Fetal Radiation Shield

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Client: Dr. Zac Labby

Overview

Motivation

Problem Statement

Previous Work

Timeline

Logistics

Budget

Acknowledgements

Motivation

4000 patients

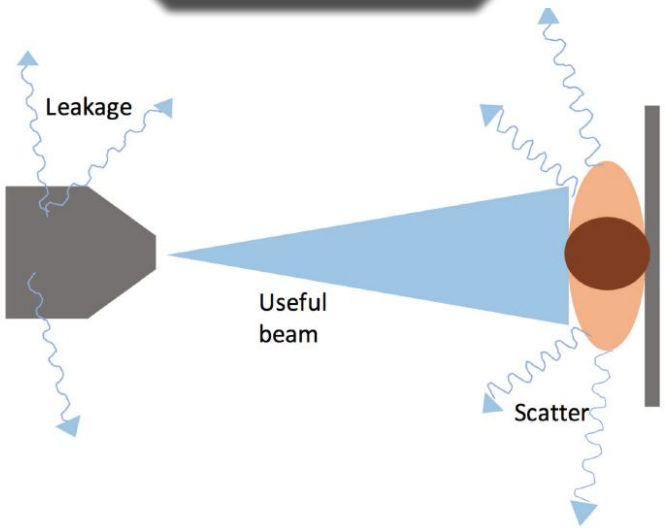
4000 pregnant women undergo radiation therapy in the US every year [2]

Leakage & Scatter

Leakage and scatter are significant sources of radiation risk to fetus [3]

Costly & Unsafe

Current measures are can be costly and usafe for patient



[Figure 1] Diagram of potential sources of radiation while undergoing therapy [1]

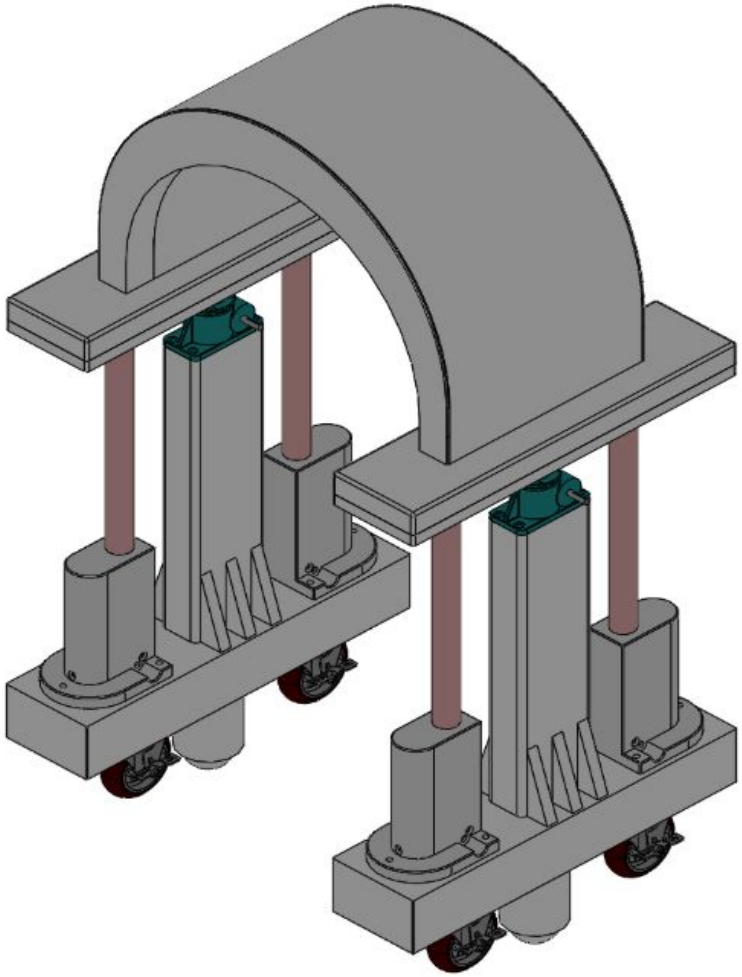
Problem Statement

- Create a physical barrier to protect fetus
  - Material Requirement: Lead
  - Size Requirement: ≥ 5 cm thick

- Other Requirements
  - Mechanically sound
  - Easy to transport and brake
  - Accommodate various body shapes/sizes
  - Reduce fetal radiation dose by at least 50%
  - Cost of fabrication/testing ≤ $10,000

Previous Work

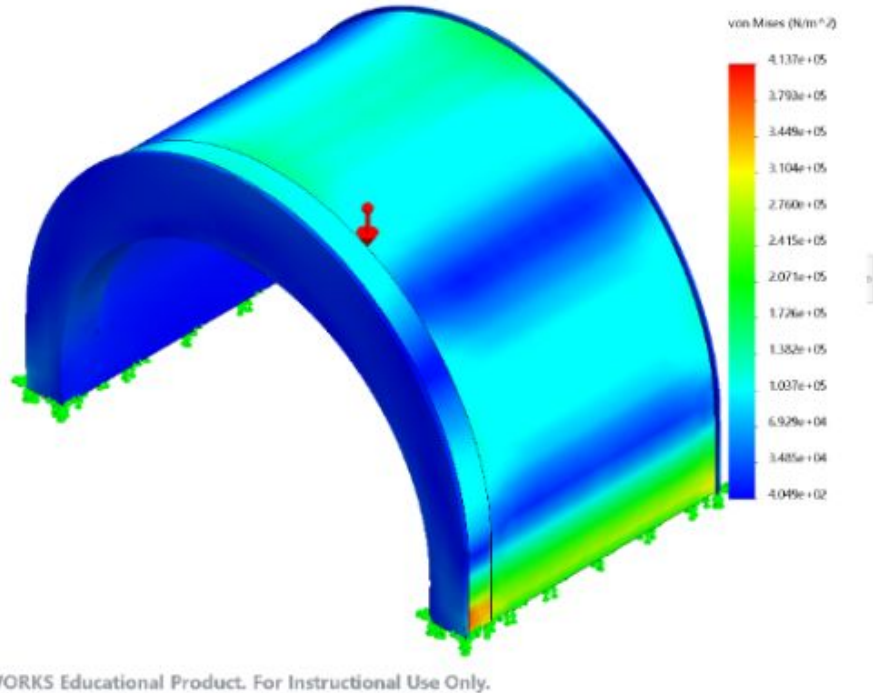
- Lead shield
  - Cylindrical shield shape
  - Steel casing
- Dual lifting mechanism
  - Linear actuators
  - Screw jacks
- Steel frame
- Transportation system
  - Caster wheels with locking brakes
- Solidworks simulations and modeling



[Figure 2] Full assembly of the shield, lifting mechanisms, frame, and transportation system.

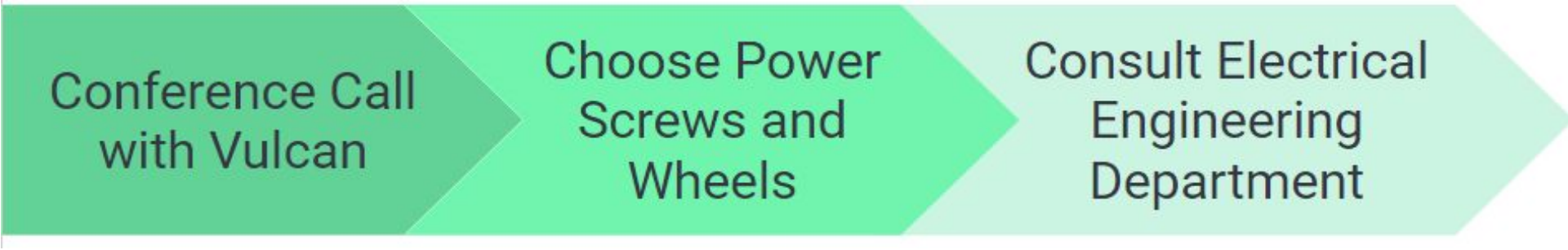
Lessons from Previous Work

- Lead and steel casing are safe when stationary
  - Need to perform dynamic and fatigue testin
- Monte Carlo simulations not feasible
- Reduced cost from previous semesters
  - Still over-budget
- Complicated assembly logistics



[Figure 3] The stress due to gravity of the lipped half-cylinder shield. Gravitational testing was performed in SolidWorks. Green arrows indicate fixed geometry. Red arrow indicates direction of gravity.

February



Goal:

- Discuss manufacturing process
- Discuss areas to reduce cost of shield

Goal:

- Decide on companies
- Reduce costs

Goal:

- Further explore the electrical components

March

Goal:

- Move forward with computer testing

Goal:

- Be able to visualize the field and identify any changes

Goal:

- Confirm it fits in radiation room and storage

Goal:

- Decide the best way to lower and raise the shield
- Start creating a plan to manufacture it

April

Goal:

- Use this to complete SolidWork Simulation

Goal:

- Discuss final design, timeline, and manufacturing process

Goal:

- Both dynamic and fatigue simulations
- Analyze the safety of device

Goal:

- Present final results in both a poster and journal

Logistics

- 12-week lead time on fabrication of lead shield
  - Lead casting and fabrication
  - Radiograph to check for inconsistencies
  - Painting shield “medical white”
  - Multiple locations
- Assembling of support system
  - Potentially contract this out to Vulcan
  - Installation of electrical components will possibly be contracted
- Delivery of shield assembly
  - Vulcan would deliver assembly to UW-Hospital
  - Our responsibility to off-load and transport to storage

Budget

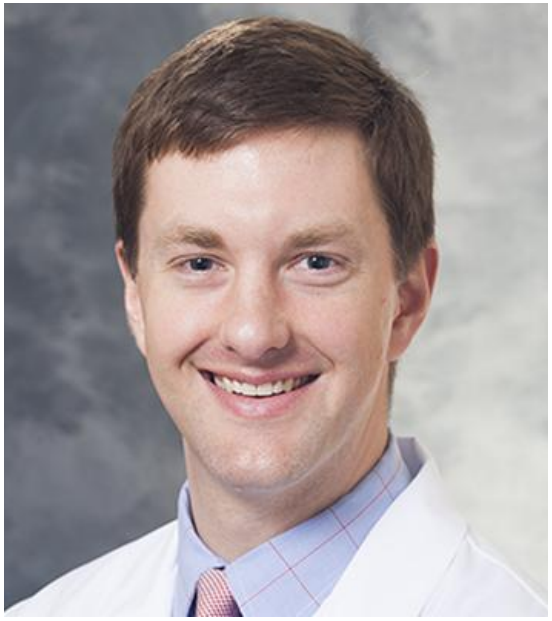
- Total Budget: $10,000
- Must cover shield, support/transportation system, electrical components, shipping and handling, and any consulting work

Current cost estimate:

Part	Quantity	Manufacturer	Cost Estimate
Caster wheels	6	Caster HQ	6 x $43.99 = $263.94
Power Jackscrews	2	Joyce	2 x $1750.00 = $3500.00
Linear actuators	4	Progressive Automations	4 x $315.95 = $1263.80
Shield	1	Vulcan Global Manufacturing Solutions	1 x $7328.98 = $7328.98
Contracting	n/a	n/a	$2,000
Total			**$14,356.72**

Acknowledgements

Dr. Beth Meyerand, *Advisor*



Dr. Zachariah Labby, *Client*

References

[1] "Radiation Protection For The X-Ray Technologist", 2017. [Online].

[2] M. Stovell and C. Robert Blackwell, "501 Fetal dose from radiotherapy photon beams: Physical basis, techniques to estimate radiation dose outside of the treatment field, biological effects and professional considerations", International Journal of Radiation Oncology*Biology*Physics, vol. 39, no. 2, p. 132, 1997.

[3] D. D. Martin; Review of Radiation Therapy in the Pregnant Cancer Patient; Clinical Obstetrics and Gynecology, Review vol. 54, no. 4, pp. 591-601, Dec 2011.

Questions?