ENGINEER 1P13:
PROJECT FOUR WORKSHEETS (TEAM)

Table of Contents

PROJECT FOUR MILESTONE ZERO: TEAM DEVELOPMENT AND PROJECT PLANNING

MILESTONE 0 – COVER PAGE

Team ID: Fri-43

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

Full Name:	MacID:
Aman Minhas	minhaa18
Noor Ahmed	ahmem125
Emilya Hum	hume3
Shajijan Narendran	narends
Shadi El-Fares	elfaress

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Insert your Team Portrait in the dialog box below.

MILESTONE 0 – TEAM CHARTER

Team ID: Fri-43

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Emilya Hum	☐ M ☒ A ☒ C ☐ S
2.	Noor Ahmed	☒ M ☒ A ☐C ☒ S
3.	Aman Minhas	☒ M ☒ A ☒ C ☐ S
4.	Shajijan Narendran	☒ M ☒ A ☒ C ☐ S
5.	Shadi El-Fares	☒ M ☐ A ☒ C ☐ 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.

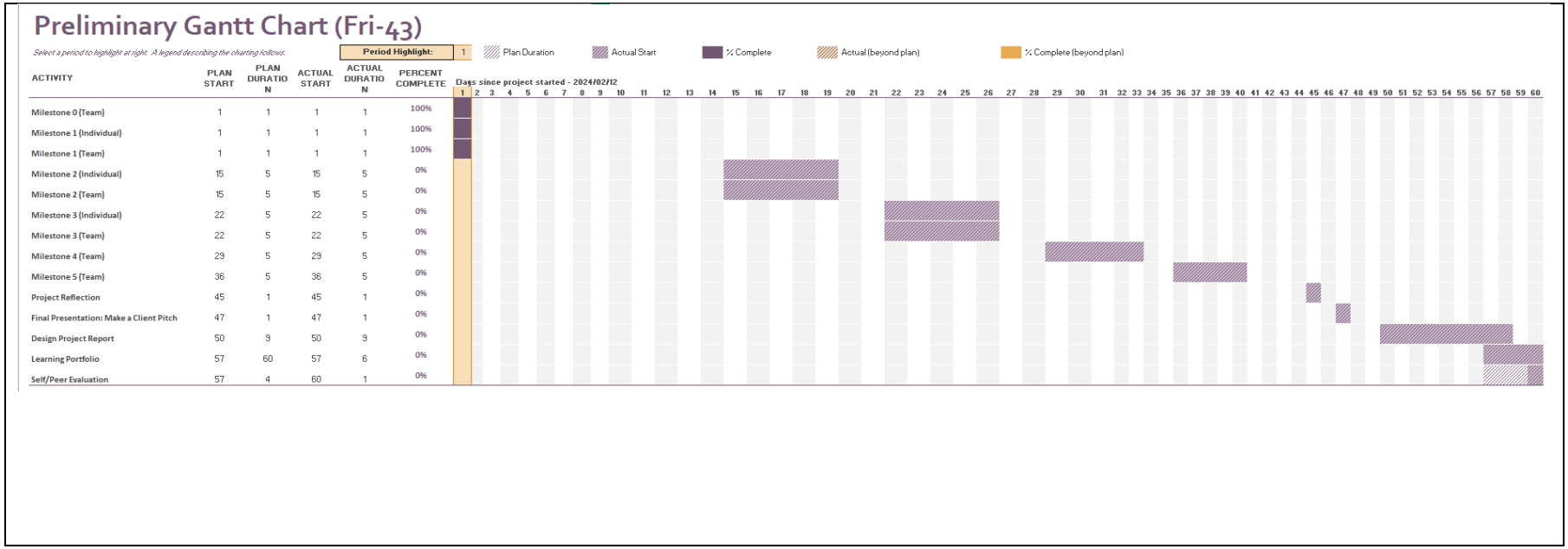
Role:	Team Member Name:	MacID
Manager	Emilya Hum	hume3
Administrator	Aman Minhas	minhaa18
Coordinator	Noor Ahmed	ahmem125
Subject Matter Expert	Shajijan Narendran	narends
Subject Matter Expert	Shadi El-Fares	elfaress

MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

Team ID: Fri-43

Full Name of Team Manager:	MacID:
Emilya Hum	hume3

Preliminary Gantt chart



MILESTONE 0 – PREVIOUS PROJECT EXPERIENCE

Team ID: Fri-43

In the table below, detail each of your group members' experience and skills that will be useful in Project 4. This can include prototyping knowledge, software skills, modelling, testing experience and any other relevant information.

Team Member	**Skills**
Emilya Hum	- Java, Python, Turing - Inventor, AutoCAD, Revit - P2 Computation team - P3 Modelling team
Noor Ahmed	- Modelling team for P2 - Computing team for P3 - Experience in Python and AutoCAD

Aman Minhas	- P3 Modeling Team
	  o Autodesk Inventor
	- P2 Computing Team
	  o Python

Shajijan Narendran	- Java, Python - Inventor, Solidworks
Shadi El-Fares	- Python, Various Web Development Frameworks (JS, HTML, CSS) - Inventor, AutoCAD - ROS2, C++

PROJECT FOUR MILESTONE ONE: PROBLEM FRAMING AND TEST PLAN

MILESTONE 1 – COVER PAGE

Team ID: Fri-43

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

Full Name:	MacID:
Shadi El-Fares	elfaress
Noor Ahmed	ahmem125
Emilya Hum	hume3
Shajijan Narendran	narends
Aman Minhas	Minhaa18

MILESTONE 1.2 – PROBLEM FRAMING

Team ID: Fri-43

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)
   → 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)

To aid Tiffany in her day-to-day task while feeling as comfortable as possible, without restricting her capabilities.

MILESTONE 1.3 – TESTING PLAN DEVELOPMENT

Team ID: Fri-43

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.
   → 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. Durability	Withstand excessive weight and unforeseen weather conditions.
2. Portable	Should be able to travel with ease without disrupting others.
3. Longevity	Should last for years on end without requiring replacement / fractures while working perfectly.
4. Battery Life	Should last approximately 8 hours on a full charge, to assist over a full-working day.
5. Accessible and Safe	Allows for convenient daily use without putting health or comfort at risk
Constraint	Rationale
1. Weight	Design must not exceed 10 lbs.

2. Fill out the table below with associated metrics (including units) for each objective.
   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:	Run various stimulations in Inventor.

Objective:	Portable
Unit/Metric:	Is not difficult to travel with.

Objective:	Longevity
Unit/Metric:	Years

Objective:	Battery Life
Unit/Metric:	Time the battery lasts in minutes

Objective:	Accessible and Safe
Unit/Metric:	Should not hurt others around her, or herself.

Constraint:	Weight
Unit/Metric:	Pounds

3. 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 "P4 Testing Plan Example"

mive	Testing Method
1. Durable	We need to test the max carrying capacity of the arm.
2. Portable	Have someone in a rolling-chair carry the arm and receive input on how comfortable they are. This will mimic Tiffany's response.
3. Longevity	We can test if any structural fractures happen over the testing period.
4. Battery Life	Have the motors run repeatedly over a span of 8-hours.
5. Accessible and Safe	Ensure sharp edge safety for others through testing the interaction with materials and pressure tests.
Constraint	
1. Weight	Have Tiffany hold the arm and ask her if it is too heavy for her.

MILESTONE 1.4 – REFINED PROBLEM STATEMENT

Team ID: Fri-43

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? – Tiffany
- Where? – Everyday and workplace
- Why? – alternatives not safe for public (sharp) and not portable friendly
- What? – aid her arm mobility

Refined Problem Statement:

Tiffany's limited arm mobility, in addition to factors such as accidentally bumping into pedestrians, adverse weather conditions, and the necessity for portability, presents a multifaceted challenge in creating an effective solution to enhance her day-to-day life.

MILESTONE 1.5 – DESIGN EXPLORATION PREPARATION

Team ID: Fri-43

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
Shadi El-Fares	Motor Control
Noor Ahmed	Existing Solutions
Emilya Hum	Materials
Aman Minhas	Client Overview
Shajijan Narendran	Patents

PROJECT FOUR MILESTONE TWO: DESIGN EXPLORATION AND DESIGN REVIEW #1

MILESTONE 2 – COVER PAGE

Team ID: Fri-43

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

Full Name:	MacID:
Emilya Hum	hume3
Shadi El-Fares	elfaress
Noor Ahmed	ahmem125
Shajijan Narendran	narends
Aman Minhas	minhaa18

MILESTONE 2.3 – FUNCTIONAL ANALYSIS

Team ID: Fri-43

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. Make sure to include an **updated** Refined Problem Statement as well.

Changes from Milestone 1

- Initial design included motors, and Arduino motor circuits to control expandable and retractable functionality or arm. The change to the newer design does not include motors as it can be done, in a simpler manner. Reducing the complexity of the design as well as increasing user accessibility.

Major Design Change:

- Instead of an expendable / retractable arm the team has moved towards an add-on to the tires that will prevent the snow that surrounds the tires. The new design will essentially be military-style treads that push snow back and allow for snow clearance while driving.

Updated Refined Problem Statement:

- Tiffany's condition, Spina Bifida, which requires her to rely on a wheelchair faces significant adversity due to snow and salt placed on the roads wearing down the tires presents a multifaceted challenge in creating an effective solution to enhance her outdoors mobility.

Individual Research Assignment:

- Client Overview: Researching into Spina Bifida and the obstacles it creates for Tiffany.
    - Movement in the winter months, especially in Canada, becomes a great obstacle. Due to limited traction between wheels and snow or ice, Tiffany finds challenges with transportation within those months.
    - To improve her independence, ensuring her wheelchair is safe and reliable no matter the road conditions is important.

- Motor Control: Researching how the retractable / expandable portions of the arm would work.
    - Controlling multiple motors with Arduino would allow for precise coordination in the expand / retract functions. This would also help in automation, providing benefits like complex movements and increased load capacity, achieved through motor selection, drivers, power supply, and programming for optimal operation.
    - .
- Existing Solutions: An analysis of the pre-existing products that may serve as potential solutions to challenges faced by Tiffany.
    - Several products exist to help improve the mobility and accessibility of individuals who use wheelchairs.
    - Some wheelchairs are crafted in a unique way that allows them to handle any terrain. Winter Tires also exist for wheelchairs. A wheelchair model exists that has a tracking device and navigation device embedded within. Several Reacher grabber devices exist, some employ magnets, suction cups or hooks, and claws.

- While several Reacher Grabber Devices exist, no such product has yet been devised to act as a winter add-on to wheelchair tires.

- Patents: Researching existing patents that might prevent us from creating designs/concepts with too much overlap
  - Examples include mechanisms that adjust the height of the wheelchair to improve the user's accessibility, software programs that display info about a location's accessibility, and dynamic communication methods between users and their caregivers
  - Potential solutions/designs need to be distinct from the patents by incorporating several elements
- Materials: Research which materials are best for a portable gripper so that is it durable and lightweight
  - Analysis of Granta EduPack charts and data suggests that there are various materials that are lightweight and durable. The materials that appeared to be more ideal included cast iron (ductile (nodular), steel (medium carbon, high carbon, and low alloy), aluminium alloys, bamboo and wood. Aluminium alloys are the best material for a portable gripper because it is durable while not being too heavy or expensive when compared to its alternatives.

Updated Objectives & Constraints:
- Constraint: Cost
- Durability: Ability to stay strong under extra weight
- Portability: Retractable design that allows for storage during off season
- Longevity: Withstand harsh weather such as slush, snow, ice, rain, hail, etc.
- Grip: Ensure traction of add-on is sufficient for snow ploughing

1. Include a copy of your team's functional analysis below.

Function	**Means**					
Push Snow Back	Perpendicular edges sticking out of each linkage to push back snow on each	Utilize material with greater use of friction to reduce salt size on impact.	Chain the wheels to increase contact with ground.	Rotating blades/paddles		
Reduce the Sticking of Salt to Tread	Rounded Corners of each linkage to reduce opening for salt to be stuck.	Cut out portions that reduce the space of where salt may get cut.	Heated belt	Frictionless material		
Smooth Driving Sensation	Adjacent Corners to linkages to reduce drop per rotation.	Rounded edges on the "stuck-out" portion to soften the impact to ground.	Tire studs & chains for snow	Flexible Material		

MILESTONE 2.5 – DESIGN REVIEW

Team ID: Fri-43

Design Review Comments: Use the space below to document feedback for your design

Include feedback from your faculty mentor, staff, or assigned TA/IAI in this row

- How will this be installed and maintained?
- Conveyor belt style seems a bit challenging.
- Understand the function/purpose of each wheel.
    - Do some stay stationary and solely translational while others have rotational features.
        - Which wheels **NEED** the traction belt around them? Can some wheel's not have them while serving the overall purpose.
- Do some research into the material of the add-on.
    - Rubber and Rubber → too high of a friction against each other causing little to no movement.
    - Consider maintenance, flexibility, and overall cost.
- Compare strength and maintenance, weigh the importance of both factors.
    - Have a strong product while having weaker maintenance.
    - Have an easily maintained product while having a weaker overall product

Include feedback from science students in this row. (if applicable)

- *Easy maintenance and repair*
    - *Review costs, accessibility of replacements, and maintenance procedures*
- *Tiffany mentioned a previous incident where she was alone, and her belt snapped.*
    - *To combat, our team's design must be easy to repair and avoid dependance on other.*

PROJECT FOUR MILESTONE THREE: PROTOTYPING, DECISION MAKING AND DESIGN REVIEW #2

MILESTONE 3 – COVER PAGE

Team ID: Fri-43

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

Full Name:	MacID:
Shadi El-Fares	elfaress
Aman Minhas	minhaa18
Emilya Hum	hume3
Noor Ahmed	ahmem125
Shajijan Narendran	narends

MILESTONE 3.2 – DECISION MAKING

Team ID: Fri-43

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).

Include your team's Decision Matrix below.

		Prototypes									
		Big Circle Design with popsicle sticks for traction		Circle with twine and triangular sponges attached along circumference		Trapezoidal treads with connective tubing		Rounded edge tire treads		Cylindrical Wheel with Treads	
Criteria	**Weighting**	**Score**	**Total**	**Score**	**Total**	**Score**	**Total**	**Score**	**Total**	**Score**	**Total**
Ice and snow traction	5	2	10	3	15	4	20	4	20	4	20
Push back snow	2	2	4	4	8	3	6	5	10	3	6
Durable/Strong	4	4	16	3	12	4	16	3	12	4	16
Reduce the Sticking of Salt to Tread	3	4	12	2	6	3	9	3	9	4	12
Latches onto wheel	5	4	20	2	10	4	20	4	20	2	10
Smooth Driving Sensation	3	4	12	2	6	3	9	4	12	3	9
Total			**74**		**57**		**80**		**83**		**73**

Team ID: Fri-43

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:	Trapezoidal treads with connective tubing
Concept 2:	Rounded edge tire treads

Include your team's justification below.
The final team consensus was justified through decision matrix above.

MILESTONE 3.3 – REFINED PROJECT TIMELINE

Team ID: Fri-43

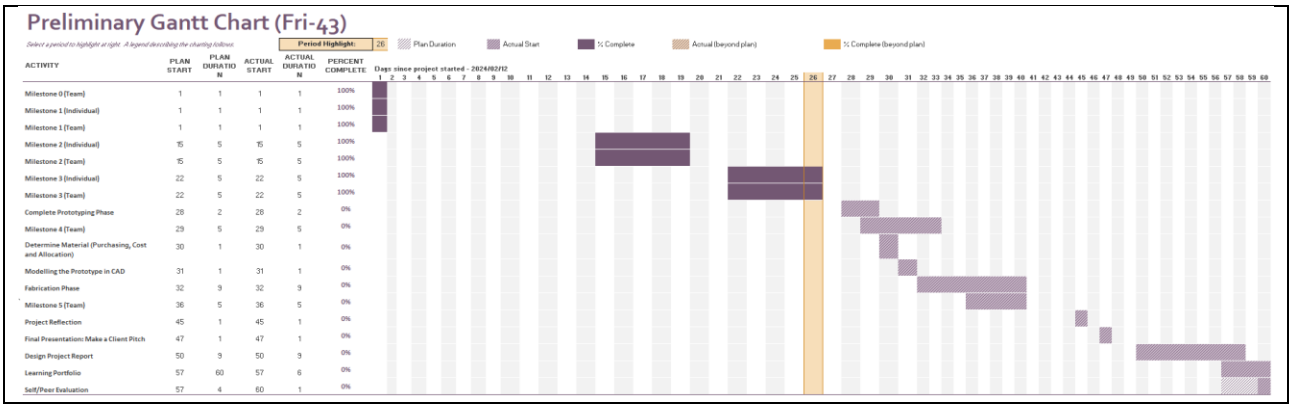
Include a list of all remaining tasks that need to be completed such that all final deliverables and remaining Milestones can be met. These may include but are not limited to:

→ 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 to Complete By:	Assigned Group Member:
Complete prototyping phase – Find circular object to fit AROUND prototype	3 Hours	Monday, March 11 2024	Emilya & Aman
Design Phase: Transfer prototype to CAD – visualize, sizing, etc.	3 Hours	Wednesday, March 13 2024	Emilya
Material Phase: Determine Material (Purchasing, cost, allocation)	1 Hour	Tuesday, March 12 2024	Aman, Emilya, Noor, Shadi, Shajijan
Fabrication Phase	TBD	Sunday, March 24 2024	Aman, Emilya, Noor, Shadi, Shajijan
Testing Period	4.5 Hours	Friday, March 29 2024	Aman, Emilya, Noor, Shadi, Shajijan
Presentation Prep	3 Hours	Saturday, March 30 2024	Aman, Emilya, Noor, Shadi, Shajijan

Include an updated image of your Gantt chart:



Preliminary Gantt Chart (Fri-43)

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

Period Highlight: 26 | Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Milestone 0 (Team)	1	1	1	1	100%
Milestone 1 (Individual)	1	1	1	1	100%
Milestone 1 (Team)	1	1	1	1	100%
Milestone 2 (Individual)	15	5	15	5	100%
Milestone 2 (Team)	15	5	15	5	100%
Milestone 3 (Individual)	22	5	22	5	100%
Milestone 3 (Team)	22	5	22	5	100%
Complete Prototyping Phase	28	2	28	2	0%
Milestone 4 (Team)	29	5	29	5	0%
Determine Material (Purchasing, Cost and Allocation)	30	1	30	1	0%
Modelling the Prototype in CAD	31	1	31	1	0%
Fabrication Phase	32	9	32	9	0%
Milestone 5 (Team)	36	5	36	5	0%
Project Reflection	45	1	45	1	0%
Final Presentation: Make a Client Pitch	47	1	47	1	0%
Design Project Report	50	9	50	9	0%
Learning Portfolio	57	60	57	6	0%
Self/Peer Evaluation	57	4	60	1	0%

Days since project started - 2024/02/12

PROJECT FOUR MILESTONE FOUR: REFINED PROTOTYPING AND TESTING PLAN

MILESTONE 4 – COVER PAGE

Team ID: Fri-43

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

Full Name:	MacID:
Aman Minhas	minhaa18
Emilya Hum	hume3
Noor Ahmed	ahmem125
Shadi El-Fares	elfaress
Shajijan Narendran	narends

MILESTONE 4.1 – REFINED PROTOTYPE

Team ID: Fri-43

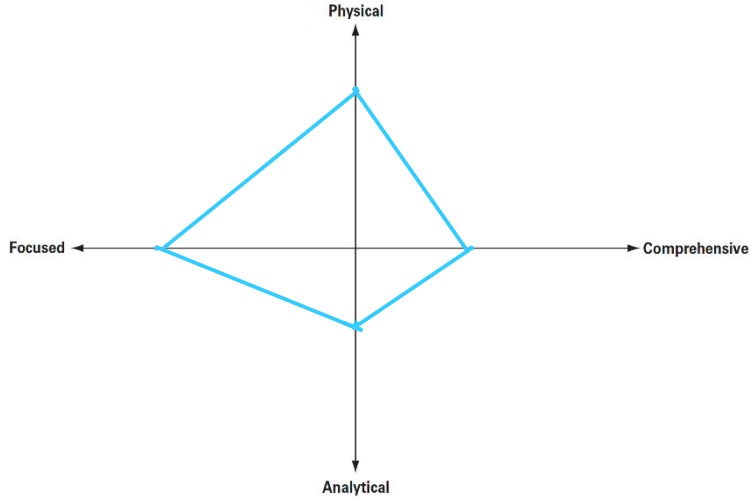
1. Create an outline for the creation of your refined prototype using the following worksheet.

Team ID: Fri-43	MacID: ahmem125, hume3, minhaa18, elfaress, narends

Write a short description of your refined prototype below.
Name: WinTire

Circular tire add on, made with paper, cardboard, sponge and popsicle sticks. Indents in circular frame of add on made with paper act as features to enhance traction. Sponge cutouts replicate tire treads that aim to improve add on grip for various terrains. Cardboard and popsicle to help reinforce add on shape and increase strength allowing for more load.

Indicate where your prototype falls on the scale below.



Kind of Prototype:
☐ Physical or ☐ Analytical
☐ Focused or ☐ Comprehensive

Purpose of Prototype:
To provide a general physical model of the design that helps envision the important aspects of the final product as well as an aid to determine areas of improvement and potential features that may enhance the design and function.

Level of Fidelity:
Medium Level

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

Objectives

- **Flexibility**
- **Durability**
- **Portability**
- **Grip**

Metrics

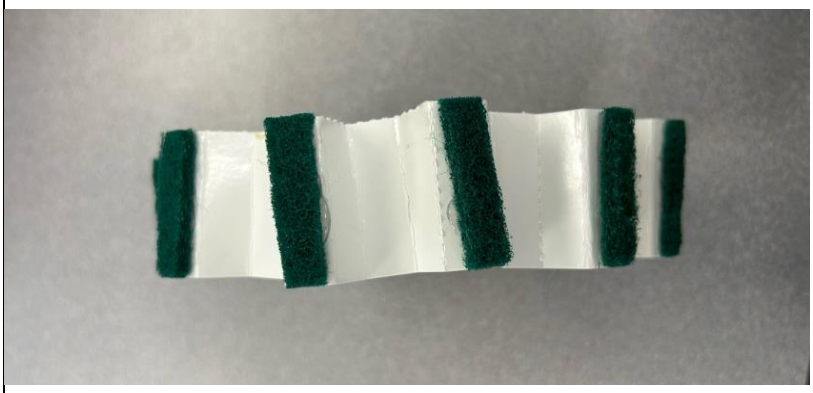
- **Weight**
- **Cost**
- **Angular Velocity**

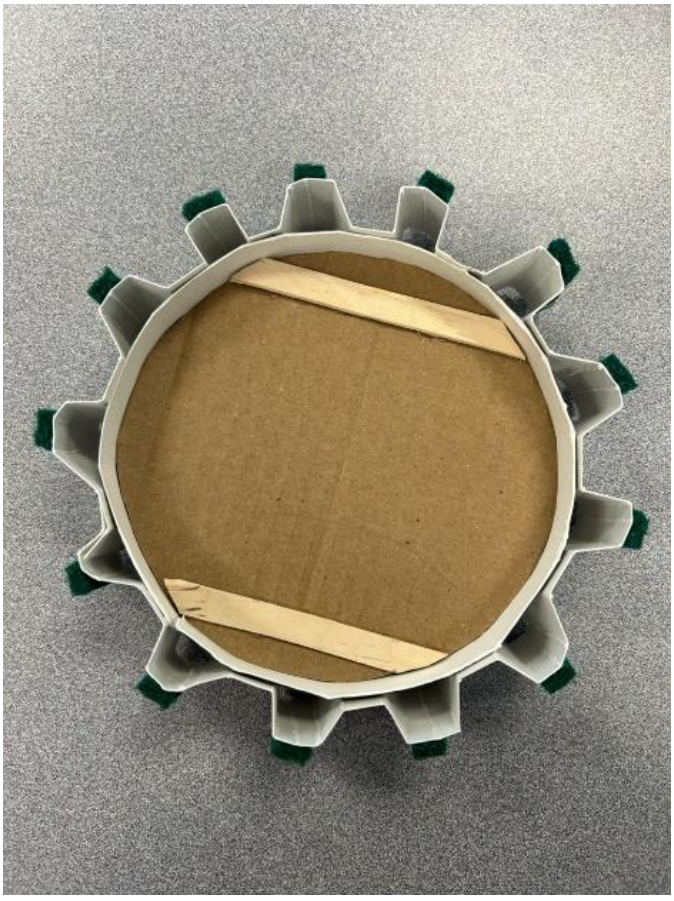
2. Take picture(s) of your refined prototype.
   → Include picture(s) of your previous prototypes(s) that you either decided to further refine or take elements from to create your refined prototype. Only include relevant previous prototypes
   → Insert your photo(s) as a Picture (Insert > Picture > This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

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

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

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: Fri-43

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

Include details on your thought process and how the concept was refined below, with notes on relevant feedback that was incorporated ***(max. 200 words).***

The design concept was refined by incorporating elements of initial protypes, feedback, and evolving ideas. Ice and snow traction is a key function, for our design concept to emanate this function, the rough parts of a sponge were attached to the tire treads. This improves the add-on's ice and snow traction, which helps the prototype achieve the highly important objective: Grip. The indents in the circular frame of the add-on, play a dual role as they act as treads and a feature responsible for the vital objective of flexibility. These indents have a certain level of flexibility which helps absorb impact and handle uneven road surfaces providing a smooth drive. To align with the objective of durability, popsicle sticks acted as support structures near the inner area of the circular frame, which helped maintain shape and handle load without deformation. The flexibility in the circular frame increased durability as it helped dissipate the force experienced by the tire while preventing the risk of add-on snapping. TA feedback regarding attachment was addressed with paper clip features incorporated as attachment mechanisms allowing for the add-on to attach securely to the tire through both its lug and hub.

MILESTONE 4.2 – PROTOTYPING TEST PLAN REFINEMENT

Team ID: Fri-43

3. 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).*

Test Plan 1

The tire add-on will move tested in numerous conditions, e.g. on grass, concrete, and most importantly in the snow. Testing the prototype in various conditions will create a conducive production environment to satisfy Tiffany's demands.

Test Plan 2

The tire add-on will be tested for durability through applying increments of weight, through wooden blocks or other standardized material weighing 15g. This will test the maximum viable weight the add-on can withstand with fracturing, further concluding if extra support joints or fine-tuning is needed.

*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).*

Several winter tire manufacturers test traction, grip, and brake handling on artificially simulated tracks at slow speeds [1]. The conditions on these tracks vary greatly, from wet to icy to snowy. To simulate snowy conditions, the prototype will be manually rolled through a track consisting of crumpled paper. Metrics to be recorded include the time it takes, in seconds, for the wheel to come to a stop after rolling at a constant speed. Another important metric would be the weight of the snow displaced in grams. Since paper has both a different density and material properties to that of snow, approximations will have to be made to determine the effectiveness of the treads. Qualitative observations would be the degree of smoothness at which the prototype moves as well as how easily it is able to attach to the wheel.

References:

[1] "Products," Testing winter tires, https://www.continental-tires.com/products/b2c/tire-knowledge/testing-winter-tires/ (accessed Mar. 11, 2024).

Team ID: Fri-43

4. Fill out the table below, detailing each team member's contribution to this stage

Team Member's Full Name:	Contribution:
Aman Minhas	Refined Prototype, Test Plan 2, Final Product
Shadi El-Fares	Test Plan 1, Final Product
Emilya Hum	Prototype, Refined Prototype
Shajijan Narendran	Reference, Future Testing Plan
Noor Ahmed	Name, Refined concept summary (200 words)

MILESTONE 4.3 – DESIGN REVIEW

Team ID: Fri-43

Include your feedback from both your peers (or TAs/IAIs) and the science students 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 feedback from science students in this row. - Asked whether the tire add on is equipped for use during various weather conditions, such as snow. - Our answer was to ensure to use a weather resistant material coated over the body of the add on allowing for use and function for various weather conditions.
Include feedback from your faculty mentor, staff, or assigned TA/IAI in this row - *Were curious as to how the add-on will attach to the actual wheel.* - *Concerned that final L shape rod may not be safe for all terrains including floors* - *Try to make the final design the right size according to the actual wheelchair tire and complete it, we may also use a* - *Ensure the material you use for the add-on is ice, water, and salt-resistant* - *Try to make the add-on cleanable* - *Do your research to determine the material choice, and have research to back up any design choices.* - *However, it is not necessary to coat the final design as long as research is done to back up the planned/anticipated design and material decisions.*

PROJECT FOUR MILESTONE FIVE: EXECUTION OF THE TEST PLAN AND FINALIZING THE DESIGN

MILESTONE 5 – COVER PAGE

Team ID: Fri-43

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

Full Name:	MacID:
Aman Minhas	minhaa18
Shadi El-Fares	elfaress
Noor Ahmed	ahmem125
Shajijan Narendran	narends

MILESTONE 5.1 - FINAL EVALUATION OF THE OBJECTIVES AND CONSTRAINTS

Team ID: Fri-43

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 (can be found under P4 documents) for more details.

State your Quantitative Objectives and their Metrics below:

Durability	Pounds
Speed/Efficiency	Angular Velocity
Snow removed per rotation	Grams

State your Qualitative Objectives and their Metrics below:

Longevity	Visual scuffing or inefficiency of add-on after a cycle of use
Grip	Ability to stay on track of path – no slipping on ice
Portability	Ease of taking on and off

State your Constraints and their Metrics below:

Cost	Dollars (CAD)
Mass (of tire on)	Kilograms

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

*Insert your **Present Testing Plan** (how you will test your prototype).*
State and justify any changes you made from last week. *For the Quantitative objective of durability: Instead of 15 g blocks, we decided to use 1 kg rice bags. This decision was made as the add-on now has a wooden frame within the inner frame intending to mimic the presence of a wheel, allowing for us to test greater loads on it.*

MILESTONE 5.2 – TESTING PLAN EXECUTION AND DISCUSSION

Team ID: Fri-43

Execute your testing plan for your Quantitative Objectives:

State and discuss the results of your testing plan in this box.
Durability: The prototype could hold 7kg (7 bags of rice) without breaking or experiencing permanent deformation.

Snow Moved per rotation: Upon testing on snowy surfaces, it was observed that the L-shaped features of the add were consistently pushing back roughly 1-3 grams of snow in its path.

Execute your testing plan for your Qualitative Objectives:

State and discuss the results of your testing plan in this box.
Longevity: Upon testing on concrete floor, gravel pavement, grass, salt, and snow the prototype did not undergo any visible scuffing or experience any notable inefficiency in its intended function.

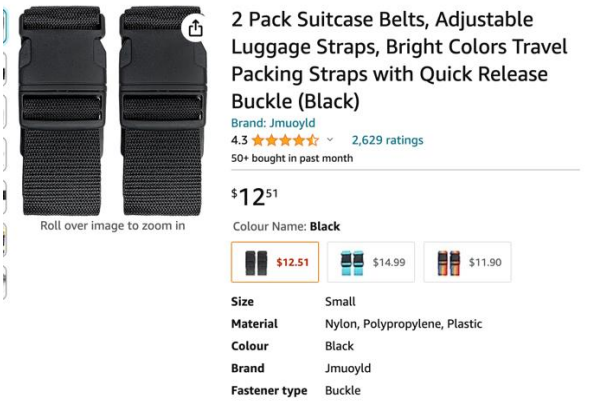
Execute your testing plan for your Constraints:

State and discuss the results of your testing plan in this box.
Cost: Ensuring to stay within an overall budget of below $100 CAD, adjustments were made through sourcing materials that were able to efficiently perform their functions while staying within the frame. The following image showcases the original rubber material which would've increased the overall cost of the prototype in comparison to the cost of the L shaped metal rods, costing less than half of the previous material.

As a team, discuss the results of your testing plan. 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 if 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.

- Testing plan was a clear indicator of great durability and strength for material of the wired frame.
  - → Weight test showed no fracture, permanent structural damage, and snow test showed no rusting.
- Structural components of design need to be heavily redesigned as it was unable to hold 1kg with dipping in structure.
  - → Create a component on the wintire which allows for attachment to a wheel through a Velcro-type securement.
  - → With a refined testing plan using a circular tire within the wintire, physical displacement of the tire frame will be prevented.
- Moving Forward:
  - → add a material to cover L shape metal features to prevent damage to surfaces (felt/rough part of dish sponges)
  - → Buy buckles or Velcro strips along with tire replicate to a tire and the attachment of the wintire



2 Pack Suitcase Belts, Adjustable Luggage Straps, Bright Colors Travel Packing Straps with Quick Release Buckle (Black)

Brand: Jmuoyld

4.3 ★★★★½ 2,629 ratings

50+ bought in past month

$12.51

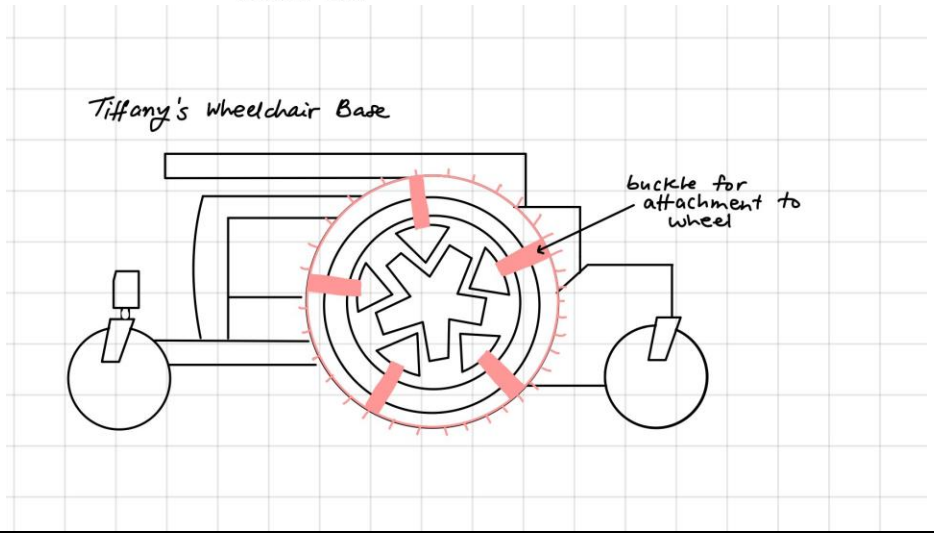
Roll over image to zoom in

Colour Name: **Black**

$12.51 | $14.99 | $11.90

Size	Small
Material	Nylon, Polypropylene, Plastic
Colour	Black
Brand	Jmuoyld
Fastener type	Buckle

→



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