Esophageal Simulator

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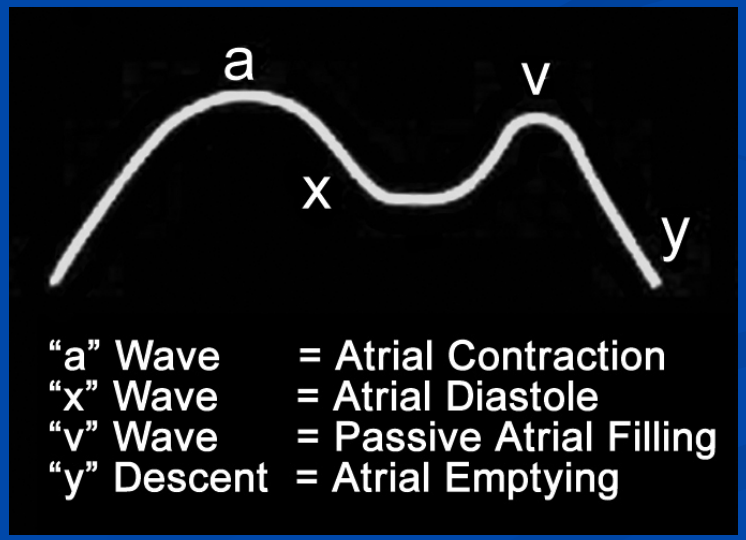
Outline

- Problem Statement
- Current Testing Methods
- Background information
- Principles
- Design Specifications
- Designs
- Future Work

Problem Statement

Our goal is to design an esophageal simulator that minimizes patient interaction while allowing quicker testing and refinement of the Eso-technologies cardiac monitor, designed to replace the Pulmonary Artery Catheter. Our device needs to be able to replicate the dynamic pressure from the heart and lungs as well as the static pressure of the esophagus.



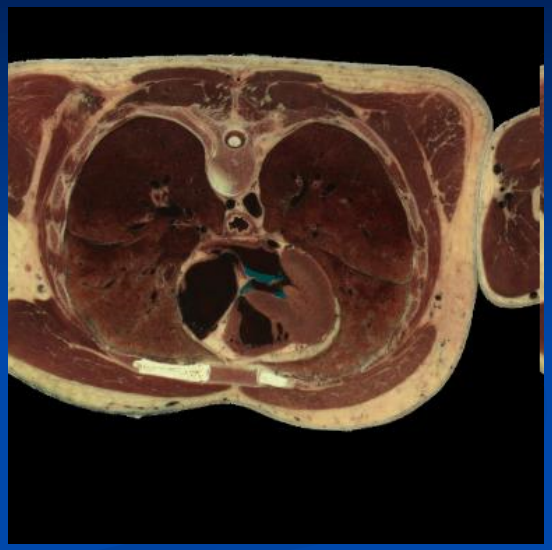
Current Testing Methods

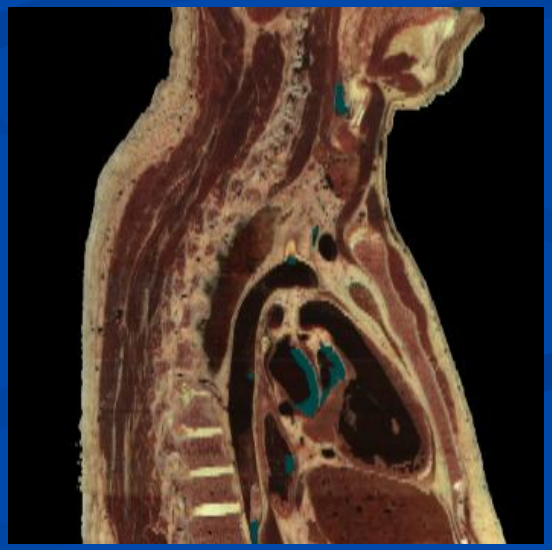
- Eso-technologies' device is still in its refinement phase
  - Testing is done in clinical trials
  - FDA has limited each new probe to 40 clinical trials

- Limiting patient interaction
  - More tests per probe
    - More opportunities for improvement
  - Avoids potential clinical mishaps

Background

- Anatomy
  - In contact with left atrium wall
  - Resides in chest cavity
  - Peristalsis



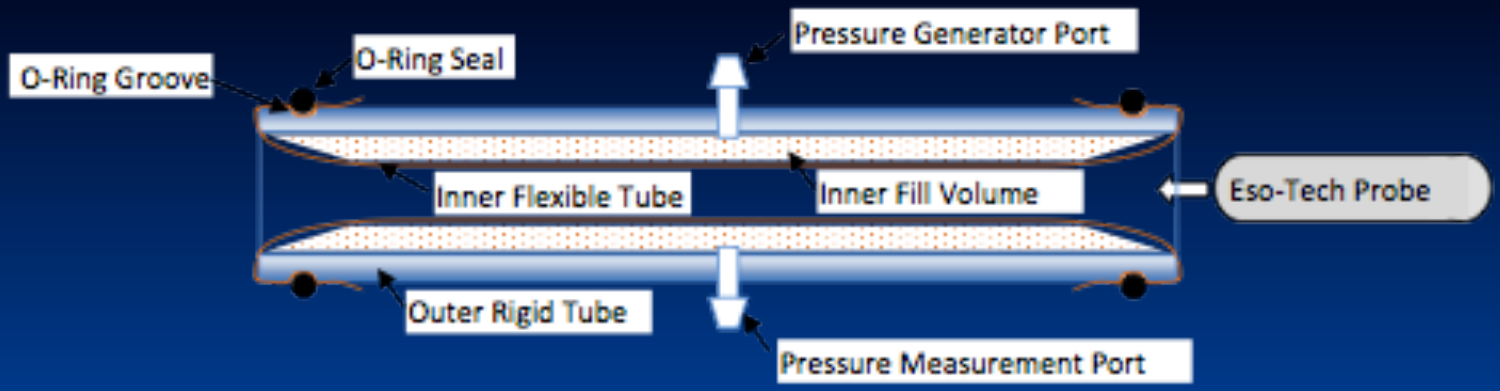


Product Design Specifications

- Eso-technologies new design
- Respiratory Pressure
  - Range: -10 to 30 cm H20 (3-8 cycles per min)
- Esophageal Pressure
  - Static: 0-50 mmHg
  - Dynamic (Peristalsis): 0-100 mmHg (0-20 per min)
- Cardiac
  - 6-22 mmHg at 60-120 per minute

Components

- Pump(s) to vary pressures controlled by computer program
- Pressure sensor to measure output and provide a feedback loop
- Flexible membrane that transmits pressure to the sensor



PRESSURE TUBE DESIGN

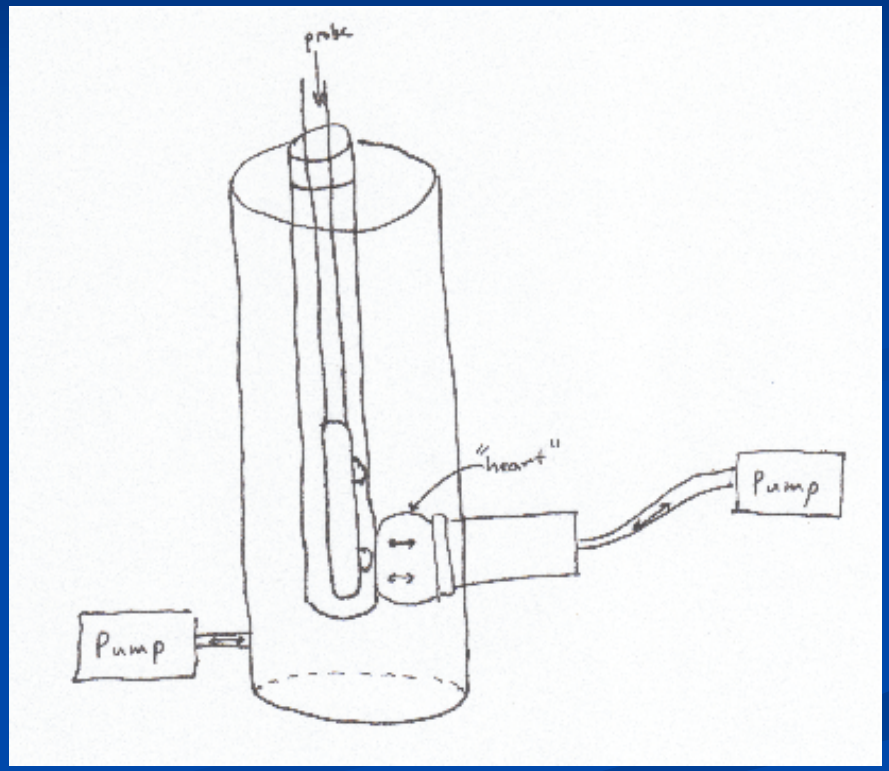
- Ridged outer tubing with flexible inner tubing
- Pressurized between both tubes
- One pump provides 3 simulated pressures
- Measurement of pressure between tubing to test against probe

Pressure Tube Design

- Pros
  - Simple construction/Low cost
  - Direction of probe in device
- Cons
  - Programming of air pump more complicated
  - Not anatomically correct

Thoracic Design

- Each pressure waveform generated separately
- Ridged box acts as chest cavity
- Lung pressure simulated by changing pressure around esophagus tube and heart
- Heart is a fluid filled sac controlled by separate pump

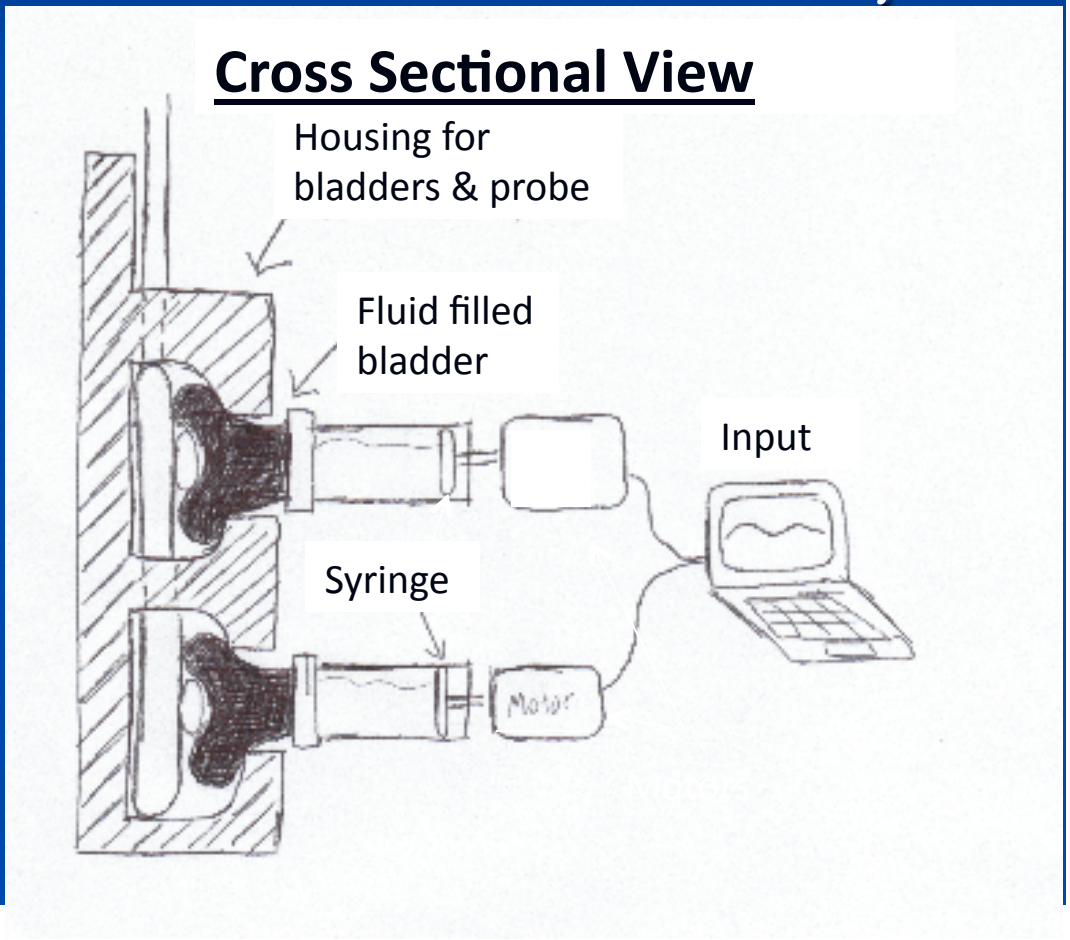


Thoracic design

- Pros
  - Simpler to program the pumps
  - More anatomically accurate
- Cons
  - More difficult to construct/maintain
  - Difficult to reproduce accurate results

Design 3: Double Bladder Apparatus

- Basic Description: Two fluid filled bladders impinge on the probes sensor balloon and reference balloon individually
- Pros
  - Rigid Support Apparatus
  - Fluid filled balloons (resembles heart)
- Cons
  - Synchronization issues
  - Complicated support frame



Design Matrix

	Accuracy (40)	Reproducibility (25)	Cost (5)	Simplicity (Ease of Construction) (20)	Anatomy (10)	Total (100)
Pressure Tube	33	23	5	18	5	84
Thoracic Cavity	27	15	2	10	10	64
Double Balloon Apparatus	33	20	4	13	5	75

Future Work

- Find appropriate pumps and valves
- Decide on correct material to use for esophagus
- Build Apparatus
- Program individual waveforms as an input to the pump (Use LabVIEW)
- Testing

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