



Hand Positioning Plate for Low-Dose Radiation Therapy (SteadyHand)

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Client: Dr. James Sohn

Advisor: Dr. Shawn Gomez



Overview

1. Problem Statement and Client Description
2. Treatment and Competing Design
3. Product Design Specification
4. Design Choices and Design Matrix
5. Chosen Design
6. Material Choices
7. Future Work

Problem Statement

- 1 in 7 American adults have osteoarthritis [1]
- Low Dose Radiation Therapy (LDRT) is becoming a popular way to treat inflammatory joint diseases [2]
- LDRT treats hand arthritis over 6 consecutive sessions with the hand in the same position each time
- Current positioning systems are overly complex, cause patient discomfort, and require long setup times

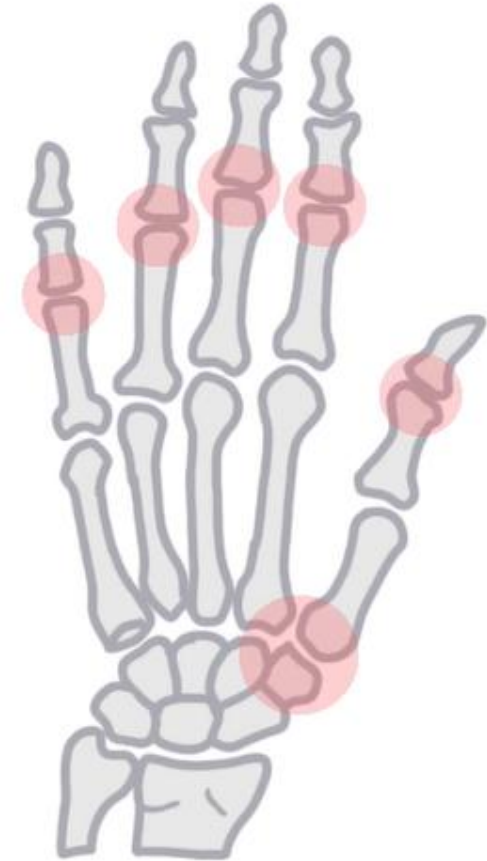


Figure 1: Osteoarthritis in the Hand [1].



Objective

Design a hand positioning device that ensures precise, reproducible treatment setup while reducing setup time and maximizing patient comfort.

Client Description

Dr. James Sohn, PhD

- UW Department of Radiation Medicine
- Assistant Professor

Research Interests

- Boron neutron capture therapy (BNCT)
- Benign diseases, including osteoarthritis



Figure 2: Dr. James Sohn

Low Dose Radiation Therapy

- CT scan taken first to make a treatment plan
- Treatment consists of 6 short sessions over 2 to 3 weeks
- 0.5 Gy each, 3 Gy total
- Standard linear accelerator, two opposed photon beams, hand lying flat
- The hand must sit in the same position at every session so the same joints are in the field



Figure 3: Current Treatment Setup

Competing Design - Dexalign Hand Positioner

Pros

- Precise and reproducible
- Base material
- Fits up to 95th percentile hand sizes

Cons

- Forces digits 2-5 together
- Overly complex indexing
- Setup looks uncomfortable
- Palm forced flat against the base



Figure 4: Dexalign Hand Positioner, CQ Medical [3]



Product Design Specifications

Physical and Operational:

- One therapist can set up the device within 2 minutes
- Ensures exact, reproducible hand placement within 2 – 3mm tolerance across CT scan and 6 treatments
- Easy attachment to the treatment couch
- Simple indexing

Product Design Specifications

Ergonomics:

- Designed to maximize patient comfort throughout procedure
- Accommodates 5th percentile female through 95th percentile male hands
- Relaxed hand posture and extra finger spacing to accommodate enlarged joints

Percentile	Greiner (USA)					
	Palm length (L1)		Hand length (HL)		Ratio scaling $E_{HL,L1}$	
	F	M	F	M	F	M
2,5th	90	99	162	175	0.56	0.57
5th	92	101	165	179	0.56	0.56
25th	97	107	174	187	0.56	0.57
50th	101	110	180	194	0.56	0.57
75th	105	114	187	200	0.56	0.57
95th	111	121	198	211	0.56	0.57
97,5th	112	122	200	214	0.56	0.57

Figure 5: Anthropometric Hand Data [4]



Product Design Specifications

Production:

- Fabrication costs should not exceed \$200; designed for straightforward clinical replication
- Compliant with CDC low-level disinfection guidelines [5]



Design Matrix Criteria

- Accuracy (25%)
- Setup Time (20%)
- Radiation Dose Consistency (20%)
- Patient Comfort (15%)
- Ease of Fabrication (10%)
- Simplicity (10%)

Battleship Design

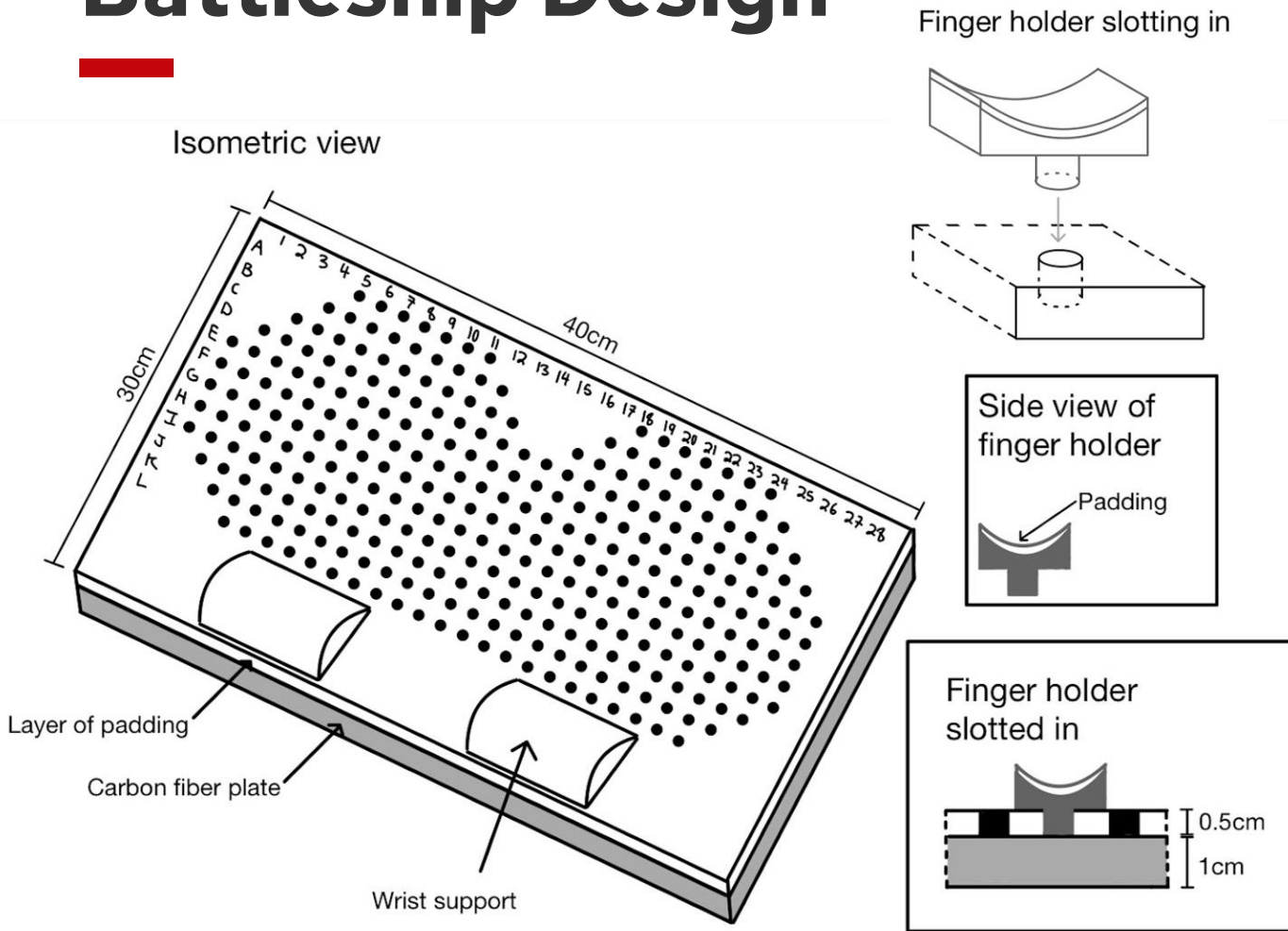


Figure 6: Battleship Hand Positioner

Criteria	Battleship	
Accuracy (25%)	5/5	25
Setup Time (20%)	3/5	12
Radiation dose consistency (20%)	4/5	12
Patient Comfort (15%)	4/5	12
Ease of Fabrication (10%)	2/5	4
Simplicity (10%)	4/5	8
Total Score	73	

Table 1: Battleship design matrix rankings

Guidelines Design

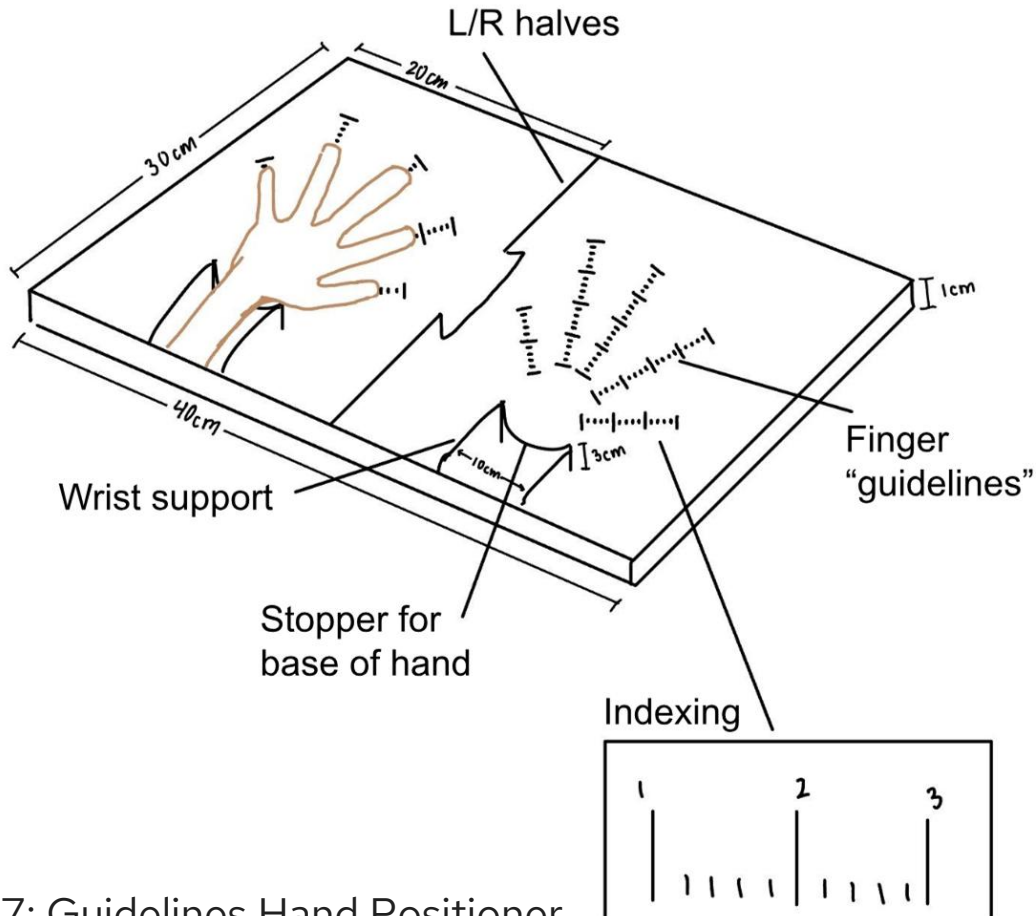


Figure 7: Guidelines Hand Positioner

Criteria	Guidelines	
Accuracy (25%)	2/5	10
Setup Time (20%)	5/5	20
Radiation dose consistency (20%)	5/5	20
Patient Comfort (15%)	4/5	12
Ease of Fabrication (10%)	4/5	8
Simplicity (10%)	5/5	10
Total Score	80	

Table 2: Guidelines design matrix rankings

Sliders Design

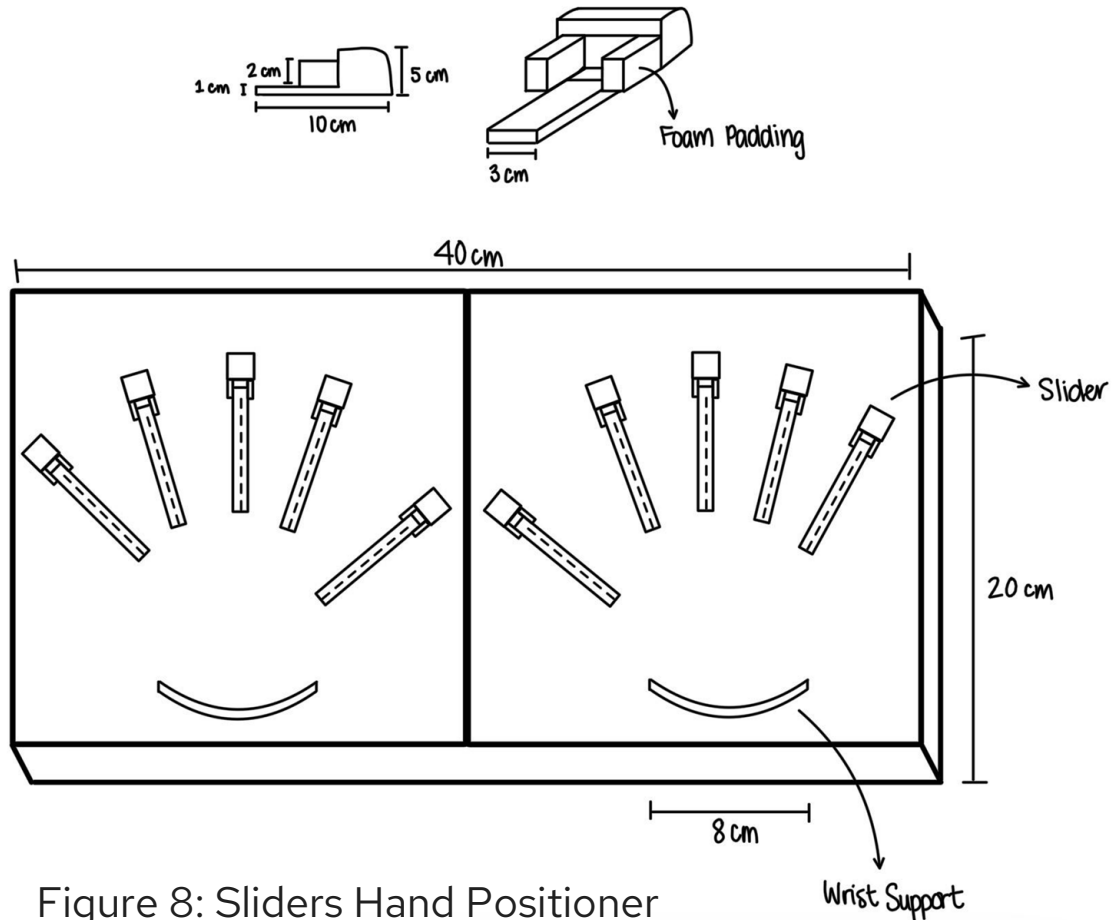


Figure 8: Sliders Hand Positioner

Criteria	Sliders	
Accuracy (25%)	5/5	25
Setup Time (20%)	4/5	16
Radiation dose consistency (20%)	4/5	16
Patient Comfort (15%)	3/5	9
Ease of Fabrication (10%)	3/5	6
Simplicity (10%)	3/5	6
Total Score	78	

Table 3: Sliders design matrix rankings



Design Matrix

Criteria	Battleship		Guidelines		Sliders	
Accuracy (25%)	5/5	25	2/5	10	5/5	25
Setup Time (20%)	3/5	12	5/5	20	4/5	16
Radiation dose consistency (20%)	4/5	12	5/5	20	4/5	16
Patient Comfort (15%)	4/5	12	4/5	12	3/5	9
Ease of Fabrication (10%)	2/5	4	4/5	8	3/5	6
Simplicity (10%)	4/5	8	5/5	10	3/5	6
Total Score	73		80		78	

Chosen Design

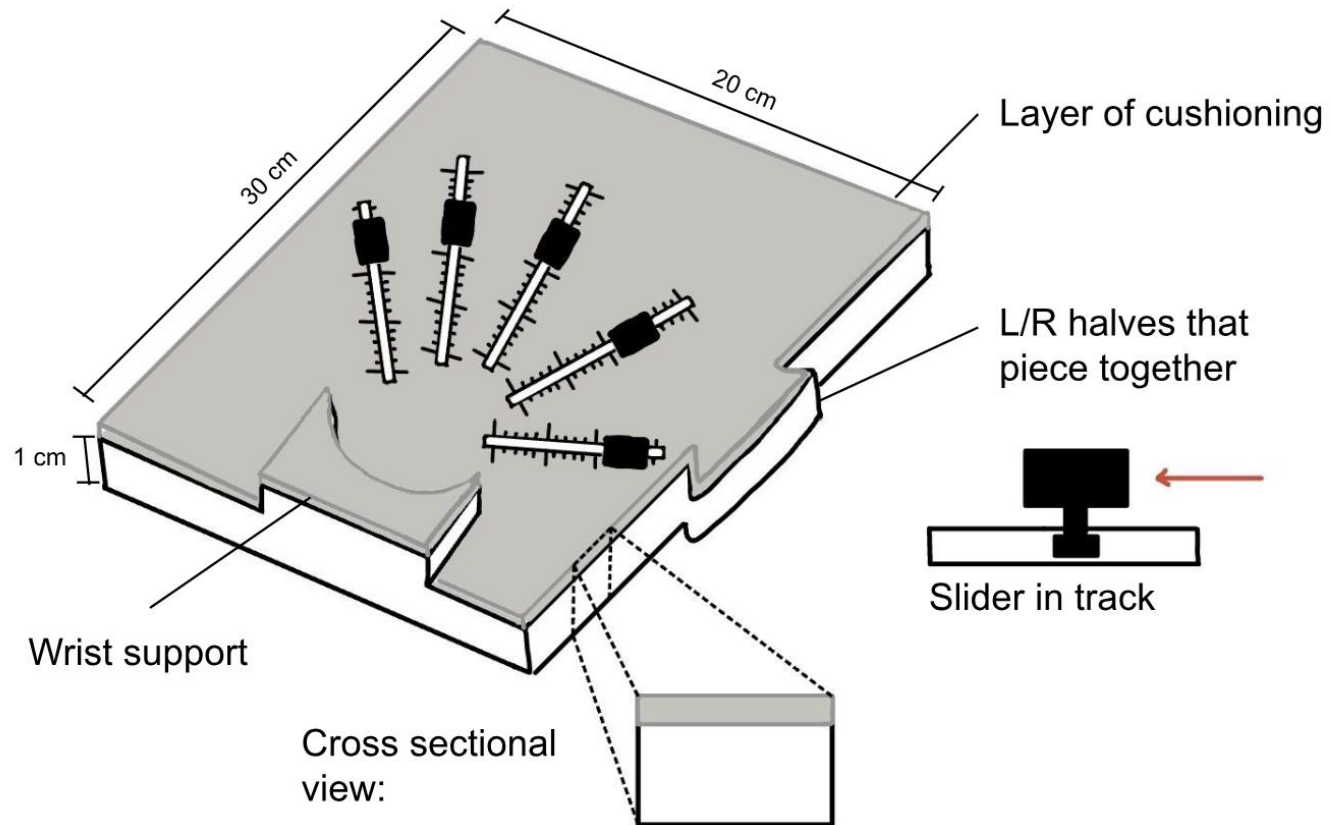


Figure 9: Preliminary Design

- Slider track for accuracy
- Indexing on each slider track
- Support added through foam
- Wrist support

Material Options

- 3D print moving parts and accessories will be PETG and/or ABS
- Design will have a carbon-fiber plate as the base
 - Testing and prototypes will use ABS/PLA as base
- Cushioning provided by polyurethane foam:
 - Line the wrist support
 - Line the inside of the sliders for finger supports

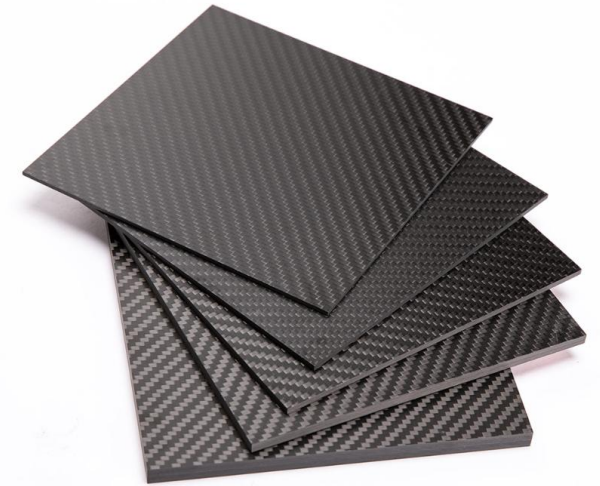


Figure 10: Carbon Fiber Plate, Element 6 Composite [6]



Future Work

10/09	Shadow our client and figure out how the LDRT process works	Design and build a rough prototype to give us an idea about dimension and overall functionality. Finish narrowing down our exact design choices and dimensions.
10/21	Model the chosen design in CAD and order desired materials	Use Onshape to make a 3D modeled design with the exact dimensions we will use when fabricating the product. Ordering the carbon fiber plate and polyurethane foam.
11/07	Test the prototype in the clinic and make improvements	Test the prototype in the clinical environment and work around any problems encountered in the iterative design process.
11/26	Fabricate final design, final presentations	Create the final design with the desired materials based on testing results. Prepare for the final presentation.



Acknowledgments

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References

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[3]"Dexalign Hand Positioner | CQ Medical," Cqmedical.com, 2026. <https://cqmedical.com/Products/radiotherapy/Functional--Low-Dose-RT/Dexalign-Hand-Positioner.htm> [Accessed Oct. 01, 2026].

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[5] Centers for Disease Control and Prevention, "Summary of recommendations: Disinfection and sterilization in healthcare facilities," CDC, 2024. [Online]. Available: <https://www.cdc.gov/infection-control/hcp/disinfection-sterilization/summary-recommendations.html>. [Accessed Sep. 17, 2026].

[6] Element 6. "Carbon Fiber Engineering and Design Services." Element6.com. <https://www.element6.com>. [Accessed Oct. 1, 2026].



Questions
