# BME Design-Fall 2025 - Dan Altschuler
# Complete Notebook

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Elle Thom

on

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# Team contact Information

Elle Thom - Dec 15, 2025, 6:21 PM CST

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# Project description

Elle Thom - Dec 13, 2025, 9:14 PM CST

**Course Number: BME 400**

**Project Name: 3D Printing Airway Trainers**

**Short Name:** airway_trainers

**Project description/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.

**About the client:**

Dr. Kristopher Schroeder is a UW Health anesthesiologist and a professor in the Department of Anesthesiology at the University of Wisconsin School of Medicine and Public Health. He also serves as interim vice chair of education and vice chair of faculty development in the Department of Anesthesiology.

# Client Meeting - 9/9/25

Lance Johnson - Sep 09, 2025, 4:35 PM CDT

**Title:** Client Meeting #1

**Date:** 9/9/25

**Content by:** Lance

**Present:** All members, Kris Schroeder

**Goals:** Outline plans for this semester, consult Dr. Schroeder on next steps and future work

**Content:**

- focusing more on physical manikin vs. further refining the scanning process

- materials choice: anatomical accuracy vs real-life feel

- laryngoscopy vs. bronchoscopy are different procedures --> laryngoscopy requires more material anatomical accuracy whereas bronchoscopy is more based on feel

- mechanical influences: mouth opening, neck extension, tongue inflation, "stuff"(blood, secretions, vomit) in the airway

- Jim Decanto "salad" method for intubation in massive airway contamination--> developed vomiting manikin

- epiglottis and vocal cords are the most important section of the airway for intubation practice

- look into creating a mix of existing trainers

- pharyngeal tone("ahhh" sound) might open the airway better and make

- UW software might allow for better transition to printing?

- replicating various pathologies in a reproduceable way could get interest from simulation labs and teaching hospitals

- game-ifying intubation practice

- developing the process for printing airways easily and quickly remains the number goal

- Rick Galgon, George Arndt could be a good contact for us

- endobronchial blocker used for lung surgery, control bleeding(Arndt invention)

**Conclusions/action items:**

The team decided that focusing primarily on the process of going from scan to print is still the number one priority but depending on how the

# Advisor Meeting 9/12/25

Cody Kryzer - Sep 12, 2025, 12:33 PM CDT

**Title:** Advisor Meeting

**Date:** 9/12

**Content by:** Cody

**Present:** Everyone

**Goals:** Set up for a semester of success

**Content:**

Recapped with Campagnola about what we worked on last semester

vocalized goals for this semester

Discussed other slicing software, difficulty converting to a printable file, acquisition of more scans,

Small talk get to know each other

**Conclusions/action items:**

The team wants to set up a time with Schroeder to get more scans

# Advisor Meeting 9/19/25

MATTHEW SHERIDAN - Sep 19, 2025, 2:36 PM CDT

**Title:** Advisor Meeting

**Date:** 9/19

**Content by:** Cody

**Present:** Everyone

**Goals:** Discuss steps moving forward

**Content:**

Talked with Campagnola about meeting with the med student and what is expected of the med student

Med students are in a role agreed upon by the team and the student, not for a grade, they are expected to meet once a week with the team.

**Conclusions/action items:**

# Advisor Meeting 9/26/25

MATTHEW SHERIDAN - Sep 26, 2025, 12:22 PM CDT

**Title:** Advisor Meeting

**Date:** 9/26

**Content by:** Matt

**Present:** Matt, Elle, Lance, Dan

**Goals:** Discuss designs

**Content:**

Paul thinks its better to actually make some sort of clip that attaches to the print rather than try to make something form fitting

Decent Simulator design of a plastic clip that attaches to the airway seems like a good idea if we can get it to work

Prelim presentation on Friday in 2239 EHall at 12:05 we present first

**Conclusions/action items:**

Get airway scans and work on prototyping.

# Advisor Meeting 10/14/25

Cody Kryzer - Oct 14, 2025, 4:29 PM CDT

**Title:** Advisor meeting

**Date:** 10/14/25

**Content by:** Cody

**Present:** Whole team and Paul

**Goals:** Discuss the next steps

**Content:**

Think up an activity for outreach. Doesn't need to be related to our design project, anything works

Does Van Hise go to engineering expo?

Fill the decent simulators mold

Positive feedback on our presentation

Try softwares to slice the MRI scan

Ask the makerspace for suggestions. **Lennon Rodgers**

Materialise Mimics - very good, allegedly able to go straight to .stl file - need to use fusion or solidworks to add the esophagus

Paul can ask his colleagues for licenses too

**Conclusions/action items:**

The team should mold the decent simulator and slice the MRI scans.

Look into licenses for slicing software.

lennon.rodgers@wisc.edu

# Advisor Meeting 10/24/25

Cody Kryzer - Oct 24, 2025, 12:27 PM CDT

**Title:** Advisor meeting

**Date:** 10/24

**Content by:** Cody

**Present:** Cody Lance Matt Elle and Paul

**Goals:** Discuss further plans

**Content:**

Show and tell is next Friday

Feedback fruits was positive

Plan to write up an outreach activity document

Segmenting is turning out well. 3D slicer was used. Lance can add the esophagus.

Paul is no longer out of town on Fridays

**Conclusions/action items:**

Team is going to maximize their free time this next week and do all of the following

- Order silicone
- Order lamp neck
- Create mold
- Segment scans
- Transfer scans to solid body and add esophagus
- Write an outreach protocol
- Get in contact with teacher or principal for outreach
- BPAG will keep track of all purchases

Beyond this week

- Testing (swapping airways and intubation)

# Tong Lecture 11/7/25

MATTHEW SHERIDAN - Nov 07, 2025, 12:44 PM CST

**Title:** Tong Lecture: Building a Career of Impact - Kristin Myers

**Date:** 11/7/2025

**Content by:** Matt Sheridan

**Present:** BME 400

**Goals:**

**Content:**

College: 4 internships, worked a bunch of jobs

After college: Worked full time at Medtronic for 5 years, then got MBA and worked in venture capital buying medical start-ups

Chapter 2 (Climb growth curve): Chief of Staff to CEO at Aetna, started a cycling studio at that time, then president & CEO at Unified Women's Healthcare

She wanted to make a difference in the healthcare industry, understand show important affordable healthcare is, and also how difficult it is for some to access it in this country.

"you don't need to know your final destination - just follow hard problems and build skills that allow you to make an impact"

What does great healthcare look like? Quadruple aim: Improved provider experience, improved patient outcomes, lower cost of care, improved patient experience

18% of GDP is spent on healthcare in this country, which is double other countries, but we have terrible outcomes. US ranked last on equity, access, and outcomes.

It is like this because of health insurance, there is $1.2T in waste, 17% of spend is on administration

Underlying challenges: misaligned incentives, fragmented financing & regulation, data silos & legacy IT, inequities (10-15yr gap between zip codes)

She wants an integrated system to enable health and wellness for all, doctor should be rewarded for affecting all aspects of a patient's life.

What's needed to do so?

Interoperable data infrastructure(seamless data exchange), human centered design(care built around people not processes), aligned incentives and measurement(everyone rewarded for outcomes not activity), connected care delivery platforms(integration of virtual, in-person, and home care), simplified and automated infrastructure(admin tasks run automatically, accurately), systems thinking, analytical rigor, design and iteration, process optimization, and reliability & safety

1. Work hard and build range: take on the hardest projects, classes and experience you can find. Effort and range are your foundation.

2. seek diverse exposure: explore different sectors, teams, and geographies. Gain perspective and learn how systems connect, not just how parts work.

3. Choose your people wisely: surround yourself with curious, driven, high-integrity people. They will shape who you become.

4. Know your values and protect them: Define what matters most - family/friends, health, career/impact, values - and make decisions that align.

5. Embrace challenge and keep growing: Run towards hard problems. Growth lives on the edge of discomfort - where big impact starts.

**Conclusions/action items:**

She's so cool

# Advisor Meeting 11/14/25

Cody Kryzer - Nov 14, 2025, 12:17 PM CST

**Title:** Advisor meeting

**Date:** 11/14/25

**Content by:** Cody

**Present:** Whole team and Paul

**Goals:** Discuss plans for the rest of the semester

**Content:**

MRI scan is sliced - print and make a mold out of it

Outreach is today

Are we expected to have testing done for this semester?

"I think you can have more of your testing next semester" "I think a good goal is to have a viable prototype based on the design"

For the poster, bring a laptop and show the slicing "I think that's actually a good stopping point"

For poster pres make sure that people understand the full scope of what we're working on. Be specific what the goal of the project is (patient specific or library or explain benefits of both)

**Conclusions/action items:**

Have a draft of our poster done before Thanksgiving for Paul to look over

Get something printed by next week.

Next week is our last advisor meeting before poster pres

After poster pres have a wrap up meeting with Paul

# Advisor Meeting 11/21/25

Cody Kryzer - Nov 21, 2025, 12:23 PM CST

**Title:** Advisor meeting

**Date:** 11/21/25

**Content by:** Cody

**Present:** Everyone!

**Goals:** Discuss plans to wrap up the semester

**Content:**

We printed the airway and a mold for it

We ordered longer lamp rods (15.7 inch) to go through the entirety of the silicone and up the head

Paul has a Bichon Frise (little white curly hair dogs)

**Conclusions/action items:**

We want to get as much done and printed as possible before spring break

Order silicone as needed

# Wrap Up 12/11/25

Dan Altschuler (daltschuler2@wisc.edu) - Dec 11, 2025, 10:24 AM CST

**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

- Poster looked nice, only a few comments
- Wants us to characterize the project marketability by saying patient specific, then evolves into a library
- Wants to see a bit more of testing and could do more work on the testing, especially looking into fidelity testing
- Also change the units and do Young's Modulus instead of stiffness
- For fidelity testing look at the print as compared to 3D model
    - this is looking at the error of converting scan data into reconstructed
    - also the error between the printer and the scan
- Can use ImageJ to calculate the fidelity, a pixel by pixel comparison to get an R value for correlation
- The number he uses is 80-85% fidelity
- Well positioned to do a bunch of testing next semester
- Next semester report is a mock paper, different format
    - get a head start on the formal writing
- write the paper in the style of a journal that could publish our work -- maybe ask the client
-

**Conclusions/action items:**

# Team Meeting 9/17/25

Cody Kryzer - Sep 17, 2025, 8:52 PM CDT

**Title:** Team Meeting

**Date:** 9/17/25

**Content by:** Cody

**Present:** Everyone

**Goals:** Update the PDS with any necessary changes, specifically new goals

**Content:**

The team made edits to the PDS, mostly changing last semester's goals into previous accomplishments while also adding new goals for the design.

**Conclusions/action items:**

The team filled out week 2's progress report. We plan to next begin brainstorming designs for a modular manikin. We also want to meet with the client to get better MRI scans.

# Design Matrix Meeting 9/25/25

Dan Altschuler (daltschuler2@wisc.edu) - Sep 25, 2025, 7:55 PM CDT

**Title:** Design Matrix Meeting

**Date:** 9/25/25

**Content by:** Dan

**Present:** Lance, Elle, Matt, Cody, Dan

**Goals:** create the design matrix due for tomorrow

**Content:**

- the team does not know exactly what we want to make for our design matrix
- we have some good ideas for how we want to make the face of the manikin and the actual manikin parts but we are not sure how to include that in the desing matrix
- the team decided it made the most sense to include a design matrix for the neck modulation so that we can play around with how we design actual manikin and not be bogged down in the details
- Cody, Lance, and Elle all drew the different designs that we came up with
- we are going to print our design for tomorrow and continue working

**Conclusions/action items:**

The team will meet with our advisor tomorrow to go over our design matrix and make any modifications. The team has some good designs to decide on.

# Team Meeting 10/12/25

Cody Kryzer - Oct 12, 2025, 3:52 PM CDT

**Title:** Team meeting

**Date:** 10/12/25

**Content by:** Cody

**Present:** Cody, Matt, Dan, Elle

**Goals:** Write the preliminary report

**Content:**

The team wrote the preliminary report and the weekly progress report.

The team discussed potential activities for outreach.

**Conclusions/action items:**

We plan to go to a fifth grade classroom at a local elementary school for our outreach activity

# Outreach Planning Meeting 10/27/25

Dan Altschuler (daltschuler2@wisc.edu) - Oct 27, 2025, 6:00 PM CDT

**Title:** Outreach Planning

**Date:** 10/27/25

**Content by:** Dan

**Present:** Dan, Cody, Elle, Lance, Matt

**Goals:** Plan our outreach program and route it to Tracey for approval

**Content:**

- The team needs to decide what we are doing for our outreach program
- We have decided on two different things to do, a prosthetic bicep and a cast activity
- The team worked on completing the document and building the slideshow

**Conclusions/action items:**

The team will route our activity for approval and plan a day to do outreach

# Show and Tell 10/31/25

MATTHEW SHERIDAN - Oct 31, 2025, 1:04 PM CDT

**Title:** Show and Tell

**Date:** 10/31/25

**Content by:** Matt

**Present:** Everyone

**Goals:** Get thoughts from other teams about steps moving forward

**Content:**

Advice from others:

- MeshGrid cleans up files to make sure it is easier to build an stl file.
- Maybe place the airway that we printed inside and mold the silicone around it to have different material properties in different parts of the airway.
- invesalius or materialize mimics for segmentation
- print supports in dissolvable material, then run it through to dissolve that material.
- Other groups that did 3d printing on CTs came to the conclusion that it is better to print the negative
- For opening the jaw we can do something like an airplane seat that allows you to open up with a ratchet mechanism.
- Tongue size is the most important thing for intubation, when inflamed it is very hard to intubate.
- Shape of vocal cords is also very important, if they are inflamed it can be very difficult to intubate.
- The jaw doesn't necessarily need to be modular, just needs to be able to be moved in the way that a human jaw moves, you have to be able to essentially "dislocate" it when doing the intubation.
-

**Conclusions/action items:**

# Initial 3D Print Meeting 10/20/25

MATTHEW SHERIDAN - Dec 02, 2025, 10:44 AM CST

**Title:** Initial 3D Printing Meeting

**Date:** 10/20/25

**Content by:** Matt Sheridan

**Present:** Matt Sheridan, Lance Johnson, Cody Kryzer

**Goals:** Finalize our plan and submit our first 3D print

**Content:**

Lance designed this part that can be printed twice and connected to make a shell. The pegs on the side allow it to be connected to the other part, and the pegs on the bottom are attachment points for the airway and the cylinder.

Our idea with this print is that both the airway and the cylinder can be placed into this shell, and silicone can be poured into the shell, creating a mold of the airway. The cylinder is a placeholder for our "spine", which will be a flexible lamp rod. After we pour the silicone, the airway and cylinder will be removed, the lamp rod will be fed through the hole made by the cylinder, and the airway will be left empty.

Before this meeting, the shell was much larger. However, we discussed and changed the shell size to more closely mimic the size of a human neck (120 mm diameter).

**Conclusions/action items:**

We now have a decent print that should work to create a mold of an airway. The silicone is being ordered, so once this print is done we should be able to create the mold, and use this to construct our prototype of an airway trainer.

# Second 3D Print Meeting 10/25/25

MATTHEW SHERIDAN - Dec 16, 2025, 11:37 AM CST

**Title:** Second 3D Printing Meeting

**Date:** 10/25/25

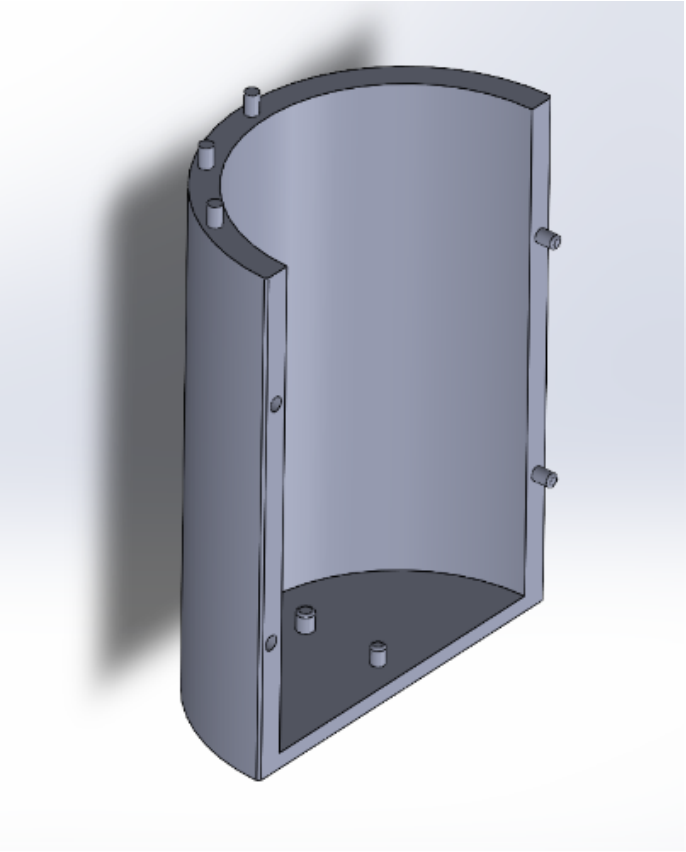
**Content by:** Matt Sheridan

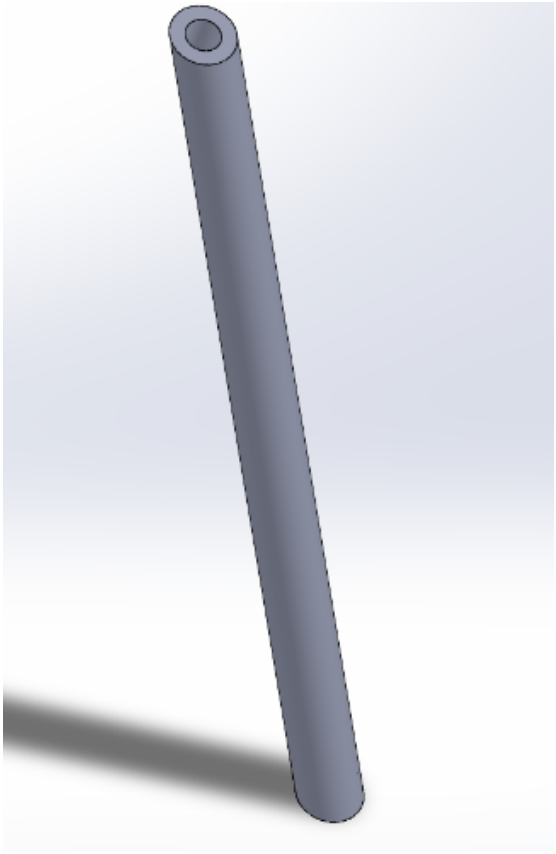
**Present:** Matt Sheridan, Lance Johnson, Cody Kryzer

**Goals:** Correct mistakes made on the first 3D print and print again

**Content:**

A few adjustments were made to our design. We needed to adjust the pegs on the cylinder so that the pieces could fit together correctly. We also angled the cylinder to more accurately model the position of the spine. We also scaled the airway up by 25% to allow for intubation.





**Conclusions/action items:**

This print worked! The pieces fit together well, and airway and angled cylinder fit together well in the mold, so we should be able to pour the silicone in as soon as possible to create our first mold of the airway.

# Expense Sheet

Cody Kryzer - Dec 09,

**Title:** Expense Sheet

**Date:** Fall 2025

**Content by:** Cody

**Present:** Whole team

**Goals:** Keep track of team spending

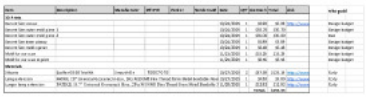
**Content:**

| Item | Description | Manufacturer | Mft Pt# | Vendor | Vendor Cat# | Date | QTY | Cost Each | Total |
|---|---|---|---|---|---|---|---|---|---|
| **3D Prints** | | | | | | | | | |
| Decent Sim screws | | | | | | 10/24/2025 | 1 | $0.98 | $0 |
| Decent Sim outer mold piece 1 | | | | | | 10/24/2025 | 1 | $30.70 | $30 |
| Decent Sim outer mold piece 2 | | | | | | 10/24/2025 | 1 | $36.00 | $36 |
| Decent Sim inner airway | | | | | | 10/24/2025 | 1 | $5.89 | $5 |
| Decent Sim mold opener | | | | | | 10/24/2025 | 1 | $0.48 | $0 |
| Mold for our scan | | | | | | 11/21/2025 | 1 | $15.26 | $15 |
| Mold for our scan reprint | | | | | | 11/25/2025 | 1 | $8.56 | $8 |
| **Materials** | | | | | | | | | |
| Silicone | Ecoflex 00-30 Trial Kit | Smooth-On | 10007010 | | | 10/27/2025 | 2 | $67.58 | $135 |
| Lamp extension | PATIKIL 7.9" Universal Gooseneck Hose, 2Pcs M10/M8 Fine Thread 8mm Metal Bendable Fl | | | | | 10/27/2025 | 1 | $9.80 | $9 |
| Longer lamp extension | PATIKIL 15.7" Universal Gooseneck Hose, 2Pcs M10/M8 Fine Thread 8mm Metal E | | | | | 11/20/2025 | 1 | $12.82 | $12 |
| | | | | | | | | **TOTAL:** | **$255** |

**Conclusions/action items:**

Email Schroeder for reimbursement.

Cody Kryzer - Dec 09, 2025, 7:37 PM CST



Download

**Copy_of_BPAG_Expense_Spreadsheet_-_Sheet1.pdf (97.7 kB)**

# Decent Simulators 3D Print 9/30/25

Cody Kryzer - Dec 15, 2025, 8:45 PM CST

**Title:** Decent Simulators 3D Print

**Date:** 9/30/25

**Content by:** Cody

**Present:** Cody Dan Lance and Elle

**Goals:** Print the 3D simulators sample mold

**Content:**

5 Separate prints are required to create the mold. The mold will allow us to later create an airway trainer design by Decent Simulators. The files can be found on their website and are free to download.

The team is printing with PLA because it is cheap. The material properties for a mold need not be specific.

The prices of the prints are as follows:

**Conclusions/action items:**

The prints will be ready in two days to be picked up. In the mean time, the team will buy silicone to use for the molding.

# Casting of Oral Cavity 10/30/25

Cody Kryzer - Dec 15, 2025, 8:48 PM CST

**Title:** Casting of Oral Cavity

**Date:** 10/30/25

**Content by:** Cody

**Present:** Whole team

**Goals:** Pour silicone into the decent sim mold to create a silicone mouth and trachea that can be intubated on and incorporated into an airway training manikin.

**Content:**

The team mixed 600 mL of the A and B silicones to perfectly fill the mold.

The mold experienced some leaking

Upon removal of the silicone, the screws snapped off inside the mold.

**Conclusions/action items:**

Overall, the mold was very successful and incredibly accurate to a human mouth

# Lower Airway Mold 11/30/25

Cody Kryzer - Dec 15, 2025, 8:49 PM CST

**Title:** Lower airway mold

**Date:** 11/30/25

**Content by:** Cody

**Present:** Whole team

**Goals:** Successfully cast an airway using the 3D printed mold that uses a negative of the patients airway

**Content:**

The team used rubber bands to securely behind together the two halves of the mold

The pegs at the bottom of the mold broke off fairly easily. This caused some annoyance while casting.

The team tried using superglue to refasten the pegs. This was unsuccessful.

The team was able to balance the airway and "spine" at the proper angle using a popsicle stick as shown in the image below.

**Conclusions/action items:**

The mold exhibited zero leaking, this was the main concern since the previously printed mold did contain leaks. The casted airway was able to be removed easily and function as intended.

# Prototype Assembly 12/2/25

Cody Kryzer - Dec 15, 2025, 8:49 PM CST

**Title:** Prototype Assembly

**Date:** 12/2/25

**Content by:** Cody

**Present:** Whole team

**Goals:** Assemble a prototype manikin using the two silicone airways, the apparatus printed two semesters ago, and the TruCorp manikin.

**Content:**

The casted mouth and airway needed to be shortened since it was not patient specific. Connecting it to the mold of the subject's airway will create a nonspecific oral cavity leading to the subject's airway.

The head of the TruCorp manikin was fastened to the apparatus to provide a nose and face.

The apparatus pivots up and down already, this in combination with the lamp rod through the silicone allows for a good range of motion.

**Conclusions/action items:**

The prototype is able to be intubated on and is reflective of an airway training manikin.

# 2025/12/15-MR Scanning Protocol

Elle Thom - Dec 15, 2025, 5:54 PM CST

**Title: MR Scanning Protocol**

**Date:** 12/15/2025

**Content by:** Whole Team

**Goals:** Create a protocol detailing the process of creating an MRI DICOM File

**Content:**

## *MR Scanning Protocol*

- Spacers were put into the MRI head coil to allow for neck extension
- Foam pads put under the neck and upper back to get volunteer into the sniffing position
- Body coil placed over the upper chest
- Blanket put over volunteer to keep warm
- Scan window focused over mouth, airway, and upper chest
- 1mm x 1mm voxel size
- Mouth closed scan ~3 minutes
- Mouth open scan ~5 minutes
- MRI done in coronal plane, but can be reformatted for axial or transverse planes for slicing/segmentation purposes

**Conclusions/action items:**

The team can now use these files to create a 3D Model on the computer.

# 2025/12/15-3D Slicer Segmentation Protocol

Elle Thom - Dec 15, 2025, 5:55 PM CST

**Title: 3D Slicer Segmentation Protocol**

**Date:** 12/15/2025

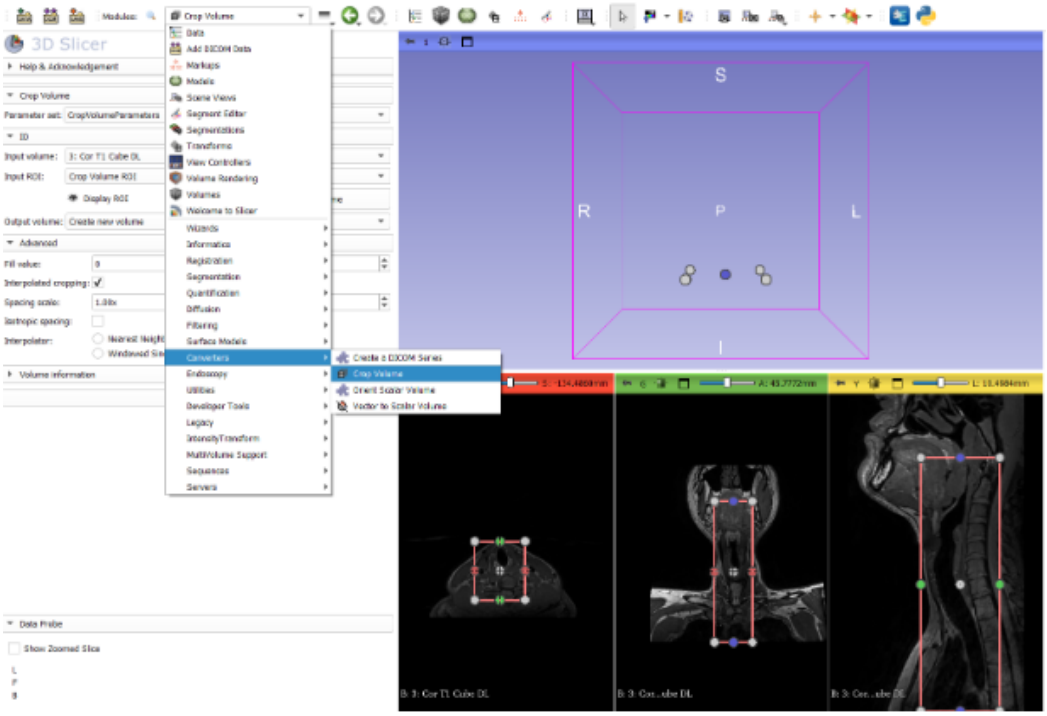
**Content by:** Whole Team

**Goals:** Create a detailed protocol showing the steps to create a 3D model of the airway on the computer.

**Content:**

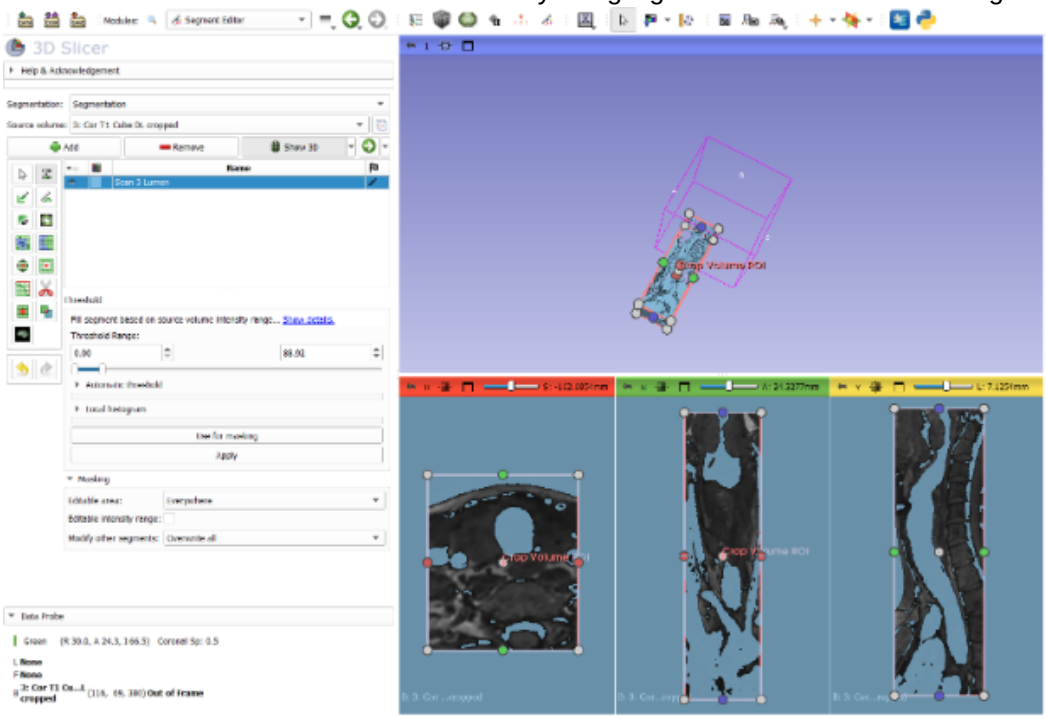
## *3D Slicer Segmentation Protocol*

1. Upload DICOM files from MR scans by selecting add DICOM data, and select desired scan by double clicking
2. Look through the three views (coronal, sagittal, and transverse) to ensure that the scan looks good, and use the crop volume module to crop the scan to only include the airway from just superior to the epiglottis to just inferior to the carina(split in the trachea). In this module you will need to select "Create New ROI", choose the desired region, and then select apply to create the new cropped volume.

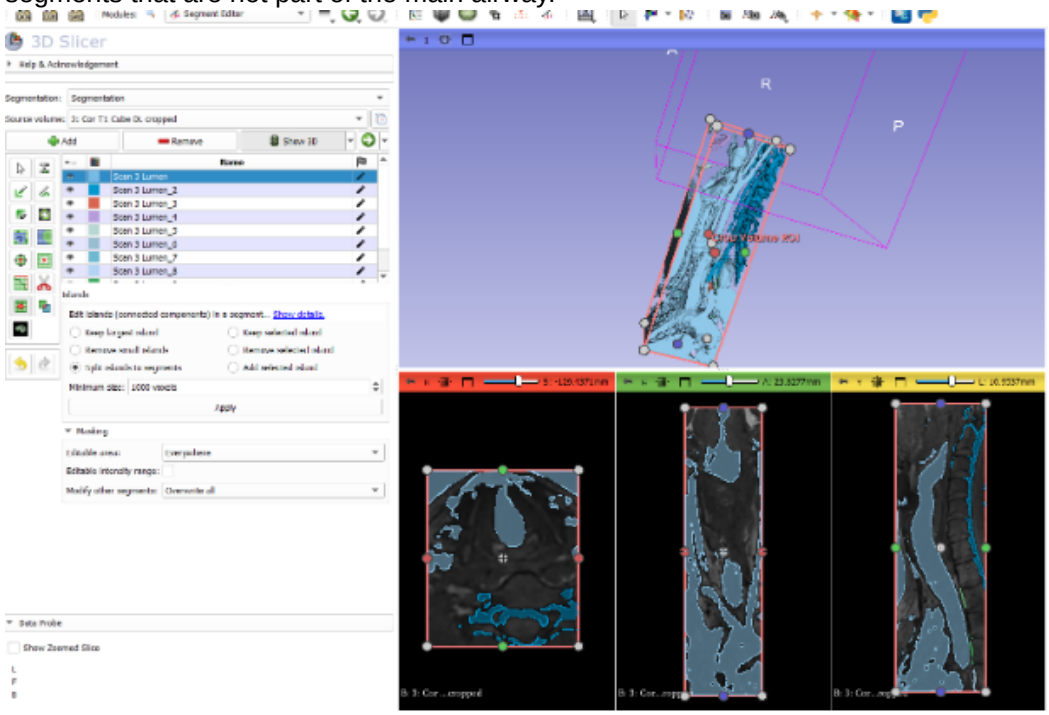



3. Under the segment editor module, select the source volume that you just created (should say the scan name and then cropped), and select Add to create a new segmentation. Rename this segment to something you will remember represents the air (I used Scan 3 Lumen). Then select Threshold from the options on the left side and change the low end of the range to 0, and the high end to something around 90. This will depend on the

scan, so look through each view to ensure that all air within the airway is highlighted. When the thresholding looks good, press Apply.

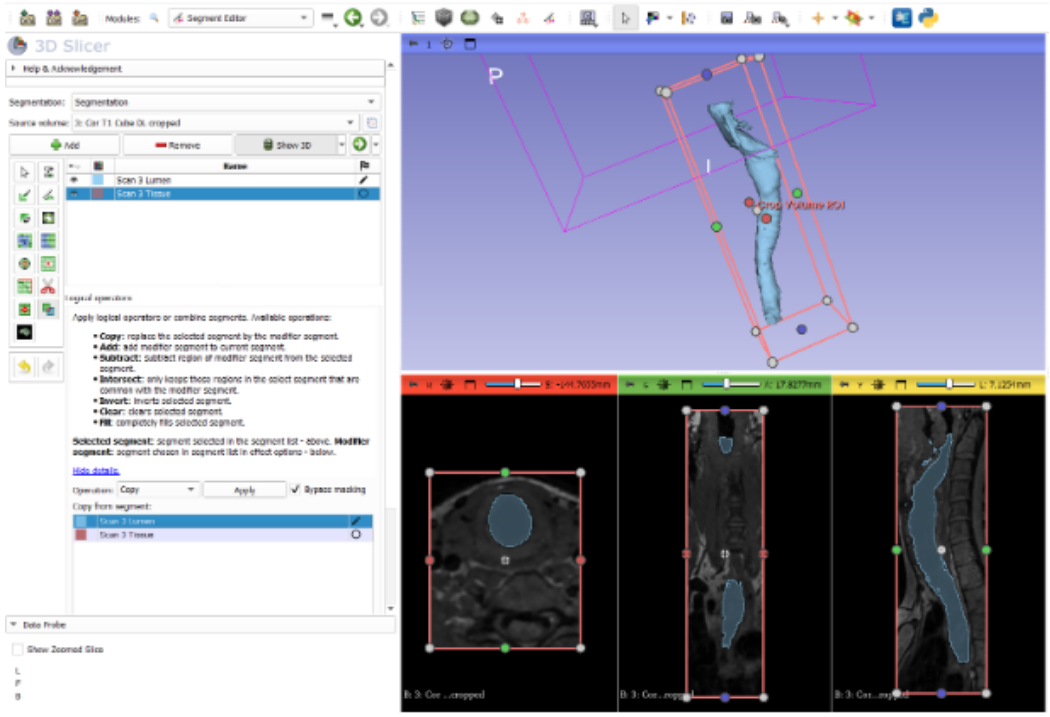


4. To begin cleaning up the segment, select Islands from the left side, and then Split islands to segments. You can adjust the minimum voxel size to include more islands. Once you split it into segments, you can remove any segments that are not part of the main airway.

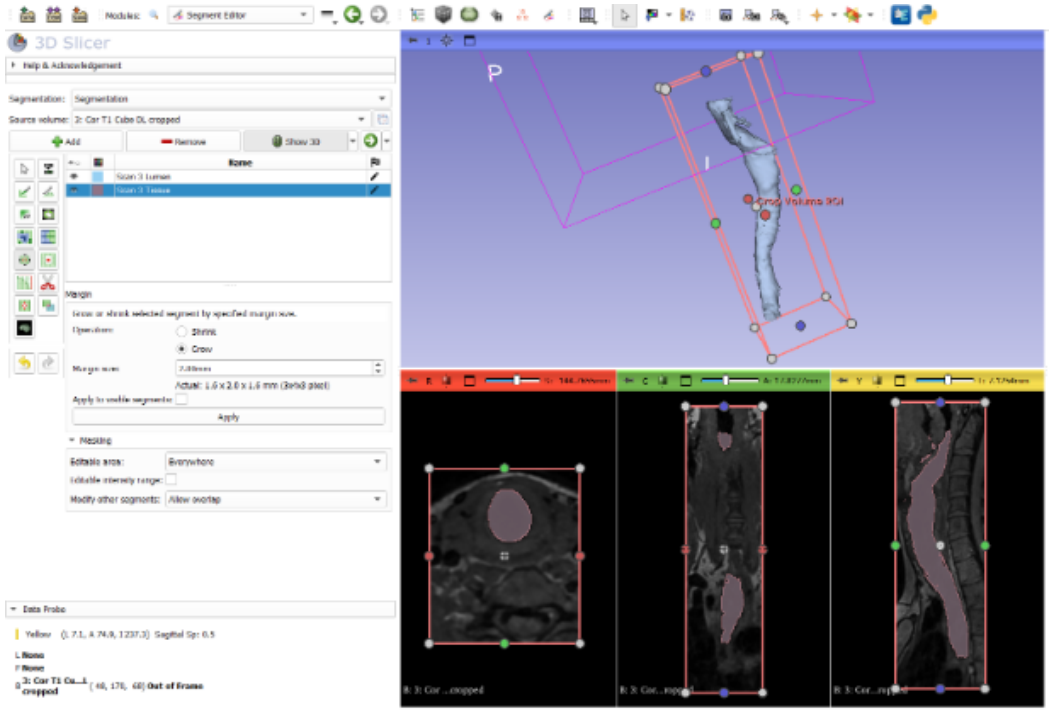


5. At this point, there will still be a lot of undesired segments still included, so you will need to use the Scissors tool to cut out sections that should not be included. This can be done by cutting small parts where the desired and undesired portions are connected to create an island, and then using the Split islands to segments feature from step 4 to remove them. This will be the longest step.

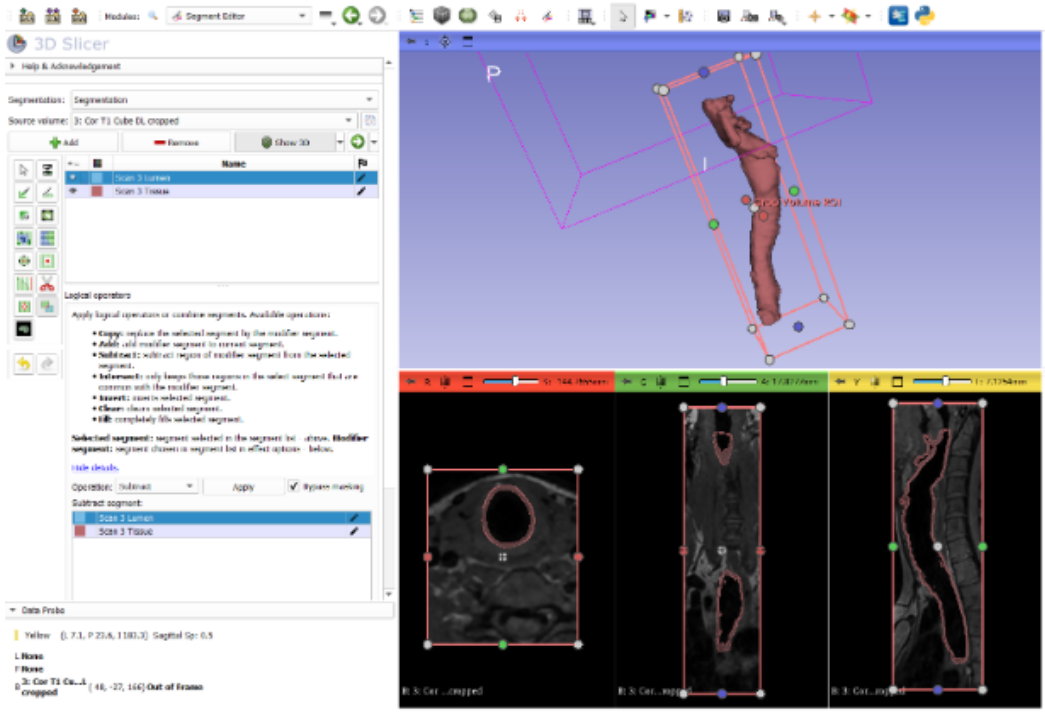
6. Once the airway is cleaned up, you will need to make the tissue around it. To do this, you need to go to logical operators, and then press Add to create a new segment, and name it something like Scan 3 Tissue. Then press Copy, and select Scan 3 Tissue up above, and Scan 3 Lumen below, then press Apply. At this point, you should have 2 identical segments.



7. Next, take this new segment and go to Margin on the left side, select Grow, and make the margin size 2 mm. Then make sure to select Allow overlap under modify other segments at the bottom! Then press Apply, and this segment should be slightly bigger than the other one.



8. Finally, in Logical Operators, select subtract, and select the tissue as your chosen segment at the top and subtract the air from the tissue. This should leave you with a hollow shell of the airway!




9. Next, go to the Segmentations module, and under Export/Import models and labelmaps, select Export and Models and then Export to the desired folder.
10. Finally, go to the Data module, select the Airway, and export as an STL file.

**Conclusions/action items:**

The team can now convert this model into a 3D print.

# 2025/12/15-3D Printing Prep Protocol

Elle Thom - Dec 15, 2025, 5:56 PM CST

**Title: 3D Printing Prep Protocol**

**Date:** 12/15/2025

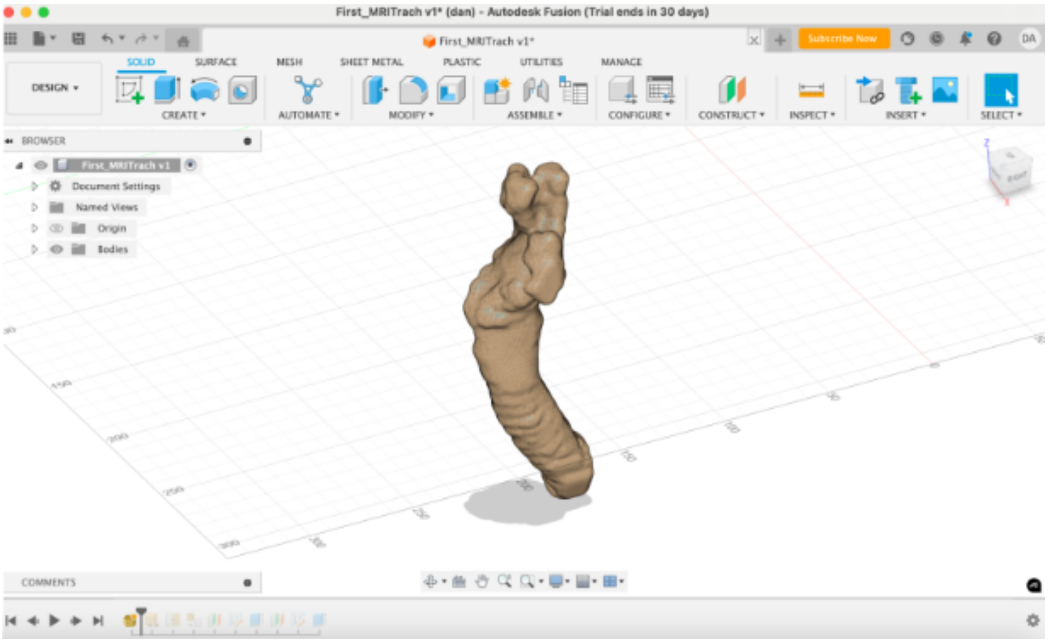
**Content by:** Whole Team

**Goals:** Create a protocol detailing the steps to convert the stl file into a printable model.

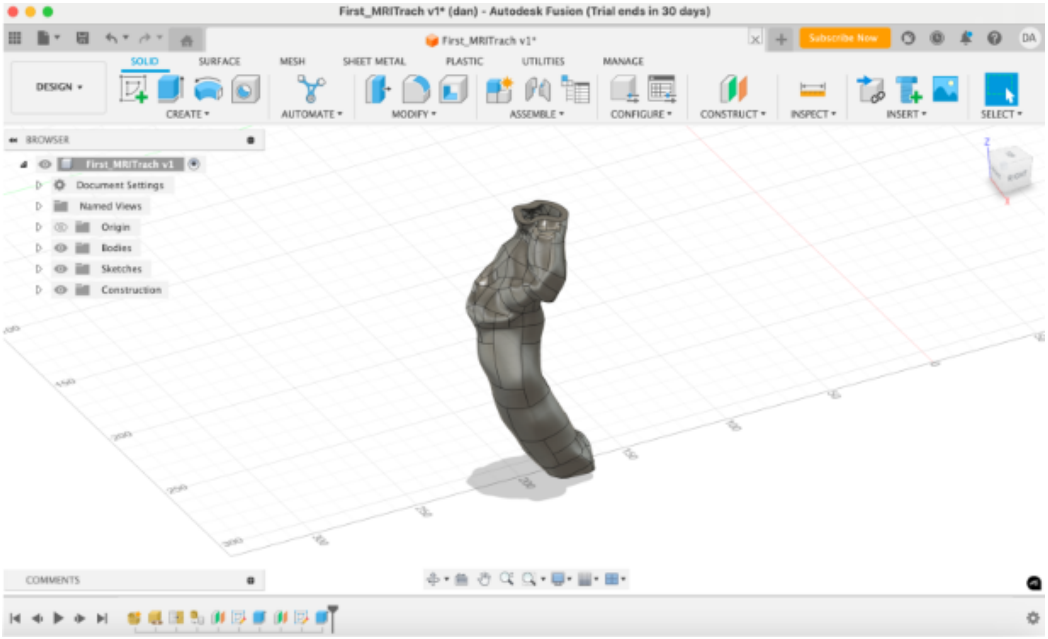
**Content:**

## *3D Printing Prep Protocol*

1. Load .stl file from segmentation into Fusion 360




2. "Insert Mesh" → choose mm
3. "Prepare" → "Repair"
4. "Modify" → "Reduce" → 9950 facets
5. "Modify" → "Convert Mesh" → "Parametric" → "Organic"
6. Cut ends (create offset plane, then sketch + cut)




7. Extrude the two ends of the airway and fillet end to create a wider opening(particularly at the top of the airway)
8. Create offset plane just inferior to the epiglottis
9. Create elliptical sketch in the offset plane and cut through bottom of the airway
10. Create sketch in the sagittal plane at the midline of the airway → create three point curve starting at the elliptical sketch and traveling down and away from the airway
11. Create an ellipse sketch 1.5 mm larger(in all directions) than the first ellipse sketch on the same plane
12. Use the “Sweep” feature to extrude the area between the ellipses(should be an elliptical ring) along the three point curve sketched in step 10 → this should result in an esophagus
13. Use the “Fillet” and “Offset Faces” tools to clean up any uneven surfaces and protruding extrusions

14. Export as .3mf or .stl

**Conclusions/action items:**

The team can now print the 3D model at the makerspace.

# 2025/12/15-3D Printing Protocol

Elle Thom - Dec 15, 2025, 5:58 PM CST

**Title: 3D Printing Protocol**

**Date:** 12/15/2025

**Content by:** Whole Team

**Goals:** Create a protocol showing the steps to 3D print at the makerspace.

**Content:**

## *3D Printing Protocol*

- The file to be printed is transferred from a mesh to a 3mf as part of the 3D Printing Prep Protocol
- Put the file onto a flash drive
- Remove the file from the flash drive onto the makerspace computer, or another compatible computer that is being used
- Open the file with Bambu software for TPU or Preform software for Formlabs Resin
- Select appropriate infill, thickness, and material
- Orient the file and apply supports
- Print to the desired printer
- Return to collect part and remove supports

**Conclusions/action items:**

The team can now make a silicon mold out of this print.

# 2025/12/15-Compression Testing Protocol

Elle Thom - Dec 15, 2025, 5:59 PM CST

**Title: Compression Testing Protocol**

**Date:** 12/15/2025

**Content by:** Whole Team

**Goals:** Create a detailed protocol that explains the steps to complete compression testing on the model.

**Content:**

## *Compression Testing Protocol*

- Swap tensile clamps for compression attachment on MTS machine.
- Open TestSuite software on computer
- Place airway on the bottom attachment so that compression can be done in the sagittal plane
- Lower the upper attachment until it begins touching the airway, and then zero the force and the displacement.
- Lower the upper attachment until the force value reaches roughly 24.5 Newtons and record the displacement value.
- Repeat for all airways

**Conclusions/action items:**

The team can now use the data to think of future work and use on the poster and final report.

# 2025/12/15-Durability Testing Protocol

Elle Thom - Dec 15, 2025, 6:00 PM CST

**Title: Durability Testing Protocol**

**Date:** 12/15/2025

**Content by:** Whole Team

**Goals:** Create a protocol that details the steps of durability testing.

**Content:**

## *Durability Testing Protocol*

- One repetition involves inserting a metal laryngoscope into the airway roughly 3cm or to where the airway would split into the trachea and esophagus and holding it with upward force for about 5 seconds.
- This process was repeated until significant damage to the airway occurred or until roughly 50 intubations
- Only the laryngoscope was used because the other materials used to intubate were observed to not scratch or stretch the airway
- The laryngoscope was in the airway for 5 seconds because it is removed quickly into the intubation process which takes at least 15 seconds

**Conclusions/action items:**

The team can now use the test data to make decisions of changes to the design in the future.

# 2025/12/13- Design Matrix

Elle Thom - Dec 13, 2025, 9:29 PM CST

**Title: Design Matrix**

**Date:** 12/13/2025

**Content by:** Whole Team

**Goals:** Create a design matrix that accurately shows three separate designs and rate them against each other to determine the best option for the project.

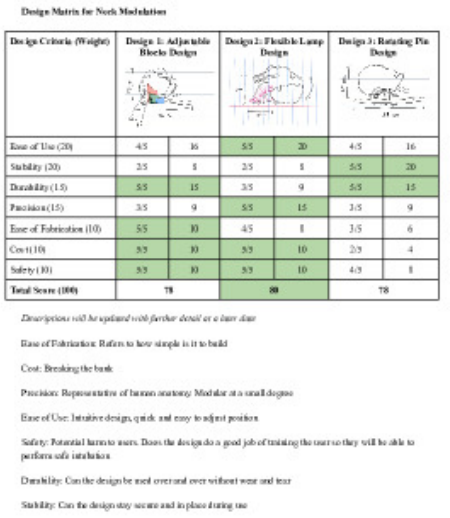
**Content:**

The design matrix pdf is attached below

**Conclusions/action items:**

This design matrix helped the team choose the lamp rod design for adjustability in the neck of the manikin. Next steps include designing the rest of the manikin, fabrication and testing.

Elle Thom - Dec 13, 2025, 9:23 PM CST



Design Matrix for Neck Modulation

| Design Criteria (Weight) | Design 1: Adjustable Blocks Design | | Design 2: Flexible Lamp Design | | Design 3: Rotating Pin Design | |
|---|---|---|---|---|---|---|
| Ease of Use (20) | 4/5 | 16 | 5/5 | 20 | 4/5 | 16 |
| Stability (20) | 2/5 | 8 | 2/5 | 8 | 5/5 | 20 |
| Durability (15) | 5/5 | 15 | 3/5 | 9 | 5/5 | 15 |
| Precision (15) | 3/5 | 9 | 5/5 | 15 | 3/5 | 9 |
| Ease of Fabrication (10) | 5/5 | 10 | 4/5 | 8 | 3/5 | 6 |
| Cost (10) | 5/5 | 10 | 5/5 | 10 | 2/5 | 4 |
| Safety (10) | 5/5 | 10 | 5/5 | 10 | 4/5 | 8 |
| Total Score (100) | 78 | | 88 | | 78 | |

*Descriptions will be updated with further detail at a later date*

Ease of Fabrication: Refers to how simple is it to build

Cost: Breaking the bank

Precision: Representative of human anatomy. Modular at a small degree

Ease of Use: Intuitive design, quick and easy to adjust position

Safety: Potential harm to users. Does the design do a good job of training the user so they will be able to perform safe intubation

Durability: Can the design be used over and over without wear and tear

Stability: Can the design stay secure and in place during use

Download

**Design_Matrix_9_25_25.pdf (1.27 MB)**

# 2025/12/13- Outreach Outline

Elle Thom - Dec 13, 2025, 9:34 PM CST

**Title: Outreach Outline**

**Date:** 12/13/2025

**Content by:** Whole Team

**Goals:** Create an activity that is fun for a 5th-grade classroom and involves the learning objectives of biomedical engineering in a fun and creative way.

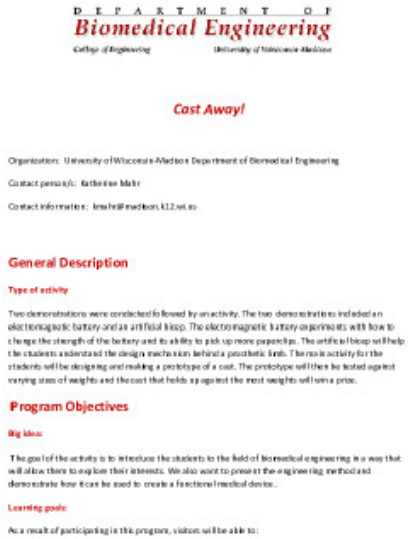
**Content:**

The outreach outline is attached below.

**Conclusions/action items:**

This activity is now planned out and ready to be used in an outreach format. Next steps involve gathering the materials needed and scheduling a time for outreach to take place.

Elle Thom - Dec 13, 2025, 9:24 PM CST



DEPARTMENT OF
Biomedical Engineering

Cast Away!

Organization: University of Wisconsin-Madison Department of Biomedical Engineering

Contact person/s: Katherine Mohr

Contact information: kmohr@madison.k12.wi.us

General Description

Type of activity

Two demonstrations were conducted followed by an activity. The two demonstrations included an electromagnetic battery and an artificial bicep. The electromagnetic battery experiments will how to change the strength of the battery and its ability to pick up more paperclips. The artificial bicep will help the students understand the design mechanism behind a prosthetic limb. The main activity for the students will be designing and making a prototype of a cast. The prototype will then be tested against varying sizes of weights and the cast that holds up against the most weights will win a prize.

Program Objectives

Big Idea:

The goal of the activity is to introduce the students to the field of biomedical engineering in a way that will allow them to explore their interests. We also want to present the engineering method and demonstrate how it can be used to create a functional medical device.

Learning goals:

As a result of participating in this program, visitors will be able to:

Download

**Outreach_Activity_Outline.pdf (223 kB)**

# 2025/12/13- Outreach Presentation

Elle Thom - Dec 13, 2025, 9:41 PM CST

**Title: Outreach Presentation**

**Date:** 12/13/2025

**Content by:** Whole Team

**Goals:** Create a presentation for 5th-grade students explaining biomedical engineering and the project they will work on

**Content:**

The presentation is attached below.

**Conclusions/action items:**

The presentation was delivered, and outreach has been submitted. There are no other action items for this assignment.

Elle Thom - Dec 13, 2025, 9:26 PM CST


Download

**Outreach_Slideshow.pdf (816 kB)**

# 2025/12/15-Product Design Specifications

Elle Thom - Dec 15, 2025, 6:05 PM CST

**Title: Product Design Specifications**

**Date:** 12/15/2025

**Content by:** Whole Team

**Goals:** Create design specifications that reflect the end goal of the project.

**Content:**

Attached below

**Conclusions/action items:**

These specifications serve as the team's guidelines on how the final design should operate.

Elle Thom - Dec 15, 2025, 6:05 PM CST

BME Design

3D Printing Airway Trainers

*Product Design Specifications (PDS)*

BME 400 Section 303

September 18th, 2025

**Client**

Kristopher Schroeder, MD

**Advisor**

Dr. Paul Campagnola

**Team**

| | |
|---|---|
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| Daniel Altschuler | daltschuler2@wisc.edu |
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| Elianna Thorn | ejthorn@wisc.edu |

Download

**9_18_25_Updated_PDS_1_.pdf (355 kB)**

# 2025/12/15- Comparison of four manikins and fresh frozen cadaver models for direct laryngoscopic orotracheal intubation training

Elle Thom - Dec 15, 2025, 6:50 PM CST

**Title:** Comparison of four manikins and fresh frozen cadaver models for direct laryngoscopic orotracheal intubation training

**Date:** 12/15/2025

**Content by:** Elleana Thom

**Present:** Elleana Thom

**Goals:** Research more on intubation training

**Content:**

Comparing manikins vs fresh frozen cadavers for teaching direct laryngoscopic intubation.

**Models Tested**

- Airway Management Trainer (Ambu)
- Airway Trainer (Laerdal)
- Airsim (Trucorp)
- Bill 1(VBM)
- Fresh Frozen Cadaver (FFC)

**Method**

- 56 participants did intubations on all models.

Rated on:

- Jaw mobility realism
- Mouth opening difficulty
- Neck flexibility realism
- Intubation difficulty
- overall reality
- Used a 0–10 visual analogue scale

**Summarizing results**

- FFC cadaver scored highest for jaw movement realism, overall reality, and preference.
- Trucorp (Airsim) & Laerdal manikins were next best and similar to each other.
- Trucorp manikin had lowest difficulty scores for mouth opening and intubation (i.e., easier).
- Overall: cadaver was more realistic and preferred, but some manikins are good alternatives.

**Conclusion**

- Fresh frozen cadaver is most realistic/preferred for training.
- Trucorp and Laerdal manikins are acceptable alternatives.

[1]J. H. Yang et al., “Comparison of four manikins and fresh frozen cadaver models for direct laryngoscopic orotracheal intubation training,” Emergency Medicine Journal, vol. 27, no. 1, pp. 13–16, Dec. 2009, doi: https://doi.org/10.1136/emj.2008.066456.

**Conclusions/action items:**

Use this information as research and background knowledge when making decisions on the project and future work.

# 2025/12/15-Manikin to patient intubation: does it translate?

Elle Thom - Dec 15, 2025, 7:31 PM CST

**Title:** Manikin to patient intubation: does it translate?

**Date:** 12/15/2025

**Content by:** Elleana Thom

**Present:** Elleana Thom

**Goals:** Collect more background research notes

**Content:**

Problem: Students have very little opportunity to practice intubation in a "real" setting before their first surgery

Challenges: Training requires hundreds of attempts at intubationin order to acheive high success rates for intubation competance, but resisdents get very few chances to do this. Simulation training is not always seen as a very realistic application when training.

Goals of the study: Evaluation of whether manikin based simulation training actually improves real patient intubation performance when paired with guided instruction.

Methods: Pediatric residents on NICU rotation attended training with: direct laryngoscopy practice on a manikin head with instructoe guidance using videolaryngoscopy. Having standard clinical intubation oppurtunities in the NICU

Conclusions: Intubation manikins have a long way to go in terms of being realistic training tools.

[1]J. Rumpel et al., “Manikin to patient intubation: does it translate?,” Journal of Perinatology, vol. 43, no. 2, pp. 233–235, Nov. 2022, doi: https://doi.org/10.1038/s41372-022-01553-9.

**Conclusions/action items:**

Use this information as background research.

# 2025/12/15- Predicting Difficult Intubation

Elle Thom - Dec 15, 2025, 7:44 PM CST

**Title:** Predicting Difficult Intubation

**Date:** 12/15/2025

**Content by:** Elleana Thom

**Present:** Elleana Thom

**Goals:** Find more research for background

**Content:**

Purpose: Evaluating simple pro-operative tests to predict which patients will be difficult to intubate before anesthesia.

Methods: patients scheduled for surgery were examined before anestesia. Two main tests were used-

-Modified Mallampati test - how much of the throat structuress can be seen when the patient opens their mouth

-Thyromental distance - distance from the thyroid cartilage to the chin, shorter distances are linked to more difficulty

Results: If a patient has a poor mallampati view and a thyromental distance < 7cm, they were much more likly to be difficult to intubate. THe tests should be used to gether for best accuracy

Conclusion: Doing simple airway assessments before surgery can help predict many difficult intubations and let clinicians plan ahead.

[1]C. M. FRERK, “Predicting difficult intubation,” Anaesthesia, vol. 46, no. 12, pp. 1005–1008, Dec. 1991, doi: https://doi.org/10.1111/j.1365-2044.1991.tb09909.x.

# 2025/12/15- Difficult intubation in adults

Elle Thom - Dec 15, 2025, 8:00 PM CST

**Title:** Difficult intubation in adults

**Date:** 12/15/2025

**Content by:** Elleana Thom

**Present:** Elleana Thom

**Goals:** Find more background research on difficult intubation

**Content:**

Purpose:  review how to recognize and manage difficult endotracheal intubation in adult patients undergoing anesthesia

Preoperative recognition: clinical exam can often detect difficult airways

- anatomical signs:
- small mouth opening
- protruding upper teeth
- stiff cervical spine
- tongue swelling
- cervical swelling
- unstable cervical spine

indirect predictors: iniability to visualize soft palate, small inframandibular space, reduced atlanto-occipital mobility

Review of strategies to handle difficult intubation:

- specialized equipment
- confirming tube placement
- alternative airway tools
- surgical front of neck access

Guidlines: Discussion of the american society of anesthesiologists difficult airway algorithm and its importance for planning

Conclusion: better preoperative airway assessment, clear guidlines, and training can reduce morbidity/mortality from difficult intubation

[1]H. Langenstein and G. Cunitz, “Die schwierige Intubation beim Erwachsenen,” Der Anaesthesist, vol. 45, no. 4, pp. 372–383, Apr. 1996, doi: https://doi.org/10.1007/s001010050274.

# 2025/12/15- Spring 2025 Final Report Notes

Elle Thom - Dec 15, 2025, 6:24 PM CST

**Title: Spring 2025 Final Report Notes**

**Date:** 9/8/2025

**Content by:** Elleana Thom

**Present:** Just me taking Notes

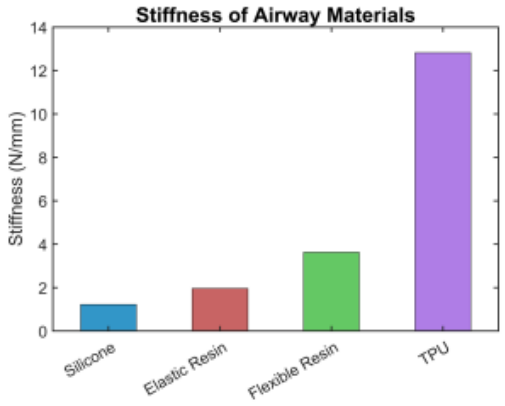
**Goals:** Get a better idea of what this project entails, what has been done, and make a list of questions if any.

**Content:**

Notes:

- Abstract
    - Making airway trainers for anesthesiologists to practice intubation
        - Intubation: insertion of an artificial airway tube into a patient's trachea
    - Some difficult trainers exist but they focus on craniofacial abnormalities
        - This project focuses on internal airway irregularities
    - This project is creating patient specific airway trainers using MRI imaging
    - Used formlabs elastic resin, flexible resin and TPU when evaluating material performance
    - Future work
        - Enhance anatomical accuracy when tracing
        - Integrate fully customizable manakins
- Intro
    - ETI = endotracheal intubation
    - Project is designing ways to practice intubation on multiple abnormal airways in a cheaper way
    - Question: Is this the new goal of the project: A larger tongue, a smaller mouth opening, an overbite, and a short thyromental distance can all lead to a more difficult intubation procedure. On an idealized airway trainer, these craniofacial factors would be adjustable by allowing for variation in mandible positioning, thyromental distance, and tongue size.
        - This is an exam[le of craniofacial abnormalities
    - Airway anomalies
        - Pyriform aperture stenosis: narrowing of the nasal airway
        - Laryngeal cleft: abnormal connection between larynx and esophagus
            - Can cause accidental esophageal intubation (Deadly)
        - Laryngeal Stenosis: narrowing of larynx
        - Laryngeal webs: partial obstructions in larynx
        - Laryngeal atresia: full blockage
        - Circular tracheal ring: leads to Tracheal stenosis
    - Magnetic resonance Imaging

        - Question: How are they getting their MRI Data?
    - Segmentation and 3D printing
        - 3D Slicer
        - ITK-SNAP
            - Capable of tracing slices automatically
                - Was there an error in this
        - Where was the prototype 3D printed using the SLA method
            - makerspace
        - SLA method is more accurate in medical industry
        - FDM printing (Makerspace) not as accurate
- Design Specs
    - Process has to be under 72 hours
    - Stay under competitors price of $272
    - Capable of 20,000 intubations
    - Mimic size, look, and texture of a real airway
    - Match youngs modulus and hardness
- Preliminary designs
    - Material Choice 1 - Formlabs Flexible resin
        - Durable, stiff yet flexible, SLA resin, ideal material properties
        - Disadvantage: This material can only be used in formlab printers, $0.29/g at Makerspace
        - How much does the final product weigh? In grams
        - Look into Shore Hardness and how it's measured
    - Material choice 2 - EcoFlex 00-50 liquid Silicone
        - Strong and flexible
        - 2 part process
            - Mold printed in PLA then cast with liquid silicone
        - Material properties are not good
        - Lower cost $0.05/g
    - Material Choice 3 - Thermoplastic Polyurethane (TPU)
        - Flexible, durable, abrasion resistant
        - Ideal material properties
        - Can be printed very easily
        - $0.05/g cost
- Final Design
    - TPU
    - Formlabs resin and TPU were both printed for testing purposes

- Final Prototype
    - 3D printed airway attached to silicone mouth so testing could be preformed(Child's anatomy, contains an esophagus, created a wider opening
        - Was the mouth made or obtained from the client?
        - Wasn't the point of abnormal airways that it should stay accurate to anatomically since it will be harder for a laryngoscope and intubation tube to get through?
- Testing
    - Is the goal to get a material that matches the stiffness of silicone?
    - 

- Discussion
    - TPU is too stiff
        - Are we looking for a new material to use?
    - TPU does not easily stretch
    - In future testing, it is vital that the airway opening is wider than a laryngoscope. What if anatomically it's not?
    - The device should specify to the user any mechanical differences between the printed airway and a typical human since in cases like this it is not reasonable for the training device to be perfectly accurate. Add to Design Spec
- Conclusions
    - The team also found that the previously desired Shore hardness based on the design specifications was too stiff to accurately simulate intubation, so the team opted to use the Formlabs 50A resin as its stiffness was much more comparable to the silicone based manikin given to the team by our client
        - So they did end up using the flexible resin?
    - Future work
        - Integrate the 3D printed airway onto a manikin that will be fabricated by the team
            - Other factors tongue size, mandible position, and neck angle could be considered.Vomiting, things stuck in the throught
        - Hopes to enhance performance in the slicer software
        - Does ITK-SNAP help with slicing or does it help with the mesh in postprocessing or both

**Conclusions/action items:**

Ask questions: In text red

Intubation during anaphylaxis?

3d printing problem due to mesh?

# 2025/04/29-DMA Training

Elle Thom - Apr 29, 2025, 2:47 PM CDT

**Title: DMA Training**

**Date:** 4/29/2025

**Content by:** Elle Thom

**Present:** Rayona and Elle

**Goals:** Learn how to use the DMA to get the resonance frequency of PMMA

**Content:**

Attachments:

-Email from Rayona to Anna Kiyanova

-Dynamic Strain Sweep

-Data tables:

**PMMA Sample Test 1:**

| e % | E' Pa | E'' Pa | tan(d) | Force (g) |
|---|---|---|---|---|
| 9.01E-06 | 1.37E+09 | -1.04E+09 | -0.7564 | 0.01546 |
| 1.17E-05 | 3.84E+08 | 2.39E+08 | 0.62259 | 0.00529 |
| 1.47E-05 | 5.81E+08 | 1.03E+08 | 0.17799 | 0.00869 |
| 1.93E-05 | 1.06E+09 | -6.70E+07 | -0.0632 | 0.0205 |
| 2.36E-05 | 1.13E+09 | -1.13E+08 | -0.0999 | 0.02681 |
| 2.98E-05 | 7.80E+08 | 8.90E+07 | 0.11406 | 0.02335 |
| 3.82E-05 | 8.53E+08 | 4.54E+07 | 0.05325 | 0.03254 |
| 4.77E-05 | 8.39E+08 | 4.12E+07 | 0.0491 | 0.04002 |
| 5.98E-05 | 8.00E+08 | 1.04E+08 | 0.12977 | 0.04817 |
| 7.62E-05 | 8.48E+08 | 1.51E+08 | 0.17783 | 0.06558 |
| 9.48E-05 | 9.73E+08 | 1.11E+08 | 0.1139 | 0.09275 |
| 1.20E-04 | 8.99E+08 | 7.41E+07 | 0.0825 | 0.10819 |
| 1.52E-04 | 8.49E+08 | 1.24E+08 | 0.14577 | 0.12985 |
| 1.90E-04 | 8.70E+08 | 8.22E+07 | 0.0944 | 0.16553 |

| | | | | |
|---|---|---|---|---|
| 2.39E-04 | 8.45E+08 | 9.69E+07 | 0.11469 | 0.20298 |
| 3.01E-04 | 8.55E+08 | 7.95E+07 | 0.09307 | 0.25787 |
| 3.79E-04 | 8.52E+08 | 9.48E+07 | 0.11125 | 0.32455 |
| 4.78E-04 | 8.49E+08 | 7.57E+07 | 0.08911 | 0.40664 |
| 6.02E-04 | 8.41E+08 | 8.42E+07 | 0.10009 | 0.50789 |
| 7.57E-04 | 8.46E+08 | 7.85E+07 | 0.09276 | 0.64221 |
| 9.54E-04 | 8.47E+08 | 9.15E+07 | 0.10792 | 0.8116 |
| 0.00121 | 8.43E+08 | 8.83E+07 | 0.10474 | 1.023 |
| 0.00152 | 8.41E+08 | 8.88E+07 | 0.10562 | 1.28421 |
| 0.00192 | 8.38E+08 | 9.45E+07 | 0.11271 | 1.61408 |
| 0.00241 | 8.36E+08 | 9.04E+07 | 0.10823 | 2.02507 |
| 0.00304 | 8.23E+08 | 9.97E+07 | 0.12108 | 2.51883 |
| 0.00383 | 8.02E+08 | 1.04E+08 | 0.1296 | 3.08964 |
| 0.00482 | 7.76E+08 | 9.73E+07 | 0.12534 | 3.76674 |
| 0.00609 | 7.28E+08 | 8.87E+07 | 0.12177 | 4.45943 |
| 0.00769 | 6.70E+08 | 8.32E+07 | 0.12418 | 5.18246 |
| 0.00971 | 6.17E+08 | 7.42E+07 | 0.12033 | 6.02093 |
| 0.01225 | 5.60E+08 | 6.42E+07 | 0.11455 | 6.89636 |
| 0.01546 | 5.20E+08 | 5.58E+07 | 0.10741 | 8.0646 |
| 0.0195 | 4.85E+08 | 4.92E+07 | 0.10147 | 9.49834 |
| 0.02459 | 4.61E+08 | 4.42E+07 | 0.09605 | 11.3577 |
| 0.031 | 4.40E+08 | 4.08E+07 | 0.09264 | 13.6756 |
| 0.03904 | 4.26E+08 | 3.77E+07 | 0.0885 | 16.6507 |
| 0.04918 | 4.15E+08 | 3.56E+07 | 0.08568 | 20.4654 |
| 0.06192 | 4.15E+08 | 3.36E+07 | 0.08095 | 25.7192 |

| | | | | |
|---|---|---|---|---|
| 0.07797 | 4.07E+08 | 3.20E+07 | 0.078 | 653 | 1.8075 |
| 0.09818 | 3.99E+08 | 3.08E+07 | 0.077 | 213 | 9.19 |
| 0.12347 | 3.92E+08 | 3.00E+07 | 0.076 | 384 | 8.5062 |
| 0.15532 | 3.88E+08 | 2.92E+07 | 0.075 | 146 | 0.3164 |
| 0.19527 | 3.83E+08 | 2.87E+07 | 0.075 | | 74.9061 |
| 0.24555 | 3.77E+08 | 2.82E+07 | 0.074 | 799 | 2.7758 |
| 0.30899 | 3.73E+08 | 2.74E+07 | 0.073 | 571 | 5.252 |
| 0.38864 | 3.68E+08 | 2.69E+07 | 0.073 | 251 | 43.084 |
| 0.48908 | 3.66E+08 | 2.65E+07 | 0.072 | 4 | 178.968 |
| 0.61565 | 3.63E+08 | 2.63E+07 | 0.072 | 462 | 23.533 |
| 0.77481 | 3.59E+08 | 2.62E+07 | 0.072 | 9 | 278.612 |
| 0.97534 | 3.52E+08 | 2.61E+07 | 0.073 | 963 | 43.928 |

**PMMA Sample Test 2:**

| e % | E' Pa | E'' Pa | tan(d) | Force (g) |
|---|---|---|---|---|
| 9.47E-05 | 7.77E+08 | 6.47E+07 | 0.0833 | 0.07368 |
| 1.20E-04 | 8.60E+08 | 4.55E+07 | 0.05288 | 0.10352 |
| 1.51E-04 | 8.57E+08 | 7.82E+07 | 0.09124 | 0.12971 |
| 1.90E-04 | 8.31E+08 | 4.64E+07 | 0.05578 | 0.15774 |
| 2.39E-04 | 8.44E+08 | 8.35E+07 | 0.09901 | 0.20239 |
| 3.01E-04 | 8.54E+08 | 9.61E+07 | 0.11242 | 0.25848 |
| 3.79E-04 | 8.55E+08 | 8.38E+07 | 0.09804 | 0.32494 |
| 4.78E-04 | 8.38E+08 | 9.37E+07 | 0.11184 | 0.40209 |
| 6.02E-04 | 8.37E+08 | 8.45E+07 | 0.10099 | 0.50518 |

| | | | | | |
|---|---|---|---|---|---|
| 7.58E-04 | 8.46E+08 | 7.72E+07 | 0.09122 | 0.64262 |
| 9.53E-04 | 8.42E+08 | 9.18E+07 | 0.10901 | 0.80635 |
| 0.00121 | 8.38E+08 | 8.65E+07 | 0.1033 | 1.01532 |
| 0.00152 | 8.43E+08 | 8.77E+07 | 0.10407 | 1.28649 |
| 0.00192 | 8.36E+08 | 8.74E+07 | 0.10463 | 1.60652 |
| 0.00241 | 8.36E+08 | 8.82E+07 | 0.10557 | 2.0232 |
| 0.00304 | 8.34E+08 | 8.90E+07 | 0.10677 | 2.54405 |
| 0.00382 | 8.30E+08 | 8.67E+07 | 0.10451 | 3.18151 |
| 0.00481 | 8.20E+08 | 9.02E+07 | 0.11004 | 3.96266 |
| 0.00608 | 7.71E+08 | 8.46E+07 | 0.10967 | 4.70511 |
| 0.00768 | 7.02E+08 | 7.88E+07 | 0.11227 | 5.4131 |
| 0.00969 | 6.42E+08 | 7.11E+07 | 0.1108 | 6.2518 |
| 0.01224 | 5.84E+08 | 6.33E+07 | 0.10842 | 7.17506 |
| 0.01544 | 5.39E+08 | 5.62E+07 | 0.10431 | 8.3485 |
| 0.01949 | 5.02E+08 | 5.00E+07 | 0.09956 | 9.82246 |
| 0.02457 | 4.73E+08 | 4.58E+07 | 0.09672 | 11.6623 |
| 0.03099 | 4.49E+08 | 4.17E+07 | 0.09299 | 13.9468 |
| 0.03903 | 4.30E+08 | 3.89E+07 | 0.09049 | 16.8115 |
| 0.0492 | 4.08E+08 | 3.63E+07 | 0.08899 | 20.1188 |
| 0.06196 | 4.01E+08 | 3.40E+07 | 0.08483 | 24.8842 |
| 0.078 | 4.01E+08 | 3.19E+07 | 0.07963 | 31.2828 |
| 0.09819 | 3.97E+08 | 3.04E+07 | 0.07667 | 39.0367 |
| 0.12345 | 3.95E+08 | 2.98E+07 | 0.07547 | 48.7578 |

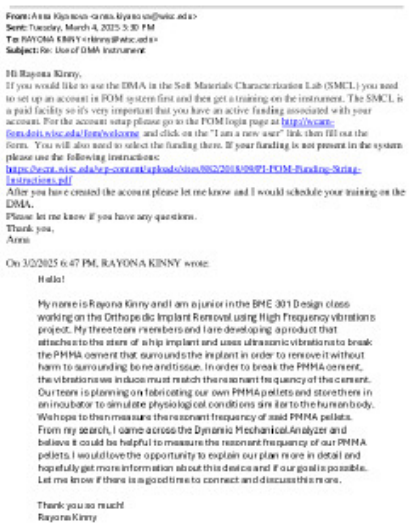
**Note: Sample 1 is one side of a single sample of PMMA and Sample 2 is the other side of the sample.

**Note: Row highlighted dark blue was the data used to calculate resonant frequency.

**Conclusions/action items:**

This DMA test helped us find the Elastic modulus used in the equation to get the resonance frequency of PMMA.

Elle Thom - Apr 29, 2025, 2:45 PM CDT



From: Anna Klyanova <anna.klyanova@wisc.edu>
Sent: Tuesday, March 4, 2025 5:30 PM
To: RAYONA KINNY <rkinny@wisc.edu>
Subject: Re: Use of DMA Instrument

Hi Rayona Kinny,
If you would like to use the DMA in the Soft Materials Characterization Lab (SMCL) you need to set up an account in FOM system first and then get a training on the instrument. The SMCL is a paid facility so it's very important that you have an active funding associated with your account. For the account setup please go to the FOM login page at http://wcam-fom.doit.wisc.edu/fom/welcome and click on the "I am a new user" link then fill out the form. You will also need to select the funding there. If your funding is not present in the system please use the following instructions:
https://ecmt.wisc.edu/wp-content/uploads/sites/882/2018/09/PI-FOM-Funding-String-Instructions.pdf
After you have created the account please let me know and I would schedule your training on the DMA.
Please let me know if you have any questions.
Thank you,
Anna

On 3/2/2025 6:47 PM, RAYONA KINNY wrote:

Hello!

My name is Rayona Kinny and I am a junior in the BME 301 Design class working on the Orthopedic Implant Removal using High Frequency vibrations project. My three team members and I are developing a product that attaches to the stem of a hip implant and uses ultrasonic vibrations to break the PMMA cement that surrounds the implant in order to remove it without harm to surrounding bone and tissue. In order to break the PMMA cement, the vibrations we induce must match the resonant frequency of the cement. Our team is planning on fabricating our own PMMA pellets and store them in an incubator to simulate physiological conditions similar to the human body. We hope to then measure the resonant frequency of said PMMA pellets. From my search, I came across the Dynamic Mechanical Analyzer and believe it could be helpful to measure the resonant frequency of our PMMA pellets. I would love the opportunity to explain our plan more in detail and hopefully get more information about this device and if our goal is possible. Let me know if there is a good time to connect and discuss this more.

Thank you so much!
Rayona Kinny

Download

**Fw__Use_of_DMA_Instrument.pdf (98.4 kB)**

Elle Thom - Apr 29, 2025, 2:45 PM CDT


Download

**PMMA_Sample1_dyn_strain_1hz_2_.emf (63.2 kB)**

# 2024/2/13 Biosafety & Chemical Safety Training

Elle Thom - Dec 15, 2025, 6:34 PM CST

**Title: Biosafety & Chemical Safety Training**

**Date:** 2/13/2024

**Content by:** Elleana Thom

**Present:** Elleana Thom

**Goals:** Complete two training modules

- Biosafety Training

- Chemical Safety Training

**Content: Attachment of file containing proof of course completion attached below.**

**Conclusions/action items:**

**I completed my required biosafety and chemical safety training that is needed for BME 201**

Elle Thom - Feb 13, 2024, 3:09 PM CST

Download

**apps.research.wisc.edu_TILT_Details_8853196.pdf (69.4 kB)**

# 2025/12/15- Human Subjects Research Training

Elle Thom - Dec 15, 2025, 6:33 PM CST

**Title: Human Subjects Research Training**

**Date:** 12/15/2025

**Content by:** Elleana Thom

**Present:** Elle Thom

**Goals:** Complete the Human Subjects Research training online before getting MRI scans from the client at the hospital.

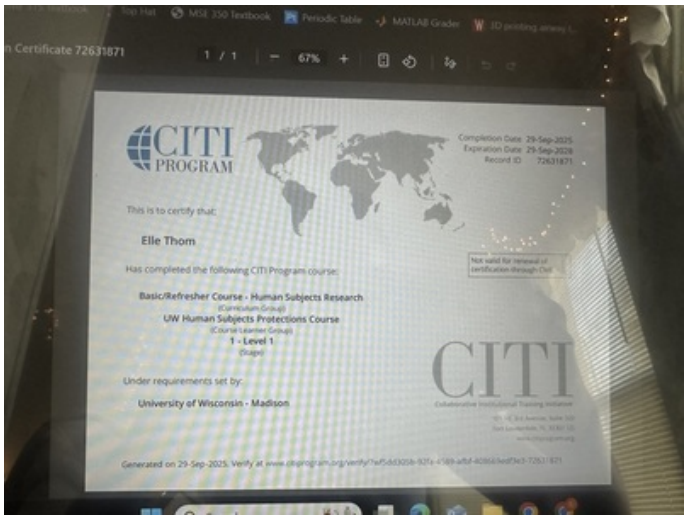
**Content:**

Attached below

**Conclusions/action items:**

I am now able to attend MRI scanning sessions with the team.

Elle Thom - Dec 15, 2025, 6:33 PM CST




Download

**IMG_2005_1_.jpg (2.92 MB)**

# 2024/03/06 Machining Permit TeamLab

Elle Thom - Mar 06, 2024, 2:08 PM CST

**Title:** Machining permit TeamLab

**Date:** 2024/03/06

**Content by:** Elleana Thom

**Present:** Individual Assignment

**Goals:** Complete the canvas quizzes, video quiz, and in person Team Lab Machining training.

**Content:**

**Completed the Machining permit for BME 201, including the canvas quizzes, video quiz, and the 4-hour in-person Teamlab training.**

**Proof of permit is attached below.**

**Conclusions/action items:**

**This training is a great way to learn how to use the Lathe and Mill. Developing skills in the team lab is important for future and present use in education and the workforce. The training was long but a lot was learned from it and it was a really great experience qith amazing instructors.**

Elle Thom - Mar 06, 2024, 2:04 PM CST

Download

**MachiningPermitTeamLab.pdf (127 kB)**

# 2025/10/23- Outreach Activity Ideas

Elle Thom - Oct 23, 2025, 4:11 PM CDT

**Title: Outreach Activity Ideas**

**Date:** 10/23/2025

**Content by:** Elleana Thom

**Goals:** Find activities appropriate for 5th graders that will teach them engineering principles

**Content:**

Activities:

1. Creating an electromagnet - https://www.teachengineering.org/activities/view/cub_mag_lesson2_activity1
2. Bridge types: Tensile and Compressive forces - https://www.teachengineering.org/activities/view/cub_mag_lesson2_activity1
3. DNA Build - https://www.teachengineering.org/activities/view/cub_biomed_lesson09_activity2
4. Kidney Filtering (Recommended for BME) - https://www.teachengineering.org/activities/view/cub_human_lesson08_activity1
5. The artificial bicep (Recommended for BME) - https://www.teachengineering.org/activities/view/cub_biomed_lesson02_activity1
6. Biohazard protection design project - (Recommended for BME) - https://www.teachengineering.org/activities/view/ewh_suitup_activity1

**Conclusions/action items:**

Review with the team to choose which activity to do for outreach.

# Manikins' Anatomical Accuracy 12/16

Cody Kryzer - Dec 16, 2025, 1:02 PM CST

**Title:** Anatomic accuracy of airway training manikins compared with humans

**Date:** 12/16/25

**Content by:** Cody

**Present:** Cody

**Goals:** Consider proper measurements for making an airway training manikin

**Link:** https://doi.org/10.1111/anae.15238

**Citation:**

[1] M. B. Blackburn *et al.*, "Anatomic accuracy of airway training manikins compared with humans*," *Anaesthesia*, vol. 76, no. 3, pp. 366–372, Aug. 2020, doi: https://doi.org/10.1111/anae.15238.

**Content:**

This study takes a look at three different airway manikins and compares their measurements to values found from human CT scans. The main discrepancy between trainer and human was the space between epiglottis and posterior pharyngeal wall.

| Measurement | Mean (SD) | Value (percentile) | | |
|---|---|---|---|---|
| | Human participants | SynDaver | Laerdal | AirSim |
| Tongue to PPW | 12.22 (5.42) | 19.9 (0.96[a]) | 24.0 (> 0.99[a]) | 16.8 (0.86[a]) |
| Epiglottis to PPW | 7.94 (3.35) | 15.4 (0.99[b]) | 23.5 (> 0.99[b]) | 11.3 (0.84[a]) |
| Tip of tongue to vallecula | 71.49 (6.01) | 50.7 (< 0.01[b]) | 73.6 (0.64) | 63.9 (0.1[a]) |
| Tip of tongue to tongue dorsum | 34.38 (5.25) | 29.7 (0.18) | 23.2 (0.02[b]) | 28.7 (0.14[a]) |
| Vallecula to epiglottis | 14.64 (4.2) | 16.0 (0.62) | 16.3 (0.66) | 8.7 (0.08[a]) |
| Base of epiglottis to PPW | 11.84 (3.1) | 23.9 (> 0.99[b]) | 28.7 (> 0.99[b]) | 16.0 (0.91[a]) |
| Vertical distance of soft palate | 26.50 (7.71) | 15.5 (0.08[a]) | 41.3 (0.97[a]) | 11.1 (0.02[b]) |
| Soft palate to laryngeal inlet | 60.64 (9.97) | 66.2 (0.71) | 112.0 (> 0.99[b]) | 82.8 (0.99[b]) |
| Uvula to epiglottis | 21.40 (7.88) | 28.1 (0.8) | 28.4 (0.81) | 25.0 (0.68) |

| Measurement | Mean (SD) | Value (percentile) | | |
|---|---|---|---|---|
| | Published human values | SynDaver | Laerdal | AirSim |
| Height mouth opens; cm [17] | 4.78 (0.83) | 5.98 (0.93) | 4.52 (0.38) | 8.10 (> 0.99) |
| First tracheal ring width; mm [18] | 1.9 (0.6) | 2.44 (0.82) | 1.52 (0.26) | 1.92 (0.51) |
| Trachea length; cm [19] | 8.6 (1.1) | 9.54 (0.80) | 3.27 (< 0.01) | 7.83 (0.24) |
| Neck circumference; cm [20] | 36.6 (3.5) | 33.4 (0.18) | 43.55 (0.98) | 41.23 (0.91) |
| Tongue to PPW; mm [16] | 16.0 (0.7) | 23.0 (> 0.99) | 35.7 (> 0.99) | 23.2 (> 0.99) |

| Measurement | Mean (SD) | Value (percentile) | | |
|---|---|---|---|---|
| | Published human values | SynDaver | Laerdal | AirSim |
| Epiglottis to PPW; mm [16] | 9.0 (0.4) | 16.7 (> 0.99) | 35.4 (> 0.99) | 14.8 (> 0.99) |

These tables show the differences in spacing at different relevant points in the human and manikin anatomy.

**Conclusions/action items:**

We should refer to these tables when using 3D modeling software to ensure our prints will be anatomically accurate. The airway itself must get values from the MRI scans, but the spaces around it are determined by us and should be precise.

# Guidelines for Difficult Airway Management 12/16

Cody Kryzer - Dec 16, 2025, 1:18 PM CST

**Title:**

**Date:** 12/16/25

**Content by:** Cody

**Present:** Cody

**Goals:** Learn about differences and similarities of different intubation devices

**Link:** https://www.sciencedirect.com/science/article/abs/pii/S0735675707007292

**Citation:** [1]B. Trabold, C. Schmidt, B. Schneider, D. Akyol, and M. Gutsche, “Application of three airway devices during emergency medical training by health care providers--a manikin study,” The American Journal of Emergency Medicine, vol. 26, no. 7, pp. 783–788, Sep. 2008, doi: https://doi.org/10.1016/j.ajem.2007.11.006.

**Content:**

The study takes a look at the use of a Combitube, Easytube, and Laryngeal tube when used by healthcare providers with varying airway management experience.

The outcomes measured are: time to successful insertion, success rate, level of education, and professional experience.

The laryngeal tube had the shortest insertion time and the highest success rate.

There was shown to be no correlation between years of professional experience and insertion time. And also level of education and the number of failed intubations.

**Conclusions/action items:**

Unfortunately this study does not address difficult airways, but there is still much to glean from it.

This study can be used as a framework for potential testing that our team can perform next semester. We only have one intubation device available but we can use a similar process, especially having subjects of different skills intubating on our manikin.

The study included two separate sessions and was shown to have no significant difference in results between sessions. This means our team can perform the testing just once will be save time and be easier to organize.

# Prototype Improvement 12/16/25

Cody Kryzer - Dec 16, 2025, 12:55 PM CST

**Title:** Prototype Improvement

**Date:** 12/16/25

**Content by:** Cody

**Present:** Cody

**Goals:** Put on paper my ideas for improving our prototype

**Content:**

Current strengths of prototype:

- Accurate and patient specific airway anatomy
- Contains most parts of facial anatomy
- Adjustable neck angle
- Made of good material
- includes a "spine"

Current drawbacks of prototype

- non specific oral cavity anatomy
- Absence of mandible
- Nonadjustable tongue
- Mouth and airway is piecewise and connected with zip ties and glue

**Conclusions/action items:**

The easiest way to significantly improve the design is to cast the mouth and airway all in one piece of silicone. This should be achievable by combining the two molds at the proper intersection point.

It is also necessary to add a jaw to the manikin. This will make it easier to adjust the mouth opening angle which is significant in making intubation scenarios more difficult.

# Training

Cody Kryzer - Dec 15, 2025, 8:52 PM CST

**Title:** Proof of training

**Date:** N/A

**Content by:** Cody

**Present:** Cody

**Goals:** This semester must add a training certificate to my repettoire of trainings

**Content:**

OVCR Training Information Lookup Tool — University of Wisconsin-Madison

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Cody Kryzer has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| 2024-2025 HIPAA Privacy & Security Training | 2024-2025 HIPAA Privacy & Security Training | 4/7/2025 | |
| Biosafety Required Training | Biosafety Required Training Quiz 2024 | 2/17/2024 | 2/17/2029 |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 2/17/2024 | |
| Responsible and Ethical Conduct of Research (RECR) | RCR Certification | 10/30/2025 | No Expiration |
| UW Human Subjects Protections Course | Basic/Refresher Course - Human Subjects Research | 2/12/2025 | 2/12/2028 |

Data Last Imported: 10/30/2025 02:54 PM



**Conclusions/action items:**

I am safe and responsible in the lab and while using machines

# BPAG Meeting 9/26/25

Cody Kryzer - Sep 26, 2025, 12:27 PM CDT

**Title:** BPAG Meeting

**Date:** 9/26/25

**Content by:** Cody

**Present:** All BPAGs and J Puccinelli

**Goals:** Learn about being BPAG

**Content:**

- Better to have client buy things than for us to buy them and get reimbursed
- Keep track of all receipts and expenses in notebook, progress report, and reports
- We can't get reimbursed by the University for tax
- Flow chart is online, refer back to with questions
- Try not to use amazon, UW has recommended vendors
- 50$ budget per team at Wendt Makerspace - account name: BMEDesign
- Design innovation lab in ECB has stuff mostly for free. But be careful because the employees down there are very mean
- Puccinelli HATES E-Reimbursements
- Poster and Labarchives are our obligation
- My expense table should allow someone random to repeat everything our team did
- Purchases over $1000 require client and department approval
- Application for funding exists if necessary (discussed on Wednesdays)
-

**Conclusions/action items:**

Using the flow chart shown in class, I should use the following path:

UW Affiliation NOT BME --> not UW funds --> Anything is fair game --> client pays or we pay and get reimbursed end of semester

Only me, the BPAG, should be getting reimbursed. I can then share with my teammates who made purchases.

Have all purchases approved by client beforehand

Use BPAG expense template and put into labarchives

If materials are used and were free, record those as well

# 3D Slicing Decisions 10/10/25

MATTHEW SHERIDAN - Dec 16, 2025, 11:56 AM CST

**Title:** 3D Slicing Decisions

**Date:** 10/10/25

**Content by:** Matt Sheridan

**Present:** Matt Sheridan

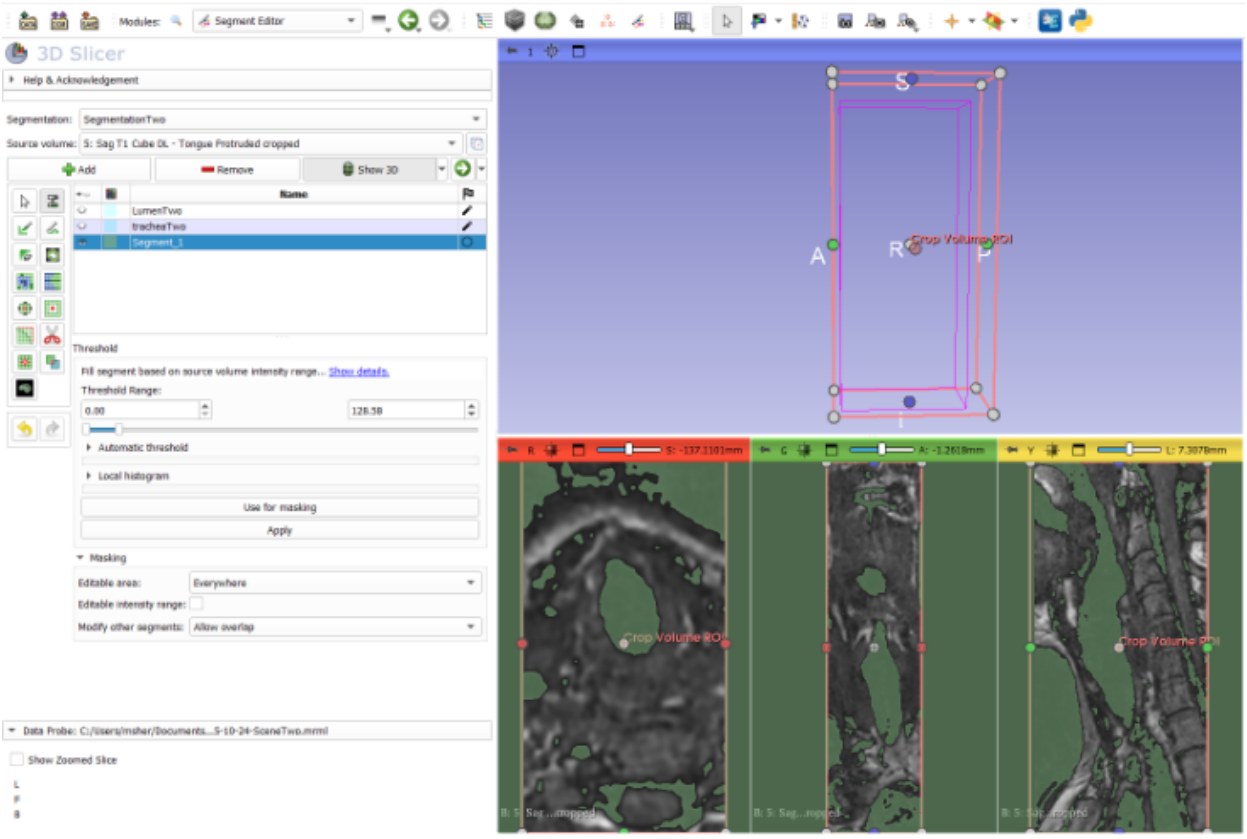
**Goals:** Make decisions about how to attack the 3D slicing for the printing of our airway

**Content:**

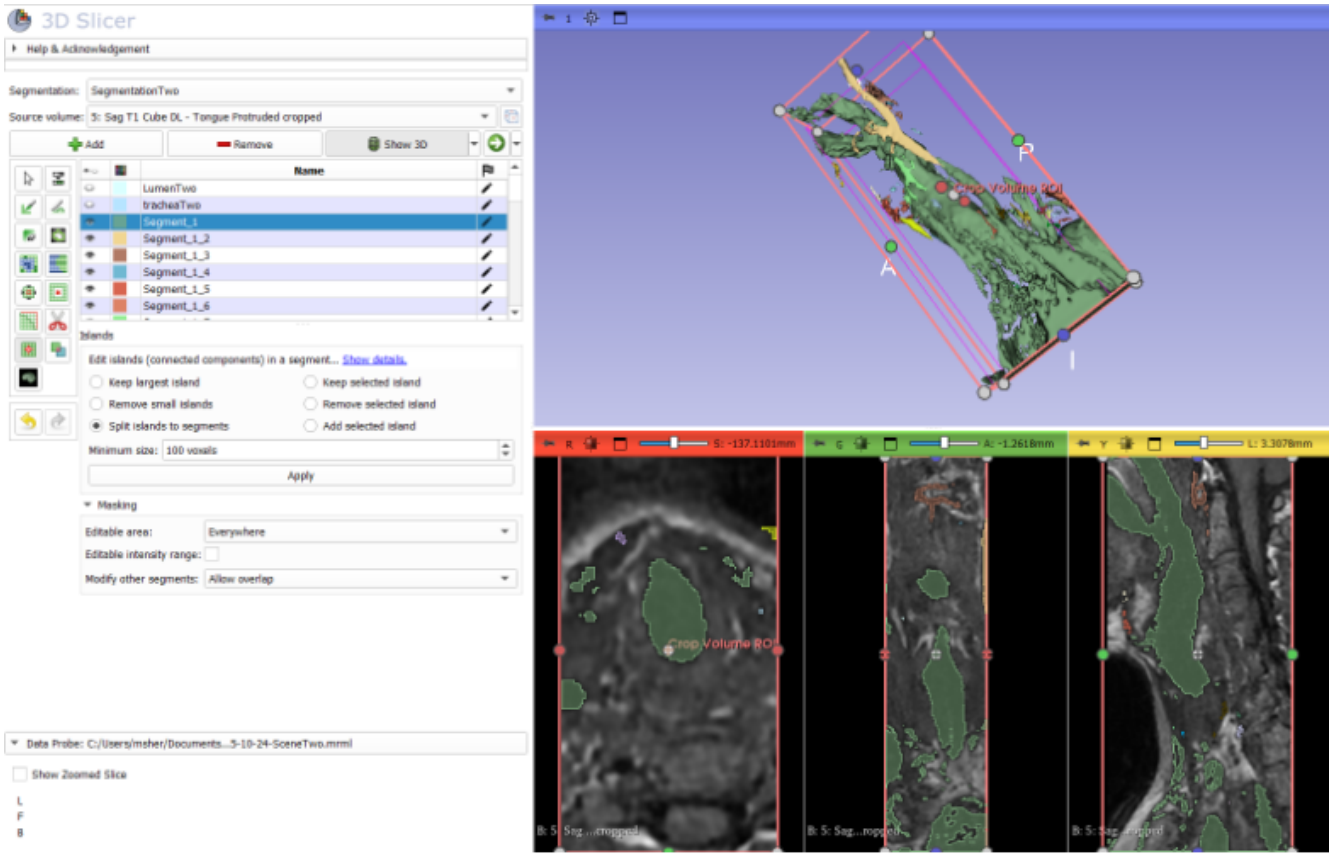
Last semester, the plan of action was to use the 3D slicing software to model the area around the airway, roughly 3 mm thick, and print this out of a resin material. This semester, we have decided that it would be much easier to print the airway out of PLA, and mold silicone around this section. So, with 3D slicer, I was able to just model the airway portion, and did not need to do anything additional on surrounding tissue.

To make the file good for printing, a few changes needed to be made to the initial segmentation. Most of this was done in Segment Editor on the Slicer software.

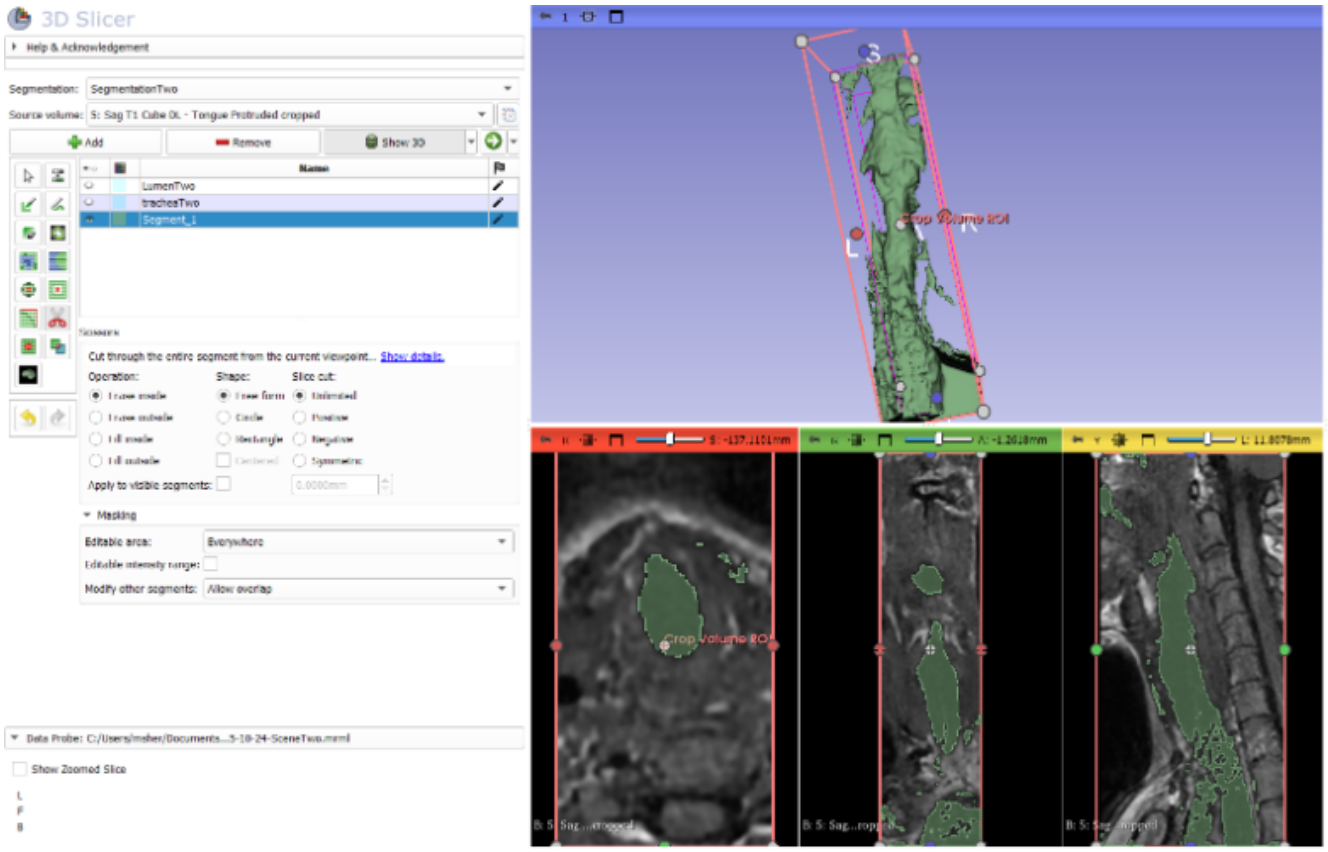
1. Use the Threshold feature to isolate regions of the darkest color values. This includes all of the airway, but also many other areas in the body, so lots of editing needs to be done to isolate that airway section for proper printing.



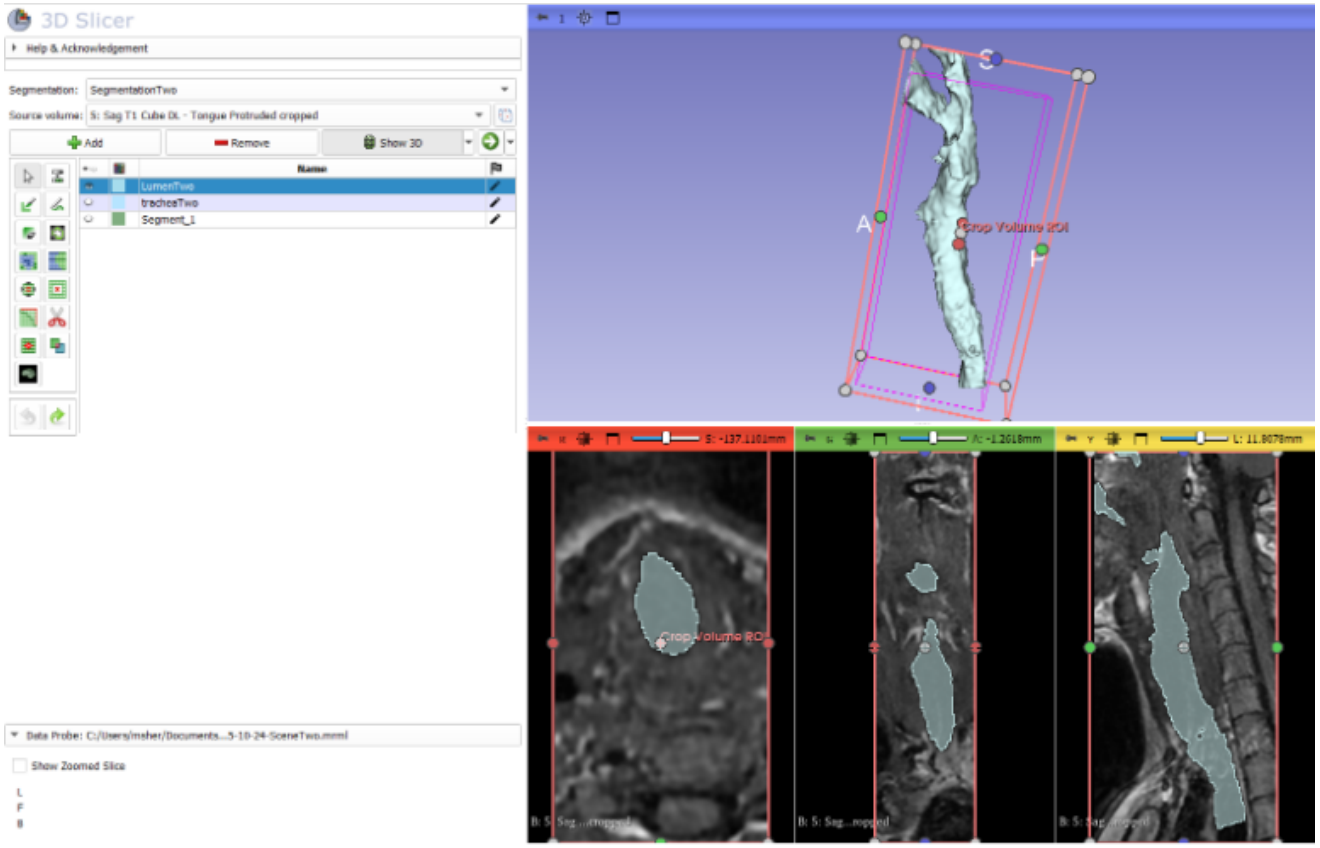

2. The islands feature is then used to split everything up into islands if it is not connected to something else. The entire airway is 1 island, so if anything isn't connected to this, it gets split into an island, and can then be deleted.

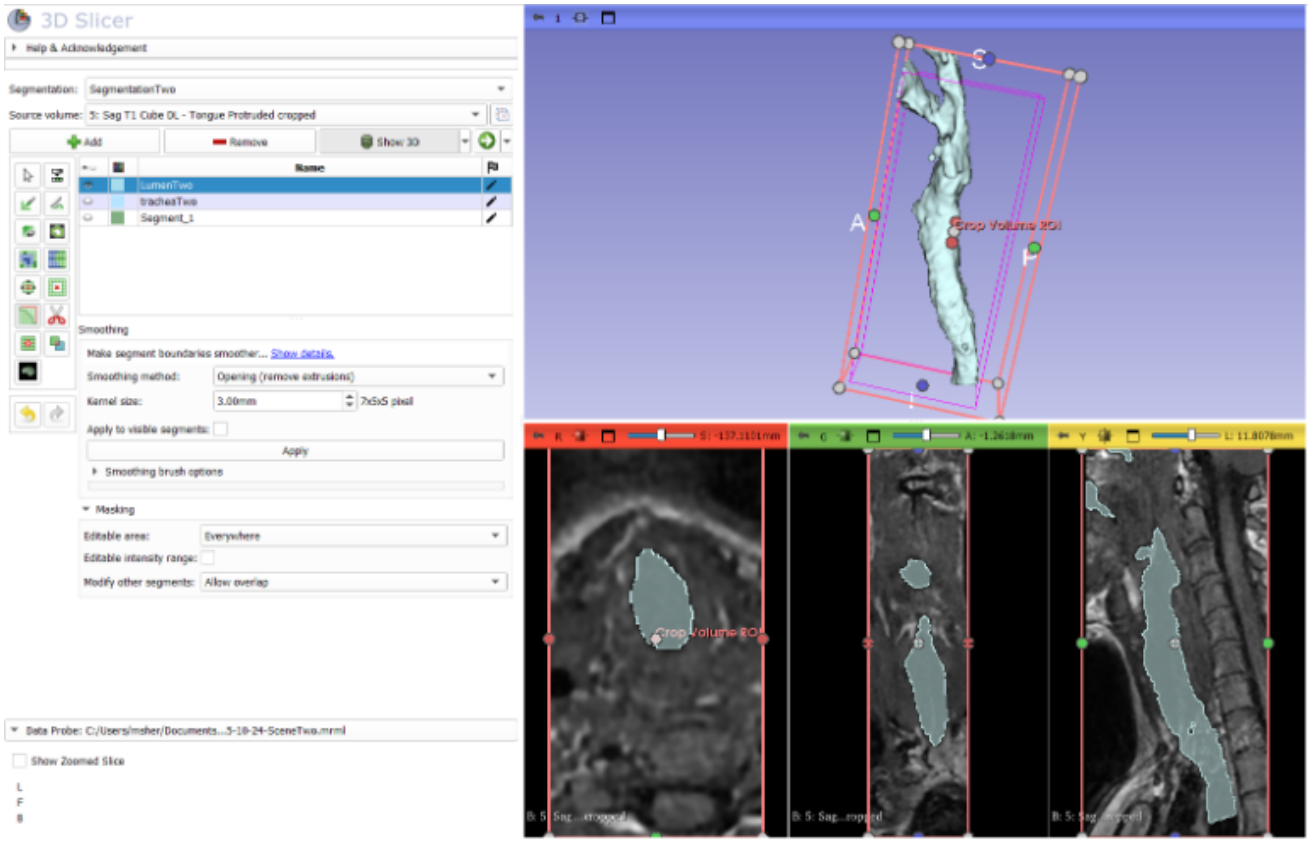



3. Next, the scissors feature is used to remove sections that are clearly not part of the airway. This part is delicate, and small sections must be removed at a time to ensure that nothing vital is removed. This is also used in tandem with the islands feature, as you can continually split the solid into islands after removing sections.




4. Finally, smoothing features are used to clean up the airway into a usable file. It is then exported as an STL to be printed.




**Conclusions/action items:**

We hope to use this to get an accurate silicone mold of the airway.

# 3D Print Adjustments 10/25/25

MATTHEW SHERIDAN - Dec 16, 2025, 11:37 AM CST

**Title:** 3D Printing Adjustments and Ideas

**Date:** 10/25/25

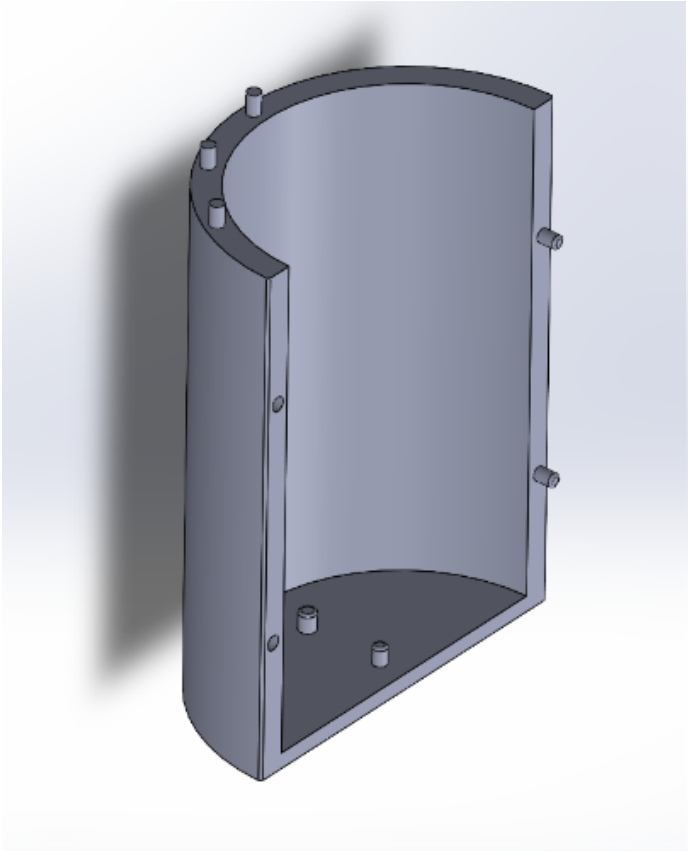
**Content by:** Matt Sheridan

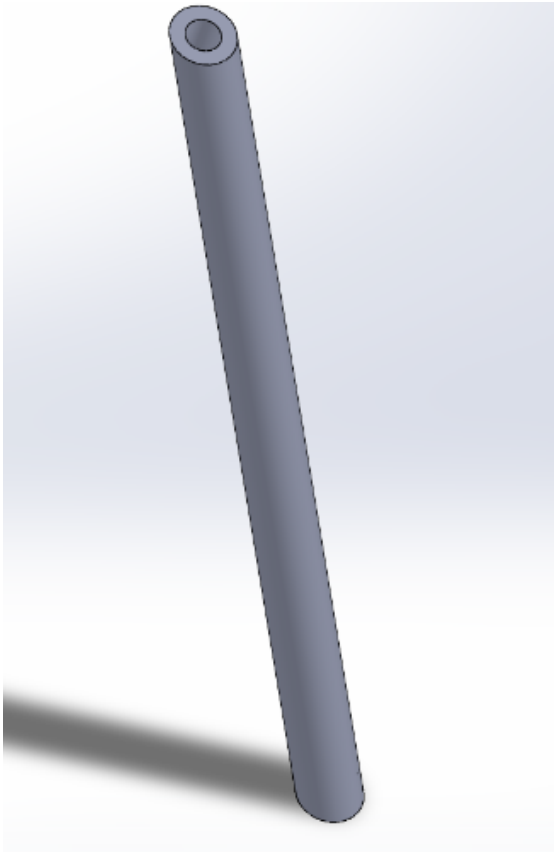
**Present:** Matt Sheridan, Lance Johnson, Cody Kryzer

**Goals:** Correct mistakes made on the first 3D print and print again

**Content:**

The part that we designed for the shell before the last print had a few errors. First of all, we decided that the airway that we were printing was too small, and we would have to marginally scale up the size of the airway part to allow for intubation to be feasible. We also had to angle the cylinder to accurately match the angle of the spine relative to the airway that we saw in the MRI scan. The pegs on the side were also off by a few millimeters, so the pieces did not connect as we had hoped. So we had to move the pegs to the correct spot, angle the cylinder, and increase the size of the peg on the shell for the airway to account for the increased scale of the airway part (25% increase).





**Conclusions/action items:**

This print worked! The pieces fit together well, and airway and angled cylinder fit together well in the mold, so we should be able to pour the silicone in as soon as possible to create our first mold of the airway.

# Prototyping Ideas 12/2/25

MATTHEW SHERIDAN - Dec 16, 2025, 12:30 PM CST

**Title:** 3D Modeling of the Airway Ideas

**Date:** 12/2/25

**Content by:** Matt Sheridan

**Present:** Matt Sheridan

**Goals:** Figure out a path forward to get a final design for poster presentations

**Content:**

There are a few things that the team needs to figure out before poster presentations. We have our printed airway model as well as the cylinder around it to make our mold. Once we have our silicone mold of the lower portion of the airway, we need to figure out how to form this into a functional prototype that can be intubated on to make for a more interesting poster presentation. I am thinking that we can attach the lower portion of the airway to the previously printed upper portion using zip ties as well as silicone glue. I also plan to cut out a portion of the lower airway to attach it to the previously created base. In the future, the goal will be to print the upper and lower portions of the airway in a way that can be easily attached to either the existing base, or a new base that we will create.

**Conclusions/action items:**

All that we need to do now is attach the lower airway to the upper airway, both portions are intubatable, just need to be combined.

# Biosafety and Chemical Safety Training

MATTHEW SHERIDAN - Mar 04, 2024, 2:55 PM CST

WISCONSIN
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This certifies that Matthew Sheridan has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| Biosafety Required Training | Biosafety Required Training Quiz 2024 | 2/17/2024 | 2/17/2029 |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 2/12/2024 | |

Data Last Imported: 03/04/2024 02:44 PM

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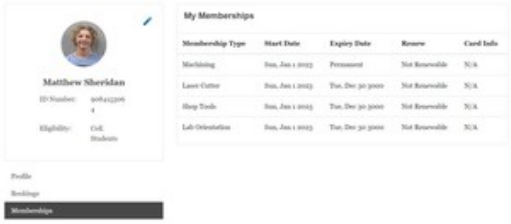
**Biosafety_and_Chem_Safety_Training_Certificates.pdf (68.6 kB)**

# Intro to Machining Certificate

MATTHEW SHERIDAN - Mar 19, 2024, 10:21 AM CDT

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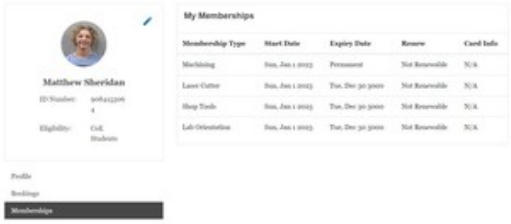
# Machining Certificates

MATTHEW SHERIDAN - Feb 10, 2025, 11:14 PM CST

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# Chemical, Biosafety, and Human Subjects Training

MATTHEW SHERIDAN - Feb 10, 2025, 11:13 PM CST


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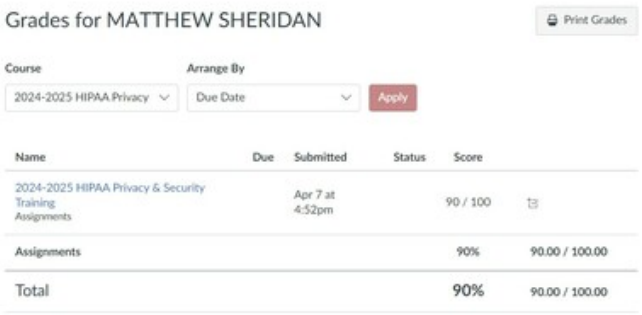
**Chem_Bio_Human_Training_Documentation.jpg (155 kB)**

# HIPAA Training

MATTHEW SHERIDAN - Apr 07, 2025, 4:55 PM CDT



Grades for MATTHEW SHERIDAN

Print Grades

Course: 2024-2025 HIPAA Privacy

Arrange By: Due Date

Apply

| Name | Due | Submitted | Status | Score | |
|---|---|---|---|---|---|
| 2024-2025 HIPAA Privacy & Security Training Assignments | | Apr 7 at 4:52pm | | 90 / 100 | |
| Assignments | | | | 90% | 90.00 / 100.00 |
| Total | | | | 90% | 90.00 / 100.00 |

Download

**HIPAA_Training.jpg (69.6 kB)**

# Research Animal Resources and Compliance Training

MATTHEW SHERIDAN - Oct 17, 2025, 1:37 PM CDT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**RARC.jpg (115 kB)**

# 12/12/25 - "Degrees of Reality : Airway Anatomy of High-fidelity Human Patient Simulators and Airway Trainers"

Lance Johnson - Dec 15, 2025, 10:10 AM CST

**Title:** "Degrees of Reality : Airway Anatomy of High-fidelity Human Patient Simulators and Airway Trainers"

**Date:** 12/12/25

**Content by:** Lance

**Present:** N/A

**Goals:** To understand the discrepancies between real human airway anatomy and the trainers used for airway management

**Link:** https://pubmed.ncbi.nlm.nih.gov/22481118/

**Citation:**

K. Schebesta, M. Hüpfl, B. Rössler, H. Ringl, Michael P. Müller, and O. Kimberger, “Degrees of Reality,” Anesthesiology, vol. 116, no. 6, pp. 1204–1209, Jun. 2012, doi: https://doi.org/10.1097/aln.0b013e318254cf41.

**Content:**

The study looked into the airway anatomy of high- and low-fidelity manikins and real human patients and found some pretty dramatic differences. For example, the pharyngeal airspace in humans averaged 13.5 +/- 7.7 cc, while it was much larger in manikins, such as SimMan(68.5 cc) and Laerdal Manikin (65.9 cc). Other measurements, like tongue diameter and the distance from the epiglottis to the posterior pharyngeal wall also differed notably. This validates the work being done in our project as it shows the need for more accurate and difficult airway trainers.

- the goal of the study was to evaluate the realism and accuracy of airway anatomy in 4 high-fidelity and 2 low-fidelity human patient simulators(HPS)

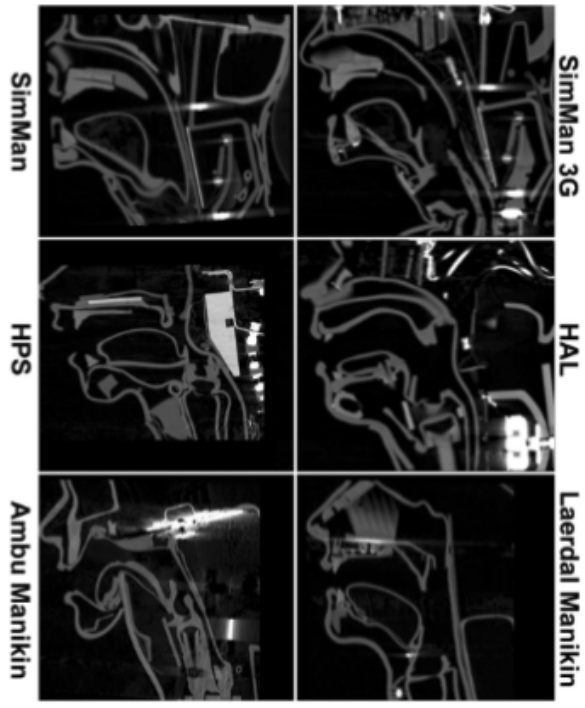
- radiographic measurements were used to quantify the accuracy of the trainers against 20 CT scans of actual trauma patients

- a variety of predefined distances, cross-sectional areas, and volumes were assessed

- the pharyngeal airspace(volume of the upper airspace) was significantly larger in the the simulators than in actual patients (68.5 cc vs. 13.5 cc)

- many simulators lacked basic anatomical features which made comparisons very difficult

- conclusions made that manikin-based training may not be effective in preparing medical professionals for real-life clinical situations




**Conclusions/action items:**

Seeing how the airway trainers weren't really even that accurate to average anatomy makes it evident why intubating and managing the airways of individuals with more unusual anatomies is very difficult and leads to many challenges. We will use this information to inform and evaluate our design.

Lance Johnson - Feb 02, 2025, 2:05 PM CST

**Degrees of Reality**

*Airway Anatomy of High-fidelity Human Patient Simulators and Airway Trainers*

Karl Schebesta, M.D.,* Michael Hüpfl, M.D.,† Bernhard Rössler, M.D.,* Helmut Ringl, M.D.,‡ Michael P. Müller, M.D.,§ Oliver Kimberger, M.D.‖

ABSTRACT

**Background:** Human patient simulators and airway training manikins are widely used to train airway management skills to medical professionals. Furthermore, these patient simulators are employed to standardized "patients" to evaluate airway devices. However, little is known about how realistic these patient simulators and airway-training manikins really are. This trial aimed to evaluate the upper airway anatomy of four high-fidelity patient simulators and two airway trainers in comparison with actual patients by means of radiographic measurements. The volume of the pharyngeal airspace was the primary outcome parameter.

**Methods:** Computed tomography scans of 20 adult trauma patients without head or neck injuries were compared with computed tomography scans of four high-fidelity patient simulators and two airway trainers. By using 14 predefined distances, two cross-sectional areas and three volume parameters of the upper airway, the manikins' similarity to a human patient was assessed.

**Results:** The pharyngeal airspace of all manikins differed significantly from the patients' pharyngeal airspace. The HPS Human Patient Simulator (METI®, Sarasota, FL) was the most realistic high-fidelity patient simulator (6/19 [32%] of all parameters were within the 95% CI of human airway measurements).

**Conclusion:** The airway anatomy of four high-fidelity patient simulators and two airway trainers does not reflect the upper airway anatomy of actual patients. This finding may impact airway training and confound comparative airway device studies.

What We Already Know about This Topic

- Manikins are a tool for education, training, and research of human airway management, but the fidelity of these devices is typically low

What This Article Tells Us That Is New

- Computed tomography scans of the upper airway revealed that the airway dimensions of the manikins significantly differed from those of humans
- Training, education, and research using this manikins should be reconsidered

AIRWAY management is a key skill in anesthesiology and emergency medical practice. Because failure to manage an airway is associated with a high risk of morbidity and mortality, many anesthesia researchers have focused their educational and research efforts on airway management techniques and devices.[1,2] After the introduction of human patient simulators in the early 1960s, airway management training could be performed, even in high-risk airway situations, without putting actual patients at risk.[3–5] These human patient simulators are now widely used not only for training purposes but also as an innovative way to answer scientific questions in airway management research.[6,7] The ability to simulate either a difficult or normal airway has granted a better understanding of different airway maneuvers and has helped with the assessment of new airway de-

◆ This article is accompanied by an Editorial View. Please see: Klein PA Jr: Airway simulators and maintainers: A case of high infidelity? ANESTHESIOLOGY 2012; 116:1179–80.





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Received from the Medical Simulation and Emergency Management Research Group, Department of Anesthesia, General Intensive Care and Pain Management, Medical University of Vienna, Vienna, Austria. Submitted for publication August 2, 2010. Accepted for publication March 5, 2012. Support was provided solely from institutional and/or departmental sources.

Address correspondence to Dr. Schebesta: Medical Simulation and Emergency Management Research Group, Department of Anesthesia, General Intensive Care and Pain Management, Medical University of Vienna, Währinger Gürtel 18–20, A-1090 Vienna, Austria. karl.schebesta@meduniwien.ac.at. Information on purchasing reprints may be found at www.anesthesiology.org or on the masthead page at the beginning of this issue. ANESTHESIOLOGY's articles are made freely accessible to all readers, for personal use only, 6 months from the cover date of the issue.

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**Degrees_of_Reality_Airway_Anatomy_of_High-fidelity_Human_Patient_Simulators_and_Airway_Trainers.pdf (592 kB)**

# 12/2/25 - Final Mold Assembly & Casting

Lance Johnson - Dec 16, 2025, 11:39 AM CST

**Title:** Final Mold Assembly & Casting

**Date:** 12/2/25

**Content by:** Lance

**Present:** Cody, Elle, Matt, Dan

**Goals:** Assemble the final mold prototype and cast the final airway in silicone

**Content:**

The team worked to clean off the 3d-printed parts by sanding and using pliers to remove supports. The team then pre-assembled the PLA parts to make sure everything fit together well and would function properly when the silicone would be cast. Once the practice fit was confirmed, the team re-assembled everything and prepared to pour silicone by sealing the mold with duct tape and rubber bands, and by placing a paper plate beneath the mold to prevent any other spills. The airway negative and spine prints were stabilized in the mold with popsicle sticks and tape to prevent them from moving while the silicone cured. The silicone was then mixed and poured into the mold to set. After setting for 3 hours, the below picture was observed.

**Conclusions/action items:**

The final 3d-prints worked well, as they fit snuggly and allowed for the casting of our final airway. Moving forward, I think the team will try to combine the mouth/throat cast with our airway cast to create one singular silicone piece for the entire airway.

# 2/19/24 - Shop Tools Fabrication Permit

Lance Johnson - Feb 19, 2024, 8:37 PM CST

**Title: Shop Tools Fabrication**

**Date:** 2/19/24

**Content by:** Lance

**Present:** N/A

**Goals:** To complete the Introduction to Machining segment and Shop Tools project

**Content:**

## Intro to Machining Assessment

**Due** No due date **Points** 19 **Questions** 19 **Time Limit** 25 Minutes
**Allowed Attempts** 3

Take the Quiz Again

### Attempt History

| | Attempt | Time | Score |
|---|---|---|---|
| LATEST | Attempt 1 | 9 minutes | 18.5 out of 19 |

Quiz results are protected for this quiz and can be viewed a single time immediately after submission.

Correct answers are hidden.

Score for this attempt: **18.5** out of 19

## Last Attempt Details:

| | |
|---|---|
| **Time:** | 47 minutes |
| **Current Score:** | 17 out of 18 |
| **Kept Score:** | 17 out of 18 |

2 More Attempts available

Take the Quiz Again

(Will keep the highest of all your scores)

^ completed Lathe alpha piece

**Conclusions/action items:**

**-** Complete the milling portion of the Shop Tools fabrication permit

Lance Johnson - Mar 09, 2024, 4:11 PM CST

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UNIVERSITY OF WISCONSIN-MADISON

This certifies that Lance Johnson has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| Biosafety Required Training | Biosafety Required Training Quiz 2024 | 2/17/2024 | 2/17/2029 |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 2/17/2024 | |

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# Training Documentation - Lance

Lance Johnson - Feb 13, 2025, 8:12 PM CST

**Lance Johnson**

ID Number: 9084318329

Eligibility: CoE Students

## My Memberships

| Membership Type | Start Date | Expiry Date | Renew | Card Info |
|---|---|---|---|---|
| Access Fee | Mon, May 22 2023 | Sun, Dec 31 2023 | Not Renewable | N/A |
| Machining - Training Eligible | Sun, Jan 1 2023 | Tue, Dec 30 3000 | Not Renewable | N/A |
| Lab Orientation | Sun, Jan 1 2023 | Tue, Dec 30 3000 | Not Renewable | N/A |
| Laser Cutter | Sun, Jan 1 2023 | Tue, Dec 30 3000 | Not Renewable | N/A |
| Shop Tools | Sun, Jan 1 2023 | Tue, Dec 30 3000 | Not Renewable | N/A |

Lance Johnson - Feb 17, 2025, 4:07 PM CST

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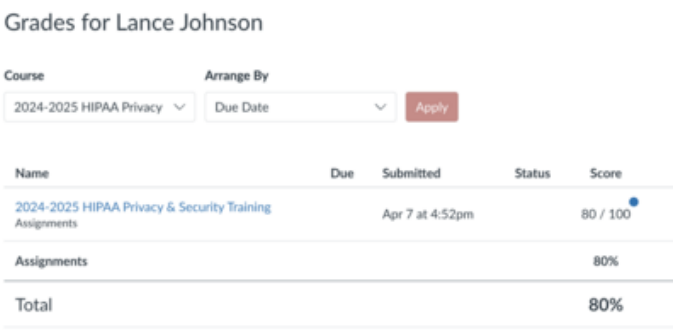
This certifies that Lance Johnson has completed training for the following course(s):

| Course | Assignment | Completion | Expiration |
|---|---|---|---|
| Biosafety Required Training | Biosafety Required Training Quiz 2024 | 2/17/2024 | 2/17/2029 |
| Chemical Safety: The OSHA Lab Standard | Final Quiz | 2/17/2024 | |
| Risk Communication in Animal Facilities | Risk Communication in Animal Facilities Quiz 2023 | 9/19/2023 | |
| Safety for Personnel with Animal Contact | Animal Contact Personnel Quiz 2023 | 9/19/2023 | 9/19/2028 |
| UW Human Subjects Protections Course | Basic/Refresher Course - Human Subjects Research | 2/13/2025 | 2/13/2028 |

Data Last Imported: 02/17/2025 04:05 PM

# 4/7/25 - HIPAA Training

Lance Johnson - Apr 07, 2025, 4:54 PM CDT

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# 10/29/25 - RARC Training

Lance Johnson - Oct 29, 2025, 8:09 AM CDT

**Title: RARC Training**

**Date:** 10/29/25

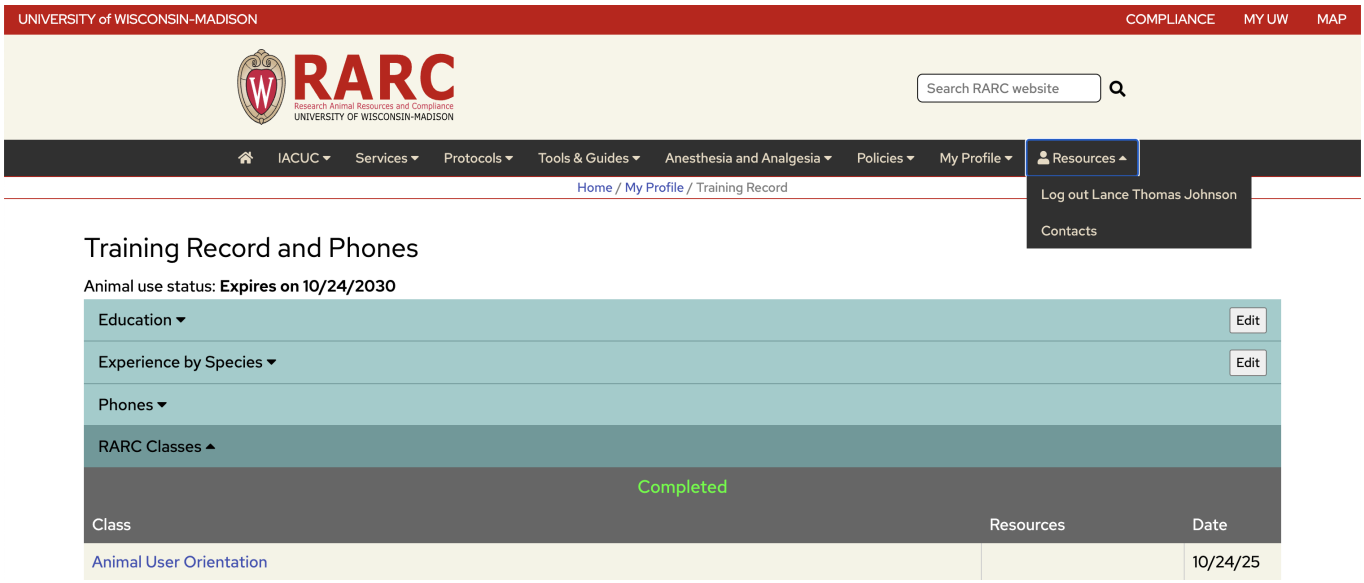
**Content by:** Lance

**Present:** N/A

**Goals:** To complete the Research Animal Resources & Compliance Training

**Content:**

Completed the Animal User Orientation




**Conclusions/action items:**

None

# 12/16/25 Smooth Muscle in Abnormal Airways

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:26 PM CST

**Title:** Smooth Muscle in Abnormal Airways

**Date:** 12/16/25

**Content by:** Dan

**Search Term:** Google Scholar: abnormal airways

**Link:** https://www-sciencedirect-com.ezproxy.library.wisc.edu/science/article/pii/S2468867321000377?casa_token=1kSNmlusfeQAAAAA:gHy7XG3wYVgeA-pC5ACkFTxe1REUjMWXMoLcvtaCgtd6DCRvk2hnejgu03Z8YRbQmLT2e9Ln9w

**Citation:**

Y. Bossé, “Smooth muscle in abnormal airways,” Current Opinion in Physiology, vol. 21, pp. 1–8, Jun. 2021, doi: https://doi.org/10.1016/j.cophys.2021.03.002.

**Goals:** Learn about the smooth muscle in abnormal airways

**Content:**

Airway responsiveness tends to be measured by the contraction of the smooth muscle in an airway (ASM), but this does not take into account other contributing factors to airway shrinkage, such as diseases or age. ASM that is considered to be normal size and have a normal contractile limit can trigger warnings in airway responsiveness in abnormal airways. For many individuals, it is possible that they have completely normal ASM, but can still show the signs of AHR. While this is the case, it is also important to note that normal ASM does not necessarily mean that there are not other problems in the airway. There is a lot of literature on ASM defects, but this study shows that there may be more to observe with AHR problems.

**Conclusions/action items:**

This information is important for designing our airway trainer, as we are going to be dealing with abnormal airways, so understanding the mechanism by which an airways responsiveness is regarded is helpful.

# 12/16/25 Difficult Airways

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:27 PM CST

**Title:** Difficult Airways

**Date:** 12/16/25

**Content by:** Dan

**Search Term:** 3d printing abnormal airways

**Link:** https://pubmed.ncbi.nlm.nih.gov/33358011/

**Citation:**

D. Ormandy et al., “Difficult airways: a 3D printing study with virtual fibreoptic endoscopy,” British Journal of Oral and Maxillofacial Surgery, vol. 59, no. 2, pp. e65–e71, Feb. 2021, doi: https://doi.org/10.1016/j.bjoms.2020.08.045.

**Goals:** Learn about the use of 3D printing in difficult airways, and how that can impact patient outcomes

**Content:**

The thorough study of abnormal airways during the preoperative phase can improve patient outcomes. 3D printing these abnormal airways is an important growing field for assisting doctors with this study. These models allow the doctor and the anesthesiologist to choose the correct intubation approach for the surgery. CT scans were done on patients airways and then these scans were moved to 3D rendering software. These softwares (OsiriX, Primeo) can be helpful for our project if we are looking for some form of a rendering service.

**Conclusions/action items:**

Using this resource to consider the patient outcomes for individuals with abnormal airways will be crucial for writing about the background and motivation for this project.

# 12/16/25 Out-of-Hospital Endotracheal Intubation Experience and Patient Outcomes

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:27 PM CST

**Title:** Out-of-Hospital Endotracheal Intubation Experience and Patient Outcomes

**Date:** 12/16/25

**Content by:** Dan

**Goals:** Get some numbers on general intubation patient outcomes for background information

**Search Term:** patient outcomes in intubation

**Link:** https://www.annemergmed.com/article/S0196-0644(09)01841-1/fulltext

**Citation:**

H. E. Wang, G. K. Balasubramani, L. J. Cook, J. R. Lave, and D. M. Yealy, “Out-of-Hospital Endotracheal Intubation Experience and Patient Outcomes,” Annals of emergency medicine, vol. 55, no. 6, pp. 527-537.e6, Jun. 2010, doi: https://doi.org/10.1016/j.annemergmed.2009.12.020.

**Content:**

As observed in Pennsylvania statewide emergency medicine services, the patient survival rate for out of hospital intubation is associated with rescuer experience with the difficult process of intubation. This is only the case for cardiac and medical non-arrest patients, not for trauma non-arrest patients. Tracheal intubation is an incredibly complex process for any medical professionals, and is increasingly difficult for individuals that do not have practice with standard intubation procedures. By increasing the access to practice trainers or manikins, there was shown to be an improvement in overall patient outcomes. The uncontrolled out of hospital setting poses many risks, so wide access to training for EMS is integral to making a difference in patient outcomes.

**Conclusions/action items:**

Using this information, it seems very clear that there is a link between intubation experience and patient outcome. Since the major goal of the project is to make these airway trainers accessible so many people can practice, there is a definite link between our project and improved patient outcome.

# 12/16/25 Management of difficult tracheal intubation

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:30 PM CST

**Title:** Management of difficult tracheal intubation: a closed claims analysis

**Date:** 12/16/25

**Content by:** Dan

**Search Term:** doctor intubation practice

**Citation:**

A. M. Joffe, M. F. Aziz, K. L. Posner, L. V. Duggan, S. L. Mincer, and K. B. Domino, “Management of Difficult Tracheal Intubation,” Anesthesiology, vol. 131, no. 4, pp. 818–829, Oct. 2019, doi: https://doi.org/10.1097/aln.0000000000002815.

**Link:** https://pmc.ncbi.nlm.nih.gov/articles/PMC6779339/

**Goals:** Learn about medical malpractice as it relates to tracheal intubation

**Content:**

Inadequate airway planning and judgement errors were considered to be the largest contributors to patient harm in this study. There continues to be a need for further practice for medical practitioners on tracheal intubation. Since there was shown to be a considerable link between practitioners comfort with the intubation process and morbidity and malpractice in the hospital setting, there needs to be an increase in trainers on the market. While trainers are also shown to be helpful for improving patient outcomes, the improvements in the guidelines for difficult airway management can also lead to increased outcomes for patients.

**Conclusions/action items:**

Looking at this study, there still exists a great need for further airway trainers be made available on the market. While it is not possible to prepare practitioners for every single airway they may face, widely accessible abnormal airway trainers will improve patient outcomes.

# Red and Green Permit

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:34 PM CST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**Screenshot_2025-02-06_at_9.27.12_PM.png (183 kB)**

# Human Subjects Training

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:34 PM CST

| | | | |
|---|---|---|---|
| UW Human Subjects Protections Course | Basic/Refresher Course - Human Subjects Research | 8/28/2024 | 8/28/2027 |

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# HIPAA Privacy and Security Training

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:34 PM CST


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# Chemical and Biosafety Lab Training

Dan Altschuler (daltschuler2@wisc.edu) - Dec 16, 2025, 12:34 PM CST

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**Training_for_430.pdf (82.4 kB)**

# 2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

**Title:** Descriptive title (i.e. Client Meeting)

**Date:** 9/5/2016

**Content by:** The one person who wrote the content

**Present:** Names of those present if more than just you (not necessary for individual work)

**Goals:** Establish clear goals for all text entries (meetings, individual work, etc.).

**Content:**

Contains clear and organized notes (also includes any references used)

**Conclusions/action items:**

Recap only the most significant findings and/or action items resulting from the entry.

# 2014/11/03-Template

John Puccinelli - Nov 03, 2014, 3:20 PM CST

**Title:**

**Date:**

**Content by:**

**Present:**

**Goals:**

**Content:**

**Conclusions/action items:**