Design and Prototype Fabrication of a Neonatal Video Laryngoscope

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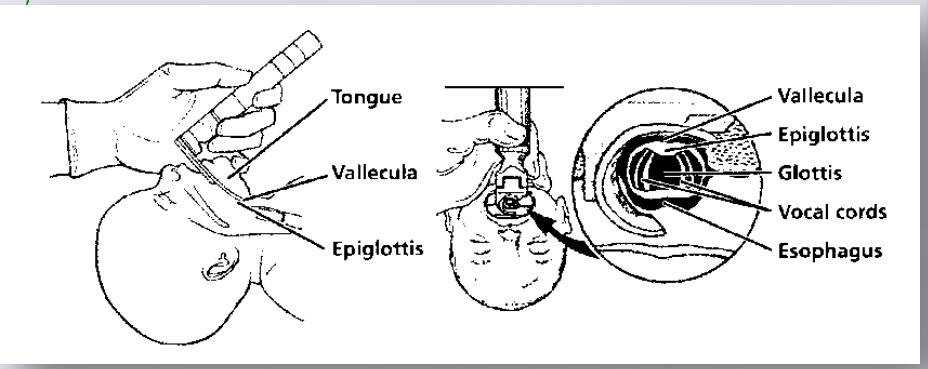
Photo: Kevin Walsh, OLR

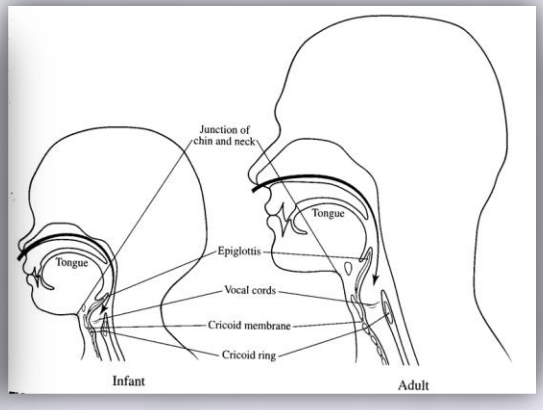
Introduction / Motivation

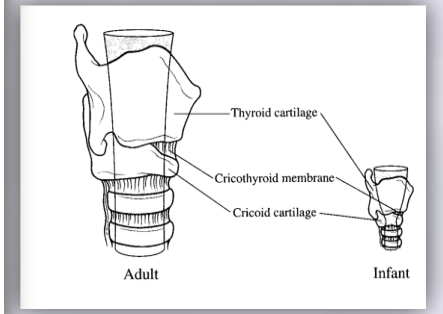
Dr. Neil Finer, Chief of the UCSD Medical Center's Division of Neonatology, and **Wade Rich**, Research Coordinator for the Division of Neonatology, approached the **Photonic Systems Integration Lab** with a collaboration proposal.

- 25,000 extremely low birth weight infants born annually,
- Most require intubation, a difficult / traumatic process for neonates
- Current instruments designed for adults, not infants, esp. not neonates.
- Project goal: Working model of a neonatal video laryngoscope.

Infant Intubation







85 - 90% of extremely low birth weight infants need intubation.

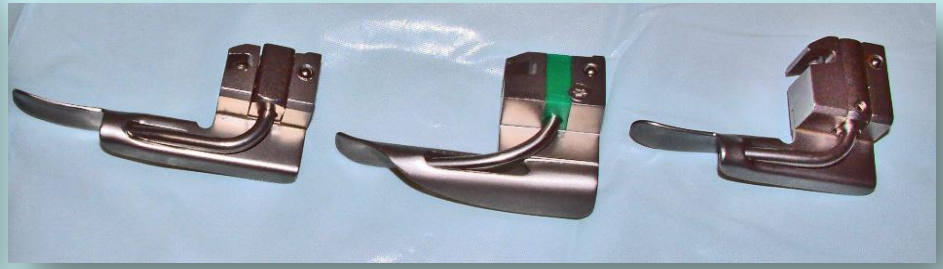
Intubation requires 3 (average) to 10 tries

Multiple attempts lead to serious risks.

Images from Manual of Emergency Airway Management, ed. Murphy and People's Daily Online

Laryngoscopes

Traditional Laryngoscopes



Video Laryngoscopes

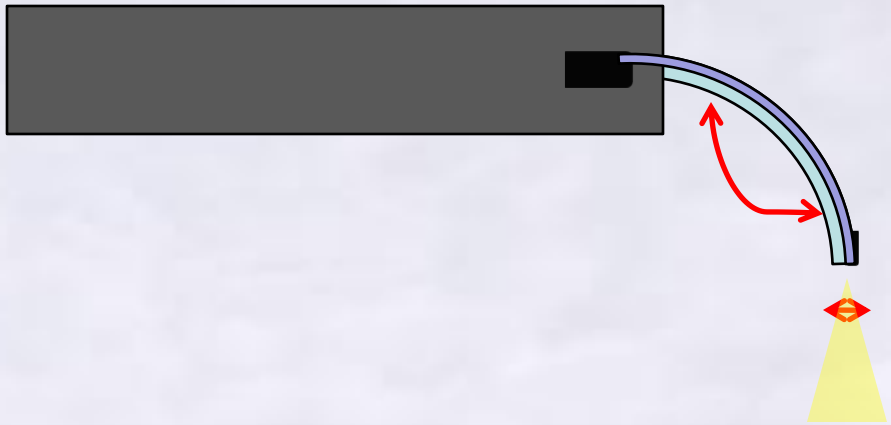
GlideScope: Video Camera

Karl Storz: Coherent Fiber Bundle

Our goal was to create a working model *neonatal* video laryngoscope to evaluate the feasibility of a commercial device.

Images are from Karl Storz website, GlideScope website

Blade and Device Constraints

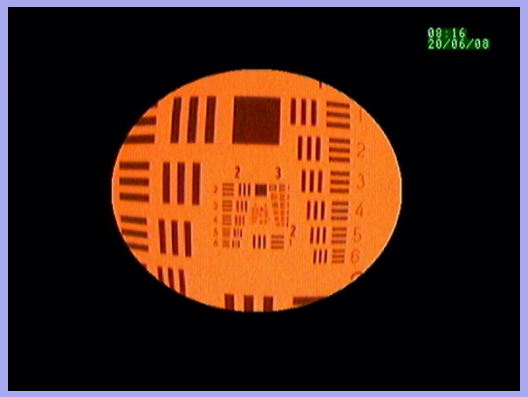


Constraints

- Blade Width
  - 2.5mm by 6.5 mm tip
- Variable Blade Angle
- Image Quality
  - Combination of Imager and Lighting
- Mechanical Properties
  - Strength
  - Heat
  - Texture

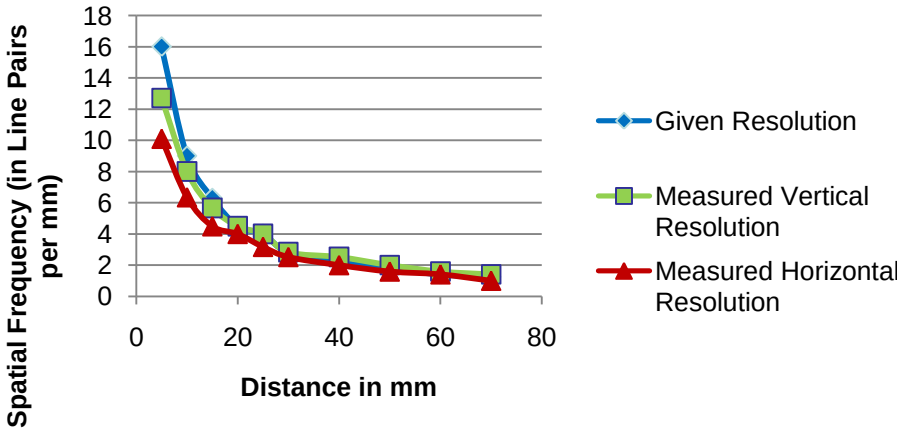
Imager Selection

Effective Focal Length	.712 mm
Field of View	100°
F-number	f/5.99



We identified a promising camera in the Medigus IntroSpicio CCD Video Camera, with a camera head measuring only 1.8 by 1.8 by 12 mm.

Maximum Resolvable Frequency



Modulation Transfer Function

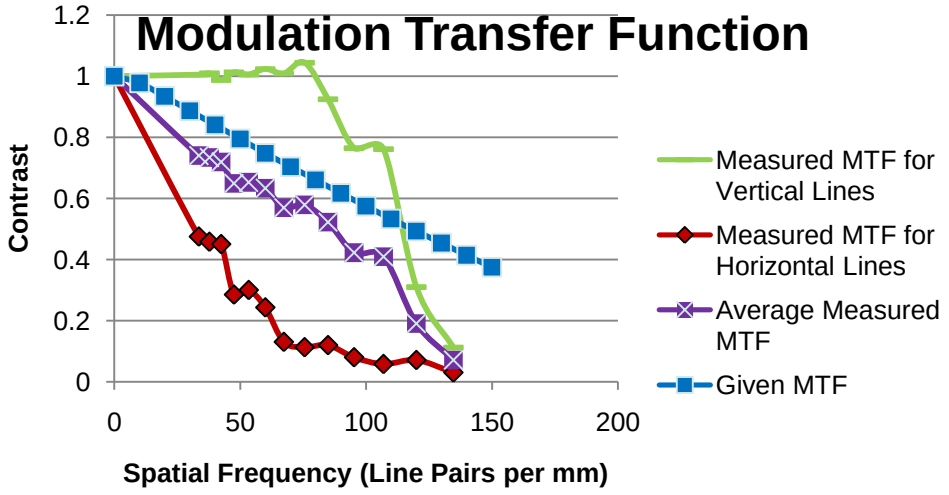
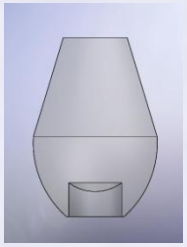


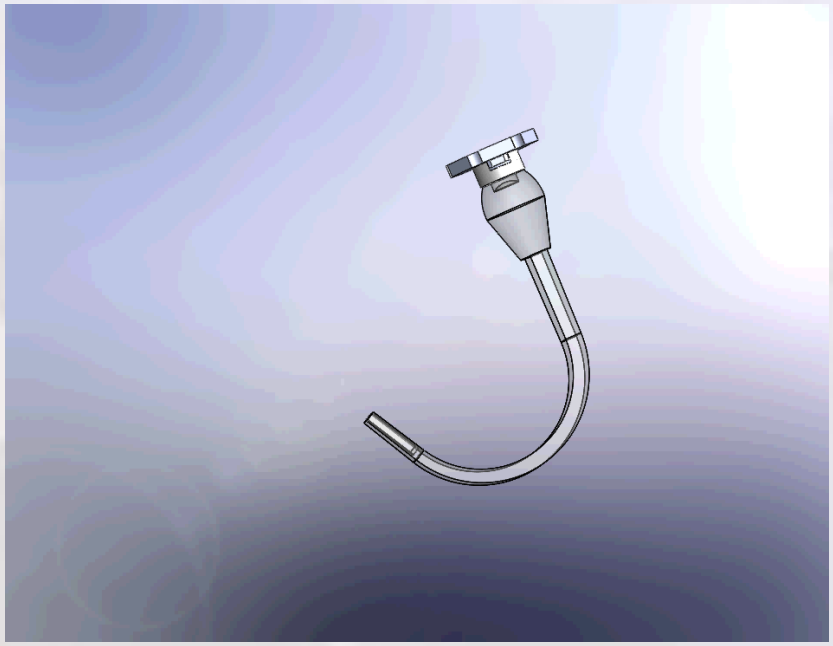
Image from Medigus website

Design Solutions

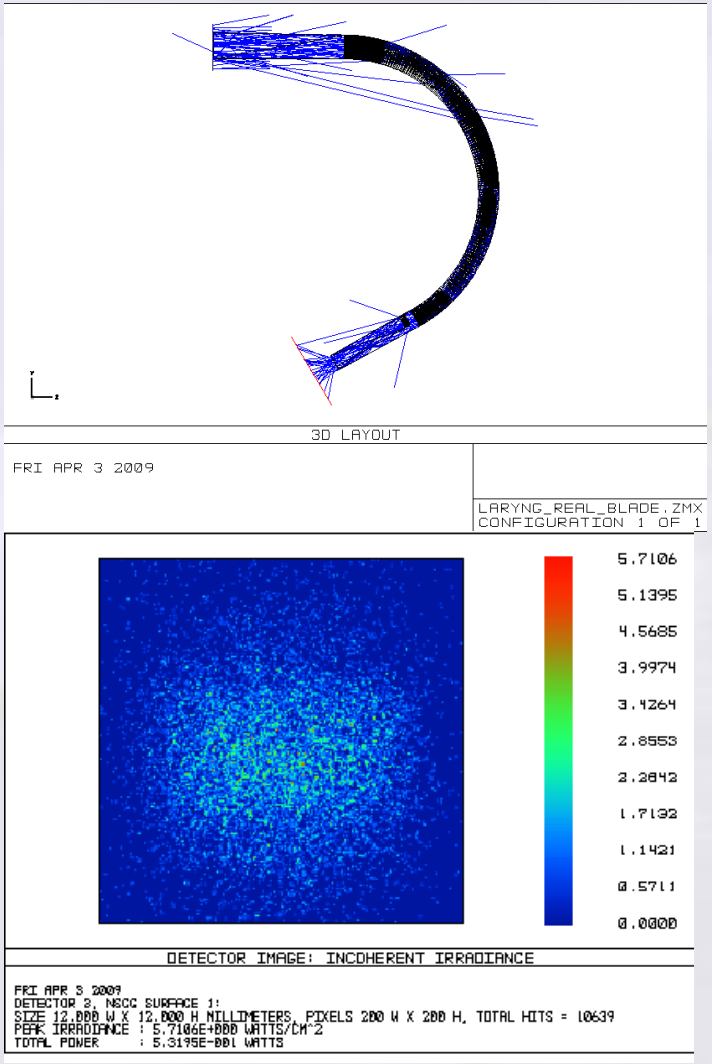
With a necessary optical power of at least 30 to 40 mW, an LED at the tip would dissipate far too much heat.



We make use of a Fraen coupling lens.



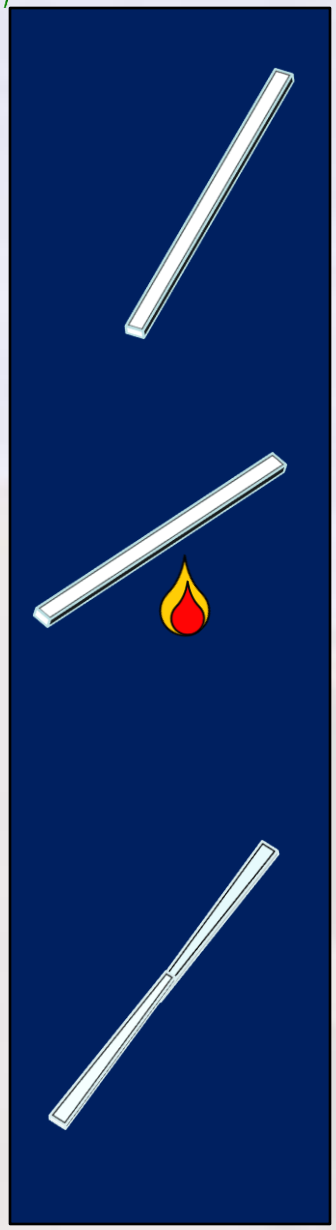
The most elegant solution is a tapered acrylic light pipe acting as the blade.



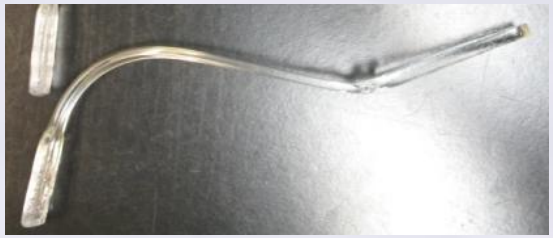
Calculated efficiency is just over 50%.

Image from Fraen website

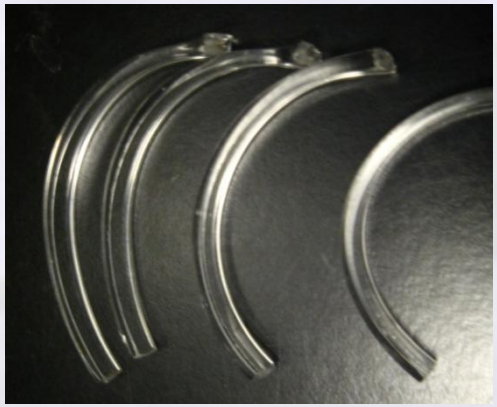
Waveguide Fabrication



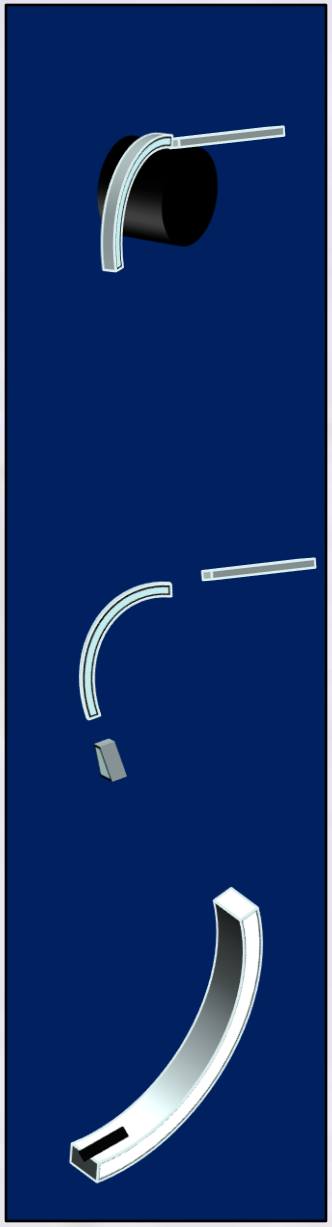
Acrylic blanks are cut at the right aspect ratio.



The edges are sanded, then flame-polished with a hydrogen-oxygen torch.



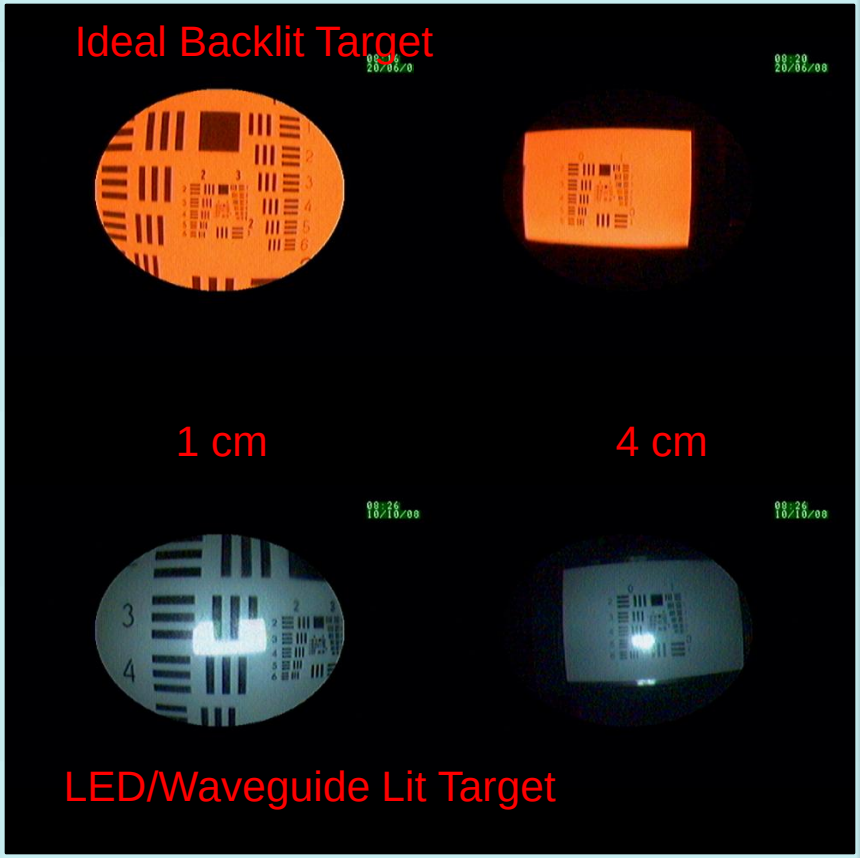
Blanks are heated to pliability, then stretched to form a taper



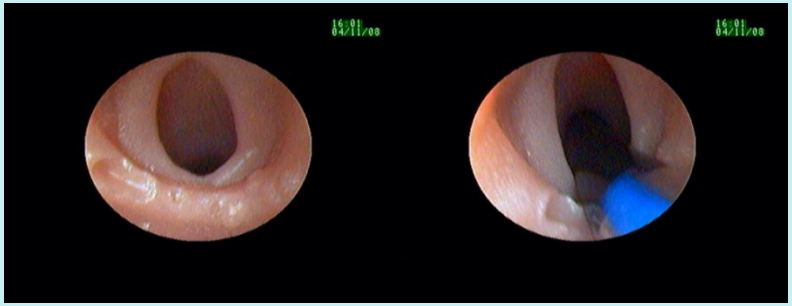
Assembly and Optical Testing of Initial Model

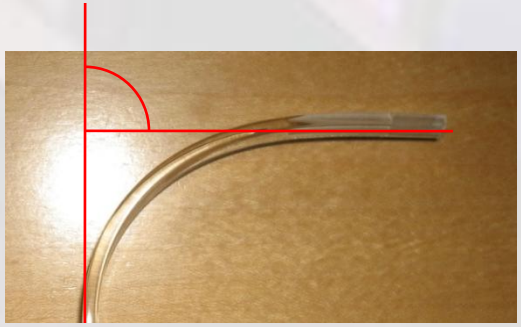
Using an Inova X0 LED flashlight as the handle and light source, we created a working model.

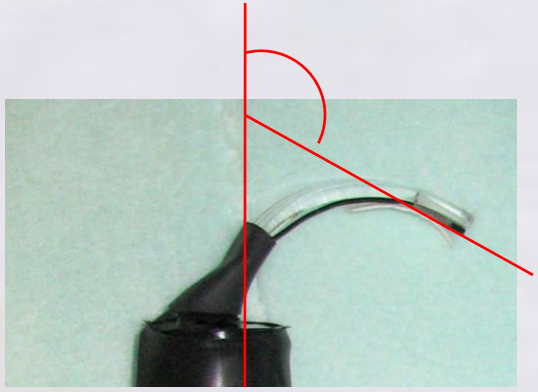
Measured efficiency is 28%, but the LED is bright enough that this is sufficient.

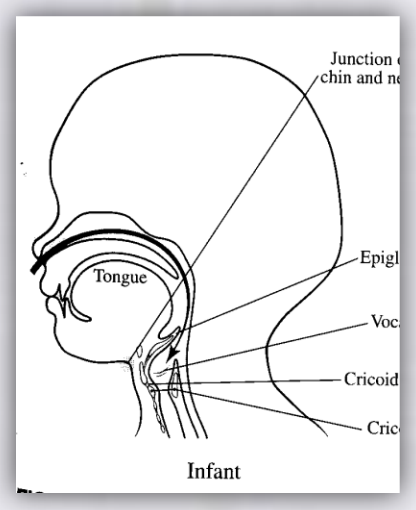


Medical Testing and Feedback

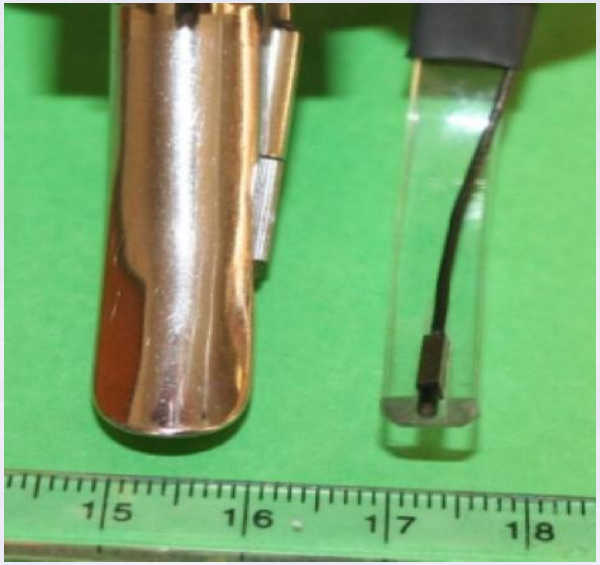




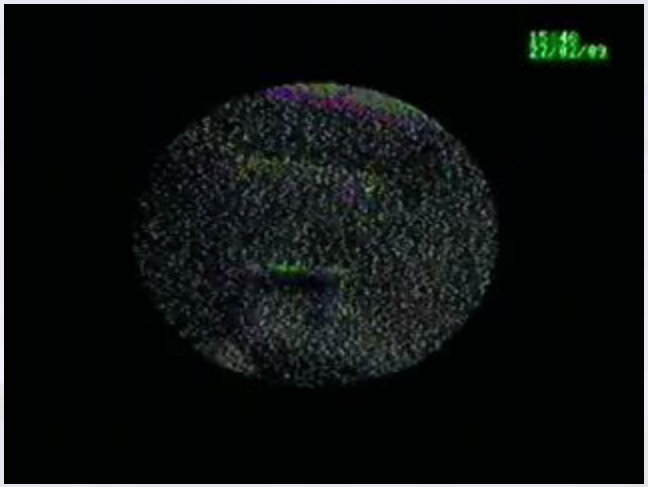




Final Model



Final Model Videos



Conclusions and Future Directions

- Neonate anatomy guided our design.
- We met all the constraints of the project.
- Less expensive wafer cameras could be used to reduce cost.
- We would need a sterilizable device to perform a clinical trial
- Further modifications could be made

Thank you

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