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3D Printing Airway Trainers

2/20/26

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Problem Statement

- Standard airway trainers are somewhat limited
- Abnormal airway practice improves patient outcomes
- No established method for printing airways
- Feasible to transform MRI to STL
- Transfer requires an advanced segmentation process
- Incorporate into a fully adjustable manikin

Background

- Dr. Kristopher Schroeder, Department of Anesthesiology
- Clinicians have 15-30 seconds before hypoxia [1]
- 12.7% of intubations fail on the first attempt [1]
- Training directly correlated to patient outcome [2]
- Trainers don't simulate varied endotracheal environments [3]
- Personalized 3D printed airways aren't used

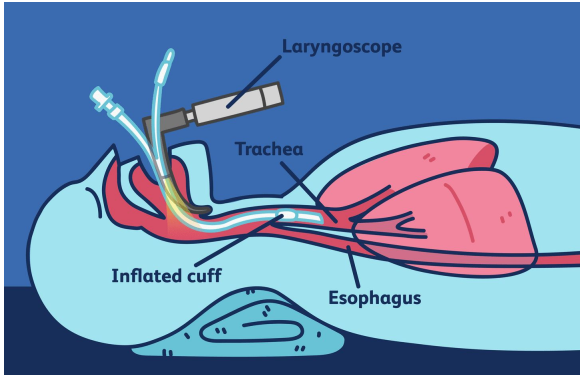

Figure 1: Intubation Diagram [4]

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Competing Designs

- A variety of airway manikins exist
  - Babies
  - Swollen craniofacial structure
  - Burn victims
- Trainers often include just one feature of a difficult airway
  - Modular mandible
  - Adjustable neck
  - Inflatable tongue
  - Induced vomiting
  - Pressure sensitive teeth
- High end trainers can cost $1,700-3,000 [5]

Figure 2: Laerdal Airway Management Trainer [5]


Figure 3: Decent Simulators [6]

Product Design Specifications

- Physiological Accuracy & Material Properties
    - Maintain integrity following 20,000 intubation cycles [7]
    - Match human airway in look and texture
- Rapid adjustability of neck angle, tongue size, and mandible position
- Aim to minimize process cost for marketability
- Printing process should be repeatable in under 48 hours total

Fall 2025

Final Design and Testing Results

Airway Fabrication Process

MRI Scan → Segment → Scale → Mold

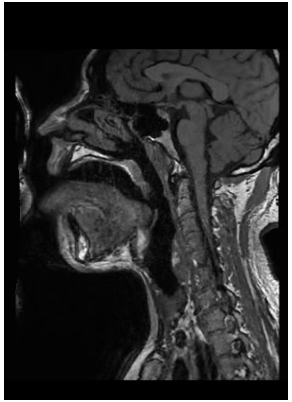

Figure 4: MRI

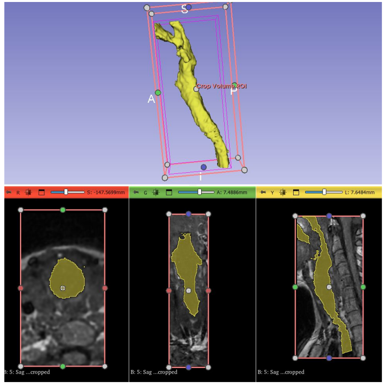

Figure 5: Segmentation

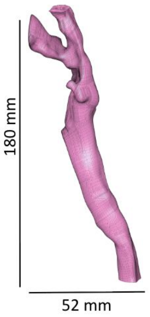

Figure 6: 3D Render

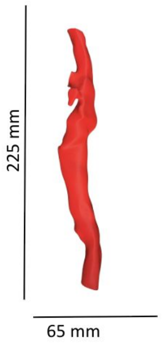

Figure 7: Scaled Render

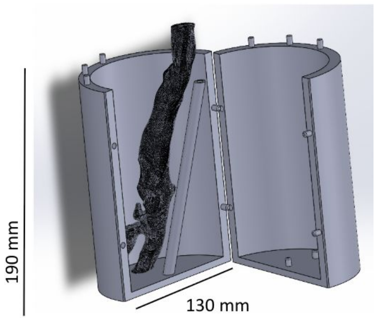

Figure 8: Mold

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Final Design: Flexible Lamp Design

- Similar to a flexible lamp rod
- Adjustable in 3 DOF
- Threaded ends that screw into the top of the neck
- Implement design 1 for stability

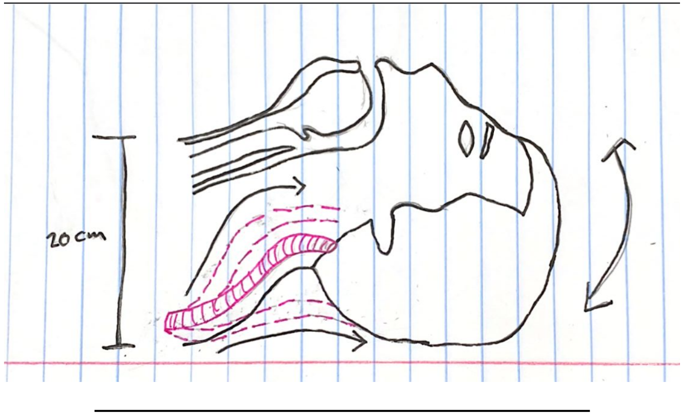

Figure 10: Sketch of Flexible Lamp Design

Fall Semester Testing - Durability

- Durability Testing (Each material)
  - Intubation cycles until visible damage or until 50 iterations occured
  - The rubber airway tested was part of a TruCorp manikin
  - EcoFlex 00-30 Silicone is the selected material for our manikin

Material	EcoFlex Silicone	TruCorp Rubber	Elastic Resin	Flexible Resin	TPU
Intubations until damaged	>50 - Minimal Damage	>50 - No Damage	4	7	>50 - No Damage

Table 1: Durability Results For All Materials During Intubation

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Fall Semester Testing - Compression

- Compression Testing (Each material)
  - Deformation was measured under a compressive load of 24.6 N (typical load experienced during intubation)
  - Values were converted into stiffness to compare material properties

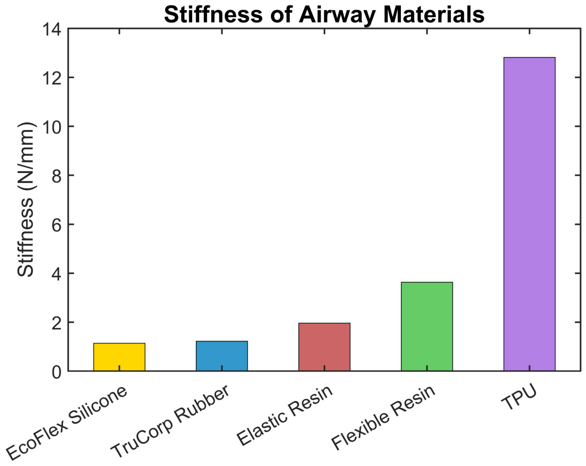

Figure 11: Stiffness of Materials During Compression Testing

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Spring 2026

Timeline, Fabrication Plan, and Testing Plan

Timeline - Fabrication Goals

February

Improve on previous designs/receive client feedback

March

3D print a mold that combines airway anatomy and oral cavity

Redesign an apparatus that fits the silicone airway and is meant to include lamp rod, adjustable jaw, etc

April

Design iteration and durability testing

Coordinate qualitative testing with client

May

Poster presentation & final deliverables

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Testing

- Neck modulation durability test
- Time to adjust manikin features/swap airways
  - Demonstrate ease of use
- Time for intubation coordinated by our client
  - Four levels of experience
  - Qualitative feedback
    - Stability, durability, and precision

Other Information

- Final prototype will be delivered directly to our client
  - IFU
  - Maintenance recommendations
- Final prototype summary
  - Product name
  - Key features and intended use
  - Technical specifications
- Hazard identification
  - Signal words
  - Precautionary statements

Budget

Previous spending:

- 3D printing ~$110
- Silicone ~$135

Expected spending:

- 3D printing ~$150
  - Similar spending on molds, increase in spending will come from manikin base and features
- Silicone ~$135
  - Expect to perform 2-3 casts, an amount similar to previous semester

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We would like to thank …

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