3D Printing Airway Trainers: BME 301

Dates: 2/7/25- 2/13/25

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 researched possible materials that could be used for the 3D prints of the airways. A team member also spoke with a professor in the radiology department to discuss the segmentation process. All team members completed the human subjects training so that we can have access to the scans from our client.

Weekly Goals and Accomplishments

- Team
    - We completed a design matrix on possible materials for the 3D print and completed the human subjects training so that we can have access to the MRI scans from our client
- Matt Sheridan
    - Researched Ecoflex silicone material to discuss
    - Completed the design matrix
- Dan Altschuler
    - Researched TPU as a possible material for the 3D print
    - Filled out my portion of the design matrix
- Cody Kryzer
    - Completed design matrix
    - Researched materials
- Lance Johnson
    - Met with a professor from the radiology department to discuss obtaining scans and segmentation processes
    - Researched Formlabs Flexible 80 A Resin and contributed to the design matrix

Upcoming Goals

- Team
    - Prepare for the advisor meeting on Monday and prepare for the preliminary presentation
- Matt Sheridan
    - Continue research into 3D modeling and make progress on going from a MRI to a 3D model
- Dan Altschuler
    - Meet with the client to talk about the scans and acquire the video laryngoscope
    - Continue researching and preparing for the preliminary presentation
- Cody Kryzer
    - Acquire a video laryngoscope from Dr. Schroeder
    - Research the segmentation process
- Lance Johnson
    - Continue research into CT/MRI scan segmenting and the printing process
    - Email radiology contact to see if we can start the process of getting scans
    - 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.