



Department of Biomedical Engineering

COLLEGE OF ENGINEERING
UNIVERSITY OF WISCONSIN-MADISON

Embouchure Assist Device

Erika Daniels, Anna van Riessen, Celia Oslakovic, Caden Kleespies, Owen
Johnson, & Owynn Garrelts

Client: Linda Chickering

Advisor: Dr. William Murphy



Problem Statement

Client

- Linda Chickering

Motivation

- Oboists with facial paralysis struggle to maintain a tight embouchure during play

Goal

- Develop a device to push facial muscles into a proper oboe embouchure



Figure 1: Client's embouchure during play with cheek puffing due to facial paralysis [1].

Background

Facial Paralysis:

- Facial nerve paralysis affects more than 100,000 Americans [2]
- Prevents instrument embouchure control

Client:

- Weak musculature in lower right facial quadrant from parotid gland cancer
- Air leak after 15 seconds of play

Oboe:

- Double reed unsupported by a mouthpiece
- Precise embouchure control

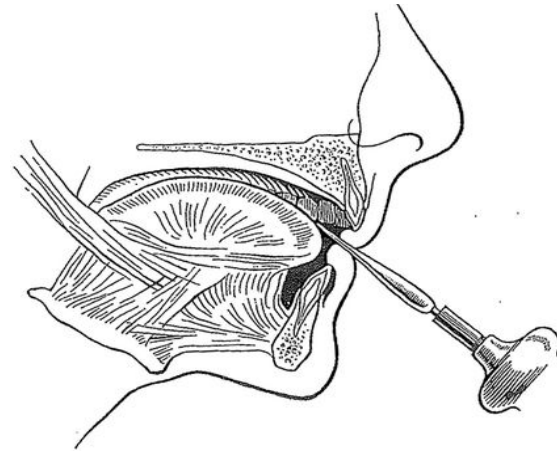


Figure 2: Schematic representation of oboe embouchure [3]

Competing Designs

Saxophone Embouchure Assist [4]

- Silicone interface mounted on a mouthpiece
- Pressure applied by player
- Seals the gap in embouchure
- Reliant on a mouthpiece

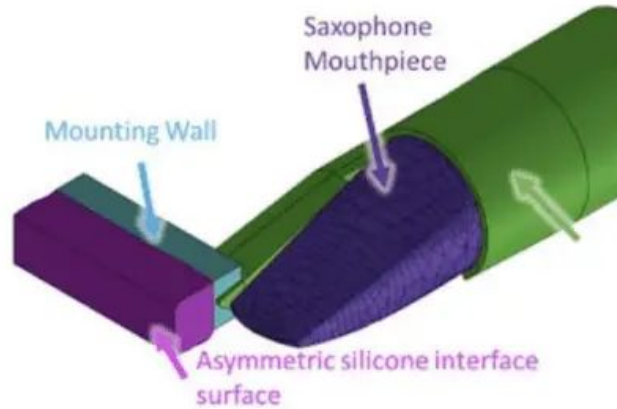


Fig. 3. Saxophone embouchure assist digital design [4]

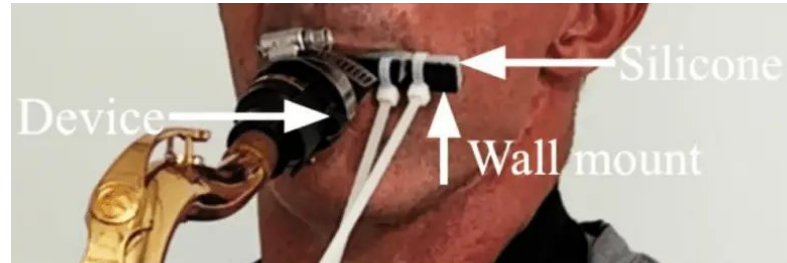


Figure 4: Saxophone embouchure assist in use [4]

Competing Designs

Ring Design [5]

- Headset design with a force arm
- Difficult to adjust, uncomfortable
- Insufficient 9N force



Fig. 5. Ring design in use [5]

Coil Design [5]

- Continuously wraps around the head
- Constant 6N force application
- Torsional effects cause discomfort



Figure 6: Coil design in use [5]



PDS - Client Requirements

- Lightweight
 - Max weight 400g [6]
 - Ideally less than 300g [7]
- Comfortable
 - Less than 620N force [8]
- Estimated cost \$50
- Adjustable
 - Pressure clamp
 - Around head
- Device can not interfere with the oboe reed



PDS - Characteristics

- Dimensions
 - Range of 49-58 cm diameter [9]
- Air pressure of 3333 Pa to 12000 Pa to oboe reed [10]
- Safety and Standards
 - CFR Title 21, Section 890.3025 [11]
 - ISO 8549 [12]
 - ISO 8551:2020 [13]
 - ISO 10993-1 [14]

- Duration
 - 30 seconds of sustained play
 - 1 to 2 hours of continuous use [15]
 - Last up to 25 years [16]



Figure 7: Human Head Circumference [17]

Headset with Clamped Pressure Piece

- Adjustable applied force
- Foam padding for comfort
- Elastic headband
- Clamp can be adjusted in three dimensions



Figure 8: Adjustable Mic for Headset [18]

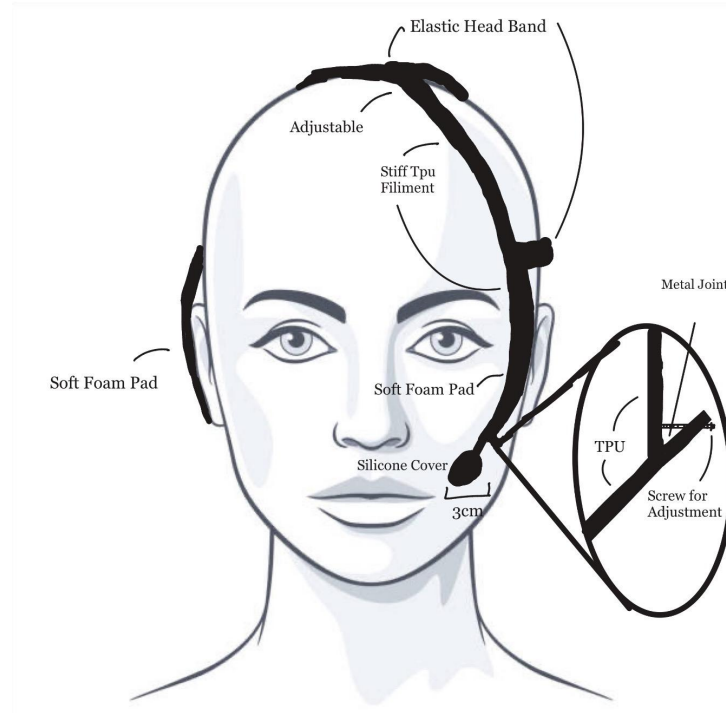


Figure 9: Headset with clamped pressure piece

Shoulder Harness Design

- Delegates weight to body/shoulders
- Secured to body
- Adjustable in three dimensions



Figure 10: Marching Band Snare Drum Carrier [19]

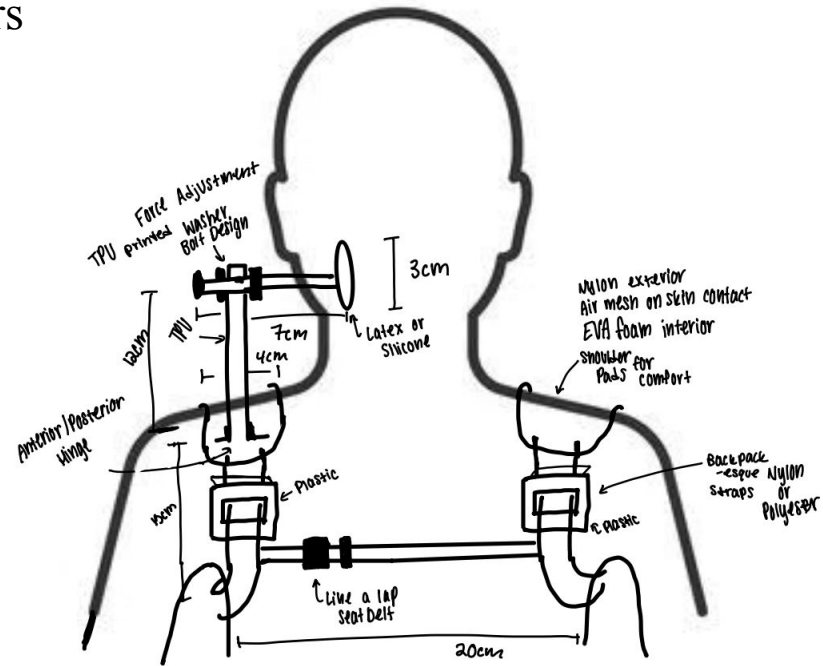


Figure 11: Shoulder Harness Design



Wrap-around Headset

- Universal headset design
- Anterior/posterior adjustment
- Superior/inferior adjustment



Figure 12: Adjustable Head Strap for Oculus Quest [20]

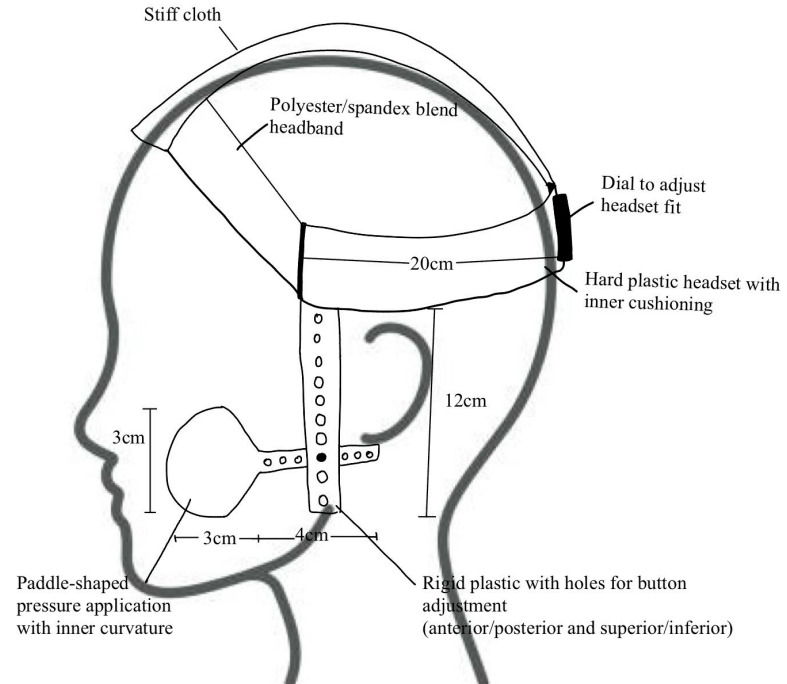
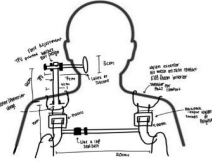
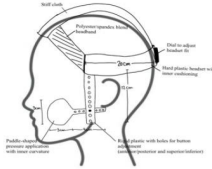


Figure 13: Wrap-around Headset Design



Design Matrix Evaluation

Table 1: Design Matrix for device designs

Designs		Headset with clamped pressure piece		Shoulder harness		Wrap-around headset	
							
Rank	Criteria	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Applied force (25)	4/5	20	4/5	20	4/5	20
2	Comfort (25)	4/5	20	3/5	15	5/5	25
3	Sustained stability (15)	5/5	15	4/5	12	5/5	15
4	Adjustability (15)	5/5	15	4/5	12	3/5	9
5	Ease of use (10)	4/5	8	3/5	7	4/5	8
6	Safety (5)	4/5	4	4/5	4	4/5	4
7	Cost (5)	4/5	4	3/5	3	2/5	2
			86		73		83

Materials Matrix

Table 2: Design Matrix for material choices

Materials			TPU + Silicone		TPU + Latex		PLA+ Silicone	
Rank	Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1	Biocompatibility	25	5/5	25	3/5	15	4/5	20
2	Mechanical Properties	25	2/5	10	2/5	10	4/5	20
3	Ease of Fabrication	20	5/5	20	2/5	8	5/5	20
4	Comfort	15	4/5	12	4/5	12	3/5	9
5	Cost	10	3/5	6	3/5	6	4/5	8
6	Aesthetics	5	4/5	4	2/5	2	4/5	4
	Total	100		77		63		81



Figure 14: PLA [21]

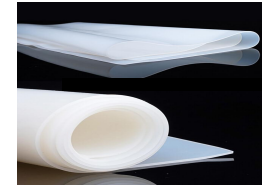


Figure 15: Silicone [22]



Figure 16: TPU [23]



Final Design

- PLA & silicone
- Stability, adjustability, & ease of use
- Manual operation
- Little interference with performance

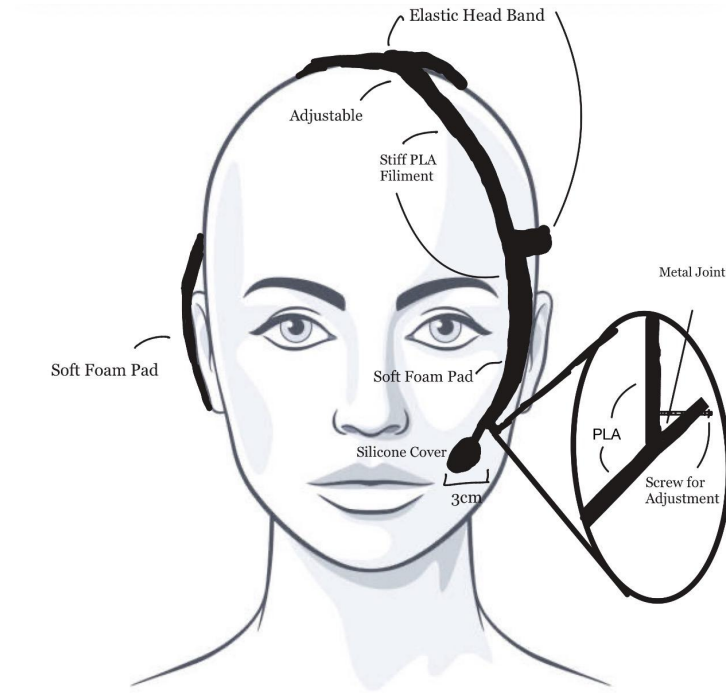


Figure 17: Headset with clamped pressure piece



Final Design Fabrication Plan

- Source adjustable headset
 - Modify to fit design
- Design & 3D print adjustable pressure piece
- Apply silicone to necessary surfaces
- Main concerns are applied force and comfort

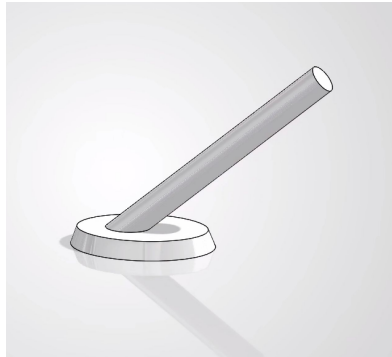


Figure 18: Simplified CAD pressure piece design

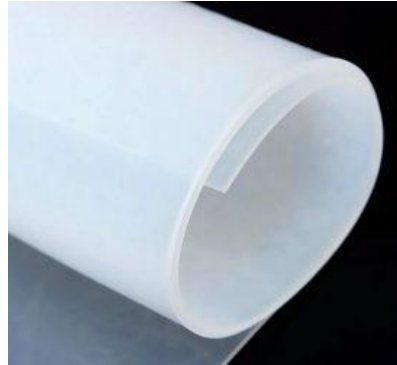


Figure 19: Medical-grade silicone film [24]



Figure 20: Sourceable headset [25]



Testing

Force Sensitive Resistor

- Apply to face
- Measures necessary force



Figure 21: Force sensitive resistor [26]



Figure 22: Water manometer example [27]

Water Manometer

- Measure air pressure
- Aim for 3333 Pa to 12000 Pa [10]

Functionality Testing

- Duration of use
 - 30 seconds of sustained play
- Visible air leaks
- Ease of use



Figure 1: Client's embouchure during play with cheek puffing due to facial paralysis [1]



Future Work

Short term

- Order materials
- 3D print headset components
- Fabricate adjustments

Long Term

- Testing with client
 - October 9th
 - October 24th



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Advisor: Dr. William Murphy

Client: Linda Chickering

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