ENGINEERING

McMaster University

Project Three – There is a Recyclable Among us:

Design a System for Sorting and Recycling Containers

ENGINEER 1P13 – Integrated Cornerstone Design Projects

Tutorial T07

Thurs-14

Mahmoud El Shafei (elshafem)

Yuvraj Sandhu (Sandhuy)

Kelvin Weng (wengc3)

Kartik Chaudhary (chaudk4)

Submitted: February 7, 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.

Yuvraj Sandhu 400319134

Recoverable Signature

X

Signed by: e2654182-da84-4556-bcb2-444c36416fbc

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.

Kartik Chaudhari 400300382

Recoverable Signature

X

Signed by: e2654182-da84-4556-bcb2-444c36416fbc

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.

Kelvin Weng 400182164

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.

Mahmoud El Shafei 400297215

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Signed by: e2654182-da84-4556-bcb2-444c36416fbc

Executive Summary

Around thirty percent of materials that are placed in recycling bins are not recyclable [1], thereby causing many recycling materials to be lost every year because they are mixed with waste. Canada only recycles just 9 percent of its recyclable plastics, leaving the rest to be incinerated or placed in a landfill with other garbage [2]. There are stations with sorting facilities that aid in separating trash from recyclable materials, however, they cannot always recycle everything that should be recycled. Sorting facilities are equipped with sensors to detect different kinds of materials, as well as the presence of contaminants. In this project, we were tasked with designing a system for sorting and recycling containers based on their material [3].

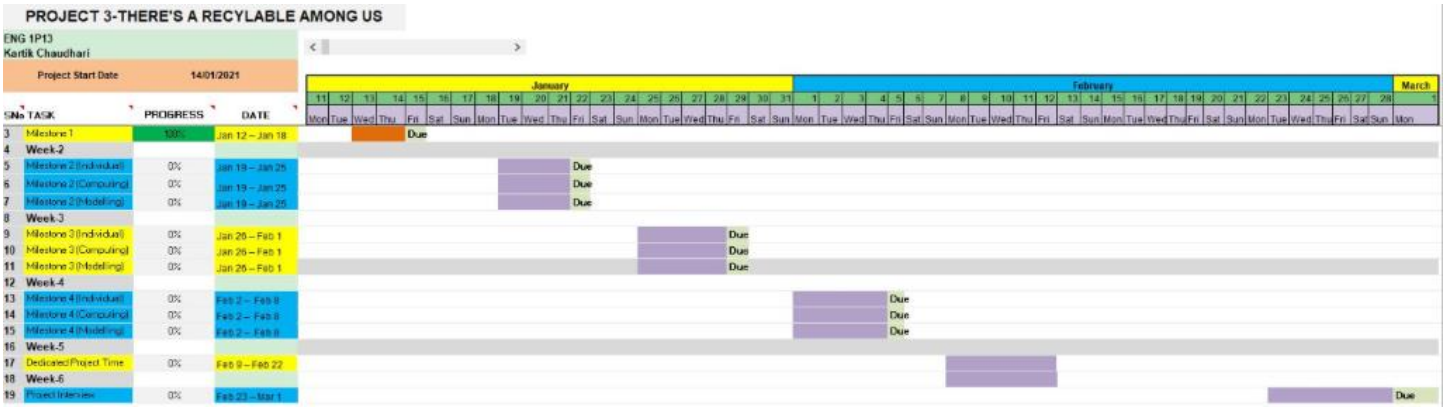
The main function of the hopper and lifting mechanism is to securely transport the recyclable and deposit materials without any issues. The hopper must fit within the distance between the rungs on the baseplate and must fit multiple containers. To guarantee the materials within the hopper can be deposited without any faults, a curved extrusion was added for the container to trip over and fall into a bin to compensate for the limits of the lifting mechanism. For the lifting mechanism, it must fit within the end of the baseplate and the actuator must be constrained to the baseplate. With these constraints, the lifting mechanism had to be simple and size efficient. The lifting mechanism designed utilized a rack and pinion design to fit these requirements and was able to lift the hopper given its smaller size. Since the actuator had to be constrained to the baseplate, a single gear would be insufficient in lifting the rack to an appropriate height for the hopper to deposit the containers. To avoid this issue, we used a second gear that would maximize the full size of the rack. For the computing sub-team, their task revolved around the idea of designing a computer program that identifies different types of garbage (containers) and deposits it into its designated bin.

At the start of the program, the container attributes are already determined, and the container is positioned in the Sorting Station for pick up. A robotic arm (Q-arm) then loads the container onto the Q-bot. The Q-arm keeps loading containers onto the Q-bot until the following: a container with a different ID than what is already on the Q-bot is positioned on the Sorting Station, three containers have been placed on the Q-bot, or the total mass of the new container positioned in the Sorting Station as well as all the containers currently on the Q-bot exceeds 90-grams. The Q-bot transfers the container(s) to the correct bin. The Q-bot then deposits the container into the correct bin. The Q-bot then returns to its Home position.

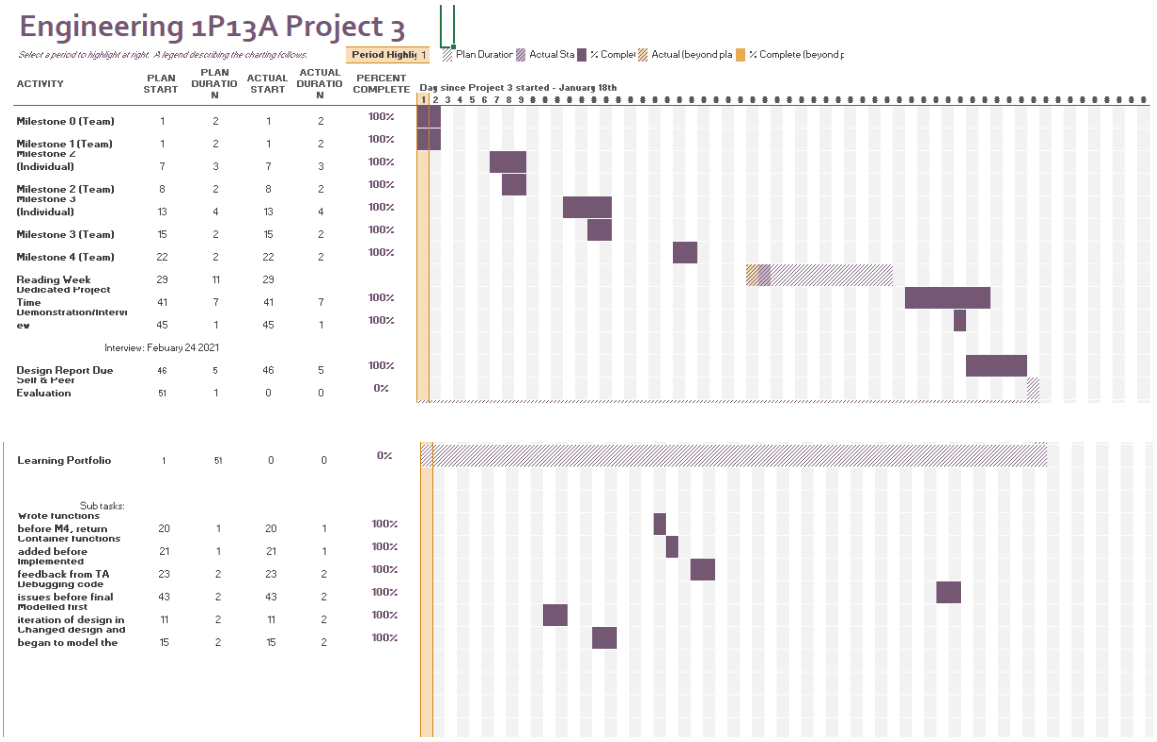
The use of newer sensor technology paired alongside efficient lifting mechanisms paves the way for the future of recyclability.

Project Schedule Meetings:

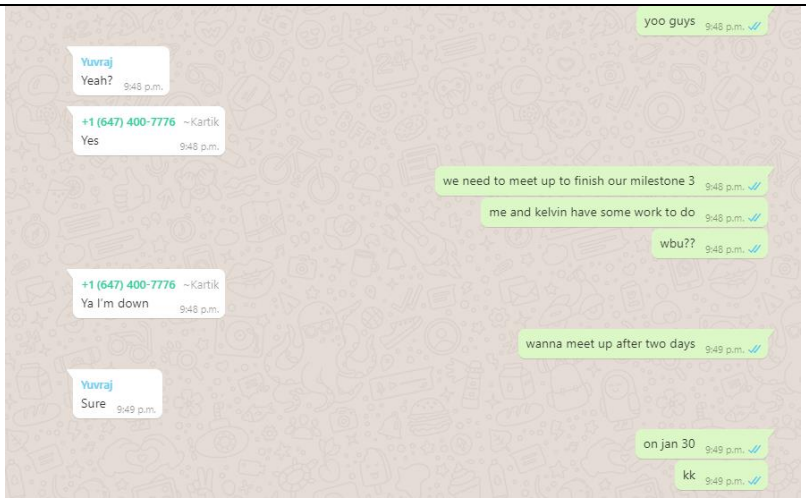
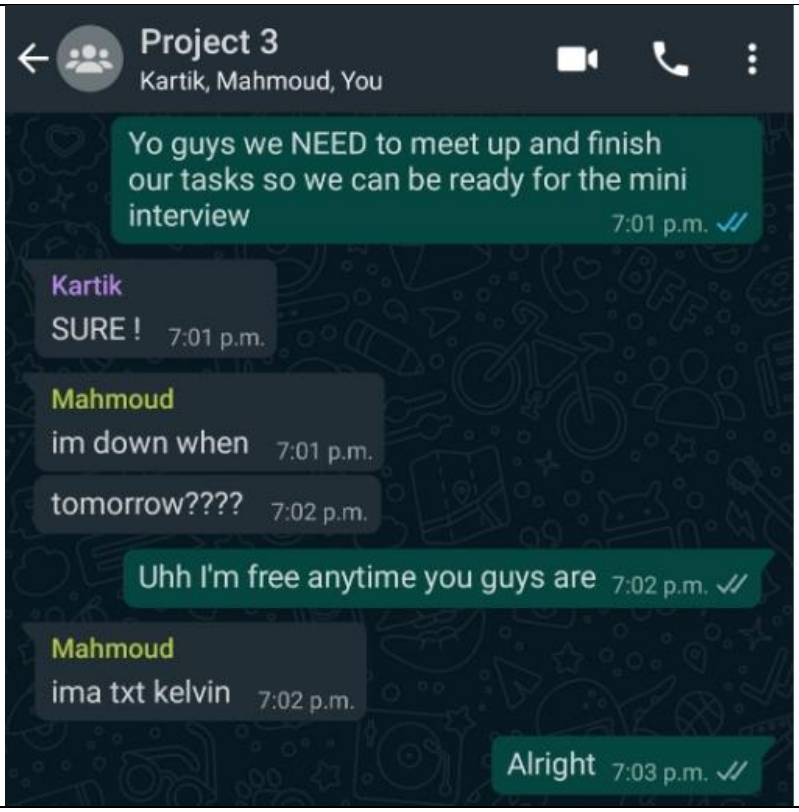
Preliminary Gantt Chart:

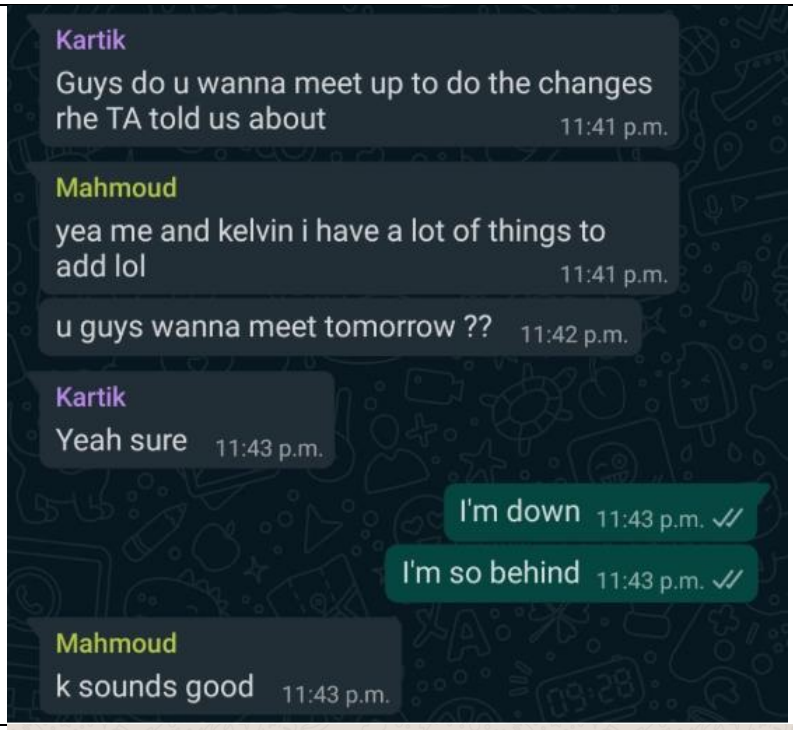
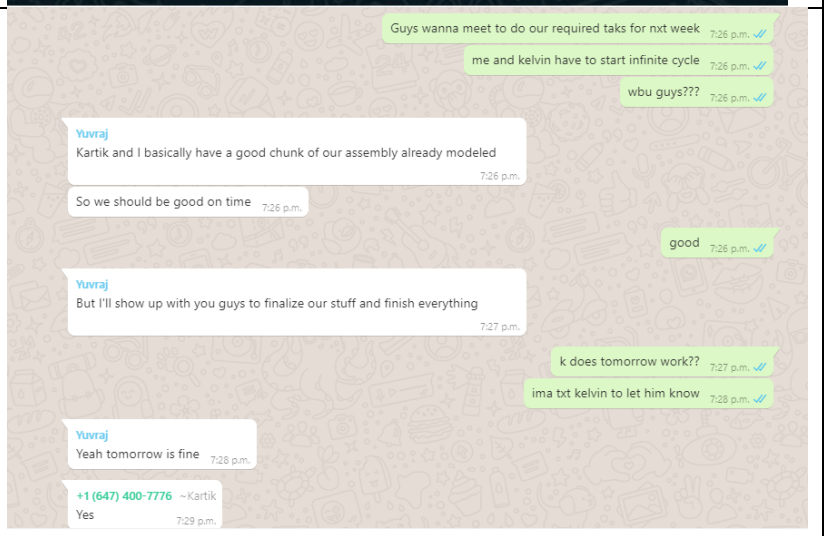


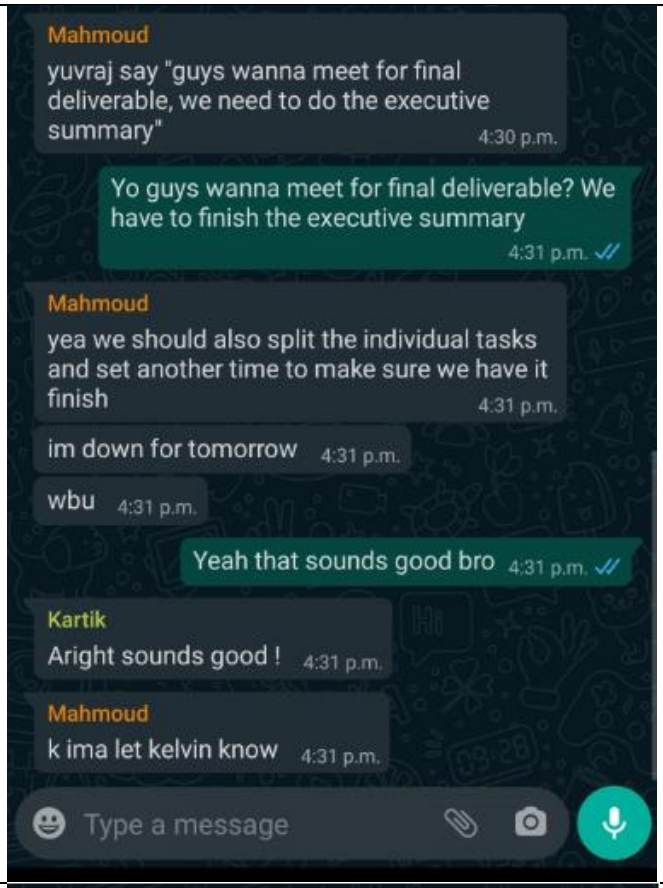
Final Gantt Chart:



Logbook of Additional meetings:

Date	Summary	Proof
January 30, 2021	Modelling Sub Team members had to meet up to finish their Milestone 3, where they had to finish creating their preliminary designs. Computing Sub team had to meet up to also finish Milestone 3, where they had to complete the code for depositing and returning home	
February 2, 2021	Modelling team had to meet up to finish their preliminary design so it could be prepared for evaluation from the TA. Computing sub team also had to finish the required part of the code that will be reviewed by the TA.	

February 6, 2021	Modelling team had to meet up to finish assembling their design and create some changes based on the TA's feedback. Computing team also had to do some changes based on the TA's feedback	
February 14, 2021	Modelling sub team had to meet to finish assembling and put some final touches for the interview. A document was made that summarizes everything that was made to prepare them for the interview. Computing sub team had to meet to finish the infinite cycle and make sure the program works multiple times with no issue.	

March 4, 2021	All group members had to meet to start the final deliverable. The executive summary had to be done and the individual tasks were split		
March 6, 2021	Group members had to meet up to make sure everything was ready to be submitted and make some changes if needed.		

Scheduled Weekly Meetings:

Weekly Design Studio Agenda and Meeting Minute's:

January 14, 2021	**Attendance/Updates:** Everyone attended the meeting **Check-in from last week:** No work or check-in was asked from last week **Pre-lab Assignment Check-in:** No pre-lab in this week **How is Milestone going?** 1. Introduction with TA and group members – 1st DS 2. Discuss Why/How Ladder 3. Feedback on Objectives vs Constraints **Future Tasks/Next week:** Divide team into sub teams Complete individual sketches Complete individual research of sensors Complete Preliminary Gantt Chart
January 21, 2021	**Attendance/Updates:** Everyone attended the meeting **Check-in from last week:** Assigned work for last week was done and submitted **Pre-lab Assignment Check-in:** Research for sensors had to be completed 2 mechanism concept Sketches is completed **How is Milestone going?** Discussing all applications for the sensors in computer program Evaluating the mechanism sketches based on metrics and choosing the best design **Future Tasks/Next week:** Complete individual computer program workflow Complete detail individual sketch of device assembly
January 28, 2021	**Attendance/Updates:** Everyone attended the meeting **Check-in from last week:** Assigned work for last week was done and submitted **Pre-lab Assignment Check-in:** Individual program workflow is completed Detail sketch of device is finished **How is Milestone going?** Planning each task for the program and writing pseudocode Creating a solid model of the components of our design assembly, then taking screenshots **Future Tasks/Next week:** Completed modelling and assembling of device components Complete 3 out of 5 program tasks

	Getting for ready for mini-interview.
February 4, 2021	**Attendance/Updates:** Everyone attended the meeting **Check-in from last week:** Assigned work for last week was done and submitted **Pre-lab Assignment Check-in:** modelling and assembling of device components are not completed due to Inventor crashing (Not completed) 2 out of 5 tasks were finished (Not completed) **How is Milestone going?** Attending the mini-interview and getting feedbacks from the TA Documenting Feedback Making changes based in the feedback that was given **Future Tasks/Next week:** Continue working on assembly and code.
February 18, 2021	**Attendance/Updates:** Everyone attended the meeting **Check-in from last week:** Assigned work for last week was done and submitted **Pre-lab Assignment Check-in:** No pre-lab was required for this week **How is Milestone going?** Dedicated work time **Future Tasks/Next week:** Getting ready for the individual interview
February 25, 2021	**Attendance/Updates:** Everyone attended the meeting **Check-in from last week:** Make sure that program and device assembly is ready to be presented **Pre-lab Assignment Check-in:** No pre-lab was required for this week **How is Milestone going?** Attending interview **Future Tasks/Next week:** Work on final deliverable

Design Studio Worksheets:

Milestone 0

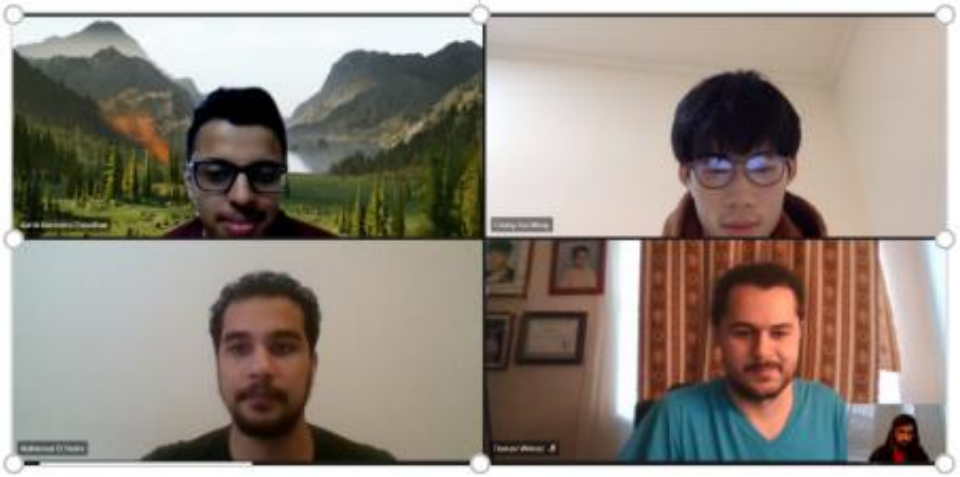
PROJECT THREE: MILESTONE 0 – COVER PAGE

Team Number: Thurs-14

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

Full Name:	MacID:
Kartik Chaudhari	chaudk4
Mahmoud El Shafei	elshafem
Kelvin Weng	wengc3
Dariusz Wolosz	wolosd1
Yuvraj Sandhu	Sandhuy

Insert your Team Portrait in the dialog box below



Page Break

MILESTONE 0 – TEAM CHARTER

Team Number:	Thurs-14

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Kartik Chaudhari	☐M ☒A ☐C ☒S
2.	Mahmoud El Shafei	☐M ☐A ☒C ☒S
3.	Kelvin Weng	☐M ☒A ☐C ☒S
4.	Dariusz Wolosz	☐M ☒A ☒C ☐S
5.	Yuvraj Sandhu	☒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.

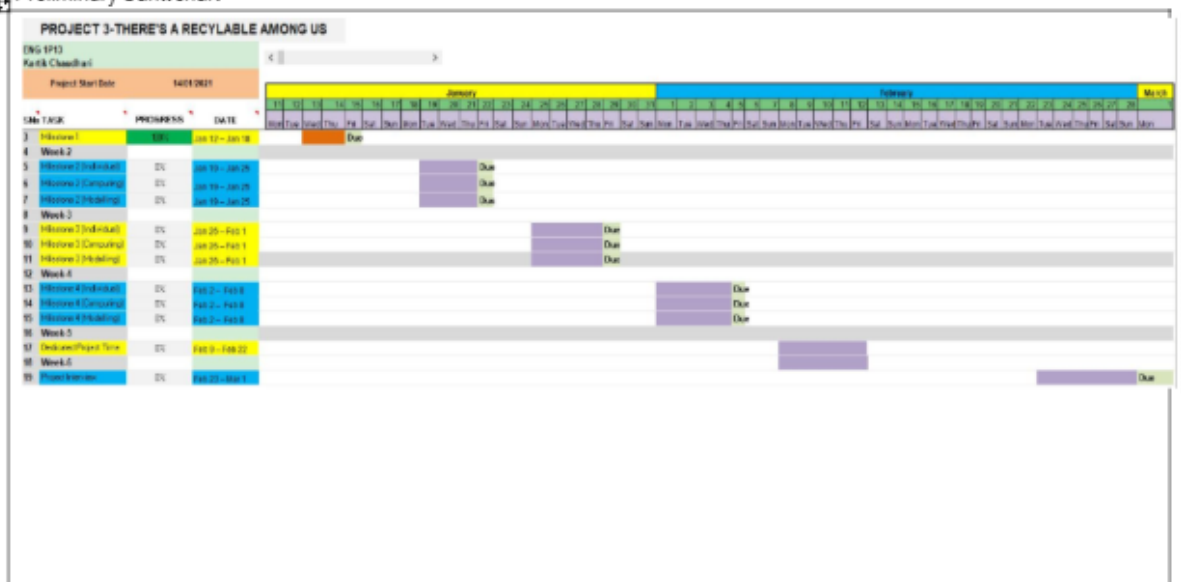
Role:	Team Member Name:	MacID
Manager	Kartik Chaudhari	chaudk4
Administrator	Mahmoud El Shafei	elshafem
Coordinator	Kelvin Weng	wengc3
Subject Matter Expert	Yuvraj Sandhu	Sandhuy
Subject Matter Expert	Dariusz Wolosz	wolosd1

MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

Team Number:	Thurs-14

Full Name of Team Manager:	MacID:
Kartik Chaudhari	chaudk4

Preliminary Gantt chart



Milestone 1

PROJECT THREE: MILESTONE 1 – COVER PAGE

Team Number:	THURS-14

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

Full Name:	MacID:
Mahmoud El Shafei	elshafem
Yuvraj Sandhu	Sandhuy
Kelvin Weng	wengc3
Kartik Chaudhari	chaudk4
Dariusz Wolosz	wolosd1

PAGE BREAK

MILESTONE 1 (STAGE 1) – WHY/HOW LADDERING

Team Number:	THURS-14

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**

	Enhances quality of life.		
	Healthier Environment.	Increase recycling output. Decrease Labour Hours.	Increases sustainability and maintainability of scarce resources.
	Less pollution.	Save time and resources.	Recycled material can be used instead of new material.
Why?	To reduce waste.	Increase efficiency of recycling centers.	Lowers the need for production of new plastics /metals

Initial Problem Statement: Design a system for sorting and recycling containers.

How?	Determine the correct type of waste.	Place the waste into the bin	Move the waste from the bin into the appropriate box
	Use a sensor. Types of Sensors: Ultrasonic, LDR, Hall, Color, Active IR(Infrared) and Retro-reflective Photoelectric	Use automation.	1. Determine the right box using a color sensor. Move the Q-Bot to the box.
		Program a robotic arm to do it automatically.	2. Use a rack and pinion to deposit them in the box automatically.

Page Break

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

Team Number:	THURS-14

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	• Design a system that deposits the waste containers in their respective bins • Design a code that will detect if a container is recyclable and moves the Q-arm accordingly • Design a code that moves the Q-Bot to the appropriate bin depending on the type of waste
Constraints	• All code must be written in python and interface with Quanser-Labs (Computing) • Components must fit on baseplate with the size of 130.175 mm x 101.6 mm (Modelling) • Components must connect directly to the actuator and supports the hopper. (Modelling) • Destination bin is based on material and its recyclability (Computing) • Components at one end of the base plate must move with the actuator (Modelling)

MILESTONE 1 (STAGE 3) – REFINED PROBLEM STATEMENT

Team Number:	THURS-14

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.

Design a system for sorting and recycling containers - that should be fully automated - to reduce recyclable waste, and increase the sustainability and maintainability of scarce resources.

Milestone 2

PROJECT THREE: MILESTONE 2 – COVER PAGE

Team Number:	Thurs-14

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

Full Name:	MacID:
Kartik Chaudhari	chaudk4
Yuvraj Sandhu	Sandhuy
Kelvin Weng	wengc3
Mahmoud El Shafei	elshafem

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

Team Number:	Thurs-14

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-14

Name: Kelvin Weng	MacID: wengc3

Sensor Type	Description	Attribute(s)
Color sensor	It can distinguish colors thought the brightness of light, then it sends this signal to the intelligent brick	Used to identify different bin by colors
Hall sensor	In the presence of a magnetic field, It convert magnetic or magnetically encoded information into electrical signals	This can be used to distinguish metals and non-metals
LDR	The light is emitted from the transmitter and the receiver senses the strength of the light to send out different signals.	Different materials have different transparency So the receiver can distinguish different materials by receiving light of different intensities

Team Number:	Thurs-14

Name: Mahmoud El Shafei	MacID: elshafem

Sensor Type	Description	Attribute(s)
Ultrasonic Sensors	• An ultrasonic sensor is an electronic device • Measures the distance of a target object by emitting ultrasonic sound wave and calculating the time it takes to echo	Can detect distance the bin is from the sensor
Active Infrared (IR) Sensor	• Measure and detects infrared light • Can be used as proximity sensor • LED gives off light, and if an object with a temperature about 5 kelvin passes Infront, infrared light will bounce off and reflects into the sensor. The waves bounce back off a nearby object and enter the sensor again for detection	Can be used to detect the proximity of a bin to the sensor with defined reading of the edges

Retro-Reflective Photoelectric Sensor	• Photoelectric sensors consisting of an emitter and receiver • Light emitted by the emitter is reflected to the receiver with a reflector • When the reflected light beam is obstructed, the output signal of the sensor changes	Could be used to detect the presence of bins

Page Break

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

Team Number:	Thurs-14

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:

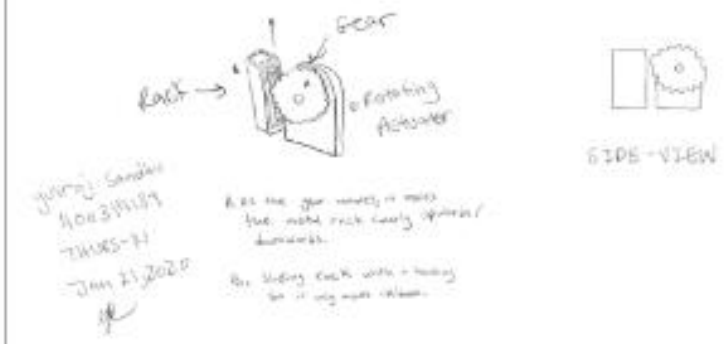
- Each team member needs to submit their concept sketches with the **Milestone Two Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone Two Team Worksheets** document allows you to readily access your team member's work
  - This will be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

Page Break

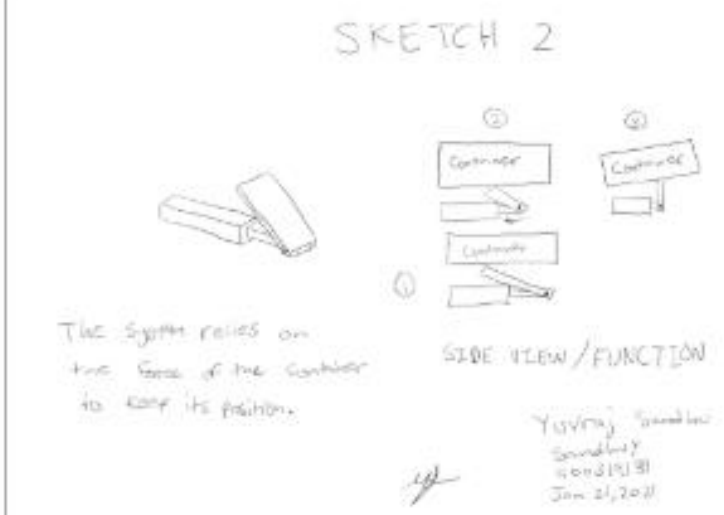
Team Number:	Thurs-14

Name: Yuvraj Sandhu	MacID: Sandhuy

Rotating Actuator:

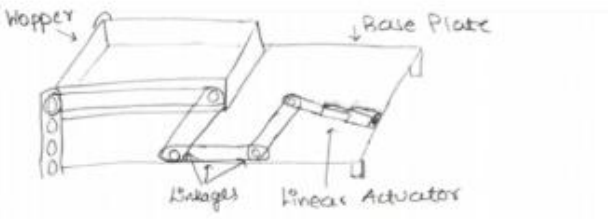


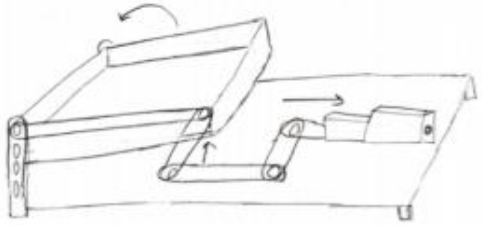
Linear Actuator:



Name: Kartik Chaudhari	MacID: chaudk4

Linear:

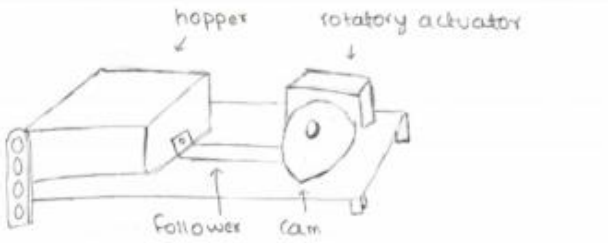


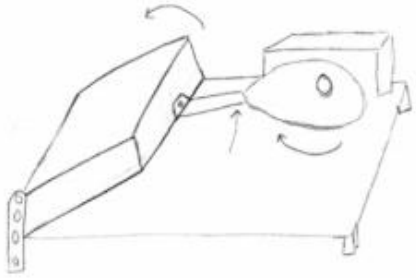


The hopper shifts upward along with the linkage connected to the hopper as the linear actuator moves backwards.

Kartik Chaudhari
Chaudk4
Thurs-14
21st Jan 2021
Chaudhary

Rotatory:





Kartik Chaudhari
Chaudk4
Thurs-14
21st Jan 2021
Chaudhary

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

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

Team Number:	Thurs-14

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
Color sensor	Used to identify different bin by colors. It can distinguish colors thought the brightness of light, then it sends this signal to the intelligent brick.
Hall sensor	This can be used to distinguish metals and non-metals.
LDR	Different materials have different transparency So the receiver can distinguish different materials by receiving light of different intensities
Retro-Reflective Photoelectric Sensor	• Output sensor changes when beam of light is obstructed, could be used in detecting the presence of bin • Not appropriate because its impossible to distinguish between different bins
Ultrasonic Sensor	• With the use of ultrasonic sound waves it can detect if there is an object and determine distance away from the robot • It is a good choice to use but it is not as reliable and easy to function as a colour sensor
Active Infrared (IR) light	• Uses the reflected IR light from an object to determine if an object is present. Useful in finding the location of the edges of a bin • Could be used but it's much more complicated to function and implement. It only distinguishes the presence of an object not the feature

3. Identify an attribute value for each bin

Bin ID	Attribute Value
Bin01: Metal Bin	Change colour to red
Bin02: Paper Bin	Change colour to blue
Bin03: Plastic Bin	Change colour to purple
Bin04: Garbage Bin	Change colour to green

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

Team Number:	Thurs-14

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

	Simplicity	Strength	Practicality	*Efficiency*	Durability	*Ease of modelling*	Score
Simplicity	*1*	*1*	1	1	1	1	6
Strength	0	1	1	1	1	1	5
Practicality	0	0	1	1	1	1	4
Efficiency	0	0	0	1	1	1	3
Durability	0	0	0	0	1	1	2
Ease of modelling	0	0	0	0	0	1	1

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

	Weight	*Kartik 1st Design*		*Kartik 2nd Design*		*Yuvraj's 1st Design*		*Yuvraj 2nd Design*	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Simplicity	6	2	12	4	18	3	18	2	12
Strength	5	2	10	2	10	2	10	3	15
Practicality	4	3	12	2	8	2	8	2	8
Efficiency	3	0	0	1	3	1.5	4.5	1	3
Durability	2	0	0	0.5	1	1	2	1	2
Ease of modelling	1	0.5	0.5	1	1	1	1	1	1
TOTAL			35		41		44		41

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

We've decided to choose the simple rotational actuating design as through our discussion, we have concluded that its simple, yet effective design will be useful in many aspects of this project. As well as the ability to utilize gear ratio's and using simple constraints in Autodesk Inventor will prove to be beneficial.

Milestone 3

PROJECT THREE: MILESTONE 3 – COVER PAGE

Team Number:	Thurs-14

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

Full Name:	MacID:
Kartik Chaudhari	chaudk4
Mahmoud El Shafei	elshafem
Kelvin Weng	wengc3
Yuvraj Sandhu	Sandhuy

Page Break

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

Team Number:	Thurs-14

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

Page Break

Team Number:	Thurs-14

Name: Kelvin Weng	MacID: wengc3

Start the program

-Drop container on the servo table

-Identify the mass of the container

-Identify the material of container

-Destination is determined based on attributes

-Q-arm picks up container and drop it into the corresponding colors Q-bot

Repeats:

-Drop container on the servo table

-Determine container attributes

- Destination is determined based on attributes

-If destination same and total weight does not over 90g then drop container into the hopper and repeats.

End infinite loop

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

Team Number:	Thurs-14

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)

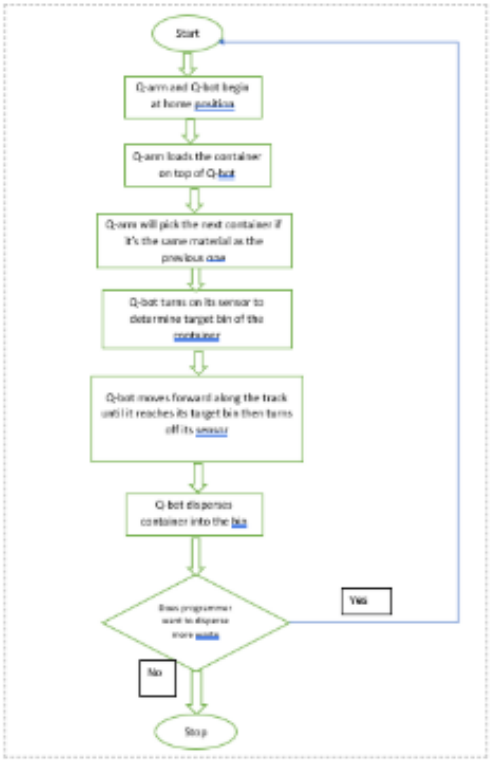
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- 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-14

Name: Mahmoud El Shafei	MacID elshafem

Insert screenshot(s) of your flowchart or storyboard.



Page Break

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

Team Number:	Thurs-14

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

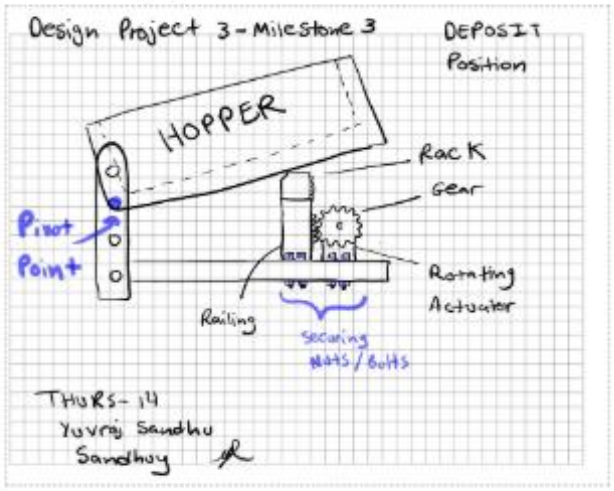
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- 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-14

Name: Yuvraj Sandhu	MacID: Sandhuy

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.

Page Break

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

Team Number:	Thurs-14

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

Rotate the table so container is in its position

Load Container

Moe the Q-arm such as the gripper is lined with the container
Close the gripper.
Rotate the Q-arm is a position such that the container is on top off the Q-bot.
Open the gripper to release the container.
Rotate Q-arm back to its home position.

Transfer Container

Transfer Container
Activate the colour sensor.
while the color sensor detects the matching bin
Move Q-bot travels along the track
Stop Q-bot

Deposit Container

```
Position the Q-bot adjacent to the bin
    Activate timer
    While the time elapsed is less than the required time of deposition the container
        Rotate the Q-bot
    Return Q-bot to home position
```

Return Home

```
Return home
    While Q-bot is not in home position
        Move the q-bot along the track
    Stop the Q-bot
```

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

Team Number:	Thurs-14

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-14

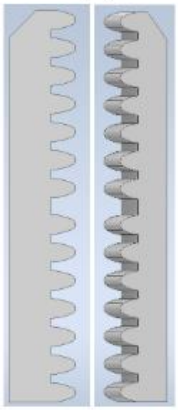
Name: Yuvraj Sandhu	MacID: Sandhuy

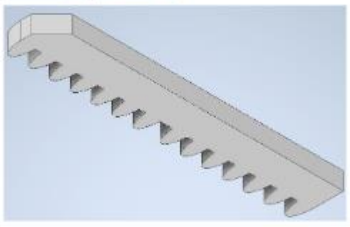
Insert screenshot(s) of your model below.

*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste

Name: Yuvraj Sandhu	MacID: Sandhuy

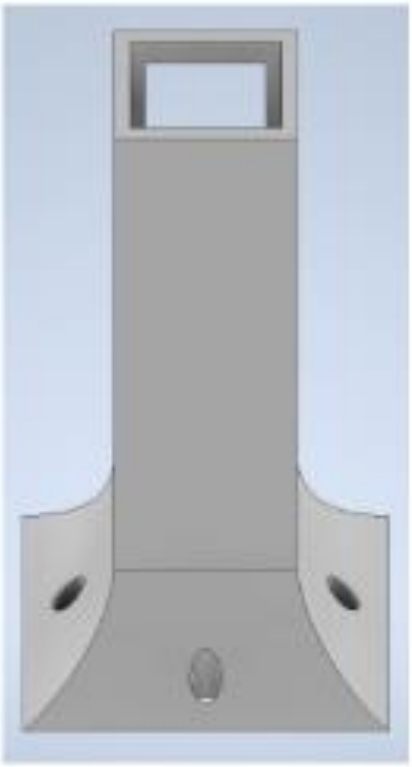
Insert screenshot(s) of your model below.





Name: Kartik Chaudhari	MacID: chaudk4

Insert screenshot(s) of your model below.



Milestone 4

PROJECT THREE: MILESTONE 4 – COVER PAGE

Team Number:	Thurs-14

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

Full Name:	MacID:
Kartik Chaudhari	chaudk4
Kelvin Weng	wengc3
Mahmoud El Shafei	elshafem
Yuvraj Sandhu	Sandhuy

Page Break

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

Team Number:	Thurs-14

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

- Combine gear to the system
- Parts are already made
- Rack set up
- Motion constraint in between gear and the rack
- Using rotating actuator
- When actuator move the rack mores up
- Hopper connected

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

- Fully finalized and completed the final assembly
- Added screws to fasten the hopper onto the rungs
- Triple-Checked the motion constraints made on the gear/rack system
- Added support for different types of hoppers

Page Break

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

Team Number:	Thurs-14

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

- Finding the correct coordinates
- The bottle needed for demonstration
- Finish the transfer function
- Coordinates for the home, drop off and pick up position is based on trials

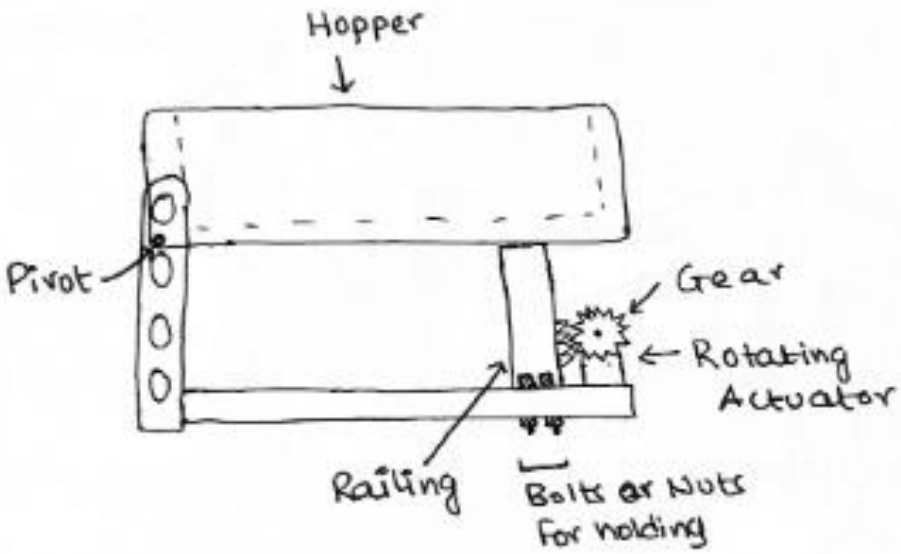
Use the space below to propose design refinements based on the feedback.

- Change the setting on Q-labs
- The code or loading the container.
- Figure out the coordinates for home, pick up and drop off position.
- Adding comments to functions to make code clearer to understand.

Team Number:	Thurs-14

Name: Kartik Chaudhari	MacID: chaudk4

DESIGN PROJECT 3-Milestone 3



DEPOSIT POSITION

Thurs-14
chaudk4
Kartik Chaudhari
27th Jan, 2021

List of Sources:

References:

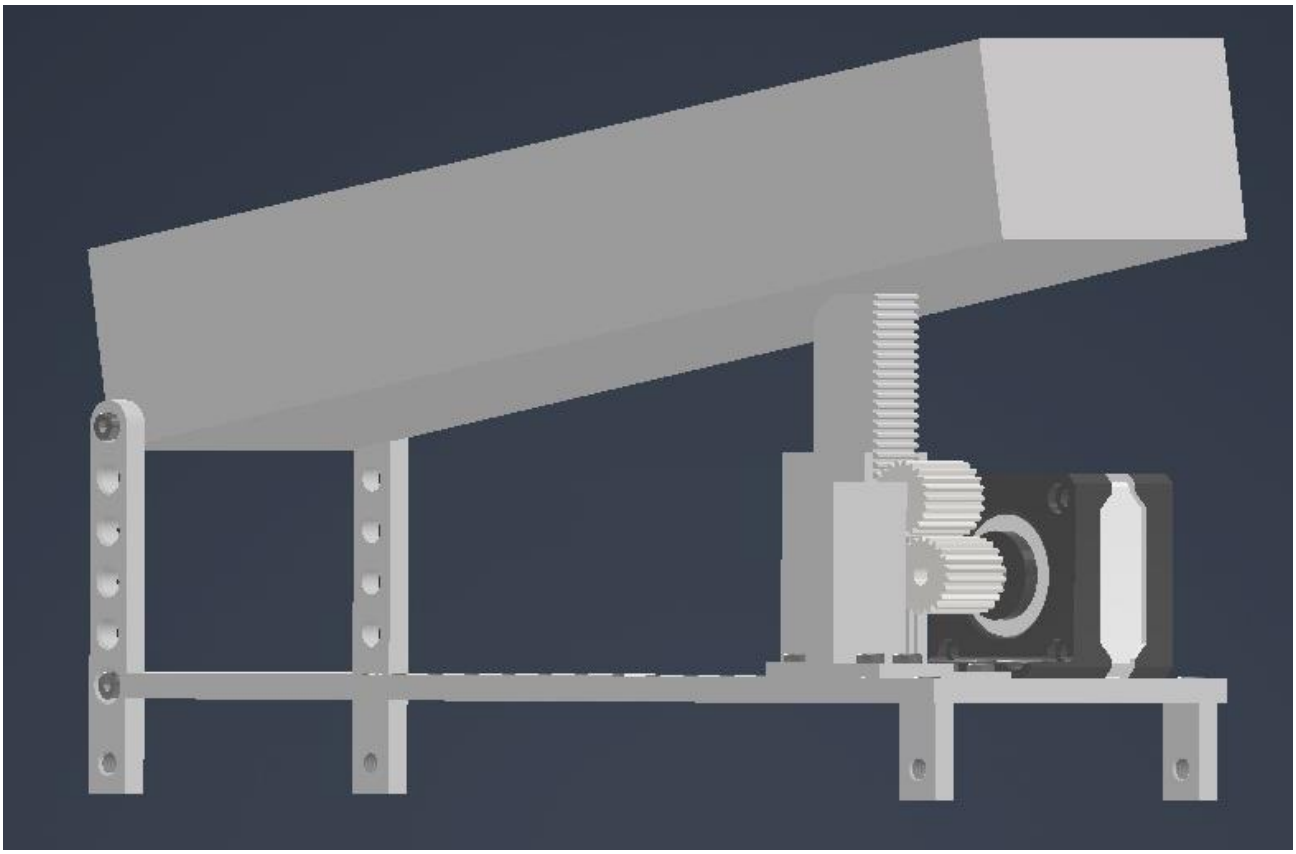
[1] "What Goes in the Blue Bin (Recycling)?," City of Toronto, 23-Dec-2020. [Online]. Available: https://www.toronto.ca/services-payments/recycling-organics-garbage/houses/what-goes-in-my-blue-bin/. [Accessed: 04-Jan-2021].

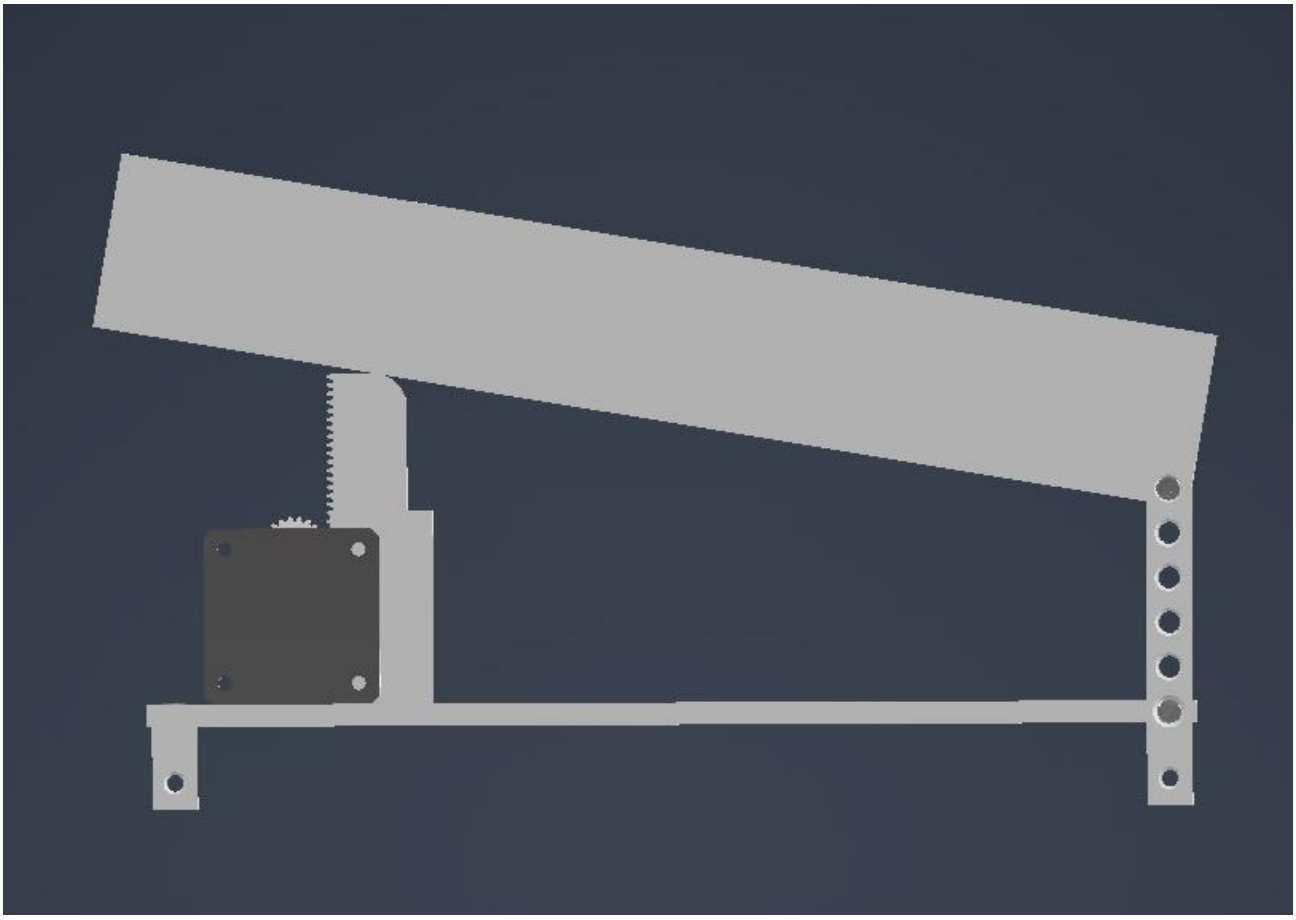
[2] "Canada recycles just 9 per cent of its plastics," Recycling Council of Ontario, 06-Dec-2019. [Online]. Available: https://rco.on.ca/canada-recycles-just-9-per-cent-of-its-plastics/. [Accessed: 04-Jan-2021].

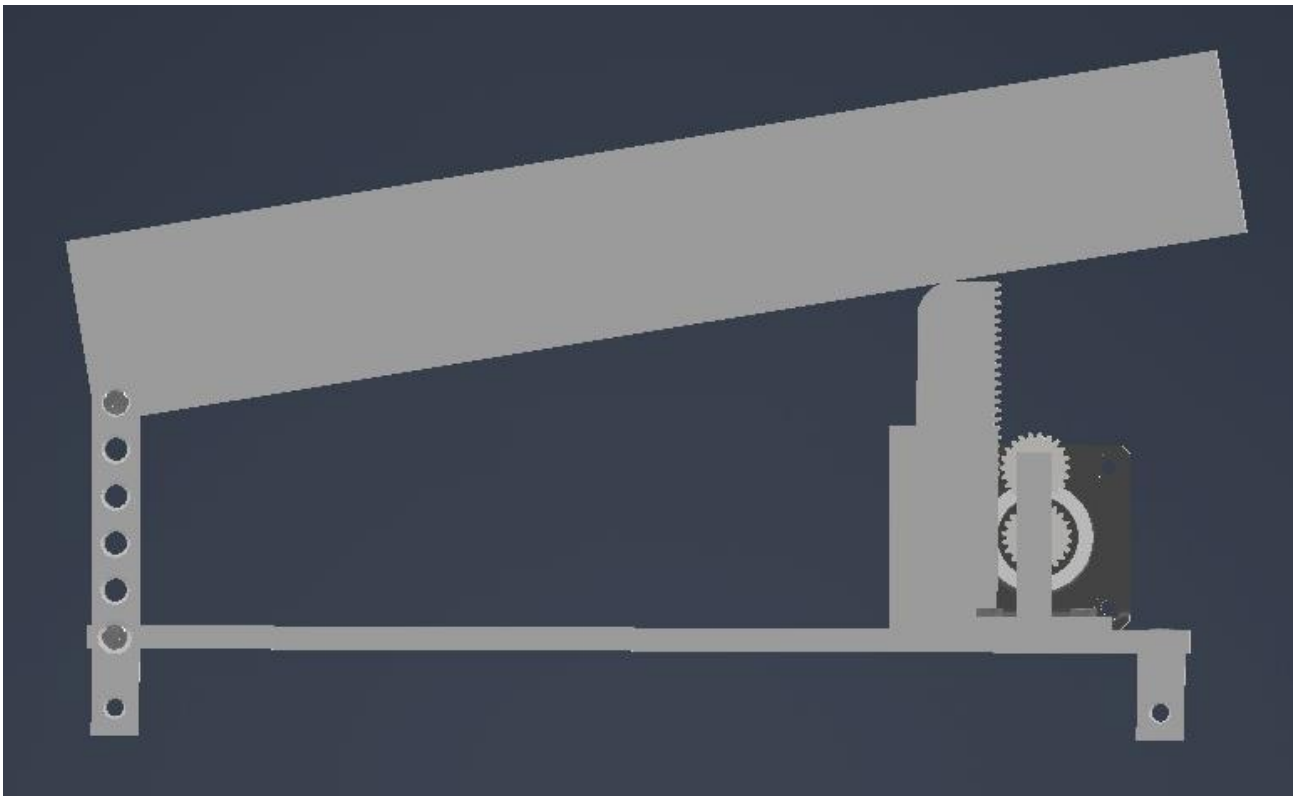
[3] J. Fingas, "Recycling robot can sort paper and plastic by touch," Engadget, 11-Apr-2019. [Online]. Available: https://www.engadget.com/2019-04-11-mit-recycling-robot.html. [Accessed: 04-Jan-20]

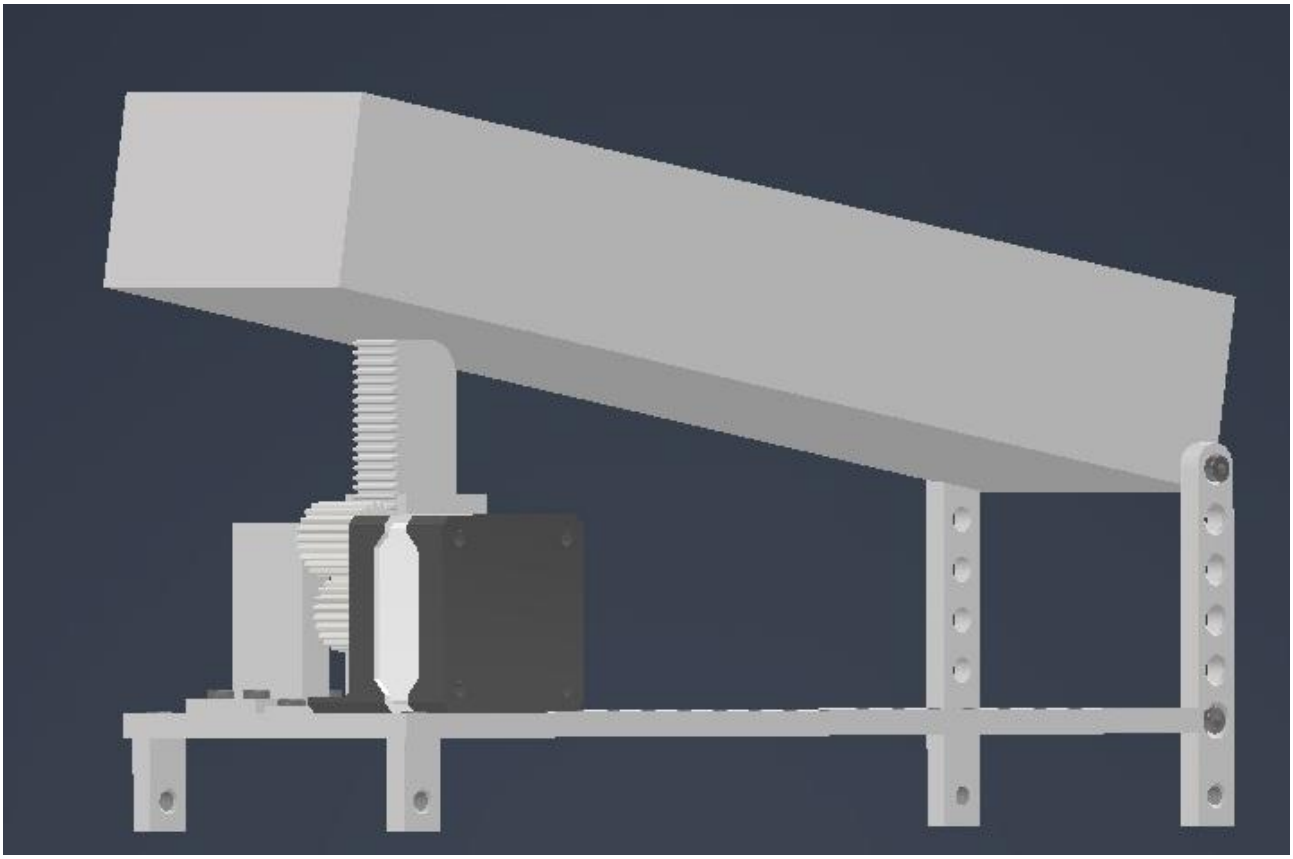
Appendices:

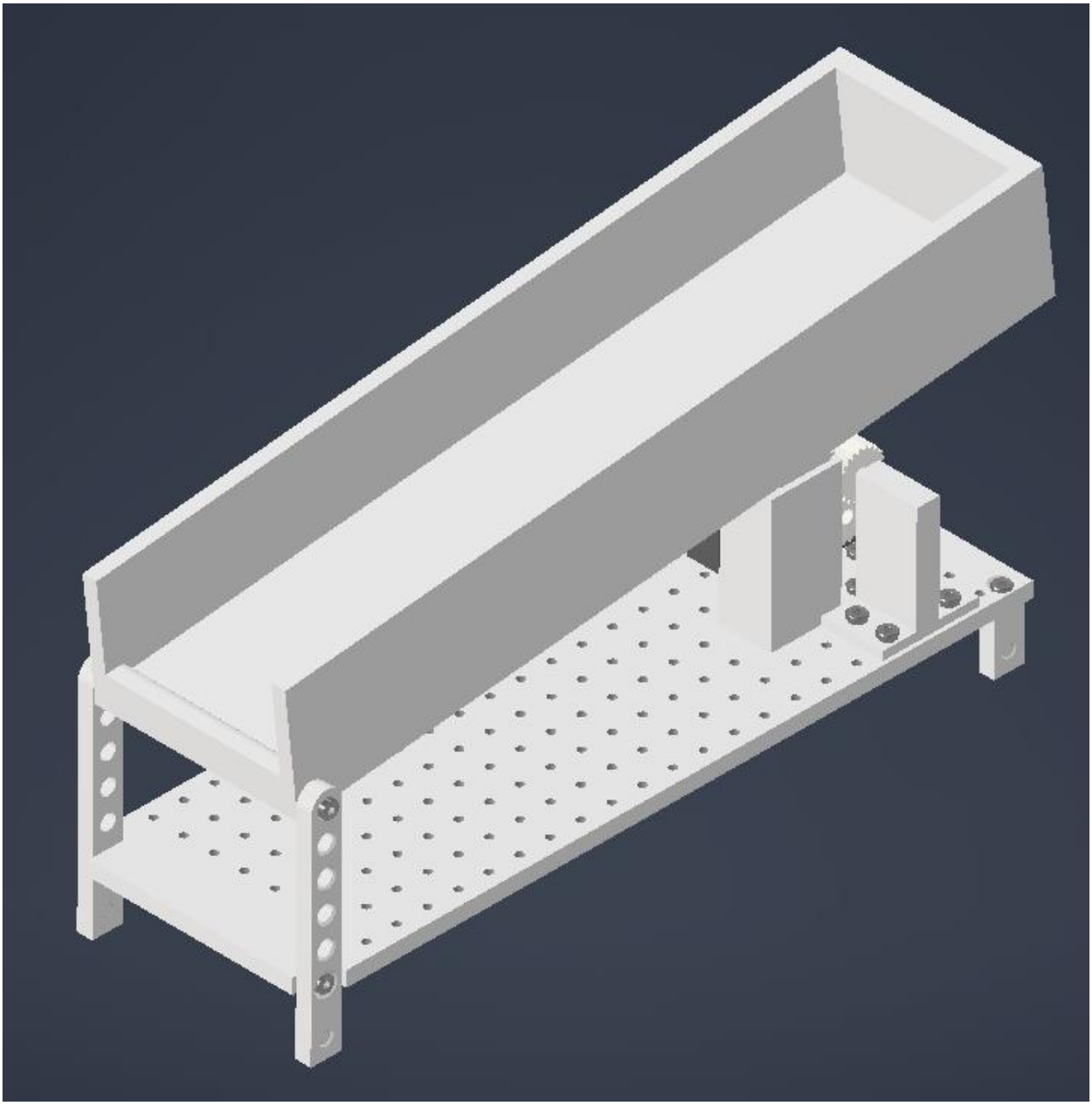
Appendix A – Screenshots of solid model:





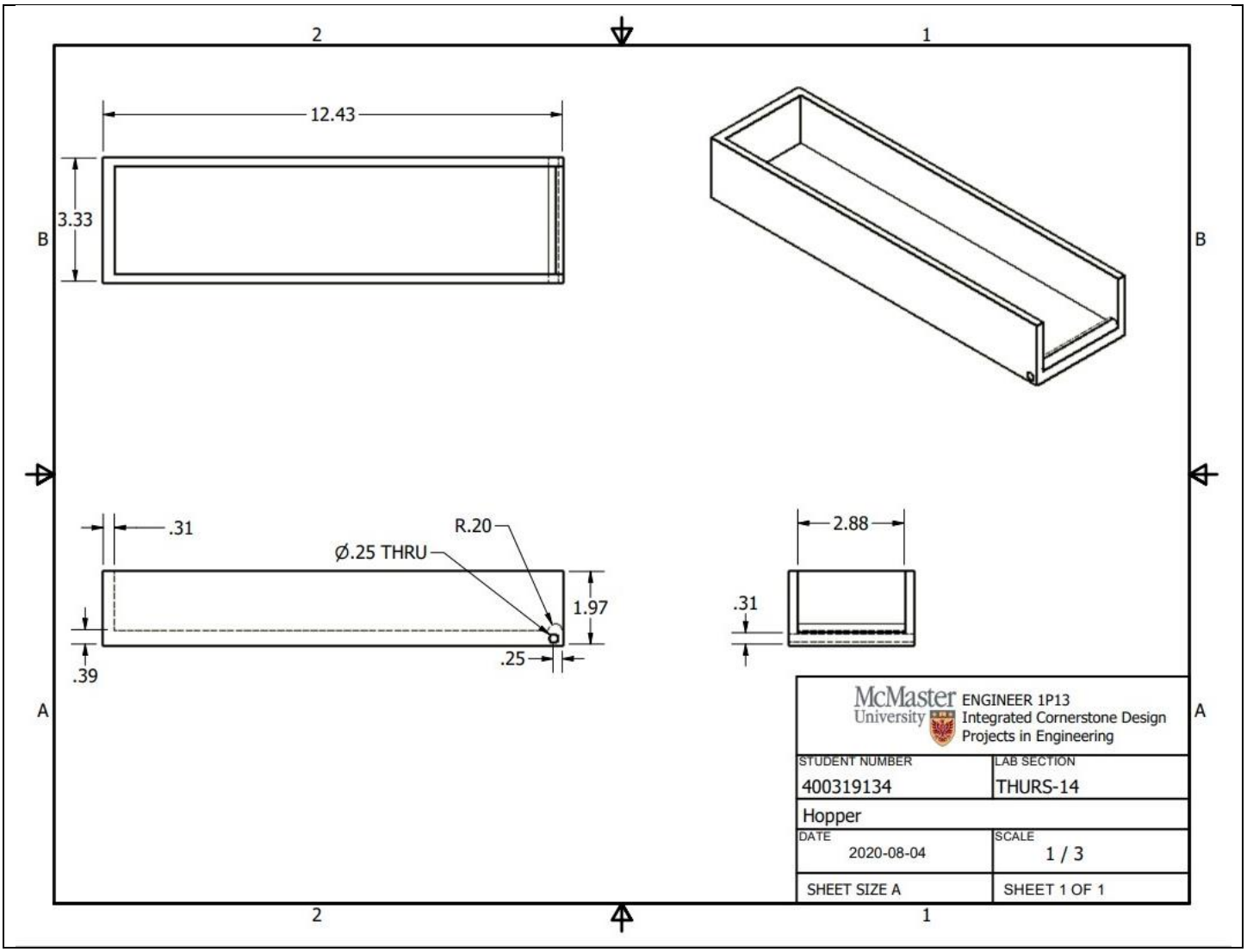


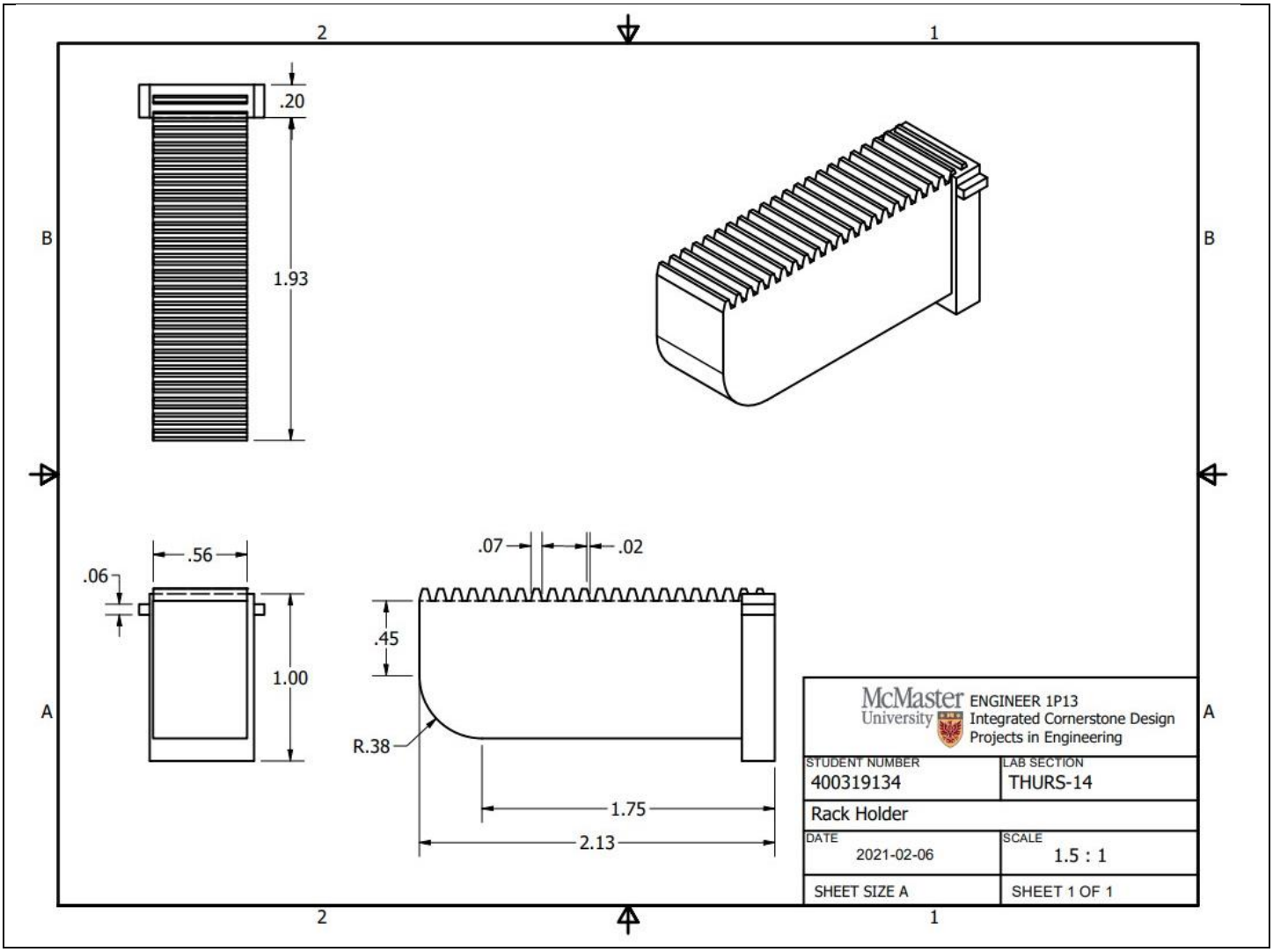




Appendix B – Engineering Drawings and Exploded Assembly:

Engineering Drawings:

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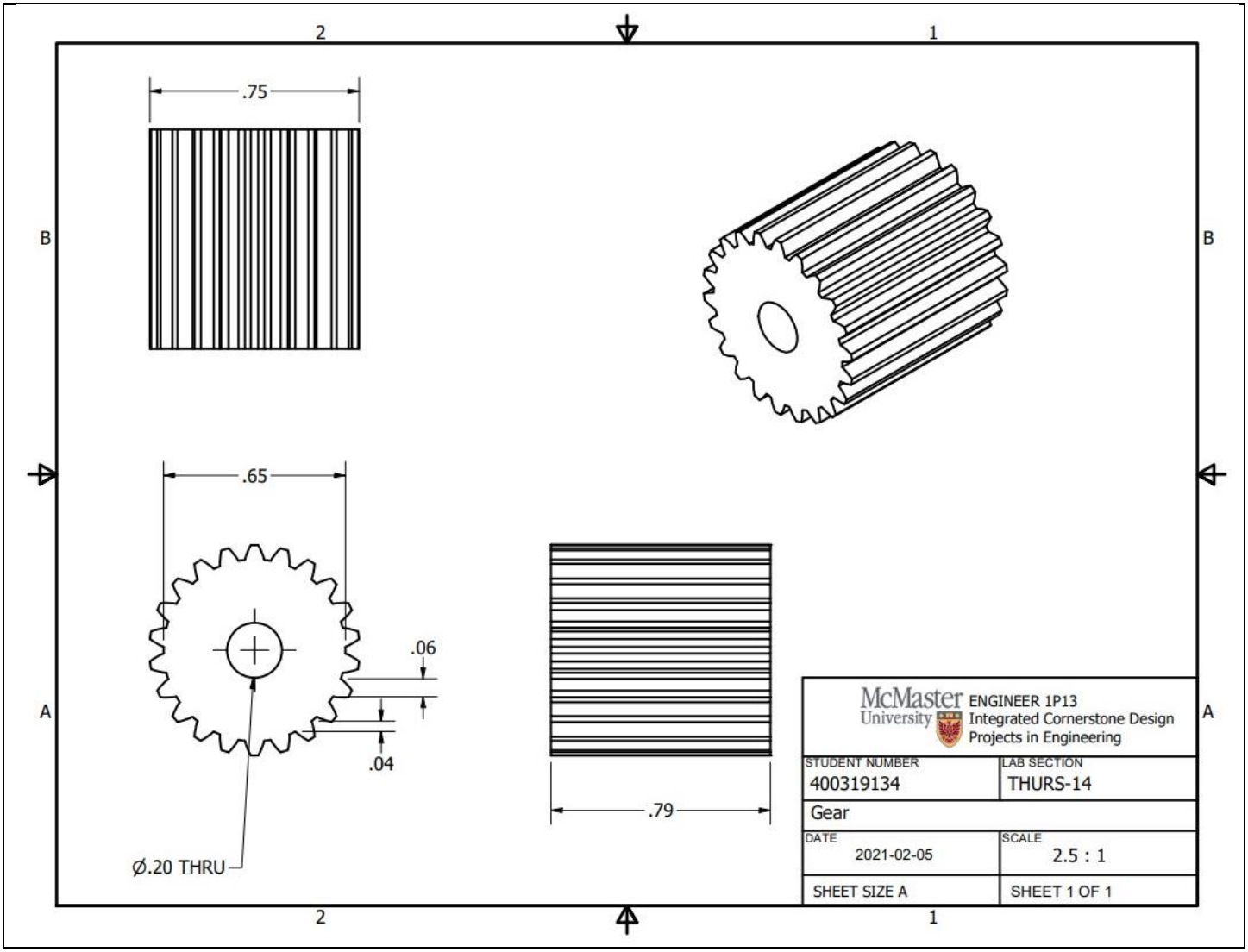
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
400319134
LAB SECTION
THURS-14
Rack Holder
DATE
2021-02-06
SCALE
1.5 : 1
SHEET SIZE A
SHEET 1 OF 1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McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
400319134
LAB SECTION
THURS-14
Gear
DATE
2021-02-05
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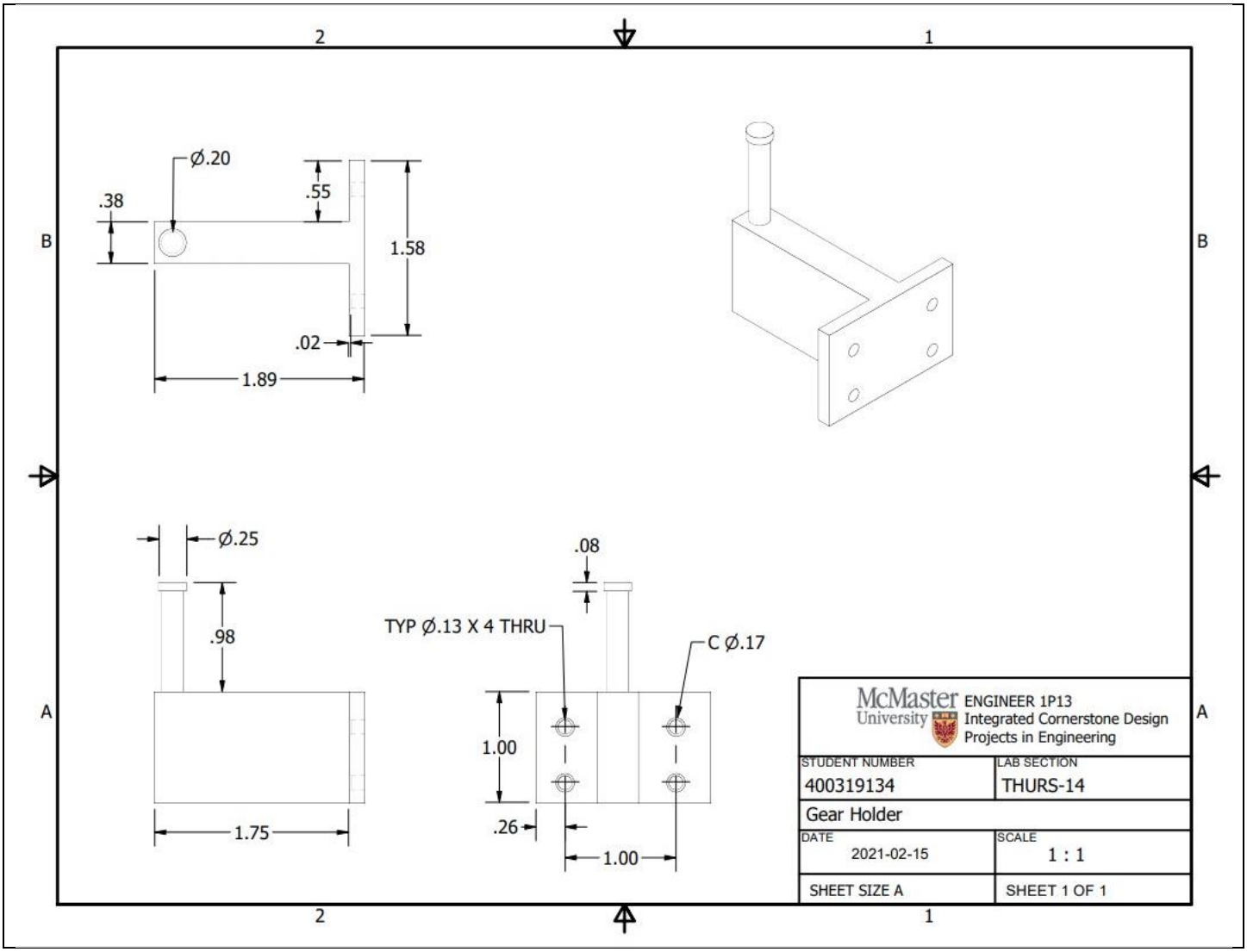
SHEET 1 OF 1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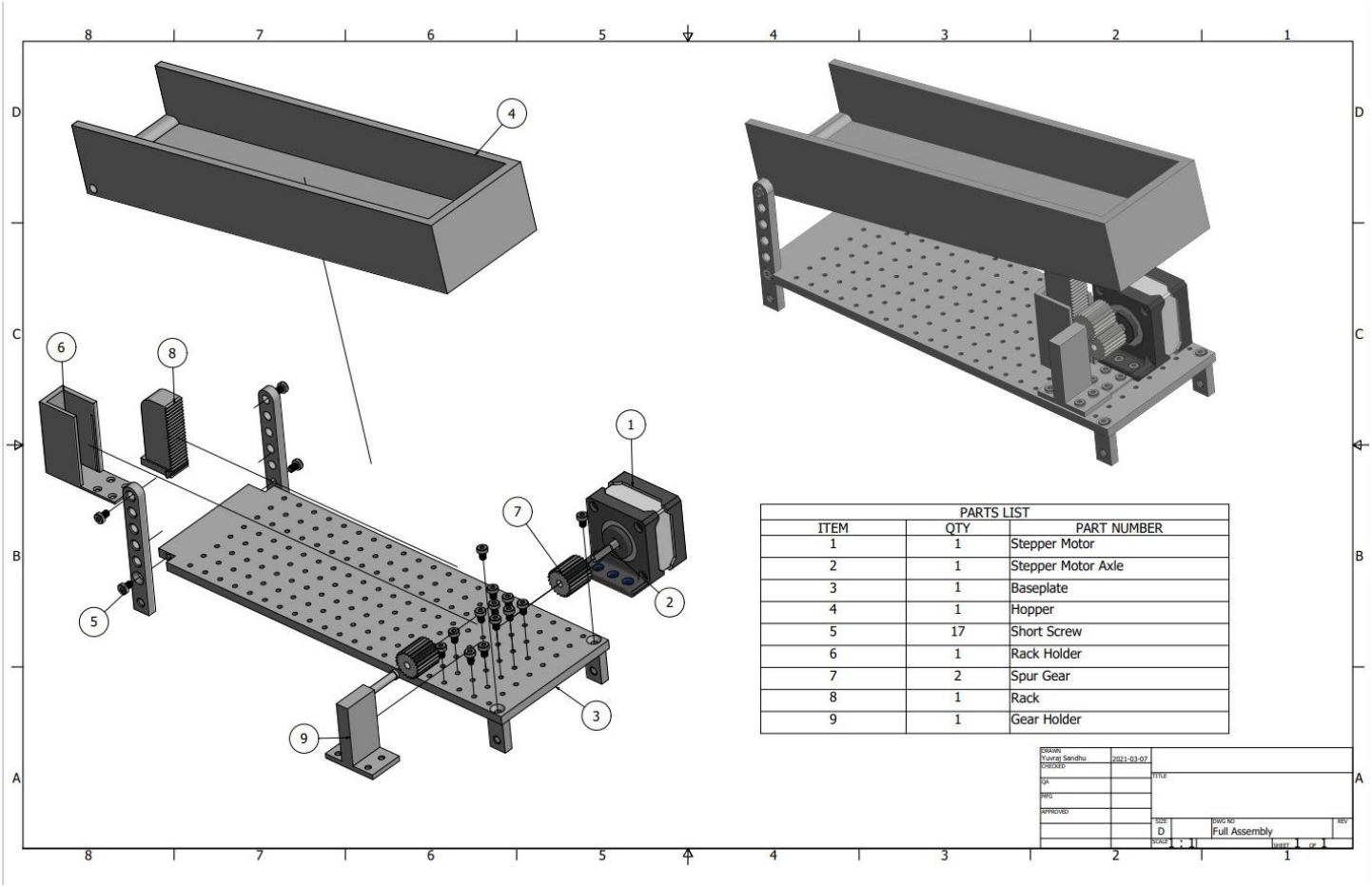
McMaster University
ENGINEER 1P13
Integrated Cornerstone Design
Projects in Engineering
STUDENT NUMBER
400319134
LAB SECTION
THURS-14
Gear Holder
DATE
2021-02-15
SCALE
1 : 1
SHEET SIZE A
SHEET 1 OF 1

Screenshots of Exploded Assembly:



PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	Stepper Motor
2	1	Stepper Motor Axle
3	1	Baseplate
4	1	Hopper
5	17	Short Screw
6	1	Rack Holder
7	2	Spur Gear
8	1	Rack
9	1	Gear Holder

DRAWN Yuvraj Sandhu 2021-03-07
CHECKED
QA
MFG
APPROVED
TITLE
SIZE D
DWG NO. Full Assembly
REV
SCALE 1 : 1
SHEET 1 OF 1

Appendix C – Screenshots of Computer Program:

```
##-------------------------------------------------------------------------------------
## STUDENT CODE BEGINS
##-------------------------------------------------------------------------------------
#Cheng-Kai (Kelvin)-Mahmoud El Shafei
#We define a function for dispensing Container. We defined the material, mass and ContainerID
# by inputing the computer value
# After defining them we have another function for dispensing the container.
# We return the mass and ID because these are the constriants
# import a random number from 1,6
def dispense_container(): # define function called dispense container
    material, mass, ID_Bin = my_table.container_properties(random.randint(1,6))
    my_table.dispense_container()
    return mass, ID_Bin


#Cheng-Kai (Kelvin)-Mahmoud El Shafei
#Function called load_container
#Determine coordinates for Pickup, home position and drop off
def load_container(count_number):
    Pick_Position = [0.665, 0.0, 0.2504]
    Home_Position = [0.4064, 0.0, 0.4826]
    Drop_Position = [[-0.0922, -0.3994, 0.3979], [0.0, -0.4002, 0.412],[0.0922, -0.3994, 0.3979]]

# Code for moving Q-arm where it picks up the material and moves it to the Q-bot
    arm.move_arm(Pick_Position[0],Pick_Position[1],Pick_Position[2])
    arm.control_gripper(45)
    arm.rotate_base(45)
    arm.move_arm(Home_Position[0],Home_Position[1],Home_Position[2])
    arm.move_arm(Drop_Position[count_number-1][0],Drop_Position[count_number-1][1],Drop_Position[count_number-1][2])
    arm.control_gripper(-25)
    arm.rotate_elbow(-39)
    arm.home()
```

```
#Cheng-Kai (Kelvin)-Mahmoud El Shafei
# Once materials are loaded, bot rotates, sensor activates
# once reaches destination, sensor deactivates
def transfer_container (Drop_off):
    bot.rotate(187)
    bot.activate_ultrasonic_sensor()
    lost_line = 0
    while bot.read_ultrasonic_sensor(Drop_off)>0.1:
        velocity = bot.follow_line(0.2)
        bot.forward_velocity(velocity[1])
        lost_line = velocity[0]
    bot.stop()
    bot.deactivate_ultrasonic_sensor()


#Cheng-Kai (Kelvin)-Mahmoud El Shafei
# Once destination of bin is reached, actuator activates,
# Materials is transfered to bin, actuator deactivates
def deposit_container():
    bot.activate_actuator()
    bot.dump()
    bot.deactivate_actuator()


#Cheng-Kai (Kelvin)-Mahmoud El Shafei
#Q-bot follows the yellow line until it returns home. If Q-bot loses track it stops
def return_home():
    lost_line = 0
    while lost_line <2:
        velocity = bot.follow_line(0.2)
        bot.forward_velocity(velocity[1])
        lost_line = velocity[0]
    bot.stop()
```

```
#Cheng-Kai (Kelvin)-Mahmoud El Shafei

def main():
    #while loop for user input

    container_on_table = False # This variable is to check if there is a mertial on a table

    while (True):
            count_number = 0 #Define variable for number of conatiners and the mass
            Mass_total = 0
            while (count_number <4): # While number of contianers is less than 4

#The whole point of this if is to check if there is a material on the table
#if there is a material with same ID it picks it up
                if container_on_table == True:
                    count_number=1
                    Drop_off = old_container[0]
                    Mass_total += old_container[1]
                    print('"The total mass ', Mass_total,'"')
                    load_container(count_number)
                    container_on_table = False
                mass, ID_Bin = dispense_container()
                print('"The Bin location is ', ID_Bin,'"')
                count_number +=1

#To check if this is the first container to drop off. You dont need to check for ID
                if count_number == 1:
                    Mass_total = Mass_total + mass
                    Drop_off = ID_Bin
                    print('"The total mass ', Mass_total,'"')
                    load_container(count_number)

#Checks if other material on table matches the one on Q-bot
# Also checks if the total mass is less than 90
                elif Drop_off == ID_Bin and Mass_total+mass <=90:
                    Mass_total +=mass
                    print('"The total mass ', Mass_total,'"')
                    load_container(count_number)

#The Q-arm does not pick up the material bc it doesnt match the Id
# It stores the material on table as a new variable so it could be picked in the next cycle
```

```
#The Q-arm does not pick up the material bc it doesnt match the Id
# It stores the material on table as a new variable so it could be picked in the next cycle
                else:
                    container_on_table = True
                    old_container = [ID_Bin,mass]
                    print('"Do not pick up"')
                    break
            transfer_container(Drop_off)
            deposit_container()
            return_home()
# When cycle is done, program asks the user if he wishes to continue the process
            continue_cycle = 0
            continue_cycle = int(input("\nIf you wish to continue enter 1 otherwise enter 0: "))
            if continue_cycle == 0:
                break

            print("The program will run another cycle\n")


main()



##-------------------------------------------------------------------------------------
## STUDENT CODE ENDS
##-------------------------------------------------------------------------------------
```