Extendable Reacher Compatible with Rheumatoid Arthritis

Group #9
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Section 003
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Summary

Ashely suffers from severe rheumatoid arthritis which causes inflammation, reduced mobility, and lack of strength in her hands and arms. Ashley is very active in her community, often facing difficulty obtaining parking cards and payment stubs from paid parking lots because she is unable to reach the wicket from her car window. Ashley requires an extendable reaching/grabbing device that can reach the wickets and is light enough for her to hold with ease.

Thorough analysis of similar, existing devices which are not compatible with Ashley's condition was essential in generating questions about features that the device would require. Answering these questions called for some unorthodox thinking, which led to a very fitting response to a complicated request.

It was decided that an ergonomic handle, an extendable and retractable shaft, and a button trigger with an automatic locking mechanism would be the best course of action. Apart from these provisions, the group made every effort to ensure that the device is lightweight, eco-friendly, and cost-competitive with similar equipment on the market.

Through analysis of existing designs and the creation and examination of a morphological chart and evaluation matrices, a feasible design concept was created. In the end, the team designed a device with a comfortable grip, an extendable and retractable body for easy storage, and rubber pincers for improved traction as depicted in Figure 10. A survey was also created to gauge an understanding of how the clientele might react.

The team's goal along every step of the design process was to create an efficient, lightweight device whose materials could also be acquired at reasonable rates, to end up with a reasonable expense report. The total cost of the device's materials was estimated to be around $15 (CAD), which is valued reasonably closely with any pre-existing devices and will undoubtedly be amongst the best values for such a device.

Overall, refinement should be made near the end of the design process in order to adhere to feedback and ensure the client's satisfaction. Analyzing specific feedback from the written response survey questions would help the team to satisfy specific suggestions and to refine the design accordingly, such as including an equivalent design for left-handed users. Testing would begin once the design feedback has been utilized and the design is fit for the clients. Testing the device may be achieved using multiple sample groups with varying severity of rheumatoid arthritis to gather accurate feedback. After this stage is completed, the design will be ready for construction and distribution.

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1 Introduction and Problem Definition

Ashely is a young woman suffering from severe rheumatoid arthritis: an autoimmune, inflammatory disease where her immune system attacks healthy cells by mistake, causing inflammation, reduced mobility, and lack of strength in her hands and arms. Ashley actively contributes to her community, driving herself to events in a converted, wheelchair-accessible van. Ashley often faces difficulty obtaining parking cards and/or payment stubs for paid parking lots, such as those of hospital parking lots, as she is unable to comfortably reach the wicket from her car window and struggles to grab the paper. Ashley requires an extendable reaching/grabbing device that is long enough to reach the wickets and light enough to match her limited strength. The device must also be versatile given the different versions of parking wickets, it must be strong enough to firmly hold a parking stub, and it must be compactable for easy storage.

Despite certain extendable reach devices being currently available on the market, they often come with limited versatility and flimsy connections. Devices already on the market offer good grip, foldability, and adaptable pincers from which inspiration may be taken. However, these devices can be flimsy, their parts (defective trigger, faulty suction cups, etc.) may not work correctly all the time, they may not close completely, they wear down easily, they are not capable of grasping heavy items, and they are not eco-friendly. Certain adjustments must be implemented to current devices in order to create a satisfactory design.

2 Background Research

Where is the device used?

Ashley's hand/arm mobility, reach, and strength/grip is greatly reduced due to her condition and she needs an extendable reacher to use in her van so she can grab tickets, etc. from outside her vehicle's window.

What is right with things already on the market?

Current available devices typically exhibit good grip and a comfortable handle, they are sturdy, foldable, and lightweight, and the pincers are able to turn so the fit can be vertical or horizontal. Current devices are also reasonably priced, ranging from $10 to $30.

What is wrong with things on the market?

Current devices tend to be flimsy, they may not close completely, suction cups may not always work, they do not pick up heavy items, triggers often defect, they are often not designed for practical use, and they are not eco-friendly.

What additional constraints must be considered?

The device must be able to reach 4 feet. The pincers must be able to rotate about their axis, and the device must be lightweight, sturdy, compact, extendable, and versatile. The pincers must have a good grip in order to keep a hold on the cards, and it should also be able to press buttons. The materials should be eco friendly.

What materials should be considered?

Given that the device must be sturdy and durable, compounds such as stainless steel and alloy based aluminum should be considered to build the shaft. The pincers must have good traction, therefore rubber or textured plastic would be a better alternative plastic pincers available on the market. In addition, the device should be eco-friendly, therefore recycled materials should be considered when possible for any components made of plastic, rubber, etc.

Desired goal state:

The grip should be lightweight and easy to use. The device should be compact to not take up much space in the car, sturdy, and versatile. It should be able rotate, being used in multiple different angles and situations. It must be able to grip cards with ease, and ideally it should hold larger objects if needed. The price should be as low as possible so it is accessible, but not at the expense of the product's quality; it should still contain good materials and be built well.

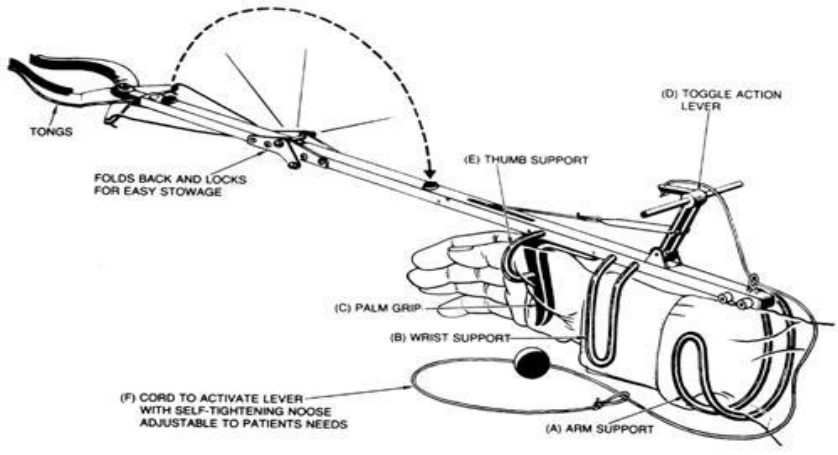
Relevant Pictures:

(Figure 1 : example of extendable reacher currently on the market)

https://www.amazon.com/Extendable-Grabber-Foldable-Rotating-Anti-Slip/dp/B08BF1NCD6

(Figure 2 : example of extendable reacher currently on the market)

https://www.amazon.com/dp/B078LKJ91C/ref=sspa_dk_detail_4?psc=1&pd_rd_i=B078LKJ91C&pd_rd_w=yaHYF&pf_rd_p=7d37a48b-2b1a-4373-8c1a-bdcc5da66be9&pd_rd_wg=32lgx&pf_rd_r=MFQQZ8QKEBD5ES2FEJ7A&pd_rd_r=35400409-2ecb-41bd-ae95-bb7faebfaf71&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExMTVBVTlCV1k5UjBCJmVuY3J5cHRlZElkPUEwMTQxMzIwMTlQMEREUUpRTlJKRCZlbmNyeXB0ZWRBZElkPUEwMzEwNzMzRjdIRU9GNERCWFNGJndpZGdldE5hbWU9c3BfZGV0YWlsJmFjdGlvbj1jbGlja1JlZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==



(Figure 3 : current design aimed to compliment rheumatoid arthritis.)

https://justhomemedical.com/products/vee-zee-c5-reacher-folding

3 Requirements

Functions: what the device must do in order to work.

- Provide an extendable “arm” to reach items that are far away.
- Can be folded into a compact space so it can be easily stored.
- Must be stable while being used and should not be easily broken.

Objectives: the device should be…

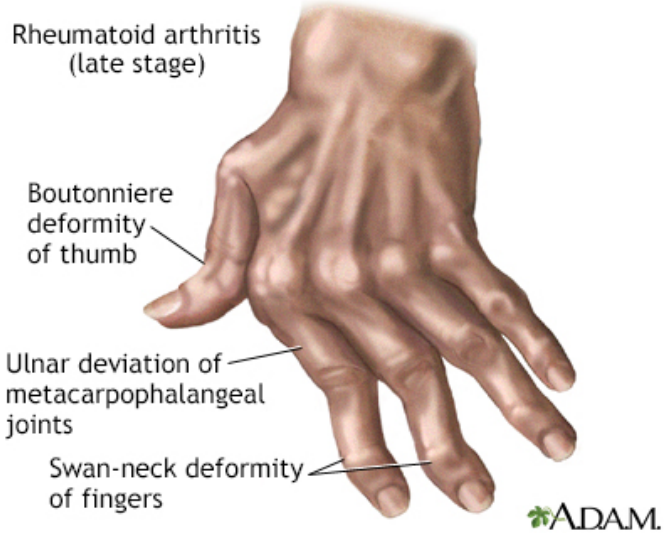
- Easy to use:
    - Lightweight and versatile.
    - Ergonomic handle that does not take much effort or cause discomfort.
    - The grip on the pincers must be non-slip so objects are not dropped.
    - Pincers need to rotate to access items on an angle.
- Cost Effective:
    - Eco friendly while not settling for inferior materials.
    - Impose minimal cost for the user.
    - Priced competitively with other companies offering similar solutions, less than $30.
- Durable:
    - Material must be light yet sturdy.
    - Able to withstand wind and being dropped.
    - Long lasting materials that are not affected by usage.
    - Bendable to save space - this should not affect the durability of the products.

Constraints: the device must…

- Have a minimally complex design as to impose little difficulty for the user.
- Be retractable for convenient storage.
- Compliment possible disfigurement of hands.
- Be lightweight and eco friendly.

4 Ideation

4.1 Concept Generation



(Figure 4: Rheumatoid arthritis symptoms and causes www.pennmedicine.org)

When generating concepts for the extendable reacher, many different aspects had to be assessed. This product is being designed for users with rheumatoid arthritis, and therefore should be compatible with the limitations of their condition. Research was conducted on existing solutions, as well as the restraints and accommodations for the user's rheumatoid arthritis. Certain findings may be used in the new design, including an ergonomically shaped handle to lessen the pain of the user, lighter materials which would make for ease of use during a prolonged time period, an extendable arm to reach items that are far away, and pincers that can be rotated to accommodate for different situations.

Before ideas were created, functions, objectives, and constraints were listed to ensure that all design concepts fit the needed requirements. Potential prototypes would include different types of triggers, grips, materials and shafts. The finger trigger may be designed for only the pointer finger to close the trigger, which may be difficult to control given the user's condition and may be more painful. This idea ensures that the person may rest their other fingers, however the design does not take into account that their arthritis could place the pointer finger in the most pain, which would nullify its practicality. Full grip triggers are similar to the

single finger trigger, as it would allow the user to control how tight the pincers hold an object. It may ease the pain on some fingers by allowing the user to evenly distribute pressure throughout their fingers using a larger trigger. However, the user may have great difficulty clutching the trigger for an extended time period due to the pain from their arthritis, meaning this may not be the most effective way to accommodate their illness. A button trigger with an automatic locking mechanism accounts for the user's inability to clench their hand or finger for any length of time. Once the button is pressed, the pincers close down tightly on the object, and the user does not have to maintain pressure. When they wish to release the object the user will press the button again to release the pincers. This would ensure that the user would not have to worry about their arthritis affecting the strength of the clutch on the object, which would decrease the likelihood of the object falling if they accidentally loosen their grip. It would also ensure that the user would not have to maintain pressure on the trigger, which could lead to pain.

There were also four types of grips to be assessed; pincers, square plates, differently sized plates, and suction cups. The pincers would have been too small to hold an object as the small surface area could lead to the object being dropped. Square plates and differently sized plates would be a much more reliable option as they offer a greater surface area for the object to be held; this would be a more stable option, being less likely to drop the object. However, differently sized plates could offer more force on a specific point while still allotting a larger surface area. Lastly, suction cups would be a great option to hold onto the object for any period of time without the worry of dropping it. Despite this, there are disadvantages to the suction cups as well: it would be more difficult to release the object, and over time the suction cups could lose their suction, resulting in a more ineffective grip after each use.

Materials for the device were also researched. The material has to be sturdy yet lightweight. Materials fitting to this include plastic and aluminum alloy. While rubber is cost efficient and eco-friendly, it can be flimsy, and stainless steel may be too heavy for the user.

Finally, the shaft has four viable options - foldable, extendable, bendable, and fixed. The extendable reacher needs to be compact, sturdy, and able to reach objects that are far away, which is why a good choice for the shaft would be an extendable and retractable body. Bendable and foldable options could loosen the connections on the shaft, leading to damage after use, and a fixed shaft would not be able to compact for storage, nor reach distant objects.

Throughout the ideation phase, the limitations of the users' rheumatoid arthritis were taken into great consideration to accommodate the features most effectively.

4.2 Brainstorming

Although team members are unable to physically meet and discuss ideas, the design group found alternative ways to discuss design options virtually. Some of these included:

Rapid ideation: In this technique, a set amount of time – often 2 minutes – was provided to all three group members, during which they would have to come up with as many solutions as possible to the problem being tackled. This method eliminated the possibility of members talking themselves out of sharing their ideas with the group.

Figure Storming: Since all three group members have close contact with someone in the family who is a practiced engineer, it was useful to look at problems from this person's perspective; it was easy for members to ask "What would they do?" and come up with ideas.

Brain netting: A separate google doc file was created where any and every idea that came across the minds of group members was recorded whenever inspiration struck. After this, in subsequent discussions, these ideas were followed up on to decide which ones to pursue and which ones to abandon. This method helped compensate for the remote nature of the brainstorming session and arguably turned out to be the best method of brainstorming for the group.

Starbursting: This brainstorming technique proved especially useful during the two rounds of screening. In this method, each idea is examined from six different angles: who, what, when, where, why, and how. Since this is a very vigorous method of assessing an idea's feasibility, it helped in giving out standardized scores to the design variations.

4.3 Morph Chart

Table 1: **Feasibility Analysis Morphological Chart**

FUNCTION			MEANS	
Handle-Trigger	*Finger Trigger*	*Full Grip Trigger*	*Button*	—
Grips	*Pincers*	*Square Plates*	*Differently Shaped Plates*	*Suction Cups*
Material	*Plastic*	*Stainless Steel*	*Aluminum Alloy*	*Rubber*
Shaft	*Foldable*	*Extendable*	*Bendable*	*Fixed*

2 of many possibilities

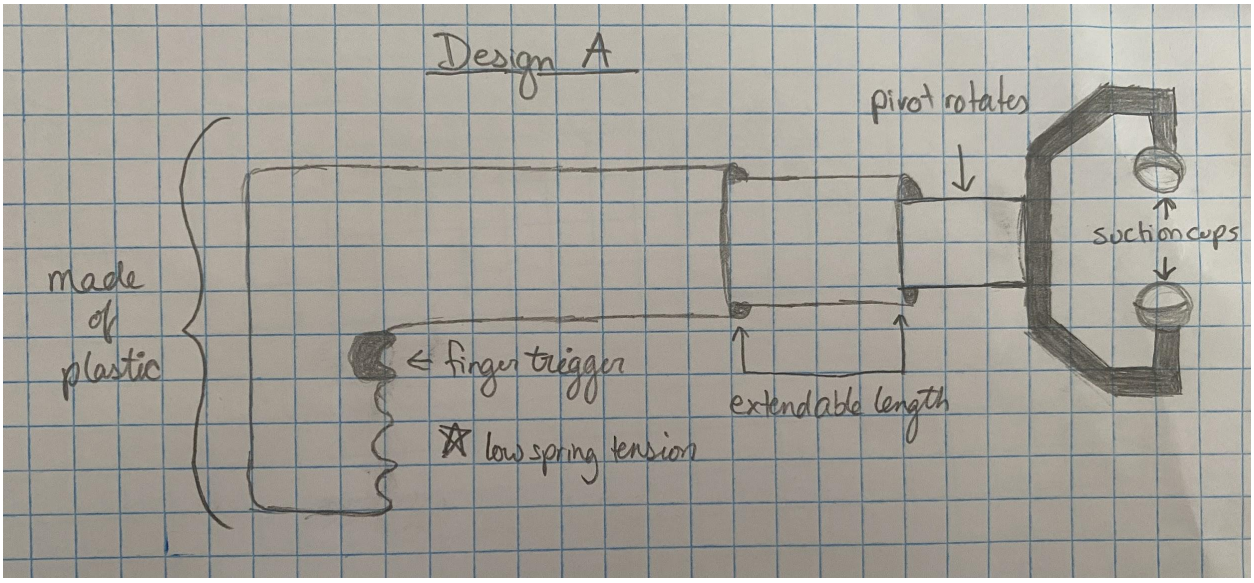
Feasible Full Grip Trigger - Square Plates - Aluminum Alloy - Extendable

Non-Feasible Finger Trigger - Suction Cups - Plastic - Fixed

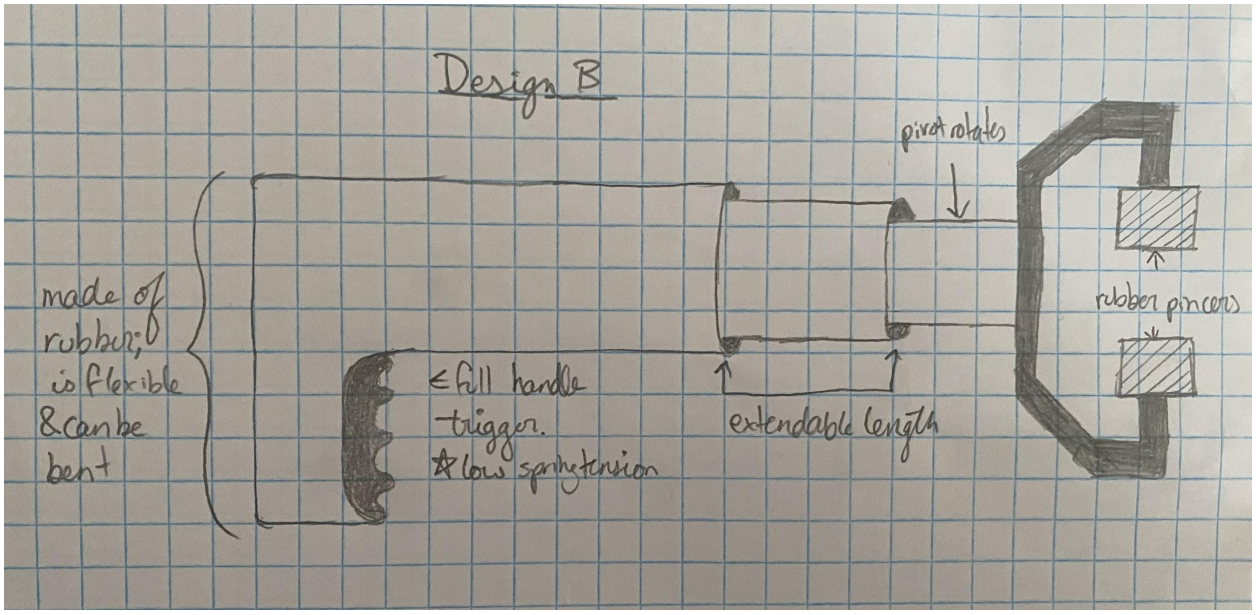
Above is the Morphological Chart created to analyze various options for the device's features. Along the left-most column are design functions that must be determined in order to design the structure. Along the rows are varying means aimed to satisfy the corresponding function. A line drawn from the top to the bottom passes through one mean per function, representing a possible design combination. This allows a decision to be made regarding the design's effectiveness in satisfying the criteria.

4.4 Concept Sketches

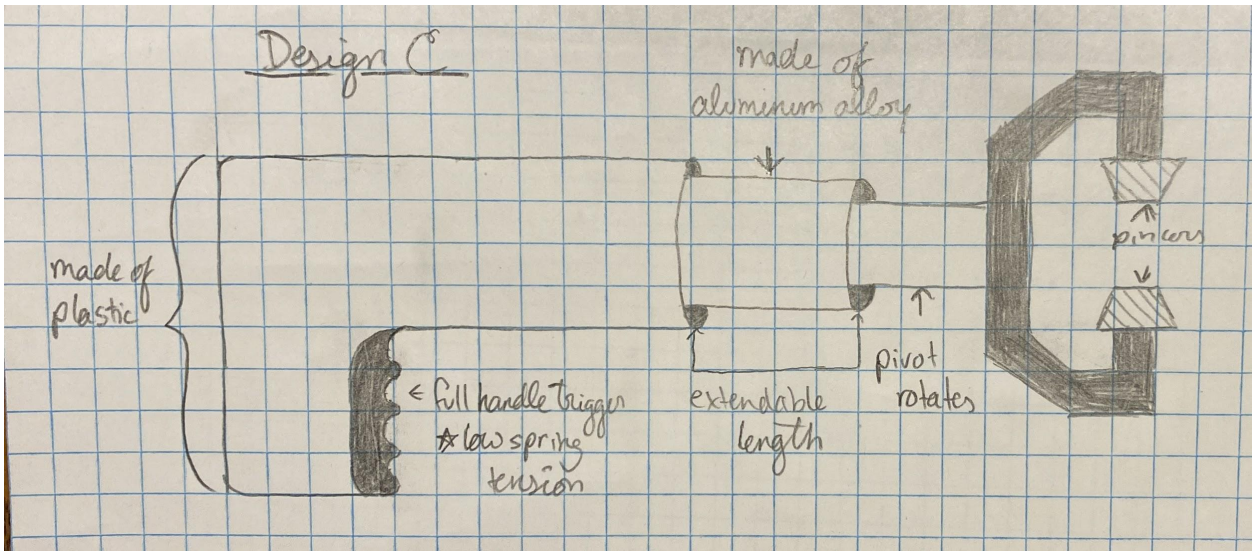
Below are sketches of each of the five design concepts outlined by the team during the concept creation process. The goal of this process was to create many feasible design options to be considered during the evaluation process to determine the greatest design. The following design sketches (Figures 5-9) were chosen to move into the evaluation phase.



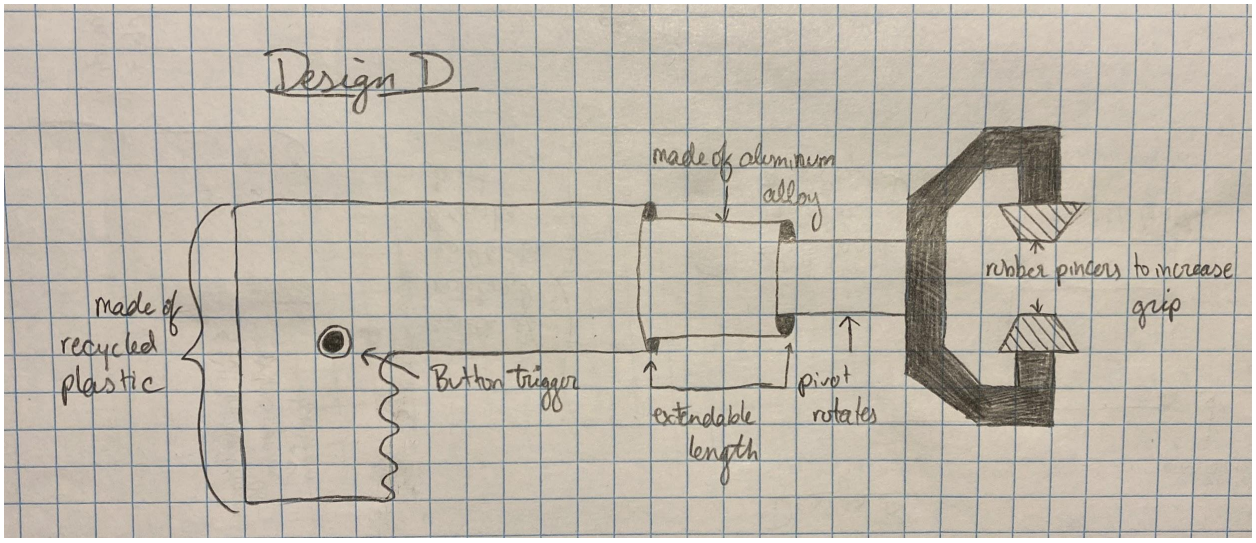
(Figure 5: Design A as sketched by group member Anna Behm. Plastic handle and body with single finger trigger, extendable body, and suction cup pincers.)



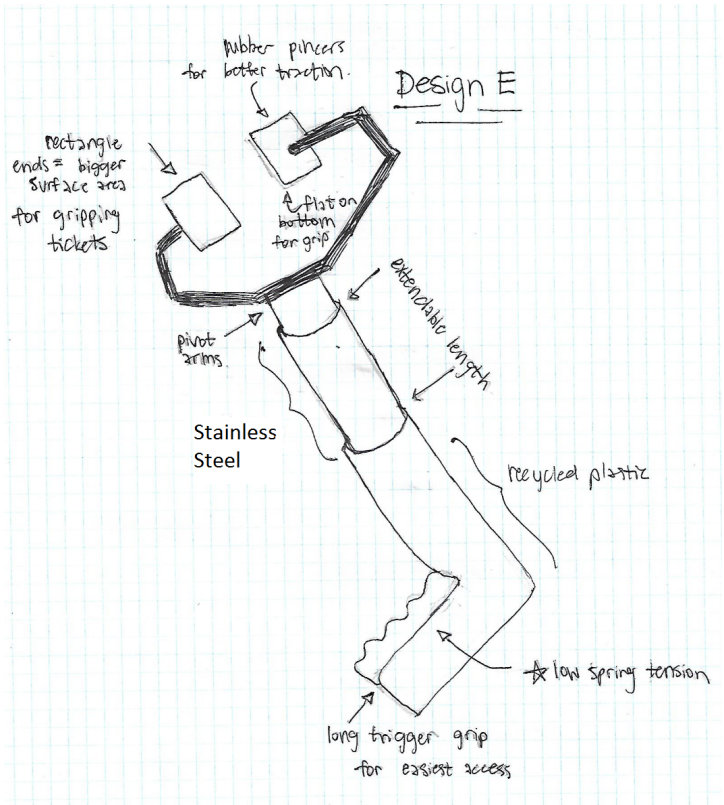
(Figure 6: Design B as sketched by group member Anna Behm. Rubber handle with full grip trigger, extendable and bendable body, and rubber pincers.)



(Figure 7: Design C as sketched by group member Anna Behm. Plastic handle with full grip trigger, extendable body composed of aluminum alloy, and rubber pincers.)



(Figure 8: Design D as sketched by group member Anna Behm. Recycled plastic handle, button trigger with automatic locking, extendable body composed of aluminum alloy, and rubber pincers.)



(Figure 9: Design E as sketched by group member Claudia Matchem. Handle made from recycled plastic, extendable body composed of stainless steel, full grip trigger, and rectangular rubber plates.)

5 Selection of the Best Solution

5.1 Screening Matrix

Table 2: **Screening Matrix**

SELECTION CRITERIA	**A**	**B**	**C (REF)**	**D**	**E**
Weight	+	+	0	+	+
Cost	+	+	0	+	+
Durability	-	-	0	-	+
Stability/ Length	-	-	0	0	0
Grip Strength	0	-	0	0	0
Pincer Strength	-	+	0	+	+
Extendability/ Ease of Storage	0	+	0	0	0
Eco-friendly	-	+	0	+	+
Quality of Material	-	-	0	+	+
Sum of +'s	2	5	0	5	6
Sum of 0's	2	0	9	3	3
Sum of -'s	5	4	0	1	0
Net Score	-3	1	0	4	6
Rank	5	3	4	2	1
Continue?	No	Yes	No	Yes	Yes

Scale	
Relative Performance	*Rating*

Better than Reference	+
Same as Reference	0
Worse than Reference	-

In this first matrix, the feasibility of variants of the designs were evaluated by the group using a fixed reference. The reference design was given a completely neutral score, and each design option was given a positive or a negative score based on how they performed each criterion in comparison. This yardstick design was taken as Design C. The three designs that made it into the next stage of evaluation through the screening matrix were Designs B, D, and E. The designs that did not make it through the first screening were A and C. Design A was rejected in the first round due to the non-feasible concept of suction cups as pincers. Additionally, Design A would be significantly less durable and eco-friendly. Design C, which was the reference, was rejected as most competing designs performed better in most categories. Designs E, D, and B were selected on account of their weight, cost, pincer strength, and eco-friendly design all being better alternatives to the reference.

5.2 Scoring Matrix

Table 3: **Scoring Matrix**

		B	**B**	**D**	**D**	**E (REF)**	**E (REF)**
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Weight	20%	4	0.20	3	0.20	3	0.20
Cost	5%	5	0.05	4	0.05	4	0.05
Durability	10%	2	0.10	4	0.10	5	0.10
Stability/ Length	20%	0	0.20	5	0.20	5	0.20

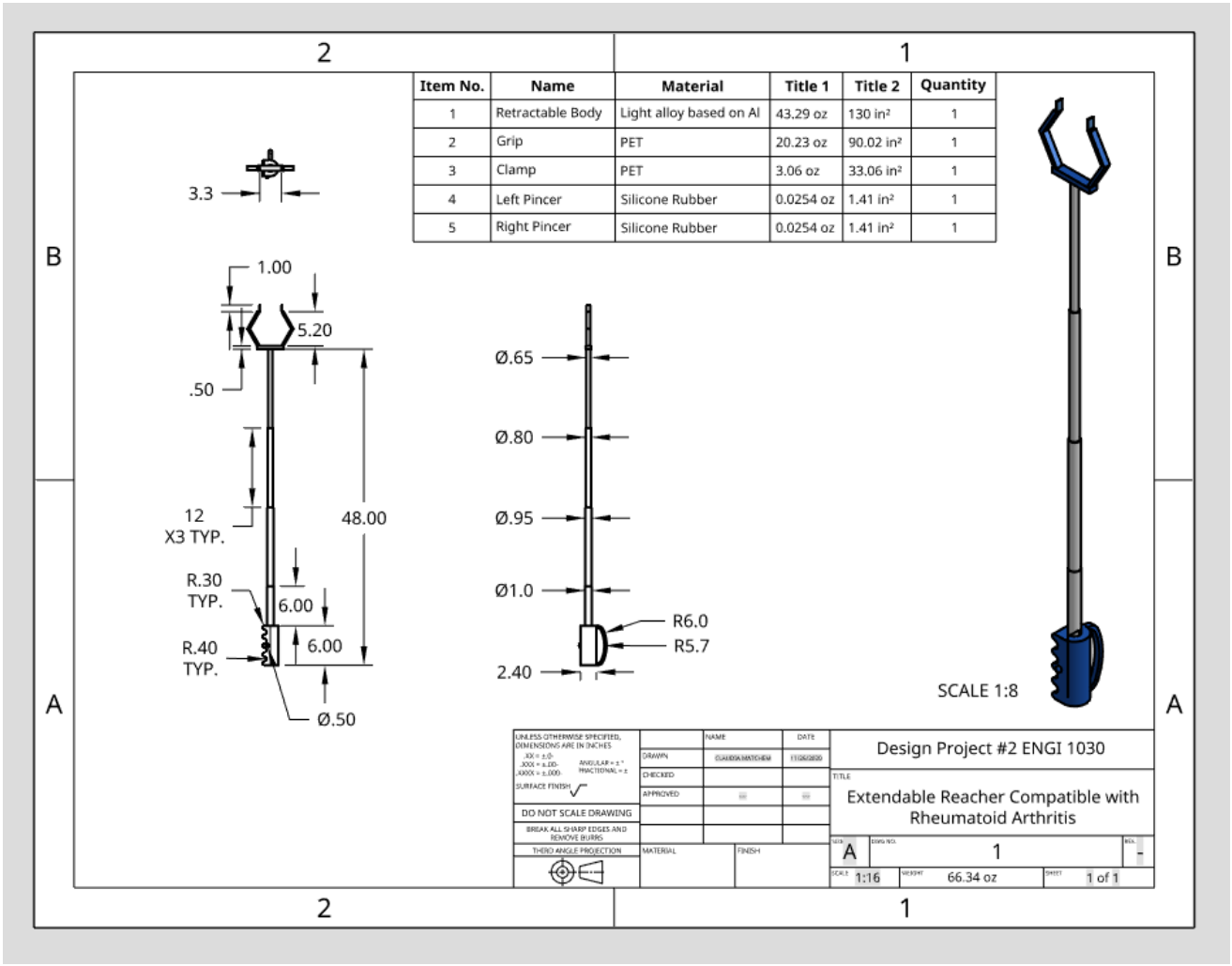
Grip Strength	12.5%	3	0.125	5	0.125	3	0.125
Pincer Strength	12.5%	5	0.125	5	0.125	5	0.125
Ease of Storage	10%	5	0.10	4	0.10	4	0.10
Eco-friendly	5%	2	0.05	5	0.05	5	0.05
Quality of Material	5%	0	0.05	5	0.05	5	0.05
	Total Score Rank	2.85 3		4.35 1		4.20 2	
	Continue?	No		Yes		No	

Scale	
Performance Relative to Reference	*Rating*
Doesn't meet Objective at all	0
Weakly meets Objective	1
Somewhat meets Objective	2
Mostly meets the Objective	3
Strongly meets the Objective	4
Outstanding with respect to the Objective	5

In the second and final round of screening, the reference design was changed from Design C to Design E, as E was the top scorer from the first matrix. Selection criteria were assigned a weight based on the importance of the feature being a part of the design. Each design was once again evaluated by the group members and assigned a score out of 5 based on how they performed each criterion in comparison to the reference. Design D was the top scorer, doing exceedingly well in nearly all of the criteria. It was the clear winner and all members were happy to proceed with this design.

6 Solution Investigation and Iteration

(Figure 10: Final design concept and multiview sketch related to design concept D)



The final design concept for the extendable reacher involves a 4’ extendable body. The arm consists of four segments, measuring 12” each, which can be contracted within each other for easy storage. The body is composed of aluminum alloy to ensure that the device is lightweight, durable, and stable. While a rubber body would offer the device more versatility, alloy based aluminum is better equipped to withstand harsh conditions and maintain a stable connection.

The device's handle is composed of recycled plastic as it is lightweight, cost effective, and eco-friendly. The grip has an ergonomic design with curvature around the fingers, making for a comfortable hold despite any disfigurement of the hand. The right side of the grip has a handle for the user's hand in order to maintain grip and to prevent from dropping the device. The left side of the grip contains the trigger mechanism. The button is placed midway between the ends of the grip in a comfortable position near the user's thumb. The button trigger is designed to lock down the pincers after it is pressed, and to release them upon being pressed again. This way the user can grab an object with the device without dropping it, while not having to maintain constant pressure on the trigger. This design is optimal for the reduced strength and grip experienced by those suffering from rheumatoid arthritis.

The clamp is made of recycled plastic and the pincers are made of rubber, these materials are cost effective and eco-friendly. The clamp is able to rotate about the body to approach objects from multiple different angles. The rubber pincers have improved traction, making the acquisition of objects, such as tickets, easier for the user.

The button trigger with an automatic locking mechanism was decidedly the ideal model for the device. Although the full grip trigger would make for relatively easy use, the button has better control as it is less likely to accidentally release the clamp. The client may even use their other hand to press it, focusing their dominant hand on gripping the device. The safety handle was designed to minimize the possibility of dropping the device. While certain devices already on the market include other gadgets of this manner, such as implementing a glove into the handle, the safety handle is a simple and cost effective method which is easy to use and store.

Remaining details to be evaluated include exact measurements for the device's grip, the device should be designed in different sizes in order to accommodate different users. In addition, the grip should be designed in mirrored dimensions to accommodate left-handed users. Although the current design is able to be used inconsequential to which hand is dominant, switching the sides on which the handle and buttons will make use more comfortable for left-handed users. Furthermore, a series of prototype testing may determine the efficacy of the length of the clamp's arms, the size of the grip, and other specifications.

Table 4: **Quantities & Approximate Cost**

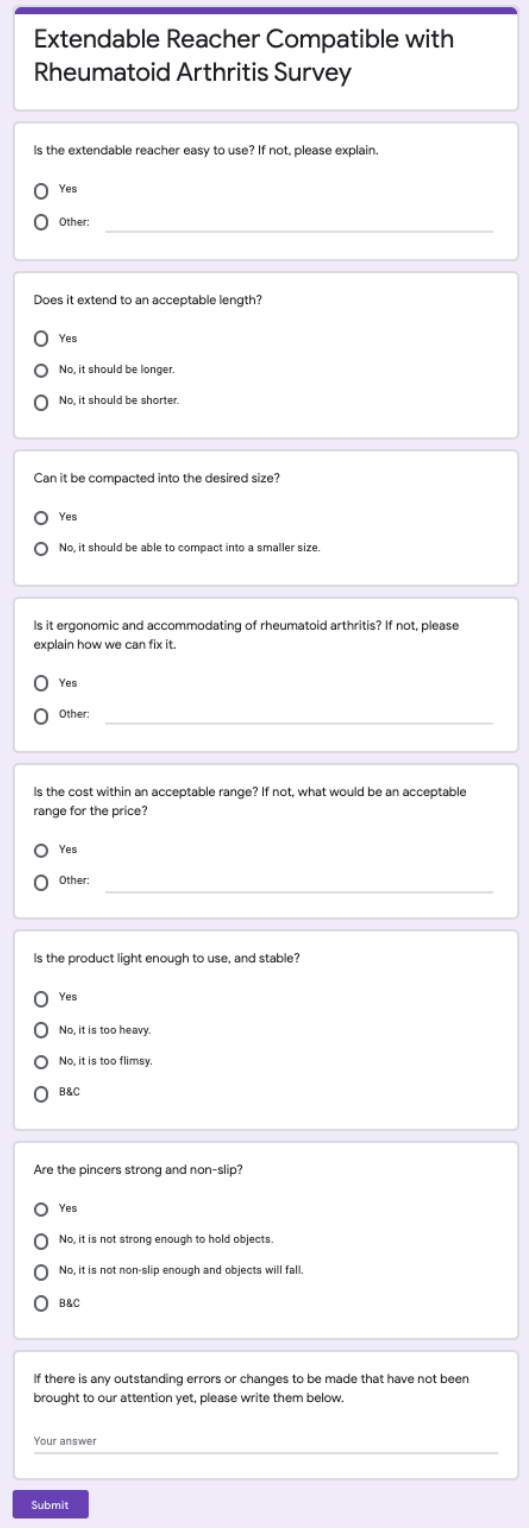
Material	**Required Quantity**	**Unit Cost (CAD)**	**Total Cost (CAD)**
Alloy Based Aluminum	(Purchased by custom sheet, 1/16" thickness) 0.65π x 12 in 0.80π x 12 in 0.95π x 12 in 1.0π x 12 in	(Calculated custom price) 2.50 3.08 3.65 3.85	 13.08
Silicone Rubber	2.82 in²	5.35 / ft²	1.26
Recycled Plastic	23.29 oz	0.46 / lb	0.67

Overall cost of device materials: $15.01

7 Solution Testing and Evaluation

One way to test the chosen extendable reacher design would be to conduct a survey on the client. The purpose of this survey is so the client can accurately test the product and provide input before receiving the device, as well as to see if the design is worthy of further development and refinement. It is imperative that feedback is gained before the final design is established to be cost and time efficient. The best design should be chosen ahead of its development to ensure no loss of time or money. The client could be sent a prototype, and they could test the product while simultaneously taking the survey. By only asking the client to take the survey, it would show exactly what they need and want, as well as what to change to determine the next steps with more knowledge on the prototype from the feedback. A potential survey for the client is included in Figure 11.

Based on responses to these questions, the design would be considered a success if "Yes", was the predominant choice chosen. Considering the extendable reacher must meet all of the requirements and accommodate rheumatoid arthritis, it is essential that the product is designed to meet all of the client's wishes. For the questions with long answer responses, the feedback would be taken into consideration when finalizing the plans & ensuring that the best design is implemented. *(Figure 11: Surveys conducted through Google Forms in order to gather design feedback from staff and students)*



8 Conclusions

In conclusion, Design D, as depicted in Figures 8 and 10, is best suited to satisfy Ashley's needs, as well as the needs of other individuals suffering from rheumatoid arthritis. Remaining details, depending on fabrication as outlined in the report, are the final details to be decided with the client. This design is comfortable to hold with a strong grasp on items, while also being cost effective and eco-friendly.

This design offers a comfortable grip while not compromising the strength of the clamp or the sturdiness of the device. Using this design, the device is easy to use and also convenient for grabbing distant items as constant trigger pressure is not required. This design is also fairly priced in comparison to similar devices on the market, which is important when designing such a project. The cost of materials for the structure is roughly $15, in competition with current devices which may vary from $10 to $30.

In the end, the design created and chosen by the team is believed to be functional while adhering to the needs of the client, and to provide the greatest functionality while maintaining ease of use given the constraints. As expected there are always improvements that can be made. Given more research, resources, and the opportunity to test the structure's practicality, a near-perfect design could be achieved. The design, as outlined, is believed to fit all criteria given by the client successfully.

9 Recommendations

Based on the analysis and conclusions in this report, it is recommended that the design be approved by the client before proceeding with further testing and development. Upon receiving feedback from Ashley and other individuals suffering from rheumatoid arthritis, the next step would be to refine the design accordingly and proceed with testing of the device in action. It is recommended that refinements adhere to the feedback specifically and accurately to ensure maximum satisfaction. If the client is unhappy with the extendability and retractability of the device, the team should analyze the specific feedback from the first three questions to incorporate changes as suggested by clientele. If the clients are unhappy with the ergonomic structure of the device, the team should inquire specific suggestions from questions 4, 6, and 7 to improve the design to their recommendations. Physical testing should not begin until feedback on the sketches have been considered and the clients are satisfied with the design.

Moving into the design testing stage, it is recommended that a model of the device be built to be tested. Ashley should test the structure first to verify her specific needs, followed by testing from many individuals suffering from rheumatoid arthritis on a wider range from mild to severe disfigurement to receive active feedback regarding the device's level of practicality and ease of use, making any changes to the existing model. After considering these recommendations the design should be fully developed and ready to be distributed.

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Appendix A: Meeting Minutes

Meeting #1 November 1 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: Meeting number one was to determine the choice of research project & begin researching the appropriate background information. The idea chosen was the "Extendable reacher compatible with rheumatoid arthritis". The objectives were defined and research was done on the different aspects of the project; including the target users, constraints, potential budgets, desired goal state, and obstacles. It was planned to have finished the research by the next meeting (November 5 2020) and to look over the objectives of the next task: requirements and ideation.

Meeting #2 November 5 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: During the second meeting, the researching was summarized and the most important finds were highlighted. From the information found, the functions, objectives and constraints of the reacher were discussed and the brainstorming of a potential model started. Multiple brainstorming tactics were utilized during this meeting, and great progress was made on the designs, while keeping in mind the objectives of the project. Over the next few days it was planned to continue brainstorming and narrowing down the objectives, in order to obtain the best possible design.

Meeting #3 November 9 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: For the third meeting, the brainstorming continued and the best ideas were chosen from the objectives, functions, and constraints created in the last meeting. Models were drawn out both on paper and in the program Onshape to more clearly depict the models that were designed. A morph chart was also created in order to more clearly see the best options out of the presented ideas. The choice of the final model was not to be rushed, so appropriate methods of selection were researched to determine the winning design. Group members agreed to refresh their knowledge of evaluation tactics for the next meeting (November 14 2020) in order to finalize the playground model.

Meeting #4 November 14 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: The fourth meeting was used to select and iterate the final design. Screening and scoring matrices were found to be the best way to determine the ideal design. They were used to narrow down the ideas based on important aspects, including how durable the reacher would be, how convenient it would be for a person suffering from rheumatoid arthritis to use, how easy it would be to store the reacher when not in use, and the prices of the different materials. This concept screening allowed for the optimal model to be chosen, and for the refinement of this selected design to begin. Over the week following, more specific information about prices was to be gathered & plans for a multiview drawing were started.

Meeting #5 November 20 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: Since the final design for the extendable reacher had been selected, meeting five was designated to create specifications to understand and fabricate the design. An Onshape model of the reacher was created by Claudia Matchem for both the multi-view and isometric angles. The budget of the materials was created with more detail and accuracy, and group members started finalizing the design report over the following days.

Meeting #6 November 24 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: In order to see if the finalized design would be enjoyed by the clients, a survey was created, and a review of how the results would be analyzed was also written. The purpose of this survey would be to test the popularity of potential reacher choices to see if the design is worthy of further development and refinement. The type of model to be used was determined, as was the target test group, and targets and explanations for the responses gathered. Furthermore, the design report was edited and formatted to the project rubric during this time.

Meeting #7 November 29 2020, 3:00-4:50PM

Meeting Participants: Aabir Basu, Anna Behm, Claudia Matchem

Meeting Notes: This final meeting was used to conclude the research process and focus on editing the design report. For each part of the report, a person was appointed to edit and explain more thoroughly, the given ideas. Any changes in the design report were discussed and the

missing elements were highlighted and given to each group member to finish before the deadline.