Design Project 3 – Revenge of the Recycling System

Design a System for Sorting and Recycling Containers

ENGINEER 1P13 – Integrated Cornerstone Design Projects in Engineering

Tutorial 07

Team Thurs-18

Noah Hsu (hsun1)

Qingyang Hou (houq8)

Manas Paudel (paudelm)

Yahya Zaher (zahery)

Submitted: March 4, 2024

Course Instructors: Dr. McDonald, Dr. Doyle, Dr. Ebrahimi, Dr. Fleisig, Dr. Hassan, Dr. Zurob

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Junyi Chen 400410275

(Student Signature) *

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Qingyang Hou 400502937

_____
(Student Signature) *

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Noah Hsu

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Manas Paudel

__ _____
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Yahya Zaher 40080726

Yahya Zaher
(Student Signature) *

Executive Summary

The primary aim of project 3 was to design a system which can, transfer and then deposit containers into their designated bins. This project required both the use of a computer program, as well as a fully functioning mechanism to tilt a hopper. It also had a variety of real-world applications, especially in the recycling industry. The primary objectives that our team had were: (1) to maximize strength, (2) to minimize parts used, and (3) minimize computational time.

With the objectives in mind, the computer sub team designed a program in the virtual environment Q-labs, where we utilized five primary functions. The first function dispense_container(), dispenses a container, and stores the information (weight, correct bin etc.) of the container as a global variable , which will be used throughout the program to reference the container properties. The next function, load_container(), loads the container onto the Q-bot. Our code utilizes a for loop which iterates the dispense container function three times, ensuring that there are no more than three containers on the Q-bot. The program then utilizes if-else statements to check other requirements for loading (such as weight). If those requirements are met, the Q-arm will add the container onto to the hopper.

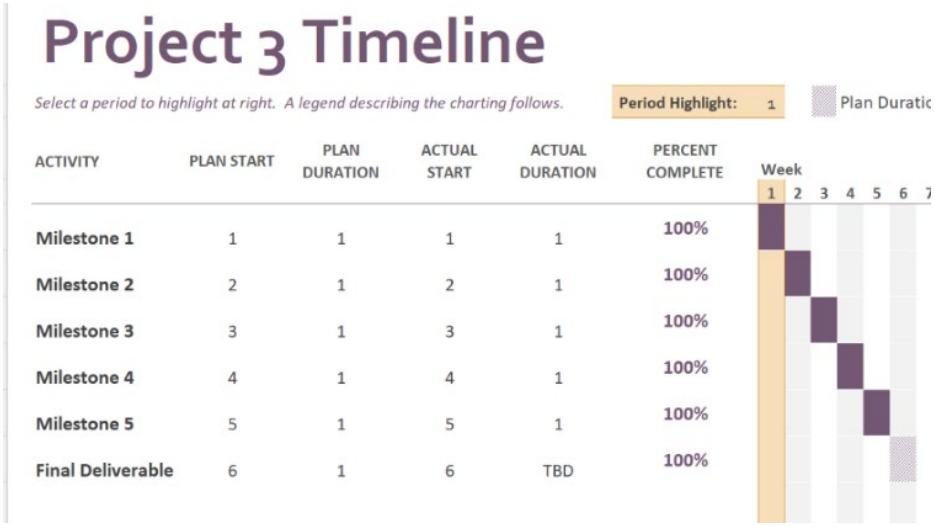
The next function, transfer_container() utilizes the colour and ultrasonic sensors, as well as a yellow line reading sensor. The program will run a while loop, where it will stay on the yellow line unless the colour sensor detects the colour of the correct bin, and the distance read by the ultrasonic sensor is smaller than a value (we chose 0.08). Once those requirements are met, the Q-bot will run the deposit container function which simply activates the actuator and deposits the container into the bin. Finally, the last function, return_home brings the bot back home. The program utilizes the same yellow line following algorithm, until the Q-bot is back at its home position, where the Q-bot will then stop and prepare for the next loading.

The modeling sub-team meanwhile was tasked with designing a mechanism using an actuator to tilt the hopper and thus deposit the container into the bin. The mechanism designed utilizes a variety of features to meet the primary objectives of this project. We utilized a rotational actuator, which generates rotational torque. This rotational energy is then transferred using a series of gears, which leads to the movement of a rod (or better known as a slider), which can then adequately tilt the hopper and thus deposit the containers into the bin.

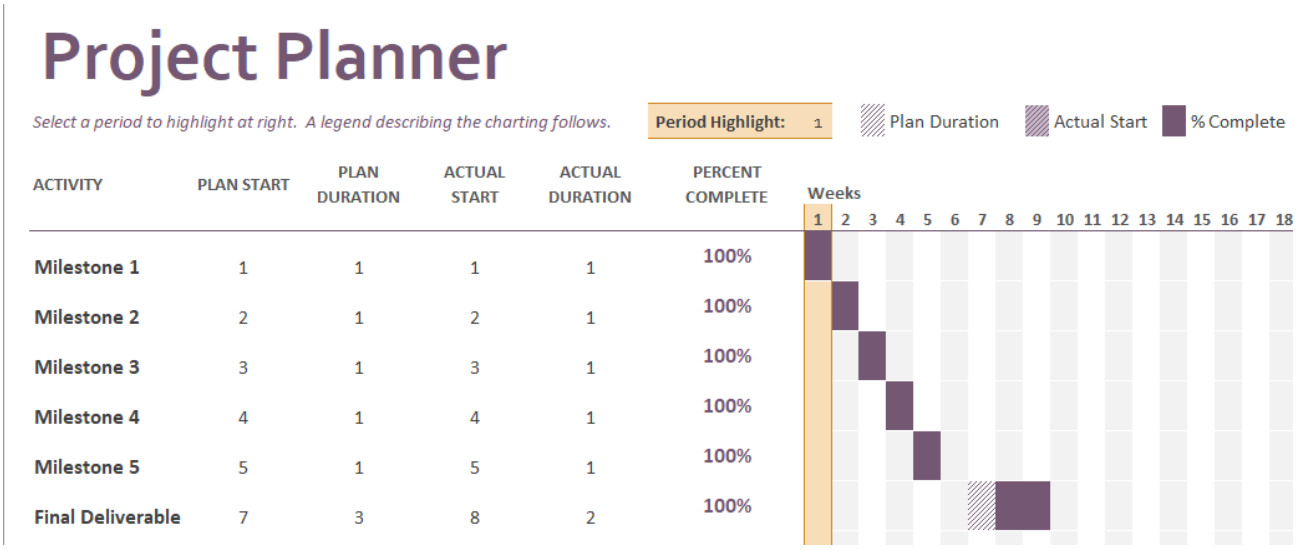
Appendices

Appendix A: Project Schedule

Preliminary Gantt Chart:



Final Gannt Chart:



Appendix B: Scheduled Weekly Meetings

ENGINEER 1P13
MEETING WITH Thurs 18 - Thurs, Jan 11, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Noah Hsu	hsun1	Yes
Administrator 1	Manas Paudel	paudelm	Yes
Administrator 2	Junyi Chen	chenj539	Yes
Coordinator	Yahya Zaher	zahery	Yes
Coordinator	Qingyang Hou	houq8	Yes

AGENDA ITEMS

1. TEAM CHECK-IN: OPEN DISCUSSION ABOUT TEAM MEMBERS' WELL-BEING.
2. MILESTONE 2 PRE-PROJECT WORK (COMPUTING, MODELLING):
   A. COMPUTING SUB TEAM: CLARIFY CONFUSION ON ATTRIBUTES AND DISCUSS RESEARCH FINDINGS.
   B. MODELLING SUB TEAM: REVIEW UNDERSTANDING OF MILESTONE 2, ADDRESS CHALLENGES DURING DISCUSSIONS.
3. REFLECTION ON TODAY'S MILESTONE: SHARE THOUGHTS ON CHALLENGES AND IDEAS FOR THE CURRENT MILESTONE.
4. OPEN DISCUSSION (LABS, ETC.): A. OVERVIEW OF UPCOMING LABS: I. LAB B: NON-GRADED ACTIVITIES IN QLABS FOR FAMILIARITY. II. LAB A: COMMUNICATION WORKSHOP.

MEETING MINUTES

1. Team Well-being Check: Contentment with post-break workload adjustment but noted fatigue.
2. Milestone 2 Pre-Project Work:
a. Modelling Team: Resolved confusion collaboratively.
b. Computing Team: Overcame confusion, discussed research.
3. Reflection on Today's Milestone: Anticipation of an enjoyable challenge.
4. Open Discussion: a. Planned Labs: i. Lab B: Non-graded QLabs activities. ii. Lab A: Communication workshop.

POST-MEETING ACTION ITEMS

1. *Lab Files Download: All team members.*
2. *Milestone 3 Detailed Sketches:* Junyi Chen, Yahya Zaher, Qingyang Hou
3. *Milestone 3 Flowchart and Pseudocode:* Manas Paudel, Noah Hsu

ENGINEER 1P13

MEETING WITH Thurs 18 - Thursday, January 18, 2024

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Noah Hsu	hsun1	Yes
Administrator 1	Manas Paudel	paudelm	Yes
Administrator 2	Junyi Chen	chenj539	Yes
Coordinator	Yahya Zaher	zahery	Yes
Coordinator	Qingyang Hou	houq8	Yes

Agenda Items

1. Check-in
2. Review of Last Week's Milestone
3. Preliminary Work for Milestone 3
4. Discussion on Today's Milestone (Challenges, Ideas)
5. Open Discussion

Meeting Minutes

1. Check-in:
   a. All members are well, but school is stressful.
2. Last Week's Milestone Review:
   a. Modelling: Worked on sketches, a table, and design selection.
   b. Computing: Found it easy, completed during the designated study time.
3. Milestone 3 Preliminary Work:
   a. Milestone is pass/fail.
   b. Modelling: Creating components of the design.
   c. Computing: Finished preliminary work; discussed details.
4. Today's Milestone (Challenges, Ideas):
   a. Modelling: Tasked with creating a final sketch.
   b. Computing: Yet to review due to pre-work discussions.
5. Open Discussion:
   a. Query about zip files.
   b. Casual check on life.

Post-Meeting Action Items

1. *Complete Milestone 3 (all members).*
2. *Prelab for Thursday's Lab A (all members).*
3. *Download zip files for tomorrow's Lab B (all members).*

ENGINEER 1P13

MEETING WITH Thurs 18 - Thursday, January 25, 2024

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Noah Hsu	hsun1	Yes
Administrator 1	Manas Paudel	paudelm	Yes
Administrator 2	Junyi Chen	chenj539	Yes
Coordinator	Yahya Zaher	zahery	Yes
Coordinator	Qingyang Hou	houq8	Yes

Agenda Items

1. Casual Check-In
2. Off-Topic Discussion
3. Weekly Accomplishments
4. Outlook for the Next Few Weeks
5. Progress Towards Interview Readiness (Week 6 Booking)

Meeting Minutes

1. Casual Check-In:
   a. Team members are ready for the upcoming reading week.
2. Off-Topic Discussion:
   a. Brief discussion about the physics midterm.
3. Weekly Accomplishments:
   a. Both teams haven't actively worked on tasks as there are still two weeks left for completion.
4. Outlook for the Next Few Weeks:
   a. Focus on booking interviews once emails are sent out.
5. Progress Towards Interview Readiness:
   a. Both teams are progressing on their assigned tasks.
      i. Modelling: Completed the 3D model, yet to work on the animation.
      ii. Computing: Changed sensor choice, one more function to code.

Post-Meeting Action Items

1. *Continue working on the model and code (everyone).*
2. *Prepare for project interviews (everyone).*
3. *Schedule a time for the interviews (everyone).*

Appendix C: Comprehensive List of Sources

Source Materials Database:

[1] McMaster Faculty of Engineering, “P3 Project Module.” McMaster University, Hamilton

[2] McMaster Faculty of Engineering, “Python Library Documentation.” McMaster University, Hamilton, 2023

[3] 2023. *Autodesk Inventor Professional 2024*. Autodesk.

[4] 2023. *PrusaSlicer.* PrusaResearch.

[5] 2023. *Quanser Interactive Labs*. Quanser.

Appendix D: Additional Documentation

Assembly Model:

Figure 1. Open position

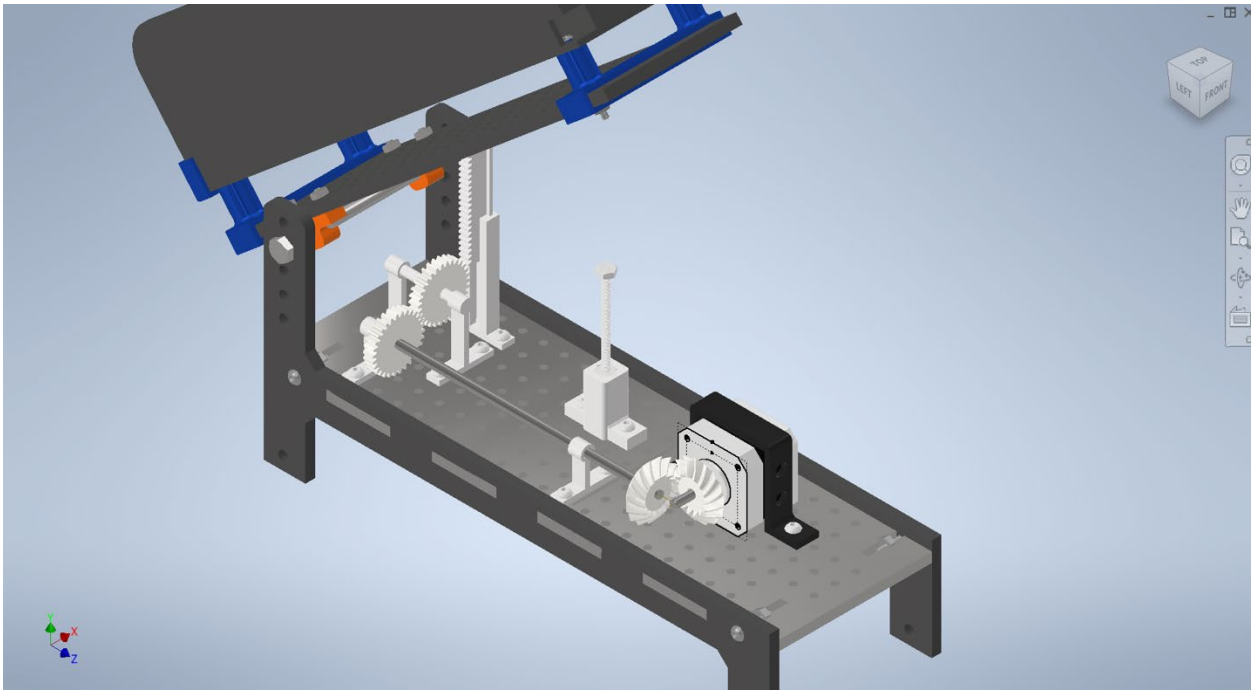
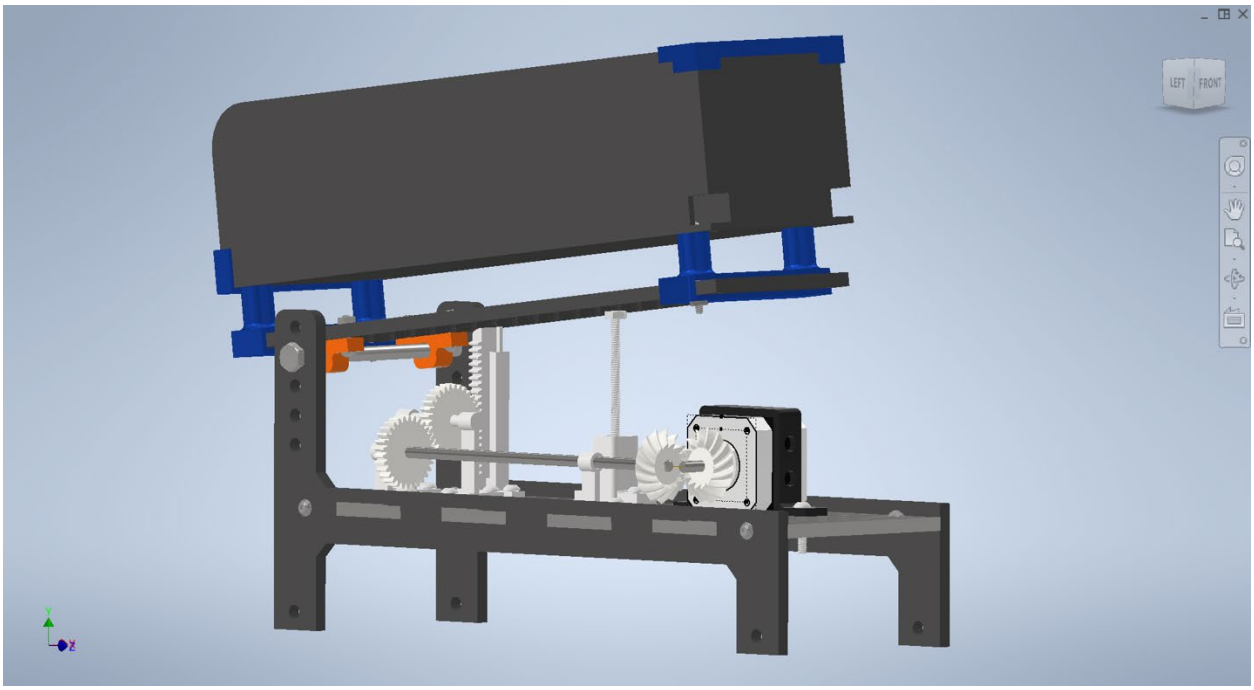
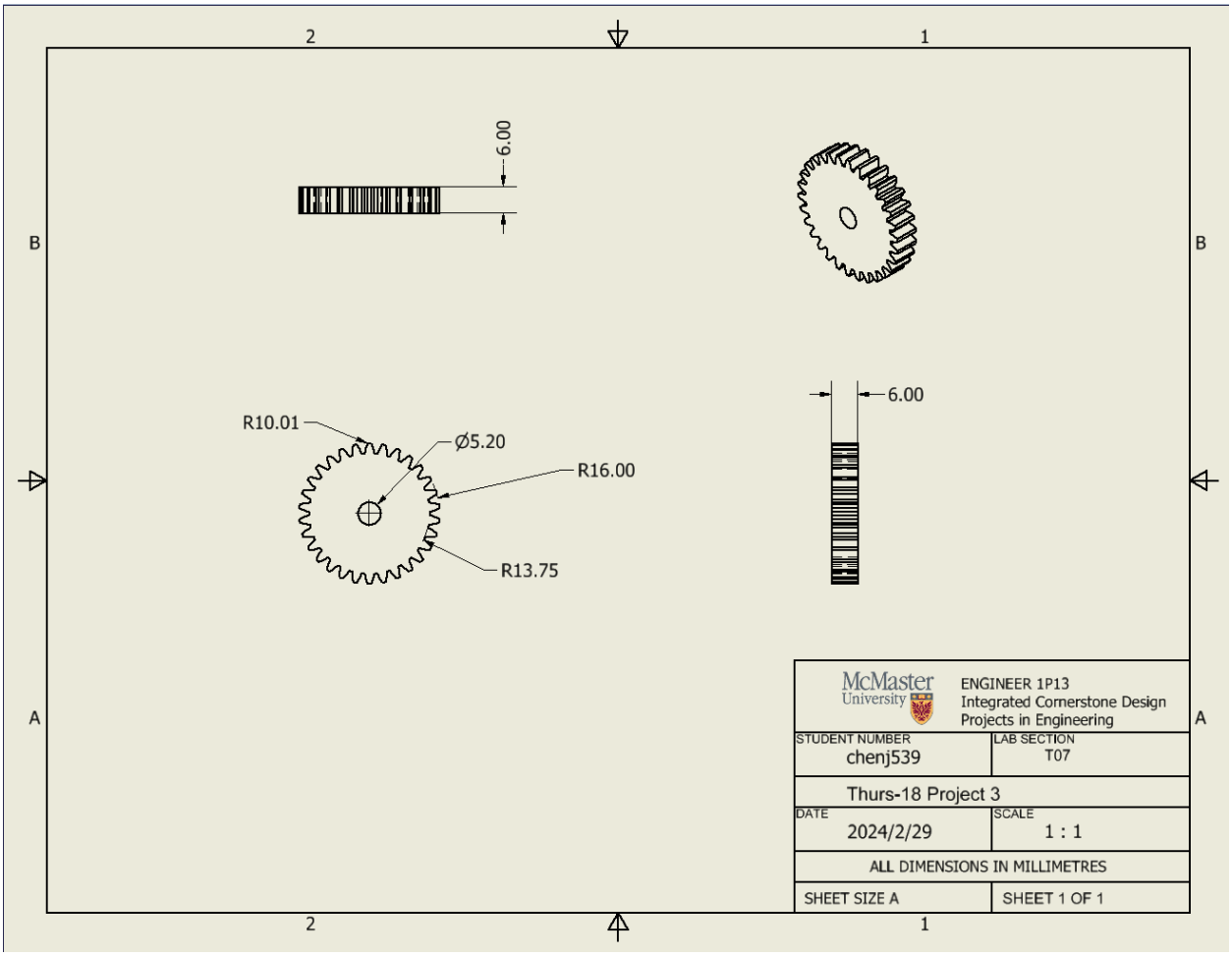


Figure 2. Closed position



Engineering Drawings: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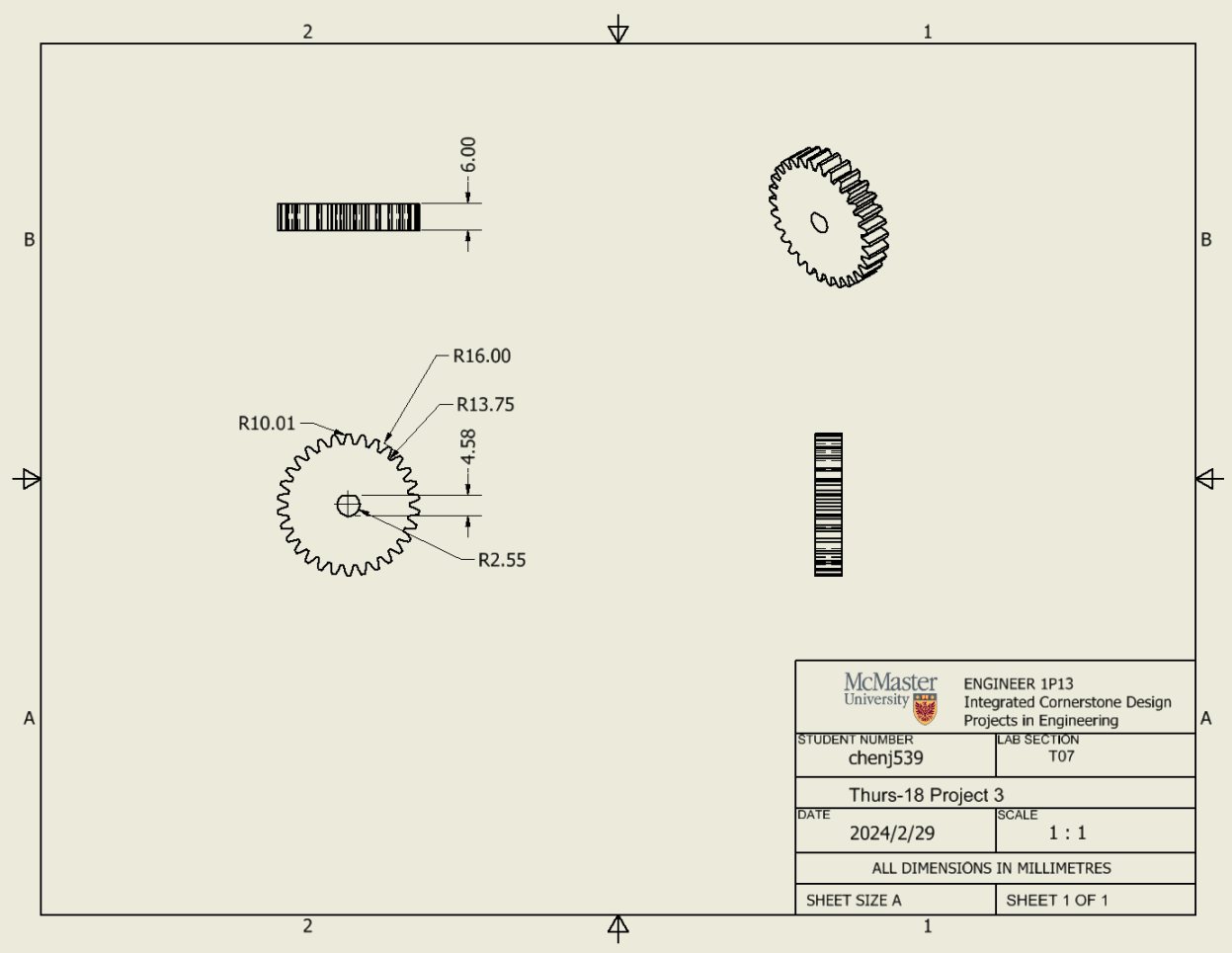
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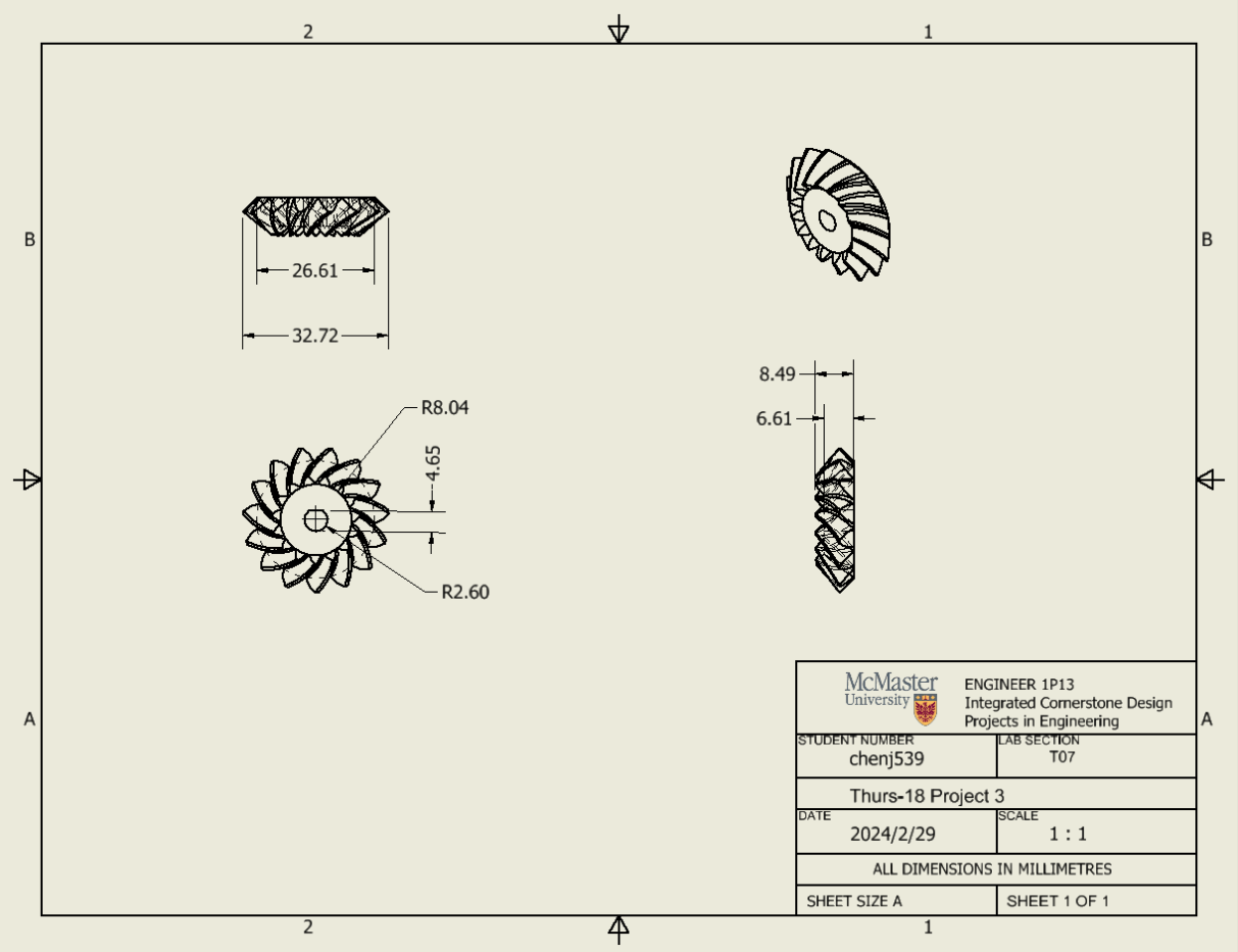
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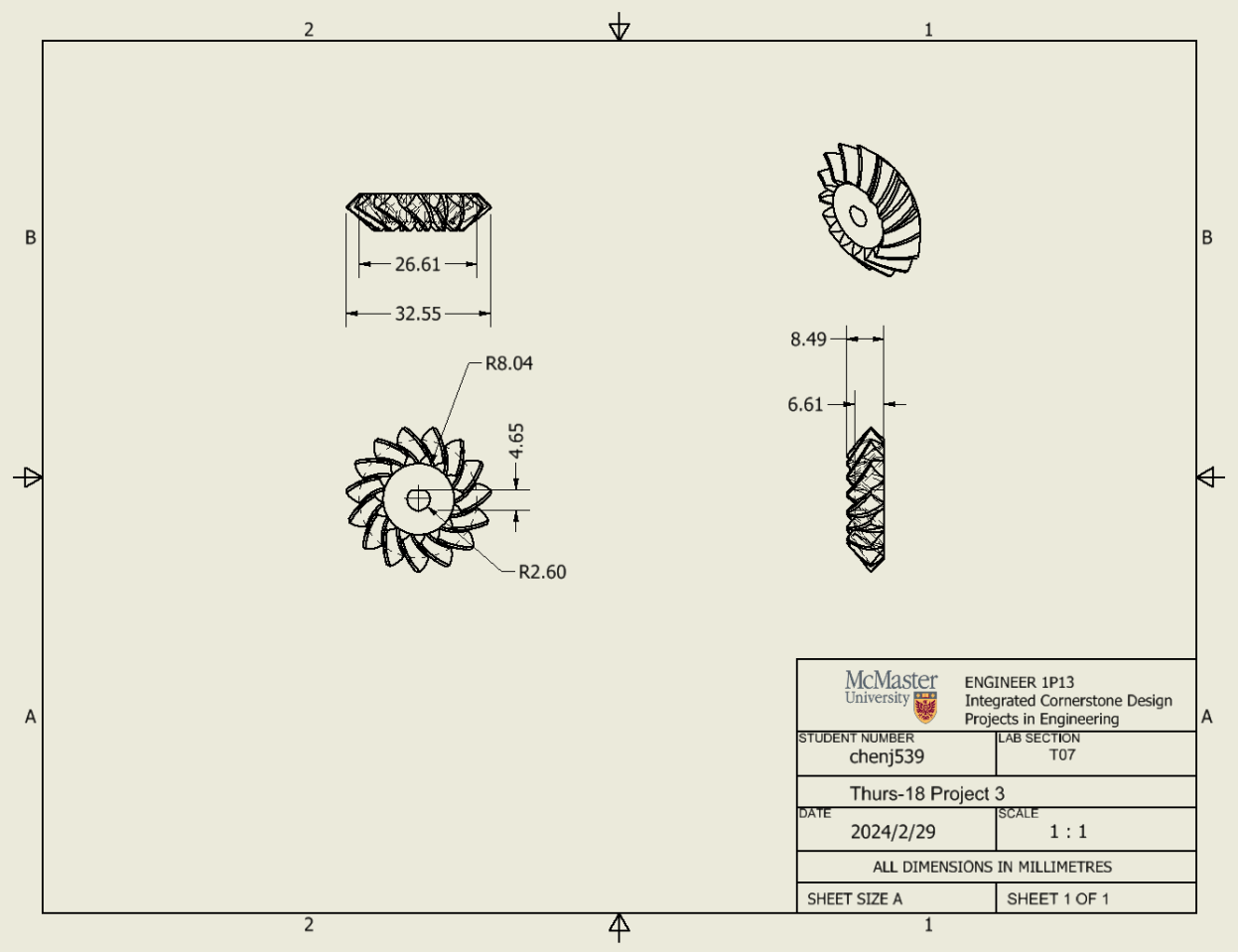
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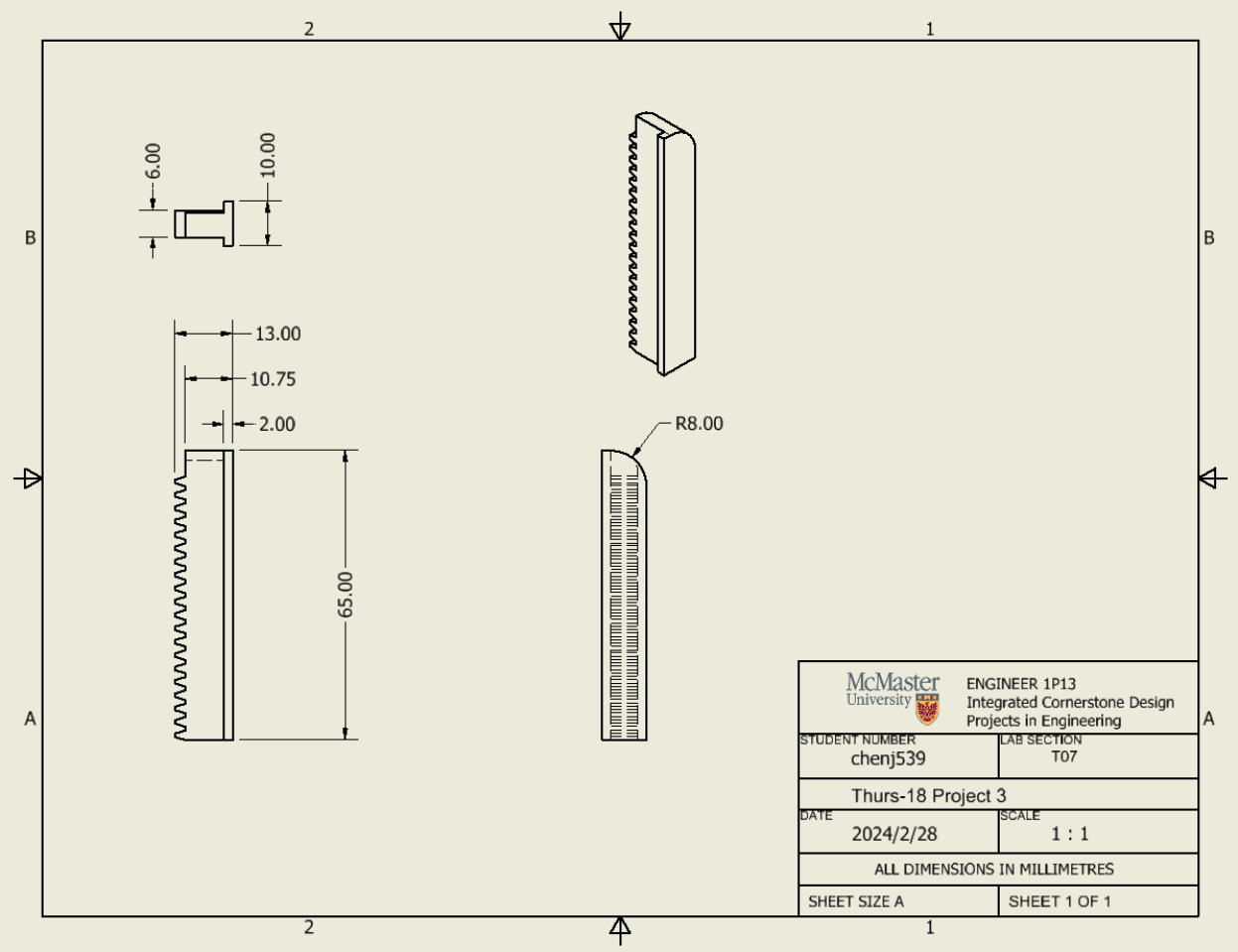
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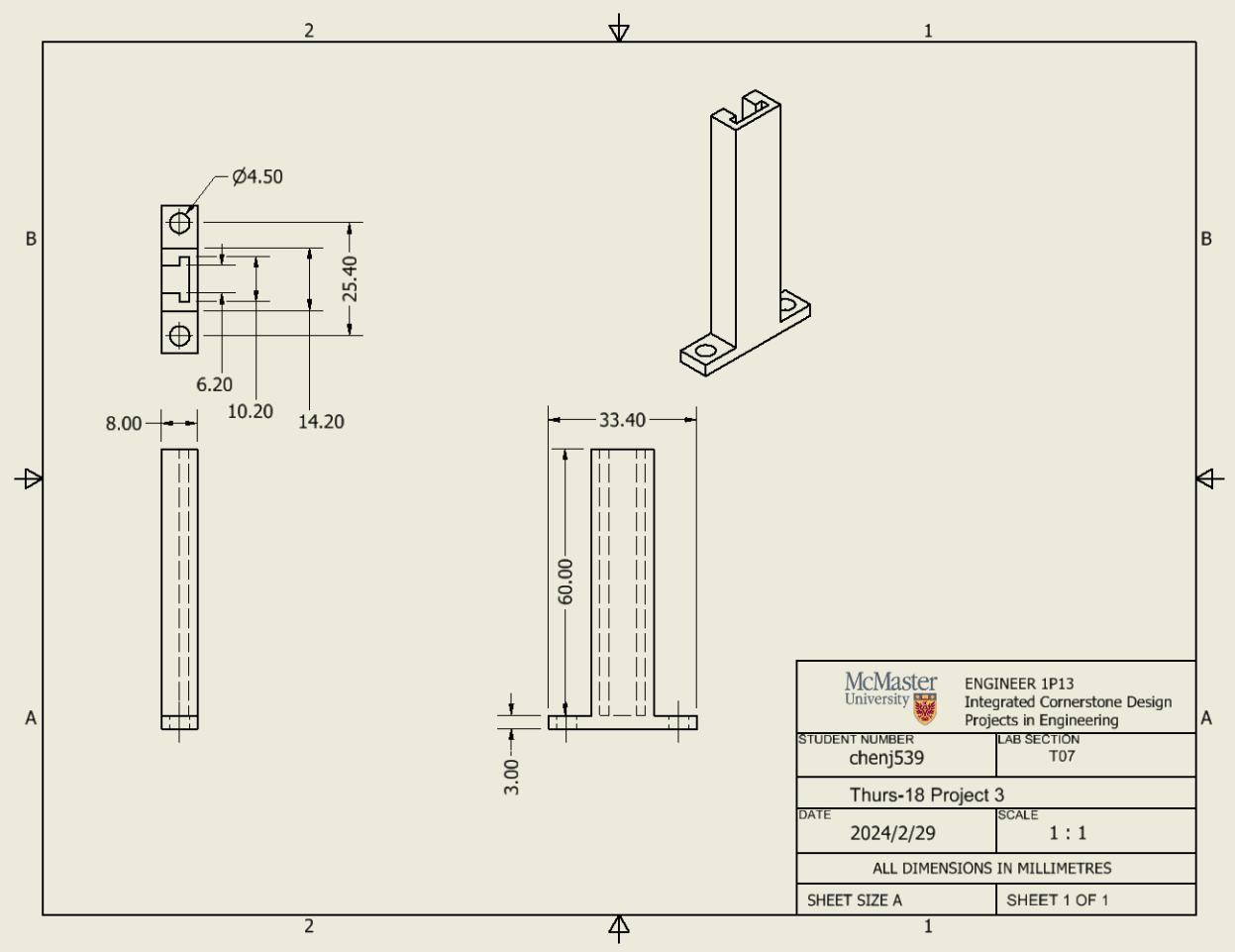
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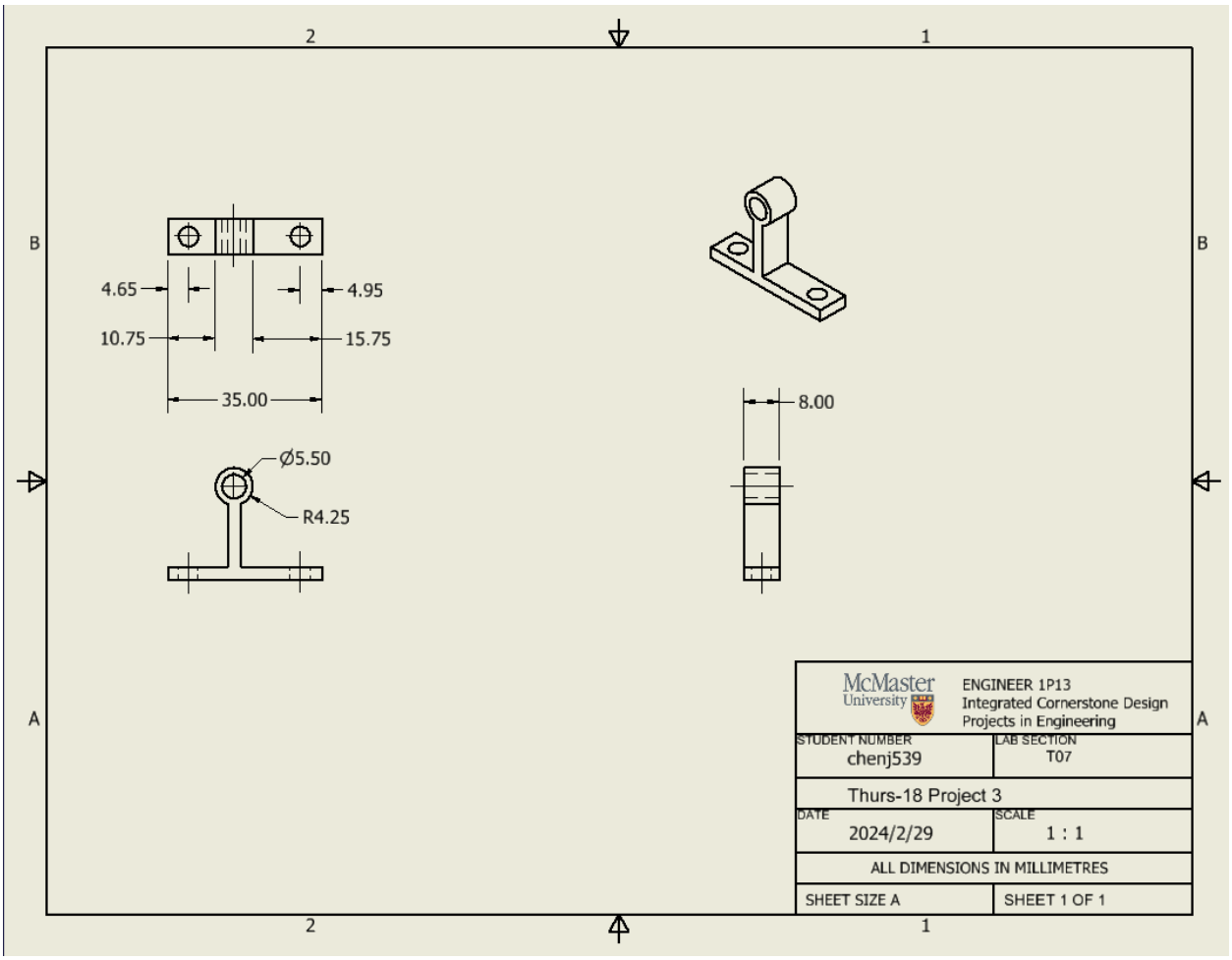
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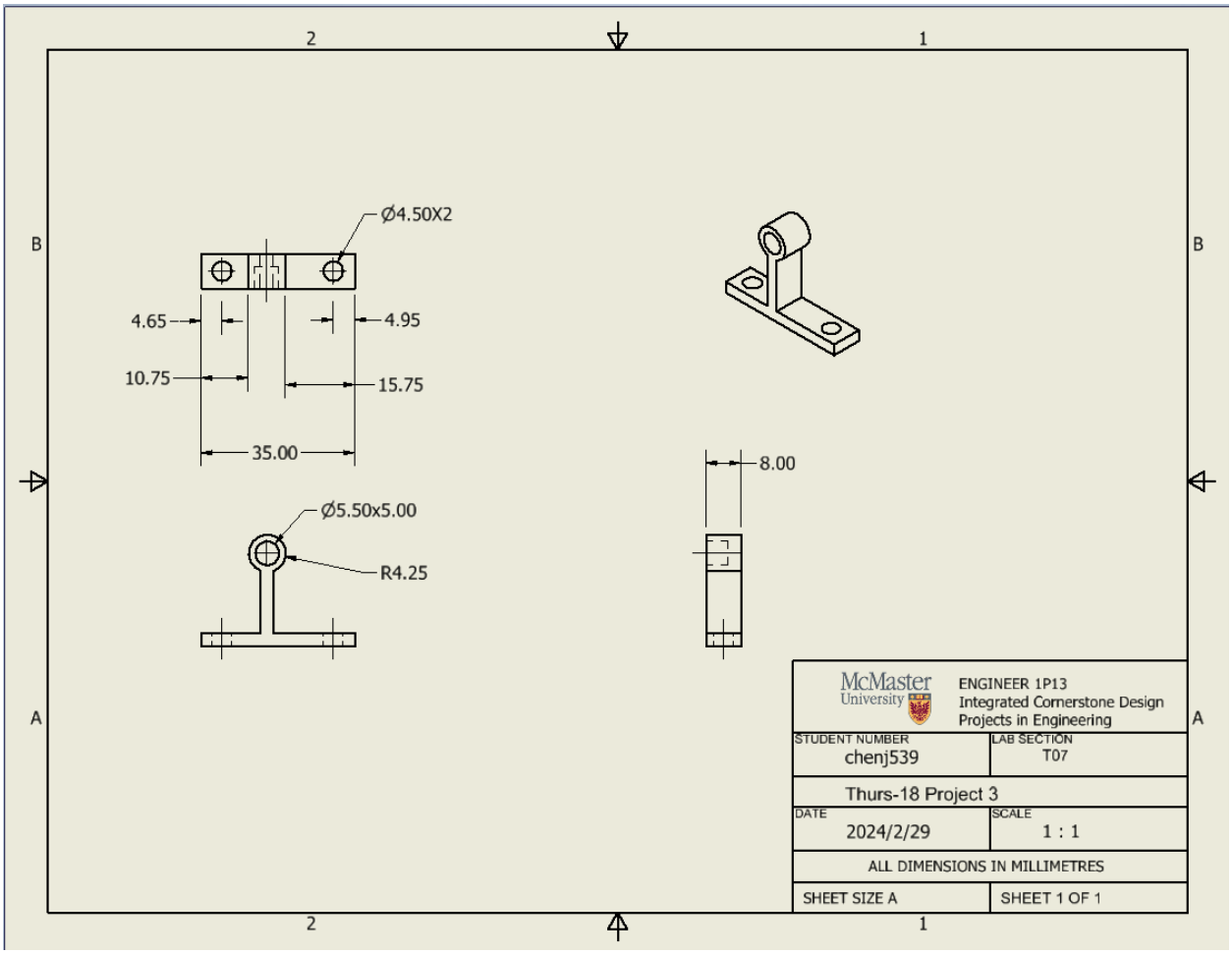
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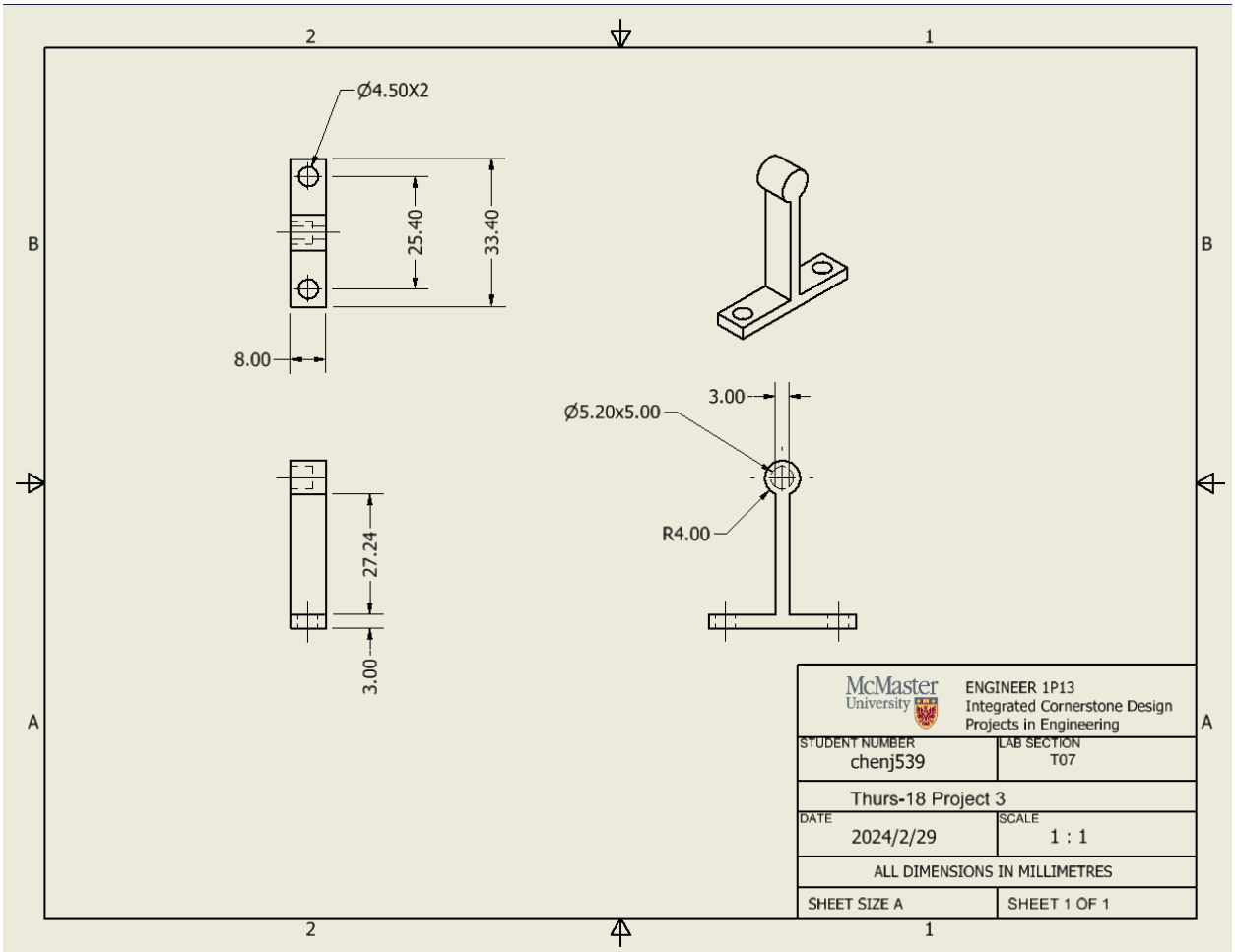
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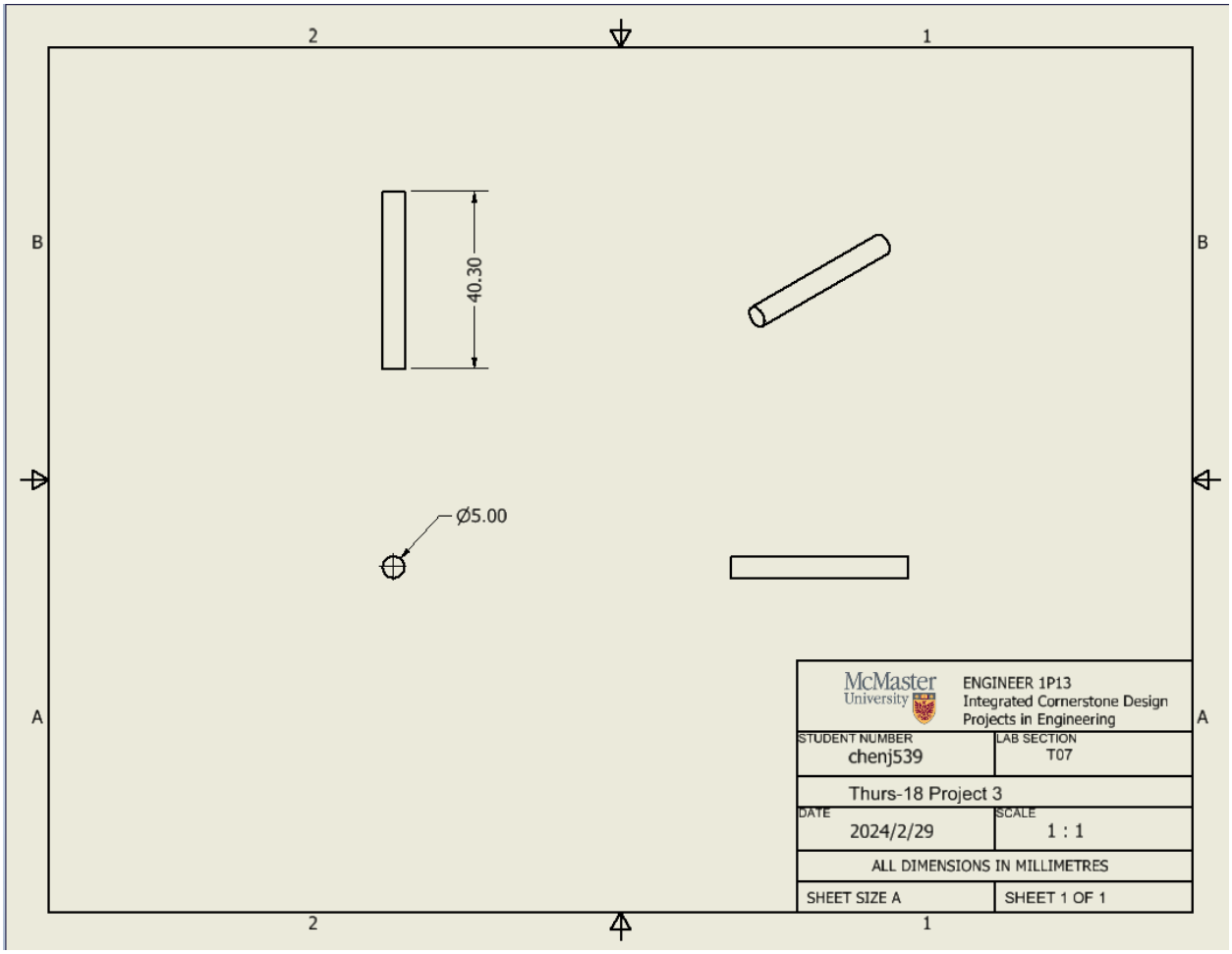
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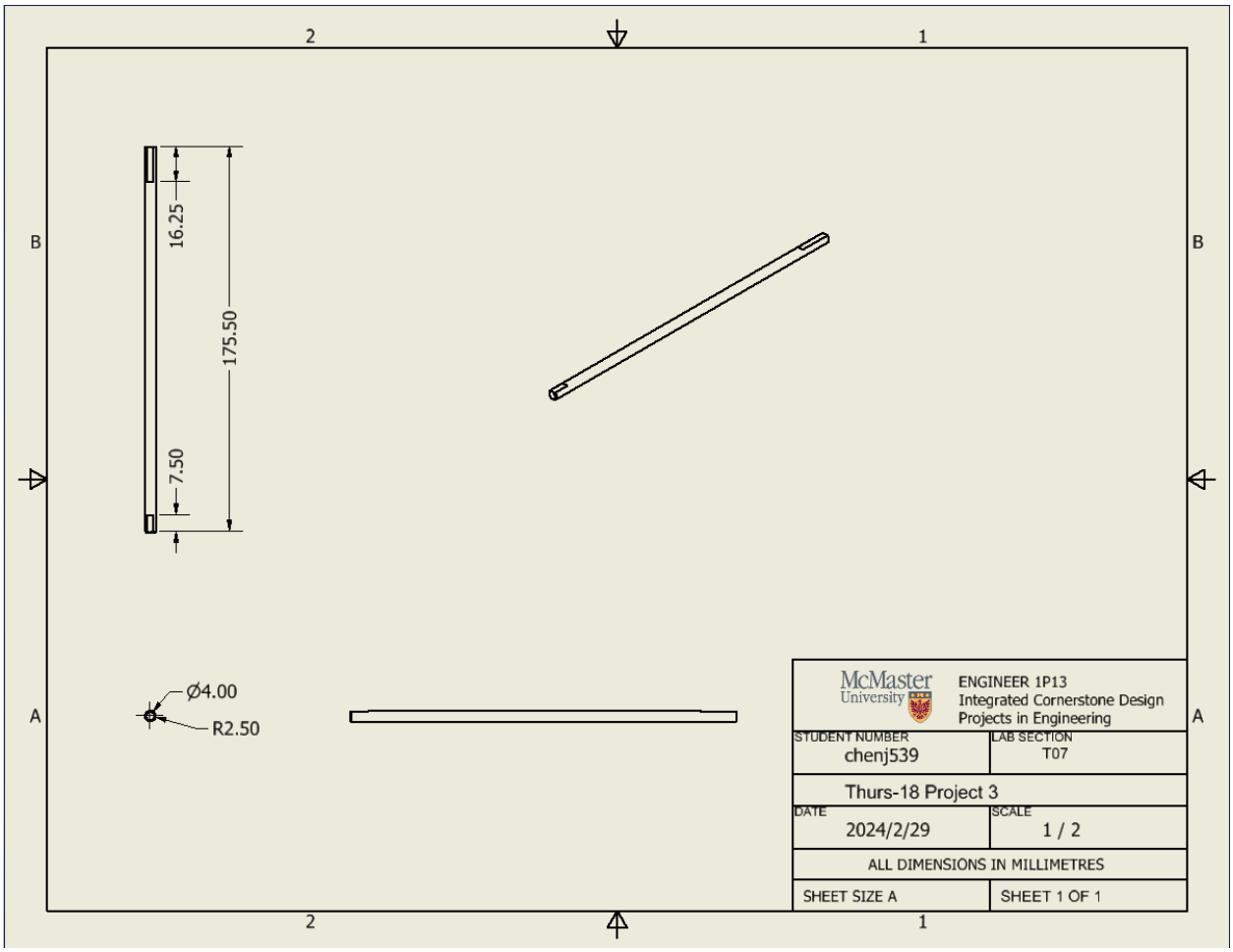


Computer Program:

Figure 7: Dispense container function and settings

```
ip_address = 'localhost' # Enter your IP Address here
project_identifier = 'P3A' # Enter the project identifier i.e. P2A or P2B

# SERVO TABLE CONFIGURATION
short_tower_angle = 315 # enter the value in degrees for the identification tower
tall_tower_angle = 90 # enter the value in degrees for the classification tower
drop_tube_angle = 180 # enter the value in degrees for the drop tube. clockwise rotation from zero degrees

# BIN CONFIGURATION
# Configuration for the colors for the bins and the lines leading to those bins.
# Note: The line leading up to the bin will be the same color as the bin

bin1_offset = 0.5 # offset in meters
bin1_color = [1.0,0,0] # e.g. [1,0,0] for red
bin1_metallic = False

bin2_offset = 0.5
bin2_color = [0,1.0,0]
bin2_metallic = False

bin3_offset = 0.5
bin3_color = [0,1.0,1.0]
bin3_metallic = False

bin4_offset = 0.5
bin4_color = [0.1,0.1,0.1]
bin4_metallic = False
#-----------------------------------------------------------------------------
import sys
sys.path.append('../')
from Common.simulation_project_library import *

hardware = False
if project_identifier == 'P3A':
    table_configuration = [short_tower_angle,tall_tower_angle,drop_tube_angle]
    configuration_information = [table_configuration, None] # Configuring just the table
    QLabs = configure_environment(project_identifier, ip_address, hardware,configuration_information).QLabs
    table = servo_table(ip_address,QLabs,table_configuration,hardware)
    arm = qarm(project_identifier,ip_address,QLabs,hardware)
    bot = qbot(0.1,ip_address,QLabs,project_identifier,hardware)
else:
    table_configuration = [short_tower_angle,tall_tower_angle,drop_tube_angle]
    bin_configuration = [[bin1_offset,bin2_offset,bin3_offset,bin4_offset],[bin1_color,bin2_color,bin3_color,bin4_color],[bin1_metallic,bin2_metallic, bin3_metallic,bin4_metallic]]
    configuration_information = [table_configuration, bin_configuration]
    QLabs = configure_environment(project_identifier, ip_address, hardware,configuration_information).QLabs
    table = servo_table(ip_address,QLabs,table_configuration,hardware)
    arm = qarm(project_identifier,ip_address,QLabs,hardware)
    bot = qbot(0.1,ip_address,QLabs,project_identifier,hardware)
#-----------------------------------------------------------------------------
# STUDENT CODE BEGINS
#-----------------------------------------------------------------------------

#Noah and Manas
def dispense_container():
    bottle = random.randint(1,6)                        #Random container is deteremined
    container_type = table.dispense_container(bottle,True)          #Container properties are stored and Container is dispensed
    return container_type
```

Figure 8: Load container function

```
#Noah and Manas
def load_container():
    global bottles_disposed
    global old_bin_number
    global old_weight
    total_weight = 0            #Stores total weight of cans/bottles going on bot
    bin_number = ""     #stores the bin number when new bottle/can spawns
    for bottle_num in range(1,4):                       #For loop set to add 3 cans/bottles to bot unless certain condtions can't be met, maximum 3 as project module states
        if(old_bin_number == ""):                       #Checks if there is an old bin number that needs to be
            container_type = dispense_container()           #Runs the dispense_container storing the returned variable which contains the bottle properties
            weight, bin_destination = container_type[1], container_type[2] #stores all relevant continer properties(weight and bin destination
            total_weight += weight                          #Adds the weight of container
        else:
            total_weight += old_weight          #Adds the old weight as the current bottle is the old bottle
        if bottle_num == 1 :                    #Checks only on the first bottle
            if(old_bin_number == ""):           #Checks if there is an old bin number as it indicates there is a bottle
                bin_number = container_type[2]      # if first bottle/cans dispensed set the old bin number to that value to be used for future bottles/cand
            else:
                bin_number = old_bin_number     #Sets bin_number to the old bin number
                bin_destination = bin_number    #Sets bin_destination as the same as bin_number since we know they should be the same
                old_bin_number = ""             #Set old_bin_number back to "" so it doesn't disrupt code during next loop
        if bin_number != bin_destination:       #break loop if new bin destination is not equal to the current bin destination
            old_bin_number = bin_destination    #Set old_bin_number to the new bin_destination as next run it will be the destination
            old_weight = weight                 #Set old_weigth to the weight of current bottle/can as that will be the weight of the first bottle next run
            bottles_disposed += 1               #Add +1 as it breaks the loop
            break
        else:
            if total_weight > 90:               #break if weight limit has been exceeded
                old_bin_number = bin_number     #Set old_bin_number to the new bin_destination as next run it will be the destination
                old_weight = weight             #Set old_weigth to the weight of current bottle/can as that will be the weight of the first bottle next run
                bottles_disposed += 1           #Add +1 as it breaks the loop
                break
            else:
                arm.move_arm(0.644, 0.0, 0.2733)            #Arm commands to load bottle/cans
                time.sleep(0.75)
                arm.control_gripper(45)
                time.sleep(0.75)
                arm.move_arm(0.4064, 0.0, 0.4826)
                if bottle_num == 1 :
                    arm.move_arm(0.0156, -0.3967, 0.4907) #Different commands on first bottle/can
                    time.sleep(0.75)
                    arm.move_arm(0.0156, -0.5967, 0.5407)
                elif bottle_num == 2:
                    arm.move_arm(0.0156, -0.3967, 0.4907)#Different commands on second bottle/can
                    time.sleep(0.75)
                    arm.move_arm(0.0156, -0.5367, 0.5407)
                elif bottle_num == 3:
                    arm.move_arm(0.0156, -0.5767, 0.4907)#Different commands on third bottle/can
                    time.sleep(0.75)
                    arm.move_arm(0.0156, -0.4867, 0.5407)
        time.sleep(1.25)
        arm.control_gripper(-25)
        time.sleep(1.5)
        arm.home()
        bottles_disposed += 1     #Adds to number of bottles/cans disposed'
    return bin_number
```

Figure 9: Transfer container function

```
#Noah and Manas
def transfer_container(bin_destination):
    go = True
    bin_color = []
    distance_toBin = 0

    if bin_destination == "Bin01":                #Set of conditonals to check where the bin destination is and assign the colour and distance the sensors should detect
        bin_color = bin1_color
        distance_toBin = 0.08

    elif bin_destination == "Bin02":
        bin_color = bin2_color
        distance_toBin = 0.08

    elif bin_destination == "Bin03":
        bin_color = bin3_color
        distance_toBin = 0.08

    elif bin_destination == "Bin04":
        bin_color = bin4_color
        distance_toBin = 0.08

    bot.activate_color_sensor()                                #Activate Sensor
    bot.activate_ultrasonic_sensor()
    bot.activate_line_following_sensor()
    while(True):                                                                    ##While loop runs the line following algorithm until bot gets to desired bin
        sensor_color = bot.read_color_sensor()[0]
        distance = bot.read_ultrasonic_sensor()
        left_wheel, right_wheel = bot.line_following_sensors()[0],bot.line_following_sensors()[1]

        if (bin_color == sensor_color) and (distance <= distance_toBin):    #Break condtion when coloured bin is detected and within certain range based on Ultrasonic and Ccolour of the bin based on the colour
            print("stop")
            go = False
            bot.set_wheel_speed([0,0])
            deposit_container()         #Triggers deposit_container function
            break
        if go == True:
            if left_wheel == 1 and right_wheel == 1:
                bot.set_wheel_speed([0.1,0.1])

            elif left_wheel == 1 and right_wheel == 0:
                bot.set_wheel_speed([0,0.02])

            elif left_wheel == 0 and right_wheel == 1:
                bot.set_wheel_speed([0.02,0])

            else:
                bot.set_wheel_speed([0.5,0.2])

#Noah and Manas
def deposit_container():
    time.sleep(2)
    bot.activate_linear_actuator() #Activates actuator
    bot.dump()                     #Dump container(s)
```

Figure 10: Return home function and main ():

```
#Noah and Manas
def return_home():
    while(True):                                                                    #While loop runs the line following algorithm until bot returns
        left_wheel, right_wheel = bot.line_following_sensors()[0],bot.line_following_sensors()[1]
        if (1.47 <= bot.position()[0] <= 1.49) and (-0.22 <= bot.position()[1] <= 0.24):            #Break condtion if bot enters a certain range of coordinates similar to home position
            bot.set_wheel_speed([0.0,0.0])
            break
        if left_wheel == 1 and right_wheel == 1:
            bot.set_wheel_speed([0.1,0.1])

        elif left_wheel == 1 and right_wheel == 0:
            bot.set_wheel_speed([0,0.02])

        elif left_wheel == 0 and right_wheel == 1:
            bot.set_wheel_speed([0.02,0])

        else:
            bot.set_wheel_speed([0.5,0.2])

#Noah and Manas
def main():
    global bottles_disposed
    global old_bin_number
    global old_weight
    old_bin_number = ""                #Stores the bin_number of the previous bottle
    bottles_disposed = 0                 #Counts how many containers disposed of
    while (bottles_disposed <= 6):        #While loop will run for 6 containers
        bin_destination = load_container()  #Set variable for the returned value of load_container()
        transfer_container(bin_destination) #transfer_container runs with parameter set in line above
        return_home()
        print(bottles_disposed)
    print("done")
```

Appendix E: Design Studio Worksheets

ENGINEER 1P13:
PROJECT THREE WORKSHEETS (INDIVIDUAL)

Table of Contents

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

Milestone 1 (Stage 1) – Initial Problem Statement, Objectives and Constraints

Team ID: Thurs-18

Complete this worksheet individually *before* coming to Design Studio.

Initial Problem Statement

1. Write the initial problem statement in the space below. This was discussed in your first lecture and is provided in the Avenue announcement.

Design a system for sorting and recycling containers

Objectives and Constraints

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 Module and previous lectures.

Objectives	Adjustable rotation height. High strength, minimum energy lost, simple to assemble
Constraints	The actuator is mounted in limited zone. The orientation for actuators is fixed

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

MILESTONE 1 (STAGE 3) – SENSOR EXPLORATION (COMPUTING SUB-TEAM)

Team ID:

Complete this worksheet individually *during* Design Studio.

1. Each team member is expected to complete the demo for at least four (4) of the five (5) sensors available for characterizing bins
   → **Refer to Table 3 in the Project Objective 3 section of the Project Module for a list of available sensors**
2. For each sensor:
   → Briefly describe how the sensor works
   → Indicate the attribute you would measure to characterize each bin
3. Complete your sensor research on the following page
   → Be sure to clearly write your Team ID, Name and MacID

Team ID:

Name:	MacID:

Sensor Type	Description	Attribute(s)

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

MILESTONE 1 (STAGE 4) – MECHANISM CONCEPT SKETCHES (MODELLING SUB-TEAM)

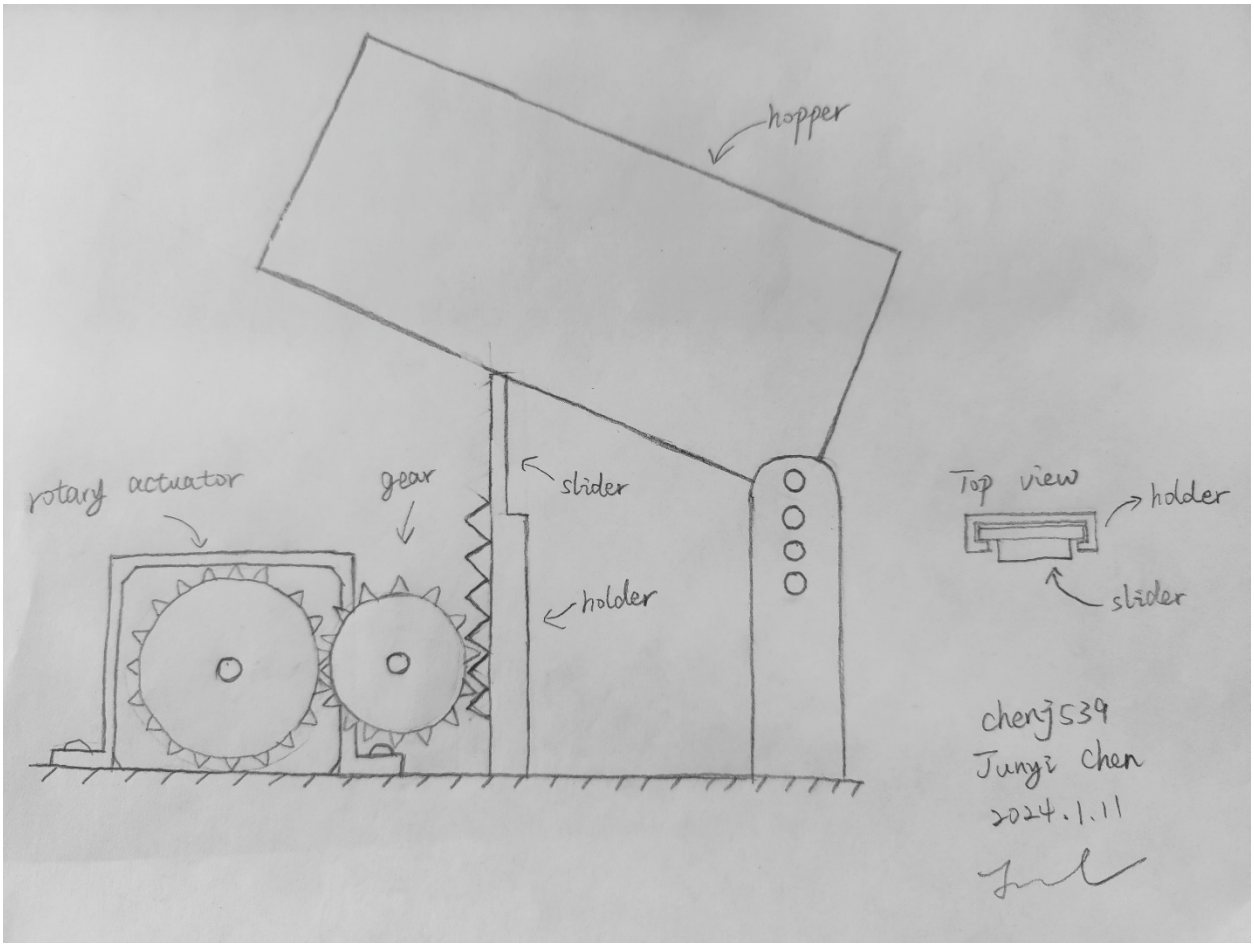
Team ID: Thurs-18

1. Each team member is required to complete **two (2)** preliminary concept sketches for the mechanism design. You should incorporate a different actuator for each sketch.
   → Each sketch should be on a separate piece of paper
   → Be sure to clearly write your Team ID, Name and MacID for each sketch
2. Take photos of your sketches
3. Insert your photos as a Picture on the following pages

Team ID: Thurs-18

Name: Junyi Chen	MacID:chenj539

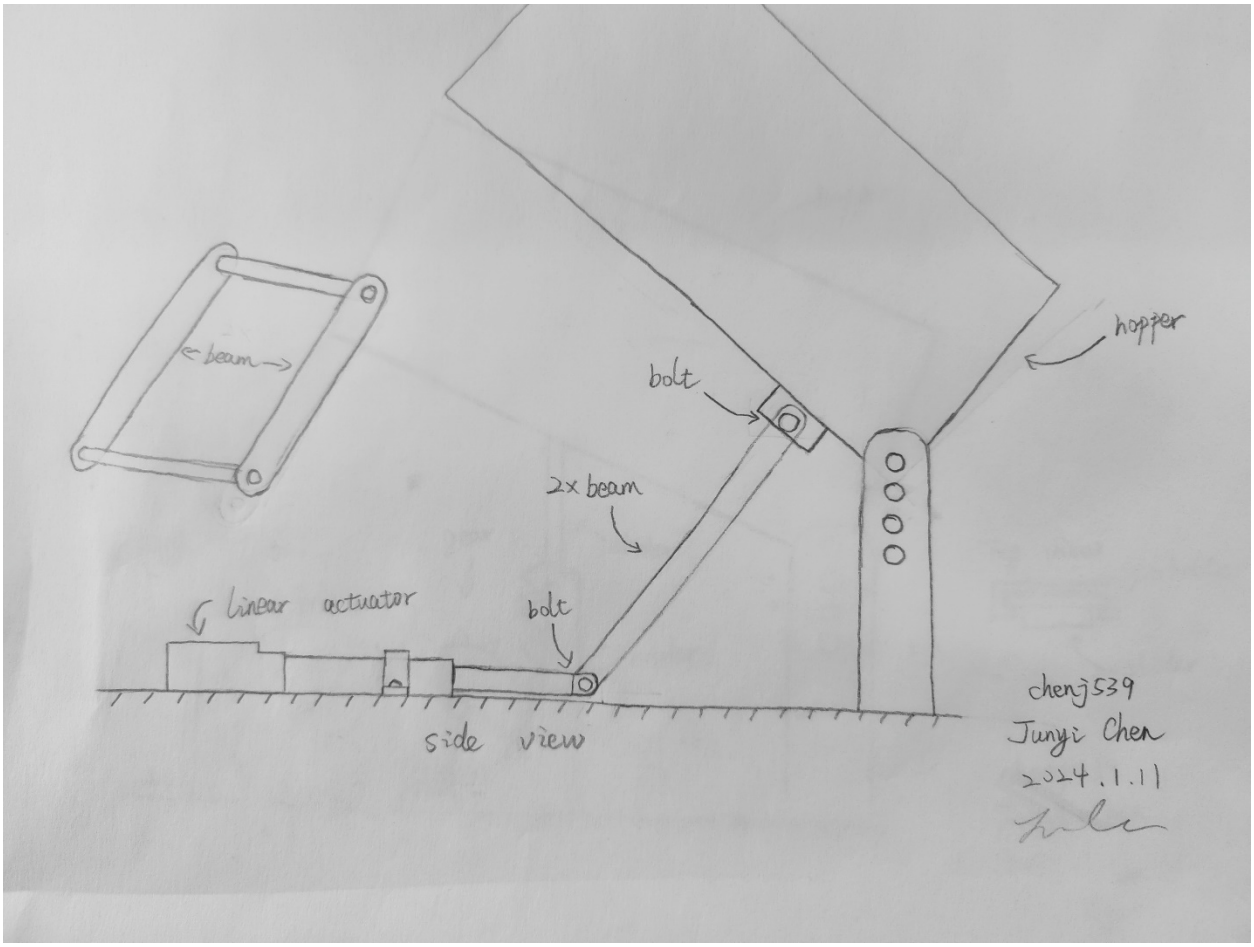
Insert picture of preliminary concept sketch below



Team ID: Thurs-18

Name:Junyi Chen	MacID: chenj539

Insert picture of preliminary concept sketch below



PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

Milestone 1 (Stage 1) – Initial Problem Statement, Objectives and Constraints

Team ID: Thurs-18

Complete this worksheet individually *before* coming to Design Studio.

Initial Problem Statement

1. Write the initial problem statement in the space below. This was discussed in your first lecture and is provided in the Avenue announcement.

Design a system for sorting and recycling containers

Objectives and Constraints

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 Module and previous lectures.

Objectives	- Sensors must be able to detect different types of materials. - Robot must drop of the containers at the right position. - The baseplate must fit the hopper. - Robot must stay in the designated area
Constraints	- Limited with the materials given for experiment. - Hopper hold a maximum of three containers. - Only able to detect three types of materials. - Position to place the actuator is restricted in a certain area.

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

MILESTONE 1 (STAGE 4) – MECHANISM CONCEPT SKETCHES (MODELLING SUB-TEAM)

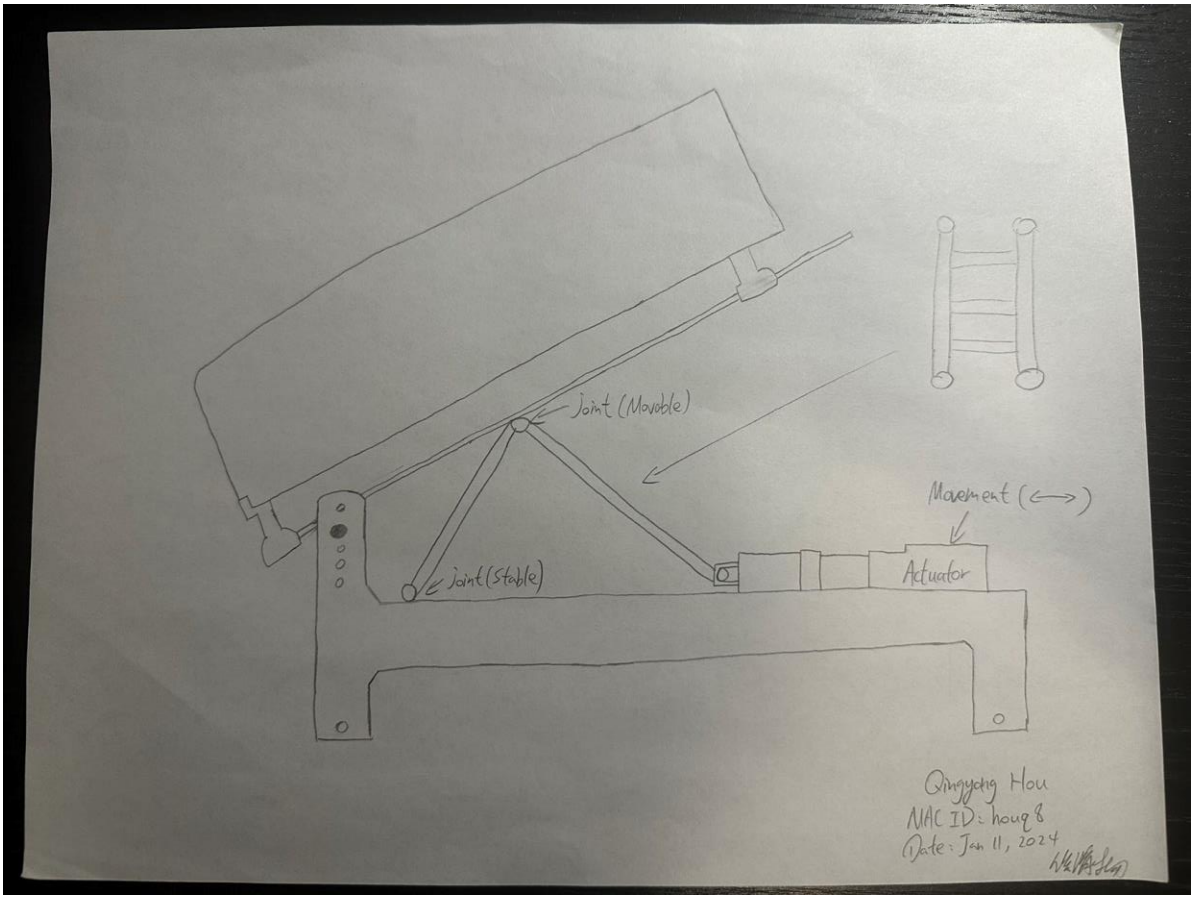
Team ID: Thurs-18

1. Each team member is required to complete **two (2)** preliminary concept sketches for the mechanism design. You should incorporate a different actuator for each sketch.
   → Each sketch should be on a separate piece of paper
   → Be sure to clearly write your Team ID, Name and MacID for each sketch
2. Take photos of your sketches
3. Insert your photos as a Picture on the following pages

Team ID: Thurs-18

Name: Qingyang Hou	MacID: houq8

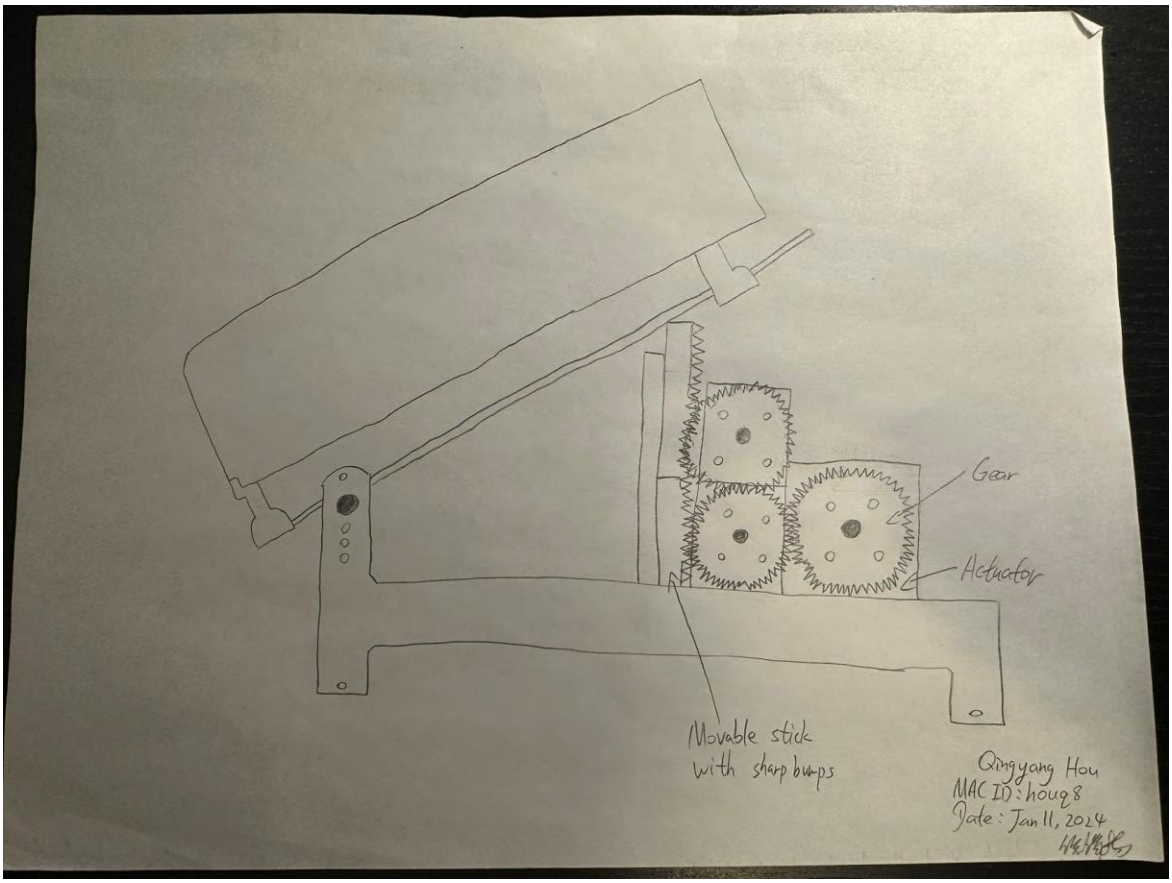
Insert picture of preliminary concept sketch below



Team ID: Thurs-18

Name: Qingyang Hou	MacID: houq8

Insert picture of preliminary concept sketch below



ENGINEER 1P13:
PROJECT THREE WORKSHEETS (INDIVIDUAL)

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PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

Milestone 1 (Stage 1) – Initial Problem Statement, Objectives and Constraints

Team ID: Thurs-18

Complete this worksheet individually *before* coming to Design Studio.

Initial Problem Statement

1. Write the initial problem statement in the space below. This was discussed in your first lecture and is provided in the Avenue announcement.

Design a system for sorting and recycling containers

Objectives and Constraints

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 Module and previous lectures.

Objectives	- Mechanism to deposit recyclable items into correct bins - High strength - Simple to assemble - Program should be executed with minimal errors and complexity should be avoided
Constraints	- Assembly of mechanism should be fully constrained to the base plate - Hopper must hold a maximum of three containers - Location of actuator is fixed

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

MILESTONE 1 (STAGE 3) – SENSOR EXPLORATION (COMPUTING SUB-TEAM)

Team ID: Thurs-18

Complete this worksheet individually *during* Design Studio.

1. Each team member is expected to complete the demo for at least four (4) of the five (5) sensors available for characterizing bins
   → **Refer to Table 3 in the Project Objective 3 section of the Project Module for a list of available sensors**
2. For each sensor:
   → Briefly describe how the sensor works
   → Indicate the attribute you would measure to characterize each bin
3. Complete your sensor research on the following page
   → Be sure to clearly write your Team ID, Name and MacID

Team ID: Thurs-18

Name: Manas Paudel	MacID: paudelm

Sensor Type	Description	Attribute(s)
Active Infrared (IR) Sensor	- Uses infrared radiation to detect the presence of movement of objects - Done by emitting infrared radiation and a receiver detecting the reflection of that emitted infrared radiation - Outputs high voltage readings	Location of bin
Color Sensor	- Detects and differentiates between colours - Done by using photodetectors, which are sensitive to a specific range of wavelength - Outputs converted RGB values	The specific colour of bin
LDR (Light Dependent Resistor)	- Measures the amount of light - Can be used to measure how close object is to bin, as if an object is close, it will block the light - Object must be very close to be detected - Outputs 1 for object very close to Q-bot	Bins proximity to Q bot (very close)
Hall Effect Sensor	- Detects if object is metallic or not - Outputs 1 if object is metallic	Determine if it is a bin or not

ENGINEER 1P13:
PROJECT THREE WORKSHEETS (INDIVIDUAL)

Table of Contents

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

Milestone 1 (Stage 1) – Initial Problem Statement, Objectives and Constraints

Team ID: Thurs-18

Complete this worksheet individually *before* coming to Design Studio.

Initial Problem Statement

1. Write the initial problem statement in the space below. This was discussed in your first lecture and is provided in the Avenue announcement.

Design a system for sorting and recycling containers based on the material.

Objectives and Constraints

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 Module and previous lectures.

Objectives	1. Determine whether or not containers are fit for recycling 2. Design a mechanism to put containers in recycling bin(Modelling) 3. Design code for transferring containers to a bin in the recycling station(computing) 4. Make sure designs are efficient and work correctly
Constraints	- Must follow pathway of track - Mechanism designed to connect to base plate and connecting plate - Must connect to the connecting plate of the hopper and rotate it about a chosen rung - Container should be reandomly dispensed and positioned in the sorting station for pick up - Program should be written for controlling movement of the Q-bot until it has returned to the sorting station

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

MILESTONE 1 (STAGE 3) – SENSOR EXPLORATION (COMPUTING SUB-TEAM)

Team ID: Thurs-18

Complete this worksheet individually *during* Design Studio.

1. Each team member is expected to complete the demo for at least four (4) of the five (5) sensors available for characterizing bins
   → **Refer to Table 3 in the Project Objective 3 section of the Project Module for a list of available sensors**
2. For each sensor:
   → Briefly describe how the sensor works
   → Indicate the attribute you would measure to characterize each bin
3. Complete your sensor research on the following page
   → Be sure to clearly write your Team ID, Name and MacID

Team ID: Thurs-18

Name: Noah Hsu	MacID:hsun1

Sensor Type	Description	Attribute(s)
Ultrasonic sensor	Similar to sonar uses high frequency sound waves to determine the distance between the sensor and what is in front of it by calculating the sound waves and the time it takes for them to bounce back towards the sensor	- Sound dependent - Unaffected by visual variables
LDR(Light dependent sensor)	Observes the absence or presence of light in a certain area/ measure light intensity	- Unaffected by sound variables - Visual dependent
Color sensor	Uses white LEDs which travel and hit a surface, some light is absorbed and some is reflected, The sensor detects the reflected light which then determines the colour of the surface	- Unaffected by sound variables - Visual dependent
Active Infrared sensor	Similar to ultrasonic fires waves at a surface and determines the return time to calculate the distance between the sensor and surface.	- Unaffected by sound variables - Unaffected by visual variables

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

Milestone 1 (Stage 1) – Initial Problem Statement, Objectives and Constraints

Team ID: Thurs-18

Complete this worksheet individually *before* coming to Design Studio.

Initial Problem Statement

1. Write the initial problem statement in the space below. This was discussed in your first lecture and is provided in the Avenue announcement.

Design a system for sorting and recycling containers

Objectives and Constraints

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 Module and previous lectures.

Objectives	• Maximize recyclables. • Identify different disposable container types. • Efficient and quick recycling. • Categorize items by disposable type.
Constraints	• Containers on the bot must weigh under 90g in total. • Hopper capacity is limited to three containers. • Identify contaminated items for recycling. • Connect to the baseplate at two points.

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

MILESTONE 1 (STAGE 4) – MECHANISM CONCEPT SKETCHES (MODELLING SUB-TEAM)

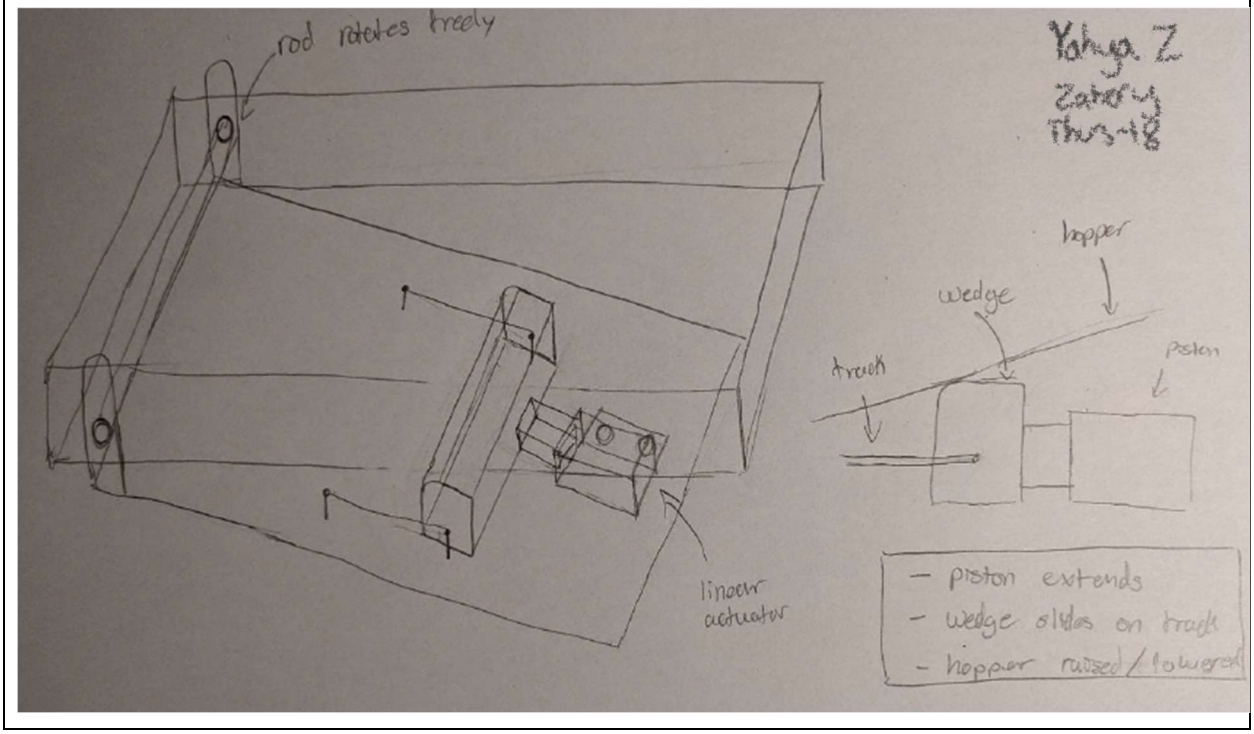
Team ID: Thurs-18

1. Each team member is required to complete **two (2)** preliminary concept sketches for the mechanism design. You should incorporate a different actuator for each sketch.
   → Each sketch should be on a separate piece of paper
   → Be sure to clearly write your Team ID, Name and MacID for each sketch
2. Take photos of your sketches
3. Insert your photos as a Picture on the following pages

Team ID: Thurs-18

Name: Yahya Zaher	MacID: zahery

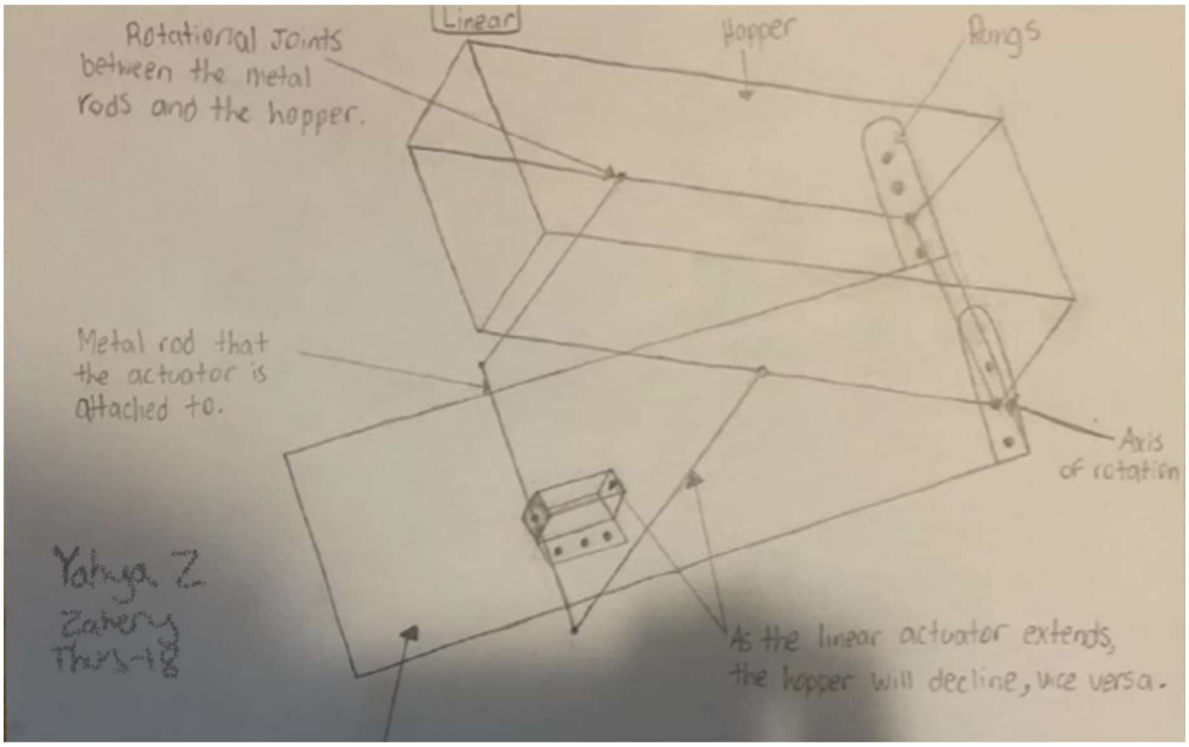
Insert picture of preliminary concept sketch below



Team ID: Thurs-18

	MacID: zahery

Insert picture of preliminary concept sketch below



ENGINEER 1P13:
PROJECT THREE WORKSHEETS (TEAM)

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PROJECT THREE: MILESTONE ZERO (TEAM): TEAM DEVELOPMENT AND PROJECT PLANNING

Milestone 0 – Cover Page

Team ID: Thurs-18

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

Full Name:	MacID:
Manas Paudel	paudelm
Junyi Chen	chenj539
Yahya Zaher	zahery
Noah Hsu	hsun1
Qingyang Hou	houq8

Insert your Team Portrait in the dialog box below

Milestone 0 – Team Charter

Team ID: Thurs-18

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Manas Paudel	☒M ☐A ☒C ☐S
2.	Junyi Chen	☒M ☐A ☐C ☒S
3.	Yahya Zaher	☒M ☒A ☐C ☐S
4.	Noah Hsu	☐M ☒A ☒C ☐S
5.	Qingyang Hou	☒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	Noah Hsu	hsun1
Administrator 1	Manas Paudel	paudelm
Administrator 2	Junyi Chen	chenj539
Coordinator	Yahya Zaher	zahery

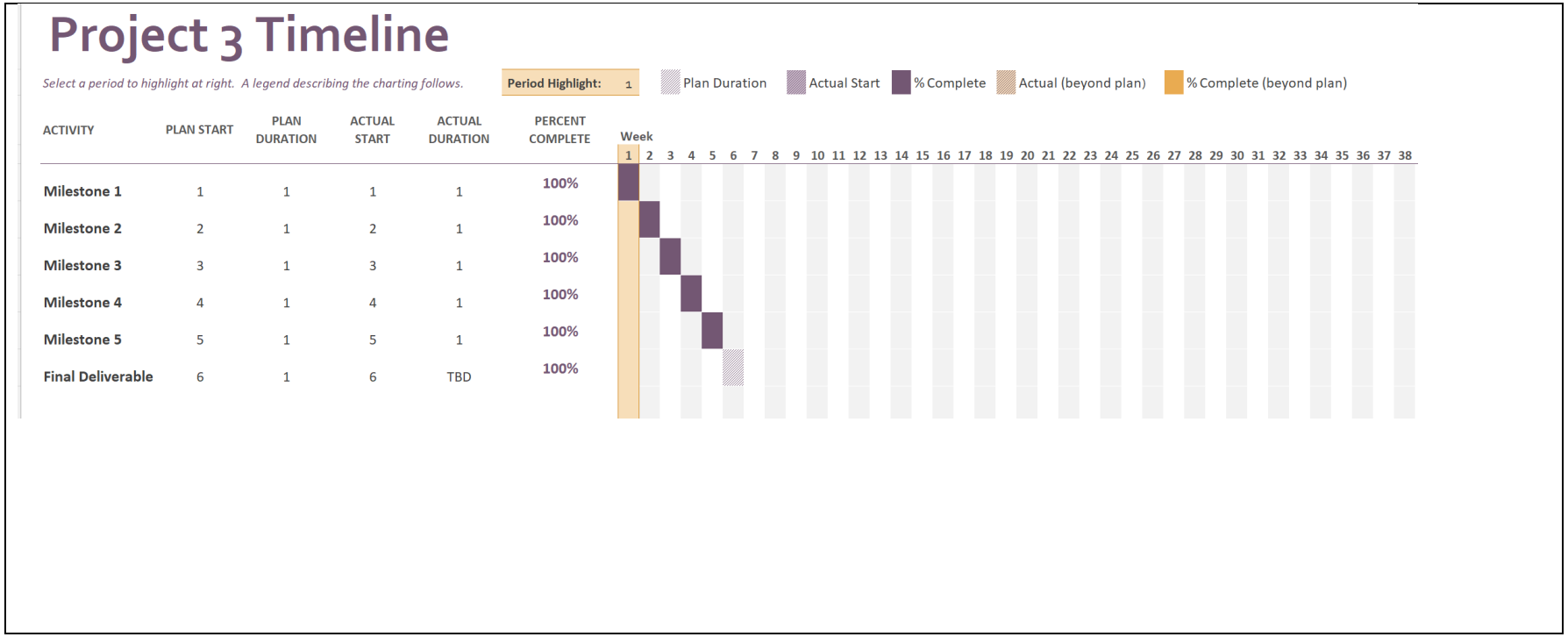
Coordinator	Qingyang Hou	houq8

Milestone 0 – Preliminary Gantt Chart (Team Manager Only)

Team ID: Thurs-18

Full Name of Team Manager:	MacID:
Noah Hsu	hsun1

Preliminary Gantt chart



PROJECT THREE: MILESTONE ONE (TEAM): PROBLEM FRAMING AND CONCEPTUAL DESIGN

Milestone 1 – Cover Page

Team ID: Thurs-18

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

Full Name:	MacID:
Yahya Zaher	zahery
Qingyang Hou	houq8
Junyi Chen	chenj539
Noah Hsu	hsun1
Manas Paudel	paudelm

Milestone 1 (Stage 1) – Initial Problem Statement, Objectives and Constraints

Team ID: Thurs-18

You should have already completed these tasks individually *prior* to Design Studio 13.

Initial Problem Statements

Copy and paste the initial problem statement(s) below.

Design a system for sorting and recycling containers

Objectives and Constraints

Copy and paste each team member's Objectives and Constraints tables here or combine the objectives and constraints into the single table below.

Objectives	-Maximize Recyclables - Distinguish between different types of disposable containers Adjustable rotation angle. High strength, minimum energy lost, simple to assemble. Program should be executed quickly, and complexity should be avoided
Constraints	- Prohibited use of external prebuilt parts – Assembly of mechanism should be fully constrained to the base plate - Position to place the actuator is restricted in a certain area. - The orientation for actuators is fixed. - Hopper must hold a maximum of three containers -

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 work with the **Milestone 1 Individual Worksheet** document so that it can be ***graded***
- Compiling your individual work into this **Milestone 1 Team Worksheet** document allows you to readily access your team member's work
    - This will be especially helpful when completing ***Stage 2*** of the milestone

Milestone 1 (Stage 2) – Refined Problem Statement

Team ID: Thurs-18

Refined Problem Statement

1. As a team, write the refined problem statement below. Kindly refer to the Refined Problem Statement rubric in the P3 Project Module. This will guide your group in creating a valid statement.

Recycling institutions require a computer program to sort various recyclable objects, and a mechanism to deposit those recyclable objects into their designated bins.

PROJECT THREE: MILESTONE TWO (TEAM): PRELIMINARY DESIGN

Milestone 2 – Cover Page

Team ID: Thurs-18

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

Full Name:	MacID:
Yahya Zaher	zahery
Junyi Chen	chenj539
Noah Hsu	hsun1
Qingyang Hou	houq8
Manas Paudel	paudelm

Milestone 2 (Stage 1) – Sensor Selection and Computer Program Workflow (Computation Sub-Team)

Team ID: Thurs-18

1. As a sub-team, discuss the results of your individual sensor demo activity and select the sensor(s) that you will use in your project. Identify the sensor(s) in the box below and include any decision-making tools or justification in the space provided.
   Teams are allowed to use a maximum of 2 sensors

   Chosen sensors: Color and ultrasonic

Justify: Color sensor is being used due to the colours for the bins while ultrasonic will be used to determine distance from containers to determine how close it should move

2. As a sub-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 under the appropriate task

Dispense Container

1. Dispenses a container based on sets of attributes
2.container will be randomly dispensed
3. atrributes will be selected from existing attributes

Load Container

1.Qarm will move based on conditons

- if there are fewer than 3 containers on the Q bot
- if new container can be placed where existing containers are going to be placed as well
- if the mass of the container would exceed 90g

Transfer Container

1. Q bot will move along the yellow line
2.Based on attributes of bins will determine if it stops or not
- Will be done with sensors

Deposit Container

1.Q bot will use color sensor to determine the bin it's looking for
2. Bot will then move closer to bin
3. deposit container then
4. return to yellow line to move to next bin

Return Home

1. Q-bot will keep moving forward from where it currently is positioned
2. Based on how much distance it has already travelled will determine how much further it needs to travel

Milestone 2 (Stage 2) – Detailed Sketches of Mechanism Assembly (Modelling Sub-Team)

Team ID: Thurs-18

1. As a sub-team, review your concept mechanism concept sketches, and use a decision-making tool of your choice to decide which mechanism design to pursue. Examples of decision-making tools include simple or weighted decision matrices (Slide 22 of the P1 Milestone 3A Slides). Show evidence of your decision-making below, and clearly identify which mechanism design your sub-team has chosen.

Name:	MacID

Show your decision-making process below, and clearly identify which mechanism concept your team will pursue.

	Linear (Chen)	*Rotary (Chen)*	*Linear (Hou)*	*Rotary (Hou)*	*Linear (Zaher)*	*Linear (Zaher)*
cost	*3*	*3*	*4*	*3*	*3*	*2*
Range of motion	*1*	*5*	*2*	*3*	*3*	*3*
stiffness	*2*	*3*	*2*	*4*	*2*	*4*
Adjustability	*2*	*5*	*4*	*4*	*4*	*2*
simplicity	*4*	*4*	*4*	*3*	*3*	*2*
Total	*12*	*20*	*16*	*17*	*15*	*13*

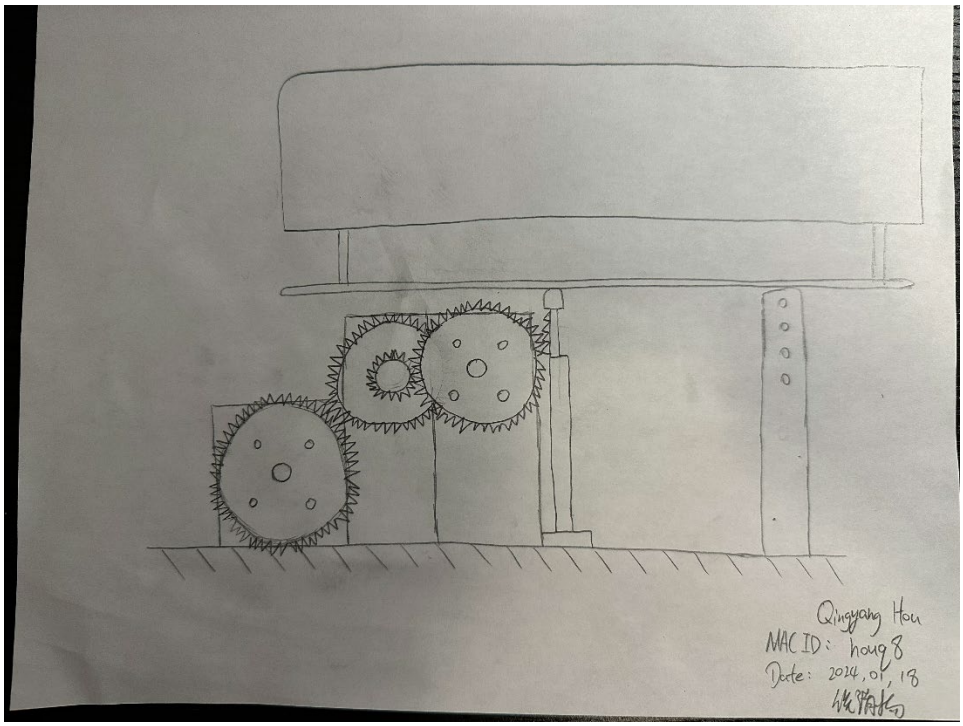
Team ID: Thurs-18

2. As a sub-team, select a design for your mechanism, then use that one (1) design for the detailed sketches.
   - → Each sub-team member is responsible for one (1) detailed sketch of the same design, either in the transfer position or the deposit position
   - → For sub-teams with 3 members, the work of 2 sketches should be split evenly between members. For example, 2 members could complete the sketches while the other member adds labels, descriptors, and constraints to both sketches.
   - → Complete your sketches on a separate sheet of paper
     i. Be sure to indicate each team member's Name and MacID
   - → Take a photo of your sketch
   - → Insert your photo as a Picture in the space below

Team ID: Thurs-18

Name: Qingyang Hou	MacID:houq8

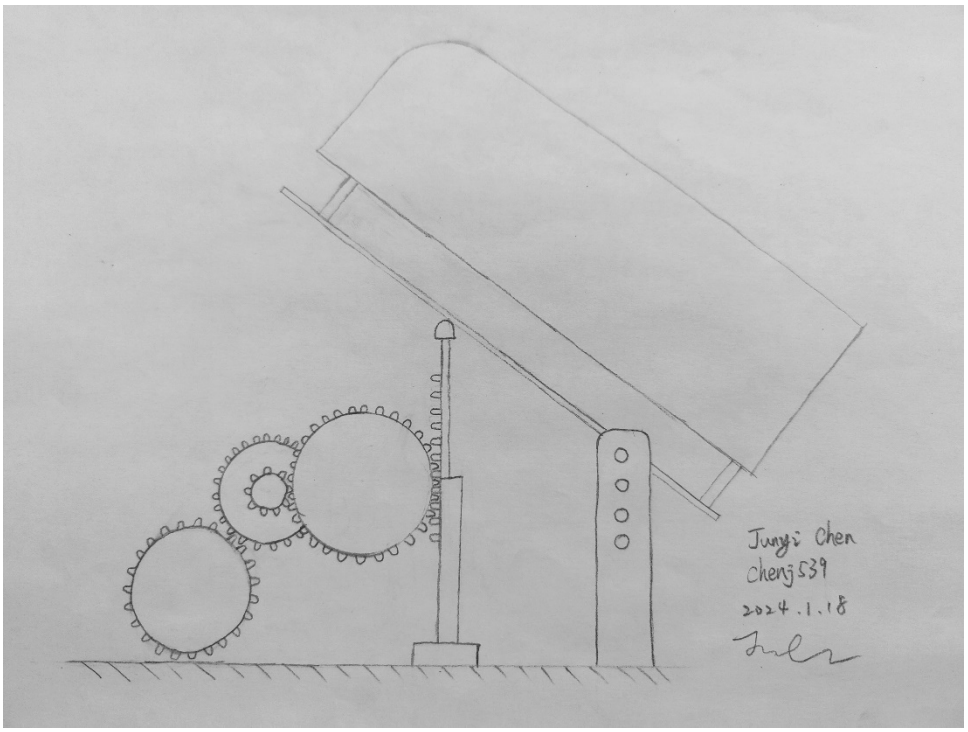
*Insert picture of the **transfer** detailed sketch below*



Team ID: Thurs-18

Name: Junyi Chen	MacID: chenj539

*Insert picture of the **deposit** detailed sketch below*



Milestone 2 (Stage 5) – Informal TA check-in (Modelling Sub-Team)

Team ID: Thurs-18

☐ Sketches include ONE actuator (linear or rotary) that is the input of the mechanism

☐ Sketches in both deposit and transfer position are drawn.

- Components are identified and labelled
- Any relationships and constraints (such as assembly constraints and motion constraints) are highlighted.
- Component that will serve as the grounded part of the assembly once conducted is identified. 0

Output of the mechanism allows for rotation of the connecting plate/hopper. Rotation angle is sufficient to allow for container deposit.

☐ The mechanism attaches to both the baseplate and the connecting plate (below the hopper)

☐ Mass of all components is considered

- The design should intentionally minimize materials

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

First design (With gear):

- Where does the slider go at the bottom
- Not a lot of range of motion
- Adding more gears means adding more torque, where to fit the gears?
- Rotary actuator doesn't have a lot of power
- Able to get the gear higher

Second design (With beam):

- Don't have a starting motor
- The motion is going to be random

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

Adding more gears to adjust the torque.

Reduce the friction between the slider and holder.

Figure out the dimension and ratio of the gears.

Lift the gears higher to have more movement range.

Milestone 2 (Stage 5) – Informal TA check-in (Computing Sub-Team)

Team ID: Thurs-18

☒ A sensor(s) has been selected. Discuss reasons as to why the group chose said sensor(s).

☒ The following tasks have been planned either in pseudocode or flowchart format:

→ Dispense container
→ Load container
→ Transfer container
→ Deposit container
→ Return home

☒ The following tasks are planned in pseudocode or flowchart format as their own functions:

→ Load container
→ Transfer container
→ Deposit container

☒ Do the tasks cover the following:

- Container attributes are determined
- Containers are positioned in the sorting station
- Q-arm loads the containers until one of the following conditions are met:
    - A container with a different ID is placed in the sorting station
    - The total mass of the bottle placed in the sorting station and the bottles loaded on the Q-bot is greater than 90 grams
    - 3 bottles have been placed on the Q-Bot
- Q-bot transfers the containers to the correct recycling bin
- Q-bot deposits the containers into the bin
    - If needed, Q-bot turns 90 degrees to face the required bin, and then locomotes to bin
- Q-bot returns home
- Cycle repeats

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

- Return home function changed to be based on Q-bots current position and returning to home position while following the line via line following sensors

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

- Return home function will be changed to incorporate bot positioning

PROJECT THREE: MILESTONE THREE (TEAM): WORK PERIOD / INFORMAL TA CHECK-IN

Milestone 3 – Cover Page

Team ID: Thurs-18

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

Full Name:	MacID:
Yahya Zaher	zahery
Manas Paudel	paudelm
Qingyang Hou	houq8
Noah Hsu	hsun1
Junyi Chen	chenj539

Milestone 3 (Stage 3) – Informal TA check-in (Modelling Sub-Team)

Team ID: ☐

☒ Assembly includes one actuator (linear or rotary) that is the input of the mechanism

☒ Output of the mechanism allows for rotation of the connecting plate/hopper. Rotation angle is sufficient to allow for container deposit.

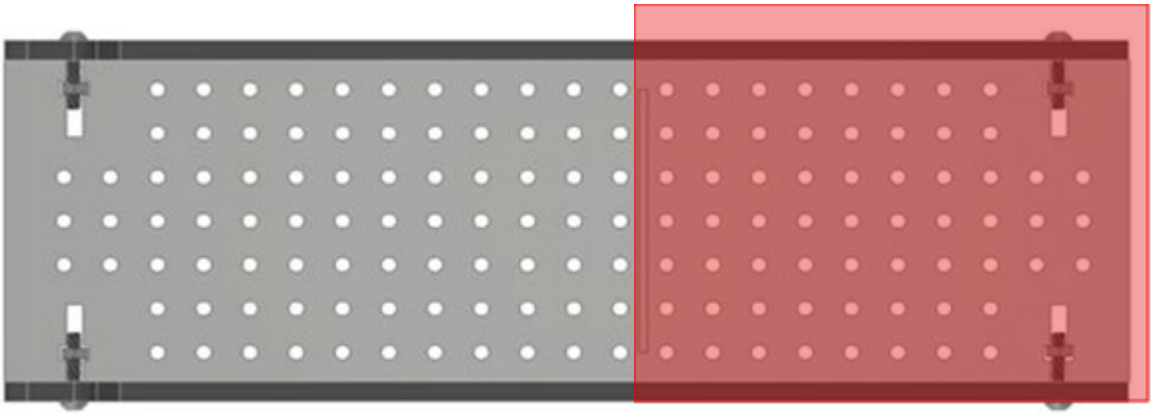
☐ Assembly is complete and constrained properly

→ No interference between parts, clean assembly model, no errors, one part grounded

→ Proper assembly constraints (define position of components in assembly)

→ Proper motion constraints (define motion ratios between assembly components)

☒ The mechanism attaches to both the baseplate and the connecting plate (below the hopper)



☒ All *holes* on the chosen actuator housing are *attached* WITHIN the highlighted region (see figure above)

☒ Mass of all components is considered

- The design should intentionally minimize materials

☒ Total print time of ALL 3D printed components does not exceed 2 hours

- Discuss a prototyping plan. Is it within the time constraint to re-print or redesign if needed?
- Discuss if components need any support for 3D printing (i.e., for any overhanging features). If so, TAs will assist the sub-team in adding supports
- Discuss/suggest potential for laser-cutting (flat components in particular)

☒ ALL features of 3D printed parts are feasible for printing

- Features and spaces are suggested to be 2mm or greater (Features between 2mm and 4mm are appropriately sized and will not compromise the printed design)

☒ Consideration of additional materials

- Students have considered and sourced any additional materials as necessary (i.e. fasteners)

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

- Make the gears movable, when moving one gear the rest of the system should also move.
- Missing the constraints.

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

- Add constraints.

Milestone 3 (Stage 3) – Informal TA check-in (Computing Sub-Team)

Team ID: Thurs-18

☒ All 5 program tasks are accounted for (dispense container, load container, transfer container, deposit container, return home)
☒ One cycle (for ONE container of the sub-team's choice) sufficiently executes based on requirements outlined in project module

- The general flow: home → dispense → load → transfer → deposit → home

☒ The following tasks are written as their own functions:

- Load container
- Transfer container
- Deposit container

☒ The return home task executes properly by following the yellow line *around the loop* and back to the sorting station
☒ No errors in program
☒ Commenting their code (i.e., headers explaining purpose of functions & any other appropriate comments where needed)

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

- Minor Issues with code.
- Code is cluttered.
- Can't run a full cycle consistently, Qbot often glitches out
- Can't run a full cycle with 3 containers (can only run 1 cycle).
- Qbot fails to stay on the yellow line.
- Redundant if statements that can be nested.

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

- Add comments to code to make it neater.
- Ensure Qbot remains on the yellow line.
- Redundant debugging code and redundant if statements should be removed.

PROJECT THREE: MILESTONE FOUR (TEAM): WORK PERIOD / INFORMAL TA CHECK-IN

Milestone 4 – Cover Page

Team ID: Thurs-18

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

Full Name:	MacID:
Junyi Chen	chenj539
Qingyang Hou	houq8
Yahya Zaher	zahery

Milestone 4 – Informal TA check-in (Modelling Sub-Team)

Team ID: Thurs-18

☐ Design Meets Design Objectives

→ Facilitates container depositing (visual inspection that the hopper rotates enough for container depositing)

☐ Physical model is complete and works as intended

→ All components are ready for assembly or assembled

☐ Mass of all components is considered

→ The design should intentionally minimize materials

☐ ALL features are reasonably sized

→ No components contain small features that are likely to break

☐ Consideration of additional materials

→ Students have considered and/or sourced additional materials as necessary (ie. fasteners)

☐ APPROVED FOR PHYSICAL ENVIRONMENT

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

→ Mentor provided positive feedback on the design.
→ Specifically mentioned that "everything looks good" and praised the overall design.
→ Mentor expressed concerns about the design's ability to lift the hooper.
→ Specifically mentioned worries regarding insufficient torque.

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

- Conduct thorough torque analysis to optimize the lifting mechanism.
- Fine-tune gear ratios, optimize mechanical layout for maximum torque delivery.

Milestone 4 – Informal TA check-in (Computing Sub-Team)

Team ID: Thurs-18

☐ More than one cycle of pick-up/transfer/drop-off sufficiently executes

→ At least two different containers are correctly deposited

→ The general flow should be Home → Dispense Container → Q-Arm Loads Container onto Q-Bot → Transfer Container to Proper Bin → Deposit Container → Home

→ Q-Bot should determine bin using line-following and using measured sensor values.

→ If the bins are setup so that they are far away from the yellow loop, the Q-Bot should move as specified on page 16 and 17 of the project module.

☐ All required program tasks are written as their own section of code (Dispense Container, Return Home) or function (Load Containers, Transfer Containers, Deposit Containers)

☐ No errors in program

☐ Code well commented

☐ APPROVED FOR PHYSICAL ENVIRONMENT

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

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