Fetal Radiation Shield

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Overview

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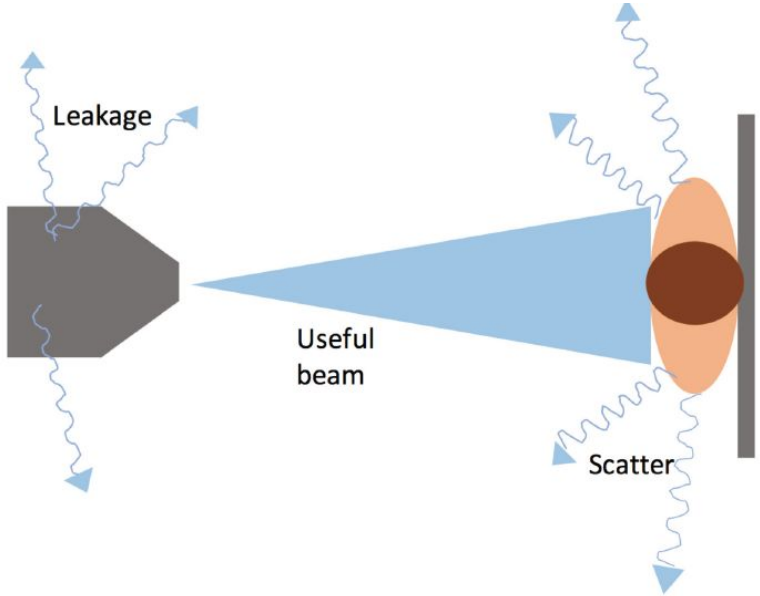
Cancer Treatment: Radiation Therapy

- Radiation therapy attacks cancer cells via external radiation beams
  - 4000 pregnant women per year need this treatment [2]
- Ionizing radiation is harmful to developing fetus
  - Sources: leakage and scatter [3]
- Current methods to protect from exposure are costly/unsafe



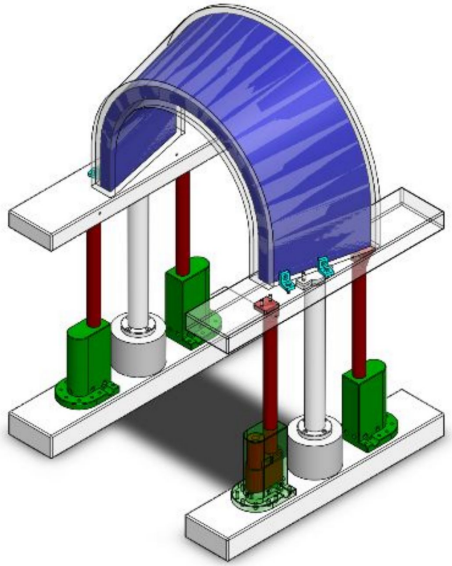
[Figure 1] Diagram of potential sources of radiation while undergoing therapy [1]

Problem Statement

- Create a physical barrier to protect fetus
  - Requires lead shield
  - ≥ 5 cm thick
- Requirements
  - Safe
  - Effective: Reduce fetal radiation dose by at least 50%
  - Mobile
  - Accommodate various body shapes/sizes
  - Cost of fabrication/testing ≤ $10,000

Previous Work

- Lead Shield
  - “High-Waisted Skirt”
  - Steel casing
- Lifting/Support
  - Dual electric lifting mechanisms
  - Effective and sturdy
- Current Focus: Transportation



[Figure 2] CAD Model of shield. Patient bed is situated under lead shield (blue) with six supports on either side.

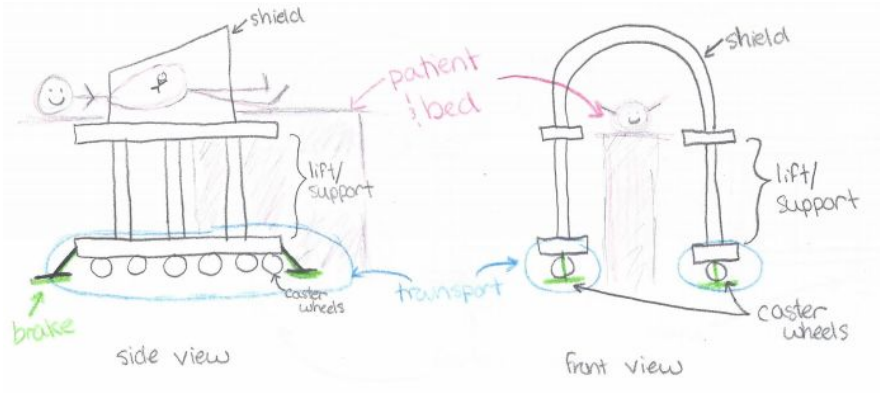
Product Design Specifications

- Shield must prevent 50% radiation from reaching fetus
- Transportation system
  - Must be movable between rooms
  - Braking system must be easily applied/removed during treatment
  - High safety factor and fatigue limit
    - Support roughly 3x the weight (5000-6000 lbs)
  - Avoid force plate

[Figure 3] Typical treatment rooms at UW Hospital

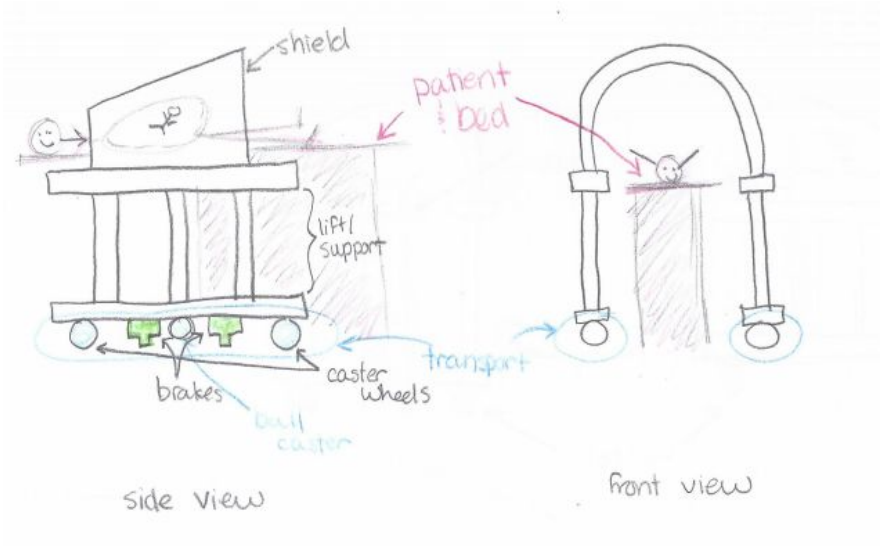
Proposed Design: Rollerblade

- Pros
  - Multiple wheels
    - Weight is more distributed
  - Simplified braking system → no pinching
  - Easy integration with current design
- Cons
  - More parts that could fail
  - No simultaneous braking of all parts
  - Complicated placement over bed



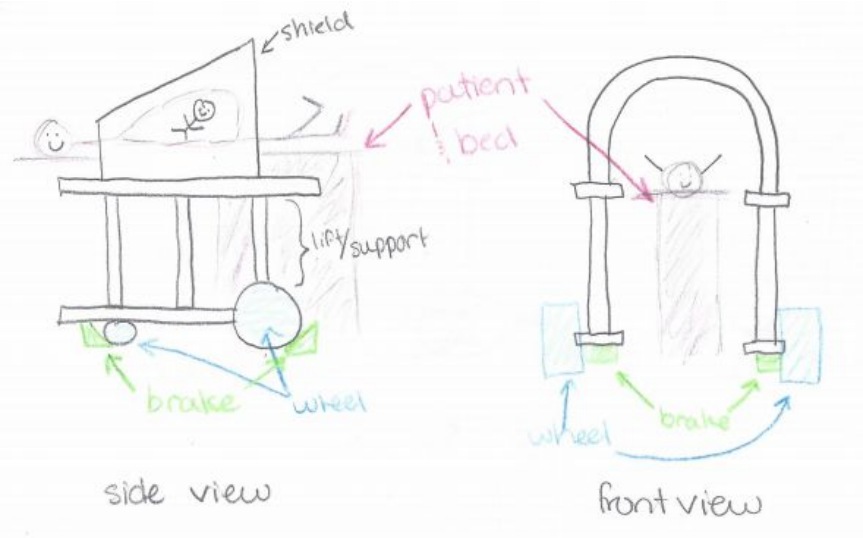
Proposed Design: Semi

- Pros
  - Fewer parts
  - Easy steering
  - Brake via foot controls → no pinching
- Cons
  - Higher load per wheel
  - Complicated braking system
  - Complicated placement over bed



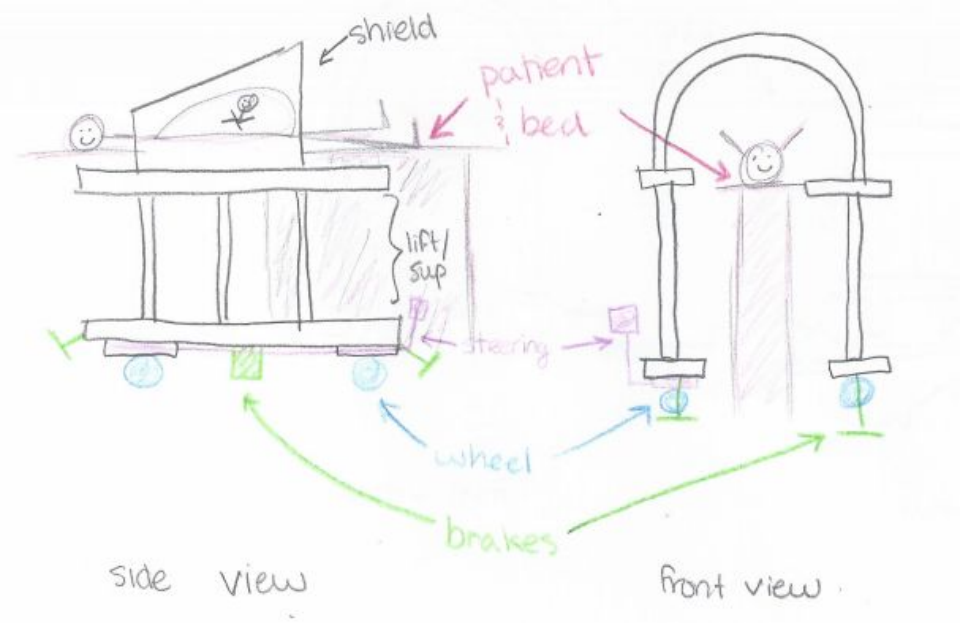
Proposed Design: Trolley

- Pros
  - Fewer parts
  - Braking system uses wedges ➜ simple to remove
- Cons
  - Higher load per wheel
  - Braking system poses pinch risk
  - Difficult turning ➜ back wheels can’t rotate



Proposed Design: Control Enthusiast

- Pros
  - More control over steering
  - Easy braking → safe and intuitive
- Cons
  - Higher load per wheel
  - Steering mechanism is expensive
  - Complex design



Design Criteria

- Safety
- Intuitive Design
- Durability
- Maneuverability
- Feasibility
- Cost

Design Matrix

Design Criteria	Designs			
	"The Trolley"	*"The Semi"*	*"The Rollerblade"*	*"The Control Enthusiast"*
Safety (30)	12 (2/5)	18 (3/5)	21 (3.5/5)	18 (3/5)
Intuitive Design (25)	10 (2/5)	15 (3/5)	15 (3/5)	15 (3/5)
Durability (20)	4 (1/5)	18 (4.5/5)	8 (2/5)	14 (3.5/5)
Maneuverability (10)	2 (1/5)	8 (4/5)	6 (3/5)	10 (5/5)
Feasibility (10)	4 (2/5)	8 (4/5)	8 (4/5)	6 (3/5)
Cost (5)	3 (3/5)	4 (4/5)	3 (3/5)	3 (3/5)
Total	35	71	61	66

Table 1. Evaluation of the four designs quickly ruled out the feasibility of "The Trolley" and revealed that "The Semi" best meets our design criteria.

Future Works

- Improve current shield design
- Mechanical testing of final prototype
- Third party review of design
- Manufacturing
- Clinical testing

[Figure 4] Picture of radiation device in use

Potential Pitfalls

- Budget constraints
- Force plate limitations
- Full movement of current radiation device
- Testing device

[Figure 5] Picture of radiation device with force plate

[Figure 6] Picture of radiation device 90 from patient head

Acknowledgements

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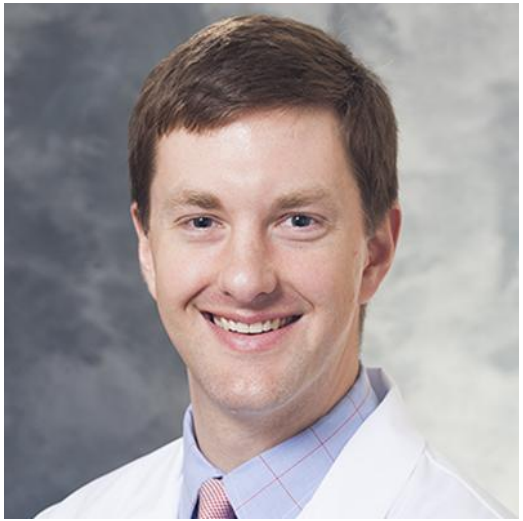

Dr. Zachariah Labby, *Client*

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?