

Flow Limitation

Progress Report #3

Date: 9/24/2026

Client: Dr. Chris Green

Advisor: Dr. Mehmet Orman

Team: “Flow State”

Lakshika Nanda Kumar Reddy: Co-Leader

Julia Shefchik: Co-Leader

Caroline Blust: Communications

Eliza Kubicek: BSAC

Brady Mayer: BPAG

Jillian Seibert: BWIG

Problem statement:

Flow limitation is the phenomenon in which increasing respiratory effort no longer increases airflow beyond a certain point during forced exhalation, because the airway itself becomes the limiting factor rather than muscles driving expiration [1, 2]. During forced expiration, intrathoracic pressure rises sharply and can exceed the pressure inside the airway, resulting in the airway walls, specifically the bronchi, to narrow and eventually reach a choke point past which further effort in exhalation cannot increase flow [3]. This mechanism is central to interpreting spirometry, since flow-volume curves reflect the mechanical properties of airways rather than respiratory muscle effort alone [4, 5]. It is most relevant to obstructive diseases such as asthma, cystic fibrosis, and COPD, where airway walls are more prone to premature collapse or are already narrowed by inflammation, mucus, or loss of elastic recoil. This leads to prominent flow limitation occurring during forced exhalation [6]. This device will model the branching anatomy of the airway and use flexible materials to replicate the compression and collapse that occurs in the affected patient population. This will allow the users to visualize the equal pressure point (EPP) and the resulting choke point as it moves distally through the airway. The device is intended to physically demonstrate flow limitation during forced expiration for use in an educational teaching video. The final video will be used to teach medical fellows and students how these airway mechanics underlie clinical measures such as spirometry, and how they explain and monitor these obstructive conditions that experience flow limitation.

Brief status update:

The team has created a design matrix to evaluate three designs each for the airway geometry, material choice, and alveoli design. These matrices were presented to the client, where the team was able to gain valuable insight into the proposed design outcomes and helped to aid in completion of the matrix criterion and scores for each design.

Difficulties/advice requests:

None at this time.

Current design:

The box from last year's group project will be used in our current design.

Materials and expenses:

None at this time.

Major team goals for the next week:

- Complete the preliminary design presentation and report
- Investigate method for delivering compressed air to the pressure box system

Next week's individual goals:

Lakshika Nanda Kumar Reddy

- Complete assigned sections of the preliminary design report and preliminary presentation
- Continue researching
- Start brainstorming on how to model the airway in Solidworks

Julia Shefchik

- Complete assigned sections of the preliminary design report and preliminary presentation
- Start brainstorming on how to model in SolidWorks
- Brush up on SolidWorks interface

Caroline Blust

- Complete section of preliminary design presentation and start on report
- Continue researching
- Successfully find vacuum pump and use last year's project with help from Simon if needed

Eliza Kubicek

- Work on the preliminary design presentation and practice my section
- Begin researching fabrication methods and purchasing options for chosen designs
- Continue looking into learning how last year's device connects to compressed air and vacuum pumps available in ECB

Brady Mayer

- Work with the client to finalize ideas and confirm all expectations are met.
- Continue researching our chosen model before deciding on a final design.
- Work on the preliminary design presentation.

Jillian Seibert

- Work with client with our design ideas to make sure we are meeting his requirements
- Work on preliminary design presentation and practice parts
- Research more on the designs that we are looking to go with/scored better

Previous week's goals and accomplishments:

Lakshika Nanda Kumar Reddy

- Brainstormed and wrote sections of material and alveoli design matrices for the project
- Edited all three design matrices, so that they were all cohesive in information
- Continued researching the project to support design ideas and materials.

Julia Shefchik

- Brainstormed airway and alveoli design ideas for the project
- Continued researching the project to support design ideas

Caroline Blust

- Wrote sections of materials and alveoli matrices
- Did significant research into silicone molding possibility and alveoli materials
- Input further research articles into LabArchives

Eliza Kubicek

- Worked on the Materials and Alveoli design matrices through collaboration with the team
- Conducted research on material properties, available fabrication methods, and prices for use in the design matrix

Brady Mayer

- Worked on the design matrices and edited with the team to create a cohesive document.
- Researched articles about pathological adaptability and durability.
- Created drawings for our design matrix.
- Communicated with the team via meetings to ensure all components were completed accurately, on time, and efficiently.

Jillian Seibert

- Worked on design matrix ideas
- Researched manufacturing and modeling feasibility
- Researched different balloon types for alveoli
- Got pictures and descriptions for the three balloon types we are looking at

ACTIVITIES

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Lakshika Nanda Kumar Reddy	9/7/2026	Review previous team's final report	1	2.5	15.5
	9/7/2026	Brainstorm questions for the client meeting	0.5		
	9/10/2026	Conducted research on flow limitation and took notes	1		
	9/15/2026	Worked on PDS	1	5.5	
	9/15/2026	Researched FV curves, obstructive diseases, and flow limitation for PDS	2		
	9/16/2026	Edited PDS	1.5		
	9/16/2026	Researched materials for design ideas	1		
	9/21/2026	Started preliminary research on material ideas for 3D printing and alveoli	1	7.5	
	9/22/2026	Caroline/Eliza meeting for materials	1.5		
	9/23/2026	Conducted intensive research on 3D printing materials and alveoli materials	2		

	9/23/2026	Wrote the assigned sections of the design matrix	1		
	9/24/2026	Edited and reformatted all three design matrices to have cohesiveness through the documents	2		
Julia Shefchik	9/7/2026	Review previous team’s deliverables (final report, PDS, final poster)	1	4	15.5
	9/7/2026	Brainstorm questions for the client meeting	0.5		
	9/9/2026	Annotated and read a review article on Expiratory Flow Limitation	1.5		
	9/9/2026	Researched mechanical properties of the Airway Tree	1		
	9/13/2026	Worked on PDS	1	4	
	9/14/2026	Research standards and worked on PDS	2		
	9/16/2026	Edited PDS	1		
	9/21/2026	Preliminary research to support design ideas	1	7.5	
	9/22/2026	Research on physiological airway models and balloon materials	2		
	9/23/2026	Work on design matrices	3		
	9/24/2026	Edit design matrices	1.5		
Caroline Blust	9/7/2026	Brainstorm questions and review past project	0.5	1	15.5
	9/7/2026	Add research entry to LabArchives	0.5		
	9/11/2026	Researched project concepts and summarized client article	1.5	6	
	9/15/2026	Worked on PDS	3		
	9/15/2026	Further research	1		
	9/16/2026	PDS edits	0.5		

	9/21/2026	Materials research and design matrix initial brainstorming	1	8.5	
	9/22/2026	Lakshika/Eliza materials matrix meeting	1.5		
	9/23/2026	Materials matrix research and writing	3		
	9/24/2026	Materials/alveoli matrix work	2		
	9/24/2026	Final edits on matrices	1		
Eliza Kubicek	9/5/2026	Read through last semester’s final report documentation and took notes on previous work and potential starting points in LabArchives	2	6	16
	9/7/2026	Brainstormed questions for the client meeting	0.5		
	9/7/2026	Conducted research on flow limitation during forced expiration and took notes in LabArchives	2		
	9/9/2026	Conducted research on tube law and physical properties of human airways for future design use and took notes in LabArchives	1.5		
	9/14/2026	Outlined PDS sections	0.5	4	
	9/15/2026	Conducted research for and wrote PDS sections	2.5		
	9/16/2026	Edited PDS based on feedback	0.5		
	9/16/2026	Updated LabArchives with research findings used in writing the PDS	0.5		
	9/21/2026	Conducted research on possible materials to model the bronchi and alveoli	2	6	
	9/22/2026	Met with Caroline and Lakshika to work on the materials design matrix	1.5		
	9/23/2026	Worked on the materials and alveoli design matrices	1.5		

	9/24/2026	Finalized my assigned parts of the materials and alveoli design matrices	1		
Brady Mayer	9/7/2026	Researched background information and brainstormed questions for client meetings. I also further researched information about the trachea and bronchi and updated lab archives after previous issues.	2	4	14
	9/9/2026	I also further researched information about the trachea and bronchi and updated lab archives after previous issues.	2		
	9/15/2026	Worked on PDS and researched info for it.	2	3	
	9/16/2026	Made PDS edits based on team recommendations.	0.5		
	9/17/2026	Worked on progress report and final PDS edits.	0.5		
	9/22/2026	Met with sub-group and discussed design matrices.	1	7	
	9/23/2026	Worked on design matrices, research, drawings and explanations.	4		
	9/24/2026	Completed progress report and design matrices	2		
Jillian Seibert	9/7/2026	Added research entries to LabArchives and contributed to research more background information	1.5	2	15
	9/7/2026	Went through previous teams reports and clients powerpoint	0.5		
	9/11/2026	Researched more on the math and COPD aspect of project	1	5	
	9/13/2026	Researched anything necessary for the PDS	1		
	9/13/2026	Worked on my section of PDS	1.5		
	9/16/2026	Revised the PDS and updated my labarchives to match with my research for the PDS	1.5		

	9/20/2026	Researched previous groups design to figure out problems and solutions	1	8	
	9/20/2026	Came up with three design ideas to come to the group meeting with	1		
	9/22/2026	Researched more for the manufacturing and modeling feasibility	1		
	9/23/26	Wrote sections for the airflow design matrix	2.5		
	9/24/26	Wrote sections and researched for the alveoli design sections	2.5		

PROJECT TIMELINE

[illegible]

Testing														
Deliverables														
Progress Reports	X	X	X											
PDS		X												
Design Matrix			X											
Prelim presentation														
Preliminary Deliverables					7th									
Final Poster														
Final Deliverables														9th
Meetings														
Client		X	X											
Advisor	X	X	X											
Website														
Update	X	X	X											

Materials and expenses:

Item	Description	Manufacturer	Mft Pt#	Vendor	Vendor Cat#	Date	#	Cost Each	Total	Link
Category 1										
									\$0.00	
									\$0.00	
Category 2										
									\$0.00	
									\$0.00	
								TOTAL:	\$0.00	

References

- [1] C. Tantucci, "Expiratory Flow Limitation Definition, Mechanisms, Methods, and Significance," *Pulm Med*, vol. 2013, p. 749860, 2013, doi: 10.1155/2013/749860.
- [2] T. C and G. V, "Flow limitation: an overview," PubMed, Accessed: Sep. 15, 2026. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/10546481/>
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- [4] "Lung Flow Volume Curve - an overview | ScienceDirect Topics." Accessed: Sep. 15, 2026. [Online]. Available: <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/lung-flow-volume-curve>
- [5] "Pulmonary Function Testing - PMC." Accessed: Sep. 15, 2026. [Online]. Available: <https://pmc.ncbi.nlm.nih.gov/articles/PMC7158317/>
- [6] R. L. Dellacà et al., "Detection of expiratory flow limitation in COPD using the forced oscillation technique," Feb. 2004, Accessed: Sep. 15, 2026. [Online]. Available: <https://publications.ersnet.org/content/erj/23/2/232>