

Helmet for Continuous Laryngoscopy During Exercise

Team Members:

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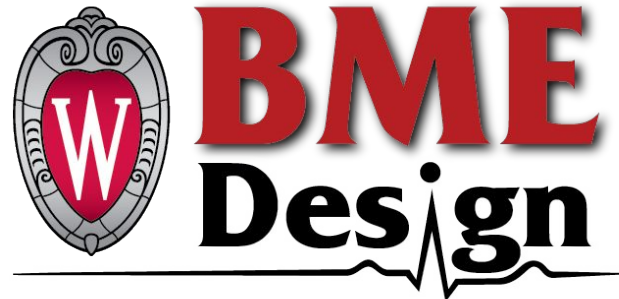
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Reghan Ziegler (BWIG)

Clients: Mr. Jacob Tangney

Advisor: Dr. Randolph Ashton



Overview

- Introduction to the team and their client
- Background of why the product is needed
- Explaining what problem the product is solving
- Competing designs
- Product Design Specifications
- Mount Designs
- Helmet Designs
- Project Timeline



Figure 1: Bucky in training facility [1]

About the Client

Kate

Jacob Tangey
M.S in Speech Therapy
Speech Language Pathology

- ❖ Treats patients with voice disorders
- ❖ Helps patients with breathing disorders
- ❖ Research on the relationship between swallowing and voice disorders



Figure 2: Photo Mr. Jacob Tangey [2]

Background

- ❖ CLE- Continuous Laryngoscopy during Exercise
 - Used as a diagnostic tool for exercise induced laryngeal obstruction
- ❖ Securable helmet mount prevents the laryngoscope from slipping during use
 - The more stable the mount, the more comfortable the patient
 - The more stable the mount, the more consistent the collected data is
- ❖ Most prevalent in athletes 20-40 years of age [3]
 - More often found in female patients [4]
- ❖ No standardized helmet on the market



Figure 3: CLE in action [5]

Problem Statement

Joe

Project motivation: no CLE in use at UW-Hospital

- CLE is the gold standard diagnostic tool to assess exercise induced laryngeal obstruction (ELIO).
- All current helmets are custom made.
- Currently, our client has patients walk or run up a flight of stairs and then has them sit for the laryngoscopy, which often does not work.

Objective: Design a successful helmet and mount for CLE

- Laryngoscope mount that resists 6N of force and a $1.5\text{N}\cdot\text{m}$ moment applied in all directions.
- During full sprint, the laryngoscope must not move more than 5mm from its original position relative to the helmet and must not apply a moment greater than $30\text{N}\cdot\text{m}$ on the occipital condyle in both flexion, extension, and bending.
- Helmet must not slip/rotate relative to the patient's head more than 10 degrees from its initial wear position.



Competing designs



Figure 4: HelpILO Laryngoscope headgear design [6]

HelpILO design

- Thin plastic and mesh hat with metal exoskeleton and ring clamp
- Mask attachment for cardiac stress test [6]

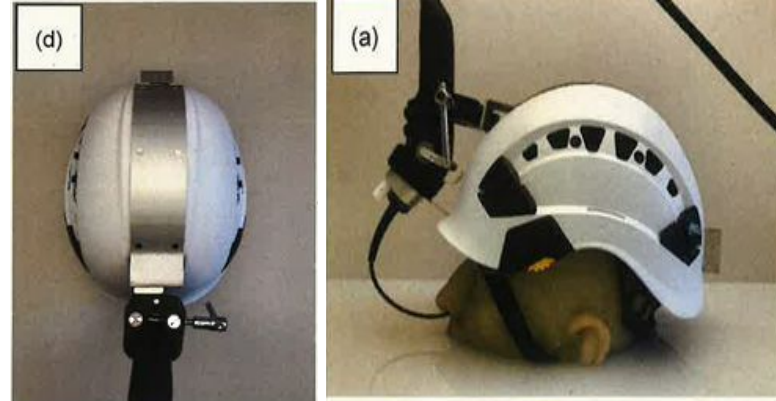


Figure 5: HALOS headgear design [7]

HALOS Headgear design

- Hard hat design with counterweight and ring clamp
- 29 participants in study; nearly all feedback either neutral or positive.



Product Design Specifications

2.0g Stability

- Minimal scope displacement, no airway trauma during sprinting.
- Resists 6N of force and a 1.5N*m moment applied in all directions.
- Helmet must not slip or rotate > 10 degrees in any direction.

300+ Test Cycles

- 2-year clinical service life.
- Resists degradation from repeated chemical disinfection.

≤ 1.20 kg Mass

- Minimizes neck muscle fatigue and head micro-movements.
- Torque limits: < 190 Nm flexion and < 57 Nm extension.

50–61 cm Head Fit

- Universal fit. (ranges from 3rd percentile for women to 98th percentile for men) [8]
- Comfort rating ≥ 3.5 / 5.0 based on user survey



Helmet 1: Airsoft Tactical Helmet



Figure 6: Airsoft Tactical Helmet [9]

- Multiple adjustable straps
 - Allows for secure fit during exercise
- Pre-existing mounting area
 - Easier attachment of the scope mount
- Internal Padding
 - Improves comfort and helmet stability



Helmet 2: Climbing Helmet



Figure 7: Climbing Helmet [10]

- Lightweight shell
 - Reduce added weight and potential neck strain
- Larger ventilation opening
 - Improve airflow and comfort during exercise
- Adjustable chin strap for easy fitting and adjustment
- Durable interior foam provides structural support and impact protection



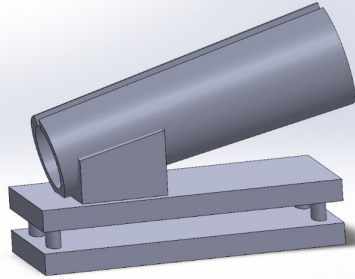
Helmet 3: Wrestling Helmet



Figure 8: Wrestling Headgear [11]

- Lightweight design
 - Minimize load on head and neck
- Open design
 - Allows ventilation and less heat build up
- Holes on the top can easily allow mounts to be strapped on
- Soft design
 - Improve comfort of the patient

Figure 10: 3D Rendering of Angled Cone Mount



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- Technical drawing of a Final Laryngoscope Mount, showing four views: Top View, Front View, Side View, and Bottom View. The drawing includes dimensions and a title block.
- Top View:** Shows the top of the mount. Dimensions: 70.00 (width), 15.00 (height of the central feature), 20.00 (height of the side flange).
- Front View:** Shows the front of the mount. Dimensions: 70.00 (width), 15.00 (height of the central feature), 20.00 (height of the side flange).
- Side View:** Shows the side of the mount. Dimensions: 70.00 (width), 15.00 (height of the central feature), 20.00 (height of the side flange).
- Bottom View:** Shows the bottom of the mount. Dimensions: 70.00 (width), 15.00 (height of the central feature), 20.00 (height of the side flange).
- Isometric View:** A 3D perspective view of the mount.
- Dimensions:**
- 70.00 (width)
 - 15.00 (height of the central feature)
 - 20.00 (height of the side flange)
- Material:** 304 STAINLESS STEEL
- Part Name:** Final Laryngoscope Mount
- Scale:** 1:1
- Drawn by:** [Blank]
- Checked by:** [Blank]
- Approved by:** [Blank]
- Date:** [Blank]
- Sheet No.:** [Blank]
- Total Sheets:** [Blank]
- Revision:**
- | Rev | Description | Date | By | Check |
|-----|----------------|------|----|-------|
| 1 | Initial Design | | | |

6

Design Idea #2 Split Ring Mount



Figure 12: Basic Split Ring

- Stabilized by dual stainless steel ring clamps
- Adjustable hinge for angle adjustment
- Rigidly mounted on to helmet

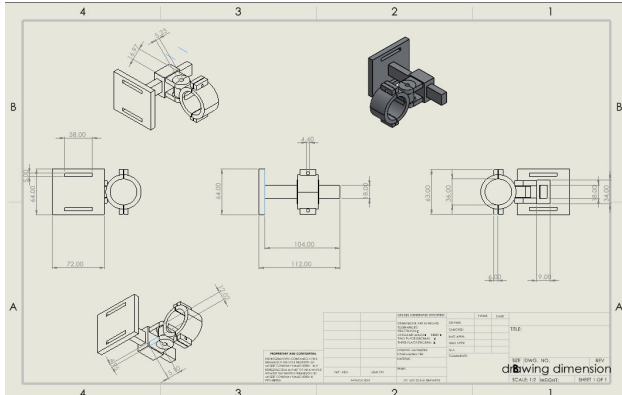
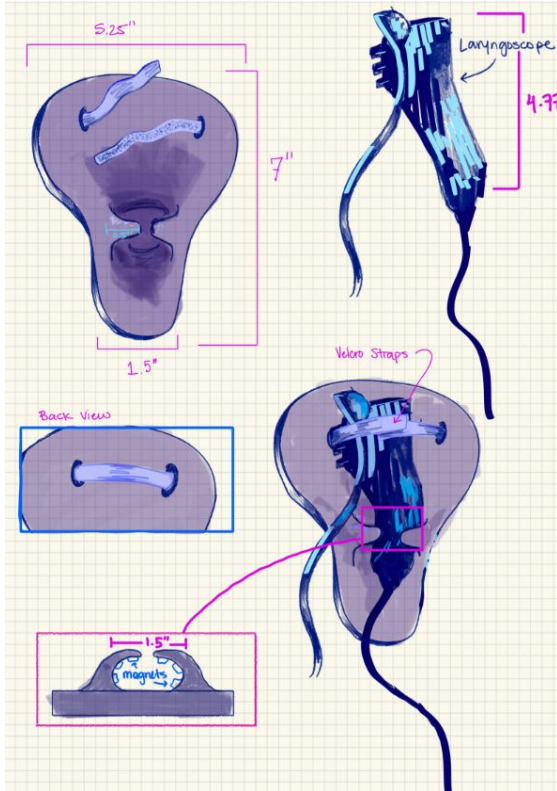


Figure 13: CAD Draft of Split Ring Mount

Design #3 Magnet+Velcro Mount



- Stabilized by indentation, velcro straps, and magnets
- Base made of TPU with high friction rubber surfaces

Figure 14: Magnet+Velcro Mount Sketch

Helmet Design Matrix

Kavin



Table 1: Helmet Design Matrix

Criteria (Weight)	Design #1: Airsoft Tactical Helmet		Design #2: Climbing Helmet		Design #3: Wrestling helmet	
						
	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Stability (40)	4.5/5	35	4/5	32	4/5	32
Durability (15)	5/5	15	4/5	12	3.5/5	10.5
Price (10)	4/5	8	4/5	8	4/5	8
Comfort (10)	3.5/5	7	3.5/5	7	5/5	10
Fit (15)	3/5	9	3/5	9	5/5	15
Ease of Use (10)	4/5	8	5/5	10	2/5	4
Total (100)	82		78		79.5	

Figure 15: Design matrix table showing weighted scores in selected categories for three helmet options

Laryngoscope Mount Design Matrix

Kavin



Table 1: Helmet Design Matrix

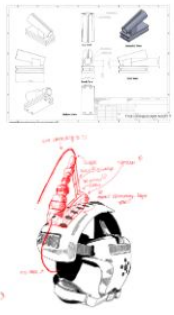
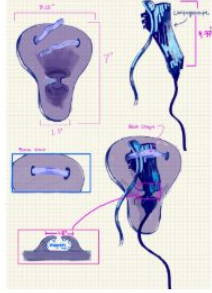
Criteria (Weight)	Angled Cone Mount		Split Ring Mount		Magnet+Velcro Mount	
						
	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Stability (40)	4/5	32	4/5	32	2.5/5	20
Durability (15)	5/5	15	4/5	12	4.5/5	13.5
Ease of Fabrication (15)	5/5	15	4/5	12	4.5/5	13.5
Weight (10)	4/5	8	3/5	6	5/5	10
Adjustability (10)	2/5	4	5/5	10	4.5/5	9
Price (10)	5/5	10	4/5	8	3/5	6
Total (100)	84		80		72	

Figure 16: Design matrix table showing weighted scores in selected categories for three mount options

Final Design

Reghan



Figure 17: Airsoft Tactical Helmet [9]

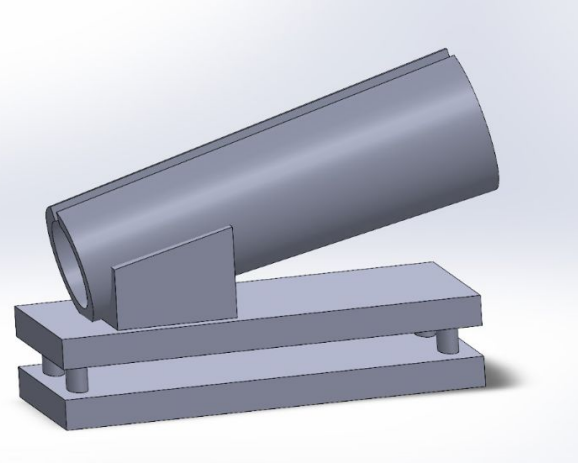


Figure 18: 3D Rendering of Angled Cone Mount

- Airsoft Tactical Helmet
- Most stable, durable, and cost effective

- Angled Cone Mount
- Most stable, durable, cost effective, and producible



Timeline

Early October

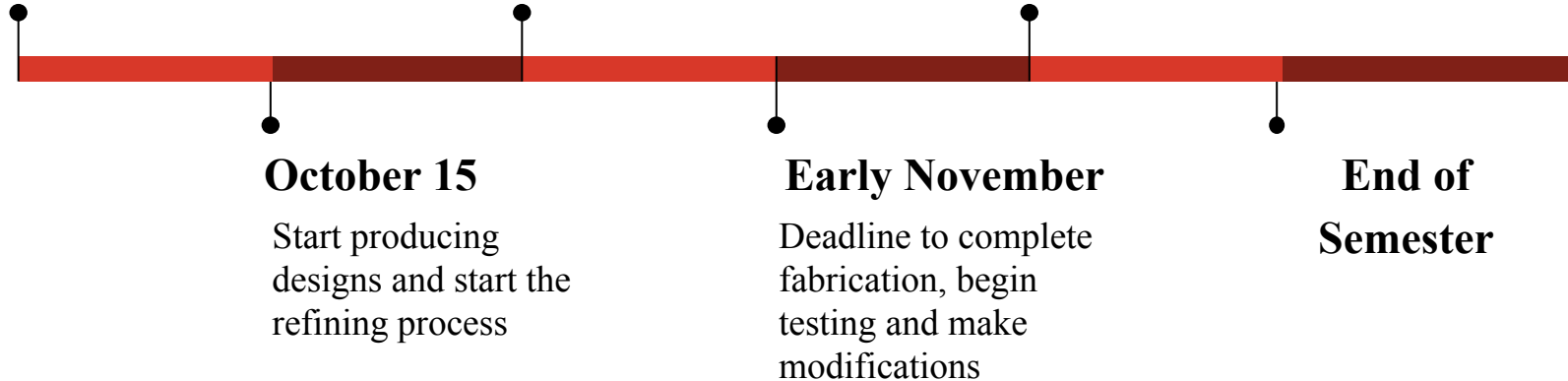
Meet with client, discuss preliminary designs, address modifications

November 1

Reassess designs, make modifications, finalize prototypes

December 5

Final Poster Presentation





Future Work

- Finalize and CAD designs
 - 3D print prototypes and assemble
- Prototype testing
 - Material performance (impact and longevity)
 - Comfort/safety
 - Physical condition testing
- Design iterations
 - Incorporate feedback from client and testing

Acknowledgements



Figure 19: Dr. Ashton PhD



Figure 20: Dr. Puccinelli PhD



Figure 21: Mr. Jacob Tangey [2]



References

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Questions?

