

SteadyHand Progress Report #3

Date: 9/24/2026

Client: Dr. James Sohn

Advisor: Dr. Shawn Gomez

Team:

Anna Wood

Tess Brazee

Mara Van Dyke

Sam Anderson

Ben Pytlik

Miti Patel

Problem statement

Severe joint pain in the hands due to arthritis and other inflammatory conditions is now frequently treated using low-dose radiation therapy (LDRT). Current LDRT protocols require high setup reproducibility across 6 treatment sessions. Existing positioning systems are overly complex, use complicated indexing systems, and compress digits 2-5 together. This causes significant discomfort for patients and creates unnecessarily long setup times.

This project aims to develop a hand positioning device to be used in a clinical setting that minimizes setup time and patient discomfort while ensuring exact hand placement for each treatment session.

Brief status update

This week, the full team brainstormed different aspects of the design, and each team member sketched a potential design concept. From these concepts, three designs were selected for further consideration, incorporating useful aspects from some of the designs that were not selected. The team also completed two design matrices: one comparing the three selected designs and another comparing three potential materials. Both matrices will be included with this progress report. The team met its goals for this stage of the project and remains on schedule with the project timeline.

Difficulties / advice requests

None

Current design

The Dexalign Hand Positioner is pictured below. We will be trying to create a simpler solution for faster setup times.



<https://cqmedical.com/Products/radiotherapy/Functional--Low-Dose-RT/Dexalign-Hand-Positioner.htm>

Goals

Major team goals for the next week

1. Work on preliminary design presentation
2. Finalize the design matrix and pick a prototype design
3. Begin working on preliminary report

Next week's individual goals

- Anna Wood
 - Begin planning a schedule for prototyping and delegating parts for team members to focus on
 - Compile all of our information thus far to create and present our preliminary research and designs
 - Help to refine and finalize the winning preliminary design
- Mara Van Dyke
 - Improve preliminary design based on client and advisor feedback
 - Complete preliminary design presentation and start working on preliminary report
 - Update PDS based on notes from client and additional research
 - Look into acquiring winning material from matrix
- Tess Brazee
 - Continue research on positioning devices and radiation therapy
 - Continue working on improving designs using feedback from Dr. Sohn and Dr. Gomez
 - Compile information and prepare for preliminary presentations.
- Sam Anderson
 - Research more about PETG and how the team might be able to attach it to the device without affecting the radiation beam
 - Start working on the preliminary design presentation
 - Continue to work on the design matrix
- Ben Pytlik

- Continue materials research
- Work on preliminary design presentation
- Refine design matrix, finalizing the design of the prototype
- Present preliminary design to the client
- Miti Patel
 - Determine the best design from the design matrix
 - Work on refining final preliminary design
 - Work on preliminary presentation
 - Update PDS and Progress reports as needed
 - Conduct more research as needed

Timeline

Task	Aug.	Sept.					Oct.				Nov.					Dec.
	30	6	13	20	27	4	11	18	25	1	8	16	22	29	6	
Project R&D																
Empathize	X	X	X													
Background...																
Prototyping																
Testings																
Deliverables																
Progress Reports			X	X												
Prelim presentation																
Final Poster																
Meetings																
Client		X														
Advisor	X		X	X												
Website																
Update	X	X	X													

Filled boxes = projected timeline

X = task was worked on or completed

Detailed accomplishments

Previous week's goals and accomplishments

- Anna Wood
 - Created detailed sketches of one preliminary design
 - Worked with teammates to create our design matrix and weight three preliminary designs
 - Conducted research on PLA and effects of LDRT to inform design matrix decisions
- Mara Van Dyke

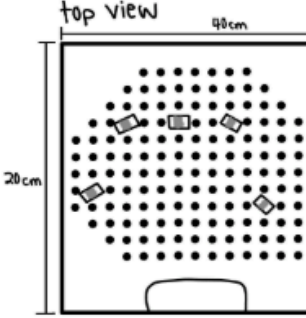
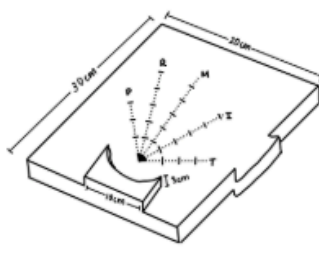
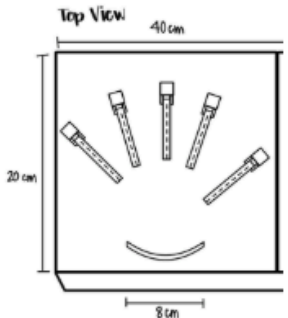
- Brainstormed design ideas and created a finalized sketch for one of the matrix designs
- Created overall design matrix with teammates and worked on explanation and justification sections for two categories
- Researched properties of PETG to determine viability of its use in the device
- Tess Brazee
 - Completed sketched design
 - Collaborated with teammates to complete design matrices of material and design
 - Conducted research on Polyurethane foam and options for effective sanitation of foam
 - Brainstormed with teammates on aspects of potential designs
- Sam Anderson
 - Completed assigned parts of the PDS
 - Conducted research on PLA and low density foam and how they interact with the radiation beam
 - Sketched a potential design for the prototype
 - Collaborated with teammates to find an optimal material for the accessories of the device
- Ben Pytlik
 - Finished assigned sections of the PDS
 - Completed research on osteoarthritis as well as standards for 3D printing and how it is affected by radiation therapy
 - Researched low-dose radiation therapy to better understand the procedure
- Miti Patel
 - Researched competitors and worked on PDS.
 - Sketched and refined preliminary designs.
 - Attended BSAC meeting and contributed to discussion around the curriculum.

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Anna Wood	9/24/26	Researched PLA as a material option, sketched a preliminary design, met with teammates to discuss designs and weight the design matrix, and completed assigned matrix parts.	5	5	9.5
Mara Van Dyke	9/24/26	Sketched design ideas and discussed them with teammates, created a finalized design sketch, worked on design matrix sections, researched PETG	4.5	4.5	9.5
Tess Brazee	9/24/26	Researched polyurethane (PU) foam, possible films and coatings for sanitation of PU foam, researched sanitation practices for PLA and PETG materials, brainstormed ideas for the design of the positioning device	4.5	4.5	9.5
Sam Anderson	9/24/26	Researched materials (PLA and low-density foam) for the design matrix, worked with teammates to decide on a material for the prototype, brainstormed	4.5	4.5	8.5

		an idea for the product's design.			
Ben Pytlik	9/24/26	Did materials research for materials design matrix, filled out PETG section of design matrix and collaborated to finalize the prototype's material, created a prototype design	4	4	8
Miti Patel	9/24/26	Brainstormed ideas for preliminary designs, created and refined ideas for the design matrix, and completed the design matrix. Researched materials and how they interact with LDRT. Attended BSAC meeting.	5	5	9

Design Matrix:

Design	Battleship Design		Guidelines Design		Slider Design	
						
Criteria (Weight)	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score
Accuracy (25%)	5/5	25	2/5	10	5/5	25
Setup Time (20%)	3/5	12	5/5	20	4/5	16
Radiation dosage consistency (20%)	3/5	12	5/5	20	4/5	16
Patient Comfort (15%)	4/5	12	5/5	15	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 (100%)	73		83		78	

Matrix Category Explanations

Accuracy

The most important characteristic of the hand-positioning device is that it replicates the exact initial hand position and orientation from the CT scan within $\pm 2-3$ mm for each subsequent treatment round [1]. This is crucial for maintaining consistent dosage and treatment area across sessions and minimizing normal tissue exposure [1]. Since this category is so important for the success of the design, it was weighted the highest at 25%. The Battleship Design was rated 5/5 because the pegs enable the finger rests to be placed in the same spot and orientation each session, and combined with the wrist support, this will accurately recreate the position of the hand across each treatment round. The Slider Design was also rated 5/5 because the sliding finger holds on

the track will keep each finger in the same line across treatment rounds, while the indexing on the tracks enables the finger placement to be consistent across rounds. The wrist rest also holds the patient's palm in place. The Guidelines Design received the lowest rating at 2/5. The indexed lines on the plate and the wrist support allow for the patient's fingers to be placed in the same line, but the lack of finger holds makes it more difficult for the hand to be maintained in that position.

Setup time

Patients' hands will likely be stiff and painful, so quick and easy placement is crucial to improve the existing positioning design—ideally about two minutes for one therapist. One component is simpler indexing, which would allow for accurate placement without unnecessary complexity that would slow down the process. Due to the importance of this category for positive patient experience and ease of use, it was weighted second-highest at 20%. The Guidelines Design was rated highest at 5/5 because the hand is placed against the wrist support and lined up with the indexed finger guidelines, not requiring adjustment of individual finger supports. The Slider Design was rated second-highest at 4/5 because although it does require adjustment of the sliding finger holders, the process is relatively quick because the sliders move along only one axis and are set to the same index each treatment round. The Battleship Design was rated 3/5 because the 5 finger holders for each hand must be slotted in individually, making the process more time-consuming than for the other devices. However, this process could be done ahead of time, lowering the actual setup time with the patient, which is why this design is not rated lower.

Radiation dosage consistency

To maintain treatment accuracy, the positioning device must be spatially uniform so that the radiation dosage is consistent across the treatment field. This is important for the treatment to actually work, so this category was weighted at 20%. The guidelines design received a 5/5 because it features a smooth surface, ensuring consistent attenuation across the field. The slider design has mostly uniform material distribution, but the slider tracks could create minor variations in dosage, so this design was rated 4/5. The battleship design received the lowest score, 3/5, because the pegboard creates significant discontinuities across the plate, which could lead to unpredictable attenuation.

Patient comfort

Patient comfort was assigned a 15% weight because, while secondary to clinical accuracy and dose delivery, maintaining patient comfort through a relaxed hand posture will improve the overall patient experience. The guidelines design got a 5/5 in this category because it allows the patient's hand to rest in a natural position without awkward finger positioning, and features wrist support. The battleship design also has a wrist support component and can accommodate many different hand positions with movable pegs for custom placement, so it received a 4/5. The slider design requires the fingers to fit into specific tracks, which could force unnatural finger splay depending on patient hand size, which is why it scored lowest with a 3/5.

Ease of fabrication

Ease of fabrication was defined to determine if the preliminary design was reasonable to make with the given time constraints. The criterion was assigned a 10% weight as it did not significantly alter the design plan, but was an important consideration to make when determining which design was the forerunner. Designs with simple, straightforward designs were determined to be the goal for the project, and the designs were scored accordingly. The Battleship design was given a score of 2/5 as it is the most difficult to fabricate due to its many

holes. The design is labor-intensive and increases the likelihood of errors. The Slider design is easier to fabricate and was given a score of 3/5; the foam is harder to cut and refine for commercial use. The Guidelines design has the most time-efficient and straightforward fabrication process. The design was given a 4/5 as the steps are linear and reliable. The design requires minimal work outside the fabrication of the surface for the hand to be set on.

Simplicity

Simplicity was assigned a 10% weight as it remained a guiding principle for the project. The simplicity was measured as an overall measure of complexity, as well as how straightforward the design was. The Guidelines design provided the simplest solution to the hand positioning device, providing an accurate setting for patients to leave their hands on during low-dose radiation therapy. The design was determined to be a 5/5 on the scale provided. The Battleship design provides a simple design overall, while the indents from the peg holders complicate some aspects of the overall design. It was given a 4/5 due to aspects that appeared overcomplicated. The Slider design is the most complex and was given a score of 3/5, as it has specific designs that extrude out of the flat surface, increasing its intricacy.

Materials Matrix:

Materials	Polylactic Acid (PLA)		Polyethylene Terephthalate Glycol (PETG)		Pure Polyurethane (PU) Foam	
	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score
Attenuation (25%)	4/5	20	4/5	20	5/5	25
Durability (20%)	3/5	12	5/5	20	4/5	16
Comfort (20%)	3/5	12	4/5	16	5/5	20
Biocompatibility (15%)	5/5	15	5/5	15	5/5	15
Cost (10%)	4/5	8	3/5	6	4/5	8
Sanitation (10%)	3/5	6	5/5	10	1/5	2
Total (100)	73		87		86	

Matrix Category Explanations

Attenuation

In this section, the materials were being looked at in how much each of them weakens the radiation beam or causes it to scatter when the beam comes in contact with the material. It is desired to have the material not affect the beam and let the radiation pass through undisturbed. This section was given the highest weight of 25% because it is extremely important to not affect the treatment in any way, as a high beam attenuation could decrease the effectiveness of the low-dose radiation therapy.

While all of these materials are very good at not attenuating the beam, polyurethane is the best at not disrupting the radiation beam. Polyurethane has a very effective low atomic number and density [2] meaning that the radiation passes through it nearly transparently. PLA and PETG were also very good at not attenuating the beam as they also have a relatively low density and consist of low atomic number elements. However, the 3D printed materials are more rigid than foam so they disturb the beam a little more than the polyurethane foam[3]. Which is why it got a 5/5 and PLA and PETG were given a 4/5. Also, the radiation beam used in Low-Dose Radiation Therapy is not extremely strong which helps lower the attenuation rate of all materials.

Durability

Durability is ranked as the second most important component to the material decision. The material must be able to withstand repeated uses, 6 treatment sessions per each individual patient. The chosen material must be able to maintain shape, structural components, and flexibility throughout each treatment. PETG ranked highest at 5/5 as it shows complete resistance to moisture, chemicals, and heat [4]. It will maintain its structure through repeated radiation and clinical chemicals for sanitation. Polyurethane (PU) foam is able to withstand total cumulative doses of 3 to 6 Gy of radiation required of low-dose radiation therapy for osteoarthritis [5] without physical degradation, structural breakdown, embrittlement, or loss of flexibility [2]. PLA received the lowest score for durability, 3/5 as durability is largely maintained at low dose range of radiation therapy. However, mechanical strength, tensile strength and elongation, experienced a steep decline as radiation accumulates [6]. PETG is chosen as it shows the highest durability in a clinical setting.

Comfort

The third most important part of the material is that it is comfortable, leading to its weighted score to be 20%. The material must be able to hold the hand and wrist in place, while not causing distress for the patient during treatment. Overall, the pure polyurethane foam will provide the most comfort. The soft, lightweight nature of PU foam will comfortably sit under the patient's wrist during the low-dose radiation therapy. PU foam is also flexible: able to fit to the form of a patient's wrist and hand during a procedure. This earns it a 5/5. PETG is more comfortable than PLA since it is more flexible while still being moderately tough, so it gets a score of 4/5. PLA is more brittle and rough than PETG, making it a little less comfortable for the patient to withstand, resulting in the 3/5 score.

Biocompatibility

Biocompatibility is important as patients will be directly involved in touching it and using it during treatment. For the material to be a good option to use, it must not have any negative impacts on the patient. All of the materials, polyurethane foam, PLA, and PETG, have great biocompatibility. This makes both of these materials viable options for the device design. PU foam was not associated with any observable local skin

reactions, allergies, or systemic toxic responses [5]. Furthermore, PETG and PLA are biocompatible when used superficially. PLA can be used as implants or in devices that a patient touches, making it safe to use [7]. The same is true for PETG, not showing any side effects when implanted or touched by patients [8]. This resulted in all of the materials being viable options and biocompatible, earning a 5/5.

Cost

The cost section compared each of the materials in how much they will financially affect our budget and how they compare to one another. Getting under a specific price was not the goal, rather will the addition of these materials cause the price of the entire product to substantially increase. Given that these materials will most likely only be included in a small quantity in our design, this section was given a weight of 10%.

All three of these materials are fairly affordable and will be easily accessible based on the cost factor. PLA costs around \$0.015 per gram, PETG is about \$0.020 per gram, and polyurethane foam costs around \$0.005 per gram [9]. Also, since these materials will be used in the accessories for the product and not in large quantities, there will not be a financial issue in purchasing PLA, PETG, or polyurethane foam.

Sanitation

Sanitation is ranked as one of the least important design criteria, as the ability to be sanitized does not directly affect the functional success of the hand-positioning device. Nevertheless, it is important that the materials selected for this design must be compatible with the clinical sanitation practice of disinfection with wipes. PETG received a 5/5 on sanitation, the hard non-porous surface can be sanitized using the preferred method of disinfection wipes without impact on the structure of the material [10]. PLA received a 3/5 for sanitation as the structure is simple to disinfect, but PLA has low chemical resistance and is degraded by alcohol and organic solvents. Repeated disinfections between uses will degrade PLA and compromise the structural integrity of the hand-positioning device [10]. PU foam received the lowest score of 1/5 for sanitation as unprotected foams lack a durable, impermeable surface and can absorb and retain contaminants in clinical environments [11]. PU foam can not be effectively sanitized using disinfectant wipes without appropriate protective coating or exterior film. Additional material protection would be required for clinical use.

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