ENGINEERING

McMaster University

Project Three – There's a Recyclable Among Us:

Design a System for Sorting and Recycling Containers

ENGINEER 1P13 – Integrated Cornerstone Design Projects

Tutorial 7/16

Thurs-22

Pratha Bhat (bhatp3)

Armon Bal (bala4)

Jiayue Zhu (zhu3)

Vaisnavi Shanthamoorthy (shanthav)

Nolan Roney (roneyn1)

Submitted: March 7th, 2021

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Academic Integrity Statement

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.
Pratha Bhat 400317136

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Vaisnavi Shanthamoorthy 400319038

x 

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Jiayue Zhu 400291419

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Armon Bal 400325011

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Nolan Roney 400305601

Executive Summary

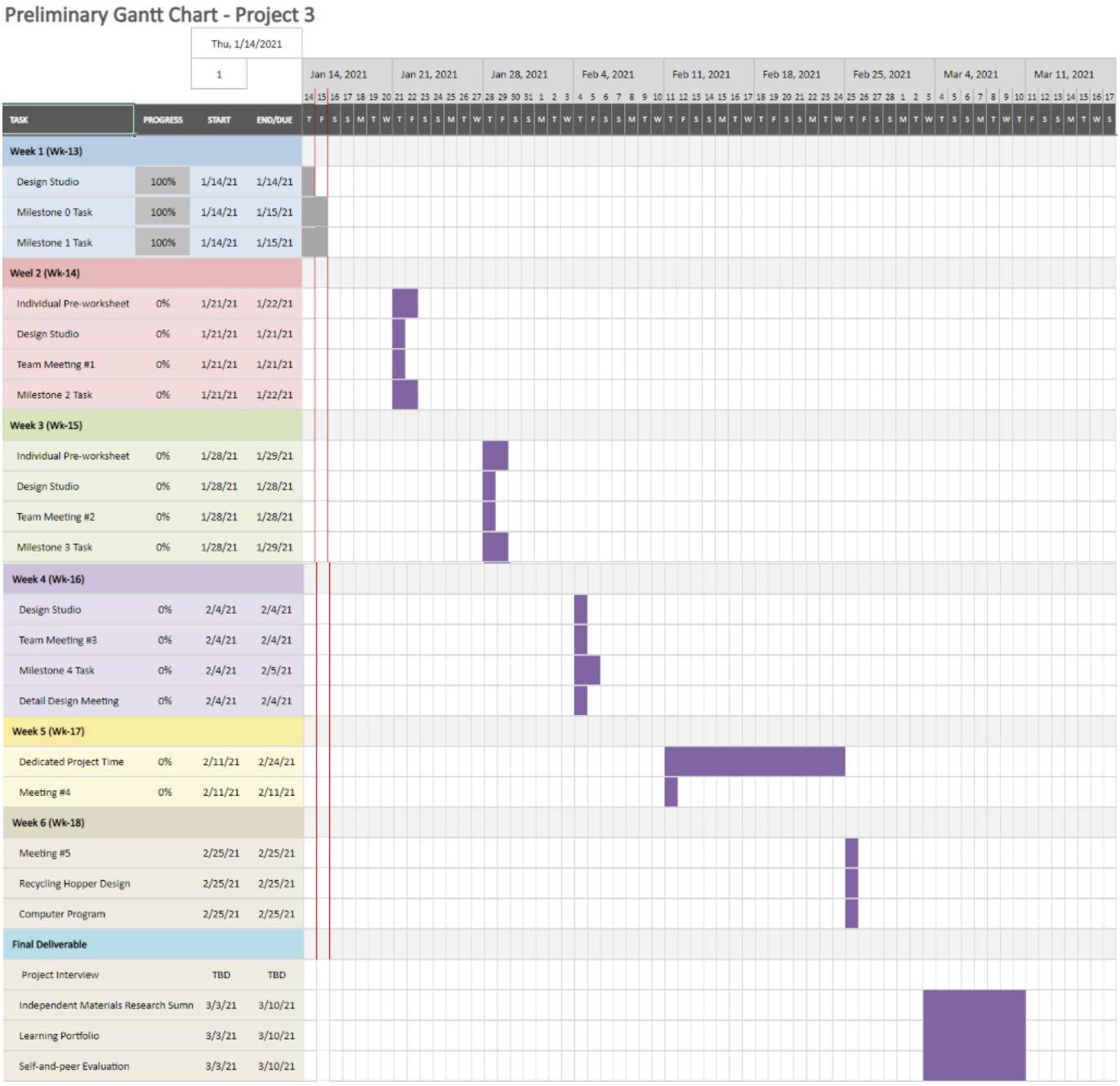
Designing a system that integrates physical and digital functionality towards the classification and sorting of recyclable containers is the primary objective of this project. As a team we were responsible with using a range of software tools to create a code that controls the Q-labs environment and designing a mechanism to deposit the containers. This project has important applications to real scenarios, since incorporating efficient systems for the sorting and recycling of materials promotes the process of reusing certain compounds and contributes towards reducing the carbon footprint.

The computation sub-team was responsible for creating a system to sort and recycle materials based on their properties within a virtual environment. The process of regulating and sorting recycling required a computer program to be written that utilized a turntable, robotic arm, Q-bot, and a range of sensors. The code itself required five key functions in the process of completing the objective and using the virtual environment. Furthermore, the functions individually served a unique role to work in unison with the rest of the code. We wrote 5 parts of python functions to accomplish this task which include: dispensing the container, loading the container, transferring the container, depositing container(s) into bins, and returning home. To ensure the codes work properly and meet all requirements, we test them in Quanser Interactive Labs. This program helped to classify waste containers and transport them to different bins for recycling, reducing the risk of potential harm to the environment.

The modelling team was responsible for designing, modelling, and simulating a device for depositing containers into a recycling bin. The main mechanism created for the design problem at hand was inspired by many key aspects of a LEGO-based prototype created early in the design process. The main mechanism is composed of a series of linkages arranged in an accordion format which was the main method to aid our device in depositing the containers in a smooth fashion. Moreover, we had several parts that played a key role in a final assembly, one worth mentioning would be our slider joint structure. This sub-assembly was a way to connect our mechanism to our hopper and it mimicked a real-life aspect which was very crucial to us in our design process stage. In addition to our assembly, we were also responsible for creating a motion simulation. Through our motion simulation we had to showcase the entire process of our method to successfully deposit the containers into the bin. To do so, we showcased the device at home position, then moving to its' respective depositing position and then back to its original home position. We did this by translating the input (actuator) and rotating the output (hopper) joints. Throughout our entire engineering design process, through the various iterations we went through with our entire design, we were able to produce a final device that successfully deposits containers into their respective bins at ease.

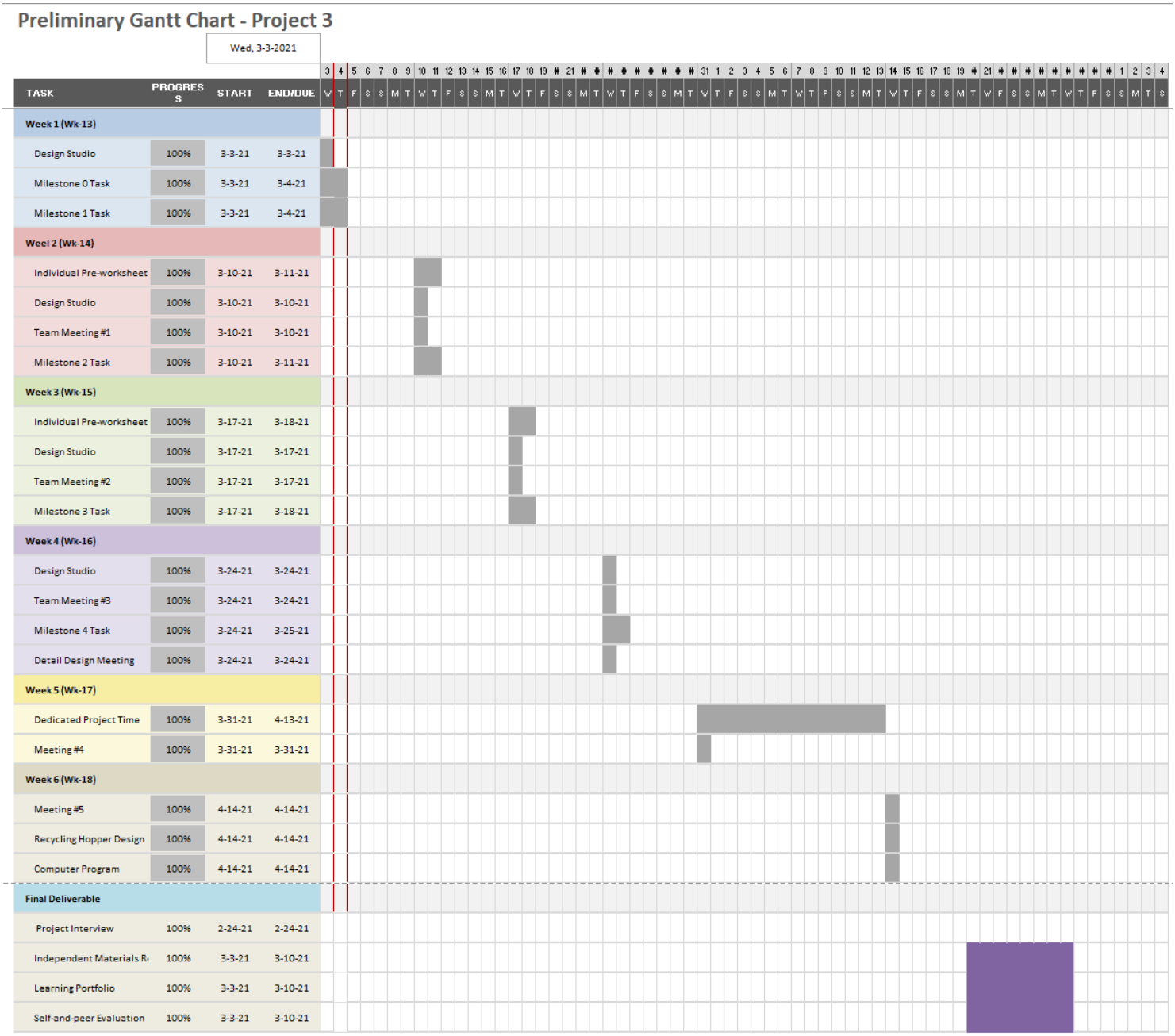
Project Schedule

Preliminary Gantt Chart – Pratha



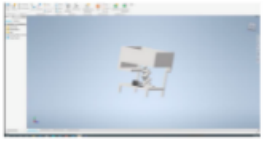
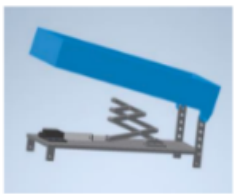
TASK	PROGRESS	START	END/DUE
Week 1 (Wk-13)			
Design Studio	100%	1/14/21	1/14/21
Milestone 0 Task	100%	1/14/21	1/15/21
Milestone 1 Task	100%	1/14/21	1/15/21
Weel 2 (Wk-14)			
Individual Pre-worksheet	0%	1/21/21	1/22/21
Design Studio	0%	1/21/21	1/21/21
Team Meeting #1	0%	1/21/21	1/21/21
Milestone 2 Task	0%	1/21/21	1/22/21
Week 3 (Wk-15)			
Individual Pre-worksheet	0%	1/28/21	1/29/21
Design Studio	0%	1/28/21	1/28/21
Team Meeting #2	0%	1/28/21	1/28/21
Milestone 3 Task	0%	1/28/21	1/29/21
Week 4 (Wk-16)			
Design Studio	0%	2/4/21	2/4/21
Team Meeting #3	0%	2/4/21	2/4/21
Milestone 4 Task	0%	2/4/21	2/5/21
Detail Design Meeting	0%	2/4/21	2/4/21
Week 5 (Wk-17)			
Dedicated Project Time	0%	2/11/21	2/24/21
Meeting #4	0%	2/11/21	2/11/21
Week 6 (Wk-18)			
Meeting #5		2/25/21	2/25/21
Recycling Hopper Design		2/25/21	2/25/21
Computer Program		2/25/21	2/25/21
Final Deliverable			
Project Interview		TBD	TBD
Independent Materials Research Summ		3/3/21	3/10/21
Learning Portfolio		3/3/21	3/10/21
Self-and-peer Evaluation		3/3/21	3/10/21

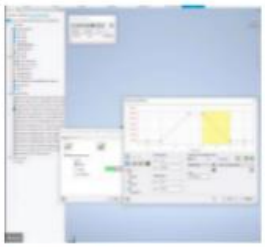
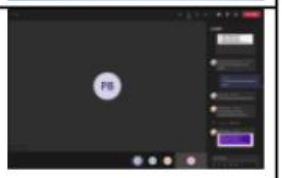
Final Gantt Chart – Nolan

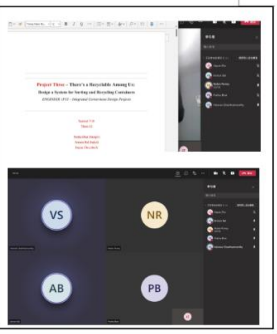


TASK	PROGRESS	START	END/DUE
Week 1 (Wk-13)			
Design Studio	100%	3-3-21	3-3-21
Milestone 0 Task	100%	3-3-21	3-4-21
Milestone 1 Task	100%	3-3-21	3-4-21
Weel 2 (Wk-14)			
Individual Pre-worksheet	100%	3-10-21	3-11-21
Design Studio	100%	3-10-21	3-10-21
Team Meeting #1	100%	3-10-21	3-10-21
Milestone 2 Task	100%	3-10-21	3-11-21
Week 3 (Wk-15)			
Individual Pre-worksheet	100%	3-17-21	3-18-21
Design Studio	100%	3-17-21	3-17-21
Team Meeting #2	100%	3-17-21	3-17-21
Milestone 3 Task	100%	3-17-21	3-18-21
Week 4 (Wk-16)			
Design Studio	100%	3-24-21	3-24-21
Team Meeting #3	100%	3-24-21	3-24-21
Milestone 4 Task	100%	3-24-21	3-25-21
Detail Design Meeting	100%	3-24-21	3-24-21
Week 5 (Wk-17)			
Dedicated Project Time	100%	3-31-21	4-13-21
Meeting #4	100%	3-31-21	3-31-21
Week 6 (Wk-18)			
Meeting #5	100%	4-14-21	4-14-21
Recycling Hopper Design	100%	4-14-21	4-14-21
Computer Program	100%	4-14-21	4-14-21
Final Deliverable			
Project Interview	100%	2-24-21	2-24-21
Independent Materials R	100%	3-3-21	3-10-21
Learning Portfolio	100%	3-3-21	3-10-21
Self-and-peer Evaluation	100%	3-3-21	3-10-21

Logbook of Additional Meetings and Discussions – Jiayue

Team	Date & Time	Attendance	Content	Support materials
Modelling sub-team	Feb 1st 4 - 6 pm	Nolan Roney, Vaisnavi Shanthamoorthy, Pratha Bhat	- Modelling sub-team started the assembly, and tried to add a T-shaped bar to secure both hopper and mechanism. - An error is found in the angle the mechanism was creating because nowhere was it perpendicular to the base-plate so the T-bar is supposed to help create that 90 deg angle.	   
Modelling sub-team	Feb 3rd 3 - 5 pm	Nolan Roney, Vaisnavi Shanthamoorthy, Pratha Bhat	- The modelling team was struggling with adding t shape piece to a contact set. They weren't satisfied with the cylindrical level like shape, so discussed rectangular prism substitutes. They finally decided on a slider joint.	   

Computing sub-team	Feb 3rd 7 - 8 pm	Armon Bal, Jiayue Zhu	- Computing sub-team looked at the process of each member's code. - There were some problems and errors regarding the load function and the transfer function. - Computing team needs some help in the live design studio.	
Computing sub-team	Feb 5th 12:30-1:00 pm	Armon Bal, Jiayue Zhu	- Members in computing sub-team talked about the difficulties they met in the programming process, and showed each other the functions they have so far.	 
Modelling sub-team	Feb 16th 1:00 - 2:20 pm	Nolan Roney, Vaisnavi Shanthamoorthy, Pratha Bhat	The modelling sub-team completed the motion simulation and exploded assembly. - Assigned engineer drawings to team members (of modelling sub team)).	 
Both sub-teams	Feb 16th 2:30-3:30	Nolan Roney, Vaisnavi Shanthamoorthy, Pratha Bhat, Armon Bal, Jiayue Zhu	- The whole group had a meeting to write the final project report together.	

Both sub-teams	March 6 6:30-7:30 pm	Nolan Roney, Vaisnavi Shanthamoorthy, Pratha Bhat, Armon Bal, Jiayue Zhu	- The whole group had a meeting to finish up the project report.	

Scheduled Weekly Meetings – Pratha & Jiayue

ENGINEER 1P13
MEETING WITH TEAM 22 - THURSDAY, JAN. 21, 2021

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Pratha Bhat**	**bhatp3**	**Yes**
Administrator	**Nolan Roney**	**roneyn1**	**Yes**
Coordinator	**Jiayue Zhu**	**zhu3**	**Yes**
Subject Matter Expert	**Vaisnavi Shanthamoorthy**	**shanthav**	**Yes**
Subject Matter Expert	**Armon Bal**	**bala**	**Yes**
Guest	**Bilal Shaikh**	**(TA) N/A**	**Yes**

AGENDA ITEMS

1. Complete Stage 1 and 2 + Upload images and information respectively
2. Break into sub-teams Complete Stage 3 and 4
3. General meeting to discuss progress
4. Goals for next week
5. Update Design Report

MEETING MINUTES

1.
   a. Complete stage 1 and 2, upload researches (computing)/ images (modelling)
2.
   a. Computing – discussed findings based on the research
   b. Modelling – compared and discussed everyone's sketches
3.
   a. Computing - Chose sensor; detect distance
   b. Modelling – Work on the matrix after sharing everyone's work (criteria turned out to be the most difficult part)
4. .
   a. Modelling sub-team and computing sub-team changed information of what they did during this week's design studio, as well as the difficult parts.

POST-MEETING ACTION ITEMS

1. *Computing sub-team – complete the workflow before next week's design studio*
2. *Modelling sub-tam – complete detailed sketches before next week's design studio*

1

ENGINEER 1P13
MEETING WITH TEAM 22 – THURSDAY, JAN. 28, 2021

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Pratha Bhat	bhatp3	Yes
Administrator	Nolan Roney	roneyn1	Yes
Coordinator	Jiayue Zhu	zhu3	Yes
Subject Matter Expert	Vaisnavi Shanthamoorthy	shanthav	Yes
Subject Matter Expert	Armon Bal	bala	Yes
Guest	Bilal Shaikh	(TA) -N/A-	Yes

AGENDA ITEMS

1. Greetings + Check on Individual Milestones
2. Upload Stage 1 and 2; respectively
3. Discuss + Start Stage 3 and 4; respectively
4. Check up at @ 10:50
5. Goals for next week
6. Submission Details + Project Report

MEETING MINUTES

1. .
    a. Both sub-teams talked about their processes towards the project. Modelling sub-team uploaded the detailed sketches, and computing sub-team uploaded the flowchart and pseudocode.
2. .
    a. Team manager assigned the two subject matter experts to upload the screenshots of the worksheets on teams.
3. .
    a. Team manager assigned a meeting of two sub-teams at 11:00am in order to see the processes of each sub-teams and change information.
4. .
    a. During the meeting at 11:00am, both sub-teams were on the right track with their tasks. Both sub-teams may have another meeting after the design studio to finish up. The coordinator will record the time.

ENGINEER 1P13
MEETING WITH TEAM 22 – THURSDAY, JAN. 28, 2021

POST-MEETING ACTION ITEMS

1. *Submit our team milestones [Nolan]*
2. *Source Coordinators – Update milestone worksheets on design report weekly [VAISHNAVI/ARMON]*
3. *Future meetings? [Jia]*

ENGINEER 1P13
MEETING WITH TEAM 22 - THURSDAY, FEB. 4, 2021

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Pratha Bhat**	**bhatp3**	**Yes**
Administrator	**Nolan Roney**	**roneyn1**	**Yes**
Coordinator	**Jiayue Zhu**	**zhu3**	**Yes**
Subject Matter Expert	**Armon Bal**	**bala**	**No**
Subject Matter Expert	**Vaisnavi Shanthamoorthy**	**shanthav**	**Yes**
Guest	**N/A**	**-N/A-**	**No**

AGENDA ITEMS

1. How was everyone's weekend? Any meetings outside of class?.
2. How are we feeling about the Design Review?
3. Meet up after design review + future plans

MEETING MINUTES

1. .
    a. Both sub-teams attended the design review, and received some feedback from the mentor.
2. .
    a. The whole team had a meeting together, and talked about the meetings they had outside the class last week, as well as the feedback received from design review.
3.
    a. Both sub-teams kept working on the project.

POST-MEETING ACTION ITEMS

1. *Upload screenshots [Armon/Vaisnavi]*
2. *Upload Team Milestone worksheet [Nolan]*
3. *Logbook updates + future updates [Jia]*

Design Studio Worksheets:

Milestone 0:

PROJECT THREE: MILESTONE 0 – COVER PAGE

Team Number: Thurs-22

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

Full Name:	MacID:
Pratha Bhat	bhatp3
Jiayue Zhu	zhu3
Vaisnavi Shanthamoorthy	shanthav
Armon Bal	bala
Nolan Roney	roneyn1

Insert your Team Portrait in the dialog box below

MILESTONE 0 – TEAM CHARTER

Team Number: Thurs-22

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Pratha Bhat	☐M ☒A ☒C ☐S
2.	Jiayue Zhu	☒M ☐A ☐C ☒S
3.	Vaisnavi Shanthamoorthy	☒M ☒A ☐C ☐S
4.	Armon Bal	☒M ☐A ☒C ☐S
	Nolan Roney	☐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.

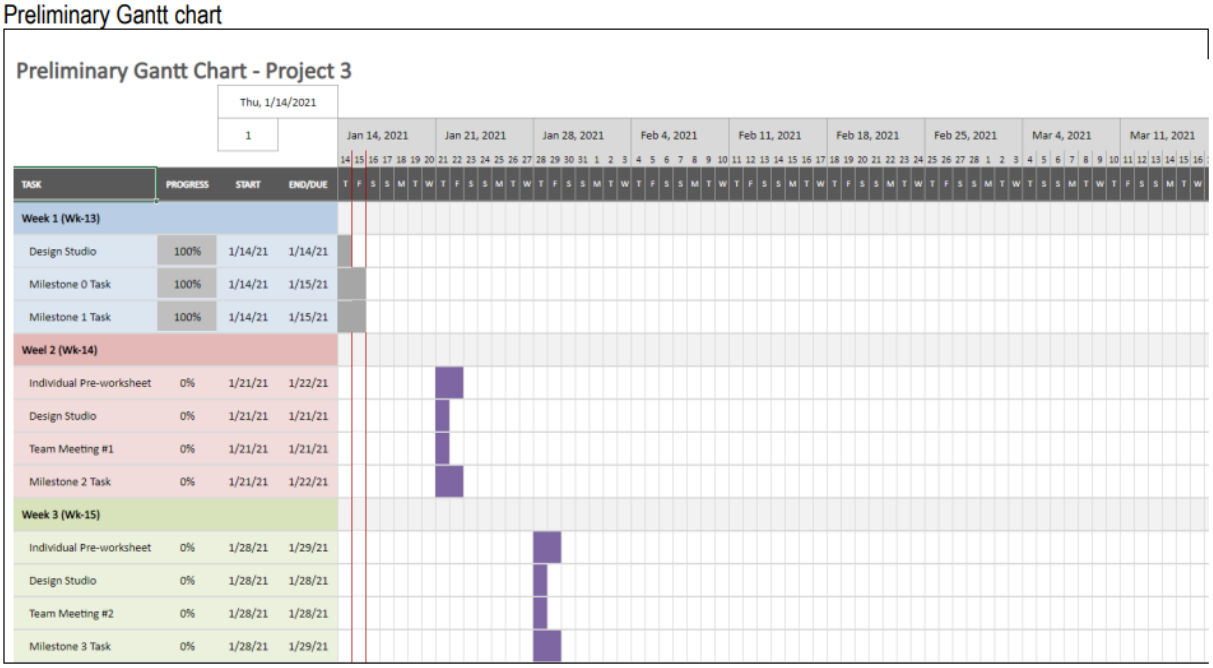
Role:	Team Member Name:	MacID
Manager	Pratha Bhat	bhatp3
Administrator	Nolan Roney	roneyn1
Coordinator	Jiayue Zhu	zhu3
Subject Matter Expert	Armon Bal	bala
Subject Matter Expert	Vaisnavi Shanthamoorthy	shanthav

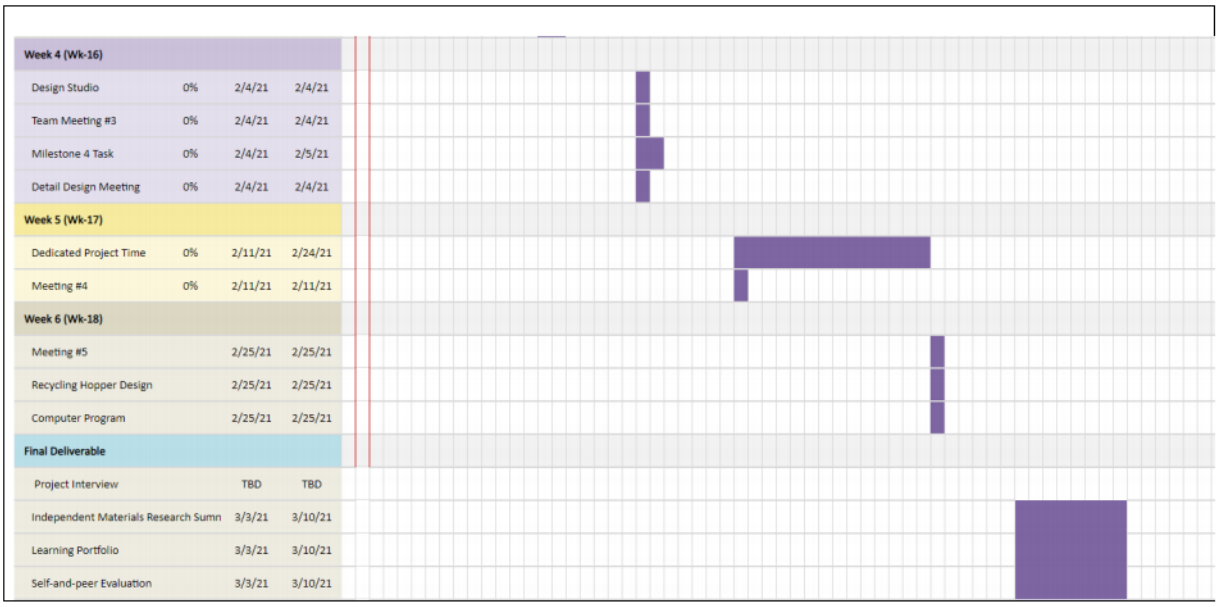
MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

Team Number: Thurs-22

Full Name of Team Manager:	MacID:
Pratha Bhat	bhatp3

Preliminary Gantt chart




Week 4 (Wk-16)
Design Studio 0% 2/4/21 2/4/21
Team Meeting #3 0% 2/4/21 2/4/21
Milestone 4 Task 0% 2/4/21 2/5/21
Detail Design Meeting 0% 2/4/21 2/4/21
Week 5 (Wk-17)
Dedicated Project Time 0% 2/11/21 2/24/21
Meeting #4 0% 2/11/21 2/11/21
Week 6 (Wk-18)
Meeting #5 2/25/21 2/25/21
Recycling Hopper Design 2/25/21 2/25/21
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Final Deliverable
Project Interview TBD TBD
Independent Materials Research Sumn 3/3/21 3/10/21
Learning Portfolio 3/3/21 3/10/21
Self-and-peer Evaluation 3/3/21 3/10/21

Milestone 1:

PROJECT THREE: MILESTONE 1 – COVER PAGE

Team Number: Thurs-22

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

Full Name:	MacID:
Pratha Bhat	bhatp3
Vaisnavi Shanthamoorthy	shanthav
Nolan Roney	roneyn1
Armon Bal	bala
Jiayue Zhu	zhu3

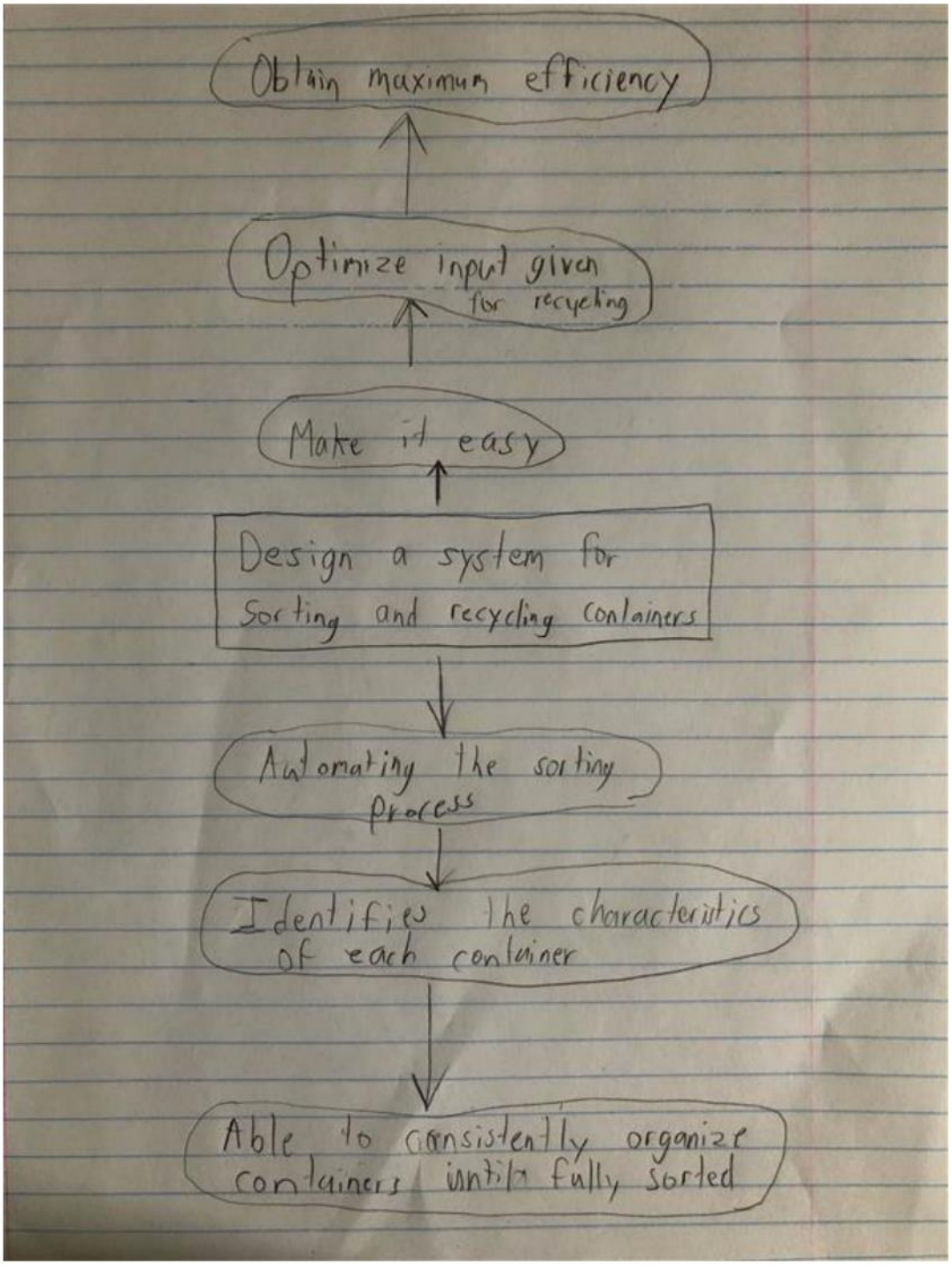
MILESTONE 1 (STAGE 1) – WHY/HOW LADDERING

Team Number: Thurs-22

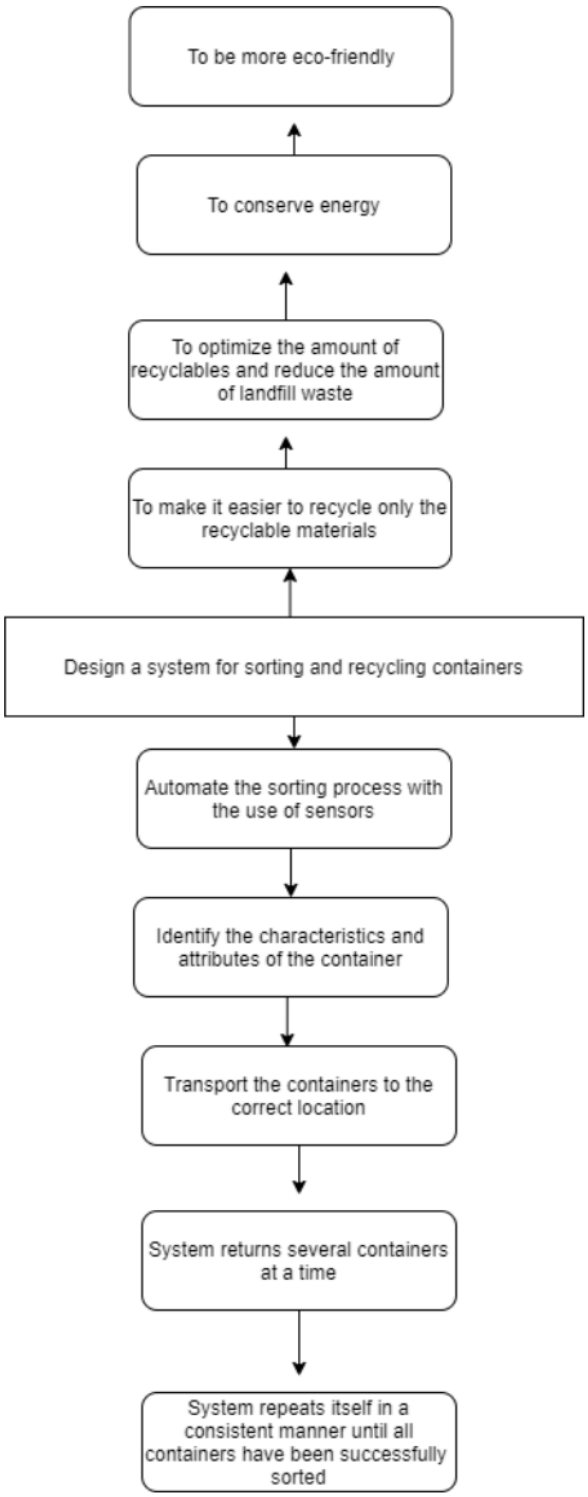
1. Document both your conversation and a refined visual on a separate sheet of paper
2. Take a photo of both your rough work and refined visual
3. Insert each photo as a Picture (Insert > Picture > This Device)
4. **Do not include more than one Picture per page**

***Both the rough copy and the refined visual of the Why/How Ladders can be found on the next two pages**

Rough Work of the Why/How Ladder:



Refined Visual of the Why/How Ladder:



MILESTONE 1 (STAGE 2) – LIST OF OBJECTIVES AND CONSTRAINTS

Team Number: Thurs-22

As a team, create a list of objectives and constraints in the table below. The exact number you should have depends on what information you have gathered from the Project Pack as well your previously completed needs hierarchy.

Objectives	- Should be easy to use - Should be able to securely hold the containers in place - High storage capacity - Successfully able to deposit containers - Navigate all pathways and stations successfully
Constraints	- The device must hold at least three containers - Sensor can sort containers based on characteristics (material, mass, etc.) - Total mass of the containers picked up at once cannot exceed a mass of 90 grams - The device must deposit the containers into the recycling bins

MILESTONE 1 (STAGE 3) – REFINED PROBLEM STATEMENT

Team Number: Thurs-22

Initial Problem Statement

1. Write the initial problem statement in the space below. This will have been defined in a previous lecture, prior to your scheduled Design Studio.

Design a system for sorting and recycling containers

Refined Problem Statement

2. Write the refined problem statement below. Kindly refer to the Refined Problem Statement rubric provided on Avenue (see P3 Rubrics). This will guide your group in creating a valid statement.

Refined Problem Statement: Improve means of recycling items by designing a system for sorting recyclable and non-recyclable containers based on their characteristics in order to be more eco-friendly by reducing the number of recyclables that end up in landfills.

Milestone 2:

PROJECT THREE: MILESTONE 2 – COVER PAGE

Team Number: Thurs-22

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

Full Name:	MacID:
Vaisnavi Shanthamoorthy	shanthav
Armon Bal	bala
Pratha Bhat	bhatp3
Jiayue Zhu	zhu3
Nolan Roney	roneyn1

MILESTONE 2 (STAGE 1) – SENSOR RESEARCH (COMPUTATION SUB-TEAM)

Team Number: Thurs-22

You should have already completed this task individually *prior* to Design Studio 14.

1. Each team member is expected to research 3 types of sensors for characterizing bins
   → Refer to Table 3 of the Computation Sub-Team Objectives document
2. For each sensor:
   → Briefly describe how the sensor works
   → Indicate the attribute you would measure to characterize each bin (refer to Table 4 of the Computation Sub-Team Objectives document)

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their sensor research with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 3*** of the milestone

Team Number: Thurs-22

Name:Armon Bal	MacID: bala

Sensor Type	Description	Attribute(s)
Ultrasonic Sensor	The head of the sensor can emit ultrasonic waves that will eventually be reflected at the sensor when they hit a target, thereby used primarily to measure distance. It can do so by sending these waves and measuring the interval of time it takes for the wave to have been emitted to when it returns, thereby calculating the distance from the start to end of this duration of time. This would make it most useful for detecting distance from an object.	-distance -
Hall Sensor	A Hall sensor measures the size of an electric field by outputting a voltage that is directly proportional to the magnetic field strength that passes through. By being able to detect a magnetic field it can be used for positioning, detecting speed, and checking its proximity to an object. Usually only adequate in situations where there is high-current/high-voltage.	-distance
Active-infrared Sensor	Detects infrared radiation in its environment which allows it to be useful for tracking things that give off this radiation such as heat. It is naked to the normal eye which requires a sensor to notice these waves. Composed of a light emitting diode and receiver, the sensor receives a signal of when something is close by when the infrared LED comes close to an object and reflects at the sensor, thereby acting similar to an ultrasonic sensor. Therefore, its primary use would be for detecting proximity.	-distance

[4] "What is an ultrasonic / level sensor? " *Sensor Basics*. [Online]. Available: https://www.keyence.ca/ss/products/sensor/sensorbasics/ultrasonic/info/. [Accessed: 21-Jan-2021].

[5] "https://electronics.stackexchange.com/questions/515093/hall-effect-sensor-through-plastic," *Stack Exchange*. [Online]. Available: https://electronics.stackexchange.com/questions/515093/hall-effect-sensor-through-plastic . [Accessed: 21-Jan-2021].

[6] D. Jost, "What is an IR sensor?," *Fierce Electronics*, 29-Jul-2019. [Online]. Available: https://www.fierceelectronics.com/sensors/what-ir-sensor#:~:text=An%20infrared%20(IR)%20sensor%20is,radiation%20in%20its%20surrounding%20environment.&text=Active%20infrared%20sensors%20both%20emit,(LED)%20and%20a%20receiver.. [Accessed: 21-Jan-2021].

Team Number: Thurs-22

Name: Jiayue Zhu	MacID: zhu3

Sensor Type	Description	Attribute(s)
LDR (Light Dependent Resistor)	Light-dependent resistors are special resistors made of semiconductor materials such as cadmium sulfide or cadmium selenide. Their working principle is based on the internal photoelectric effect, meaning with the increase of light intensity, the resistance will reduce rapidly. LDR is very sensitive to light. With the absence of light, it will have a high value of resistance (most). LDR is commonly used to convert light changes into electrical changes [1].	-transparent or not
Color Sensor	The color sensor is a type of photoelectric sensor. There are two types of the color sensor. One detects the object with red, blue, and green light independently, while the other detects the object with broad wavelength light and classify red, blue, and green light within the receiver. Color sensor can compare the color of the object with the previous reference color. When the data of the two colors match within a certain error range, the sensor will give an output of detection results [2].	- color
Retro-reflective Photoelectric Sensor	Retro-reflective Photoelectric Sensor can be used to detect the presence of an object and then decide whether an object is metal or non-metal. The device can build a light path between the sensor and a special reflector. The object will be detected when it breaks the light beam [3].	- presence or absence - metal or non-mental

[1] keyence.com, "What is a color sensor?", n.d. [Online]. Available: https://www.keyence.com/ss/products/sensor/sensorbasics/color/info/. [Accessed: Jan. 20, 2021].
[2] WatElectronics, "What is a Light Dependent Resistor and Its Applications", Jul. 18, 2019. [Online]. Available: https://www.watelectronics.com/light-dependent-resistor-ldr-with-applications/. [Accessed: Jan. 20, 2021].

[3] Senasys Photosensors.com, "Retroreflective sensors", n.d. [Online]. Available: http://senasysphotosensors.com/photoelectric-sensors/retroreflective-sensors. [Accessed: Jan. 20, 2021].

MILESTONE 2 (STAGE 2) – CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team Number: Thurs-22

You should have already completed this task individually *prior* to Design Studio 14.

1. Copy-and-paste each sub-team member's refined sketch on the following pages (1 sketch per page)
   → Be sure to indicate each team member's Name and MacID

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

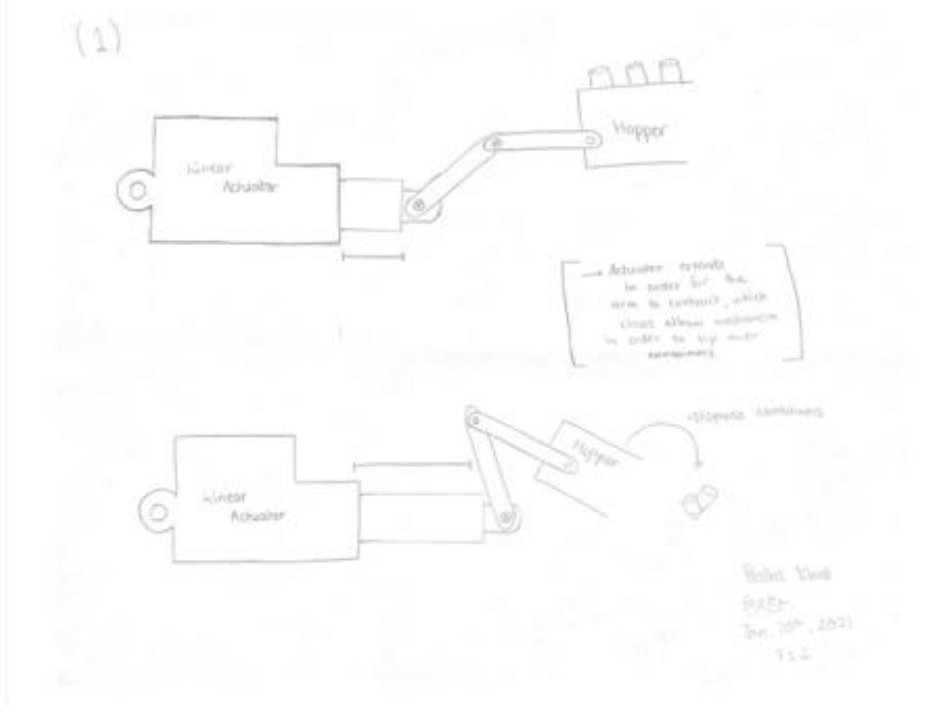
- Each team member needs to submit their concept sketches with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 4*** of the milestone

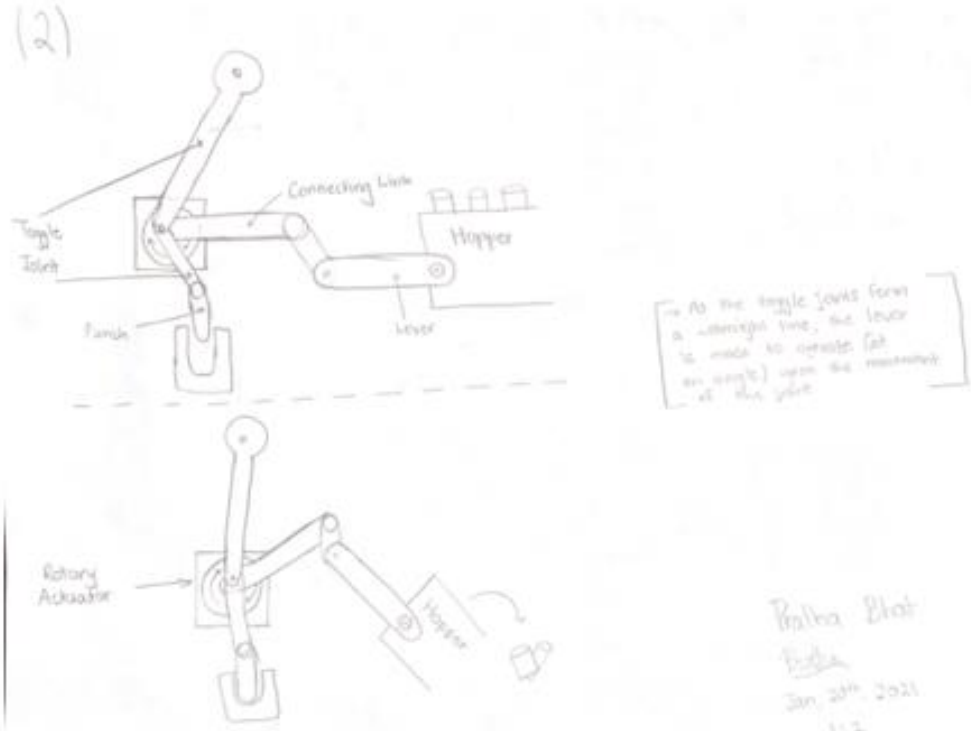
Team Number:	Thurs-22

Name: Pratha Bhat	MacID: bhatp3

Insert screenshot(s) of your concept sketches below

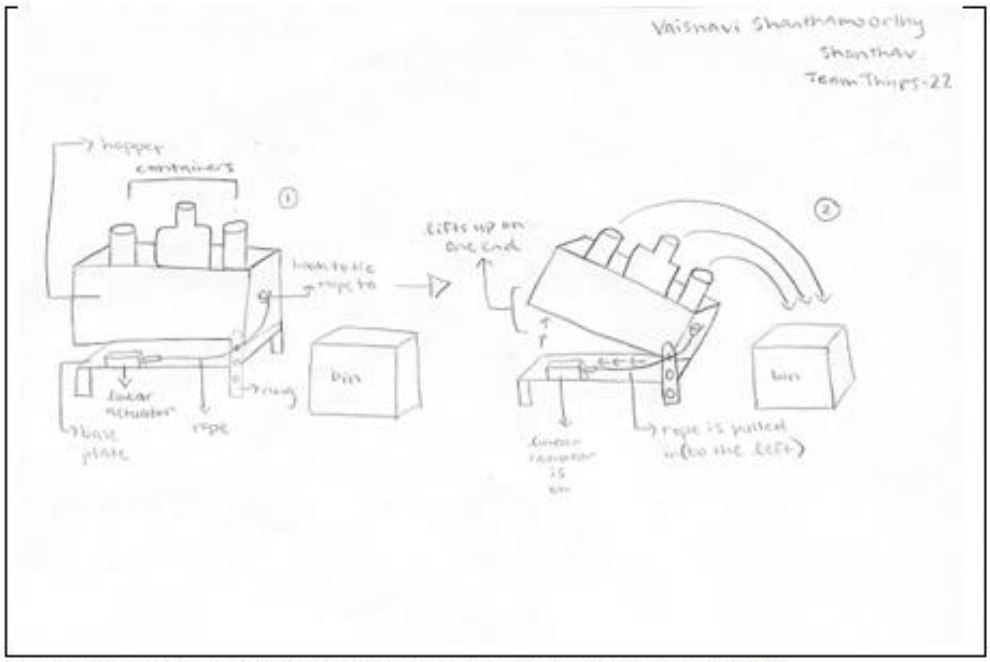
#1 – Linear Actuator



Name: Pratha Bhat	MacID: bhatp3
Insert screenshot(s) of your concept sketches below *#2 – Rotary Actuator* 	

Team Number: Thurs-22

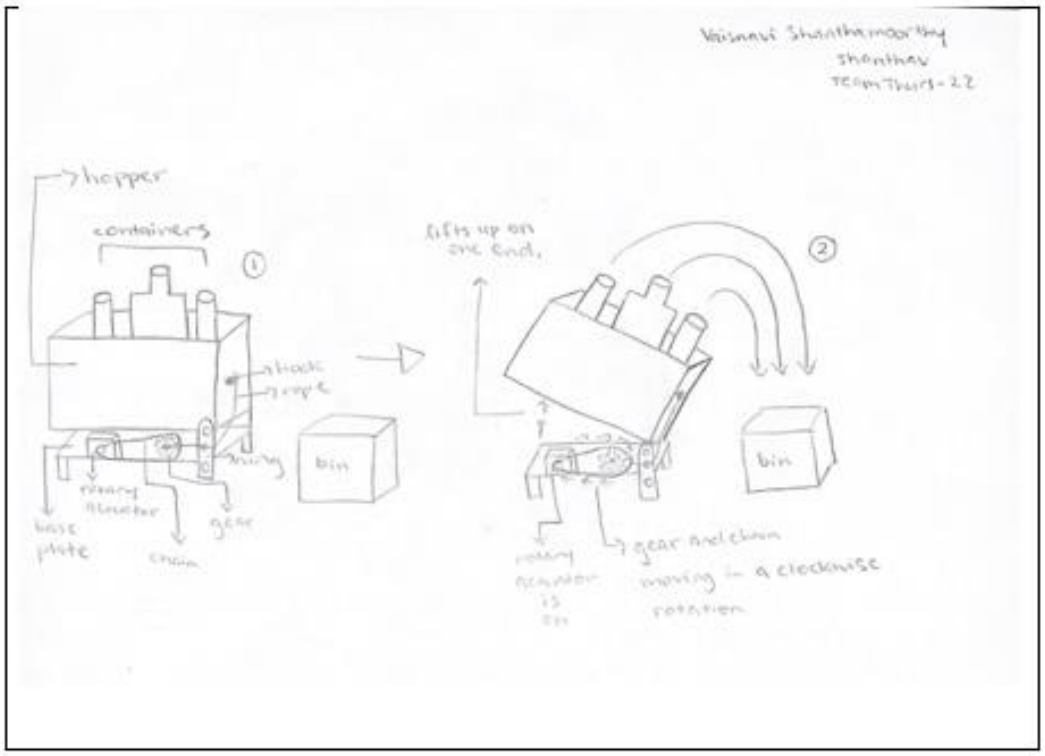
Name: Vaisnavi Shanthamoorthy	MacID: shanthav
Insert screenshot(s) of your concept sketches below *Concept Sketch #1(using a linear actuator)*	



*If you are in a sub-team of 3, please copy and paste the above on a new page

Team Number: Thurs-22

Name: Vaisnavi Shanthamoorthy	MacID: shanthav
Insert screenshot(s) of your concept sketches below	
Concept Sketch #2 (using a rotary actuator)	

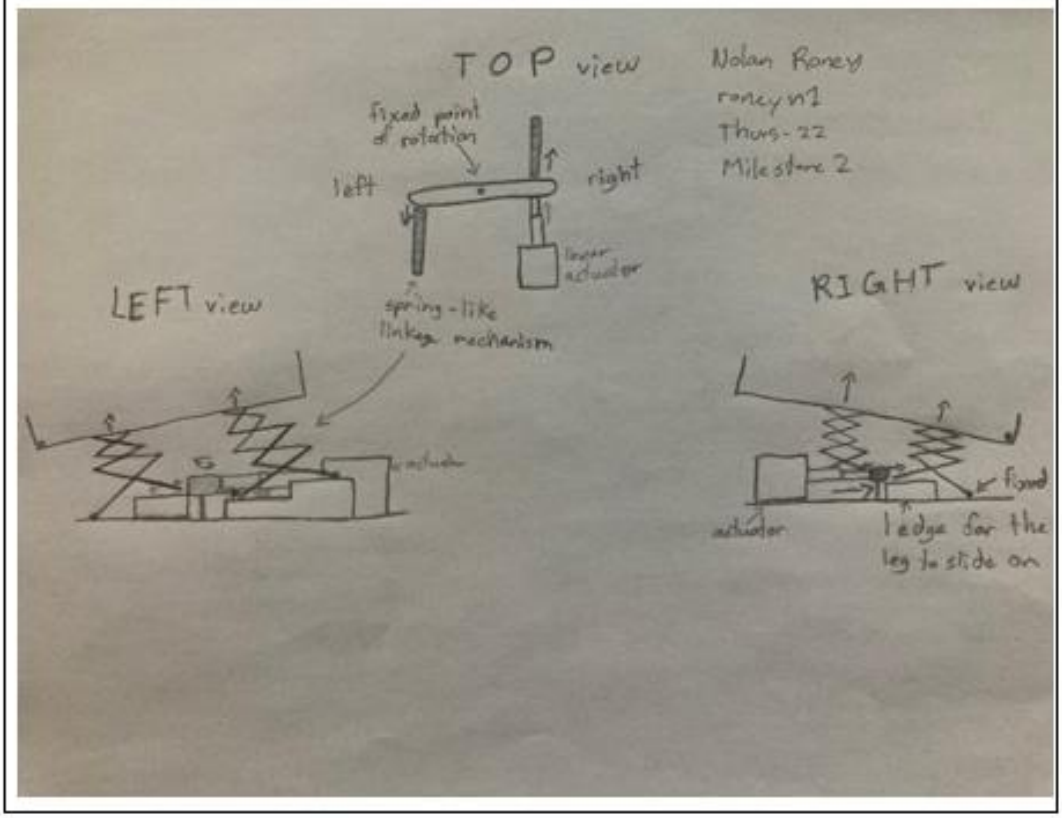


*If you are in a sub-team of 3, please copy and paste the above on a new page

Team Number: Thurs-22

Name: Nolan Roney	MacID: roneyn1

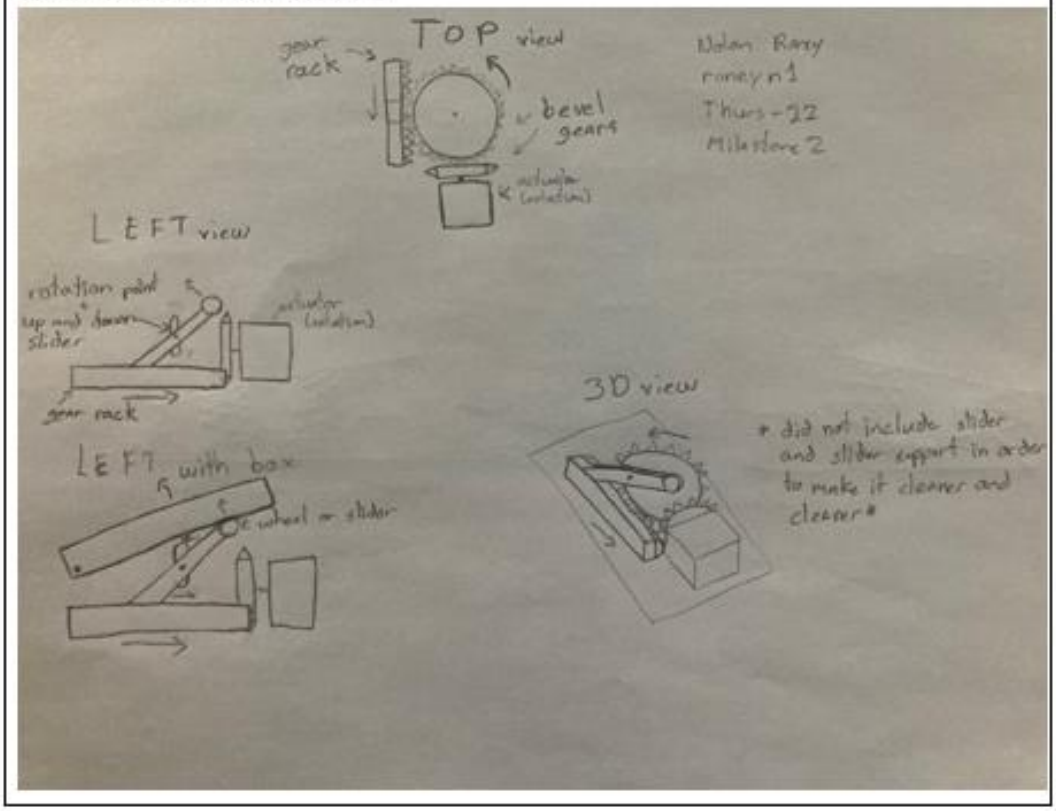
Concept Sketch 1: Linear Actuator



Team Number: Thurs-22

Name: Nolan Roney	MacID: roneyn1

Concept Sketch 2: Rotary Actuator



MILESTONE 2 (STAGE 3) – SENSOR CHARACTERIZATION (COMPUTATION SUB-TEAM)

Team Number: Thurs-22

1. As a team, consolidate the results of your individual sensor research
   → Discuss your findings and appropriateness of each sensor for your application
   → Keep discussion brief, using point form

Sensor Type	Findings and Appropriateness for Application
Ultrasonic Sensor	• Useful for calculating distance by emitting waves • Emits Ultrasonic waves that are optimal for the current scenario of detecting bins spaced from the line
Hall Sensor	• Requires a high voltage/high current to be fully functional • Good for motors • Can be disrupted
Active-Infrared Sensor	• Useful for calculating distance • Accurate for finding distance between objects • Similar to an ultrasonic sensor
LDR (Light Dependent Resistor)	• Sensitive to light, can convert light changes into electric changes
Color Sensor	• Detect colors of the objects
Retro-reflective Photoelectric Sensor	• Detect the presence of an object and then decide whether an object is metal or non-metal

2. Identify one sensor to incorporate into your computer program

We will be using the ultrasonic sensor to incorporate into our computer program. We can change the distance from the line on the floor and use the sensor to detect each bin.

3. Identify an attribute value for each bin

Bin ID	Attribute Value
Bin01: Metal Bin	0cm
Bin02: Paper Bin	25cm
Bin03: Plastic Bin	50cm
Bin04: Garbage Bin	75cm

MILESTONE 2 (STAGE 4) – DECISION MATRIX (MODELLING SUB-TEAM)

Team Number: Thurs-22

1. As a team, establish a weighting factor for each criterion
   → Move row-by-row
   - If *Criteria 1* is preferred over *Criteria 2*, assign a 1. Otherwise, assign 0
   - If *Criteria 1* is preferred over *Criteria 3*, assign a 1. Otherwise, assign 0

   → Add additional rows/columns as needed

	Feasibility	*Easy to assemble*	*Easy to mount actuator in specified location*	Securely attached to baseplate + supports hopper	High range of motion	**Score**
Feasibility	1	1	0	1	1	**4**
Easy to assemble	0	1	0	1	1	**3**
Easy to mount actuator in specified location	1	1	1	1	1	**5**
Securely attached to baseplate + supports hopper	0	0	0	1	0	**1**

High range of motion	0	0	0	1	1	**2**

2. As a team, evaluate your concepts against each criterion using your weighting
   → Add additional rows as needed

	Weight	*Concept 1*		*Concept 2*		*Concept 3*		*Concept 4*		*Concept 5*		*Concept 6*	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Feasibility	4	4	**16**	1	**4**	3	**12**	4	**16**	3	**12**	3	12
Easy to assemble	3	5	**15**	1	**3**	4	**12**	2	**6**	3	**9**	3	9
Easy to mount actuator in specified location	5	3	**15**	2	**10**	5	**25**	5	**25**	5	**25**	5	25
Securely attached to baseplate + supports hopper	1	4	**4**	3	**3**	2	**2**	3	**3**	5	**5**	3	3
High range of motion	2	3	**6**	5	**10**	2	**4**	4	**8**	5	**10**	4	8
TOTAL			**56**		**30**		**55**		**58**		**61**		**57**

3. Discuss conclusions based on evaluation, including what concept you've chosen

We chose concept 5 as our base mechanism, we chose to build of this because it scored highly on our weighted matrix. This design includes a linear actuator. The reason for this was because the accordion-like structure made the mechanism flexible in order for it extend further away than other designs, this satisfies our condition to tilt our hopper so that we can release the containers into the bins. Concept 5 had two points of contact, holding the hopper from the bottom of its base; providing it maximum stability. Lastly, this design was feasible as it was inspired by Lego dump truck structures, Lego's a great building tool as they make great connectors and were very similar to the linkages seen in the sketch.

Milestone 3:

PROJECT THREE: MILESTONE 3 – COVER PAGE

Team Number: Thurs-22

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

Full Name:	MacID:
Armon Bal	bala4
Jiayue Zhu	zhu3
Nolan Roney	roneyn1
Pratha Bhat	bhatp3
Vaisnavi Shanthamoorthy	shanthav

MILESTONE 3 (STAGE 1A) – WORKFLOW PSEUDOCODE (COMPUTATION SUB-TEAM)

Team Number: Thurs22

You should have already completed this task individually *prior* to Design Studio 15.

1. Write out a pseudocode outlining the *high-level workflow* of your computer program on the following page
   → Only one team member is responsible for this task (not *both*)
   → Be sure to clearly indicate who each code belongs to

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their pseudocode with the **Milestone Three Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 3*** of the milestone

Team Number: Thurs-22

Name: Jiayue Zhu	MacID: zhu3

*Write out a pseudocode outlining the **high-level workflow** of your computer program in the space below.*

Start

Rotate the turntable.

Check whether the pick-up location has a container or not.

Keep rotating until there is a container.

Define a function to classify the container.

If the container is metal, type == metal

Elif the container is opaque and plastic, type == opaque plastic

Elif the container is opaque and paper, type == opaque paper

Else: type == garbage

Q-arm picks up the container.

Q-arm drops off the container on the hopper on Q-bot.

Define a function to move the Q-bot to the correct bin (determine the distance Q-bot moves, distance is the attributes)

If type == metal, Q-bot goes to bin01, distance == 0cm.

If type == opaque paper, Q-bot goes to bin02, distance == 25cm.

If type == opaque plastic, Q-bot goes to bin03, distance == 50cm.

If type == garbage, Q-bot goes to bin04, distance == 75cm.

Q-bot moves to the correct bin.

Hopper in Q-bot rotates for the container to fall into the bin.

Hopper returns to home position.

Q-bot returns to home position.

MILESTONE 3 (STAGE 1B) – WORKFLOW FLOWCHART / STORYBOARD (COMPUTATION SUB-TEAM)

Team Number:	Thurs-22

You should have already completed this task individually *prior* to Design Studio 15.

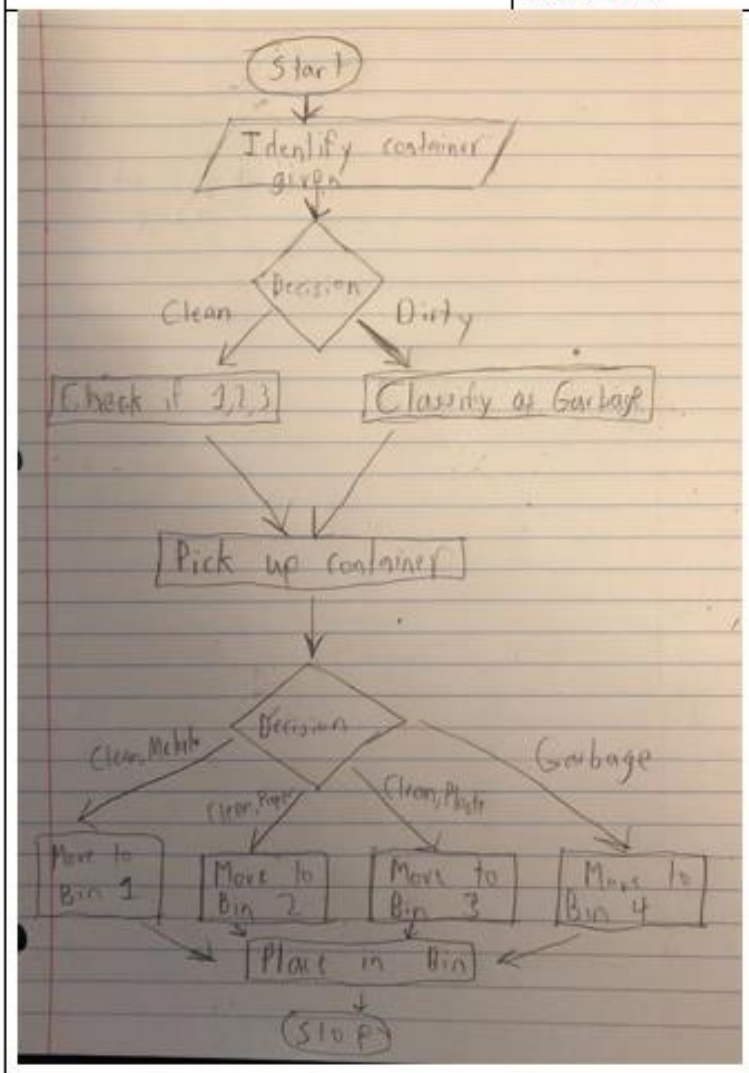
1. Only one team member is responsible for this task (not *both*)
2. Copy-and-paste your flowchart or storyboard on the following page
   → Be sure to include your Team Number, Name and MacID
3. Take a photo of your flowchart / storyboard
4. Insert your photo as a Picture (Insert > Picture > This Device)

We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their flowchart/storyboard screenshots with the **Milestone Three Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 3*** of the milestone

Team Number: Thurs - 22

Name: Armon Bal | MacID: bala



MILESTONE 3 (STAGE 2) – DETAILED SKETCHES (MODELLING SUB-TEAM)

Team Number: Thurs-22

You should have already completed this task individually *prior* to Design Studio 15.

1. Copy-and-paste each sub-team member's detailed sketch on the following pages (1 sketch per page)
   → Be sure to indicate each team member's Name and MacID

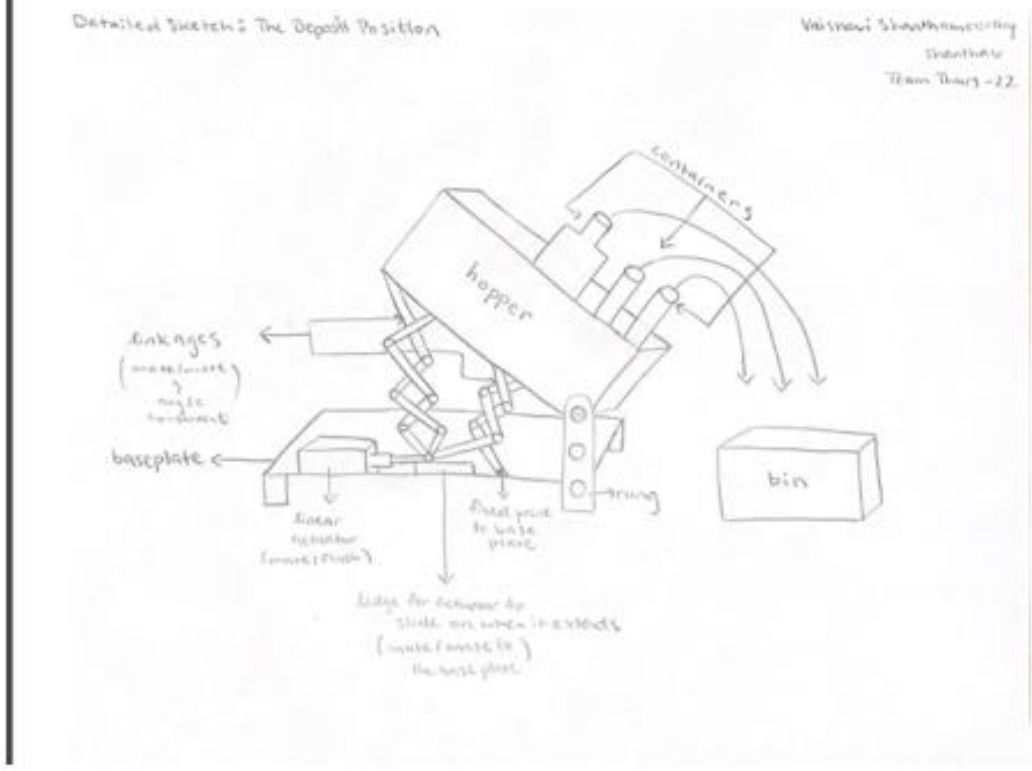
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their detailed sketches with the **Milestone Three Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Three Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 4*** of the milestone

Team Number: Thurs-22

Name: Vaisnavi Shanthamoorthy	MacID: shanthav

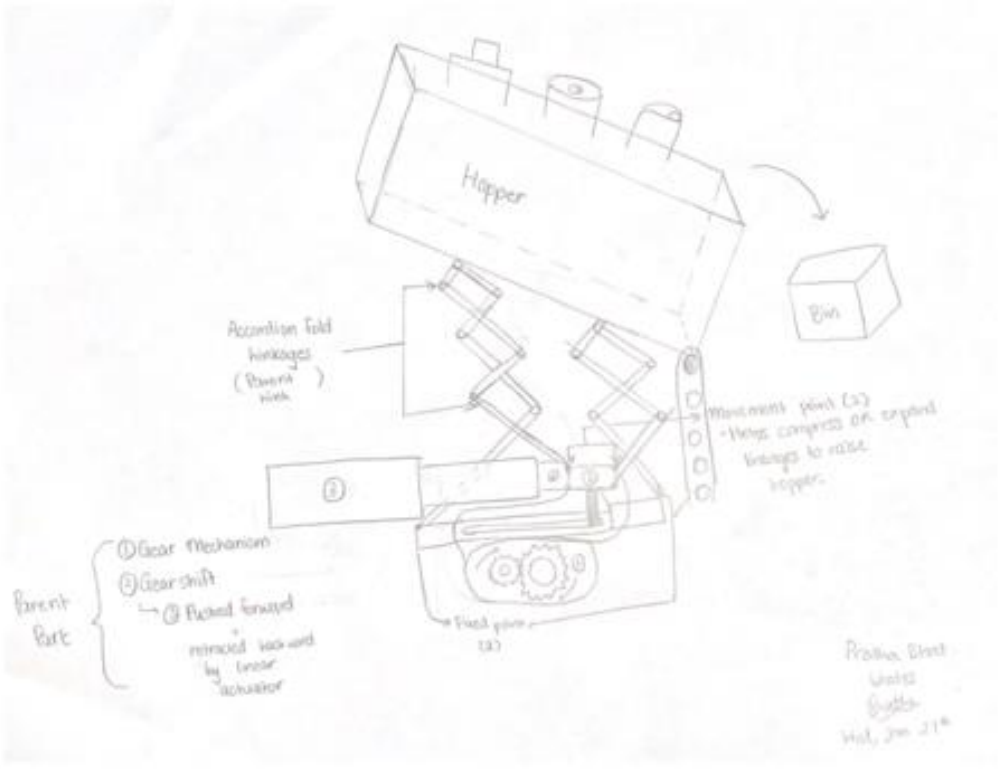
Insert screenshot(s) of your detailed sketch below.



Team Number: Thurs-22

Name: Pratha Bhat	MacID: bhatp3

Insert screenshot(s) of your detailed sketch below.

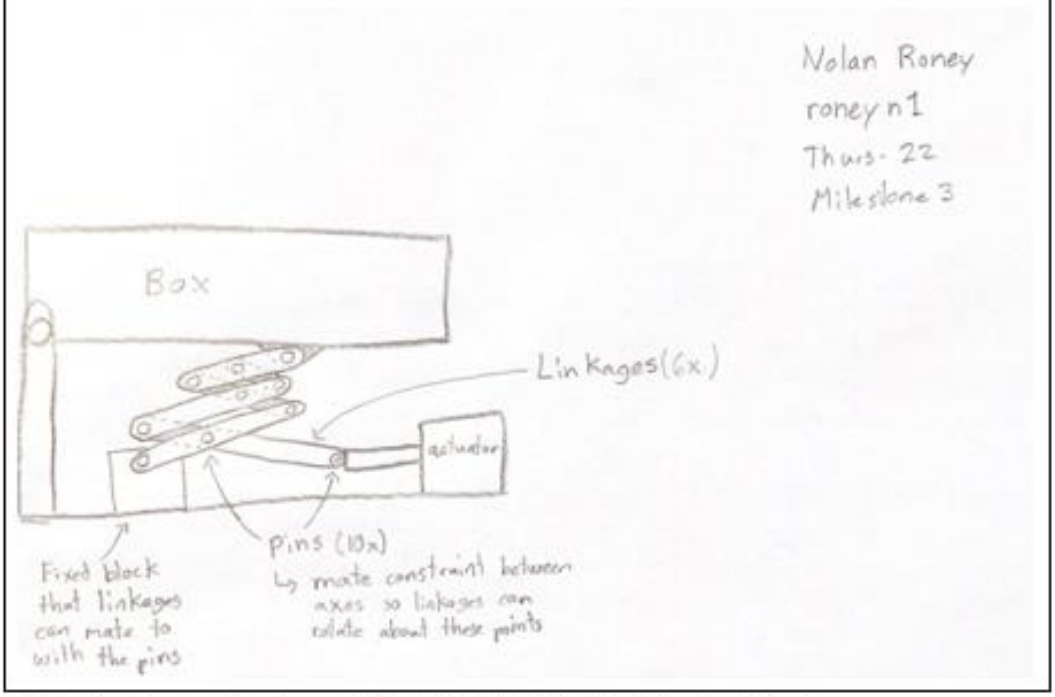


*If you are in a sub-team of 3, please copy and paste the above on a new page.

Team Number: Thurs-22

Name: Nolan Roney	MacID: roneyn1

Insert screenshot(s) of your detailed sketch below.



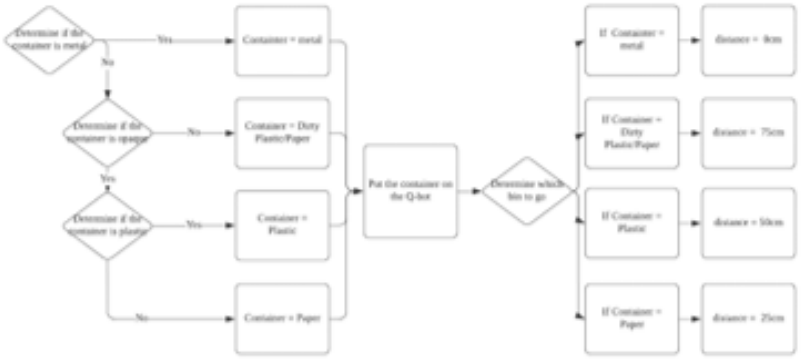
*If you are in a sub-team of 3, please copy and paste the above on a new page.

MILESTONE 3 (STAGE 3) – PROGRAM TASK PLANNING (COMPUTATION SUB-TEAM)

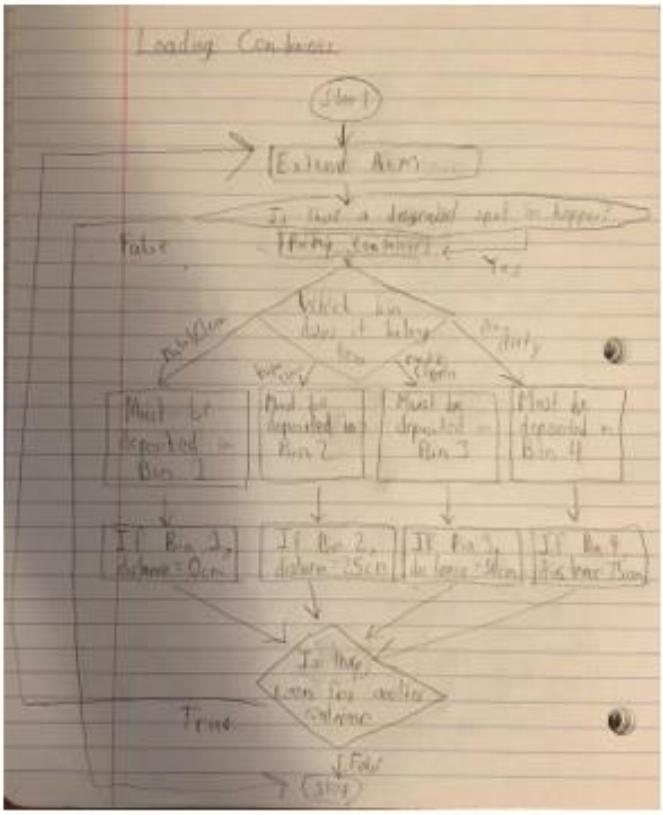
Team Number: Thurs - 22

1. As a team, write out the pseudocode or create a flowchart for the indicated tasks in the space below.
   → If creating a flowchart, complete your flowchart on a separate sheet of paper, take a photo of your sketch and insert photo as a Picture (Insert > Picture > This Device)

Dispense Container



Load Container



Transfer Container

Define a function for the Q-bot to stop once it next to the correct position.

If distance == 0 cm:

    Q-bot moves a cm

Else if distance == 25 cm:

    Q-bot moves b cm

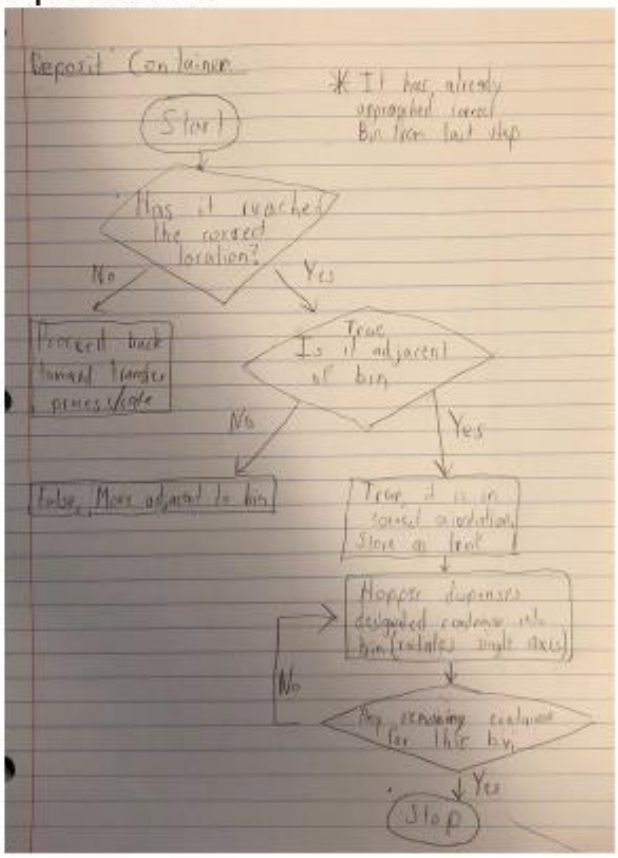
Else if distance == 50 cm:

    Q-bot moves c cm

Else:

    Q-bot moves d cm

Deposit Container



Return Home

#controlling the movement of the Q-bot until it gets to the home position
Q-bot rotates to the direction towards the turntable.
Q-bot moves forward, following the line on the floor.
Q-bot stops moving when it reaches the end of the line.
Q-bot rotates certain degrees, towards the pick-up location on the turntable.

MILESTONE 3 (STAGE 4) – PRELIMINARY MODELLING (MODELLING SUB-TEAM)

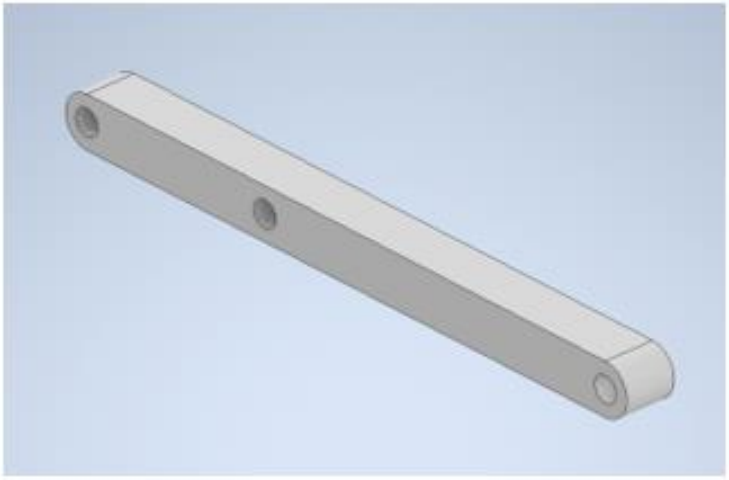
Team Number: Thurs-22

1. As a team, create solid models of the various components of your device in Autodesk Inventor, based on the detailed sketches.
   → Take multiple screenshots of each solid model you create
   → Insert your photo(s) as a Picture (Insert > Picture > This Device)
   → **Do not include more than *two* solid modelling screenshots per page**

Team Number: Thurs-22

Name: Nolan Roney	MacID roneyn1

Insert screenshot(s) of your model below.



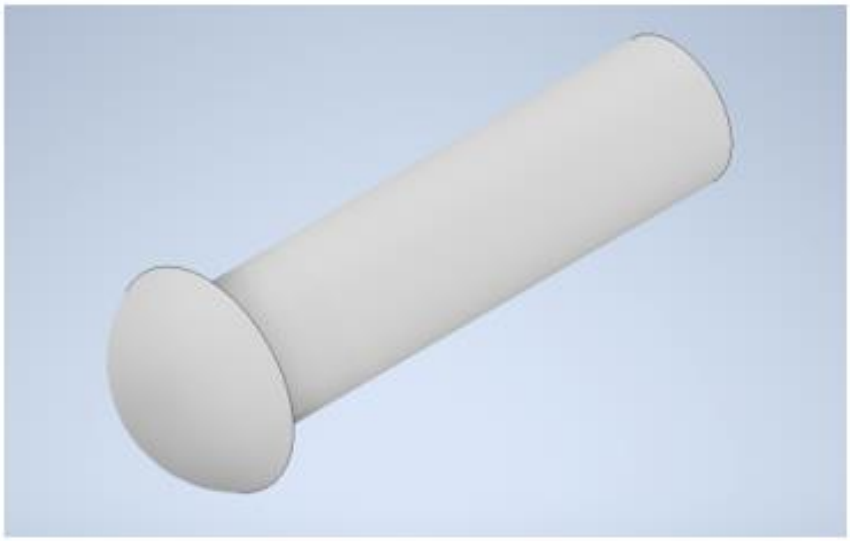
Long – Linkage Piece

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

Team Number: Thurs-22

Name: Nolan Roney	MacID roneyn1

Insert screenshot(s) of your model below.



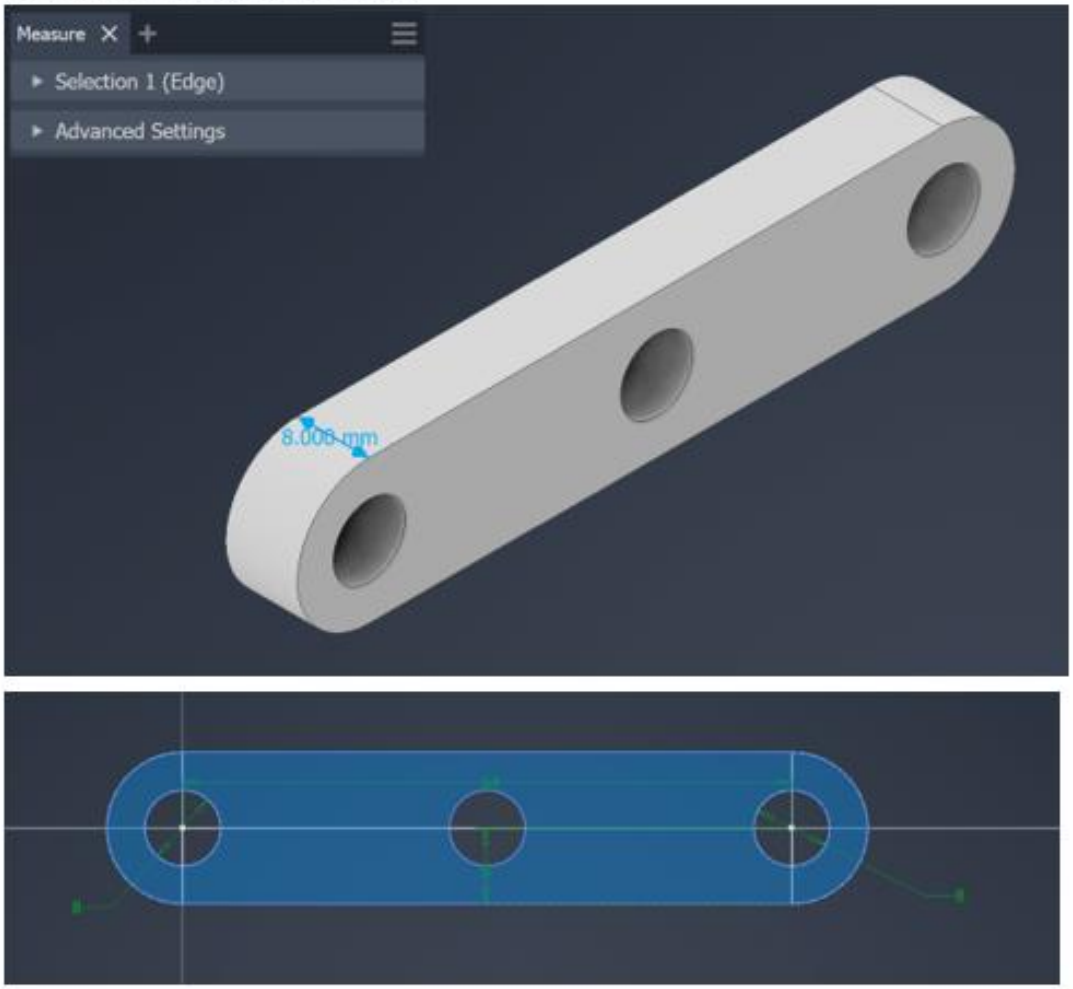
Pin

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

Team Number: Thurs-22

Name: Pratha Bhat	MacID: bhatp3

Insert screenshot(s) of your model below.



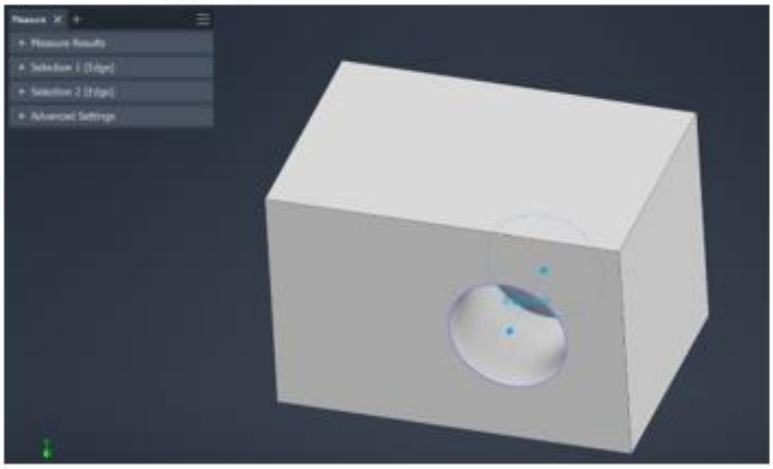
Medium – Linkage Piece

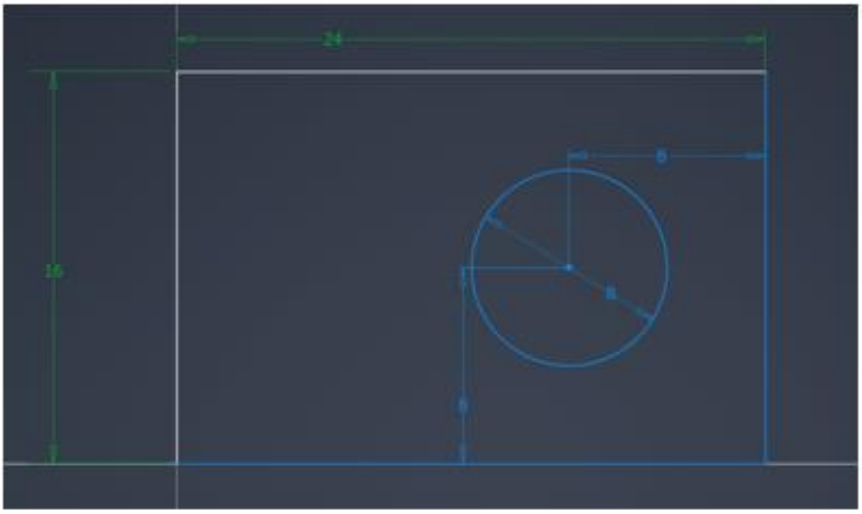
*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

Team Number: Thurs-22

Name: Pratha Bhat	MacID: bhatp3

Insert screenshot(s) of your model below.





BasePiece

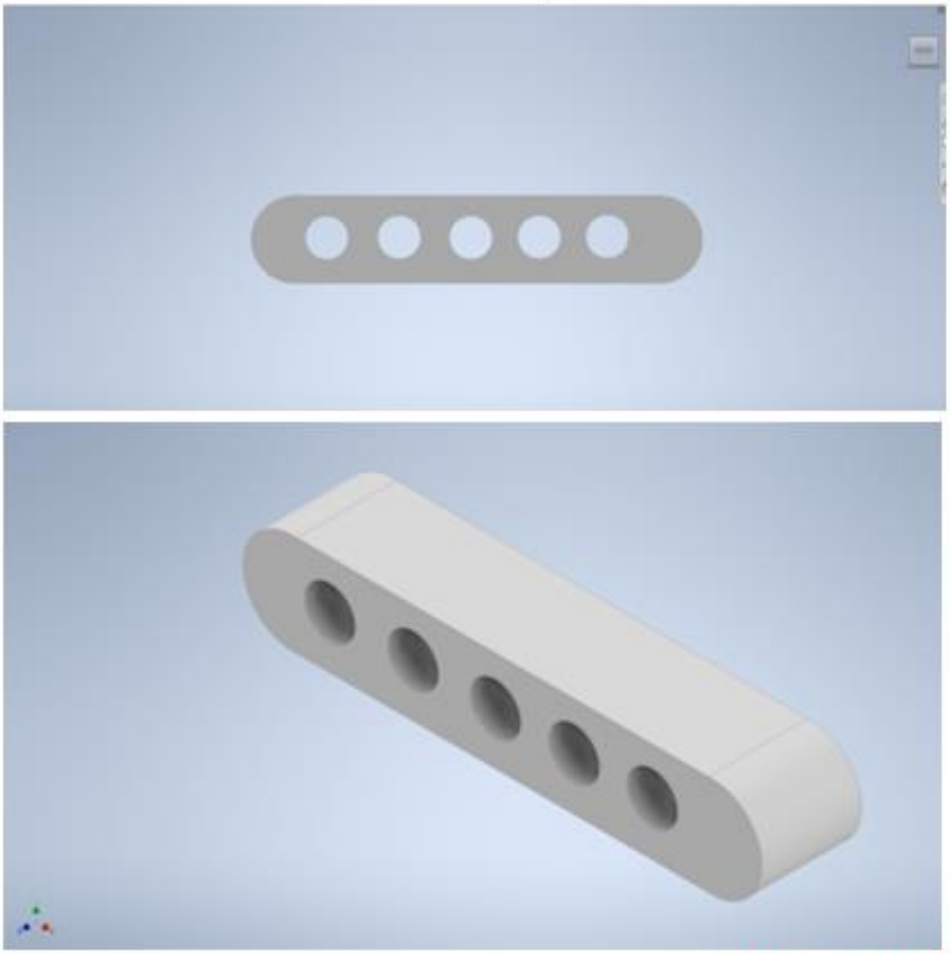
*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

Team Number: Thurs-22

Name: Vaisnavi Shanthamoorthy	MacID: shanthav

Insert screenshot(s) of your model below.

Screenshots for the solid model for the shortest linkage:



Short – Linkage Piece (1)

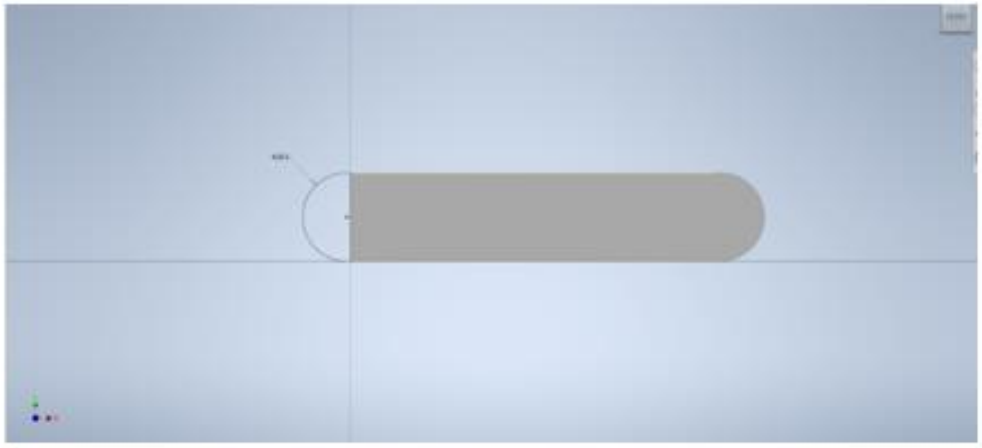
*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

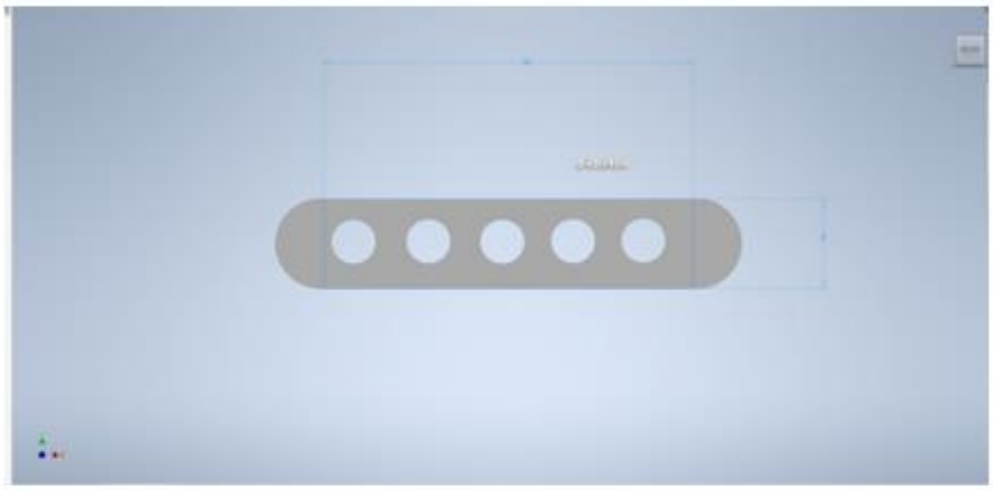
Team Number: Thurs-22

Name: Vaisnavi Shanthamoorthy	MacID: shanthav

Insert screenshot(s) of your model below.

Screenshots of the solid model for the shortest linkage(continued):





Short – Linkage Piece (2)

Milestone 4:

PROJECT THREE: MILESTONE 4 – COVER PAGE

Team Number: Thurs-22

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

Full Name:	MacID:
Vaisnavi Shanthamoorthy	shanthav
Nolan Roney	roneyn1
Jiayue Zhu	zhu3
Pratha Bhat	bhatp3
Armon	bala

MILESTONE 4 (STAGE 3) – DESIGN REVIEW FEEDBACK (MODELLING SUB-TEAM)

Team Number: Thurs-22

Use the space below to document mentor feedback for your design.

- Ensure a way your mechanism lifts your hopper for transfer
- Make sure T-shaped head piece slides across L mechanism

Use the space below to propose design refinements based on the feedback.

- Cut a slice at the bottom face of the cylindrical piece to allow it to slide across L-shaped base
- Finish assembly and modify according to the way it transfers/deposit
- Mate T-shaped piece with L shaped track.

MILESTONE 4 (STAGE 3) – DESIGN REVIEW FEEDBACK (COMPUTATION SUB-TEAM)

Team Number: Thurs-22

Use the space below to document mentor feedback for your design.

- Add comments on the codes
- Fix the errors regarding to the transfer code
- Ensure the codes can run without error when the IAI runs it

Use the space below to propose design refinements based on the feedback.

- The error of the transfer function is "object has no attributes", we need to fix that later.
- We need to add some more conditions in the load code.
- We will finish the deposit code.
- Add comments for clarity.

Source Materials Database (Vaisnavi Shanthamoorthy and Armon Bal)

[1] “P3 Project Module”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3021767/View. [Accessed Feb-2021].

[2] “P3 Demo Sample Solution”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3046614/View [Accessed Feb-2021]

[3] “P3 Demo – Changing the Environment”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3053261/View [Accessed Feb-2021]

[4] “P3 Demo – Configuring the Hopper”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3053266/View [Accessed Feb-2021]

[5] “P3 Demo – Controlling the Servo Demo”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3046610/View [Accessed Feb-2021]

[6] “P3 Demo – Dispensing the Container”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3053268/View [Accessed Feb-2021]

[7] “P3 Demo – Dumping the Container”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3053271/View [Accessed Feb-2021]

[8] “P3 Demo – Moving the Q-bot”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3046613/View [Accessed Feb-2021]

[9] “P3 Demo – Servo Sensors”, *McMaster University Online Courses*. [Online]. Available: https://avenue.cllmcmaster.ca/d2l/le/content/340370/viewContent/3046615/View [Accessed Feb-2021]

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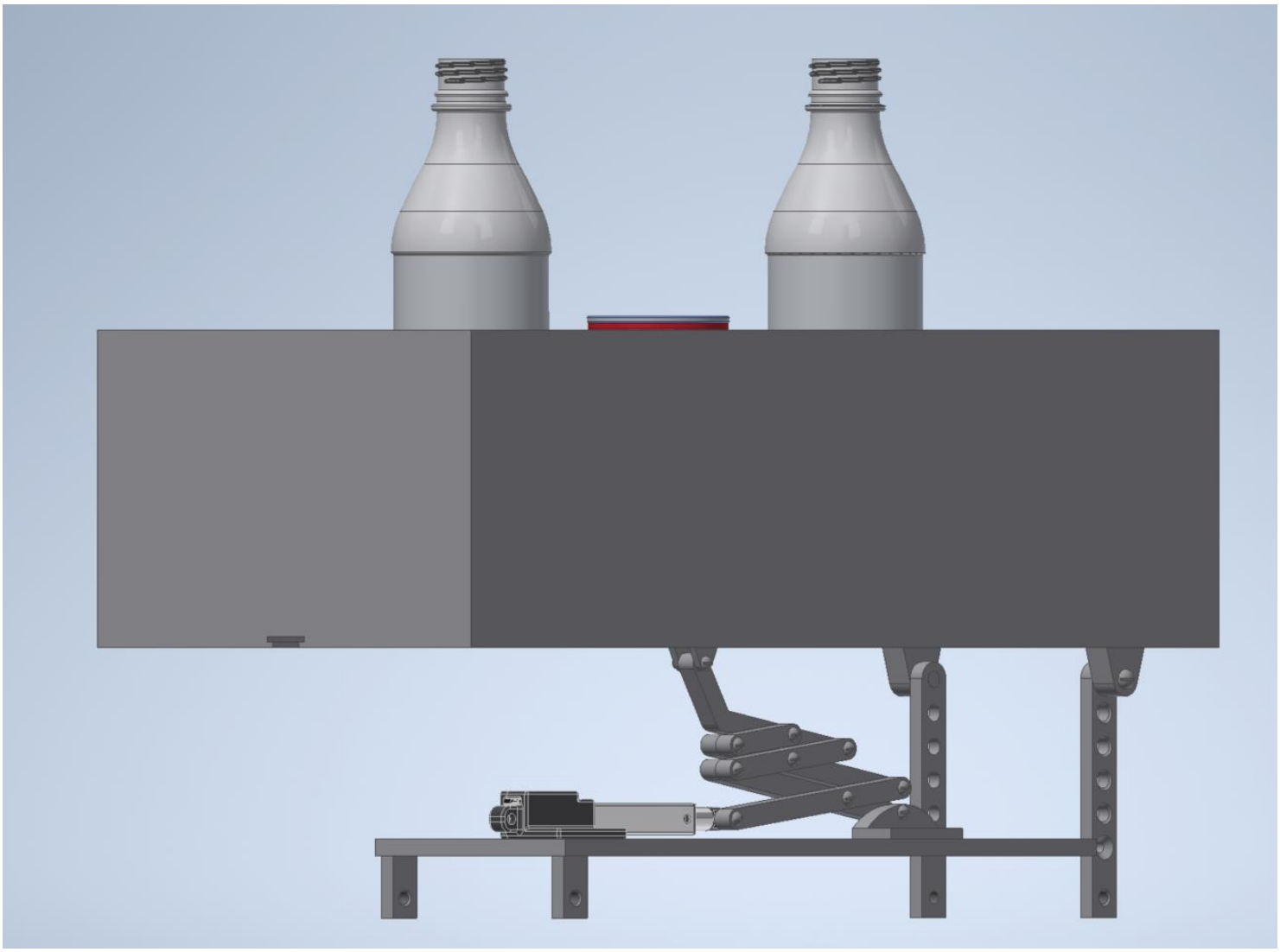
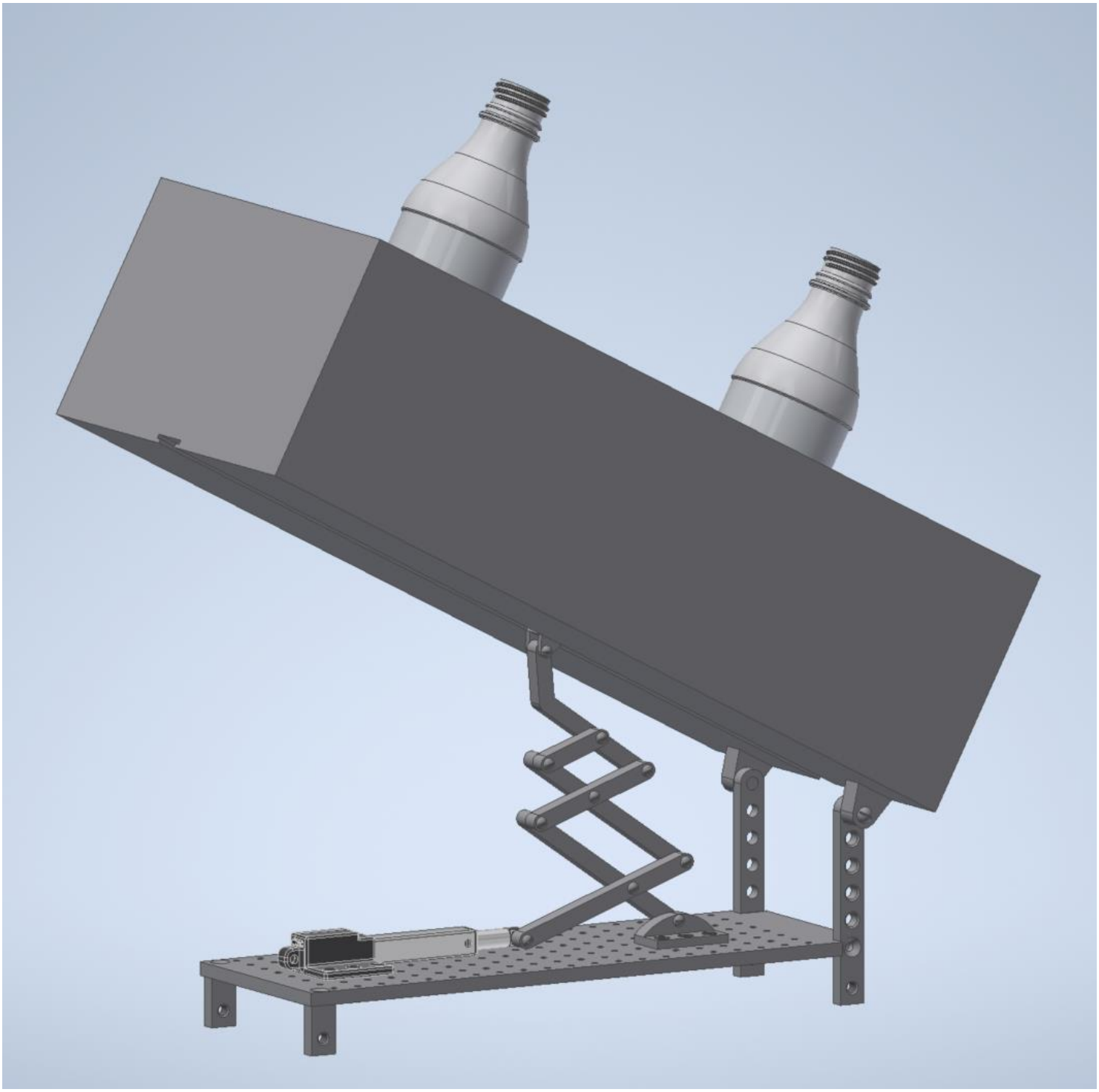
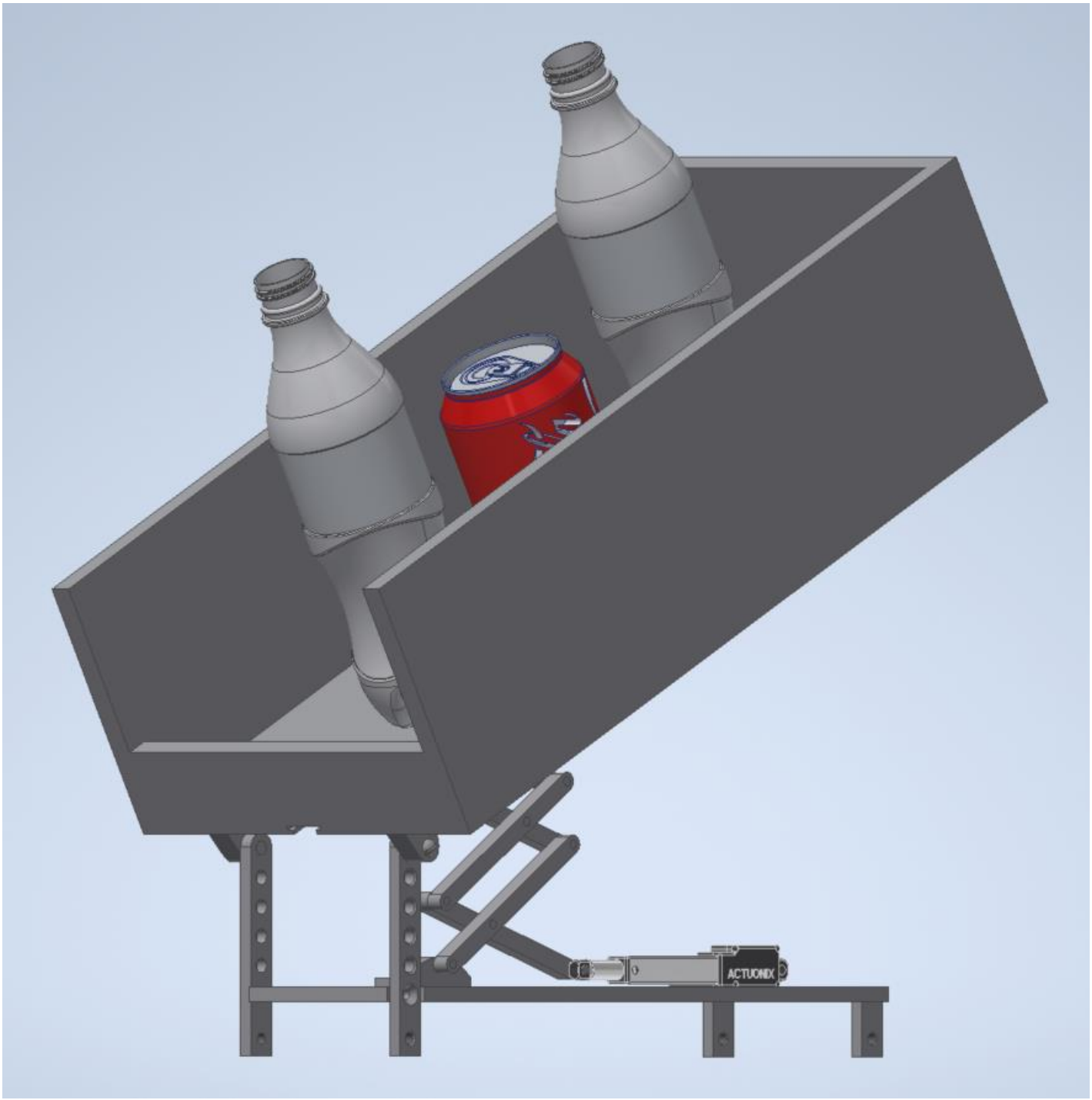
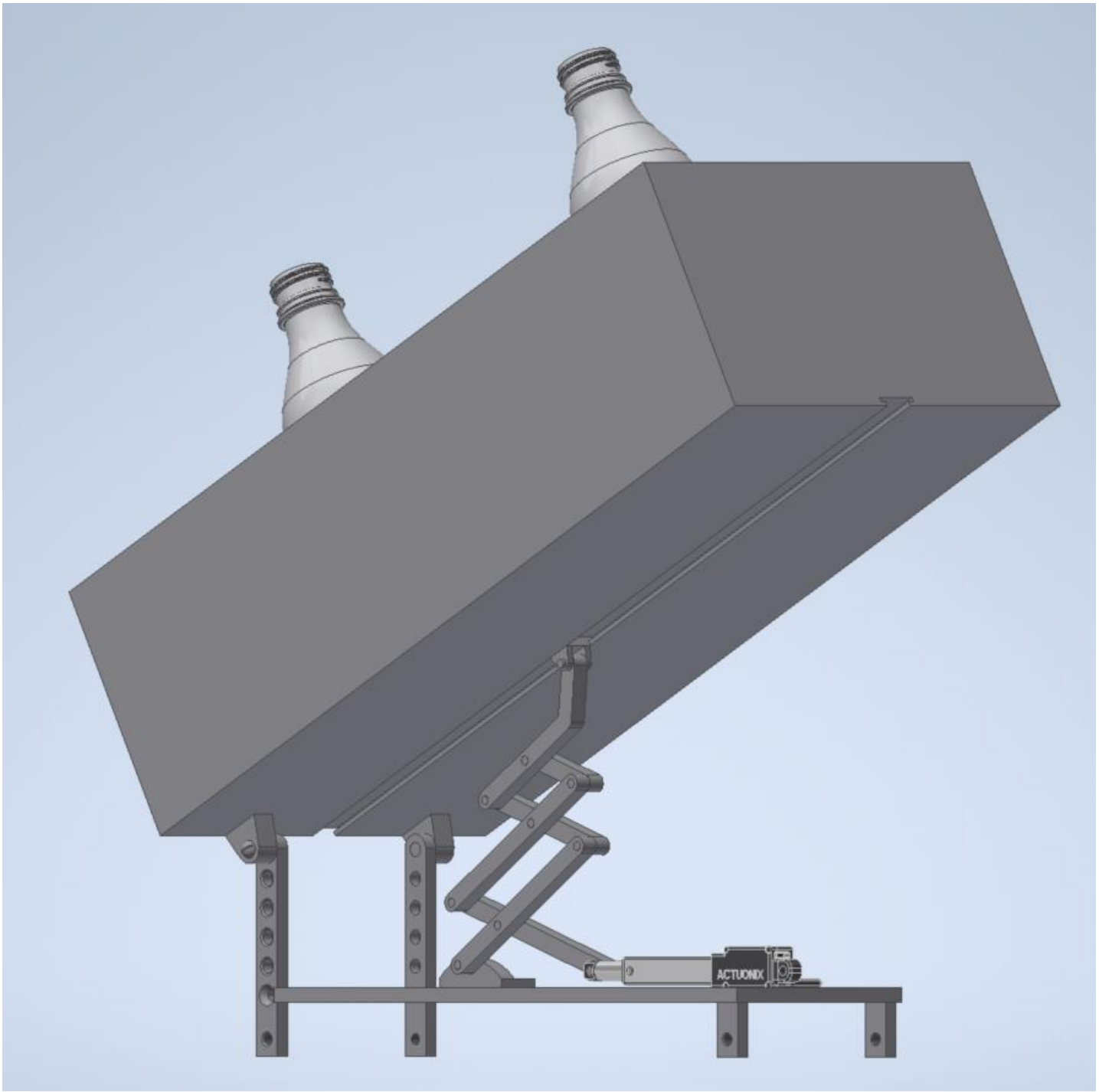
Appendices

Appendix A: Screenshots of Solid Model



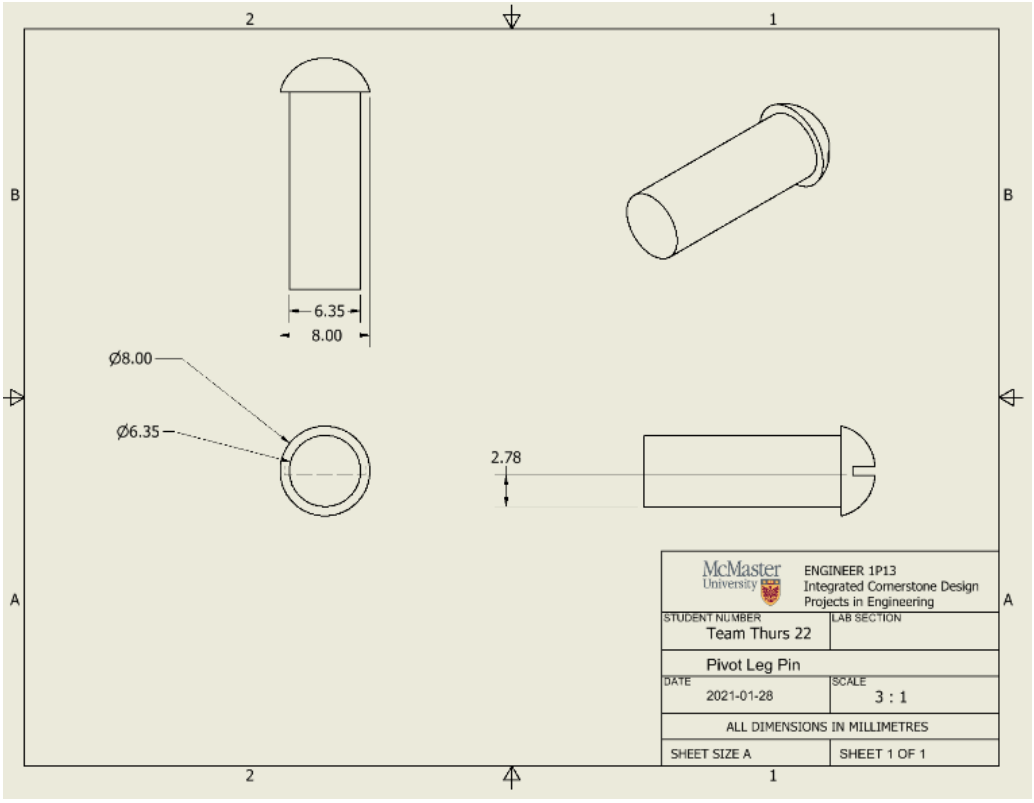


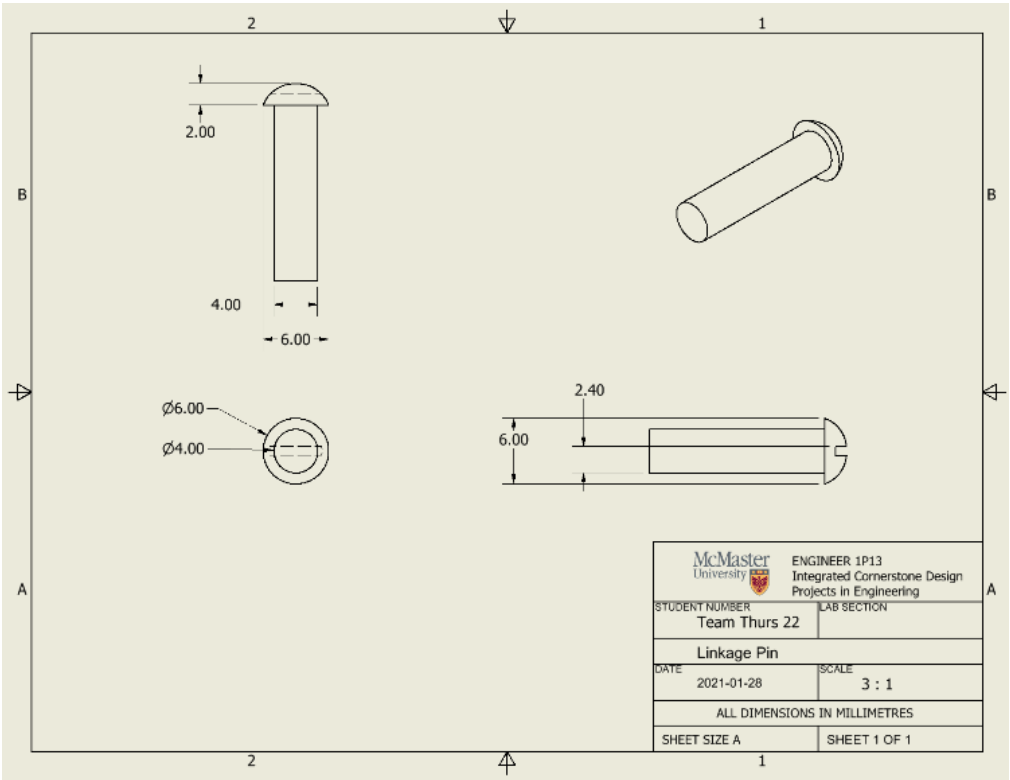

ACTUONIX

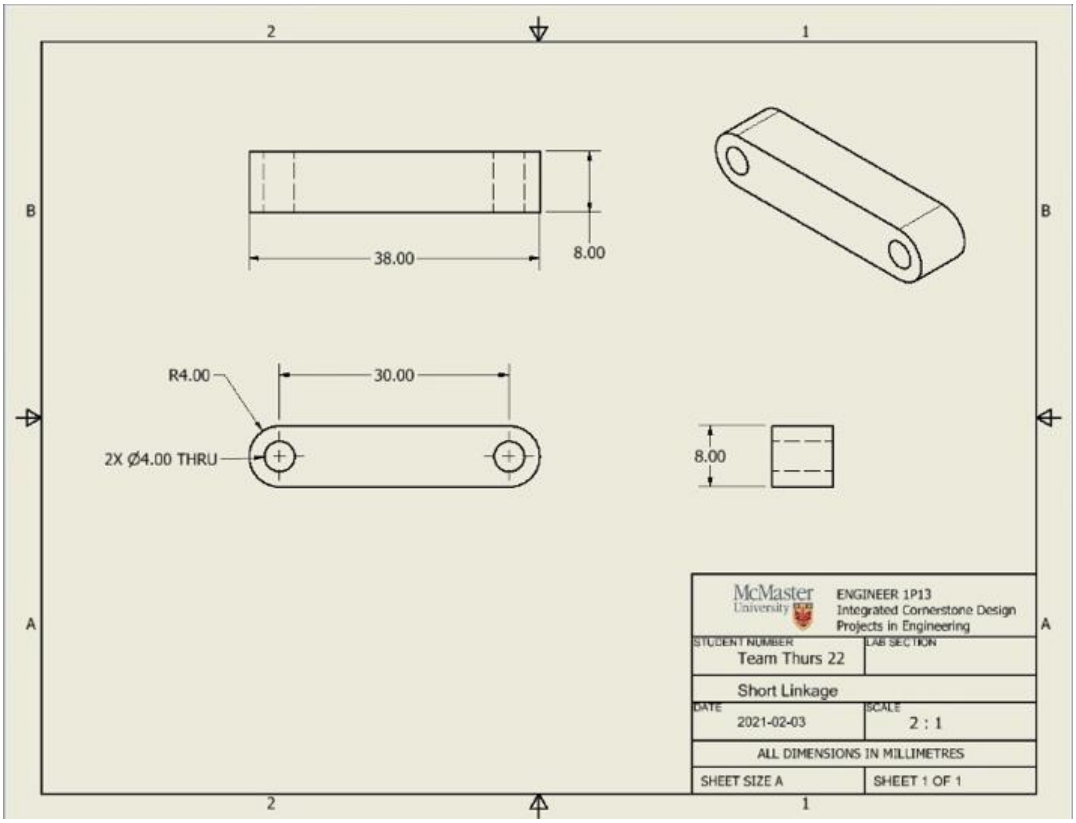

ACTUONIX

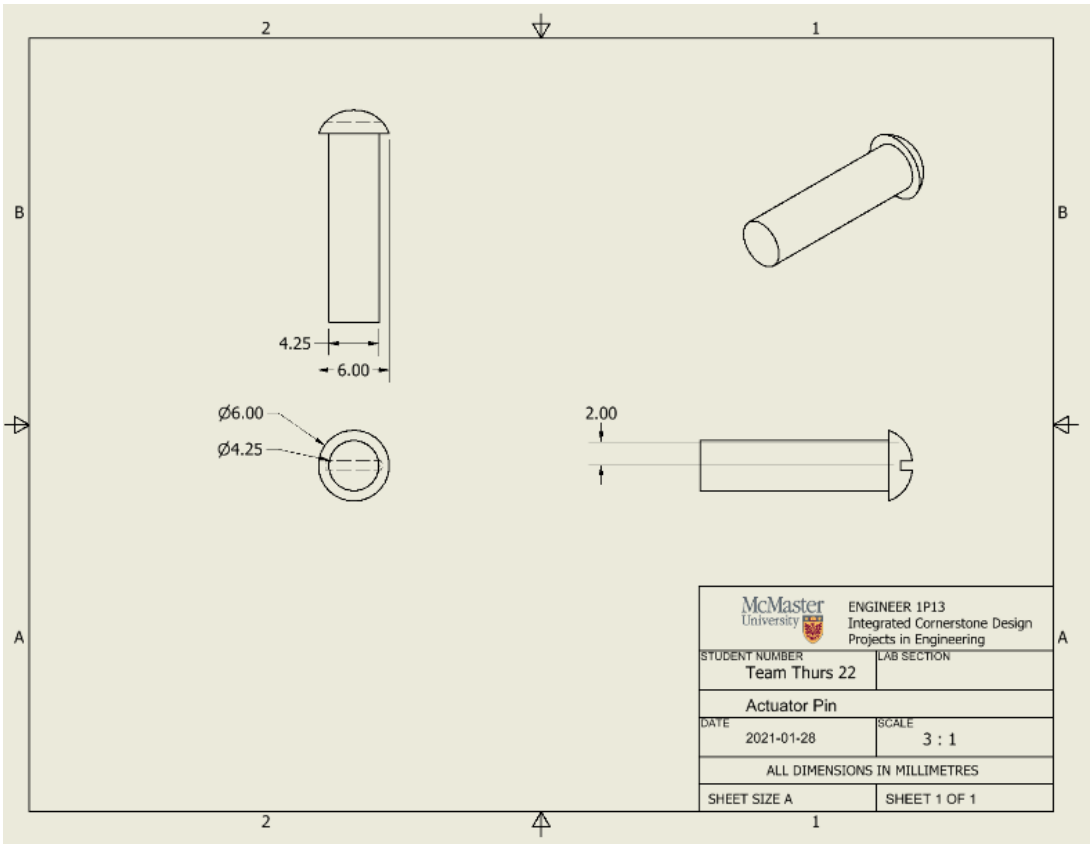
Appendix B: Engineering Drawings

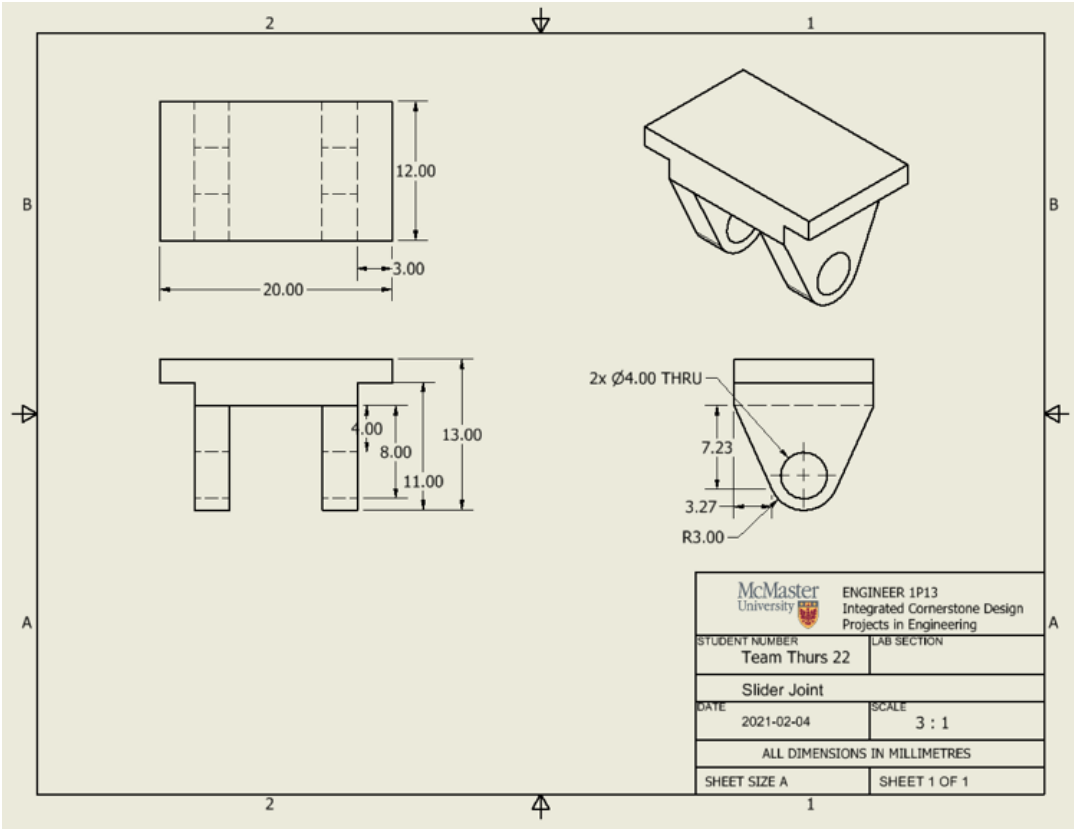
- Mechanism:






38.00
8.00
R4.00
30.00
2X Ø4.00 THRU
8.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Team Thurs 22
LAB SECTION
Short Linkage
DATE
2021-02-03
SCALE
2 : 1
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1


4.25
6.00
Ø6.00
Ø4.25
2.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Team Thurs 22
LAB SECTION
Actuator Pin
DATE
2021-01-28
SCALE
3 : 1
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1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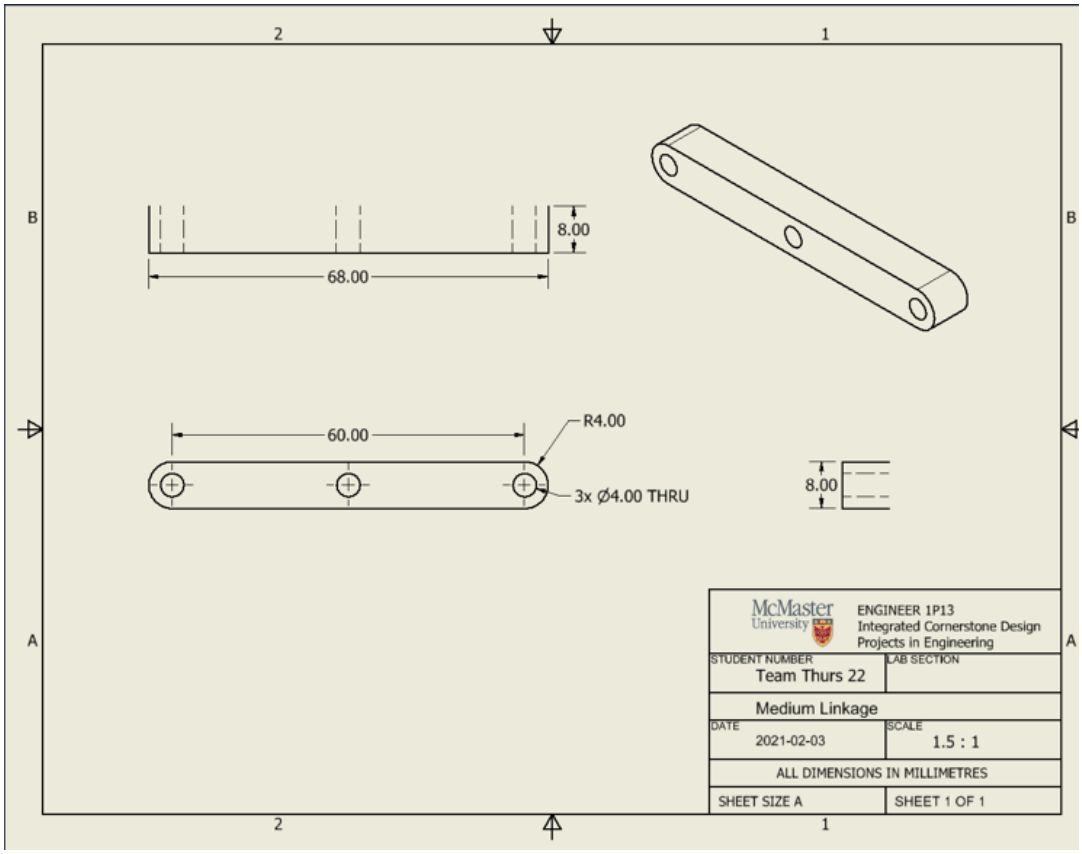
3.00
20.00
4.00
8.00
11.00
13.00
2x Ø4.00 THRU
7.23
3.27
R3.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Team Thurs 22
LAB SECTION
Slider Joint
DATE
2021-02-04
SCALE
3 : 1
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1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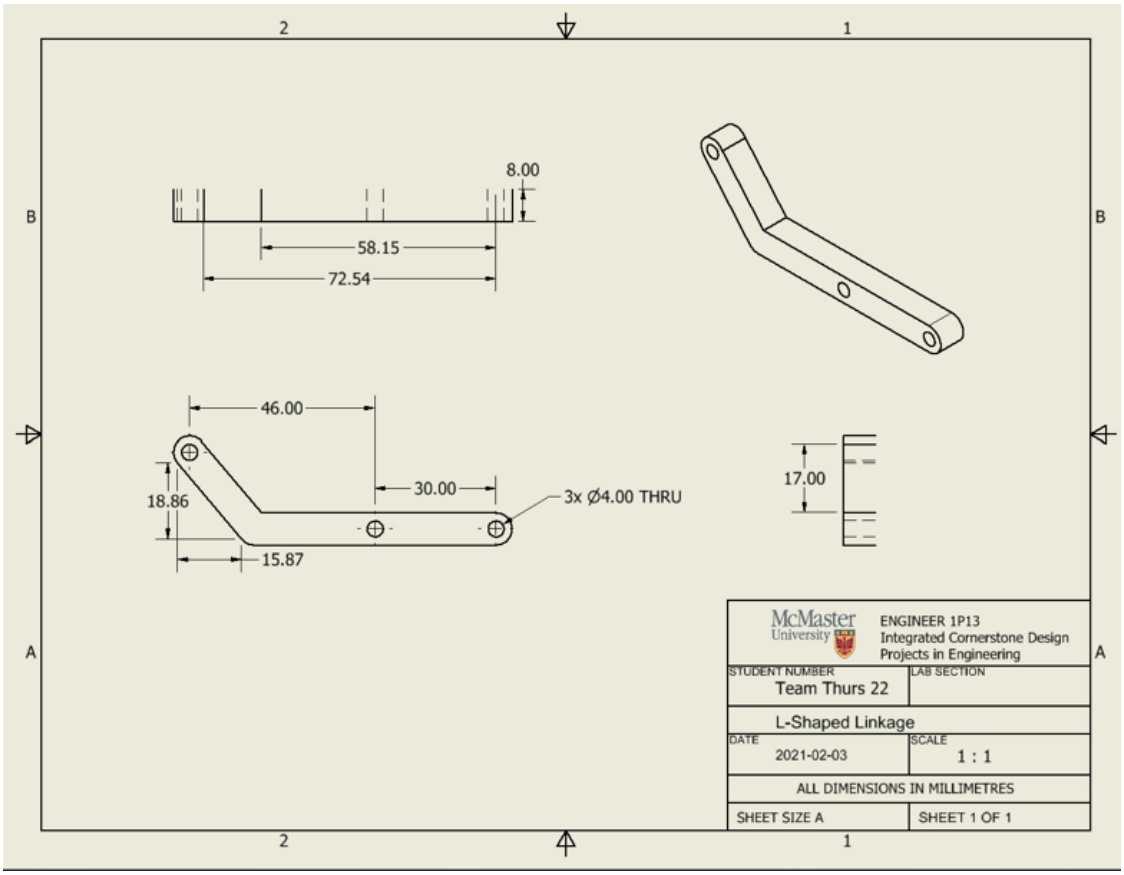
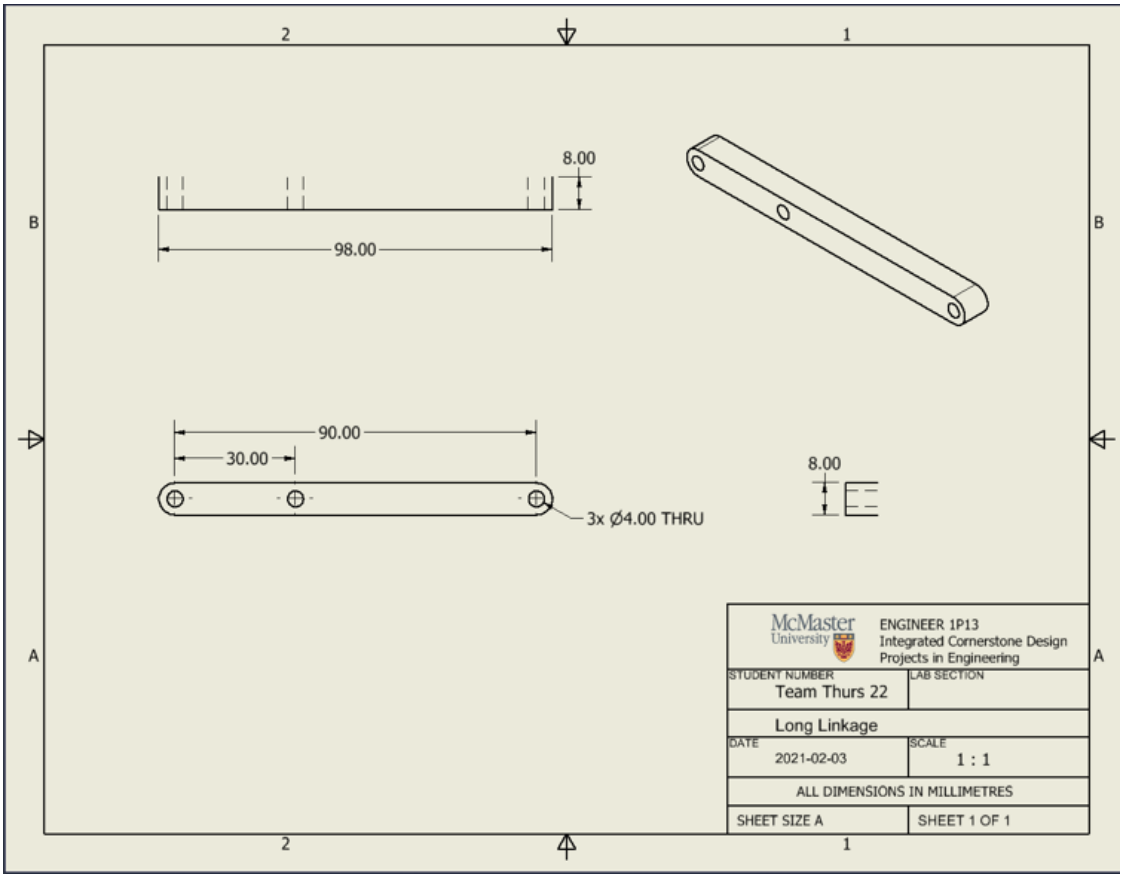
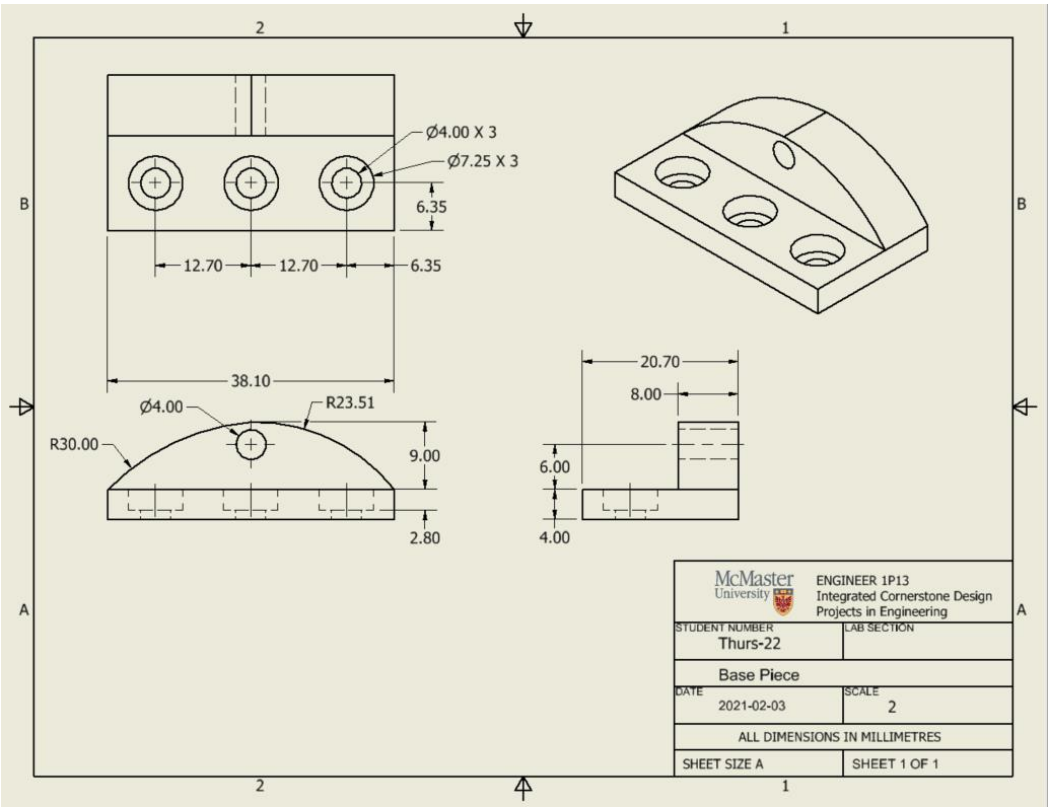
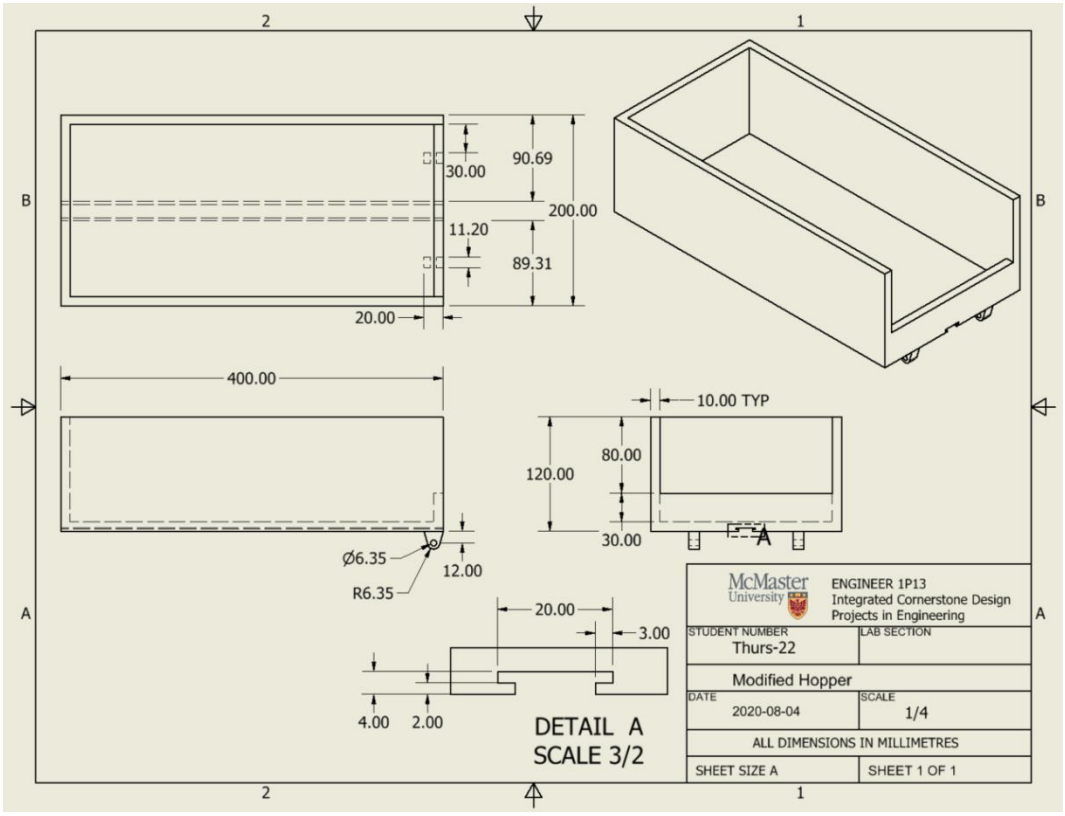
68.00
60.00
R4.00
3x Ø4.00 THRU
8.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Team Thurs 22
LAB SECTION
Medium Linkage
DATE
2021-02-03
SCALE
1.5 : 1
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1


8.00
58.15
72.54
46.00
30.00
18.86
15.87
3x Ø4.00 THRU
17.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Team Thurs 22
LAB SECTION
L-Shaped Linkage
DATE
2021-02-03
SCALE
1 : 1
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1


8.00
98.00
90.00
30.00
3x Ø4.00 THRU
8.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Team Thurs 22
LAB SECTION
Long Linkage
DATE
2021-02-03
SCALE
1 : 1
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1


Ø4.00 X 3
Ø7.25 X 3
6.35
12.70
12.70
6.35
38.10
Ø4.00
R23.51
R30.00
9.00
2.80
20.70
8.00
6.00
4.00
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Thurs-22
LAB SECTION
Base Piece
DATE
2021-02-03
SCALE
2
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1

- Hopper: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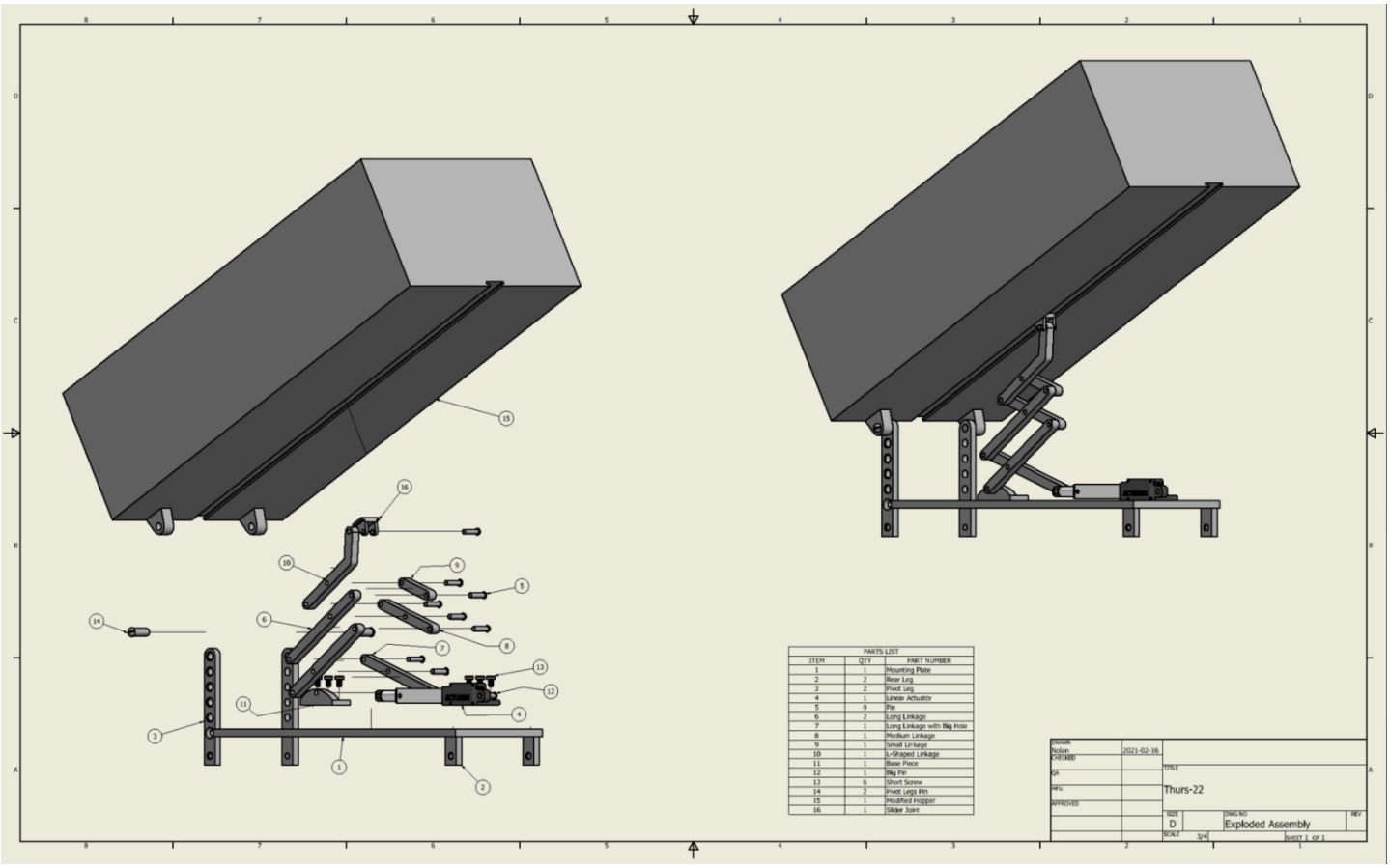
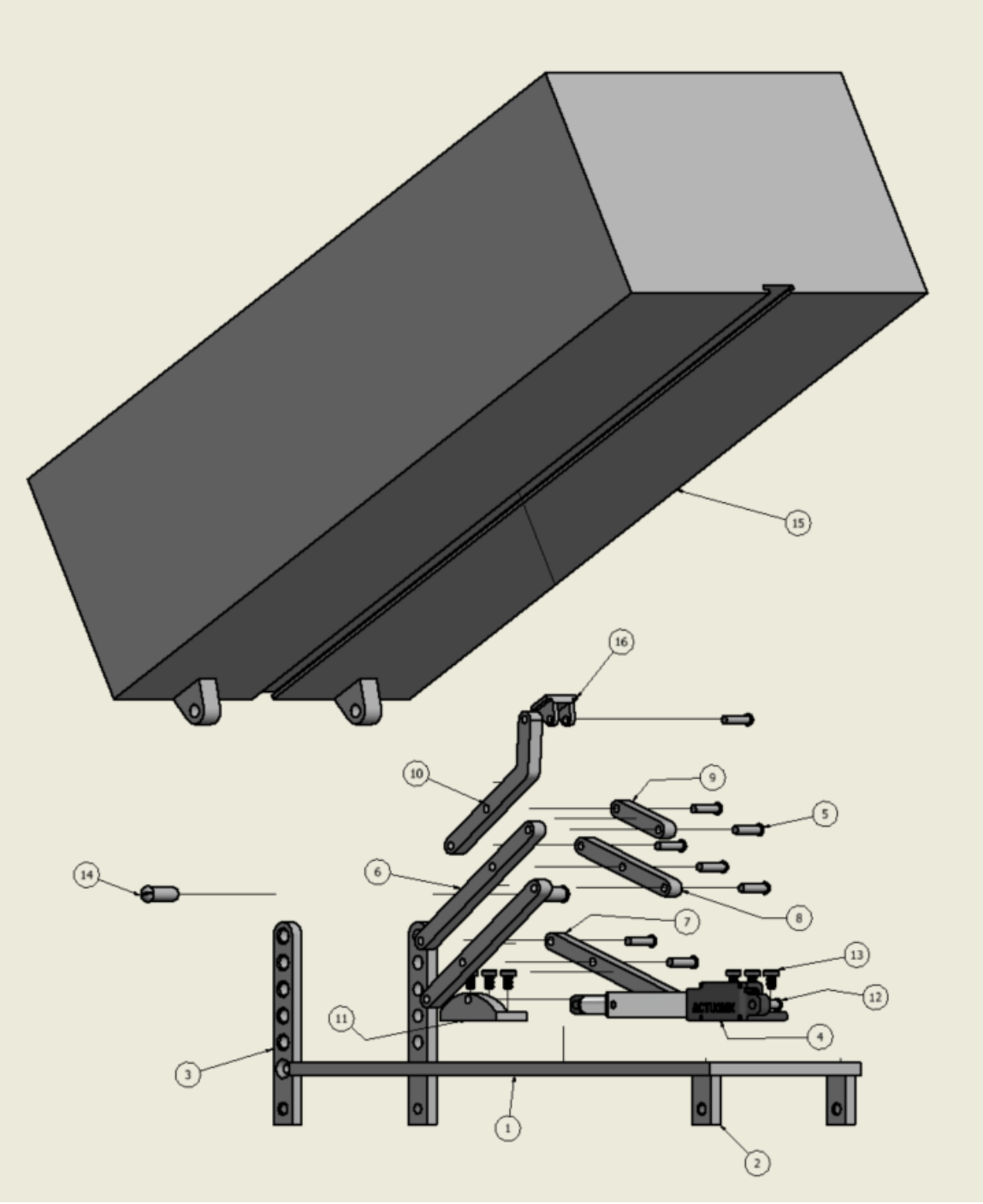
200.00
11.20
89.31
20.00
400.00
10.00 TYP
120.00
80.00
30.00
Ø6.35
R6.35
12.00
20.00
3.00
4.00
2.00
DETAIL A
SCALE 3/2
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
Thurs-22
LAB SECTION
Modified Hopper
DATE
2020-08-04
SCALE
1/4
ALL DIMENSIONS IN MILLIMETRES
SHEET SIZE A
SHEET 1 OF 1

- Exploded Drawing:



Closer look at Exploded Assembly:



PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	Mounting Plate
2	2	Rear Leg
3	2	Pivot Leg
4	1	Linear Actuator
5	9	Pin
6	2	Long Linkage
7	1	Long Linkage with Big Hole
8	1	Medium Linkage
9	1	Small Linkage
10	1	L-Shaped Linkage
11	1	Base Piece
12	1	Big Pin
13	6	Short Screw
14	2	Pivot Legs Pin
15	1	Modified Hopper
16	1	Slider Joint

Appendix C: Screenshots of Computer Program

```
import time
import random
import sys
sys.path.append('../')

from Common_Libraries.p3b_lib import *

import os
from Common_Libraries.repeating_timer_lib import repeating_timer

def update_sim():
    try:
        my_table.ping()
    except Exception as error_update_sim:
        print (error_update_sim)

### Constants
speed = 0.2 #Qbot's speed

### Initialize the QuanserSim Environment
my_table = servo_table()
arm = qarm()
arm.home()
bot = qbot(speed)

##


##-------------------------------------------------------------------------------------
## STUDENT CODE BEGINS
##-------------------------------------------------------------------------------------
'''
dispense made by Jiayue, modified by Armon
load made by Jiayue
transfer made by Armon
deposit made by Armon, modified by Jiayue
returnHome made by Jiayue
'''


#dispense_container:
#The dispense_container function will return a list of container value.
def first_Container():


    bottle_ids = random.randint(1,6)
    my_table.container_properties(bottle_ids)
    my_table.dispense_container()
    container_Properties = list(my_table.container_properties(bottle_ids))
    print("The first container is ready!")
    print("First container's properties:")
    print (container_Properties[2])
    global value
    value = (str(container_Properties[2]))
    STEP_SIZE = 360
    my_table.rotate_table_angle(STEP_SIZE)
    return container_Properties

def second_Container():

    bottle_ids = random.randint(1,6)
    my_table.container_properties(bottle_ids)
    my_table.dispense_container()
    second_container_Properties = list(my_table.container_properties(bottle_ids))
    print("The second container is ready!")
    print("Second container's properties:")
    STEP_SIZE = 360
    my_table.rotate_table_angle(STEP_SIZE)
    return second_container_Properties
```

```
def third_Container():

    bottle_ids = random.randint(1,6)
    my_table.container_properties(bottle_ids)
    my_table.dispense_container()
    third_container_Properties = list(my_table.container_properties(bottle_ids))
    print("The third container is ready!")
    print("Third container's properties:")
    STEP_SIZE = 360
    my_table.rotate_table_angle(STEP_SIZE)
    return third_container_Properties



#load_container
def loadContainer_motion(position):

#Control the movement of the Q-arm:
    arm.rotate_shoulder(45)
    arm.rotate_elbow(-30)
    arm.control_gripper(45)
    arm.rotate_shoulder(-45)
    arm.rotate_base(-90)
    arm.move_arm(position[0],position[1],position[2])
    arm.control_gripper(-45)
    time.sleep(1)
    arm.rotate_elbow(-30)
    arm.home()



def loadContainer_main():
#3 Q-arm drop-off positions
    position_1 = [0.0873,-0.3495,0.5132]
    position_2 = [-0.0,-0.3618,0.5582]
    position_3 = [0.0994,-0.3783,0.5654]
#dispense the first container,and print the property
    first_container = first_Container()
    print(first_container)
#put the first container on the top of the Q-bot
    loadContainer_motion(position_1)
#dispense the second container,and print the property
    second_container = second_Container()
    print(second_container)
#check if the first container and the second container go to the same bin.
    if first_container[2] == second_container[2] and first_container[1] + second_container[1] < 90:
        loadContainer_motion(position_2)
        print("Container 1 & 2 Go to the same bin!")
        #if they go to the same bin, dispense the third container, and print the property.
        third_container = third_Container()
        print(third_container)
        if first_container[2] == third_container[2] and first_container[1] + second_container[1] + third_container[1] < 90:
            loadContainer_motion(position_3)
            print("All three containers will go to the same bin!")
        else:
            print("Container 3 goes to the different bin!")
    else:
        print("Container 2 goes to the different bin!")
#Please note value was globalized earlier in order to be the determinant
#of which if statement to use in the transfer and deposit functions



#transfer
def transfer():
    bot.activate_ultrasonic_sensor()
    #Activating ultrasonic sensor to determine where bins will be for each if statement
    print(value)
    if value == "Bin03":
        print("Going to Bin 3")
        bot.forward_time(8.25)
        time.sleep(1)
        bot.rotate(45)
        time.sleep(1)
        bot.rotate(45)
        time.sleep(1)
        bot.rotate(10)
        #Note for all if statements in the transfer function have broken down rotations to reduce angular velocity
        bot.read_ultrasonic_sensor("Bin03")
        print(bot.read_ultrasonic_sensor("Bin03"))
        #If statement operates on condition  if correct bin is in range
        if bot.read_ultrasonic_sensor("Bin03") > 0.01:
            bot.travel_forward(0.24)
            bot.stop()
```

```
    if value == "Bin01":
        print("Going to Bin 1")
        bot.forward_time(4.25)
        time.sleep(1)
        bot.read_ultrasonic_sensor("Bin01")
        print(bot.read_ultrasonic_sensor("Bin01"))
        #If statement operates on condition  if correct bin is in range
        if bot.read_ultrasonic_sensor("Bin03") > 0.01:
            bot.rotate(90)
            time.sleep(1)
            bot.travel_forward(0.09)
            bot.stop()


    if value == "Bin02":
        print("Going to Bin 2")
        bot.forward_time(6.25)
        time.sleep(1)
        bot.rotate(45)
        time.sleep(1)
        bot.rotate(45)
        time.sleep(1)
        bot.read_ultrasonic_sensor("Bin02")
        print(bot.read_ultrasonic_sensor("Bin02"))
        #If statement operates on condition  if correct bin is in range
        if bot.read_ultrasonic_sensor("Bin03") > 0.01:
            bot.travel_forward(0.24)
            bot.stop()




    if value == "Bin04":
        print("Going to Bin 4")
        bot.forward_time(10.125)
        time.sleep(1)
        bot.rotate(90)
        bot.read_ultrasonic_sensor("Bin04")
        print(bot.read_ultrasonic_sensor("Bin04"))
        #If statement operates on condition  if correct bin is in range
        if bot.read_ultrasonic_sensor("Bin03") > 0.01:
            bot.travel_forward(0.24)
            bot.stop()

    bot.activate_ultrasonic_sensor()


#Deposit
def deposit():
    bot.activate_actuator()
    #Activates Actuator in order for the process of dumping materials into bin
    #Note for all if statements in the deposit function have broken down rotations to reduce angular velocity
    if value == "Bin01":
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(100)
        time.sleep(1)
        bot.dump()
        time.sleep(1)
        bot.rotate(240)
        time.sleep(1)
        bot.forward_time(0.62)
        time.sleep(1)
        bot.rotate(110)


    if value == "Bin02":
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(100)
        time.sleep(1)
        bot.dump()
        time.sleep(1)
        bot.rotate(240)
        time.sleep(1)
        bot.rotate(15)
        bot.forward_time(2)
        time.sleep(1)
        bot.rotate(95)
```

```
    if value == "Bin03":
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(90)
        time.sleep(1)
        bot.dump()
        time.sleep(1)
        bot.rotate(240)
        time.sleep(1)
        bot.forward_time(3.5)
        time.sleep(1)
        bot.rotate(95)


    if value == "Bin04":
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(100)
        time.sleep(1)
        bot.rotate(90)
        time.sleep(1)
        bot.dump()
        time.sleep(1)
        bot.rotate(250)
        time.sleep(1)
        bot.forward_time(5)
        time.sleep(1)
        bot.rotate(100)
    print("Successfuly dumped, returning to home")

    bot.deactivate_actuator()



#return_home
    #Old return function that was phased out
'''
def ReturnHome():
    while bot.follow_line(0.1)[0] < 1 :
        bot.forward_velocity(bot.follow_line(0.5)[1])
    bot.stop()
    bot.rotate(180)
    bot.follow_line(0.25)
'''

# This is the new return home function, in which we use a while loop.
def returnHome():
    bot.rotate(180)
    Lost_line = 0
    while Lost_line < 2:
        Lost_line, velocity = bot.follow_line(0.4)
        bot.forward_velocity(velocity)



# We use the mianLoop function to make the process go over again.
def mainLoop():
    num = random.randint(1,6)
    while num > 0:
        loadContainer_main()
        transfer()
        deposit()
        returnHome()
        bot.travel_forward(0.25)
        bot.rotate(195)
        print("Q-bot returns home!")
        time.sleep(3)
        my_table.rotate_table_angle(45)

mainLoop()


##-------------------------------------------------------------------------------------
## STUDENT CODE ENDS
##-------------------------------------------------------------------------------------
update_thread = repeating_timer(2,update_sim)
```

Appendix D: Graphical Plot of our Motion Simulation