standards
    - Test Methods for Packaging


Figure 14: Mono Carton Packaging for a Competing Eye Drop Device [7]


Figure 15: Clamshell Packaging for Fridge Filters [8]

# Labeling and Instructions

- Instructions for Use
  - Adequately guides all users
  - ISO 20417:2021 [9]
- Hazard Labels
  - ISO 3864-2:2016 [10]
- Marketing Graphics
  - Explain intended use
  - Clearly show device

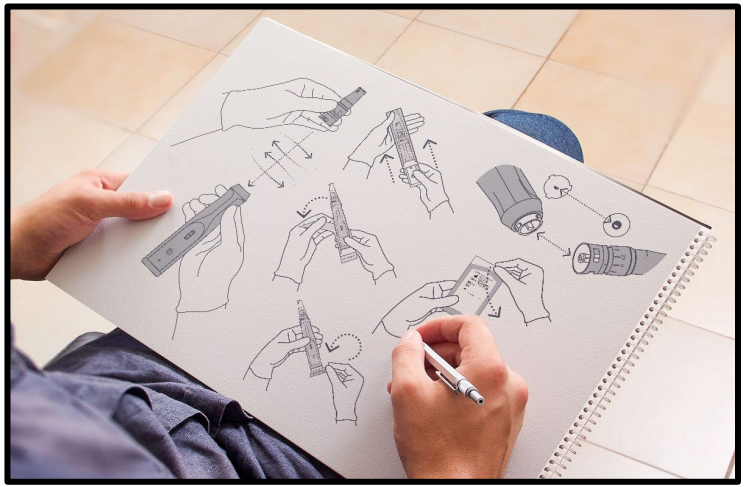

Figure 16: Instructions for Use being created for effective use of a medical device [11]

# Budget

| Purpose | Item | Cost |
|---|---|---|
| Existing Devices | Droppy Eye Drop Dispenser | 9.99 |
| Existing Devices | GentleDrop Eye Drop Guide | 17.99 |
| Prototyping | Silicone Eyelash Curler | 7.49 |
| Prototyping | MakerSpace Print | 78.29 |

Total: $113.78

$500 Budget -$113.78 Spent = **$386.22 Remaining**

# Acknowledgments

Thank you!

Dr. Beth Martin

Prof. Tracy Jane Puccinelli

BME & ME Department

UW Makerspace

# References


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[10] “ISO 3864-2:2016(en) Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels.” ISO, 2016.

[11] “313productions – Design, Digital & Beyond - User Manual Illustrations: Bellus Medical.” Accessed: Feb. 08, 2024. [Online]. Available: https://313productions.com/user-manual-illustrations-bellus-medical

# Questions and Comments?