

Laryngeal Bioreactor

Mid-semester Presentation

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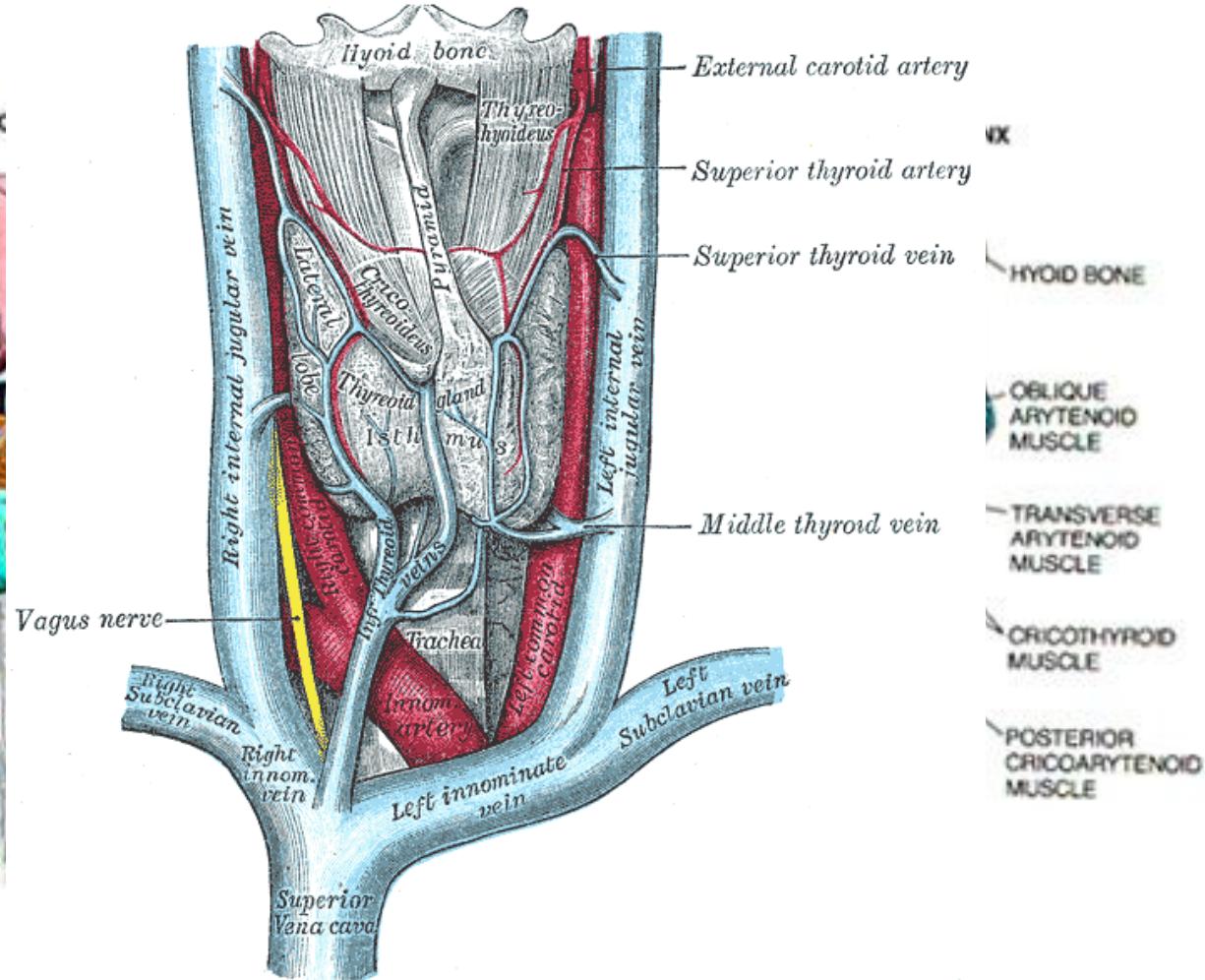
Outline

- Problem motivation
- Background- anatomy of larynx
- Previous work & current devices
- Design Specifications
- Design Alternatives
- Design Matrix
- Final Design
- Future Work

Problem Motivation

- Potential clinical benefits:
- Larynx transplant [1,2]
 - Few (2) have been successful → remove need for immunosuppressants [2]
 - Laryngeal cancer
 - May require laryngectomy
 - Bilateral laryngeal paralysis
- Adapt to tools and resources available

Background- Larynx

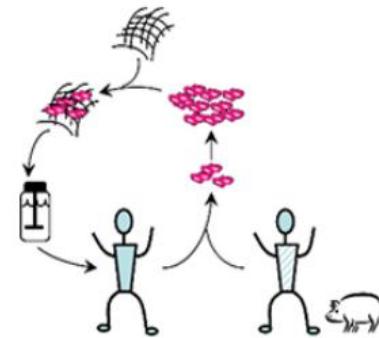


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http://www.edoctoronline.com/media/19/photos_040EAD64-F02E-4068-A04D-1B1C94AFDB10.jpg

Previous Work & Current Devices

- Whole organs grown in bioreactors:
 - Heart, lung [3]
- Implantation of trachea [4]
- Matrix + stem cells + media + bioreactor → organ
- No laryngeal bioreactor commercially available

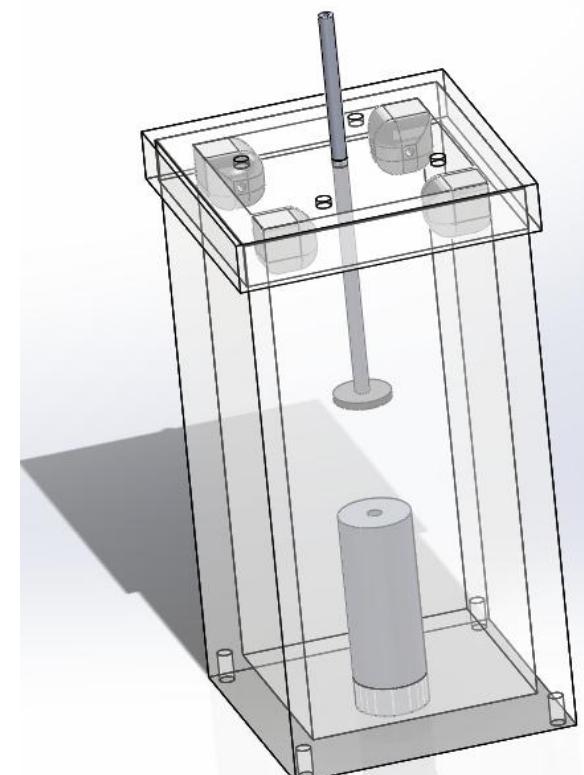


Design Specifications

- Sterilizable or replaceable components
- Continuous function for days at a time
- Operational in incubator environment
- Single unit for decellularization and recellularization
- Physiological pressure values
- Easy access to larynx
- Separate environment for lumen
 - Air exposure

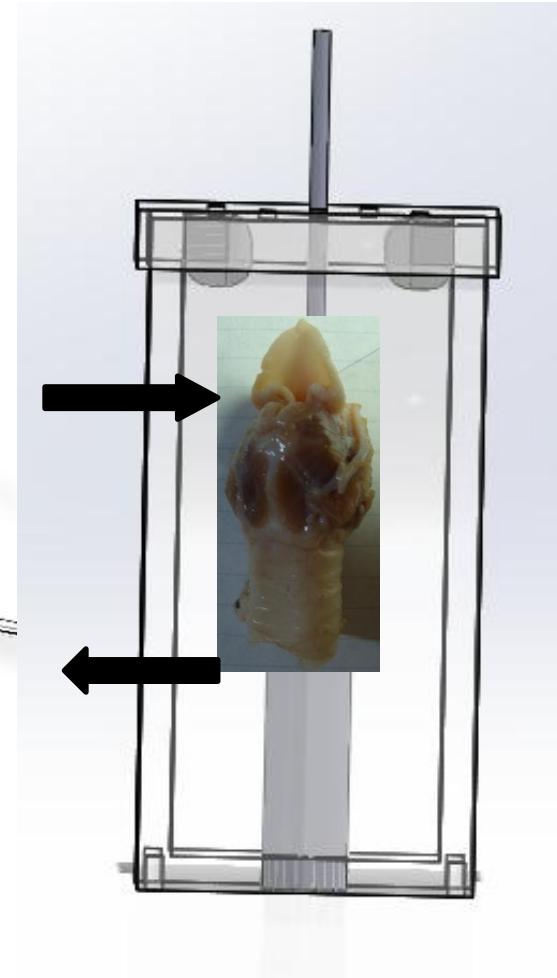
Design Alternative 1

- Removable top, support tube
- Dimensions: 10x10x20 cm
- Inflatable balloon
 - Two separate culture environments



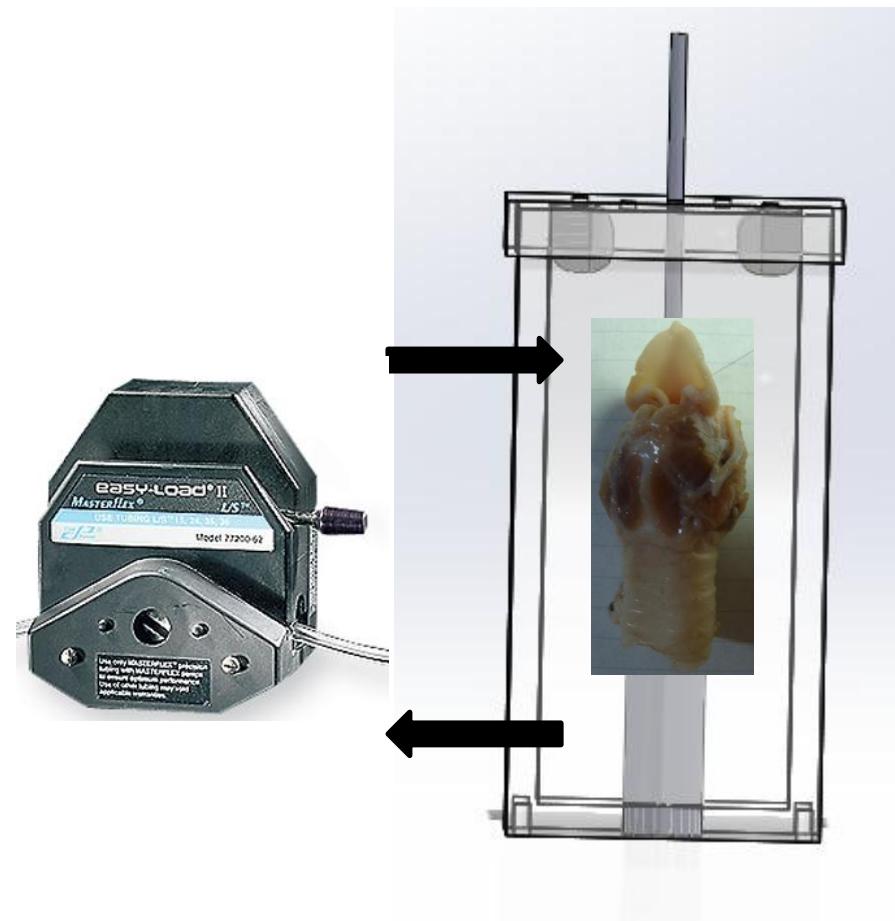
Design Alternative 1- Spray

- 2 Environments:
- Outside
 - Added manually
 - Media is perfused through vasculature system
- Inside
 - Media sprayed through nozzle
 - Air and media



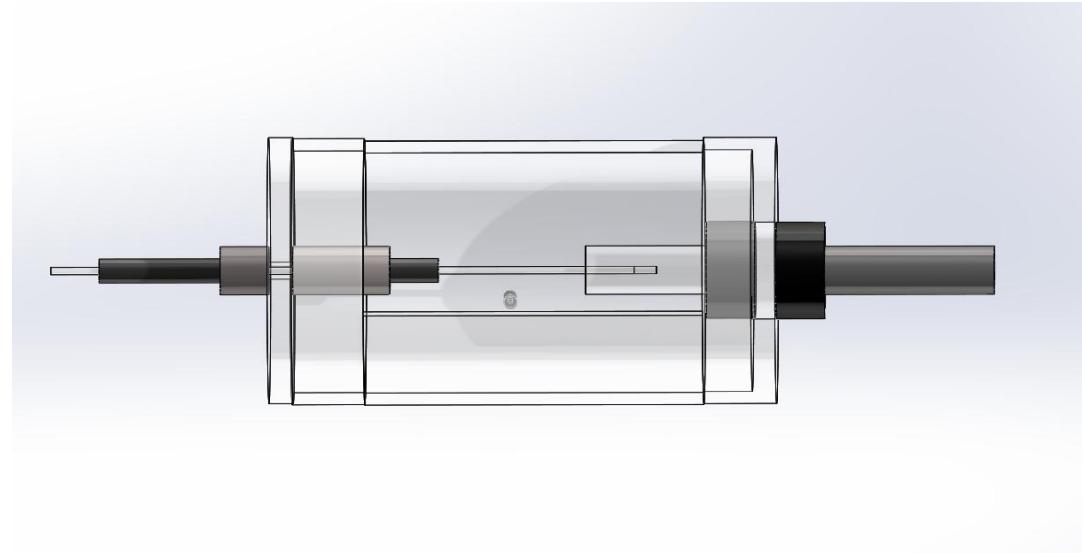
Design Alternative 2- Fill-Refill

- 2 Environments:
- Outside
 - Added manually
 - Media is perfused through vasculature system
- Inside
 - Inner lumen will be full of media or air
 - Automated by a pump



Design Alternative 3- Rotation

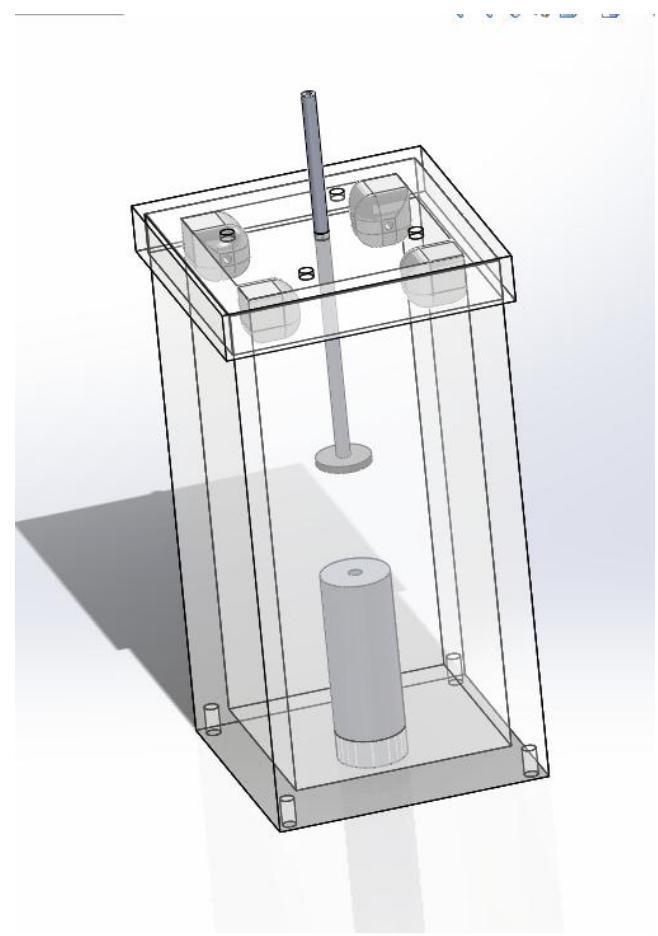
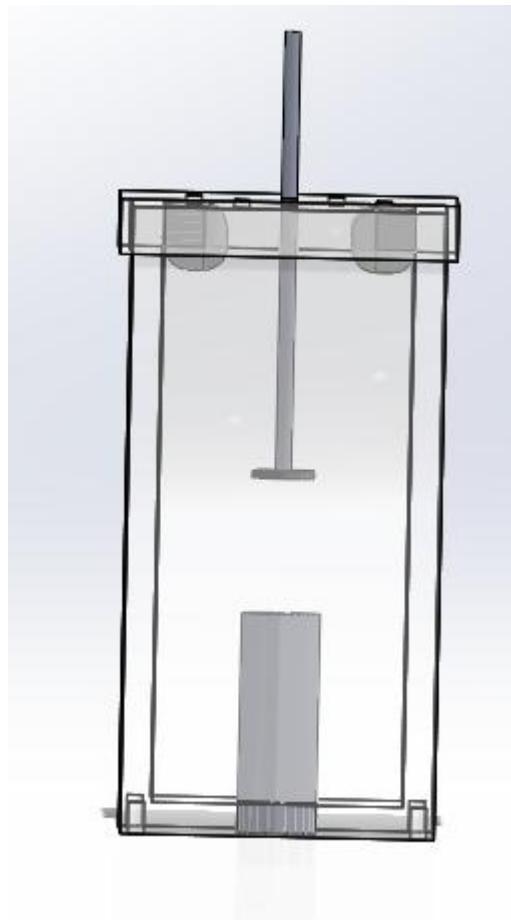
- Rotating
 - Inner lumen half full with media
- Larynx exterior is completely surrounded by media
- Perfusion of media through the vasculature



Design Matrix

	Weight	Design 1- Spray	Design 2- Fill- Refill	Design 3- Rotation
Cost	0.1	9	9	4
Decellularization/ recellularization	0.3	7	7	8
Physiological accuracy	0.2	6	8	7
Adaptability	0.15	9	9	9
Maintenance	0.25	8	8	5
Total	1	0.75	0.80	0.68

Final Design



Future Work

- Test sealing techniques for separation of lumen
- Obtain materials
- Assemble prototype
- Test prototype under expected conditions
- Modify prototype based on results

Acknowledgments

- Dr. Thomas Yen and Dr. Nathan Welham

References

- [1] Duque E, Duque J, Nieves M, Mejía G, López B, Tintinago L. Management of larynx and trachea donors. *Transplant Proc* 2007;39:2076–8.
- [2] Hou N, Cui P, Luo J, Ma R, Zhu L. Tissue-engineered larynx using perfusion-decellularized technique mesenchymal stem cells in a rabbit model. *Act Oto Lar* 2011; 131:645-652.
- [3] Asaghi et al. A double-chamber rotating bioreactor for the development of tissue-engineered hollow organs: From concept to clinical trial. *Biomaterials* (2009); 5260-5269.
- [4] Petersen, T.H., et al., Tissue-engineered lungs for in vivo implantation. *Science*. 329(5991): p. 538-41.
- Images:
 - Laryngeal Vasculature:
http://www.fpnotebook.com/_media/entLarynxAnteriorVesselsGrayBB1174.gif
 - Anatomy of larynx: http://www.edoctoronline.com/media/19/photos_040EAD64-F02E-4068-A04D-1B1C94AFDB10.jpg
 - Tracheal transplant: <http://www.businessinsider.com/lab-grown-organs-2012-8?op=1>
 - Pump image:
http://www.coleparmer.com/Product/Masterflex_L_S_Easy_Load_II_pump_head_for_precision_tubing_fixed_occlusion_CRS_rotor/EW-77200-50

Questions?