Design Project 3 – System for Sorting and Recycling Containers

Revenge of the Recycling System

ENGINEER 1P13 – Integrated Cornerstone Design Projects in Engineering

T03

Mon-42

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Submitted: March 4, 2024

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

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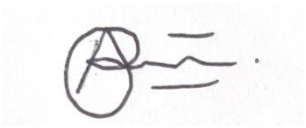
Academic Integrity Statement

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.

Amnah Syeda 400522311



_____
(Student Signature)

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Andrew Dalgleish 400440597

_____
(Student Signature)

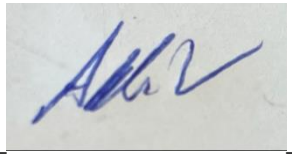
The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Vanesa Cabrera 400526393

(Student Signature)

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.

Athithan Vimalananthan 400507574



_____

(Student Signature)

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.

Talha Ahmad 400517273

(Student Signature) _____

Executive Summary

Recycling is an important aspect of sustainability and keeping our world clean. With the growing issue of plastic waste, it is obvious that many people do not know to properly recycle. In fact, about 30% of items placed in recycling are not recyclable [1]. This begs the question; how can we improve recycling systems to reduce contamination. To combat this issue, our team designed a system that identifies, classifies, and organizes recyclable waste to reduce the number of unrecyclable items being placed into improper bins. The aim of this software-based and physical system was to identify bins based on physical properties such as mass and colour and transport these bins into their respective containers to improve our recycling dilemma.

A mechanism was designed to transfer recyclable materials into correct recycling bins in an efficient manner. The mechanism needed to be strong, reliable, and efficient to fabricate. The design that was chosen involves a rotary actuator turning a series of two vertical gears which activated a rod and linkage system to push the hopper upwards. A limitation was keeping all moving parts in place which led to two support columns and an axle being designed to hold the larger gear in place.

To test the design, AutoCAD Inventor was used to create 3D models of each part, assemble the parts together, and replicate the motion expected by the design. This led to further refinement of measurements and design to account for possible interferences. Fabrication was done using 3D-printing technology through the Prusa Slicer software. The final prototype had problems with loose-fitting pieces, particularly between the larger gear and the axle, which led to an unreliable product.

The simulation code was split into 5 areas: dispensing waste, loading waste onto a QBot with a QArm, moving the QBot to the proper bin, depositing, and returning to the home position. The bin for each cycle is found when the waste is dispensed. After, the QBot follows a line around the track until the target bin’s colour is detected with a colour sensor and the bin is within a certain preassigned range sensed by an ultrasonic sensor. The disposing stage of the code uses a rotary actuator, in line with what the modelling team uses for their physical model, and for returning home. The bot continues running along the track until it arrives within a range of the home position calculated before the bot starts moving in its first cycle.

The hardware code was written to ensure the reliable transportation of waste containers into their appropriate bins. The transfer, deposit, and return home functions are utilized from the simulation code to seamlessly integrate into the real-life environment. To increase the efficiency of finding the bins and the line, various sensors were used. The colour sensor would locate the bins based on RGB values, the ultrasonic sensor would determine distance, and the line-following sensor successfully followed the line.

By incorporating sensors and integrating the simulation into the physical world, the code was able to complete successful cycles of sorting the waste.

Reference List

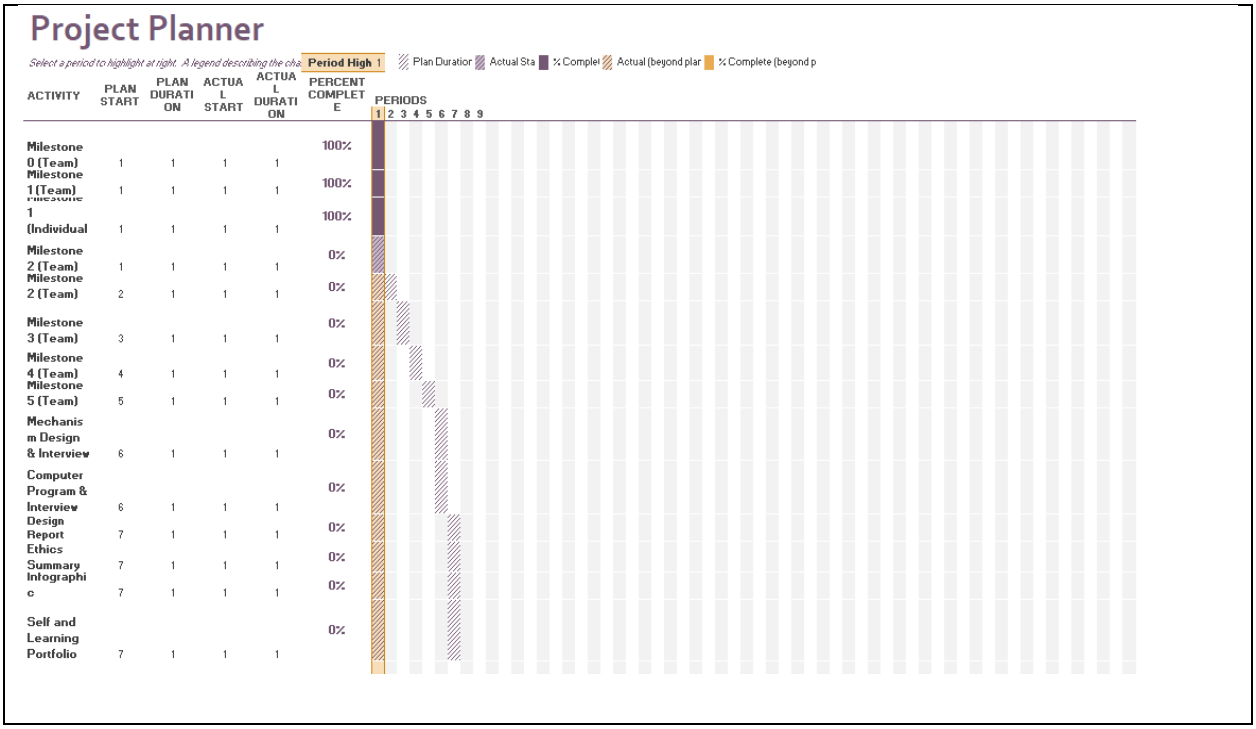
IEEE Bibliography

[1] “P3- Project Module”, class notes for 1P13, Engineering, McMaster University, Term 2, 2024.

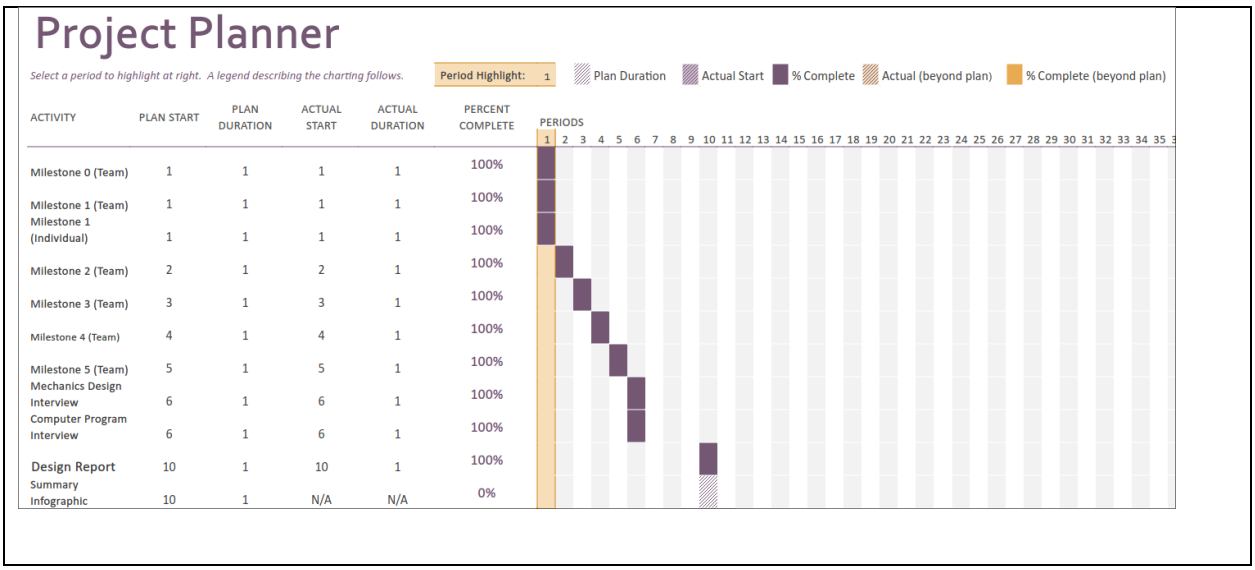
Appendices

Appendix A: Project Schedule

Preliminary Gantt Chart:



Finalized Gantt Chart:



Additional Meetings Logs:

ENGINEER 1P13

MEETING WITH MON-42- Monday, JAN. 15, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Amnah Syeda	syedaa13	No
Administrator	Talha Ahmad	ahmadt20	No
Coordinator	Andrew Dalgleish	dalgleia	Yes
Administrator 2	Vanesa Cabrera	cabrerv	Yes
Coordinator 2	Athithan Vimalananthan	vimala3	Yes

AGENDA ITEMS

- Discussion on how to 3D model design
- Delegation of parts to create
- Work on given tasks for rest of allotted time

MEETING MINUTES

- Discussion on how to 3D model design
  - Based on the initial sketch, it was decided to separate the design into a top piece,small rods, gears, support columns and an axle
- Delegation of parts to create
  - Vanessa put in charge of the top piece
  - Andrew put in charge of the gears and the later assembly
  - Athithan put in charge of the axle, support columns and small rods
- Work on given tasks
  - Axle finished, rest of pieces to be finished outside of meeting

POST-MEETING ACTION ITEMS

- *Work on given parts and send to Andrew [Everyone]*

- *Take parts and complete assembly [Andrew]*

ENGINEER 1P13

MEETING WITH MON-42- Monday, JAN. 15, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Amnah Syeda	syedaa13	Yes
Administrator	Talha Ahmad	ahmadt20	Yes
Coordinator	Andrew Dalgleish	dalgleia	No
Administrator 2	Vanesa Cabrera	cabrerv	No
Coordinator 2	Athithan Vimalananthan	vimala3	No

AGENDA ITEMS

- Create Psuedocode/flowcharts for individual functions
- Set general workflow
- .Distribute functions

MEETING MINUTES

- .Create Psuedocode/flowcharts for functions
  - Both finished by the end of meeting for each person
- .Set general workflow
  - General workflow confirmed for the milestone
- .Distribute functions
  - Dispense, Load, and Transfer functions will be done by Amnah
  - Return home, deposit functions will be done by Talha

POST-MEETING ACTION ITEMS

- *Work on assigned code [everyone]*

ENGINEER 1P13

MEETING WITH MON-42- Monday, JAN.22, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**No**
Administrator	**Talha Ahmad**	**ahmadt20**	**No**
Coordinator	**Andrew Dalgleish**	**dalgleia**	**Yes**
Administrator 2	**Vanesa Cabrera**	**cabrerv**	**Yes**
Coordinator 2	**Athithan Vimalananthan**	**vimala3**	**Yes**

AGENDA ITEMS

- Refine our components in Inventor
- Continue work on unfinished models
- Finish Assembly

MEETING MINUTES

- Refine our components in Inventor
  - Re-envisioned the axle to account for interference
  - Decided by the group to change one section of the rods in to one large rod
- Continue work on unfinished models
  - All parts effectively finished by the end of this meeting
- Finish Assembly
  - Assembly is done but not fully constrained

POST-MEETING ACTION ITEMS

- *Constrain assembly [Andrew]*
- *Find time to print [Vanessa]*
- *Get additional parts [everyone]*

ENGINEER 1P13

MEETING WITH MON-42- Monday, JAN.22, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Amnah Syeda	syedaa13	Yes
Administrator	Talha Ahmad	ahmadt20	Yes
Coordinator	Andrew Dalgleish	dalgleia	No
Administrator 2	Vanesa Cabrera	cabrerv	No
Coordinator 2	Athithan Vimalananthan	vimala3	No

AGENDA ITEMS

- Edited code.
- Come up with a plan to optimize movement of Q-bot

MEETING MINUTES

- . Edited code
  - During testing, it was found that the q-bot does not properly deliver bottles to their correct destination
  - Editing was done to fix this problem
- .Optimized movement of Q-bot
  - Instead of using bot.position(), use bot.depth and rotating to optimize program further

POST-MEETING ACTION ITEMS

- *Finish editing code [everyone]*

ENGINEER 1P13

MEETING WITH MON-42- Monday, FEB. 5, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Amnah Syeda	syedaa13	No
Administrator	Talha Ahmad	ahmadt20	No
Coordinator	Andrew Dalgleish	dalgleia	Yes
Administrator 2	Vanesa Cabrera	cabrerv	Yes
Coordinator 2	Athithan Vimalananthan	vimala3	Yes

AGENDA ITEMS

- Fabricate parts
- Test part-fitting

MEETING MINUTES

- Fabricate parts
  - Tried doing so before design studio, unfortunately it was not available
  - Instead, we came early and started fabrication there
- .Test part-fitting
  - N/A

POST-MEETING ACTION ITEMS

- *Check part-fitting [Andrew]*

ENGINEER 1P13

MEETING WITH MON-42-Monday, FEB.5, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)

Manager	**Amnah Syeda**	**syedaa13**	**No**
Administrator	**Talha Ahmad**	**ahmadt20**	**No**
Coordinator	**Andrew Dalgleish**	**dalgleia**	**No**
Administrator 2	**Vanesa Cabrera**	**cabrerv**	**Yes**
Coordinator 2	**Athithan Vimalananthan**	**vimala3**	**Yes**

AGENDA ITEMS

- Debug Code
- Organize/Comment Code

MEETING MINUTES

- Debug Code
  - All issues dealt with at the end of meeting.
- Organize/Comment Code
  - All code has been organized based on the workflow planned in previous milestones

POST-MEETING ACTION ITEMS

- *Begin working on Hardware Code [everyone]*

ENGINEER 1P13

MEETING WITH MON-42-Monday, FEB.13, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**No**
Administrator	**Talha Ahmad**	**ahmadt20**	**No**
Coordinator	**Andrew Dalgleish**	**dalgleia**	**No**

Administrator 2	**Vanesa Cabrera**	**cabrerv**	**Yes**
Coordinator 2	**Athithan Vimalananthan**	**vimala3**	**Yes**

AGENDA ITEMS

- Finish Hardware Code

MEETING MINUTES

- Finish Hardware Code
  - Based on the previously made simulation code, a hardware code was creating taking into account the lack of environment-based functions and the workflow being more simple than the simulation

POST-MEETING ACTION ITEMS

- Begin final report for Project [everyone]

ENGINEER 1P13

MEETING WITH MON-42- Tuesday, FEB.27, 2024

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**Yes**
Administrator	**Talha Ahmad**	**ahmadt20**	**Yes**
Coordinator	**Andrew Dalgleish**	**dalgleia**	**Yes**
Administrator 2	**Vanesa Cabrera**	**cabrerv**	**Yes**
Coordinator 2	**Athithan Vimalananthan**	**vimala3**	**Yes**

AGENDA ITEMS

- Discuss plan of action for final report

Meeting Minutes

- Discuss plan of action
  - Decided to divide executive summary into five equal paragraphs, each member working on one paragraph
  - All individual administrative roles are to be carried out by each person, unless notice is given for special circumstances

Post-Meeting Action Items

- *Finish Executive Summary [everyone]*
- *Finish Administrative Role sections [everyone]*
- *Submit final report [Andrew]*

ENGINEER 1P13

MEETING WITH MON-42- Monday, March 4th, 2024

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**Yes**
Administrator	**Talha Ahmad**	**ahmadt20**	**Yes**
Coordinator	**Andrew Dalgleish**	**dalgleia**	**Yes**
Administrator 2	**Vanesa Cabrera**	**cabrerv**	**Yes**
Coordinator 2	**Athithan Vimalananthan**	**vimala3**	**Yes**

Agenda Items

- Check to see hopper is available to get photos for portfolio and final report
- Work on final report for remaining time

MEETING MINUTES

- Check to see if hopper is available
  - Unavailable
  - Opted to instead take photos of the mechanism without the hopper
- Work on final report
  - Edited executive summary (>500 words beforehand)
  - Worked on additional meeting logs

POST-MEETING ACTION ITEMS

- *Finish decreasing word count on Executive Summary [Vanessa]*
- *Finish additional meeting logs [Athithan]*
- *Submit Final Report [Andrew]*

Appendix B: Scheduled Weekly Meetings

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**YES**
Administrator	**Andrew Dalgleish**	**dalgleia**	**YES**
Administrator	**Talha Ahmad**	**ahmadt20**	**YES**
Coordinator	**Vanesa Cabrera**	**cabrerv**	**YES**
Coordinator	**Athithan Vimalananthan**	**vimala3**	**YES**

AGENDA ITEMS

1. Confirm modelling design → if design will work
2. Computing team concerns
3. .
4. .
5. .

MEETING MINUTES

1. CAD team concerns
    a. Rotary actuator can continuously turn
    b. Gear can be put on motor itself
    c. Concerns about fixating components (bevel gear to arm)
    d. Do not need bevel gear (can attach arm to the gear/actuator itself)
        i. Need enough teeth for loading to deposit position
    e. Stuck in loading position / concerns with linkages
    f. When making mechanism, try and minimize mass
2. Computing team concerns
    a. Sensors: can assume where the bin is
    b. Load should be separate functions

POST-MEETING ACTION ITEMS

1. *Adapt design model to fit concerns*

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**YES**
Administrator	**Andrew Dalgleish**	**dalgleia**	**YES**
Administrator	**Talha Ahmad**	**ahmadt20**	**YES**
Coordinator	**Vanesa Cabrera**	**cabrerv**	**YES**
Coordinator	**Athithan Vimalananthan**	**vimala3**	**YES**

Agenda Items

6. CAD: how ductile/strong the 3D printed material
7. Computing: Quanser uncertainties
8. Integrating the team
9. .

Meeting Minutes

3. CAD team concerns
    a. Add resting part for base
4. Computing team concerns
    a. Sensors: can assume where the bin is
    b. Load should be separate functions
    c. TA feedback: lower graphics settings
        i. As long as final code they can see that you tried your best
        ii. Use the same actuator as subteam

Post-Meeting Action Items

4. *Adapt design model to fit concerns*

Attendance

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Amnah Syeda**	**syedaa13**	**YES**
Administrator	**Andrew Dalgleish**	**dalgleia**	**YES**
Administrator	**Talha Ahmad**	**ahmadt20**	**YES**
Coordinator	**Vanesa Cabrera**	**cabrerv**	**YES**
Coordinator	**Athithan Vimalananthan**	**vimala3**	**YES**

Agenda Items

1. CAD team ready to print → get approval
2. Laser print gears
3. Rotary actuator

Meeting Minutes

5. CAD team concerns
    a. Hammer should not be an issue but we should try gluing
        i. Make washer larger and glue it on
    b. Download 3D printing software
6. Computing team concerns
    a. Sensors: can assume where the bin is
    b. Load should be separate functions
    c. TA feedback: lower graphics settings
        i. As long as final code they can see that you tried your best
        ii. Use the same actuator as subteam

Post-Meeting Action Items

7. *Adapt design model to fit concerns*

Appendix C: Comprehensive List of Sources

[1] “P3- Project Module”, class notes for 1P13, Engineering, McMaster University, Term 2, 2024.

[2] ‘How-to-Guide Gantt Chart”, class notes for 1P13, Engineering, McMaster University, Fall Term, 2023.

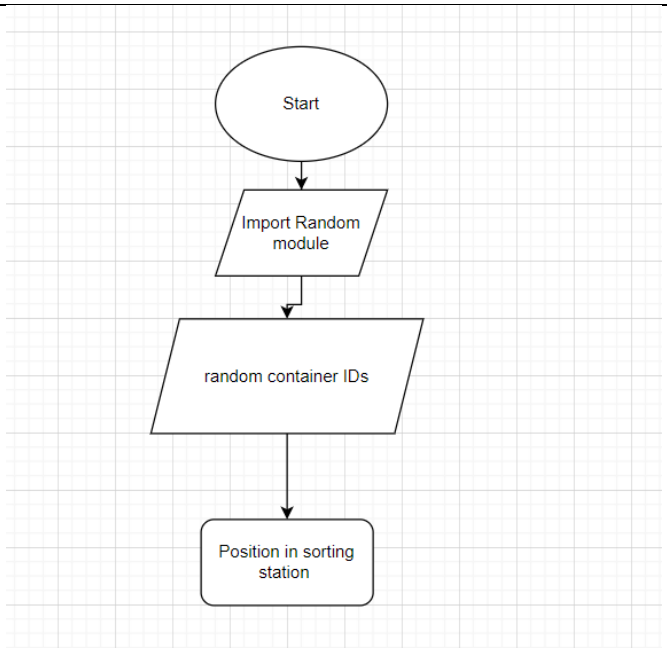
[3] “Quanser Interactive Labs Platform - enhance online learning,” Quanser, https://www.quanser.com/digital/quanser-interactive-labs/.

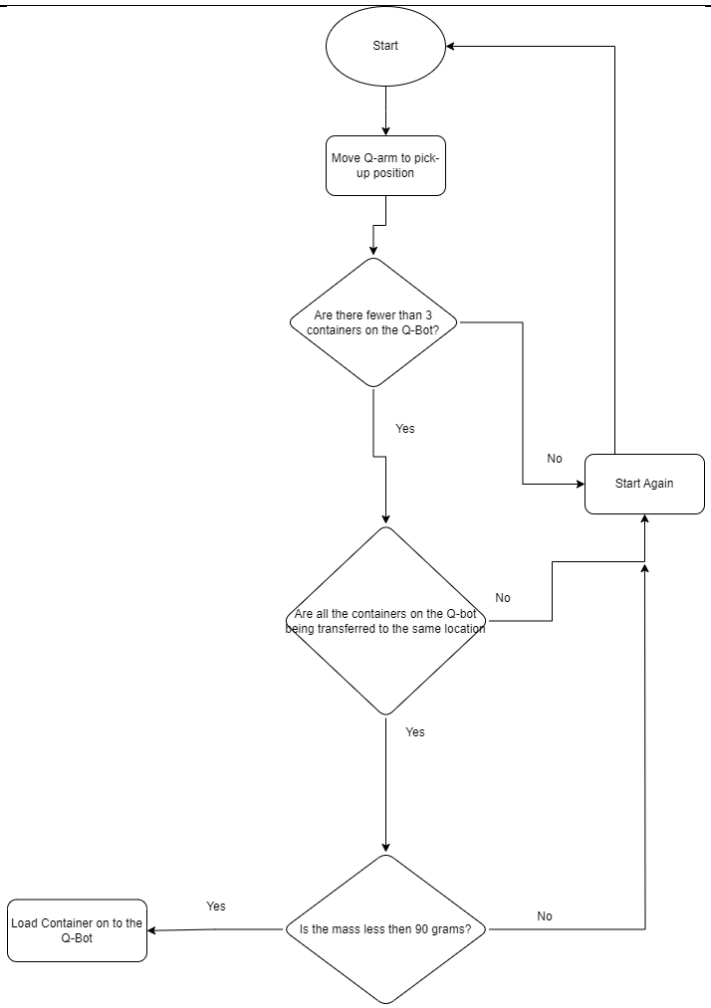
[4] “Autodesk empowers innovators everywhere to make the new possible,” Autodesk, https://www.autodesk.com/ca-en.

Appendix D: Additional Documentation

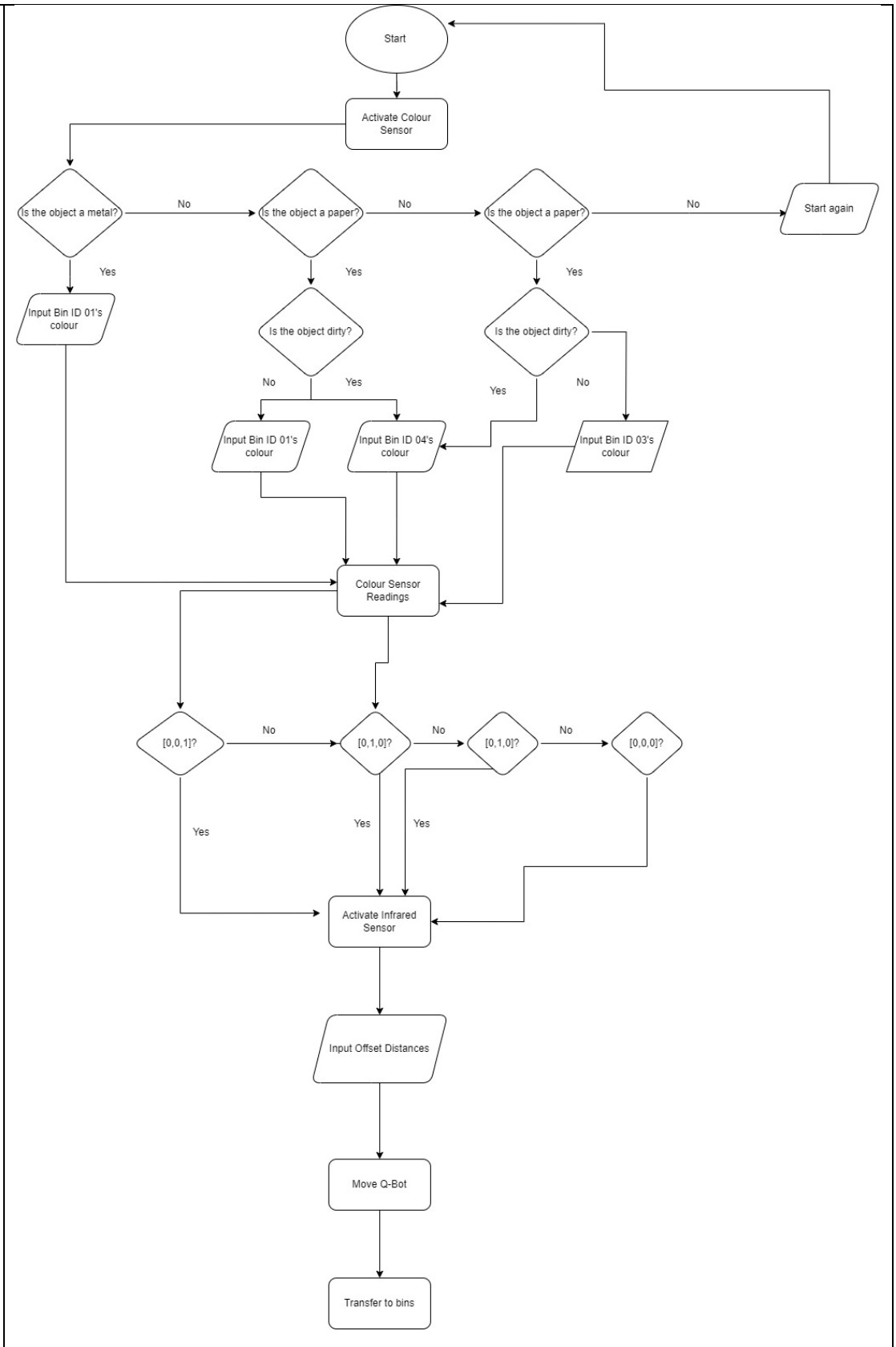
Computing Sub-Team

Psuedocode/Flowcharts

Dispense	

Load	 Start Move Q-arm to pick-up position Are there fewer than 3 containers on the Q-Bot? Yes No Start Again Are all the containers on the Q-bot being transferred to the same location No Yes Is the mass less then 90 grams? Yes No Load Container on to the Q-Bot

Transfer


Start
Activate Colour Sensor
Is the object a metal?
No
Is the object a paper?
No
Is the object a paper?
No
Start again
Yes
Yes
Yes
Input Bin ID 01's colour
Is the object dirty?
Is the object dirty?
No
Yes
Yes
No
Input Bin ID 01's colour
Input Bin ID 04's colour
Input Bin ID 03's colour
Colour Sensor Readings
[0,0,1]?
No
[0,1,0]?
No
[0,1,0]?
No
[0,0,0]?
Yes
Yes
Yes
Activate Infrared Sensor
Input Offset Distances
Move Q-Bot
Transfer to bins

Deposit	# Background info: The Q-Bot, while following the yellow track, is already # adjacent to the bin. Also, the distance from the bin is small enough for the # Q-Bot to just extend and deposit the waste into the bin. As the designers of the # system we will ensure these two facts. Activate stepper motor and linear actuator Rotate hopper 45 degrees up Deactivate stepper motor and linear actuator # Now that an item has been deposited, we can take the list that stores the # list of waste and remove the element that was just removed. Remove waste from list # The waste has been successfully recycled.

Return Home	# The Q-Bot will just continue moving along the yellow line until it reaches a position
	# corresponding to the home position.
	Activate line following sensor
	
	# Continue moving until the bot is not in the home position
	While position is not home position:
	
	  # If the yellow line is on the left side of the bot, set the wheel speed so that the bot moves
	  # inwards and rotates that way. Do the same for all other permutations.
	  If line following sensor outputs [1, 0]:
	  Set wheel speed [0.11, 0]
	  Else if line following sensor outputs [0, 1]:
	  Set wheel speed [0, 0.1]
	  Else:
	  Set wheel speed [0.1, 0.1]
	  # Move at that speed for 0.5 seconds
	  Bot move forward for (0.5) seconds
	# When the above while loop terminates it means that the bot has successfully reached the
	# home point

Final Code

Dispense

```
# Dispense Container
def dispense_container():
    id = randint(1,6) # Random module was imported to shuffle through the list of container IDs 1-6 and dispense a random container on to the servo ta
    properties = table.dispense_container(id,True)
    if id == 1:
        return [0,0,1],properties[1]
    elif id == 2 or id == 5:
        return [1,0,0],properties[1]
    elif id == 3:
        return [0,1,0],properties[1]
    elif id == 4 or id == 6:
        return [1,1,1],properties[1]

# Determines the corresponding bin colors for the containers
```

Load

```
# Existing is a variable that stores the properties of the last waste on the table.
def load_container(existing):
    bot.rotate(-90)
    time.sleep(0.1)

    # List storing the items deposited onto the qbot, variable storing total mass of the system, and the bin waste item should be deposited in
    waste = []
    total_mass = 0
    bin = [0,0,0]

    # Deposite 3 items unless break conditions are met
    for num in range(3):


        # If there is no item already on the table
        if existing == None and num == 0:
            color,mass = dispense_container()
            waste.append(color)
            bin = color
            total_mass += int(mass)

        # Waste exists
        elif existing != None:
            bin = existing[0]
            waste.append(existing[0])
            total_mass += int(existing[1])

        # If it's not the first run
        if num != 0:

            # Dispense the container and add it to the total mass.
            color,mass = dispense_container()
            total_mass += int(mass)

            # If the existing waste item is different, it means the qbot should only deposit this.
            if color != waste[num-1]:
                print("Different bin")
                existing = [color,mass]
                break

            elif total_mass > 90:# determines if the mass on the q-bot is within the mass constraint
                print("TOO HEAVY")
                existing = [color,mass]
                break

            waste.append(color)



    # Pick up the item and deposit the waste into the qbot
    arm.move_arm(0.644,0,0.273)
    time.sleep(1)
    arm.control_gripper(45)
    time.sleep(1)
    arm.rotate_shoulder(-90)
    time.sleep(1)
    arm.rotate_base(-90)
    time.sleep(1)

    # Placements of the different containers based on the order they're dispensed
    # The bots placement are measured relative to the initial perfect position so it makes sure the qarm finds the qbot even if it is a little off.
    pos = bot.position()
    if num == 0:
        arm.move_arm((pos[0] - 1.5) + 0.065, pos[1] - 0.572, pos[2] + 0.5)
    if num == 1:
        arm.move_arm((pos[0] - 1.5) - 0.05, pos[1] - 0.572, pos[2] + 0.5)


    if num == 2:
        arm.move_arm((pos[0] - 1.5) - 0.12, pos[1] - 0.572, pos[2] + 0.5)


    time.sleep(1)
    arm.control_gripper(-45)
    time.sleep(1)
    arm.home() # Loads on to the Q-bot to transfer

    # If it reachese the end, it means that an item does not exist on the table
    if num == 2:
        existing = None

time.sleep(0.1)
bot.rotate(90)

# Return the bin the qbot should deposit in as well as whether or not an item exists on the table.
return bin, existing
```

Transfer

```
# Transfer Container
def transfer(color):
    # Sensors are activated to find the line and the bins
    bot.activate_line_following_sensor()
    bot.activate_color_sensor()
    bot.activate_ultrasonic_sensor()

    while True:

        # If the bot is not on track.
        while bot.line_following_sensors() != [1,1]:
            time.sleep(0.1)

            # Turn teh bot
            if bot.line_following_sensors() == [1,0]:
                bot.rotate(-5)
            elif bot.line_following_sensors() == [0,1]:
                bot.rotate(2)

        time.sleep(0.1)
        bot.set_wheel_speed([0.1,0.1])

        # If the bot finds the bin, stop it and break the loop
        if bot.read_color_sensor()[0] == color and bot.read_ultrasonic_sensor() <= 0.07: # Reading of the bin in order to deposit the container
            bot.stop()
            print("FOUND")
            break
        time.sleep(0.1)

    # Deactivate the sensors
```

Deposit

```
# Deposit Container
def deposit_container():
    print("DUMPING")
    bot.activate_stepper_motor() # Rotary actuator is activated
    # Hopper is rotated in 10 degree increments to deposit the container into the bin
    bot.rotate_hopper(10)
    time.sleep(0.5)
    bot.rotate_hopper(20)
    time.sleep(0.5)
    bot.rotate_hopper(30)
    time.sleep(0.5)
    bot.rotate_hopper(40)
    time.sleep(0.5)
    bot.rotate_hopper(50)
    time.sleep(0.5)
    bot.rotate_hopper(60)
    time.sleep(0.5)
    bot.rotate_hopper(70)
    time.sleep(0.5)
    bot.rotate_hopper(80)
    time.sleep(0.5)
    bot.rotate_hopper(90)
    time.sleep(3)# Sleeps after depositing the container
    bot.deactivate_stepper_motor() # Rotary actuator is deactivated
```

Return Home

```
# Return Home
def return_home(pos):
    bot.activate_line_following_sensor()

    # Uses the position of the bot in order to return to home position. Position of the bot must be within a certain range of the home position initially found.
    while abs(bot.position()[0] - pos[0]) >= 0.1 or abs(bot.position()[1] - pos[1]) >= 0.1 or abs(bot.position()[2] - pos[2]) >= 0.1:
        speeds = [bot.line_following_sensors()[1]/10, bot.line_following_sensors()[0]/10]
        bot.set_wheel_speed(speeds)
        time.sleep(0.01)

    bot.deactivate_line_following_sensor()
    bot.stop()
    print("DONE BACK HOME")
```

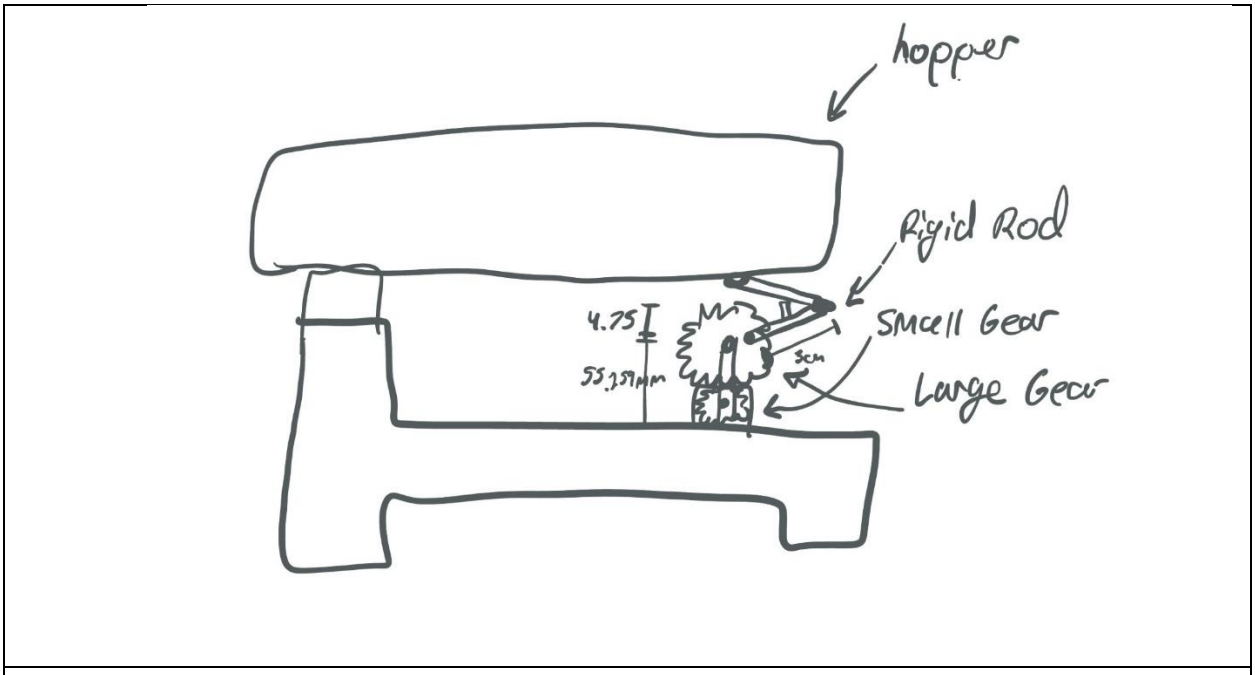
Main	

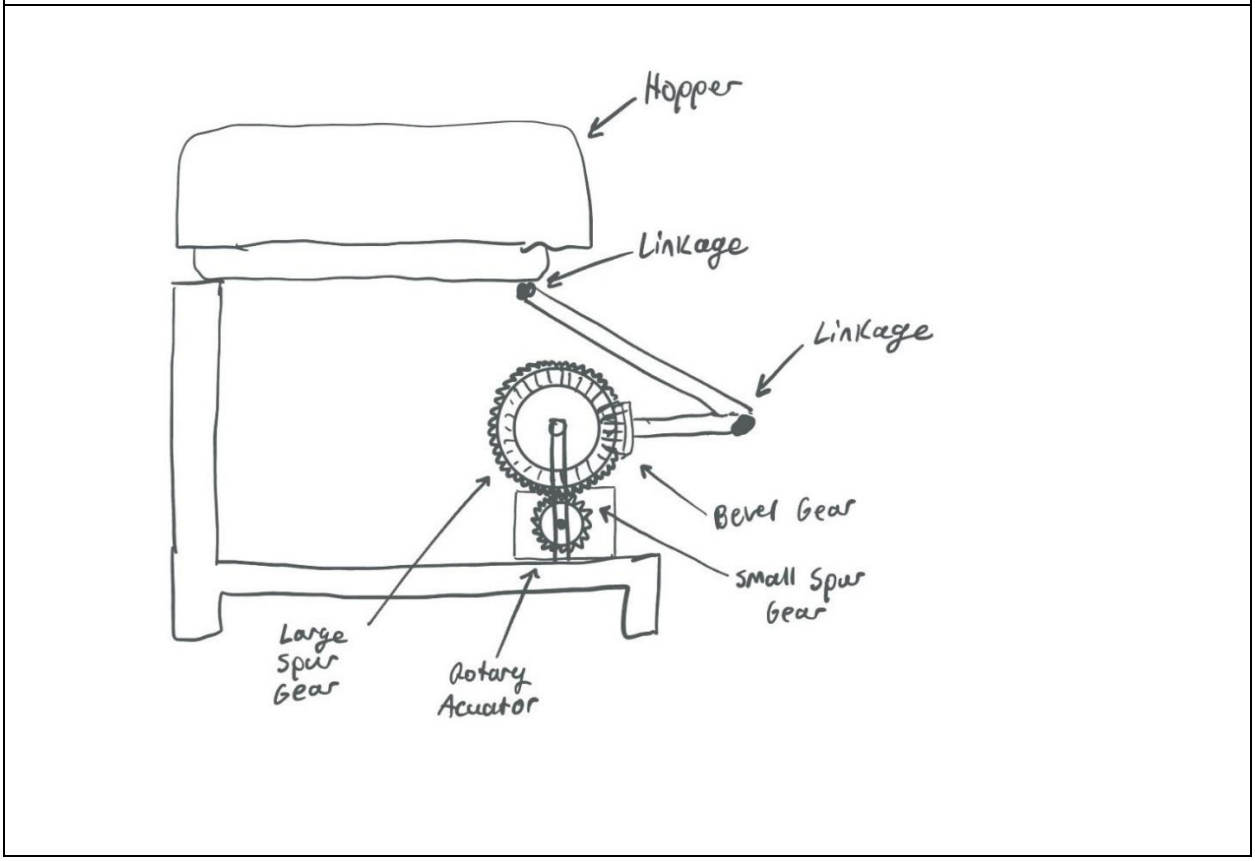
```
# Main Function
# A function that can be called out to run all of the blocks of the consecutively
def main():
    existing = None
    home = bot.position()
    while True:
        color, existing = load_container(existing)
        transfer(color)
        deposit_container()
        return_home(home)


main()
```

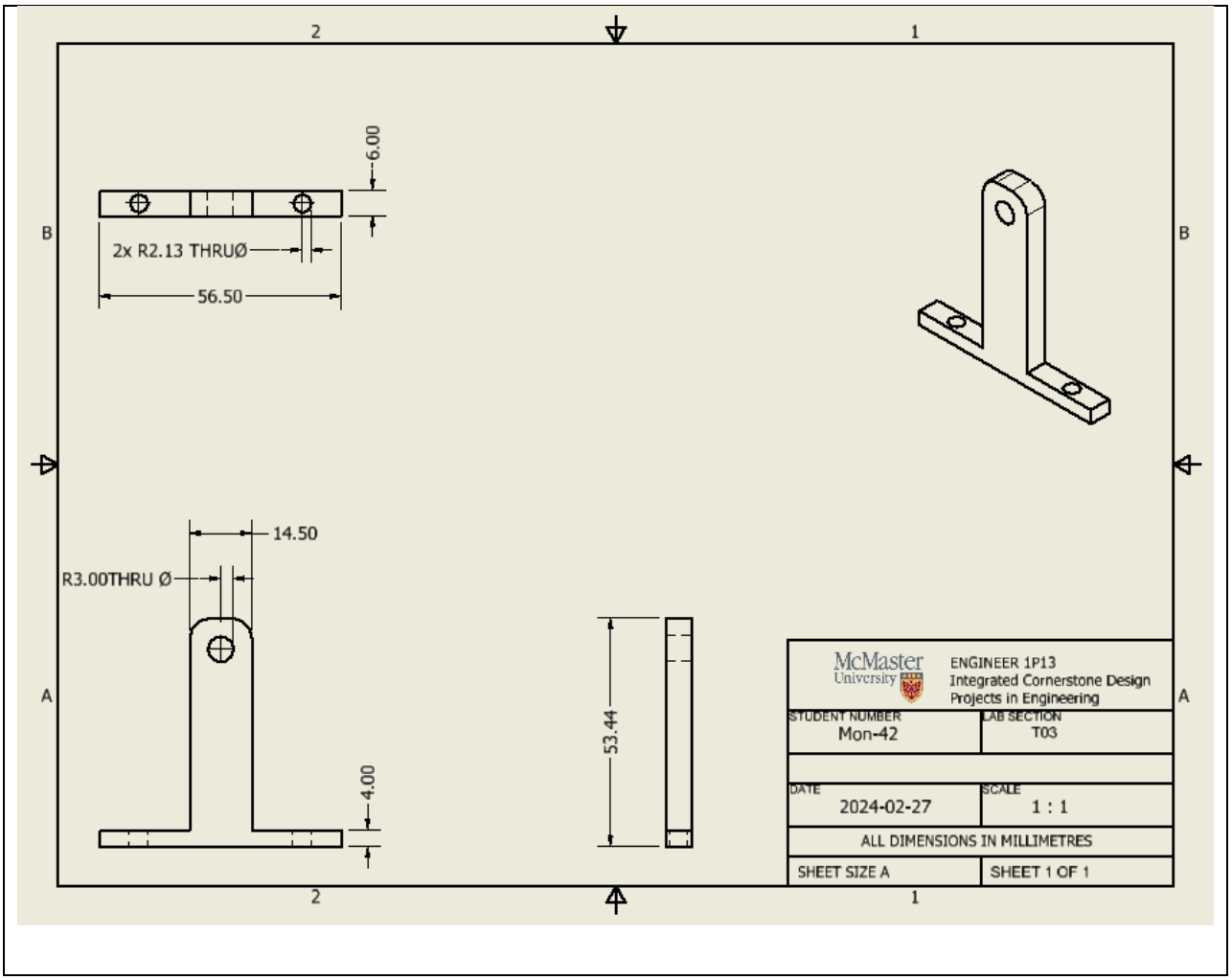
CAD Sub-Team

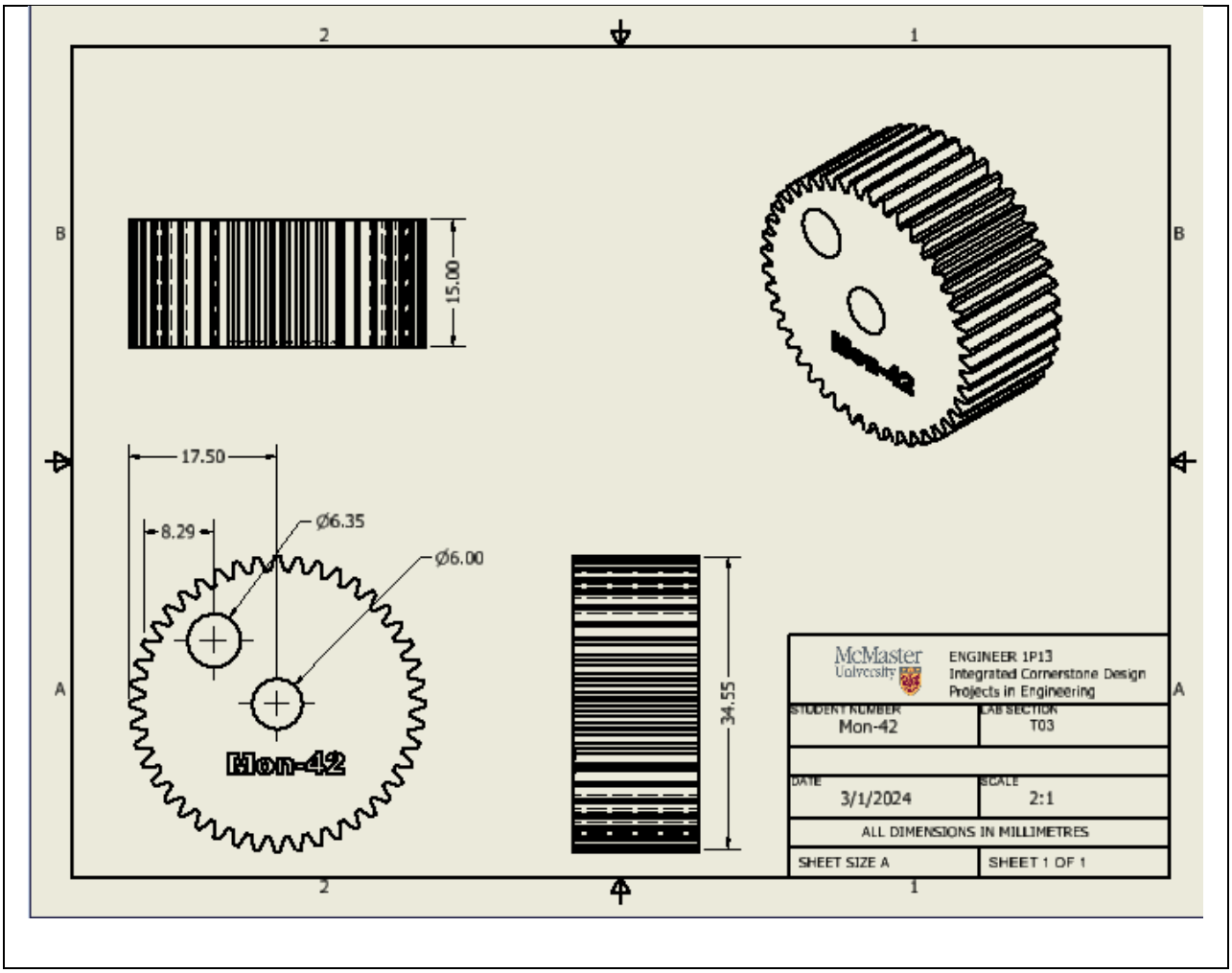
Preliminary Sketches





Engineering Drawings

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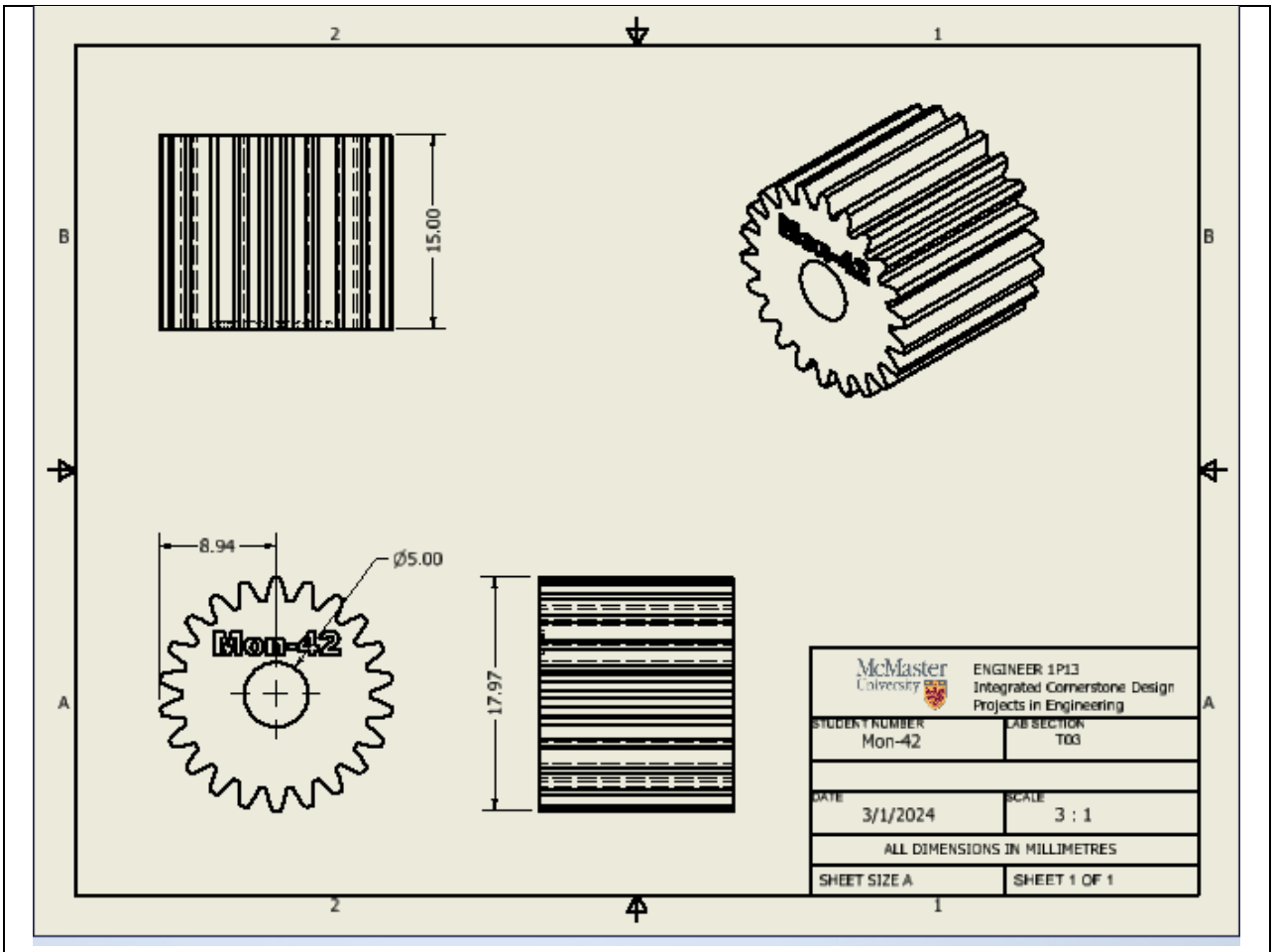
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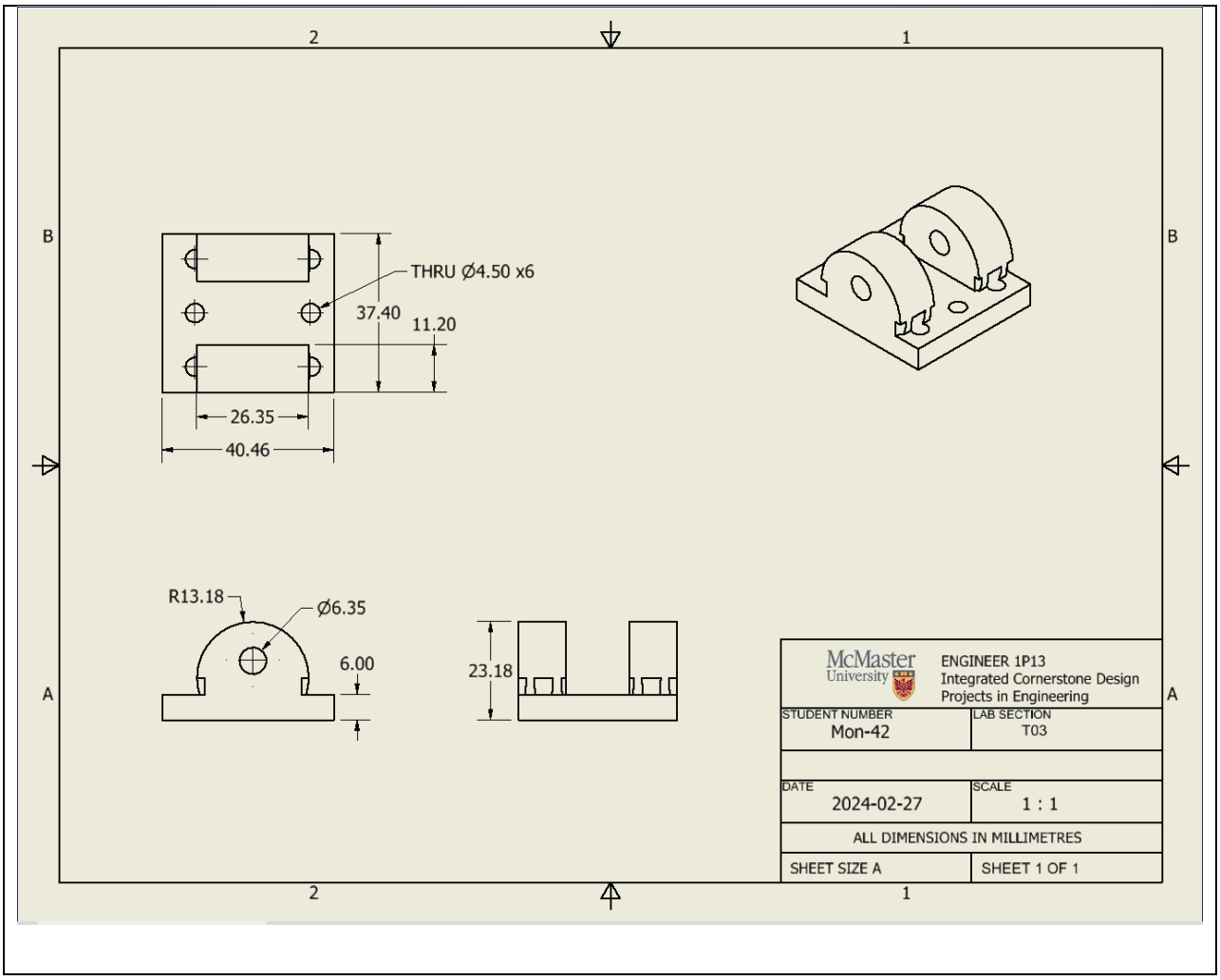
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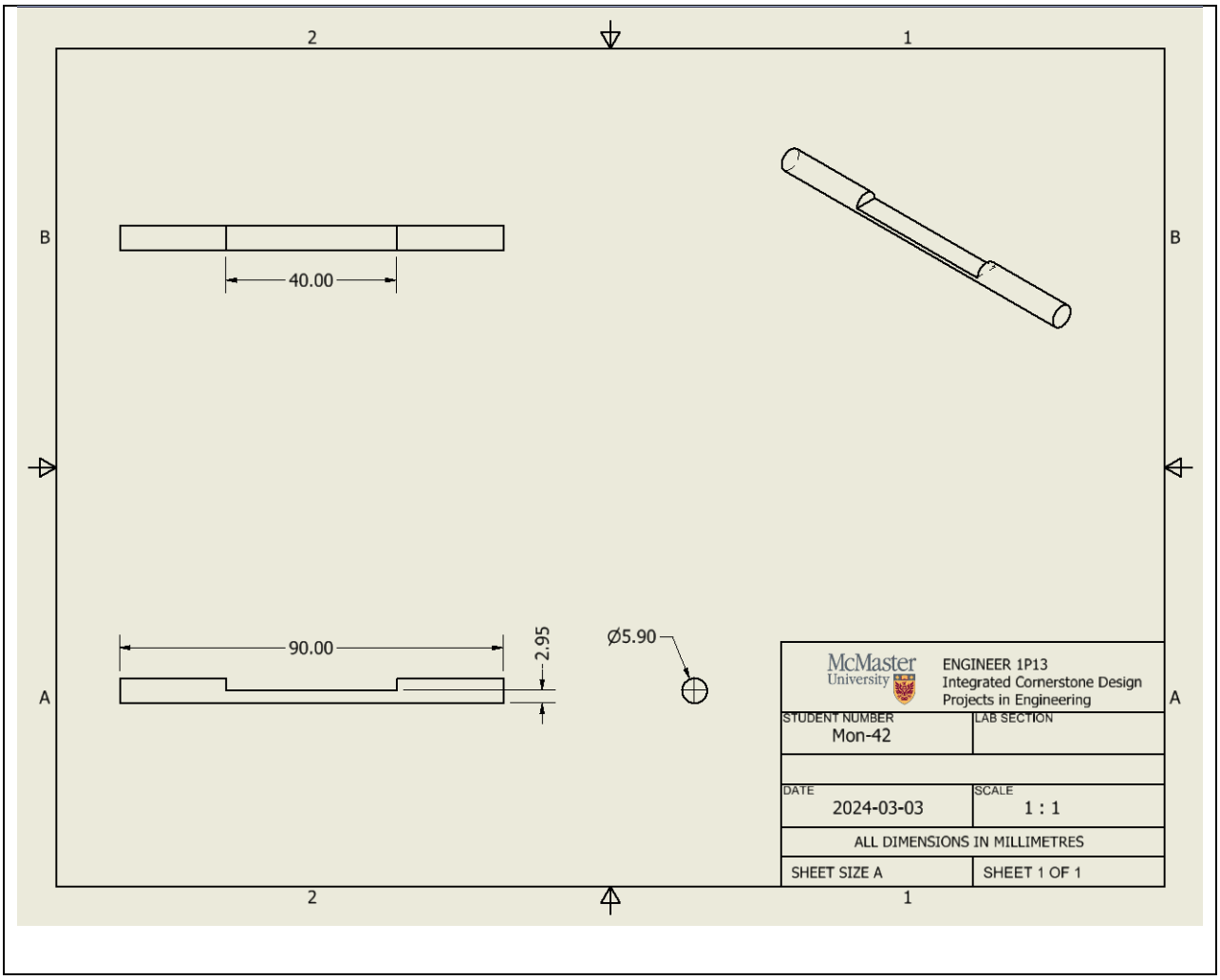
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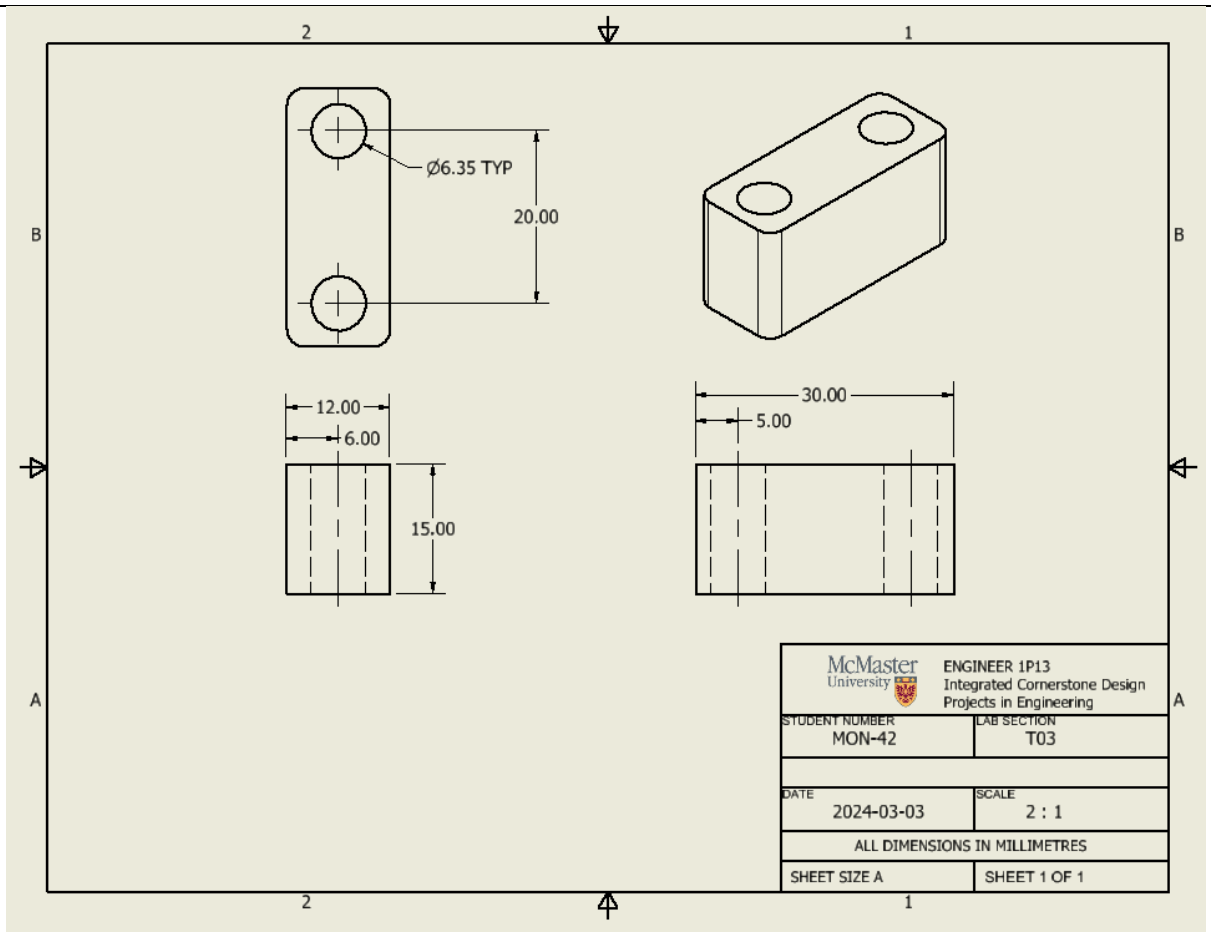
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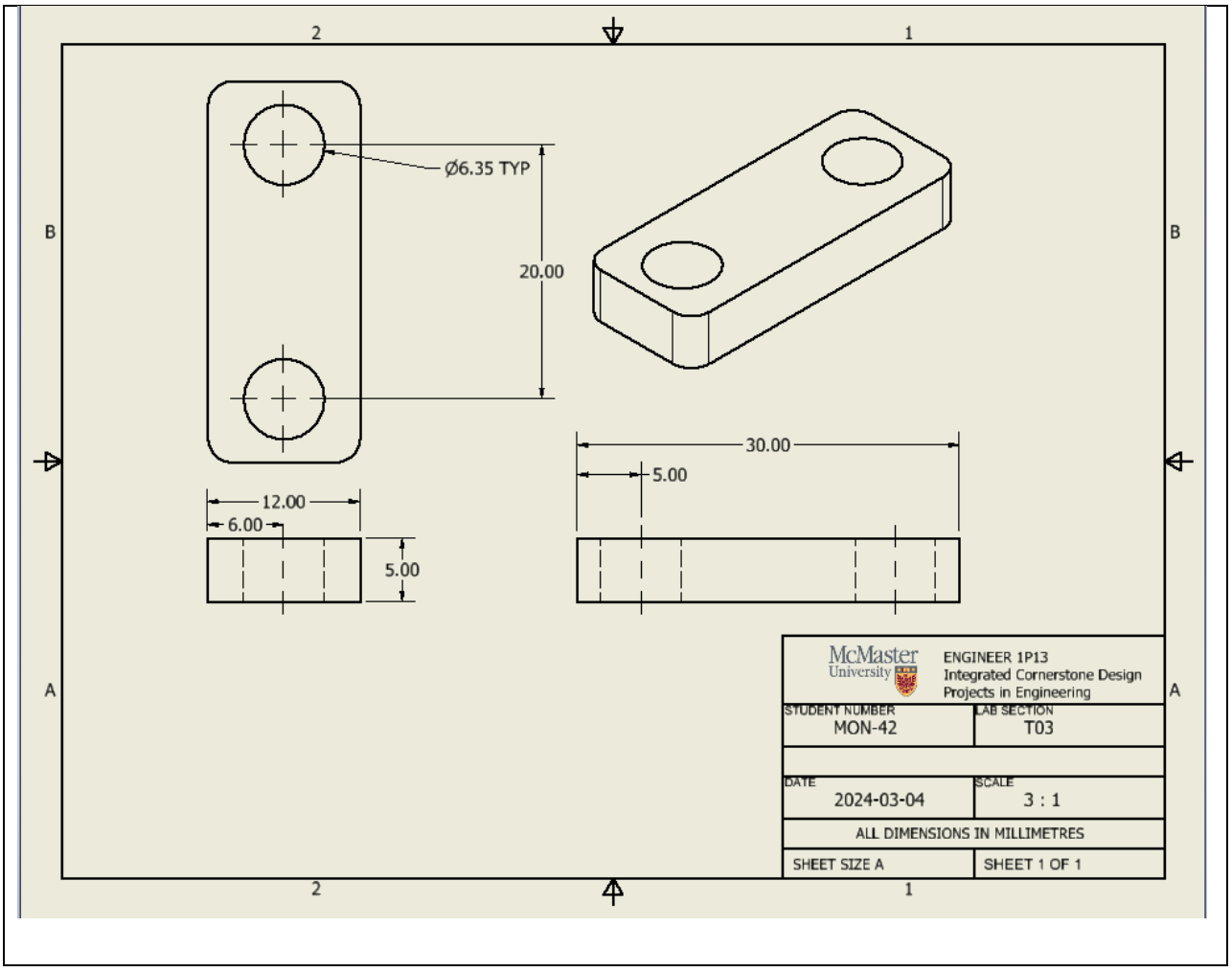
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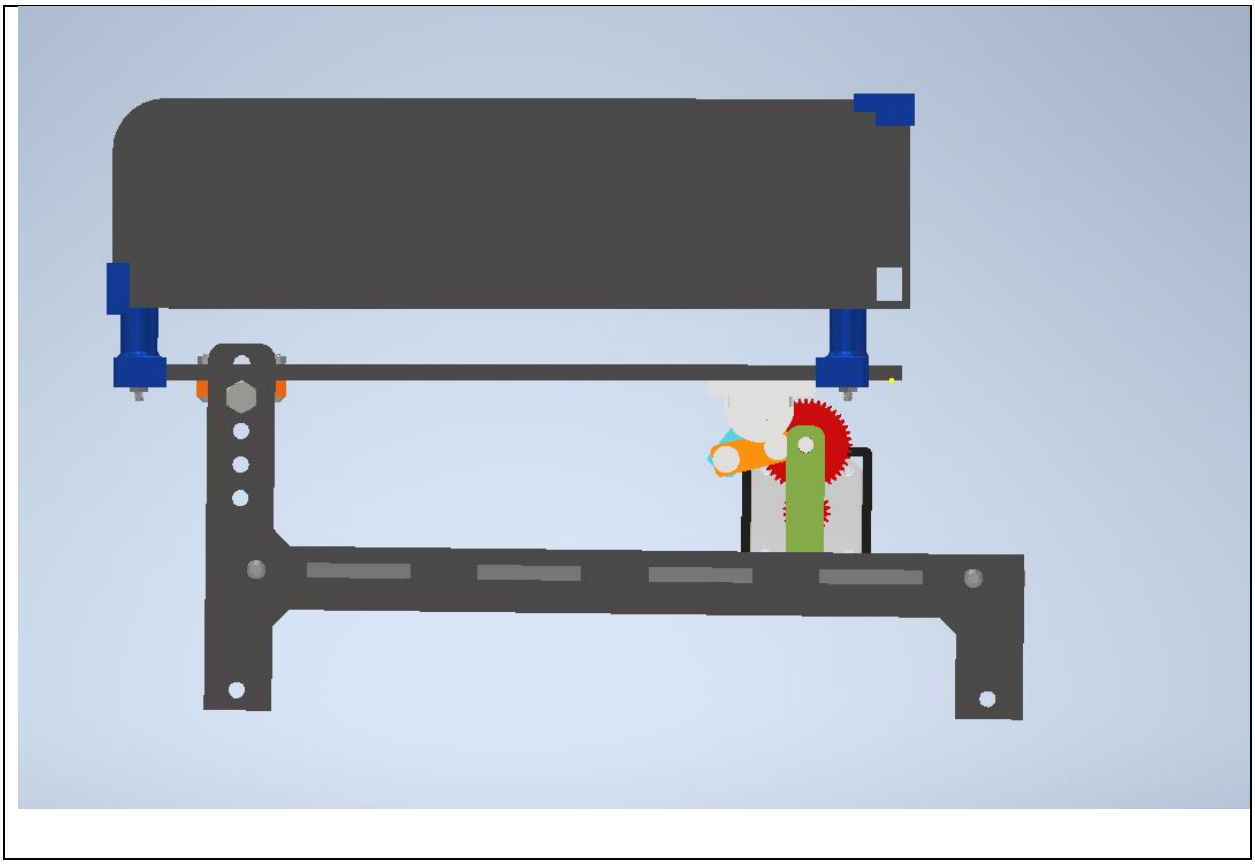
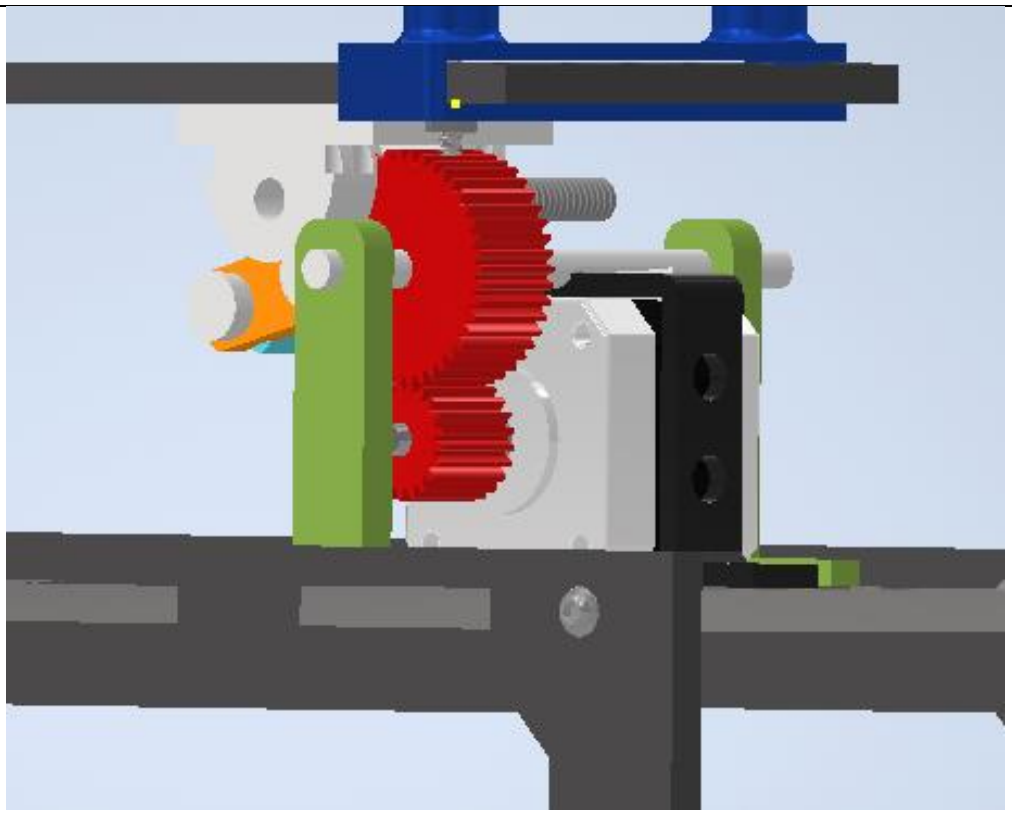
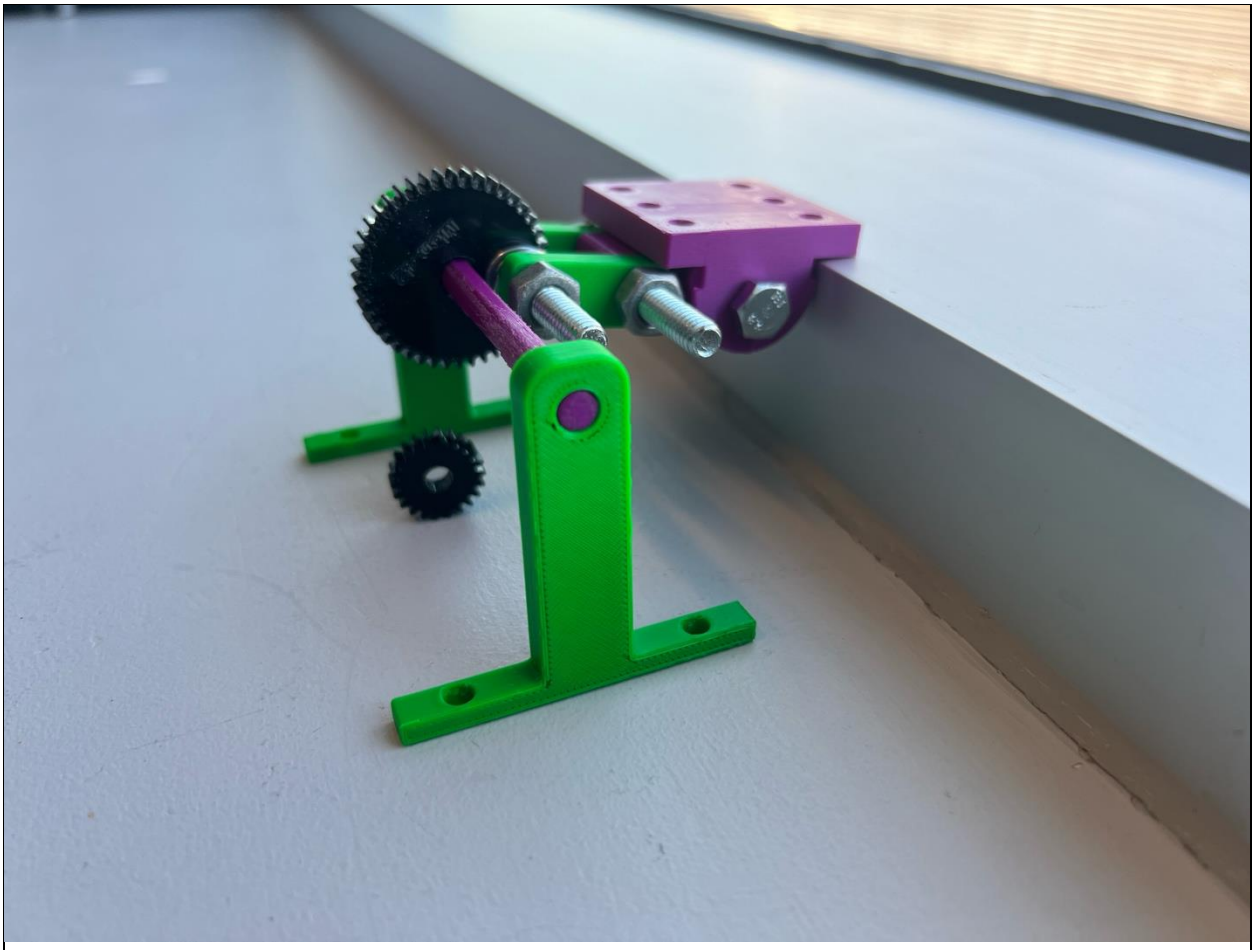
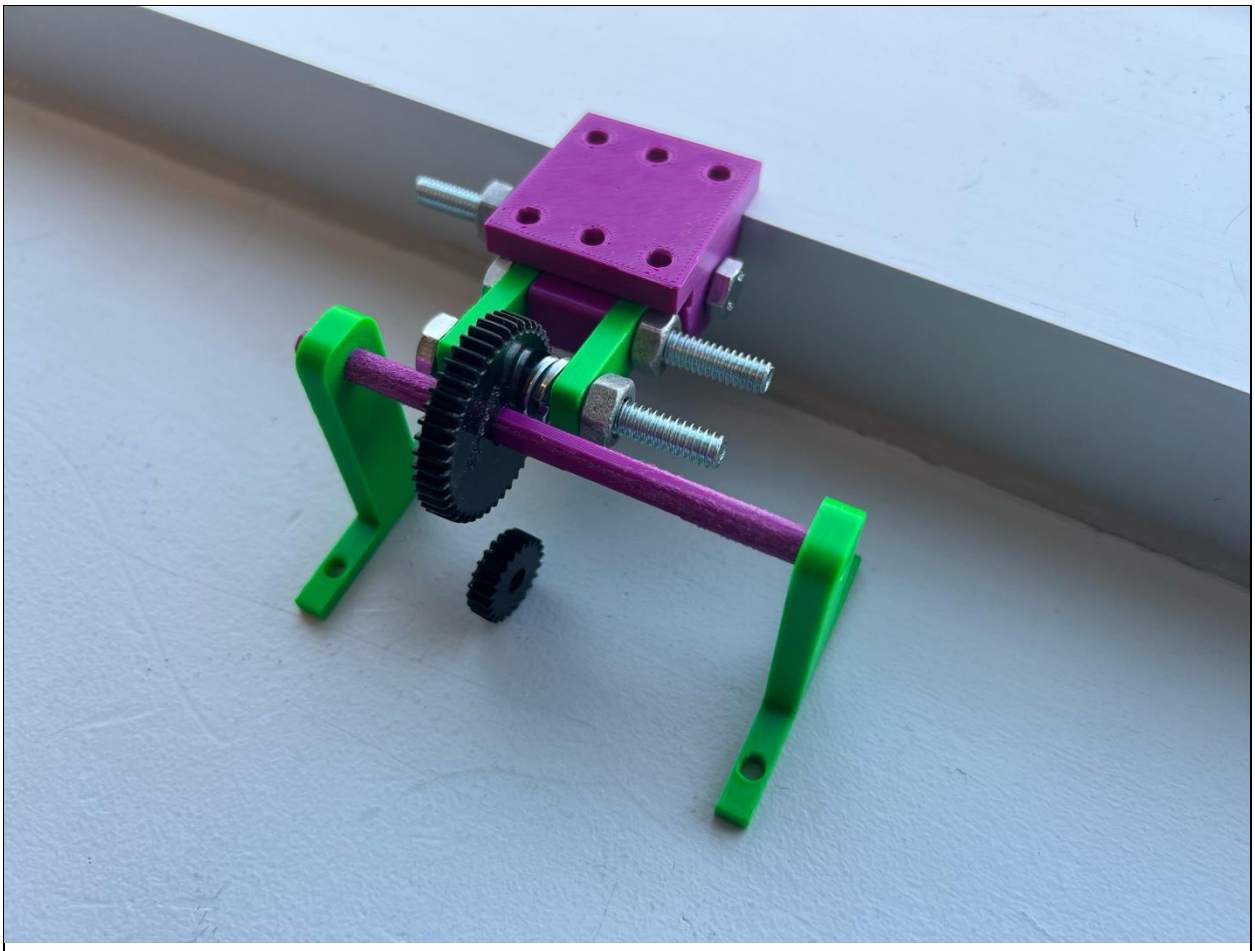
Assembly

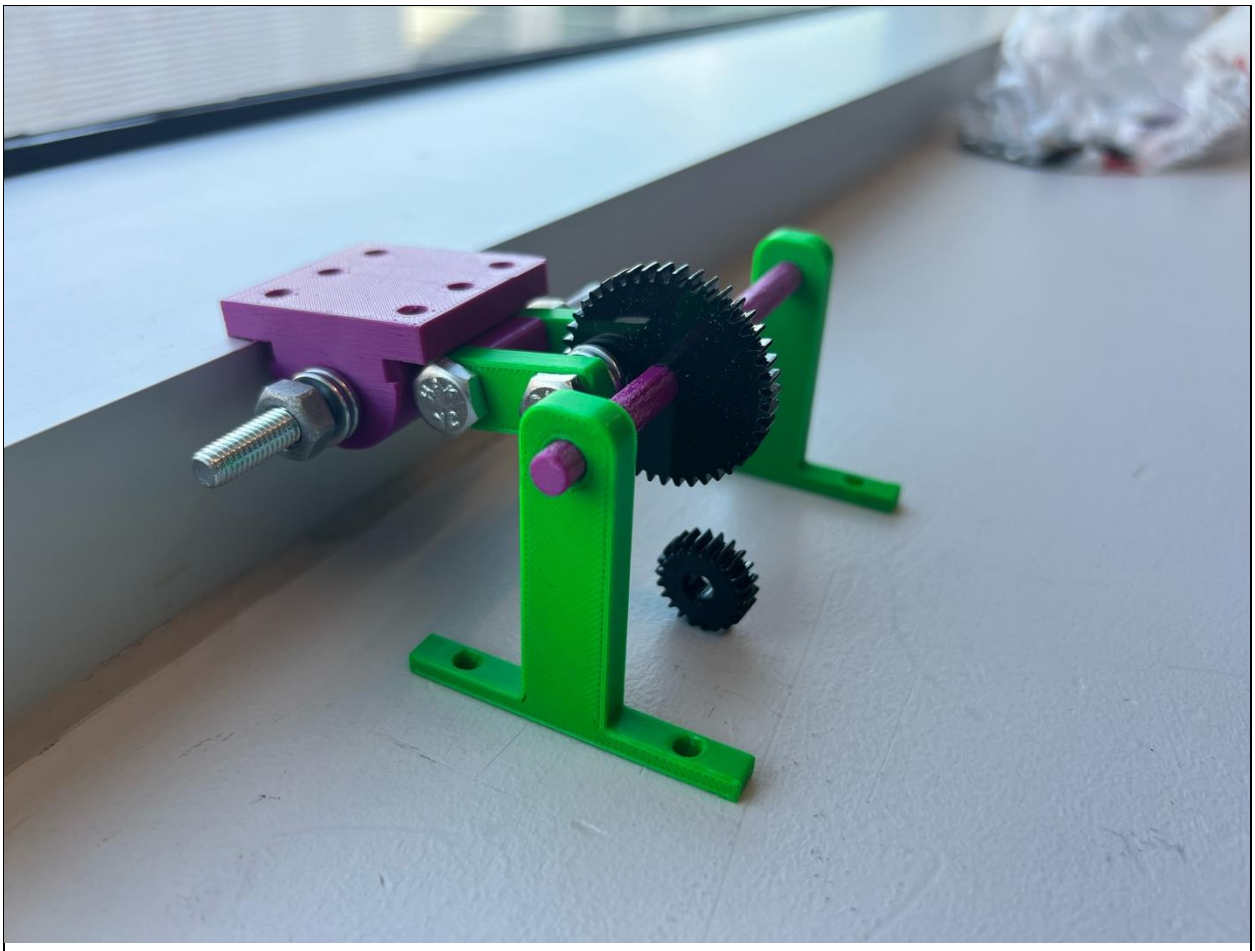




3D Printed Model







Actuator Code

```
# actuator code
def rotary_actuator():
    bot.activate_stepper_motor()
    time.sleep(0.5)
    bot.rotate_stepper_cw(2)
    time.sleep(0.5)
    bot.deactivate_stepper_motor() # Rotary actuator is deactivated
```

Appendix E: Design Studio Worksheets

ENGINEER 1P13:
PROJECT THREE WORKSHEETS (TEAM)

Table of Contents

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

Milestone 0 – Cover Page

Team ID: Mon- 42

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

Full Name:	MacID:
Vanesa Cabrera	cabrerv
Amnah Syeda	syedaa13
Talha Ahmad	ahmadt20
Athithan Vimalananthan	vimala3
Andrew Dalgleish	dalgleia

Insert your Team Portrait in the dialog box below

Milestone 0 – Team Charter

Team ID: Mon-42

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Amnah Syeda	☐M ☒A ☒C ☐S
2.	Vanesa Cabrera	☒M ☐A ☐C ☒S
3.	Talha Ahmad	☐M ☒A ☐C ☐S
4.	Andrew Dalgleish	☒M ☐A ☒C ☐S
5.		☐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	Amnah Syeda	syedaa13
Administrator 1	Talha Ahmad	ahmadt20
Administrator 2	Andrew Dalgleish	dalgleia
Coordinator	Vanesa Cabrera	cabrerv
Coordinator	Athithan Vimalananthan	vimala3

Milestone 0 – Preliminary Gantt Chart (Team Manager Only)

Team ID: Mon-42

Full Name of Team Manager:	MacID:
Amnah Syeda	syedaa13

Preliminary Gantt chart

Project Planner

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

Period High 1

Plan Duration | Actual Sta | % Complet | Actual (beyond plar | % Complete (beyond p

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Milestone 0 (Team)	1	1	1	1	100%
Milestone 1 (Team)	1	1	1	1	100%
Milestone 1 (Individual	1	1	1	1	100%
Milestone 2 (Team)	1	1	1	1	0%
Milestone 2 (Team)	2	1	1	1	0%
Milestone 3 (Team)	3	1	1	1	0%
Milestone 4 (Team)	4	1	1	1	0%
Milestone 5 (Team)	5	1	1	1	0%
Mechanism Design & Interview	6	1	1	1	0%
Computer Program & Interview	6	1	1	1	0%
Design Report	7	1	1	1	0%
Ethics Summary	7	1	1	1	0%
Infographic	7	1	1	1	0%
Self and Learning Portfolio	7	1	1	1	0%

PERIODS 1 2 3 4 5 6 7 8 9

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

Milestone 1 – Cover Page

Team ID: Mon-42

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

Full Name:	MacID:
Amnah Syeda	syedaa13
Vanesa Cabrera	cabrerv
Andrew Dalgleish	dalgleia
Athithan Vimalananthan	vimala3
Talha Ahmad	ahmadt20

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

Team ID: Mon-42

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 to organize a variety of materials into containers for recycling

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	- Be able to identify, classify, and verify containers for recyclability. - Design a mechanism for depositing containers into a recycling bin. - Design a computer program for transferring containers to a bin in the Recycling Station. - Identify bins based on properties such as mass and colour. - Sort bins by transporting them to their respective containers. - Use mechanism to drop containers off.
Constraints	- Actuator must be present within the red zone. - Total mass of containers is less than 90g.

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: Mon-42

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.

Design a system to sort recyclable waste to reduce the number of unrecyclable items being placed into improper bins, contributing to waste.

PROJECT THREE: MILESTONE TWO (TEAM): PRELIMINARY DESIGN

Milestone 2 – Cover Page

Team ID: Mon-42

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

Full Name:	MacID:
Amnah Syeda	syedaa13
Talha Ahmad	ahmadt20
Andrew Dalgleish	dalgleia
Vanesa Cabrera	cabrerv
Athithan Vimalananthan	vimala3

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

Team ID: Mon-42

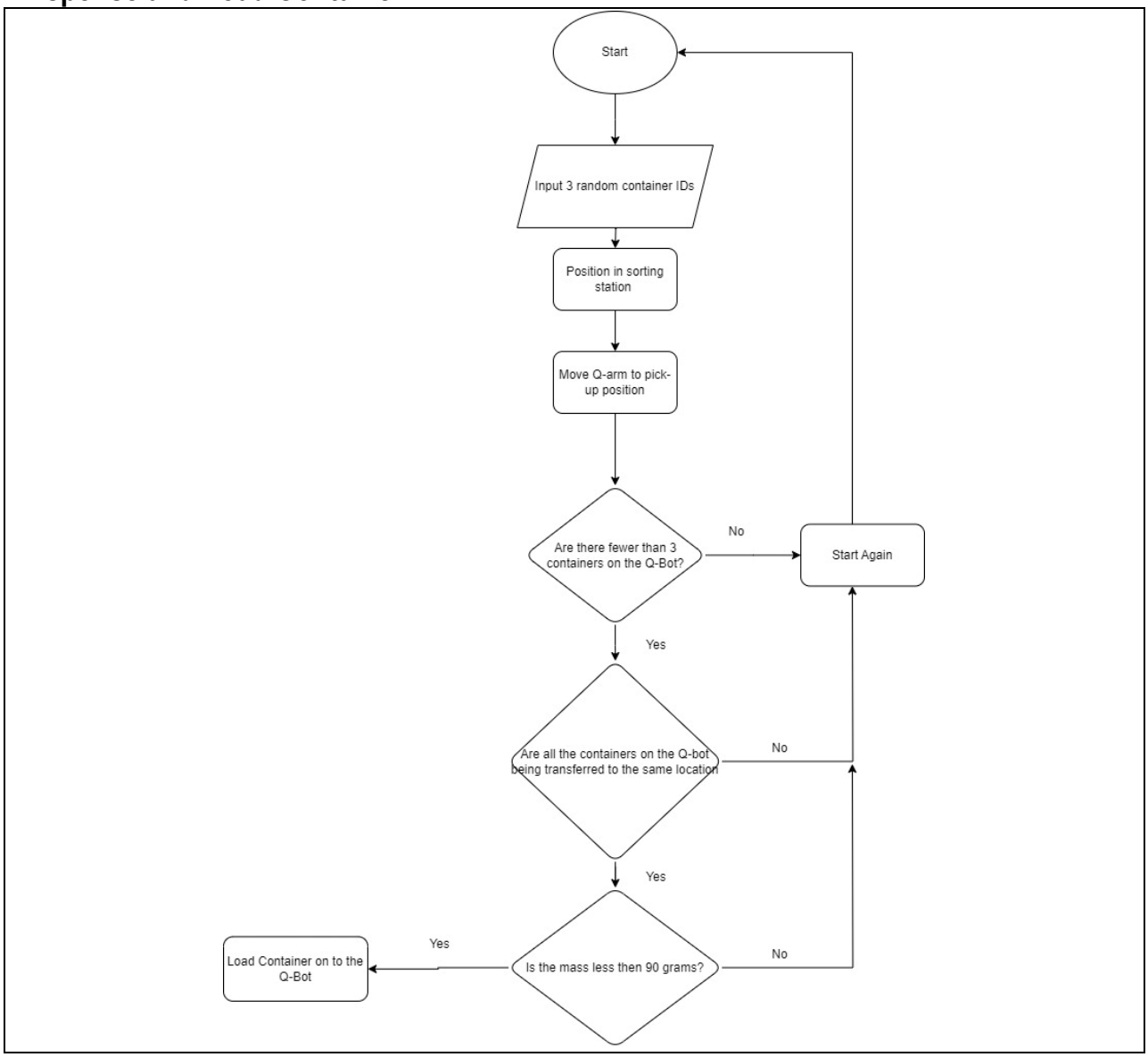
1. As a sub-team, discuss the results of your individual sensor demo activity and select the sensor(s) that you will use in your project. Identify the sensor(s) in the box below and include any decision-making tools or justification in the space provided.
   Teams are allowed to use a maximum of 2 sensors

Chosen Sensor(s): IR and colour sensors.

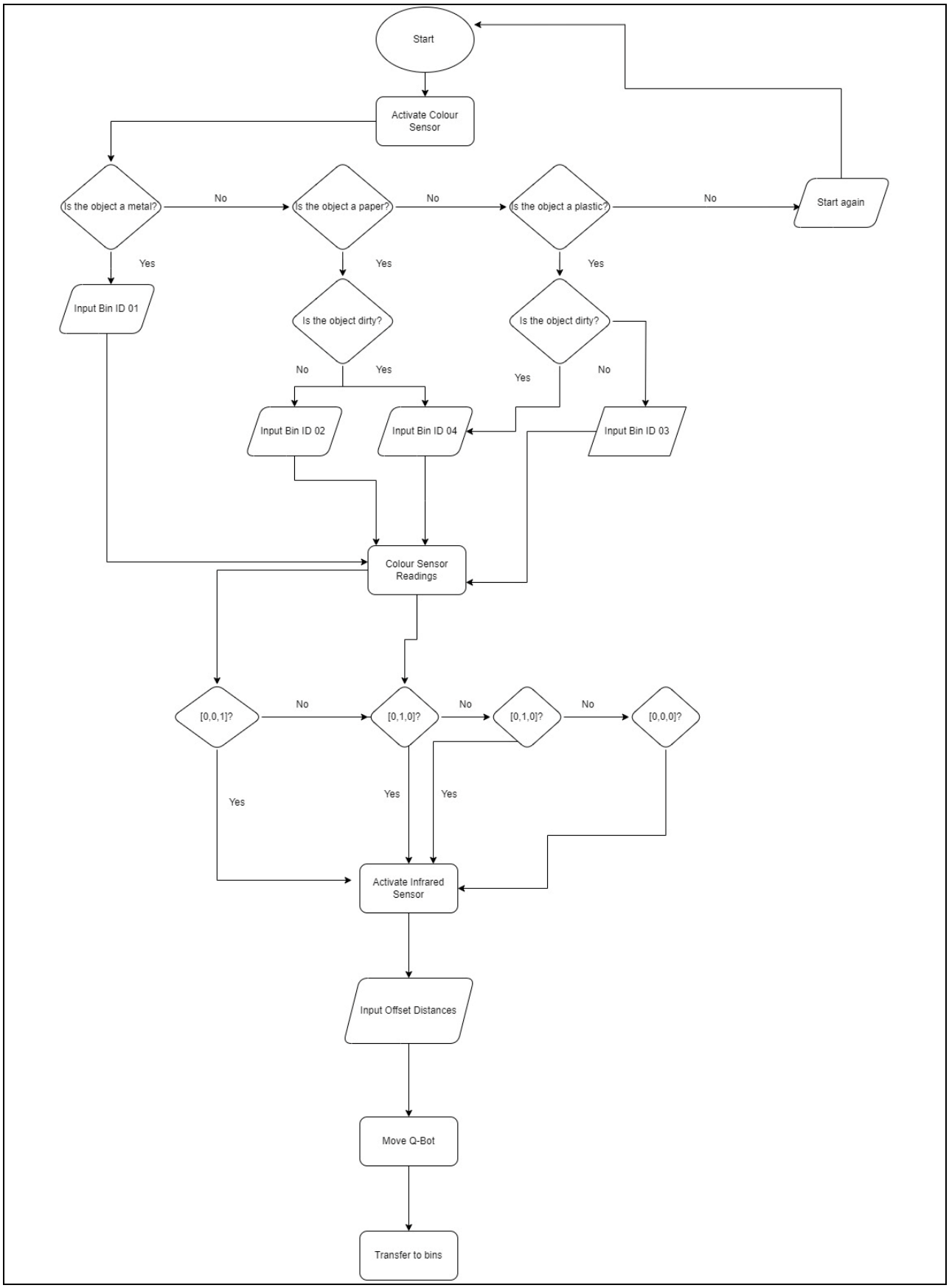
Justification and/or Decision-Making Tools:
The colour sensor will help the Q-Bot look at different bins and be able to differentiate between them. For example, if you have dirty plastic, which belongs in the garbage, then the Q-Bot simply needs to look for the black bin.
The IR sensor reads the presence of infrared radiation. In the python simulation library, it states that the Q-Bot uses 2 IR sensors for line following. So the IR sensor is necessary for this project since it allows the Q-Bot to follow the yellow line.

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 and Load Container



Transfer Container


Start
Activate Colour Sensor
Is the object a metal?
No
Is the object a paper?
No
Is the object a plastic?
No
Start again
Yes
Yes
Yes
Input Bin ID 01
Is the object dirty?
Is the object dirty?
No
Yes
Yes
No
Input Bin ID 02
Input Bin ID 04
Input Bin ID 03
Colour Sensor Readings
[0,0,1]?
No
[0,1,0]?
No
[0,1,0]?
No
[0,0,0]?
Yes
Yes
Yes
Activate Infrared Sensor
Input Offset Distances
Move Q-Bot
Transfer to bins

Deposit Container

```
# Background info: The Q-Bot, while following the yellow track, is already
# adjacent to the bin. Also, the distance from the bin is small enough for the
# Q-Bot to just extend and deposit the waste into the bin. As the designers of the
# system we will ensure these two facts.
Activate stepper motor and linear actuator
Rotate hopper 45 degrees up
Deactivate stepper motor and linear actuator

# Now that an item has been deposited, we can take the list that stores the
# list of waste and remove the element that was just removed.
Remove waste from list

# The waste has been successfully recycled.
```

Return Home

```
# The Q-Bot will just continue moving along the yellow line until it reaches a position
# corresponding to the home position.
Activate line following sensor

# Continue moving until the bot is not in the home position
While position is not home position:

    # If the yellow line is on the left side of the bot, set the wheel speed so that the bot moves
    # inwards and rotates that way. Do the same for all other permutations.
```

```
    If line following sensor outputs [1, 0]:
        Set wheel speed [0.11, 0]
    Else if line following sensor outputs [0, 1]:
        Set wheel speed [0, 0.1]
    Else:
        Set wheel speed [0.1, 0.1]
    # Move at that speed for 0.5 seconds
    Bot move forward for (0.5) seconds
# When the above while loop terminates it means that the bot has successfully reached the
# home point
```

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

Team ID: Mon-42

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: Andrew Dalgleish, Athithan Vimalananthan	MacID: dalgleia, vimala3

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

Simple Decision Matrix

Mechanism	*Linear with Linkages*	*Rotary with Linkages*	*Rotary with gears and linkages*
Easy to Model	*5*	*5*	*3*
Easy to Fabricate	*4*	*4*	*3*
Creativity	*1*	*1*	*5*
Strength	*3*	*2*	*4*
Non-Breakable	*2*	*2*	*4*
Total	*15*	*14*	*19*

Winner: Rotary Actuator with gears and linkages.

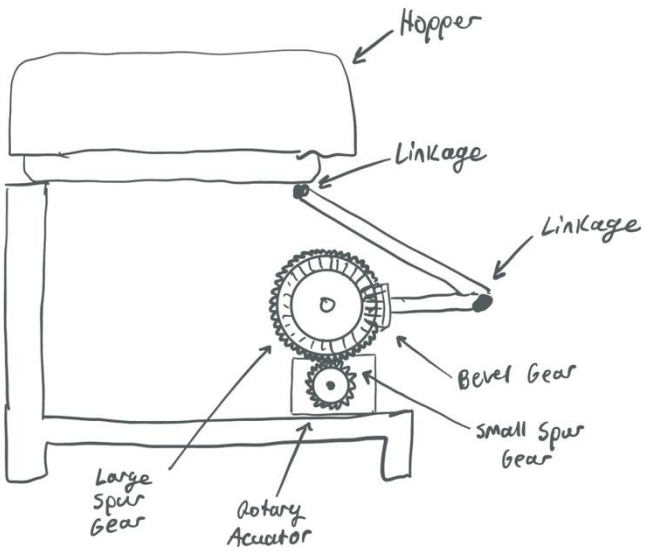
Team ID: Mon-42

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: Mon-42

Name: Andrew Dalgleish	MacID: dalgleia

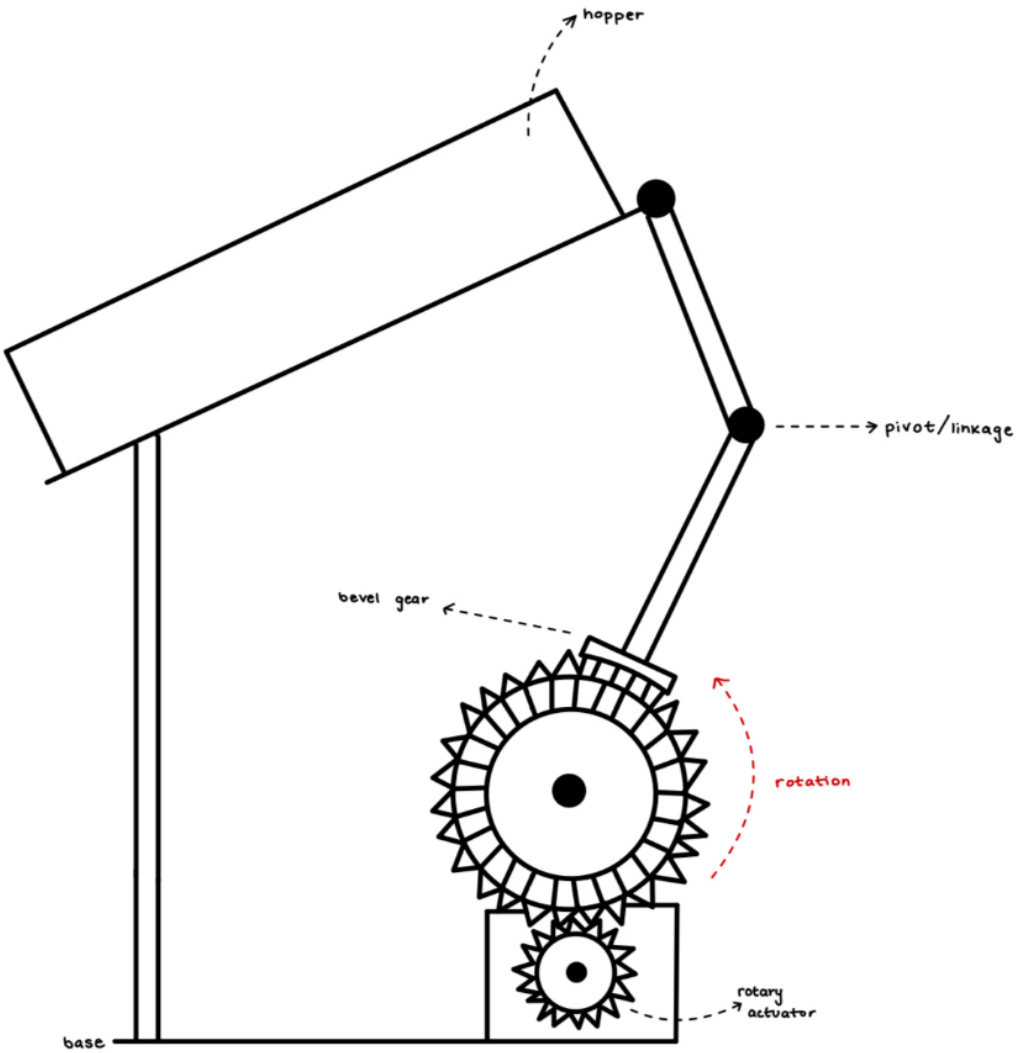
*Insert picture of the **transfer** detailed sketch below*



Team ID: Mon-42

Name: Vanesa Cabrera	MacID: cabrerv

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



Athithan Vimalananthan (vimala3) was the third member for both sketches

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

Team ID: Mon-42

☐ 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.

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.

- No need for the bevel gear, instead have the arm attached to the gear itself instead of having an additional mechanism
- Keep in mind the angle of between the two rods, certain shallow angles may not have any lift whatsoever
- Experiment with length of rods and gear size in order allow for lift while minimizing mass
- Ensure every part of the design is stable

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

- Attach two rods to keep the 'big gear' in place during motion
- Extend rod and connect to center of the gear

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

Team ID: Mon-42

☒ 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.

We put both the dispense and load functions into one section, and the mentor said we should split them up. Other than that, they said that most of our work was set to go with some fixes. The main requirement for next design studio was writing out python code which would allow us to complete one full cycle.

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

Complete the required functions and prepare a cycle. Also, split up the dispense and load functions. Prepare one full cycle for next design studio.

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

Milestone 3 – Cover Page

Team ID: Mon-42

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

Full Name:	MacID:
Amnah Syeda	syedaa13
Talha Ahmad	ahmadt20
Andrew Dalgleish	dalgleia
Vanesa Cabrera	cabrerv
Athithan Vimalananthan	vimala3

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

Team ID: Mon-42

☐ 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.

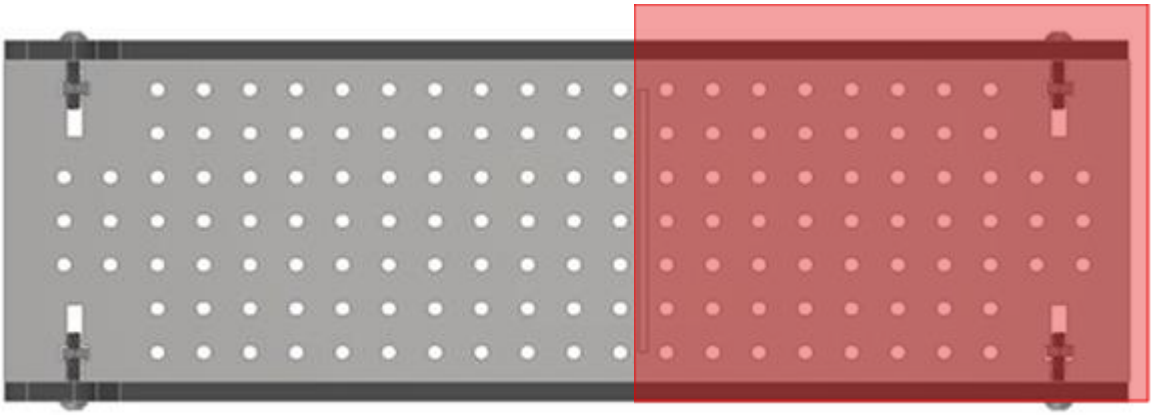
☐ Assembly is complete and constrained properly

→ 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.

a. Hammer should not be an issue but we should try gluing
    i. Make washer larger and glue it on
b. Download 3D printing software

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

- Adjust the holes to fit the glue (enlarge them)
- Finish assembly to be ready to 3D print for next DS

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

Team ID: Mon-42

☐ 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)

Check to all items above. Small bugs in the program existed though.

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

a. : lower graphics settings
    i. As long as final code they can see that you tried your best
    ii. Use the same actuator as subteam

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

Change to rotary actuator and try optimizing rotation further.

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: Mon-42

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.

To deliver recyclable materials to the appropriate containers to be processed

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	- Differentiate materials from each other and bring them to the correct containers - Successfully drop materials into the containers
Constraints	- The actuators must be placed in a designated part of the base. - Should drop all materials in hopper given by the Q-arm - Should have 100% accuracy in sorting

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

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

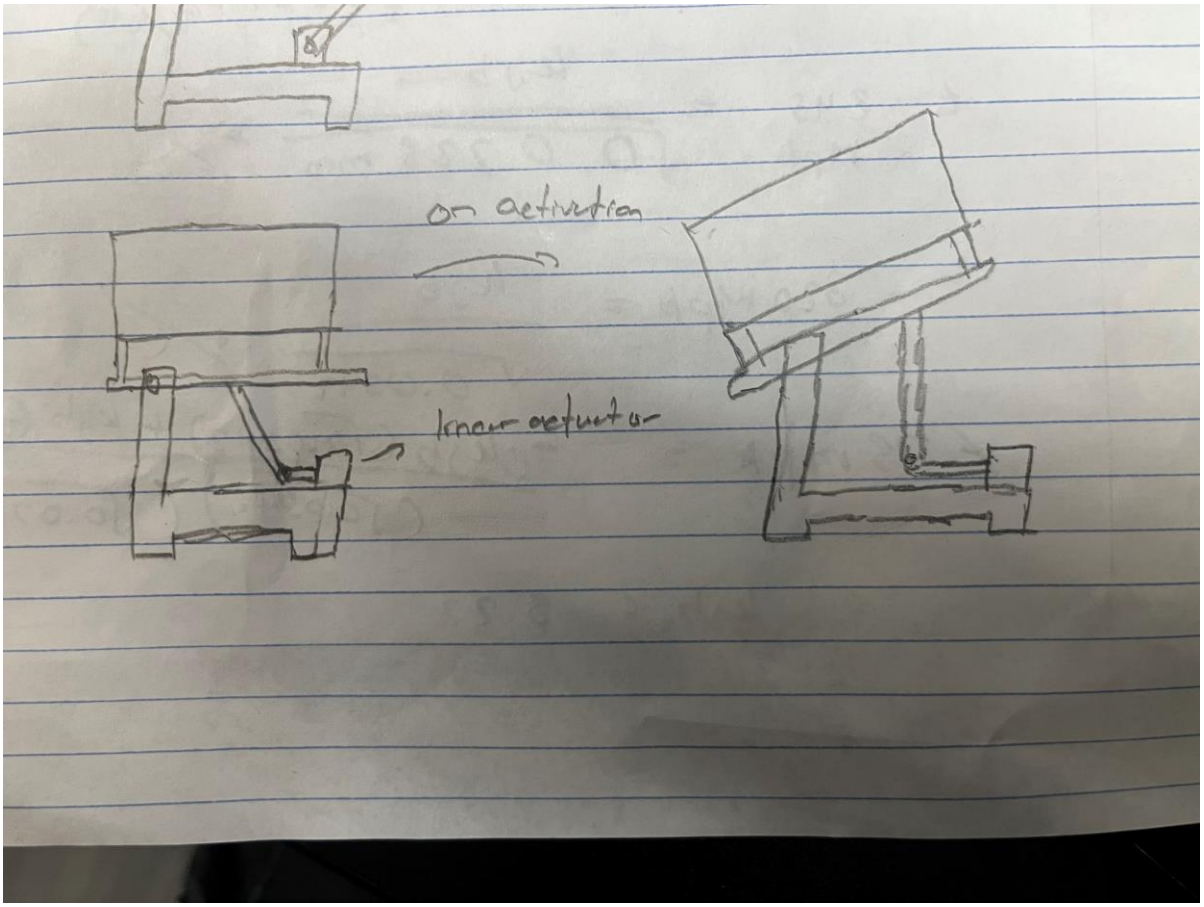
Team ID: Mon-42

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: Mon-42

Name: Athithan Vimalananthan	MacID: vimala3

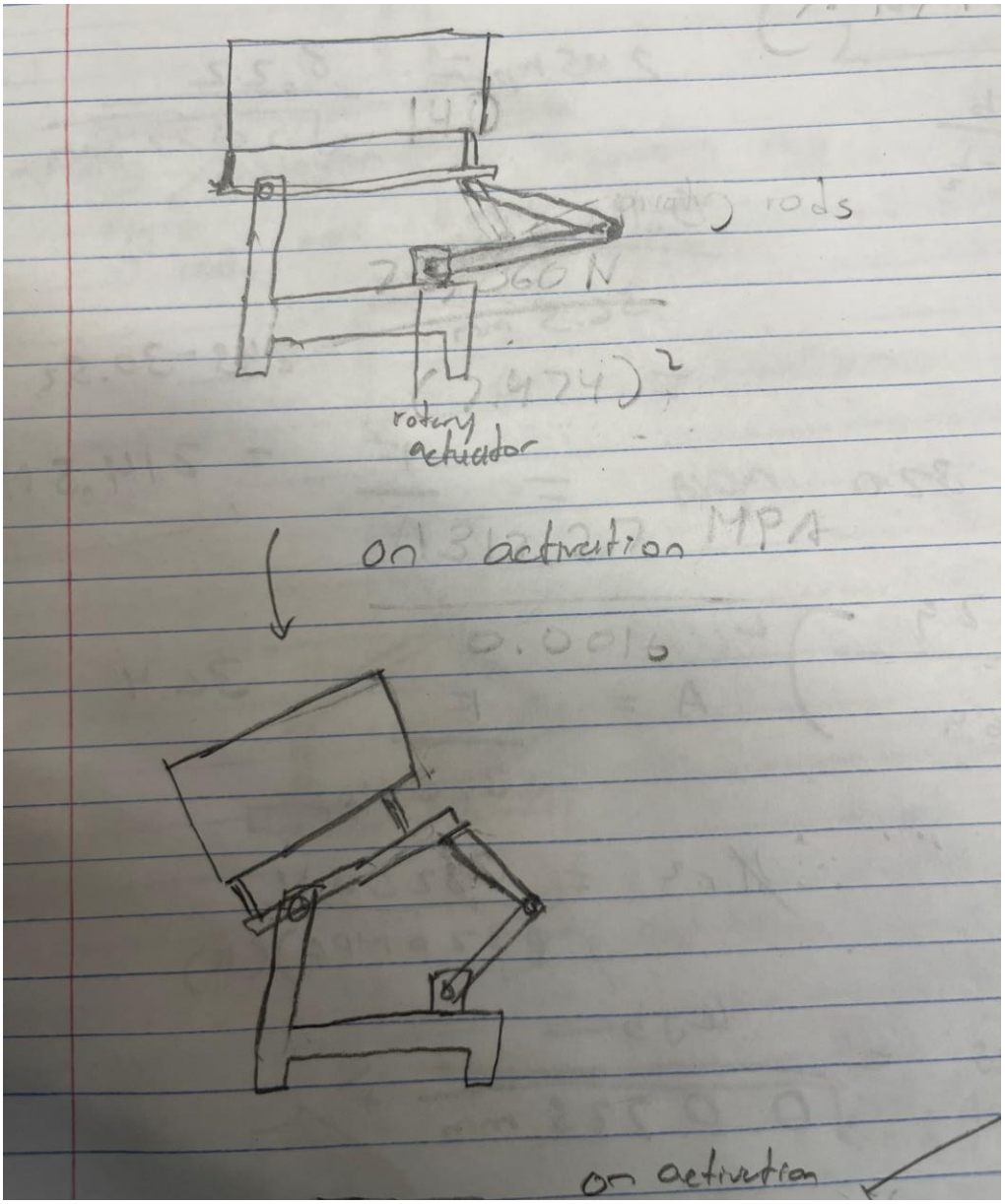
Insert picture of preliminary concept sketch below



Team ID: Mon-42

Name: Athithan Vimalananthan	MacID: vimala3

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: Mon-42

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	- Be able to identify, classify, and verify containers for recyclability. - Design a mechanism for depositing containers into a recycling bin. - Design a computer program for transferring containers to a bin in the Recycling Station.
Constraints	- Baseplate must be connected to the connecting plate. - Connecting plate must connect to the hopper and rotate about a chosen rung. - Actuator must mount to the baseplate.

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

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

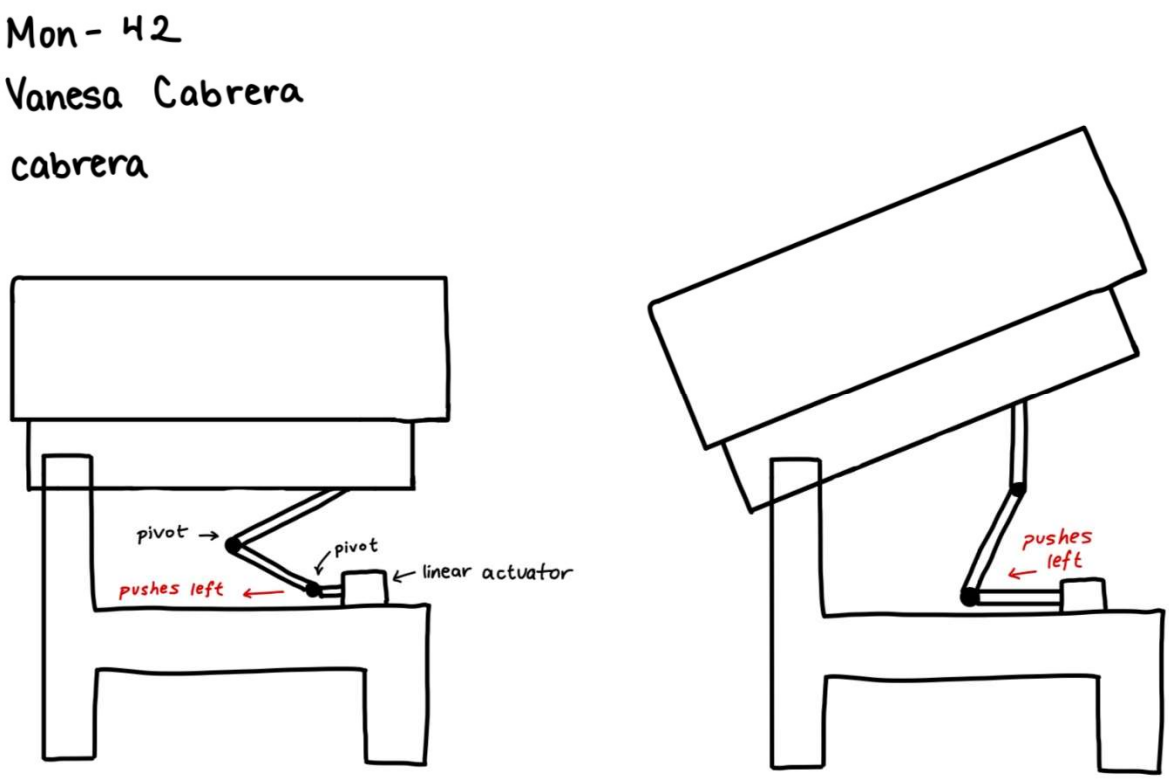
Team ID: Mon-42

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: Mon-42

Name: Vanesa Cabrera	MacID: cabrerv

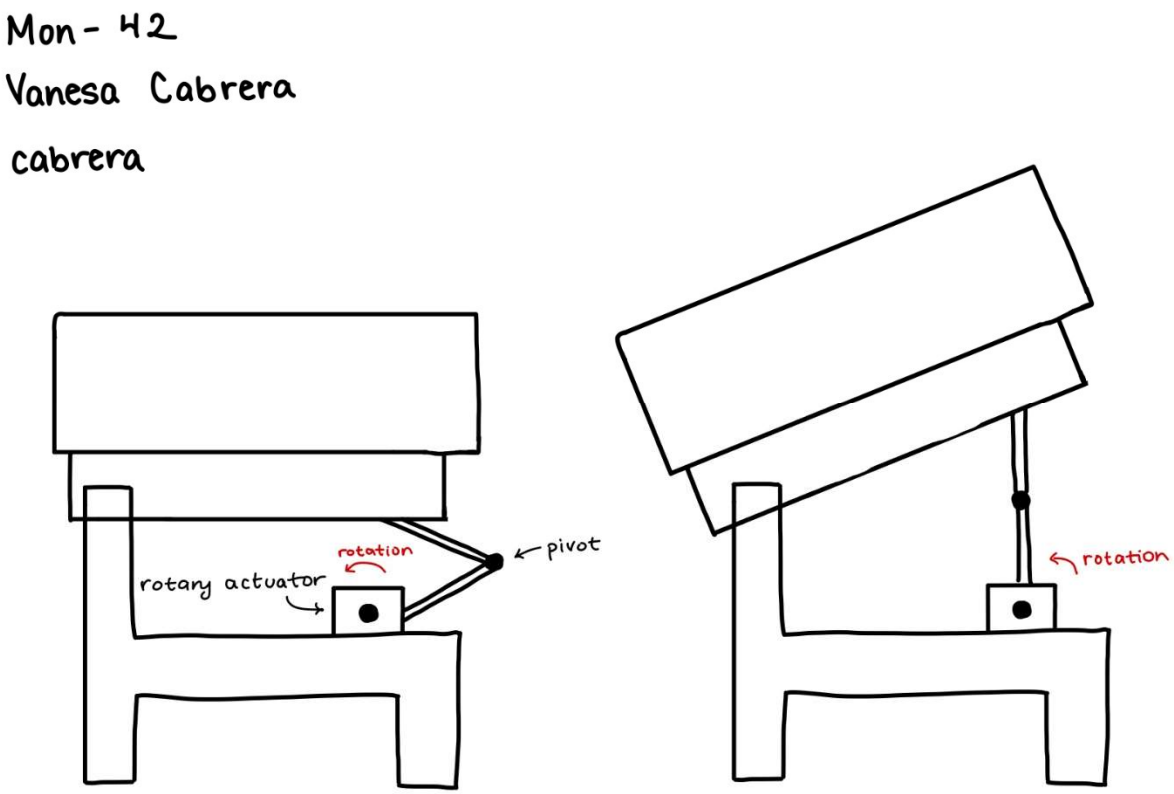
Insert picture of preliminary concept sketch below



Team ID: Mon-42

Name:	MacID:

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: Mon-42

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	• Identify the functions, constraints, and objectives and create a problem statement. • Create a pseudocode and preliminary design sketch. • Refine the concepts. • Evaluate the final designs for correctness.
Constraints	• Use either a linear actuator or rotary actuator. • Mechanism must mount to baseplate in the red zone. • Use store-bought screws. • Have the mechanism allow the hopper to rest flat.

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

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

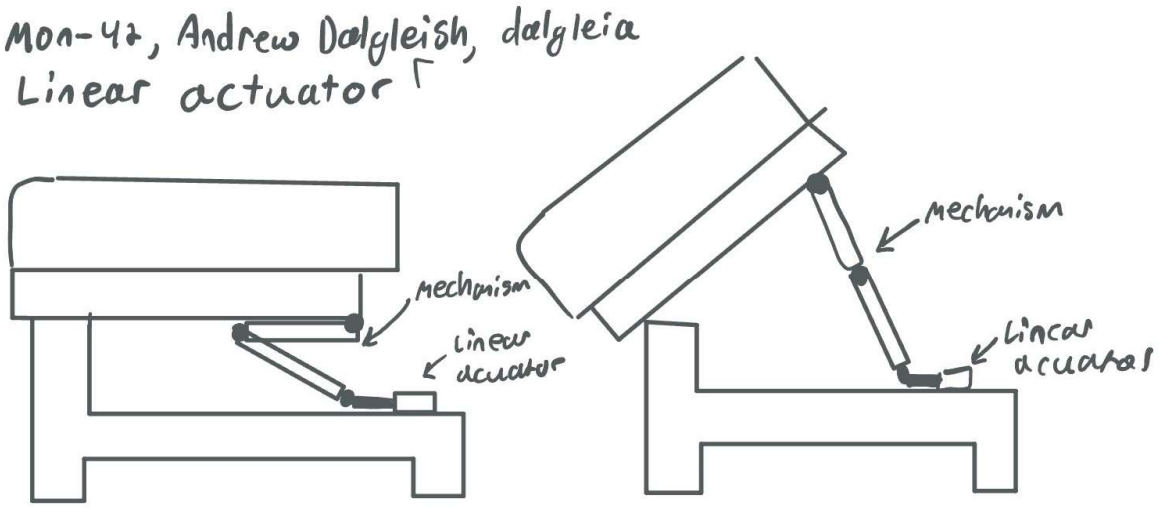
Team ID: Mon-42

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: Mon-42

Name: Andrew Dalgleish	MacID: dalgleia

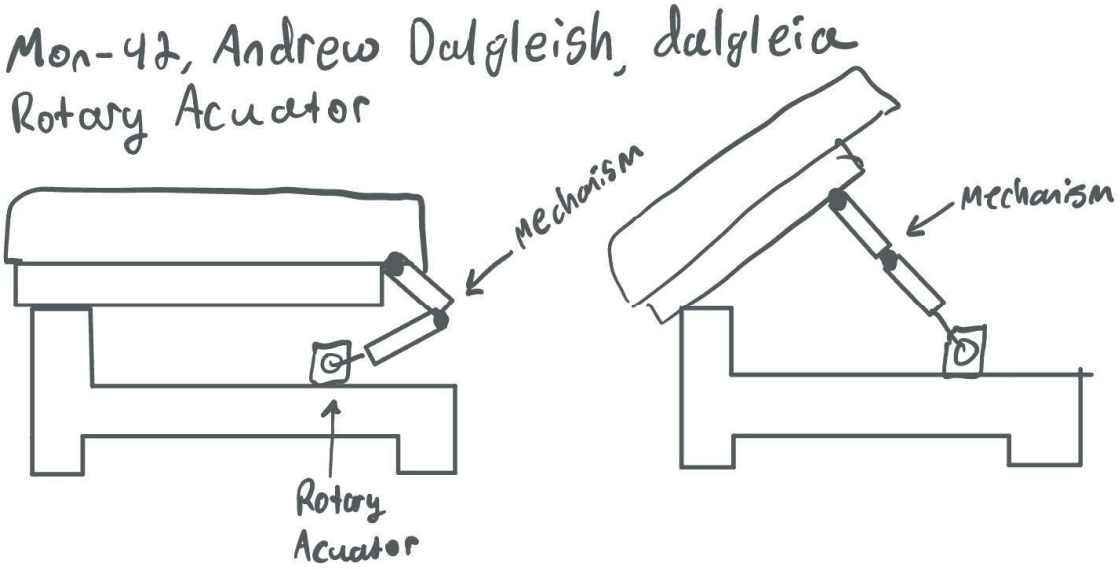
Insert picture of preliminary concept sketch below



Team ID: Mon-42

Name: Andrew Dalgleish	MacID: dalgleia

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: Mon-42

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.

To create a recycling station that has sorting capabilities to ensure the proper disposal waste.

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	- Sort waste - Eliminate the number of unrecyclable materials in landfills. - Sort containers by type.
Constraints	- Type of material - Type of sensor - Recycling object

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

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

Team ID: Mon-42

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: Mon-42

Name: Amnah Syeda	MacID: syedaa13

Sensor Type	Description	Attribute(s)
Ultrasonic	An ultrasonic sensor measures the distance to an object. If the object is not in range of the sensor, then it will return a value that is 0.	Measures and outputs distance.
LDR (light dependent resistor)	A LDR sensor analyzes the presence or absence of light. By doing this it can output a voltage value based on light that is near the sensor.	Outputs a resistance that is based on amount of light present.
Colour Sensor	A colour sensor detects light that is red, blue, and green. This sensor outputs a list that consists of RGB values, colour, and raw sensor values.	Outputs raw values of the nearest object.
Active Infrared Sensor	This sensor can detect and measure the distance of a object near the bumper of the Q-bot. By doing this it can output a distance value that is within it's range.	Outputs a voltage reading when an object is in proximity.

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: Mon-42

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.

Create a system that is capable of sorting recyclable waste.

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	- Identify bins based on properties such as mass and colour. - Transport bins to their respective containers to sort them.
Constraints	- Actuator must be present within the red zone. - Total mass of containers is less than 90g. - Should be accurate at placing and picking up items.

PROJECT THREE: MILESTONE ONE: PROBLEM FRAMING AND CONCEPTUAL DESIGN

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

Team ID: Mon-42

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: Mon-42

Name: Talha Ahmad	MacID: ahmadt20

Sensor Type	Description	Attribute(s)
Ultrasonic Sensor	Measures the distance between the sensor and the nearest object in front of it. Uses waves.	Outputs the distance from the ultrasonic sensor
Light Dependant Resistor	Measures the level of light present or absent. Outputs a value related to these.	Outputs how strong the light is in the surrounding area.
Colour Sensor	Measures the light intensity of red, green, and blue light. In other words, finds the colour of an object.	Outputs the colour of a bin.
IR Sensor	Measures and outputs infrared radiation. It uses the IR radiation from surrounding places to get distance.	Outputs how far the radiation is coming from.