
Design Project 3 – Power in Community

Motion-Activated Treat Dispenser

ENGINEER 1P13 – Integrated Cornerstone Design Projects in Engineering

Tutorial **X**

Tues-54

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Submitted: **April 21, 2026**

Course Instructors: Dr. McDonald, Dr. Ebrahimi, Dr Lee, Dr. Hassan, Dr Scott

*** Update the descriptive project titles for each new project as instructed.**

**** If your team is using a custom team name, put it here, otherwise, remove this line.**

***** Replace with each team members' names and macIDs**

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**** Use *Heading 1* and *Heading 2* from the Styles menu to keep section headers consistent throughout the document.**

**** Don't forget to update your Project #, Tutorial #, and Team # on the cover page and in the header.**

**** When you're done with this document, complete the Academic Integrity statement by inserting your signatures. If you have more or less than 4 members on your team, copy or delete the statements as needed. Each team member is responsible for their own signature. *Team members without a signature will not receive a grade for the report!***

**** Once you are finished:**

- ***Remove all yellow highlighting,***
- ***Delete all the template instructions, which are indicated by red text or blue text and prefaced by 1 or 2 asterisks (i.e., * or **).***

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Ana Alberola Almenara 400640088



(Student Signature) *

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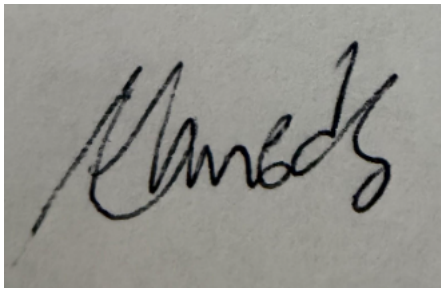
Shayan Siddiqui 400617630



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Ahmed Shehzad 400640336



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Eshal Khan 400642088



(Student Signature)

Executive Summary - Ahmed

- Introduce Problem

The problem that this product aimed to solve was to provide a way for people like Mark with limited dexterity and mobility to have a comfortable way to play with their pets, especially their dogs, to grant a sense of agency and independence. The objectives best correlated with the situation at hand is to have an intuitive, easy to use, portable, lightweight, cost-effective, and durable product.

- Description of final prototype (include photo of your prototype on this page, not in the appendix)

The final designed prototype was a box containing an Archimedes screw which rotates to push the loaded food out of a slit on the side. There is an ultrasonic sensor on top of the box to detect if someone's hand is within 15 cm and sends a signal for a motor spin. This motor is attached to three different gears with adjusted gear ratios to increase torque. The final gear is on the Archimedes screw. The box also contains an Arduino Uno, DC motor Controller, and a 12V DC Motor on one side with their associated wiring and an enclosed region with the Archimedes screw area. The box is covered with a lid with a cut out to and a plastic container to act as a funnel to funnel in food into the enclosed region and to connect the circuit to the ultrasonic sensor.

- Benefits of this prototype for the client

The benefit of this prototype for the client in comparison to many commercial products available is that it works without contact, saving pressure off his hands, causing less pain. Additionally, the design is meant to be a portable container, meaning it is not too big nor too heavy to transport while full, meaning he can take on the go. Finally, this design disperses treats a few at a time so that mark can then grab and throw to his dog, allowing him to play with his dog and have more agency while ensuring that he does not feed him too many at once.

- Next steps moving forward (How would you improve this device given mor time/money/resources/etc.

Going forward with more time and more resources, there would be tape and better wire management inside of the box to ensure the wires do not accidentally disconnect or get damaged. Additionally, the box used for a base would be made smaller to ensure the device is more portable and can more comfortably fit. Moreover, rather than using command strips for attaching the dispenser, an adjustable clip design will be adapted to ensure that the dispenser can easily come off and on without damage to the product nor the chair.

Main Body

Background Information (Shayan)

Mark is a 64-year-old wheelchair user who has had juvenile rheumatoid arthritis (RA) since he was 6 years old. RA is a chronic autoimmune system condition that can cause joint inflammation, pain, swelling, and stiffness, and over time it can reduce hand function and make grip-based tasks harder [1]. This is important for our project because Mark’s daily life is affected by low dexterity and reduced grip strength, so tasks that require fine finger control or repeated squeezing can be difficult.

Mark’s mobility has also been impacted by long-term complications related to a serious accident and later a below-the-knee amputation. Post-amputation challenges can include ongoing discomfort and pain that can affect daily function and quality of life [2]. Mark also uses hearing aids, and research shows RA can be linked with hearing issues, which reinforces the need for solutions that are simple, clear, and easy to use [3].

Problem Framing

Refined Problem Statement

Objectives and Constraints of your design

Conceptual Design – Eshal

Ideation (Design Space Exploration, Brainstorming, Initial Sketching)

Ideation process involved design space exploration, brainstorming, and sketching. To start, we investigated existing solutions

- Existing Ideas/Solutions
- Design Alternatives

Decision Matrices

- Design Evaluation (Discussion of feedback from IAIs/TAs, how this feedback impacted your design process)

Final Proposed Design – Stefan

Our final design uses an Archimedes screw mechanism to dispense the treats in controlled stages. The mechanism works like an auger, in which the treats are loaded from the top through a hole which leads to the housing for the screw. The housing is tube shaped and fits closely around the screw itself to minimize gaps where treats can get stuck. As the screw spins, the treats are pushed forward due to the spiral shape. This allows for the number of treats dispensed each time to be controlled. The screw is connected by a gear on the end which meshes with a compound gear that then meshes with our motor.

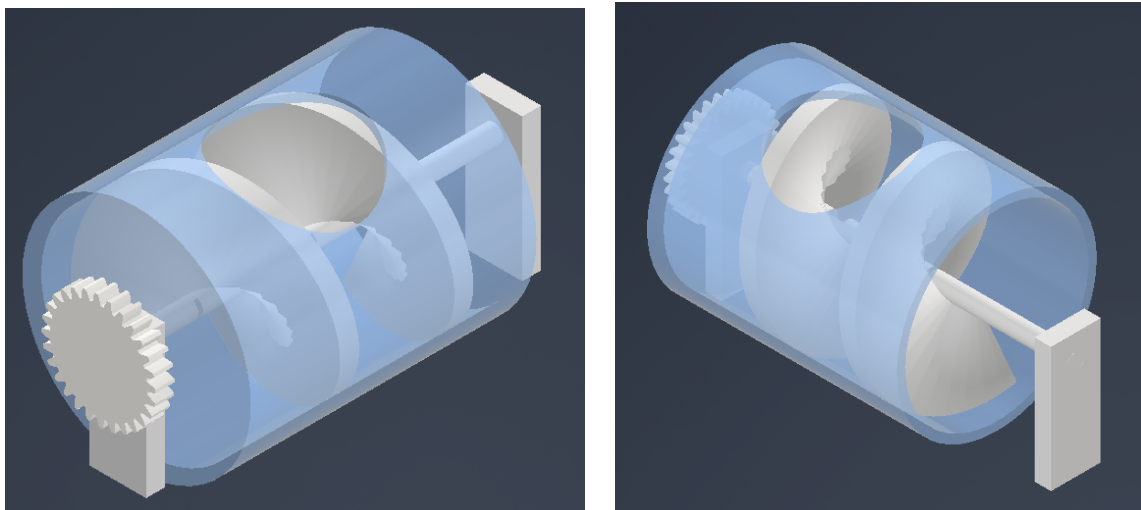


Figure 1. CAD View of Screw Mechanism

To power our mechanism, we use a 12V motor which turns the gear attached to our mechanism. The motor is then connected to a DC motor controller in order to manage back current as well as current spikes. This motor controller is connected to an Arduino uno which provides the logic and control signals for the motor. Our design is motion activated and an ultrasonic sensor is connected to our Arduino which then activates the motor when the distance the ultrasonic sensor measures is less than 15 cm. Our system is powered by 8 AA batteries connected in series through a battery pack.

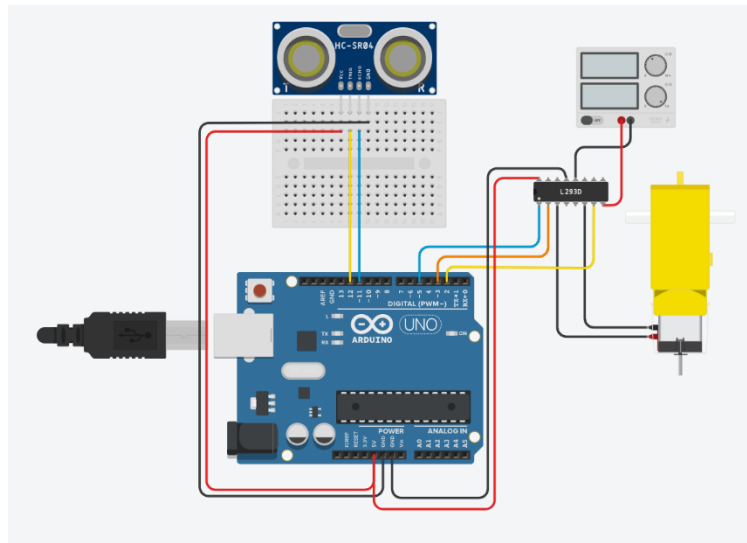


Figure 2. Circuit diagram of motor controller and ultrasonic sensor.

Metrics:

Our design met our objectives and constraints that we needed.

Objectives	
Lightweight	Weight: 386g, Our design met our objective of being lightweight and less than 1kg.
Portable	Dimensions: 31 x 14 x 12 cm. The design fits within a medium sized plastic storage box. The current dimensions suggest that it will fit on Mark’s wheelchair comfortably as our metric had accounted for a wheelchair side size of 40.6 cm.
Consistent Output	The design accurately dispenses around 3-4 treats at a time

Reliable	The system dispenses the treats when triggered with only occasional jamming. When it does jam, the system is able to fix itself when it is powered again, requiring no user interference to fix it. The motor is able to consistently perform and output the required torque to push the treats.
Durable	Our initial testing plan showed our design lacked durability, so we remade our prototype using superglue to bind our components. From our testing plan we put our prototype on a bike and rode it around to simulate the bumps and forces the prototype would feel while mounted to Mark’s chair. We tested it quite rigorously to simulate the extreme case of the forces our prototype would handle and it held up.
Intuitive / Ease of modification	We had peers attempt to use the prototype with only minimal instructions and rate the intuitiveness from 1-10. We received an average score of 8.6 showing it was relatively intuitive to use.
Constraints	
Size of treats	Our design needed to be able to accommodate the treat sizes Mark uses. From the client visit we learnt Mark used liver cube treats. As such, we used cube shaped candies to test our design. We used Hi-Chews which simulated the shape and size of Mark’s treats and our design held up.
Power of motor	Our motor needed to be strong enough to push our treats. The motor we chose was a JGA25-370 which has a rated torque of 7.7 kgf*cm. The use of a compound gear amplified this torque greatly allowing for us to have a strong enough motor. Additionally the use of a dedicated motor controller allowed for a stronger motor due to its increased current draw which would short a regular Arduino.
Client Dexterity	We have a funnel system on top with a large opening which makes it easier for Mark to load the treats.

Testing plan iterations

- Compound gear to fix motor torque

Some special features of our design was the use of a compound gear to increase the gear ratio, therefore increasing the output torque. In our original iteration our motor meshed directly to the main gear on our screw, however there was not enough torque and it would jam occasionally. The initial gear ratio between the motor gear and the gear on the screw was 2.15, but by using the compound gear this is increased to 4.62 greatly multiplying the torque from our motor.

- Modified code to burst shorter
- Fixed reliability by changing code and using superglue, fixed jamming with tube
- Tube for detextiery

Our mechanism itself was created using 3D printing

- Talk more about mechanis
- Maybe reorder electrical to mechanical

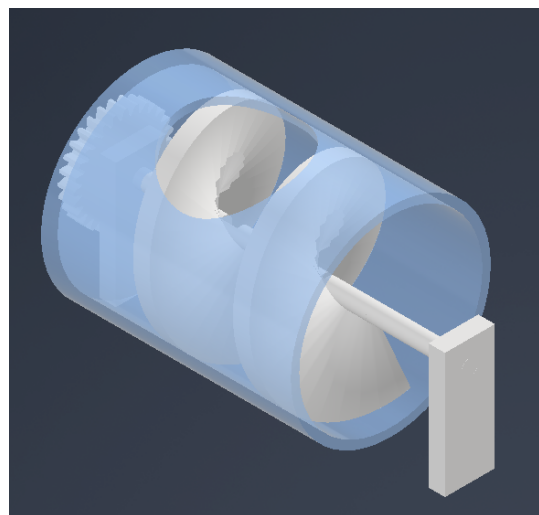
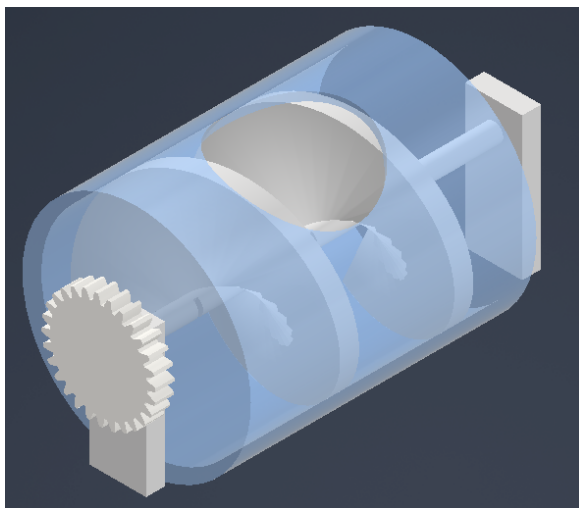


Figure 1. CAD View of Screw Mechanism

Description of Final Design and how it works

Specifications of your design

Final Drawings or screenshots of code

Discussion of objectives/constraints met (using metrics) from results of testing plan from Milestone 5 and Milestone 6

Construction/development methods (e.g., bill of materials, device construction, discussion of why certain materials/items would be used)

- Printing in parts
- 3d printing
- Motor controller
- Parts printed separately
- 4h 16min

Detailed description of testing plans (current and future) and results. How testing plan results helped aid in any iteration of the design

Materials	Qty.	Cost
PLA	108.94 g	2.77
Cardboard	580 cm ²	0.58
Plastic container	1	3.47
Old plastic jar	1	0.00
12V DC Motor – (JGA25-370 – 400 RPM)	1	13.82
DC Motor Controller – L298N	1	10.99
Arduino UNO	1	21.99
12 V Battery Pack	1	11.99

Total	65.61
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Figure X. Toronto Skyline

Table X Material Properties

Material	Density (g/cc)	Yield Strength (MPa)
Steel	7.50 - 8.08	110 - 2400
Carbon Fiber	1.40	945 - 1230

* Include explanatory details in a footnote

Subsection Heading #2

**** Don't forget your IEEE in-text citations**

Conclusions

Looking Ahead

What steps would we take, given more time, to improve our device? How did our final test plan alter future refinements made)

If given more time, we would encase the mechanism with plastic instead of cardboard, mount and secure the Arduino with a 3D printed piece, find a better power supply and use a microcontroller.

Firstly, encasing the mechanism with plastic would further decrease the friction between it and the sides, so it could turn more efficiently. Furthermore, plastic would allow for easier modification and a more cohesive casing. Currently, the mechanism's cardboard casing has many pieces and is hard to reach inside of. A plastic casing would be far less pieces and thinner, which would make it easier to see inside of, more lightweight, and more aesthetically pleasing.

Secondly, mounting and securing the Arduino with a 3D printed piece would provide a more structurally sound design. The motor and motor controller are secured with cardboard, tape, and hot glue. Strong PLA would prevent the motor components from moving around and the wires from becoming stuck in inconvenient places where they could be damaged or damage the mechanism.

Finally, finding a better power supply and using a microcontroller would decrease the number of pieces needed and the price of the mechanism. A microcontroller would also use less power, and because it is simpler, it would be more suited for this task. Many of the parts of the Arduino are not being used.

Looking Back

Throughout this project, we learned that the design process is extremely unpredictable, and solutions to problems that may arise may have subsequent problems to them. For example, we made the decision to separate the Archimedes screw to simplify the print, then rejoin them together with hot glue. When we did this, the mechanism printed successfully, but the superglue was not strong enough, and the mechanism frequently separated. Regarding team dynamics, ensuring every teammate was respected and listened to, and had time to share ideas and concerns, was key. This was one of the primary reasons we were able to brainstorm effectively and solve issues quickly, as well as anticipate issues. It also allowed our team to be on the same page. In the future, before putting together the entire mechanism, we would secure each part first. This would prevent the recurring issue we faced of the mechanism parts snapping off. The brittle and fragile nature of our mechanism caused us to lose time and limited the reliability and durability of our mechanism.

Reference List

- [1] H. K. Edwards and V. Sridhar, "Analysis of software requirements engineering exercises in a global virtual team setup," *Journal of Global Information Management*, vol. 13, no. 2, p. 21+, April-June 2005. [Online]. Available: Academic OneFile, <http://find.galegroup.com>. [Accessed May 31, 2005].
- [2] A. Altun, "Understanding hypertext in the context of reading on the web: Language learners' experience," *Current Issues in Education*, vol. 6, no. 12, July 2003. [Online]. Available: <http://cie.ed.asu.edu/volume6/number12/>. [Accessed Dec. 2, 2004].
- [3] etc.

**** Delete the sample citations and replace them with your own. Be sure to follow IEEE convention and list them in order of appearance in the document (NOT alphabetical).**

Appendices

*** Add relevant Appendices as instructed. A sample Appendix is shown below.**

Appendix A: Project Schedule

Appendix B: Scheduled Weekly Meetings

Appendix C: Comprehensive List of Sources

Source list for Background information:

- [1] Mayo Clinic Staff, “Rheumatoid arthritis — Symptoms and causes,” Mayo Clinic, Apr. 9, 2025. [Online]. Available: <https://www.mayoclinic.org/diseases-conditions/rheumatoid-arthritis/symptoms-causes/syc-20353648>. Accessed on: Mar. 25, 2026.

- [2] L. Newcombe et al., “Complications Post Amputation,” Physiopedia. [Online]. Available: https://www.physio-pedia.com/Complications_Post_Amputation. Accessed on: Mar. 25, 2026.

- [3] WebMD, “Rheumatoid Arthritis and Hearing Loss,” WebMD. [Online]. Available: <https://www.webmd.com/rheumatoid-arthritis/ra-hearing-loss>. Accessed on: Mar. 25, 2026.

Appendix D: Additional Documentation

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ENGINEER 1P13: PROJECT 3 WORKSHEETS (TEAM)

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P3 MILESTONE 0: TEAM DEVELOPMENT & PROJECT PLANNING

0.0 – COVER PAGE

Team ID: Tues-54

Please list full names and MacID's of all present Team Members.

Full Name:	MacID:
Stefan Fernandes	fernas72
Ahmed Shehzad	shehza6
Shayan Siddiqui	Siddm47
Eshal Khan	khane43
Ana Alberola Almenara	alberola

Insert your Team Portrait in the box below:



0.1 – TEAM CHARTER

Team ID: Tues - 54

Incoming Personnel Administrative Portfolio:

Prior to identifying Leads, identify each team members incoming experience with various Project Leads

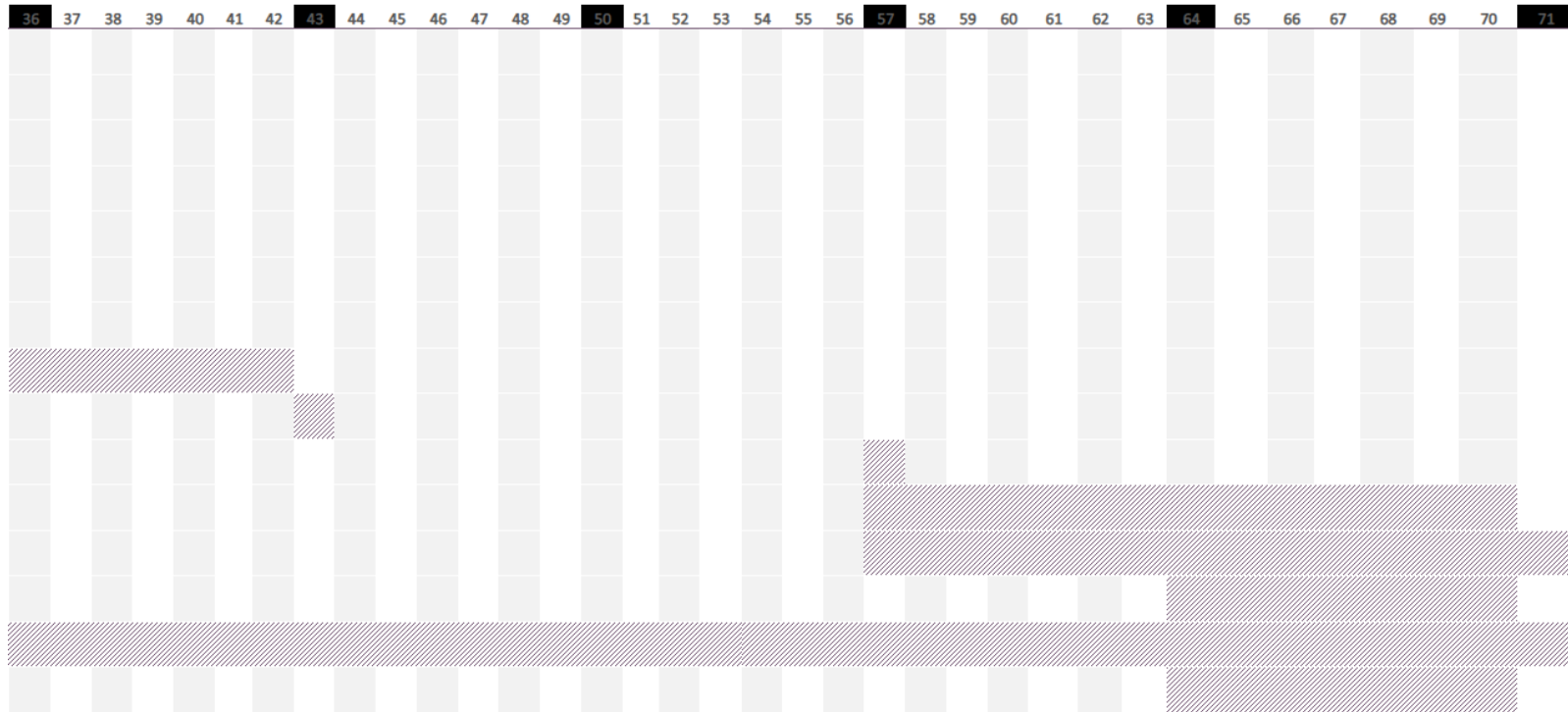
	Team Member Name:	Project Leads
1.	Stefan Fernandes	<input type="checkbox"/> M <input checked="" type="checkbox"/> A <input type="checkbox"/> C <input type="checkbox"/> S
2.	Ahmed Shehzad	<input checked="" type="checkbox"/> M <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> A <input type="checkbox"/> C <input type="checkbox"/> S
3.	Shayan Siddiqui	<input checked="" type="checkbox"/> M <input checked="" type="checkbox"/> A <input type="checkbox"/> C <input type="checkbox"/> S
4.	Eshal Khan	<input type="checkbox"/> M <input type="checkbox"/> A <input type="checkbox"/> C <input checked="" type="checkbox"/> S
5.	Ana Alberola	<input checked="" type="checkbox"/> M <input type="checkbox"/> A <input type="checkbox"/> C <input checked="" type="checkbox"/> S

To 'check' each box in the Project Leads column, you must have this document open in the Microsoft Word Desktop App (not the browser and not MS Teams)

Project Leads:

Identify team member details (Name and MACID) in the space below.

Role:	Team Member Name:	MacID
Manager	Stefan Fernandes	fernas72
Administrator	Eshal Khan	khane43
Coordinator	Ana Alberola Almenara	alberola
Subject Matter Expert	Shayan Siddiqui	Siddm47
	Ahmed Shehzad	Shehza6



0.3 – PREVIOUS PROJECT EXPERIENCE

Team ID: Tues-54

In the table below, detail each of your group members' experience and skills that will be useful in Project 3. This can include prototyping knowledge, software skills, modelling, testing experience and any other relevant information.

Team Member	Skills
Stefan Fernandes	Software – Python, CAD Hands-on – HATCH certification, machining, power tools
Ahmed Shehzad	Software Skills – Python, Testing Modelling, Design Skills
Ana Alberola Almenara	Software Skills- debugging, efficiency, diversity in coming up with solutions. Creativity/Problem-solving/Critical thinking Researching
Shayan Siddiqui	<ul style="list-style-type: none">- Software skills- Printing (Thode makerspace)- Document management - Some Cad
Eshal Khan	Software (Python), CAD, online UX design, general product development

P3 MILESTONE 1: UNDERSTANDING THE CLIENT, PROBLEM FRAMING, & TESTING PLAN

1.0 – COVER PAGE

Team ID: Tues-54

Please list full names and MacID's of all present Team Members

Full Name:	MacID:
Stefan Fernandes	fernas72
Ahmed Shehzad	shehza6
Shayan Siddiqui	Siddm47
Eshal Khan	khane43
Ana Alberola Almenara	alberola

1.2 – PROBLEM FRAMING

Team ID: Tues-54

1. As a team, come up with an initial problem statement and include it in the space below.
 - Make use of your client notes to define your primary function(s)
 - Focus on ONE area of the client's life
 - Remember to avoid solution-specific statements
 - Focus on what your design should do for the client in a general sense (not how to do it)

Mark has RA and is handicapped, which severely limits the dexterity in his hands and doing daily tasks. This makes it difficult to play with his dogs and other daily tasks. The design must be intuitive, easy to use, portable, lightweight, and durable.

1.3 – TESTING PLAN DEVELOPMENT

Team ID: Tues-54

1. As a team, come up with 5 objectives and at least 1 constraint that your design should meet and justify the reasoning behind your choices.
 - Three of your objectives should be quantitative and two should be qualitative.
 - Feel free to use such design tools as objectives trees, how/why ladders etc.

Justify your team's reasoning behind the choice of objectives:

Objective	Rationale
-----------	-----------

- | | |
|----|----------------|
| 1. | Durable |
| 2. | Lightweight |
| 3. | Portable |
| 4. | Intuitive |
| 5. | Cost effective |

Constraint	Rationale
------------	-----------

- | | |
|----|--|
| 1. | Size – Must fit in Wheelchair Pouch |
| 2. | Weight- Must be light enough for Mark to carry and use for prolonged periods of time |
| 3. | Durability- must withstand prolonged daily use |
| 4. | Easy-to-use - must avoid small buttons, excess force to be used, etc |

2. Fill out the table below with associated metrics (including units) for each objective.
 - a. Remember: Metrics should be something you can actually test or measure as part of your process (e.g., calculate weight of a part by iProperties in CAD, test results of a physical prototype).

Objective:	Durable
Unit/Metric:	Time(s/hrs/days) / Stress (Pa) / Strain

Objective:	Lightweight
Unit/Metric:	Grams/ KG

Objective:	Portable
Unit/Metric:	Size / Dimensions

Objective:	Cost Effective
Unit/Metric:	Price

Objective:	Intuitive
Unit/Metric:	Time it takes to learn (s)

Constraint:	Weight - Must be light enough for Mark to carry and use for prolonged periods of time
Unit/Metric:	grams-Kg

Constraint:	Durability - must withstand prolonged daily use
-------------	---

Unit/Metric:	Force (N)
--------------	-----------

Constraint:	Easy to Use- must avoid small buttons, excess force to be used, etc
Unit/Metric:	Time to learn (s)

- Next, come up with a testing plan for evaluating these objectives using the metrics you identified. Describe what equipment/resources will be needed, time to complete the test and another other pertinent information to completing the task.
 → An example testing plan is provided to you on Avenue, titled “P3 Testing Plan Example”

Objective	Testing Method
1. Durable	Shake it around, Apply excess force
2. Lightweight	Weigh on a scale
3. Portable	Measure the size
4. Intuitive	Test how long it takes other people to learn
5. Cost effective	Research Price of materials

Constraint	Testing Method
1. Size	Measure the dimensions of the wheelchair pockets and compare it with our product dimensions
2. weight	Determine how much mark can comfortably lift and try to aim under it.
3. durability	Drop test, lift test

4. easy to use Conduct a survey/ask around (test subjects use our product)

1.4 – REFINED PROBLEM STATEMENT

Team ID: Tues - 54

1. As a team, create a refined problem statement using the objectives you have identified and justified. Outline the Who, Where, Why, and What elements of your problem statement. Then write the refined problem statement below.
 - Who? – Mark
 - Where? – In his daily life and tasks
 - Why? – To improve his quality of life and give him more independence.
 - What? – Help address his handicaps resulting from his lack of dexterity and doing daily tasks.

Refined Problem Statement:

Design a product that addresses Mark's limited dexterity and mobility to provide a more comfortable way to accomplish daily tasks (such as walking and playing with his dog, gripping things, and cooking), while simultaneously granting further independence. The design must be intuitive, easy to use, portable, lightweight, cost-effective, and durable.

1.5 – DESIGN EXPLORATION PREPARATION

Team ID: Tues-54

1. As a team, discuss which topic each member will cover in the research summary. Then, fill out the table below.

Team Member	Research Topic
Shayan	Materials
Ana Alberola Almenara	Existing Solutions
Eshal Khan	Client Condition
Stefan Fernandes	Existing Solutions
Ahmed Shehzad	Patents

P3 MILESTONE 2: PROBLEM FRAMING, DESIGN EXPLORATION, & DESIGN REVIEW #1

2.0 – COVER PAGE

Team ID: Tues-54

Please list full names and MacID's of all present Team Members:

Full Name:	MacID:
Ana Alberola	alberola
Shayan Siddiqui	Siddm47
Eshal Khan	Khane43
Stefan Fernandes	fernas72
Ahmed Shehzad	Shehza6

2.2 – BRAINSTORM MODELLING

Team ID: Tues-54

Summary of Changes:

In the space below, please highlight any changes that were made to your items in Milestone 1 (objectives, constraints, problem statements, etc.)

- Ensure you have at least one constraint if you don't already have one
- Make sure you also explain and justify your reasons for making those changes
- Consider additional client notes and the results of your independent research assignments when making potential changes

Changes from Milestone 1

- Our initial problem statement was very broad and after discussing as a team and after reviewing the FAQ, our team decided to narrow down our problem.
- We noticed that Mark had concern's with playing with his dog as discussed in the FAQ page. We decided we would refine our problem statement to be focused on tackling issues Mark has with his dog and playing or caring for it.
- Our constraints did not change as they were still applicable to our new problem statement.

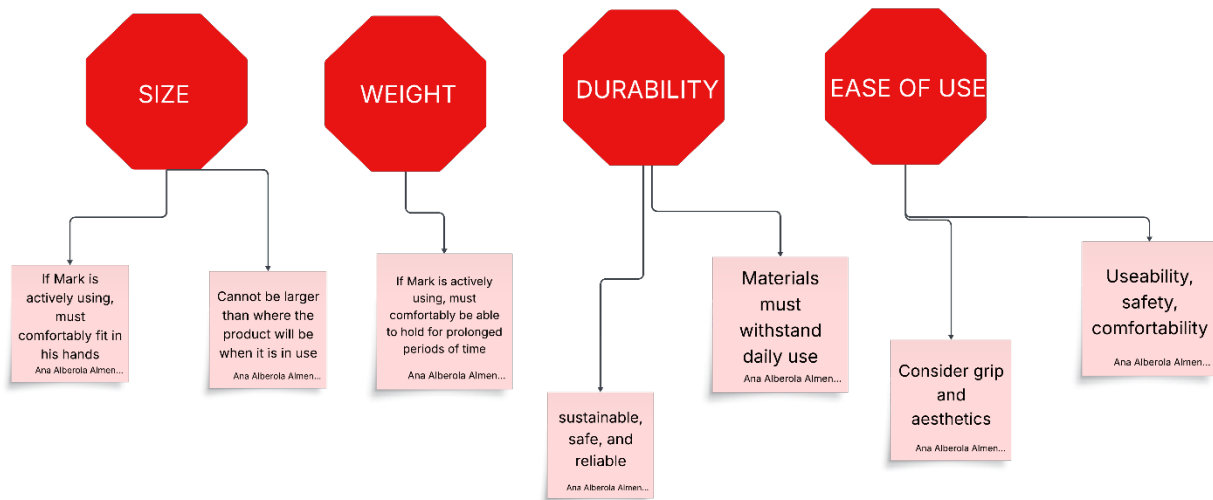
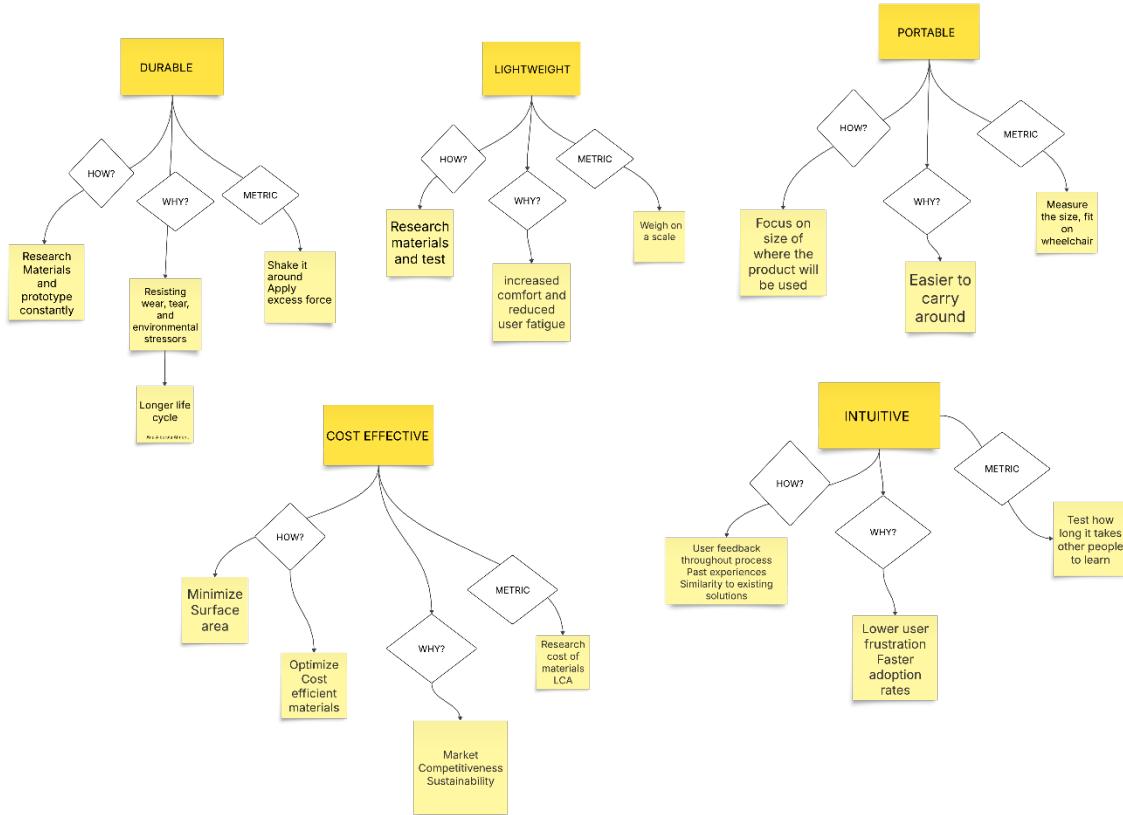
Refined: Design a product that addresses Mark's limited dexterity and mobility to provide a more comfortable way to care for his dog, while simultaneously granting further independence. The design must be intuitive, easy to use, portable, lightweight, cost-effective, and durable.

Include a copy of your team’s brainstorm modelling below:

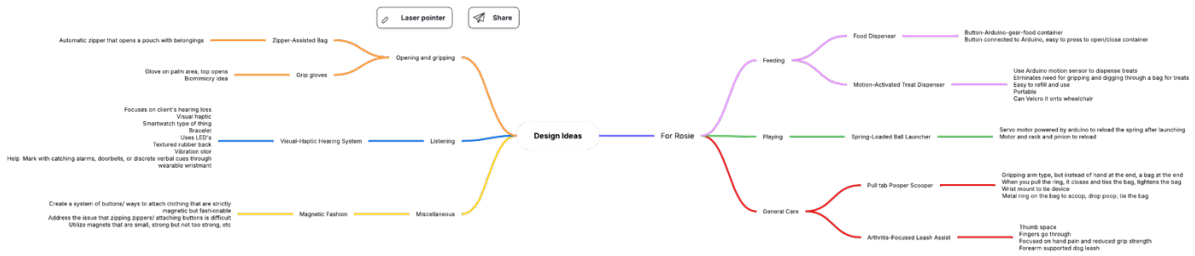
Objectives-Functions-Constraints Table (Remove if Not Applicable):

Objectives	Functions	Constraints
Durable		Size
Lightweight		Weight
Portable		Durability
Intuitive		Easy to use
Cost effective		

Other Brainstorm Modelling Methods



Other Brainstorm Modelling Methods (Remove if Not Applicable):
Other



2.4 – DESIGN REVIEW #1 + PROBLEM STATEMENT PROPOSAL

Team ID: Tues-54

As a team, you will present your refined problem statement and current project progress to your TA for feedback. This Design Review should be led by your team's Manager, who should come prepared with an agenda. This agenda should be included in the box below:

Team Manager Meeting Agenda

1. Present refined problem statement
2. Current project progress – each created individual concept sketches (share them)
3. Talk about our current direction of being geared towards the dog and addressing problems he faces with the dog
4. Ask about submissions

Any notes from this meeting should be recorded by your team's Coordinator and included in the box below:

Feedback Notes:

Our Presentation to TA

- Initial broad problem statement

- Narrowed down to focusing on Mark's dog
- Improving how he is able to take care of dog and daily life
- Focusing on limited dexterity and mobility
- Comfortability
- Further independence
- Must be intuitive, easy to use, portable, lightweight, cost-effective, and durable
- Objectives and constraints continue to apply
- Concept sketches were based on original problem statement, with at least one focused on products for the dog
- Presented sketches

Feedback

- What does Mark currently use as a leash?

- Recurring issue: dogs are unpredictable

- Ball launcher: if string is x long, no matter how long, dog may take it, run around with it, may rip out of Mark's hand

- Overall, all members have consideration for how to address problem statement

- There are further criteria:
 - How would this be cleaned/maintained?

 - Think about this long-term

 - More extension on care for his dog

 - Not solution-specific, that is good

 - Specifically target one area, i.e. how you feed/pick up after him, etc.

 - Feasibility of solution depends on team

 - Many solutions focus on Arduinos, will depend on Arduino knowledge

 - Can we design something good in the first place and apply knowledge/learning?

- Problem framing
- Have an idea of what you want to focus on
- Finalize problem statement and plan forward – group that isn't on the same page half-way through won't do well

Using the feedback from the Design Review, include an updated Refined Problem Statement in the box below:

Design a product that addresses Mark's limited dexterity and mobility to provide a more comfortable and easy way to have fun and play with his dog, while simultaneously granting further independence. The design must be intuitive, easy to use, portable, lightweight, cost-effective, and durable.

2.6 – SUMMARY OF PERSONAL PERFORMANCE

Team ID: Tues-54

Use the space below to document each persons' contributions to project:

Team Member	Personal Contributions
-------------	------------------------

- Ana Alberola Almenara
- Contributed to team discussions of objectives, constraints, brainstorming, and problem framing; offered perspective, opinion, and reasons supporting/against an idea
 - Researched existing solutions, Mark's condition, and built a general database of project information and team ideas
 - Developed concept sketches and ideas in accordance with team problem statement
 - Prepared CAD model of 2 concept sketches
 - Shared software for brainstorming diagrams to organize our ideas in more creative ways
- Shayan Siddiqui
- Helped organize objectives and constraints
 - Did materials research for grip and comfort (silicone, TPU, etc..) and shared the results with the team.
 - Thought of 2 concept ideas, drew them out and shared them with the team
 - Helped update team document and keep formatting consistent
 - Helped with brainstorming
 - Worked with other SME to make a document to keep track of sources
- Stefan Fernandes
- Did research into existing solutions for those who face dexterity and mobility issues.
 - Researched possible companies that sell products geared toward people like Mark.
 - Created 2 concept sketches and ideas and created an initial prototype.
 - Created project Gantt chart and prepared agenda items for meetings and design reviews.
- Eshal Khan
- Participate in team meetings and helped work on team sheets.
 - Researched client's condition – made sure to use reputable sources throughout
 - Connected between client's health history and the effect this has on his daily life (ultimately affecting our design choices throughout the project)
 - Consistently communicated with team members and submitted worksheets by their assigned deadlines
 - Worked on personal concept sketches and incorporated team feedback in every iteration
- Ahmed Shehzad
- Did research on Patented Ideas and concepts for ways to help people with dexterity problems in their hands to better develop an idea for a group project
 - Helped organize objectives, constraints, and helped create brainstorming models
 - Developed 2 sketches for refined and initial concepts as well as creating an initial physical prototype to test

- Participated in team meetings and brainstorm ideas and their feasibility
- Worked with other SME to continuously develop database of sources and research for overall project

P3 MILESTONE 3: DECISION MAKING, PROTOTYPING, & TESTING PLAN

3.0 – COVER PAGE

Team ID: Tues-54

Please list full names and MacID's of all present Team Members:

Full Name:	MacID:
Ana Alberola Almenara	alberola
Ahmed Shehzad	Shehza6
Shayan Siddiqui	Siddm47
Stefan Fernandes	Fernas72
Eshal Khan	khane43

3.2 – DECISION MAKING

Team ID: Tues-54

As a team, use a decision matrix to aid you in choosing two concepts to proceed with. Your concept titles should be descriptive (i.e., “Pencil with Hook” instead of “Design A”). If you had your Design Review before completing this decision matrix, use the feedback you were given from the review to influence your ratings of your concept(s).

Criteria	Weighting (out of 5)	Button- Activated Treat Dispenser	Secure Pouch	Motion- Activated Treat Dispenser	Ball Launcher Toy with Recall	Arm Attached Thrower
Durable	5	Score:3 Total:15	Score:3 Total:15	Score:4 Total:20	Score:3 Total:15	Score: 3 Total:15
Portable	4	Score:3 Total:12	Score:4 Total:16	Score:2 Total:8	Score:4 Total:16	Score: 4 Total: 16
Lightweight	3	Score:2 Total:6	Score:3 Total:9	Score:3 Total:9	Score:4 Total:12	Score: 4 Total:12
Intuitive	4	Score:5 Total:20	Score:5 Total:20	Score:4 Total:16	Score:3 Total:12	Score:4 Total:16
Cost- Effective	2	Score:3 Total:6	Score:2 Total:4	Score:3 Total:6	Score:1 Total:2	Score:2 Total:4
Feasibility	4	Score:5 Total:20	Score:4 Total:16	Score:4 Total:16	Score:4 Total:16	Score:2 Total:8

1P13 DP-3 Project Report

Design Studio Section **X**

Team Tues-54

Sum

n/a

79

80

85

73

55

Team ID: Tues-54

The numbers you associate with your criteria (objectives and constraints) will probably be an estimation at this point, so your top two concepts may not always end up being the top two scoring from the decision matrix. You should provide justification for your team's thought process in choosing the top two concepts. This should include, but is not limited to, explaining:

- Your choice of decision matrix tool
- Your rationale behind your choice of criteria
- Why you prioritized criteria the way that you did (if ranking and/or weighing them)
- What metrics you used to decide your scoring of concepts within the criteria
- Present your top concept(s) during your Design Review
 - If you had your Design Review before completing this part of the worksheet, your top two concepts may or may not be the ones you presented during your Design Review
 - Include in your justification how the Design Review influenced your top concepts

Insert your team's top two concepts below.

Concept 1: Motion-Activated Treat Dispenser

Concept 2: Button-Activated Treat Dispenser

Include your team's justification below.

Our team chose Motion-Activated Treat Dispenser and Button-Activated Treat Dispenser for several reasons. Firstly, they were 2 of the highest-scoring concepts in our decision matrix. Secondly, they are some of the most feasible designs. This aspect is extremely important because to have the best chance to succeed in this project, we must be able to create a product.

Furthermore, when brainstorming ideas for a more refined and fully formed concept, the team had a clear plan as to how to accomplish these 2 designs, especially the Motion-Activated treat dispenser. The team also has the skills to complete these designs, with experience in CAD modelling and Arduino. Finally, these designs accomplish the team's goals to have a creative product that helps Mark with one of his most important activities: caring for Rosie.

3.3 – REFINED PROJECT TIMELINE

Team ID: Tues-54

Include a list of all remaining tasks that need to be completed such that all final deliverables and remaining Milestones can be met. These may include but are not limited to:

- Prototyping
- Fabrication
- Material Purchasing/Allocation

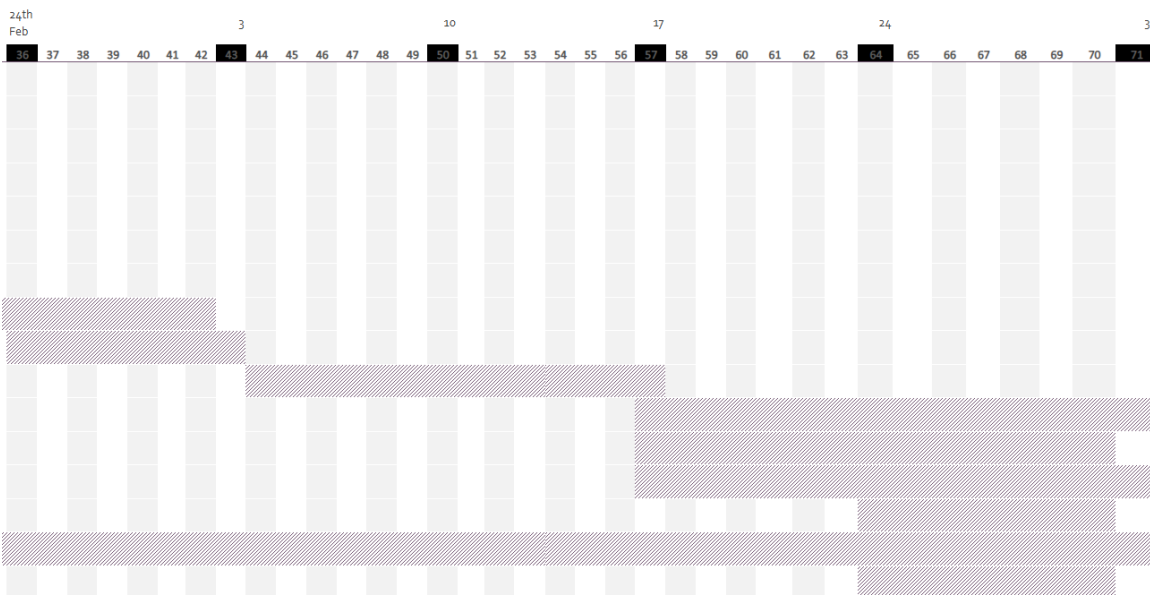
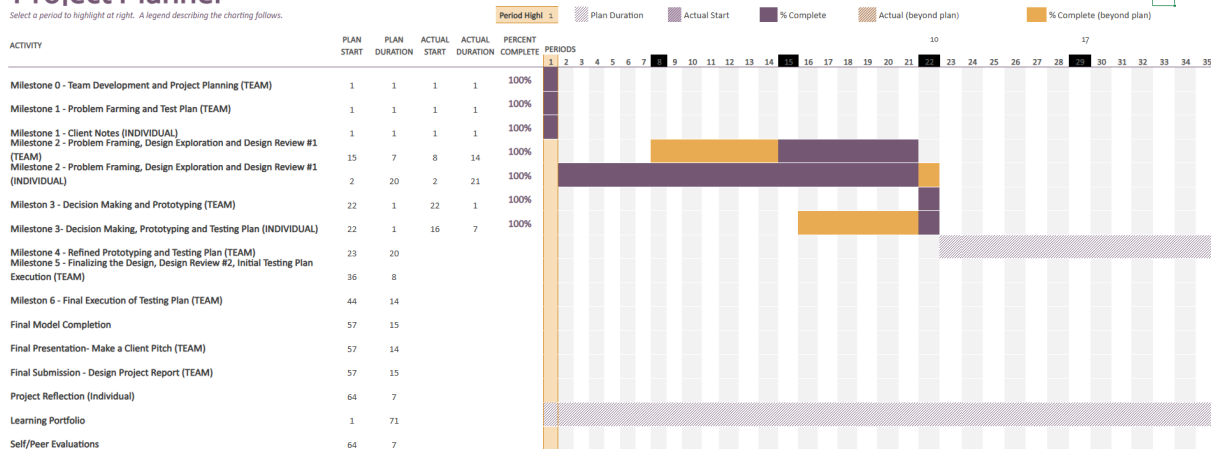
Be as specific as possible and allocate each task to a group member. There is no requirement on the number of outstanding tasks your group may have; ensure that the tasks encompass the remainder of the project and are achievable. Add these remaining tasks to your team Gantt chart and include an updated image below.

Task:	Time Needed to Complete:	Deadline Complete By:	Assigned Member:	Group
Initial Refined Prototype Modelling	3 weeks	March 2	Ana	

Testing Plan	2 weeks	March 17	Eshal and Ahmed
Fabrication of Final	2 weeks	March 30	Shayan and Stefan
Client Pitch	2 weeks	March 30	All
Design Report	2 weeks	March 31	All

Project Planner

Select a period to highlight at right. A legend describing the charting follows.



3.4 – SUMMARY OF PERSONAL PERFORMANCE

Team ID: Tues-54

Use the space below to document all your contributions to project:

Team Member	Personal Contributions
Ahmed Shehzad	<ul style="list-style-type: none"> - Helped create decision matrix and grade accordingly and choose top 2 concepts - Contributed to discussions and concept brainstorming to combine concepts to create unified finalized idea - Helped create timeline and assign roles to best suited members
Eshal Khan	<ul style="list-style-type: none"> - Assisted in brainstorming and connecting group members' prototypes - Contributed to decision matrix and team's final justification (combination of personal prototype and group members) - Ensured all worksheets are coherent and submitted milestone
Stefan Fernandes	<p>Created the project timeline and updated Gantt Chart.</p> <p>Contributed to group discussions with decision matrix.</p> <p>Showcased prototype and refined sketches</p>
Shayan Siddiqui	<ul style="list-style-type: none"> - Helped make Decision Matrix - Showcased my prototype / design - Helped with refined timeline
Ana Alberola	<p>Contributed to Decision Matrix Discussion</p> <p>Prepared team justification for decision making</p> <p>Described how design would work further and helped outline a plan to move forward with the project</p>

P3 MILESTONE 4: REFINED PROTOTYPING & TESTING PLAN**4.0 – COVER PAGE**

Team ID: Tues-54

Please list full names and MacID's of all present Team Members:

Full Name:	MacID:
Eshal Khan	khane43
Shayan Siddiqui	Siddm47
Stefan Fernandes	fernas72
Ana Alberola Almenara	alberola
Ahmed Shehzad	shehza6

4.1 – REFINED PROTOTYPE

Team ID: Tues-54

Amongst the team, share the individual refined prototypes that each person has made. From this, choose one main prototype to go forward with and continue refining.

- Discuss the benefits and disadvantages of each design – combine the benefits into your refined prototype!
- Fill out the worksheet below for your refined prototype

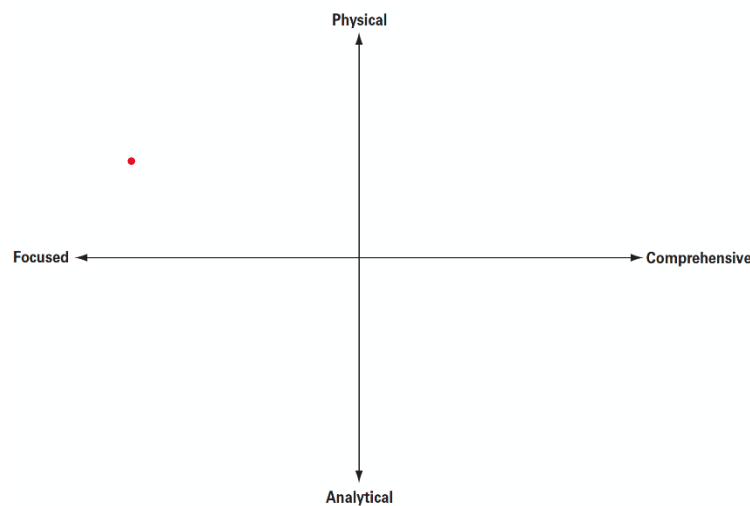
Team ID: Tues-54

Write a short description of your refined prototype below.

Our refined prototype is of a dog treat dispenser. It uses rotary motion from a motor to power an Archimedes screw which moves treats along to be dispensed. The main treat storage is in a chamber above which funnels into the Archimedes screw which brings it out for dispensing. Our prototype is controlled by a motion sensor connected to an Arduino which powers a motor to turn the gear connected to the Archimedes screw.

Our physical model consists of the first half of the print of the Archimedes screw and gear. We also have the first iteration of our Arduino motion sensor and motor code.

Indicate where your prototype falls on the scale below. Kind of Prototype:



Physical or Analytical

Focused or

Comprehensive

Purpose of Prototype:

- Test first 2 rotary mechanism design iterations
- Identify flaws in first 2 rotary mechanisms
- Narrow down choice of rotary mechanism
- Test if Arduino code, motor, works

Level of Fidelity:

High Fidelity – Use of Filament, future rotary design will closely resemble prototype

Include a list of objectives and metrics for your prototype below.

Objectives

- Lightweight
- Reliable
- Portable
- Durable

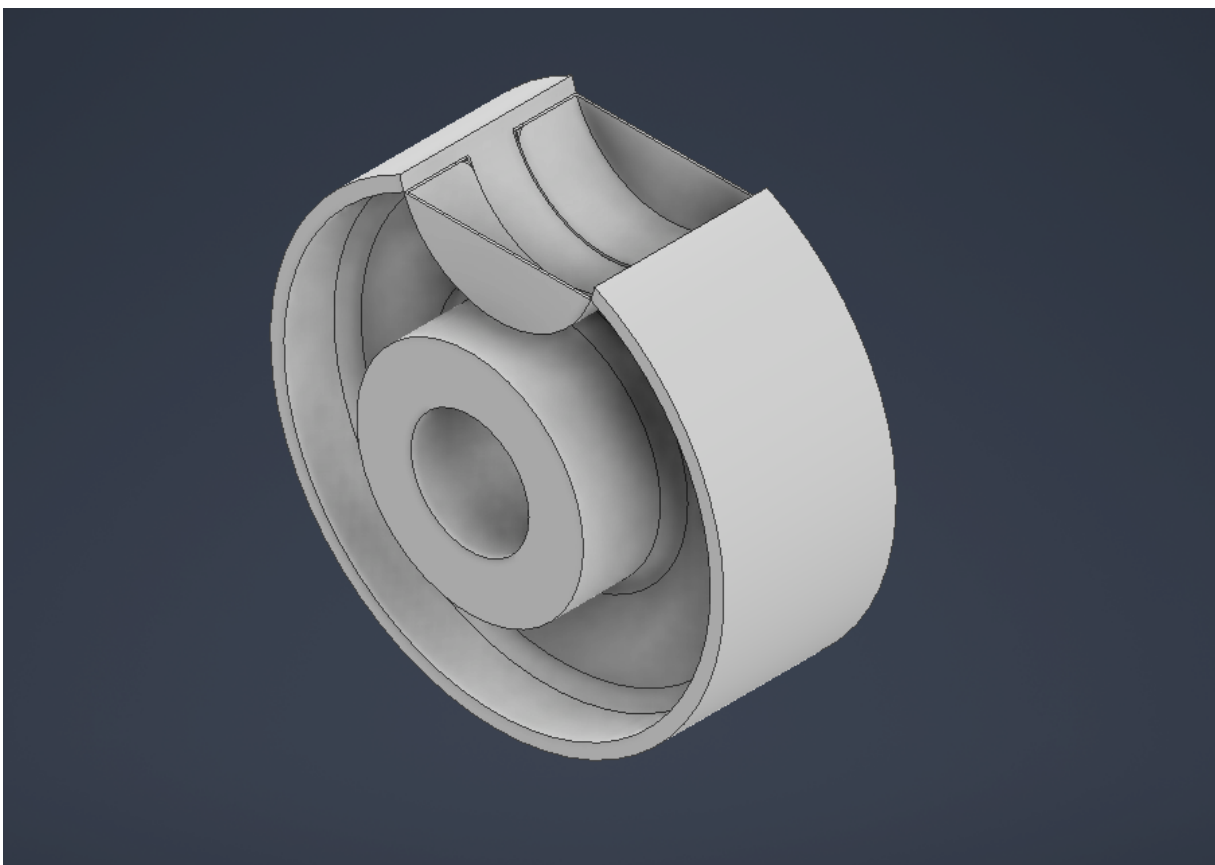
Metrics

- Weigh using scale
- Run Multiple times with increasing increments of treats and score
- Measure Dimensions
- Compressive Stress test vs Torsional Stress test
 - Increasing increments of stress to test when the fracture is reached

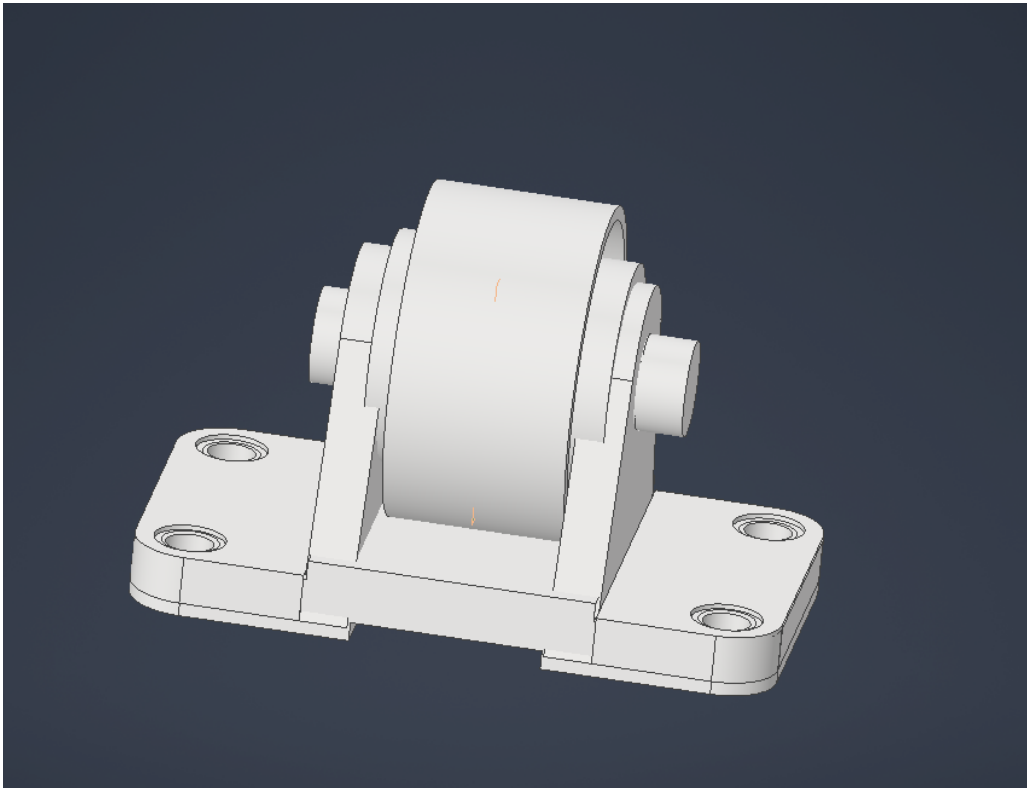
Take picture(s) of your refined prototype.

- Include picture(s) of your previous prototype(s) that you either decided to further refine or take elements from to create your refined prototype. Only include relevant previous prototypes
- Insert your photo(s) as a Picture (Insert > Picture > This Device)
- Do not include more than two pictures per page

Insert picture(s) of your previous prototype(s) below. These should be the prototypes that are relevant to your current prototype, and can be used as proof of the iteration process.

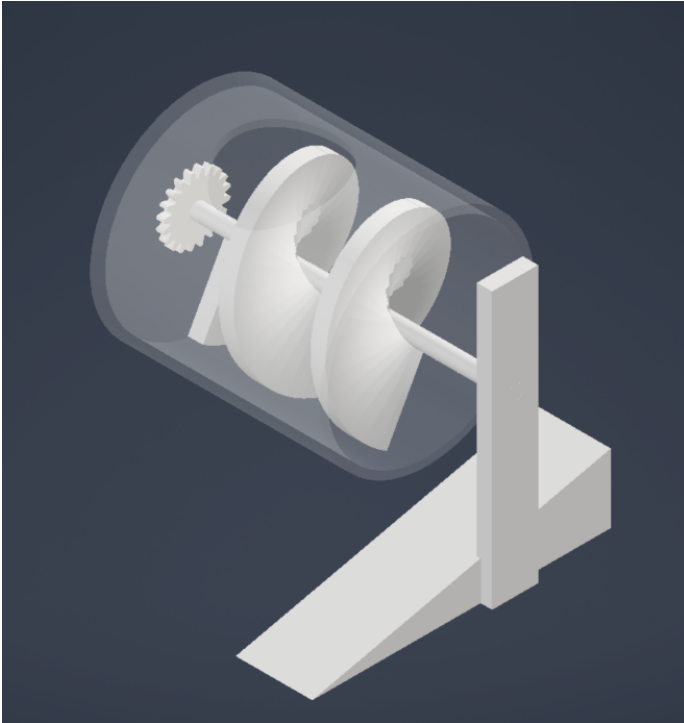


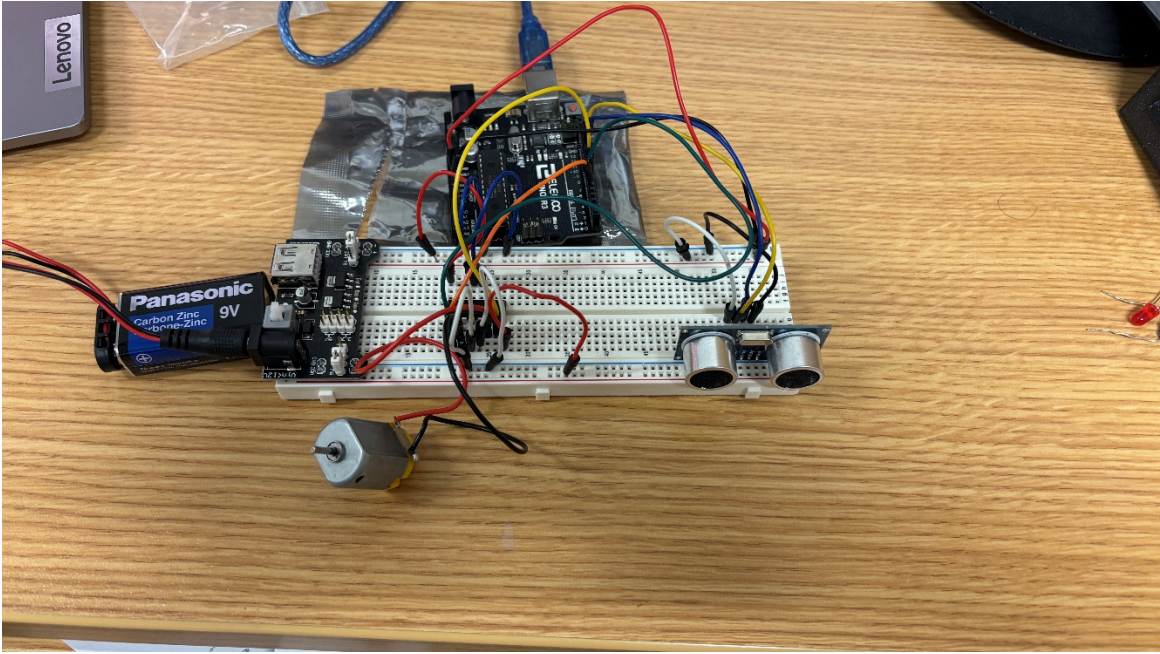
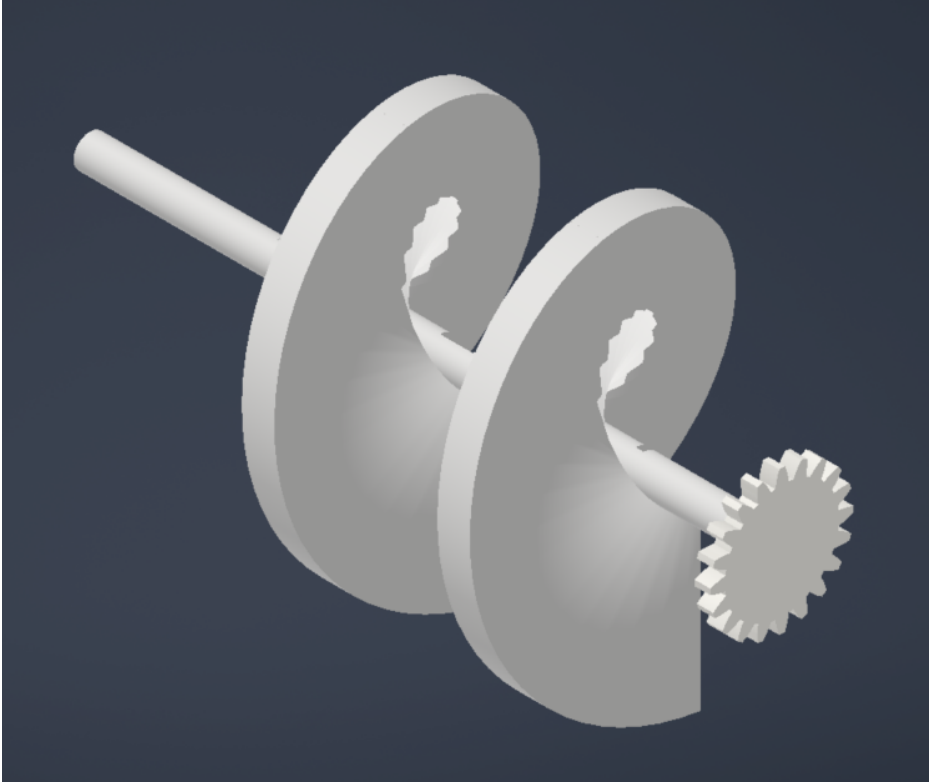






Insert picture(s) of your refined prototype below.







*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page.

Team ID: Tues-54

Include details on how design concept was refined (what feedback was incorporated, what features are different than previous refined concept (initial prototype), etc.).

The initial prototype features a hollowed-out box where the Arduino will be on the top and the treats will be dispensed out of the bottom. The box is refilled on the side, and the treats are dispensed through the motion sensor on the top.

From our initial prototype, we modified how the dispenser mechanism works as we did not have a clear vision of how it would work. We developed two different ideas, one being a gumball machine style dispenser and the other an Archimedes screw (seen in previous CADs).

Through Mark's visit we learned he uses cube shaped treats, and as such we pivoted towards the screw mechanism, as the cubes had the chance of getting stuck in the other mechanism design. Because of print feasibility, we also decided on the Archimedes screw mechanism which would work like an auger to transport the treats out.

From our initial feedback, having the entire device stored in a solid 3d printed box would make fixing internal mechanisms harder. As such we shifted away to 3D printing only the

mechanism itself and constructing the box and actual housing of the dispenser out of other easier to work with materials.

4.2 – PROTOTYPE TEST PLAN REFINEMENT

Team ID: Tues-54

Detail your prototype testing plan. (max. 500 words TOTAL for present and future plan)

- You have already outlined the testing plan in Milestone One. You should examine this testing plan and consider whether it is still feasible, document refinements, and then outline the methodology and equipment you need to source for next week’s execution of the plan.
- You should also document a future testing plan; document what refinements you would make and metrics you would like to examine if given more time and resources.
- Use IEEE referencing if any research is done.

Insert your Present Testing Plan (how you will test your prototype).

Testing Category	Objective	Constraints, Conditions	Testing	Success Metrics
Rotational Performance	Verify the reliability and precision of the motor-driven gear system.	Driven by Arduino-controlled identical conditions across all trials.	Arduino motor;	RPM (Speed), Torque Consistency, and frequency of jamming/misalignment.
Treat Flow Efficiency	Determine the maximum reliable capacity and dispensing consistency.	Uses paper balls (simulated liver cubes); incremental loading of "treats."		Dispensing Consistency, Flow Rate, and Clogging Threshold (Max Capacity).
Structural Durability	Ensure the device can withstand the physical rigors of wheelchair attachment.	Mounted to simulate wheelchair attachment; incremental force/leaning loads.		Deformation rate, identification of structural weak points, and Failure Load (Limit).

Insert your Future Testing Plan (how you would test your prototype with the resources that you do not currently have available but could have in the future).

To test the final prototype with resources not currently available, the first step would be to test the mechanism within the finalized structure. By placing all the components in the finalized shell and running the mechanism, we can determine how much space is wasted and if the mechanism needs readjustments in sizing due to friction and other damage. Next, we would run the mechanism by modelling treats as small LEGO pieces. This would allow us to test the torsional stress in the axle and whether the servo motor can move the mass of the treats in the finalized version, as well as test whether irregular shapes impact flow. This will enable us to limit the weight the motor can lift and determine whether the motor or the design must be updated. After that, we can attach the finalized design to a powerchair, which will be used for a couple of hours while determining how often the sensor/mechanism runs accidentally. By having the user then provide feedback, it can be determined how sensitive the sensor is and how it should be changed to be. Additionally, this information can provide whether the sensor should be changed for a different mechanism, like a lever or a button. Finally, the finalized design will be tested for its intuitiveness when we have more time and access to more users. We will ask 5+ users to use the product without aid or instruction and score its intuitiveness out of 10 and find the average score. This will ensure we can create an easy-to-use product that doesn't require much instruction or additional explanation. This will serve as a test for how simple the design is, ensuring any further maintenance can be done easily.

4.3 – SUMMARY OF PERSONAL PERFORMANCE

Team ID: Tues-54

Use the space below to document all your contributions to project so that it can be discussed during your weekly TA check-in

Team Member	Personal Contributions
Ana Alberola	Prepared prototype iteration on CAD, printed model. Prepared initial plan for focused prototype, worked on objectives and metrics. Discussed how to move forward.
Ahmed Shehzad	Helped brainstorm and design Refined Prototype mechanism. Aided in creating a future testing plan for focused prototype. Worked on metrics for refined prototype. Worked on Refined Prototype Worksheet. Discussed how to move forward.
Shayan Siddiqui	I contributed to the team milestone documents and helped organize updates as the design was refined. I designed and tested the Arduino control system for the prototype, including the ultrasonic sensor and DC motor setup both with and without a motor driver. I also booked and coordinated 3D prints for CAD parts using my Thode Makerspace training.
Eshal Khan	Contributed to brainstorming and planning out project timeline. Collaborated with team members on iteration process and worksheet submission. Submitted print requests for physical prototype.
Stefan Fernandes	Prepared CAD model of refined prototype and printed part of the model. Worked on refinements and iterations of refined prototype. Worked on building the physical Arduino circuit to test the code and design. Contributed to milestone documents.

P3 MILESTONE 5: EXECUTION OF THE TEST PLAN AND FINALIZING THE DESIGN

5.0 – COVER PAGE

Team ID: Tues-54

Please list full names and MacID's of all present Team Members:

Full Name:	MacID:
Eshal Khan	khane43
Shayan Siddiqui	Siddm47
Stefan Fernandes	fernas72
Ana Alberola Almenara	alberola
Ahmed Shehzad	shehza6

5.1 – FINAL EVALUATION OF THE OBJECTIVES AND CONSTRAINTS

Team ID: Tues-54

As a team, for the last time, restate the quantitative and qualitative objectives, along with constraints that you had stated in your refined testing plan of Milestone 4.

- If these objectives/constraints, metrics, and testing methods have changed over the course of your project, that is OK. Use the objectives/constraints, metrics, and testing methods that are most in line with your current design.
- You can refer to the Test Plan Guideline for more details.

State your Quantitative Objectives and their Metrics below:

Lightweight	Weigh using scale
Portable	Measure dimensions
Consistent output	Dispenses 3-5 treats at a time

State your Qualitative Objectives and their Metrics below:

Reliable	Run Multiple times with increasing increments of treats and score
----------	---

Durable	Increasing increments of stress to test when the fracture is reached
Ease of modification (Design can be opened, inside can be easily accessed)	Have 5-10 people try to take something out of the box, such as the Arduino, rewire it and put it back in

State your Constraints and their Metrics below:

Size of treats	Little liver cubes- design must be able to rotate and not get jammed on treats
Power of motor	Mechanism must effectively run with the power supplied by Arduino motor
Client dexterity	Mechanism must be activated easily by the client and without causing strain on client's muscles

Restate your current testing plan that you will be implementing today.

Insert your Present Testing Plan (how you will test your prototype).

To evaluate the rotary mechanism prototypes, we will conduct 3 categories of testing, rotational performance, treat flow efficiency, and structural durability.

First, to assess rotational performance, the mechanism will be driven by an Arduino-controlled motor connected via a gear system. The initial design will be tested under identical conditions. We will measure rotation speed, torque consistency, and any signs of jamming and misalignments over the course of multiple trials.

Second, to evaluate treat flow, paper balls approximating the size of the small liver cubes described by Mark will be used as test units. We will gradually increase the quantity of treats loaded into the mechanism and observe dispensing consistency, flow rate, and occurrence of clogging. This will help determine the maximum capacity at which the device operates efficiently without blockage or slowdown.

Finally, to assess durability, the mechanism will be mounted in a configuration like its intended attachment on Mark's wheelchair. Incremental loads will be applied to simulate leaning and accidental force. We will record deformation, structural weaknesses, and the load at which failure occurs.

Altogether, the tests will ensure the mechanism performs reliably, dispenses treats smoothly, and withstand real-world use. Overall, this will help determine if the mechanism works effectively or if a new iteration is needed.

State and justify any changes you made from last week.

Initially, the mechanism was going to have a hole in the shape of a servo motor to turn it, but we decided against this, as the motor is an Arduino motor, not a servo motor. Furthermore, the addition of a gear instead of a hole will allow us to apply more torque, and therefore more power to the mechanism to more effectively dispense the treats.

In addition, the previous carousel mechanism was changed to an Archimedes screw as it will be simpler to dispense the treats and turn it. It is also a CAD model with less parts, therefore we chose to move forward with this design for simplicity, and to align with our lightweight and cost-effective objectives.

For the Arduino, we switched from using a diode and transistor to using a motor driver for to gain bi-directional control, manage higher current/voltage loads, simplify wiring, and protect the Arduino from back-EMF spikes.

5.2 – DESIGN REVIEW #2 AND PROTOTYPE REFINEMENT

Team ID: Tues-54

Include your feedback from both your peers (or TAs/IAs) below. Remember to make clear what concept(s) you're receiving feedback for. Use the name of the concept that is used from your decision matrix

Include the discussion and feedback from the Design Review here:

Agenda

- Objectives/constraints
- Refined prototype iterations
- Testing plan refinements and team discussions
- Moving forwards and timeline

Objectives

- Quantitative
- Portable
- Consistent output
- Lightweight
- Quantitative
- Reliable
- Durable
- Ease of modification

Constraints

- Size of treats
- Power of motor
- Client dexterity

Archimedes screw, powered by a gear that spins the screw and dispenses the treats

Added a delay so that if he repeatedly waves his hand over or leaves hand over mechanism, the mechanism won't continue to operate.

How are we going to mount it?

Push clamp, to lock in place

If we don't have too much time, Velcro/command strip

Try M&Ms as a test-treat

Highlight topics that you plan to implement here:

Use M&Ms as simulators for treats

Use Velcro or command strips to easily test our device.

Request a laser cut for the gear

Acquire PET sheet panels to build the box

Servo motor

Solder the wires in the Arduino

Request 12V battery

Acquire driver controller L298N

Acquire housing- laser cut or thin wood planks

5.3.A – INITIAL TESTING PLAN EXECUTION

Team ID: Tues-54

Execute your testing plan for your Quantitative Objectives:

State and discuss the results of your testing plan in this box.

Testing Category	Testing Strategy	Results
Lightweight	Weigh, lift	Mechanism is currently lightweight, even with treats included. The motor and Arduino combo is not too heavy, so it is expected that the mechanism will remain lightweight. Exact weight: 386 g Treats weight: 101 g (approx.)
Portable	Test if can easily be attached to chair and move around NOW – JUST MEASURE DIMENSIONS	Mechanism is relatively portable. Current dimensions suggest it will fit on Mark's wheelchair comfortably, will have to revisit and ensure that it remains this way. Exact dimensions: 31 x 14 x 12 (cm)
Consistent output	Test if same amount of treats come out every time for one rotation (manual)	Addition of cardboard doors reduces amount of treats that come out. Will have to test if remains consistent with additional parts.

Execute your testing plan for your Qualitative Objectives:

State and discuss the results of your testing plan in this box.

Testing Category	Testing Strategy	Results
Reliable	Does the mechanism need the same amount of power every time, turn the same amount- is the user experience always the same	The mechanism generally needs the same amount of power every time and turns the same amount. However, this will have to be tested further in future iterations when the full motor is assembled.
Durable	Apply pressure on top simulating arm rest	Under heavy force the mechanism falls apart as it was secured using hot glue. Future iterations would use more long-lasting adhesive.
Ease of modification	Open and close, subject to outside individuals- can they easily open it, refill, etc User feedback/ Survey (outside group members)	Currently mechanism is easy to modify, but has not been closed yet. Future iterations should include an easy-open lid to fix any issues that may arise. Additionally, on average, user feedback has been positive (approx. ten people reported positive functionality).

Execute your testing plan for your Constraints:

State and discuss the results of your testing plan in this box.

Testing Category	Testing Strategy	Results
Size of treats	use smarties and hi-chews to simulate treats(both simulates smaller size and eventually also dispensed variety in size/shape)	The mechanism easily handled treats of smaller size and eventually also dispensed bigger treats
Power of motor	test if current motors, motor controllers, motor components work	Motor can spin the bigger gear to spin the mechanism, but it must be at a certain RPM. Must ensure that the mechanism is consistent when it is finalized.
Client dexterity	Test use of product without using all of our fingers or fully extending arms- simulate being in client's body	the mechanism requires some sort of physical aid to more easily refill with treats. Hole is too small to easily drop treats in

5.3.B – INITIAL TESTING PLAN DISCUSSION

Team ID: Tues-54

As a team, discuss the results of your testing plan. Consider the following points:

- How did your design do?
- Did it meet all expectations you had from your design?
- Did you go through any iteration based on the execution and the results of your test plan?
- How did the test plan influence your iterative process?
- Remember, focus on the overall functionality of your design rather than the aesthetic quality.

State and discuss the modifications of your design in this box.

Performance:

- When manually powering the mechanism by rotating the screw, it was able to dispense the treats.
- We noticed slight issues with the tube that the screw is enclosed in. Due to the low fidelity nature the dimensions were not precise or exact enough. As a result, treats would get stuck along the side and not be picked up by the mechanism.
- Additionally, when testing the motor it was not secured down properly causing the gears teeth to slip and not mesh properly.
-

Expectations:

- The design met some of the expectations we had. The initial model was able to dispense the treats when manually powered. However, when using the motor we faced issues with it meshing properly to the gear.
-

Iterations:

- We switched our motor out for a more powerful motor as our initial one was too weak.
- As a result we need to redesign our circuit and use a dedicated motor controller to power the motor.
- Due to a lack of torque from the motor, we changed the gear size on our screw in order to increase the gear ratio.
- We decided instead of constructing our own storage box we would modify a plastic box and place our components and food inside to make it more compact and lightweight.
- Add

Further Iterations (as Testing Plan Progressed):

- Added small cardboard opening to help with filtering out treats and support accurate results in (smarties and Hi-chews)
- Create a more permanent method of securing the motor that powers our device.
- Implementing a better tube for the screw which would be made out of plastic, thus limiting friction and created with the proper dimensions and shape.

5.3.C –TESTING PLAN FINAL REFINEMENTS

Team ID: Tues-54

Detail your testing plan refinements. (**max. 500** words TOTAL for the future plan):

- You have already outlined refinements of the testing plan in Milestone Four. You should examine this testing plan and consider whether it is still feasible, document new refinements, and then outline the methodology and equipment you need to source for next week’s final execution of the plan.
- Use IEEE referencing if any research is done.

Insert your **Future Testing Plan** (how you would test your prototype with the new refinements you determined from the initial execution and discussion)

Add refinements/ what has changed from previous plans

Objectives	Reliable	Durable	Intuitive	Portable
Metric	Quantity of treats dispensed per set is consistent; timing, force required consistent.	Lean on mechanism, subject to “real-life” stress simulations, and analyze number of cycles before damage	Full User Feedback from a survey	How easily does the mechanism move from one location to another, how easy is it to attach and carry

Test Using Smarties Through At least 5 users Attach to chair,
and Hi-chews, applying force attempt to use the measure
test if the on mechanism, product without dimensions, ease
mechanism is test if structure instructions or of transport
reliable in the can withstand guidance.
quantity of treats expected force
produced every by user.
time.

Each user rates
intuitiveness from
1–10; average
score calculated.
Also measure time
taken for a user to
successfully
operate the device
for the first time.

5.4 – SUMMARY OF PERSONAL PERFORMANCE

Team ID: Tues-54

Use the space below to document all your contributions to project so that it can be discussed during your weekly TA check-in

Team Member	Personal Contributions
Shayan Siddiqui	Bought and sources Arduino materials. Helped with the physical making of the prototype. Contributed to milestone. Helped with the testing process and weighing all the materials.
Stefan Fernades	Created circuit for new motor using motor controller and updated Arduino code. Designed the screw mechanism and assembled the initial prototype for testing. Worked on team sheets.
Ana Alberola	Provided candy to simulate treats, prepared milestone 5.3A, initial testing plan execution, prepared additional parts of mechanism (opening for treats to come out of), worked on overall milestone and brainstorming
Eshal Khan	Assisted with physical prototype testing, brainstorming for further iterations, contributing to milestone 5.3 (A,B, and C) and final submissions as administrator.
Ahmed Shehzad	Assisted with prototype testing with dimensions, weighing and testing intuitiveness. Brainstorming the further iterations. Aided in assembling prototype and fixing current problems. Contributed to Milestone 5 writing and idea generation.

P3 MILESTONE 6: FINAL EXECUTION OF TESTING PLAN**6.0 – COVER PAGE**

Team ID: Tues-54

Please list full names and MacID's of all present Team Members:

Full Name:	MacID:
Eshal Khan	khane43
Shayan Siddiqui	Siddm47
Stefan Fernandes	fernas72
Ana Alberola Almenara	alberola
Ahmed Shehzad	shehza6

6.1.A –TESTING PLAN EXECUTION

Team ID: Tues-54

Objectives	Reliable	Durable	Intuitive	Portable
Metric	Quantity of treatments dispensed per set is consistent; timing, force required consistent.	of Transport mechanism in bike over rough terrain - subject to “real-life” physical stress simulations, and analyze number of cycles before damage	User Feedback from a survey	How easily does the mechanism move from one location to another, how easy is it to attach and carry

<p>Test</p>	<p>Using Smarties and Hi-chews, test if the mechanism is reliable in the quantity of treats produced every time.</p>	<p>Through applying force on mechanism, test if structure can withstand expected force by user.</p>	<p>At least 5 users attempt to use the product without instructions or guidance.</p> <p>Each user rates intuitiveness from 1–10; average score calculated. Also measure time taken for a user to successfully operate the device for the first time.</p>	<p>Attach to chair, measure dimensions, ease of transport</p>
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Constraints

Size

Weight

Dexterity

Metric	Must fit on side of wheelchair; length of wheelchair is 40.6 cm.	Must be less than 1 kg	Must be used with limited hand mobility
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Test	Measure mechanism	Weigh mechanism	the At least 5 users attempt to use the product without using their fingers.
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Execute your testing plan for your Quantitative Objectives:

State and discuss the results of your testing plan in this box.

We used Hi-Chews in this testing plan and used more of them to simulate the design if it was completely full. The mechanism consistently dispensed one treat for the given motor speed. Furthermore, every time we put a hand/arm in front of the sensor, the mechanism worked. These results indicate the mechanism passed the reliability tests.

Execute your testing plan for your Qualitative Objectives:

State and discuss the results of your testing plan in this box.

To test its durability, we attached the mechanism to a bike to determine how it would handle being attached to Mark's wheelchair in rough terrain. The bike rode over bumps and turned many times on the route, while going faster than Mark's wheelchair (15 km/h vs 12 km/h). The mechanism did not withstand these conditions. It broke, although it was easy to fix. In the portability test, the mechanism performed well. It was easy to carry around, due to its lightweight and compact nature. A total of eight users used the mechanism, and when handed the treats, all of them put them in the hole, without further indications. These results indicate the mechanism passed the durability, intuitiveness, and portability tests.

Execute your testing plan for your Constraints:

State and discuss the results of your testing plan in this box.

The mechanism fits completely inside a 31 x 14 x 12 (cm) box, which should fit on the side of Mark's wheelchair. Additionally, it weighs a total of 386 g without the treats. With the treats, we estimate the mechanism will weigh about 500 g, since with the Hi-Chews it weighs 487g. These two results mean that the mechanism passes the weight and size tests. Furthermore, when the users tried to use the product without their hands, all of them were able to do this. This means that the mechanism passes the dexterity test.

6.1.B – TESTING PLAN DISCUSSION

Team ID: Tues-54

As a team, discuss the results of your testing plan. Consider the following points:

- How did your design do?
- Did it meet all expectations you had from your design?
- Did you go through any iteration based on the execution and the results of your test plan?
- How did the initial testing plan execution and results influence the execution and results of the testing plan execution?
- How did the test plan influence your iterative process?
- Remember, focus on the overall functionality of your design rather than the aesthetic quality.

State and discuss the modifications of your design in this box.

The changes made to the design include: laser cut supports for better stability in the design, revamped the cardboard tubing to make a tighter fit, and mounted motor properly with 2 laser cut supports. Previously, the screw was touching the ground, which caused there to be a lot of friction. Furthermore, the tighter fit ensures that the treats do not get stuck in the gaps. Instead, the tighter fit allows for smoother transportation of treats and no losses. After durability testing using the bike, the mechanism broke apart. We found the hot glue was not strong enough, so we superglued the parts together instead. Our design is not durable enough. In the future, we will have to secure everything much better. Using superglue and adding tape to areas that will be glued to create friction, we will ensure that the design holds together.

In the future, we would like to use a cylinder as a vessel to easily refill the treat dispenser. We plan to use something like an empty peanut butter jar and cut open the top. This will be easy to attach to the top of the mechanism and will make it easier to fill up since it is a wider mouth than the small hole. It will act like a funnel.

In the future, we would like to improve our wire management, having cables to bundle the wires together or taping the wires to the wall to ensure they do not get caught on the screw or when the food is dropped. This was because during testing the wire on the motor was disconnected due to entanglement with another wire and was caught on the screw. Fixing this will ensure that the Arduino and wires do not get damaged while in use maintaining the product and ensuring long term use.