3D Printing Airway Trainers: BME 301

Dates: 2/14/25- 2/20/25

Client: Kristopher Schroeder, MD
Advisor: Prof. Beth Meyerand

Team:
Matt Sheridan (Communicator)
Dan Altschuler (BWIG and BPAG)
Cody Kryzer (BSAC)
Lance Johnson (Leader)

Problem Statement

Airway management is an integral part of keeping a patient stable in many medical environments. While training medical practitioners with simple airway trainers has improved patient outcomes, this has not had the same effect on patients with abnormal airways. The use of 3D printing from existing patient imaging to create realistic and individualized airway manikins would assist medical professionals, allowing them to practice airway management skills on lifelike models.

Brief Status Update

The team prepared for the preliminary presentation this week and also plans to meet with a member of the radiology department at WIMR to learn more about the scanning, segmentation, and 3D printing process. The team also continued to do research into software that could be used for these processes, but hopes to learn a lot more after our meeting on Friday.

Weekly Goals and Accomplishments

- Team
    - Completed the preliminary presentation
    - Scheduled meeting with radiologist at WIMR to learn more about scanning and segmentation
- Matt Sheridan
    - Completed portions of the preliminary presentation and researched materials
    - Started preliminary report research and writing
- Dan Altschuler
    - Completed a part of the preliminary presentation
    - Began to work on some sections of the preliminary report
- Cody Kryzer
    - Work on and rehearse preliminary presentation
    - Research segmentation
- Lance Johnson
    - Scheduled a meeting with a radiologist at Radius to learn more about segmentation and 3D-printing of DICOM images
    - Researched segmentation softwares
    - Contributed to the preliminary presentation

Upcoming Goals

- Team
    - Finish preparations for the preliminary presentation
    - Work on the preliminary report
- Matt Sheridan
    - Complete preliminary report and continue researching into the MRI segmentation process to work to start a process.
- Dan Altschuler
    - Give the preliminary presentation
    - Work on the preliminary report
- Cody Kryzer
    - Meet with a radiologist to learn about segmentation
    - Work on preliminary report
- Lance Johnson
    - Continue research into CT/MRI scan segmenting and the printing process
    - Meet with a member of last semester's team to discuss the project and see if they have any materials/prototypes that we can use

Design Matrix:

Design Criteria (Weight)	**Design 1:** Formlabs 80A Resin 		**Design 2:** Silicone Casting 		**Design 3:** Thermoplastic Polyurethane (TPU) 95A 	
Mechanical Properties (25)	5/5	25	2/5	10	4/5	20
Cost (20)	2/5	8	5/5	20	5/5	20
Ease of Fabrication (20)	4/5	16	1/5	4	3/5	12
Durability (15)	5/5	15	3/5	9	4/5	12
Resemblance to Trachea (10)	3/5	6	5/5	10	4/5	8
Printer Availability (10)	2/5	4	5/5	10	4/5	8
Total Score (100)	**74**		**63**		**80**	

Mechanical Properties (25): In order to create an accurate trainer, the 3D-printed airways need to mimic the patient's airway as accurately as possible and therefore need to possess the same mechanical properties of the airway. Young's modulus and Shore hardness were determined to be the most important properties for the airway as they quantify the strength and flexibility of the airway. Based on these factors, the accuracy of the biomechanical properties was deemed the most important category in our matrix.

Cost (20): Cost references the dollar per gram of the material. It is important for the material to be relatively cheap since a new airway will need to be printed for each patient; the product is essentially a one time use. 80A Resin can be purchased for $0.29 per gram. Silicone can be purchased for $0.05 per gram. TPU can be purchased for $0.05 per gram.

Ease of Fabrication (20): The ease of fabrication category refers to the simplicity of printing each material. Also considered in this category is the ability to accurately print using each material, especially given the broader scope of the project requiring widely accessible prints for many different airways. A higher score in this category represents an airway material that is both easy to work with and can output accurate prints.

Durability (15): The material used on the trainer must be able to withstand hundreds of uses over a long period of time. Additionally, if mistakes are made during the intubation process, the material must be able to withstand pressure from a sharp object. The material's ability to both last a long period of time and undergo unique stresses will be evaluated in this category.

Resemblance to Trachea (10): This category refers both to the color and texture of the material, and how similar this is to the trachea visually. This is important as familiarizing the students with an actual human trachea is the goal of the trainer, so matching color and texture helps them feel more familiar when performing an actual intubation.

Printer Availability (10): Not every material can be used with every printer. This category grades the materials on how likely it is for a compatible printer to be available. It is important for the entire process to be streamlined and accessible and not every hospital may have access to a specific 3D printer. Formlab materials require specific Formlab printers, which fortunately are available at UW Madison. The silicone casting process can work with any 3D printer because the mold can be made of the simplest materials.