Project Three – Revenge of the Recycling System:

Design a System for Sorting and Recycling Containers

ENGINEER 1P13 – Integrated Cornerstone Design Projects

Tutorial T09

Team Thurs-39

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Submitted: March 6, 2022

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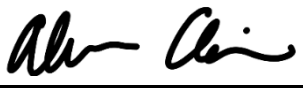
Alexandra Atkinson 400323106

X 

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x Marisa Patel

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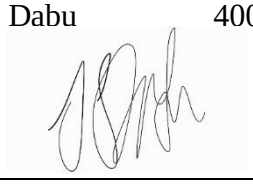
Jonah Dabu 400362008

X 

Executive Summary

Canada produces over 3 million tonnes of plastic annually, 9% of which is recycled, and the rest left in landfills, incinerated, or in the environment [1]. This happens because of the technological limitations that significantly affect a sensor's ability to identify types of plastic and its contamination level, making it difficult to sort on a large scale [1].

Thus, an effective solution to increase the amount of recycled material is to develop a reliable method of automated sorting. This design project uses a controlled environment to simulate automated sorting on a small scale by using a robot equipped with an ultraviolet, IR, colour and LDR sensor to navigate a fixed track to dump materials.

Upon exploring automated recycling and our assigned problem, our team developed a system that categorized waste and recyclables and navigated around a track to a designated bin, as well as a device that elevated a hopper to allow loaded materials to be dumped. The goal of the design was to make recycling more efficient and effective for recycling facilities to help reduce the amount of waste caused by unrecognized recycling problems.

The modelling sub-team was responsible for creating a mechanism that facilitated the movement of the hopper, making it possible to dispose of recyclables. Our device utilized the linear actuator. It featured a rod connected at one end to the actuator and the other end to the baseplate of the hopper. As the actuator translated forward, the rod pushed the hopper, creating rotation and allowing recyclables to be dumped. Pins were used to secure both ends of the rod, with small cylindrical features holding each side of the pin in place.

The computing sub-team used Python to simulate the automated disposal of waste in Quanser Interactive Labs (Q-Labs). The containers were dispensed at random on the rotary table and identified based on material and contamination level. The bin locations were determined with coordinates accessible only in the virtual environment. A Q-Arm was programmed to load up to 3 containers onto the hopper from the rotary table, with the hopper only being able to bear a weight of 90g. The built-in IR sensor was crucial in ensuring that the bot follows a fixed path, and the ultrasonic sensor assisted in positioning the bot an ideal distance away from a bin prior to disposal.

While technology is a great tool that can assist in protecting the environment, it is also important to note that technology alone should not be relied upon to solve our recycling problems. Human involvement can also boost the efficiency of recycling by properly sorting garbage and recyclables prior to collection, and thoroughly

cleaning recyclable materials before disposal. By doing so, sensors and recycling plants will be able to detect more recyclables thereby increasing the number of materials recycled.

Source Materials Database

[1] "Canada is drowning in plastic waste — and recycling won't save us" Canada's National Observer: News & Analysis [Online]. Available: https://www.nationalobserver.com/2021/03/09/canada-drowning-plastic-waste-recycling-wont-save-us [Accessed: Feb. 26, 2022].

[2] "Color sensor - Description, Working Principle & Applications." Available: https://www.elprocus.com/color-sensor-working-and-applications/ [Accessed: Jan. 19, 2022].

[3] "All About Ultrasonic Sensors & How They Work with Arduino" Arrow.com [Online]. https://www.arrow.com/en/research-and-events/articles/ultrasonic-sensors-how-they-work-and-how-to-use-them-with-arduino [Accessed: Jan. 19, 2022].

[4] D.Jost, "What is an IR sensor?," Fierce Electronics [Online]. Available: https://www.fierceelectronics.com/sensors/what-ir-sensor. [Accessed: January 20, 2022].

[5] L. Ada, "IR sensor," adafruit [Online]. Available: https://learn.adafruit.com/ir-sensor. [Accessed: Jan. 19, 2022].

[6] WatElectronics, "What is a Light Dependent Resistor and Its Applications," WatElectronics.com [Online]. Available: https://www.watelectronics.com/light-dependent-resistor-ldr-with-applications/. [Accessed: January 20, 2022].

Appendix A – Supporting documents

Computing: Bonus Assignment Modified Program

```
'''
P3 BONUS code
'''
def transfer_container():
    colour = [1,0,0] #red
    f_speed = 0.1
    t_speed = 0.03
    bot.activate_colour_sensor()
    while bot.read_colour_sensor()[0] != colour:
        bot.set_wheel_speeds[f_speed,f_speed]
        if bot.line_following_sensors()[0] < 1: #if left side does not detect yellow
            bot.set_wheel_speed([t_speed, 0]) #only left wheel spin
        elif bot.line_following_sensors()[1] < 1: #if right side does not detect yellow
            bot.set_wheel_speed([0, t_speed]) #only right wheel spin
    bot.deactivate_colour_sensor()
    bot.stop()

def dump_container(): # dumping mechanism of the Q-bot
    time_extend = 5
    dump_time = 1
    bot.activate_linear_actuator()
    bot.linear_actuator_out(time_extend) #extend the linear actuator
    time.sleep(dump_time) #let the containers fall
    bot.linear_actuator_in(time_extend) #retract the linear actuator
    bot.deactivate_linear_actuator()

def follow_line()
    f_speed = 0.1 #forward speed of the Q-bot
    t_speed = 0.03 # turning speed of the Q-bot
    while True:
        bot.set_wheel_speeds[f_speed,f_speed]
            if bot.line_following_sensors()[0] < 1: #if left side does not detect yellow
                bot.set_wheel_speed([t_speed, 0.0]) #only left wheel spin
            elif bot.line_following_sensors()[1] < 1: #if right side does not detect yellow
                bot.set_wheel_speed([0.0, t_speed]) #only right wheel spin
```

Figure 1. Modified program for bonus assignment

Computing: Final Python Program Code

```
import random

#Q-arm loads the container on the Q-bot
#Harnoor
def load_container(container):
    #Set of instructions to load the container

    arm.rotate_shoulder(30)
    arm.rotate_elbow(-20)
    arm.rotate_shoulder(15)
    arm.rotate_elbow(-5)
    time.sleep(1)
    arm.control_gripper(33)
    time.sleep(2)
    arm.rotate_shoulder(-4)
    time.sleep(2)
    arm.rotate_base(-21)
    time.sleep(1)

    if container == 1:#if its the first container: Q-arm's base rotates -58 deg
        arm.rotate_shoulder(-35)
        arm.rotate_elbow(-30)
        arm.rotate_base(-67.5)
        time.sleep(2)
        arm.rotate_shoulder(27.45)
        time.sleep(1)
        arm.rotate_elbow(4)

    elif container ==2: #if it's the second container do the following:
        arm.rotate_shoulder(-35)
        arm.rotate_elbow(-20)
        arm.rotate_base(-67.5)
        time.sleep(1)
        arm.rotate_shoulder(10)
        time.sleep(2)
        arm.rotate_elbow(20)
        time.sleep(2)
        arm.rotate_shoulder(3.5)


    else:# if its the third container do the following:
        arm.rotate_shoulder(-30)
        arm.rotate_elbow(-20)
```

Figure 2. Final Computer program code, Part 1, for load_container function

```
        arm.rotate_base(-67.5)
        time.sleep(1)
        arm.rotate_shoulder(-5)
        time.sleep(1)
        arm.rotate_elbow(30)
        time.sleep(2)
        arm.rotate_shoulder(5)
        time.sleep(2)
        arm.rotate_elbow(5)
    time.sleep(2)
    arm.control_gripper(-33)
    time.sleep(2)
    arm.rotate_elbow(-10)
    time.sleep(1)
    arm.rotate_shoulder(4)
    time.sleep(1)
    arm.rotate_shoulder(-25)
    arm.home()




'''
bin coords:
(distance away from arm, distance to the left or right of the arm, not important) destination
(1.4999991655349731, -1.7634034520597197e-05, 0.000753488508053124) home
(1.0236483812332153, 0.7021444439888, 0.0007551956223323941) bin 01
(0.1163836419582367, 0.7502954006195068, 0.0007509040879085666) bin 02
(0.00896493624895811, -0.7189100384712219, 0.0007516765617765486) bin 03
(1.0361676216125488, -0.7378526926040649, 0.0007469367701560259) bin 04
'''

#Jonah
def transfer_container(binid): #checks for the bin id and accordingly the Qbot dumps the containers in the correct bin
    bins = [(1.0236483812332153, 0.7021444439888, 0.0007551956223323941),\
            (0.1163836419582367, 0.7502954006195068, 0.0007509040879085666),\
            (-0.05993827059864998, -0.7251179814338684, 0.0007569408044219017),\
            (1.0361676216125488, -0.7378526926040649, 0.0007469367701560259)]
    f_speed = 0.15 #forward speed of the Q-bot
    t_speed = 0.03 # turning speed of the Q-bot
    threshold = 0.0005
```

Figure 3. Final Computer program code, Part 2, defining the bin coordinates for transfer_container function

```
    if binid == 1 or binid == 2:
        #go to first or second bin
        while bot.position()[0] >= (bins[binid-1][0] - threshold) and bot.position()[1] <= (bins[binid-1][1] - threshold):
            if bot.line_following_sensors()[0] < 1: #if left side does not detect yellow
                bot.set_wheel_speed([t_speed, 0.0])
            elif bot.line_following_sensors()[1] < 1: #if right side does not detect yellow
                bot.set_wheel_speed([0.0, t_speed])
            else:
                bot.set_wheel_speed([f_speed,f_speed])
        bot.stop()

    elif binid ==3 or binid == 4 :
        #go to third or fourth bin
        while bot.position()[1] > (bins[binid-1][1] - threshold):
            if bot.line_following_sensors()[0] < 1: #if left side does not detect yellow
                bot.set_wheel_speed([t_speed, 0.0])
            elif bot.line_following_sensors()[1] < 1: #if right side does not detect yellow
                bot.set_wheel_speed([0.0, t_speed])
            else:
                bot.set_wheel_speed([f_speed,f_speed])
        while bot.position()[0] < (bins[binid-1][0]):
            if bot.line_following_sensors()[0] < 1: #if left side does not detect yellow
                bot.set_wheel_speed([t_speed, 0.0])
            elif bot.line_following_sensors()[1] < 1: #if right side does not detect yellow
                bot.set_wheel_speed([0.0, t_speed])
            else:
                bot.set_wheel_speed([f_speed,f_speed])
        bot.stop()

        print("transfer container")


#Jonah
def dump_container(): # dumping mechanism of the Q-bot
    print("dumping")
    degrees = 0
    rotate_step = -5
    while bot.depth() > 0.15: #until it is 0.165m away from the bin
        bot.rotate(rotate_step)
        degrees -= rotate_step
        time.sleep(0.05)
    while bot.depth() > 0.1: #get the bot close to the bin for dumping
        bot.set_wheel_speed([0.02, 0.02])
```

Figure 4. Final Computer program code, Part 3, dump_container function

```
    bot.stop()
    bot.rotate(degrees)
    bot.activate_linear_actuator()
    bot.dump()
    #if the bin offset is small:
    while bot.line_following_sensors() != [1,1]:
        bot.rotate(5)

#Jonah and Harnoor
def return_home(): #Bot returns to home postion after dumping
    print("Returning home")
    home = (1.4999991655349731, -1.7634034520597197e-05, 0.000753488508053124) #coordinates of the home position
    thresholdy = 0.045
    thresholdx = 0.0065
    f_speed = 0.15 #forward speed
    t_speed = 0.03 #turning speed

    while (bot.position()[0] == home[0]) or (bot.position()[0] <= (home[0] - thresholdy)):
        if bot.line_following_sensors()[0] < 1: #if left side does not detect yellow
            bot.set_wheel_speed([t_speed, 0.0])
        elif bot.line_following_sensors()[1] < 1: #if right side does not detect yellow
            bot.set_wheel_speed([0.0, t_speed])
        else:
            bot.set_wheel_speed([f_speed, f_speed])
    while (bot.position()[1] == home[1]) or(bot.position()[1] < (home[1]+ thresholdx)):
        if bot.line_following_sensors()[0] < 1:#if left side does not detect yellow
            bot.set_wheel_speed([t_speed, 0.0])
        elif bot.line_following_sensors()[1] < 1:#if right side does not detect yellow
            bot.set_wheel_speed([0.0, t_speed])
        else:
            bot.set_wheel_speed([f_speed, f_speed])
    bot.stop()
    print("I'm home")

#Harnoor
def main():

    Previous_matid = 0 #variable used to compare material id
    container_num=0 #variable that stores the amount of containers
    total_weight = 0 #weight must be less than 90g, the weight on the bot
    weight = 0 #stores the weight of the container that was last dispensed
    #everything below is the process of doing infinite runs until the user closes the python shell
    while True:
```

Figure 5. Final Computer program code, Part 4, return_home function

```
        while container_num<=3: #while there are less than or equal to three containers on the Qbot
            matid = random.randint(1,6) #generate an random container id from 1 to 6
            print("Material id is", matid)


            if (container_num == 0 and weight<=0): #if there is only one container on the table (procedure to load the first container)
                properties = table.dispense_container(matid, True) #variable that contains material id, weight, and bin id
                total_weight += properties[1] #add container weight to total weight on the hopper
                weight =properties[1]
                if properties[2] == 'Bin01': #get bin id and assign integer value for the bot to determine the bin location
                    binid = 1
                    Previous_matid = matid #store the current binid to compare for the next bin
                    container_num += 1 # increment the number of containers on the hopper by 1
                    load_container(container_num)
                    weight = 0
                elif properties[2] == 'Bin02': #get bin id and assign integer value for the bot to determine the bin locaton
                    binid = 2
                    Previous_matid = matid #store the id of current container to compare for the next bin
                    container_num += 1 # increment the number of containers on the hopper 1
                    load_container(container_num)
                    weight = 0
                elif properties[2] == 'Bin03': #get bin id and assign integer value for the bot to determine the bin location
                    binid = 3
                    Previous_matid = matid #store the id of current container to compare for the next bin
                    container_num += 1 #increment the number of containers on the hopper by 1
                    load_container(container_num)
                    weight = 0
                else: #if garbage
                    binid = 4
                    Previous_matid = matid #store the id of current container to compare for the next bin
                    container_num += 1 #increment the number of containers by 1
                    load_container(container_num)
                    weight = 0

            elif(weight>0 and container_num==0): #if there's a container present on the hopper
                container_num +=1 #total weight on the hopper is reset to start a new round
                load_container(container_num)
                total_weight +=weight


            else : #if a container is already on the hopper
                #checks to see if the containers are going to the same bin and have the weight less than or equal to 90g:
```


Figure 6. Final Computer program code, Part 5, main function

```
                if ((matid == 2 and Previous_matid == 5)or (Previous_matid == 2 and matid == 5)):
                    if (total_weight<=90):
                        load = True#holds a boolean to see if the next bottle should be loaded to the hopper or not
                elif ((matid == 4 and Previous_matid ==6) or (Previous_matid == 4 and matid ==6)):
                    if(total_weight<=90):
                        load = True
                elif (matid == Previous_matid):
                    if(total_weight<=90):
                        load = True
                else:
                    load = False

                if load ==True:

                    #compare the new bin destination with previous bin destination
                    properties = table.dispense_container(matid, True)# if bin ids are same dispense container
                    weight = properties[1]
                    total_weight += properties[1]# add the weight to the toal weight

                    if container_num < 3:
                        container_num += 1 #increment the number of containers on the hopper by 1
                        load_container(container_num)
                        weight= 0

                    else: #if there are already three containers
                        container_num = 0 #number of containers is reset to start a new round
                        total_weight = 0 #total weight on the hopper is reset to start a new round
                        break

                else: #if bin destinations are different and the weight is greater than 90
                    container_num = 0#number of containers is reset to start a new round
                    total_weight = 0#total weight on the hopper is reset to start a new round
                    break

        print("I'm going to bin:", binid)
        transfer_container(binid)
        dump_container()
        return_home()
#--------------------------------------------------------------------------
# STUDENT CODE ENDS
#--------------------------------------------------------------------------
```

Figure 7. Final Computer program code, Part 6, main function continued

Modelling: Physical Mechanism

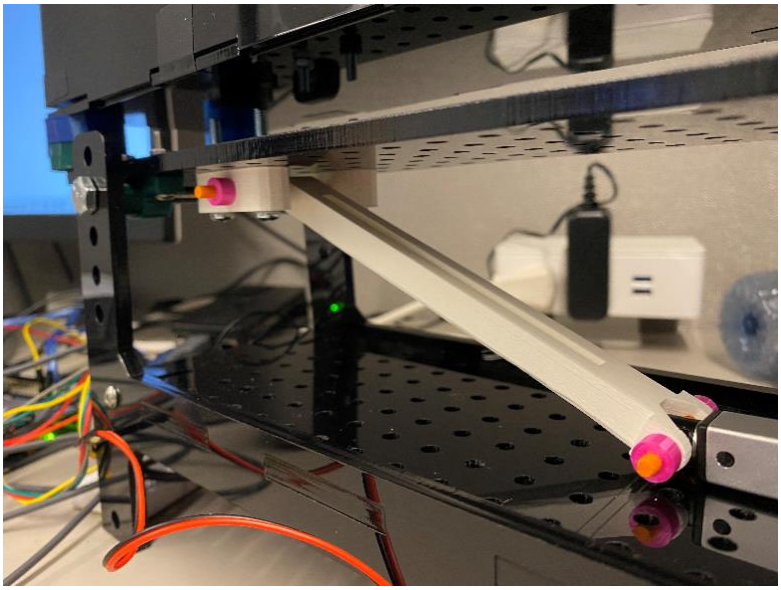


Figure 8. Physical mechanism

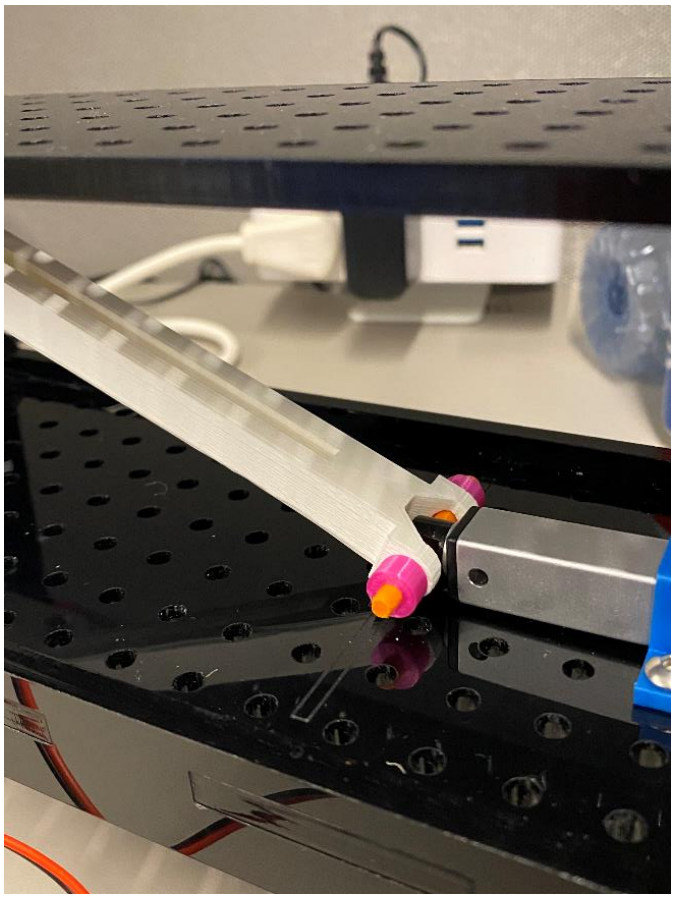


Figure 9. Physical mechanism close up

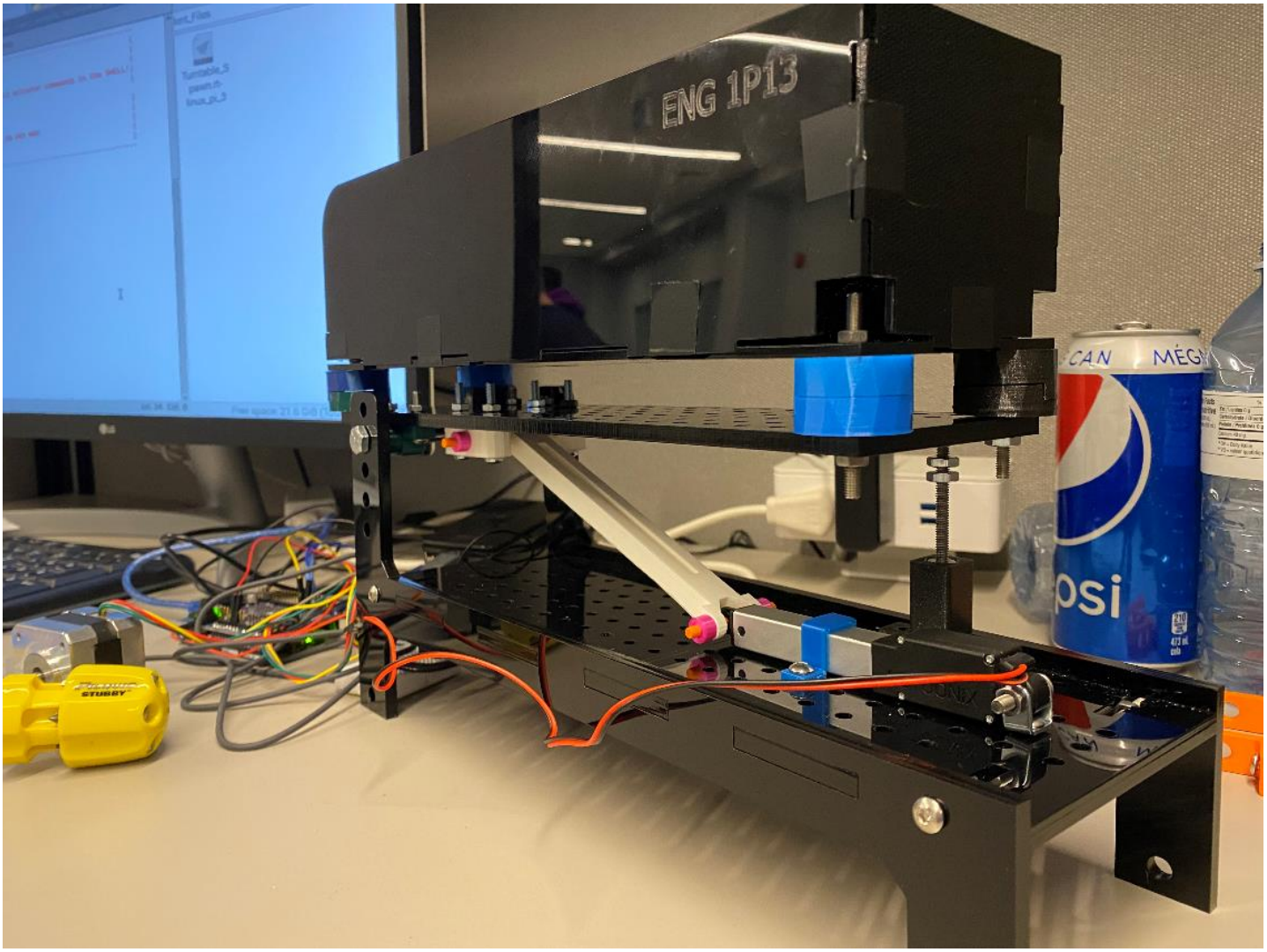


Figure 10. Physical mechanism side view

Modelling: AutoDesk Inventory Assembly of Parts

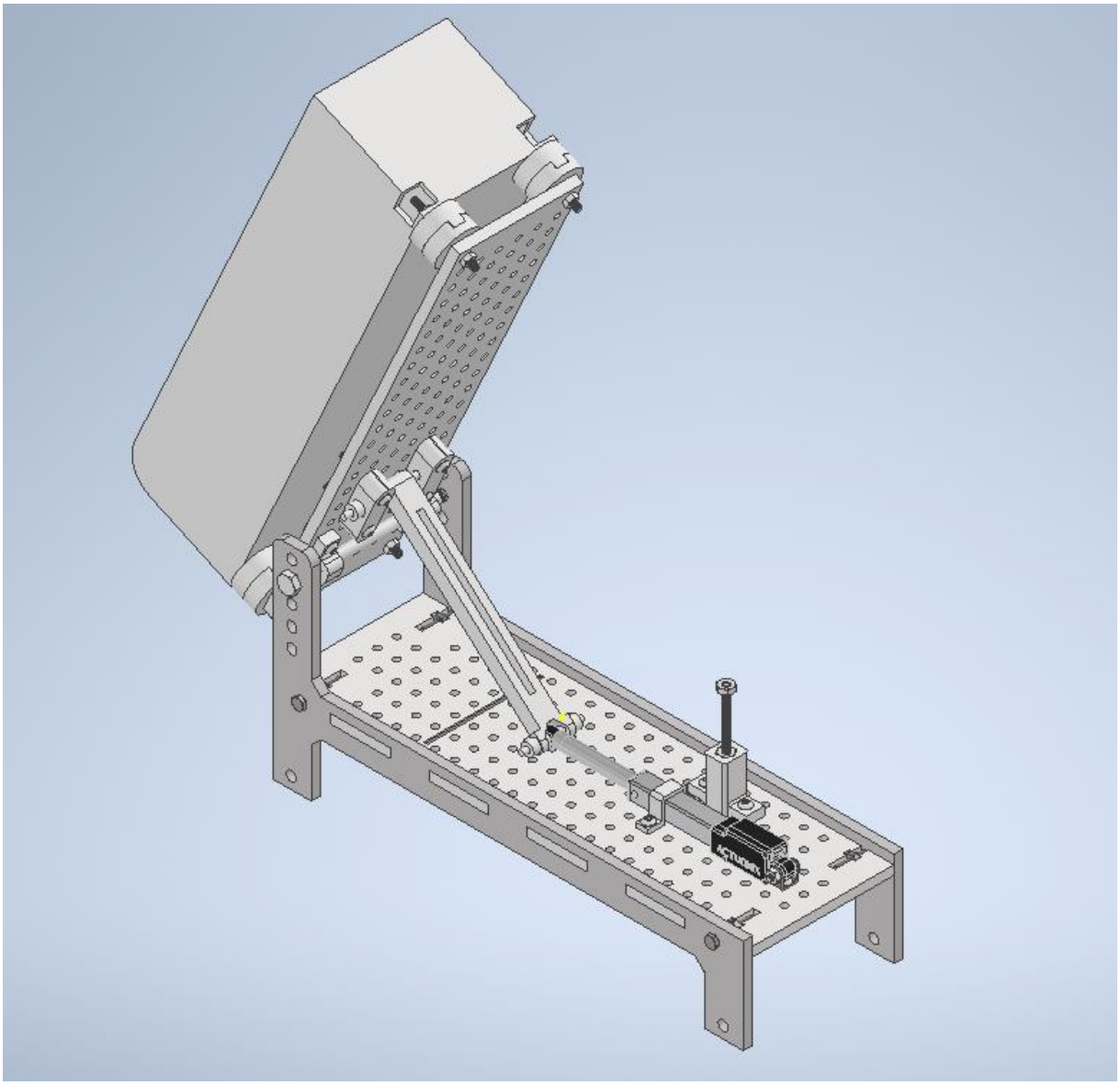


Figure 11. Screenshot of our design from the home view

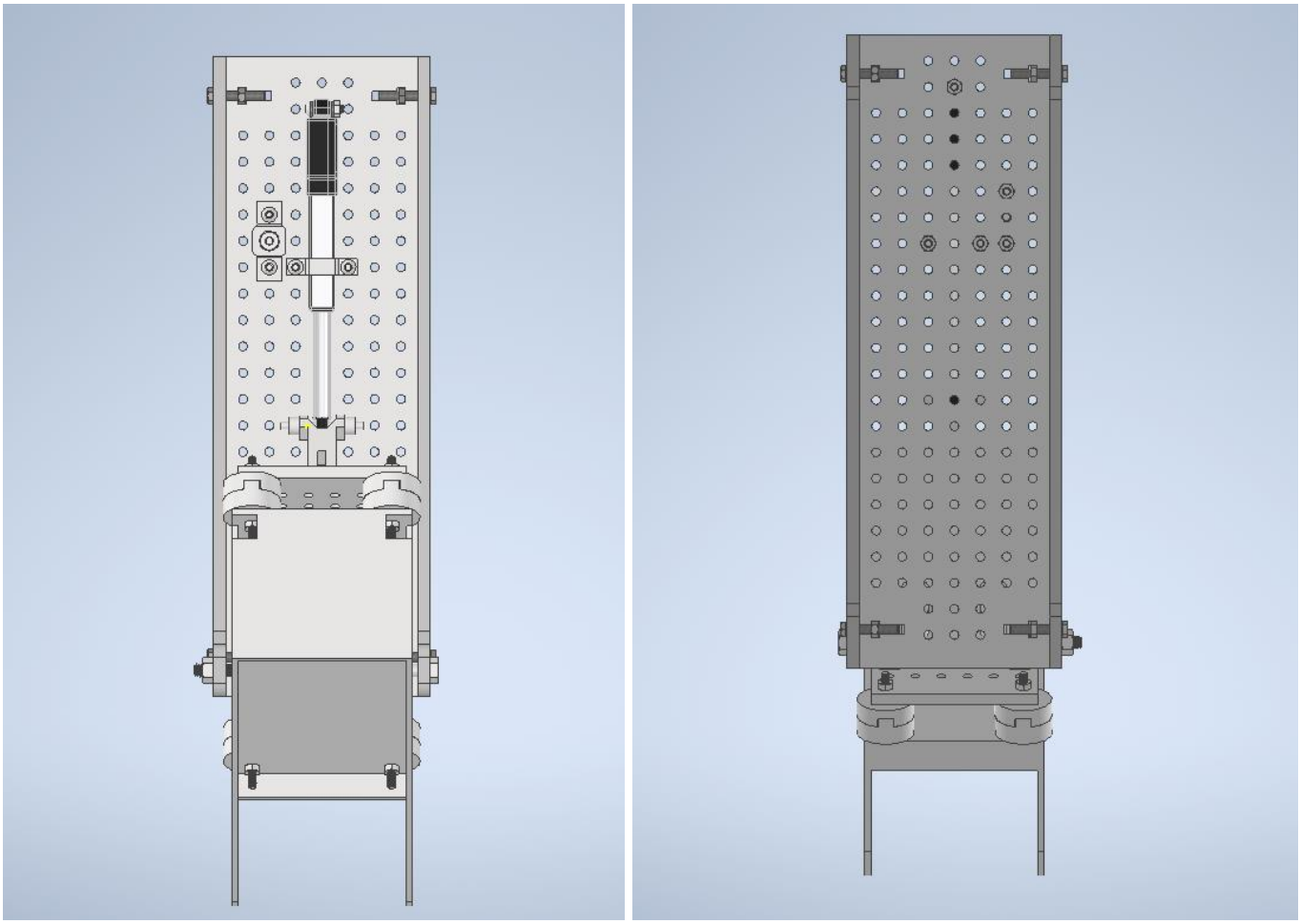


Figure 12. Top and bottom view of the design

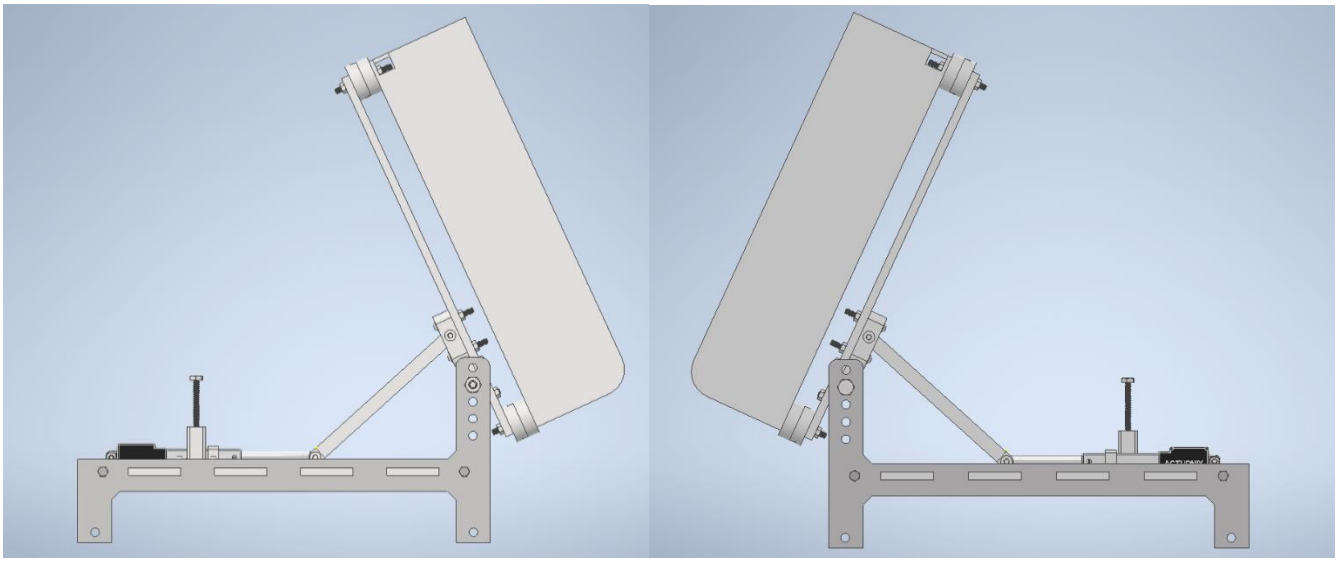


Figure 13. Left and right view of the design

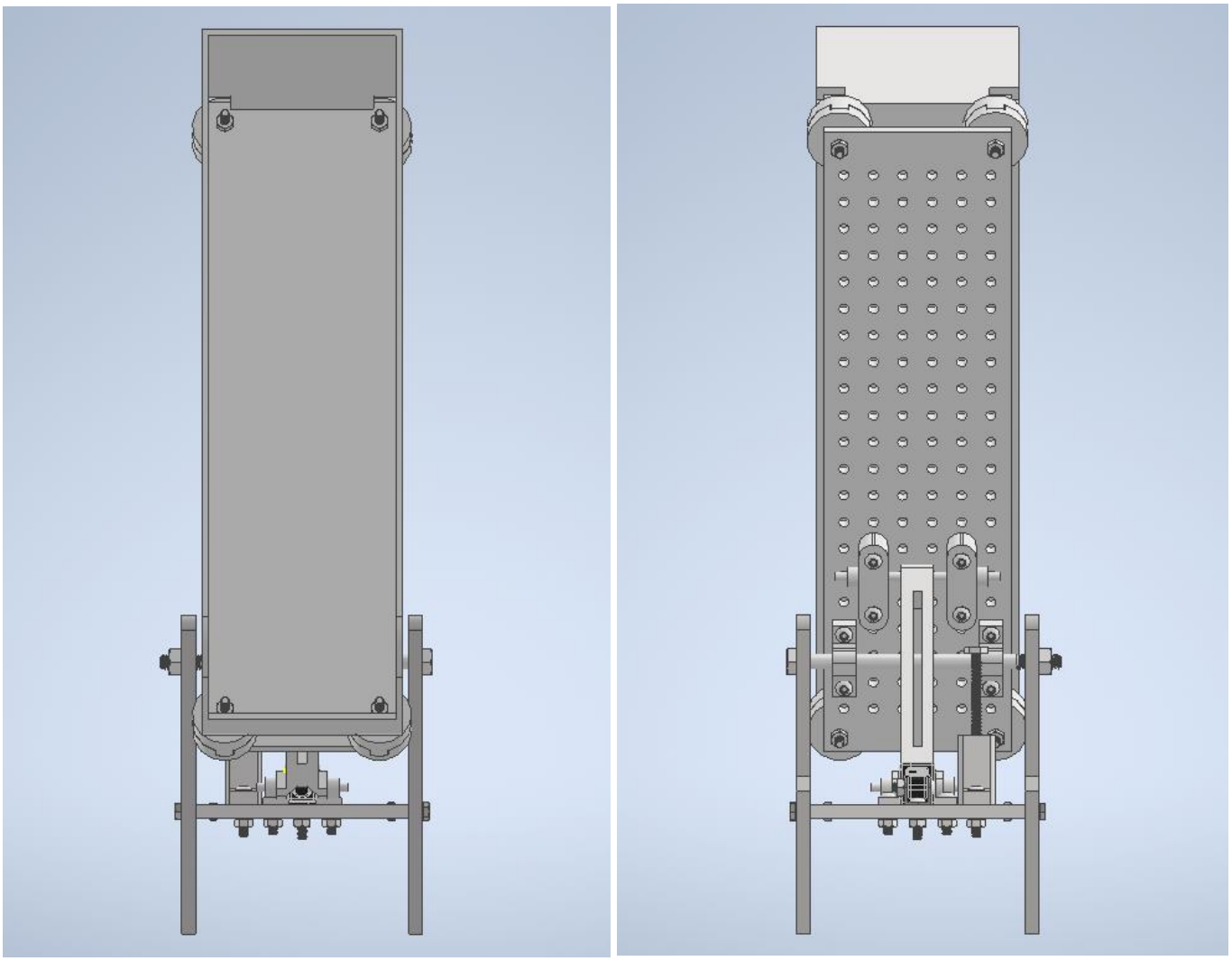


Figure 14. Front and back view of the design

Modelling: AutoDesk Inventor Individual Parts of Mechanism

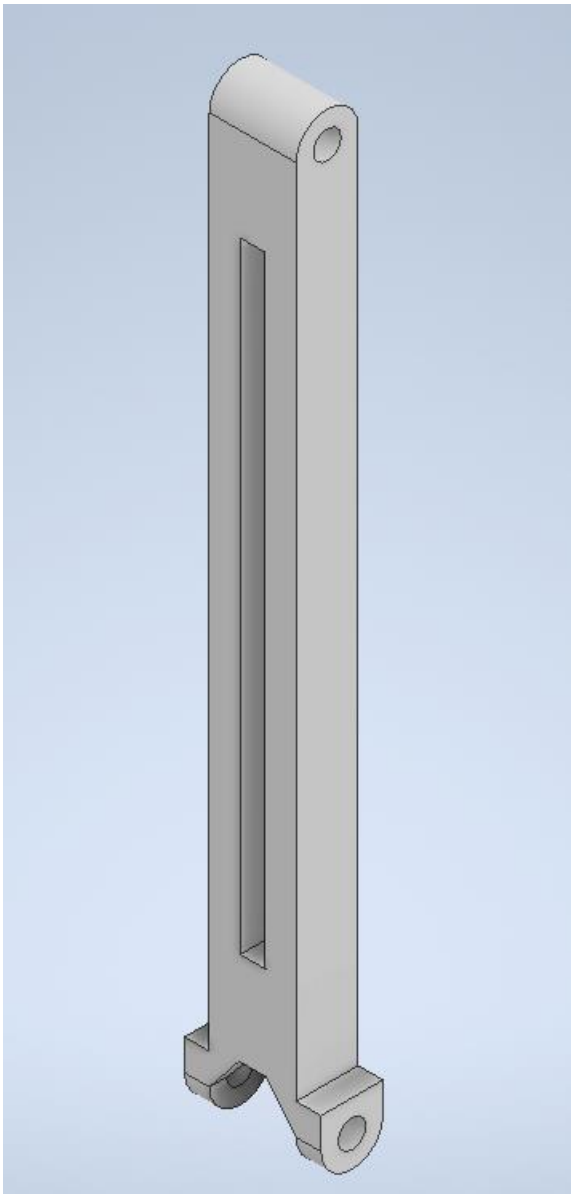


Figure 15. Rod

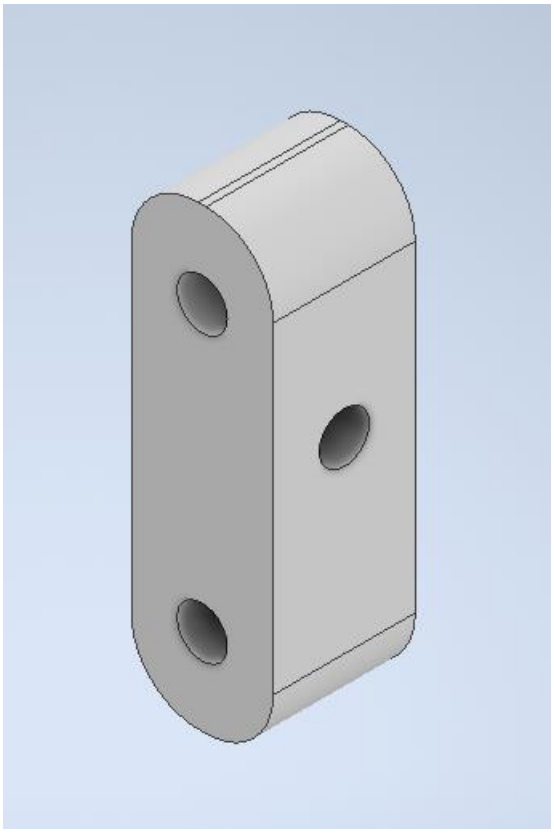


Figure 16. Slider

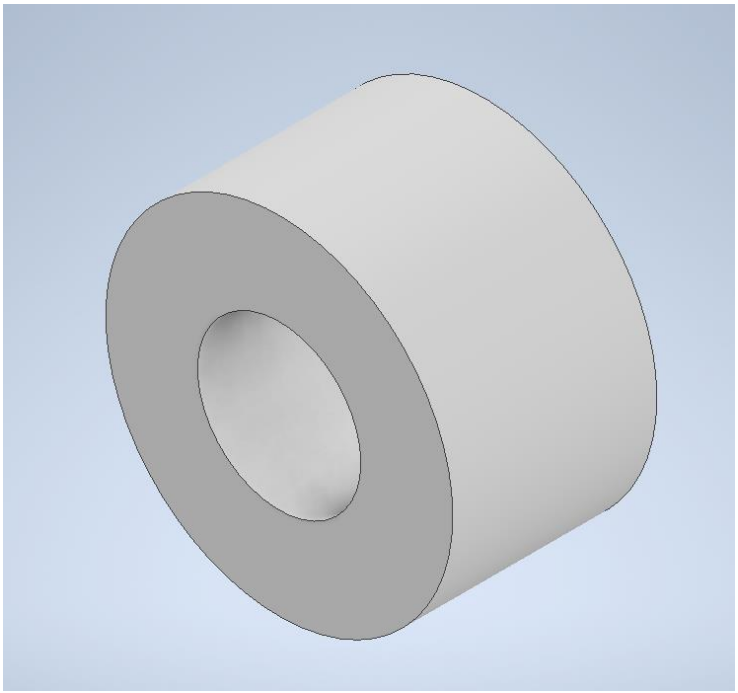


Figure 17. Pin Securing Piece

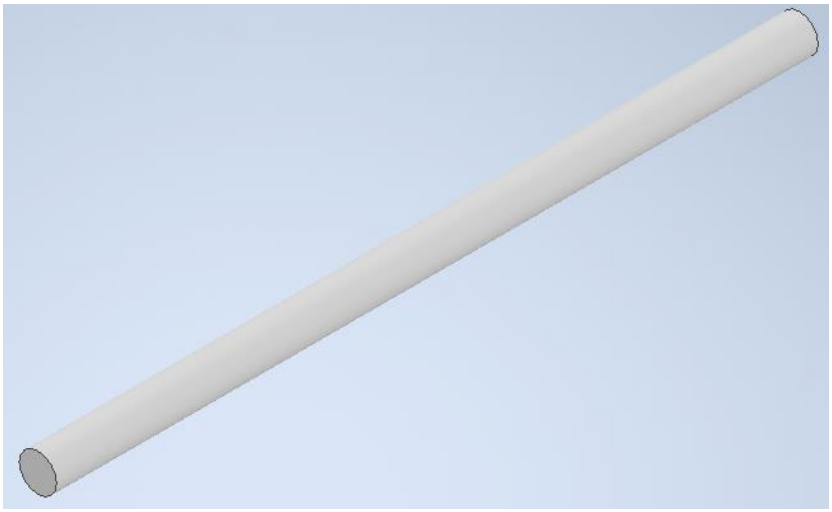


Figure 18. Cylindrical Pin

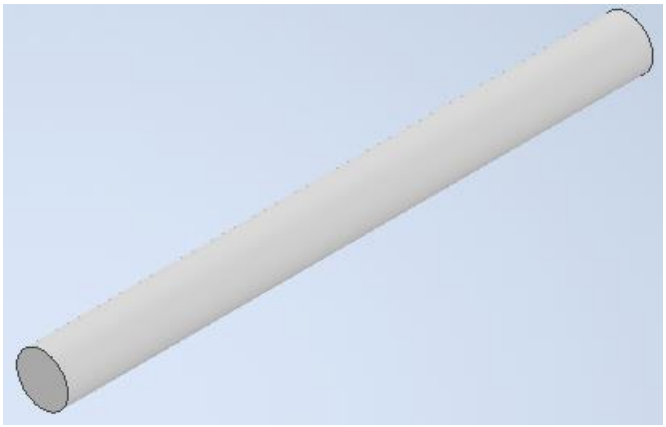


Figure 19. Cylindrical Pin Actuator Piece

Modelling: Engineering Drawings

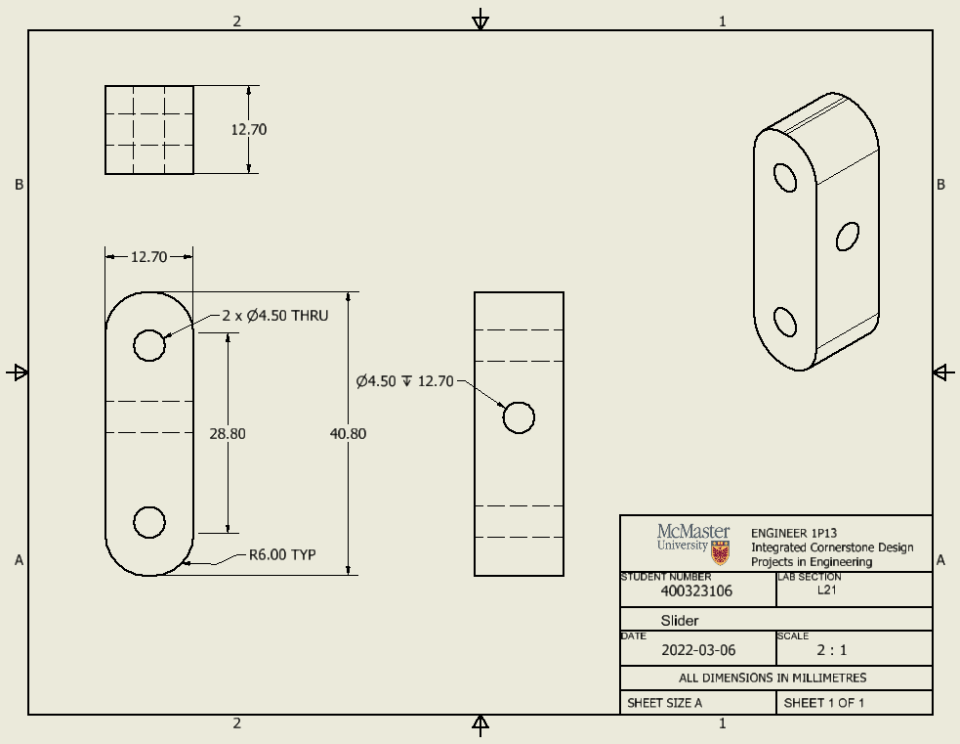


Figure 20. Engineering Drawing of the Slider

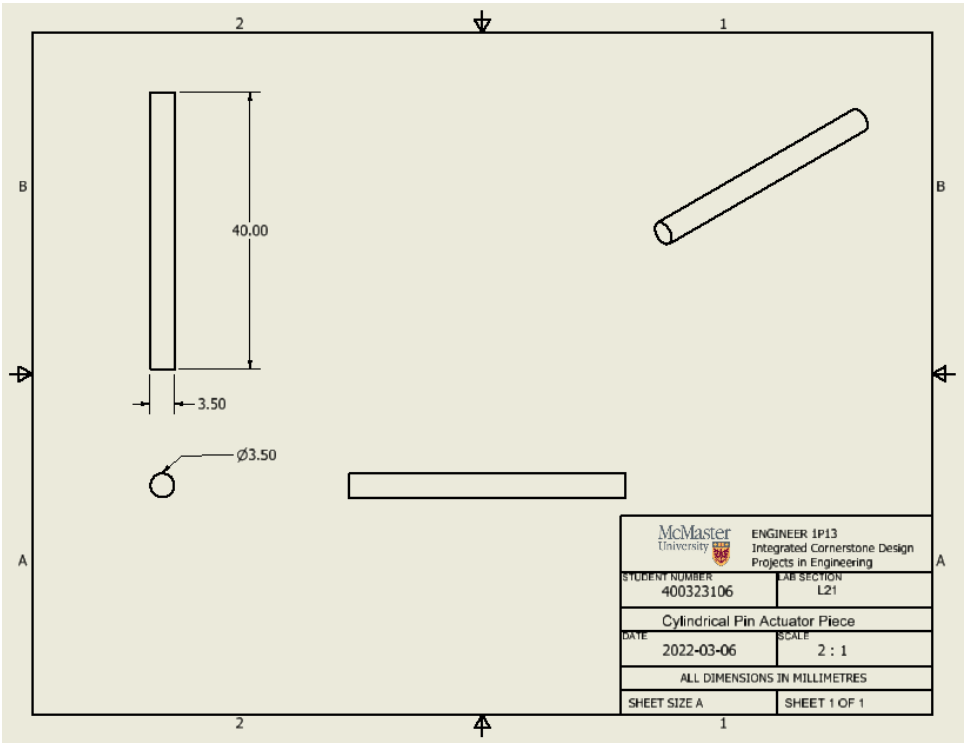


Figure 21. Engineering Drawing of the Cylindrical Pin Actuator Piece

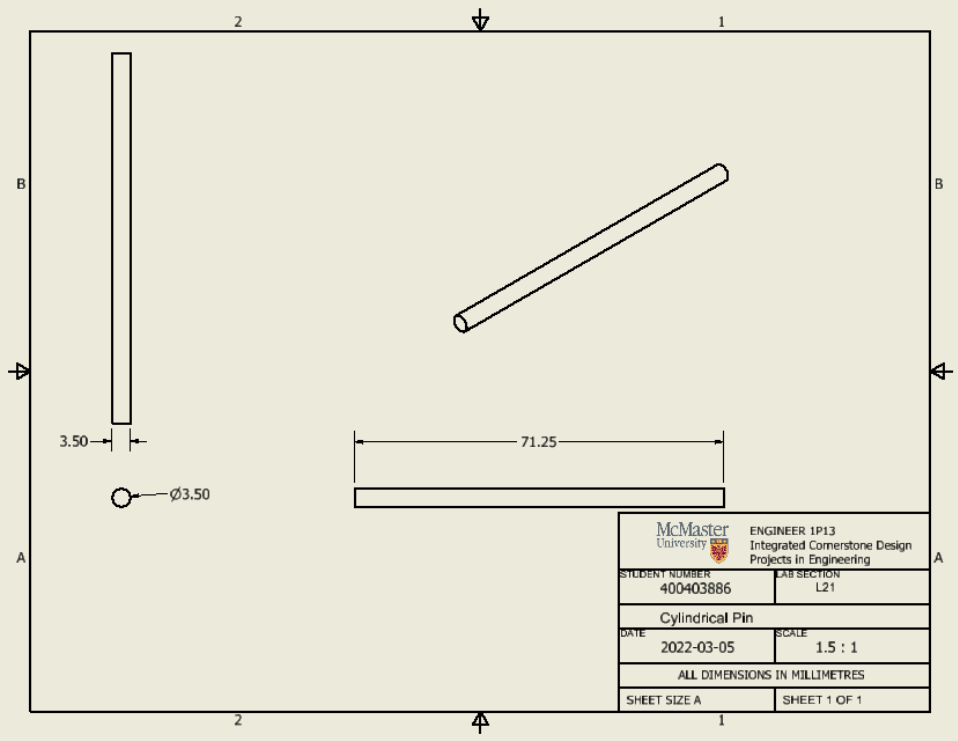


Figure 22. Engineering Drawing of the Cylindrical Pin

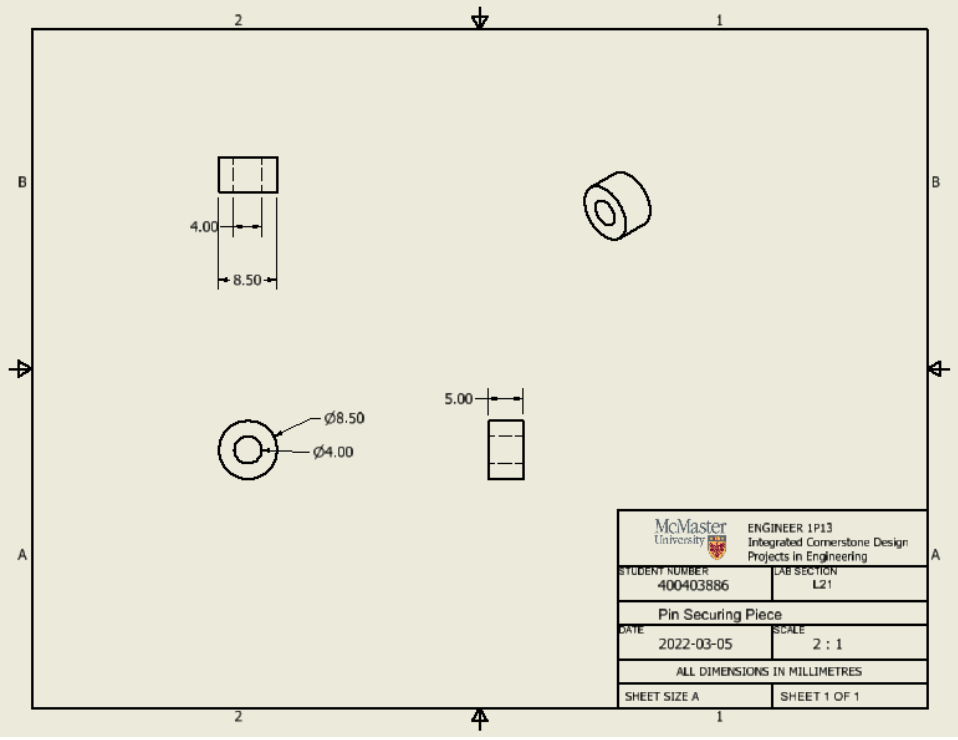


Figure 23. Engineering Drawing of the Pin Securing Piece

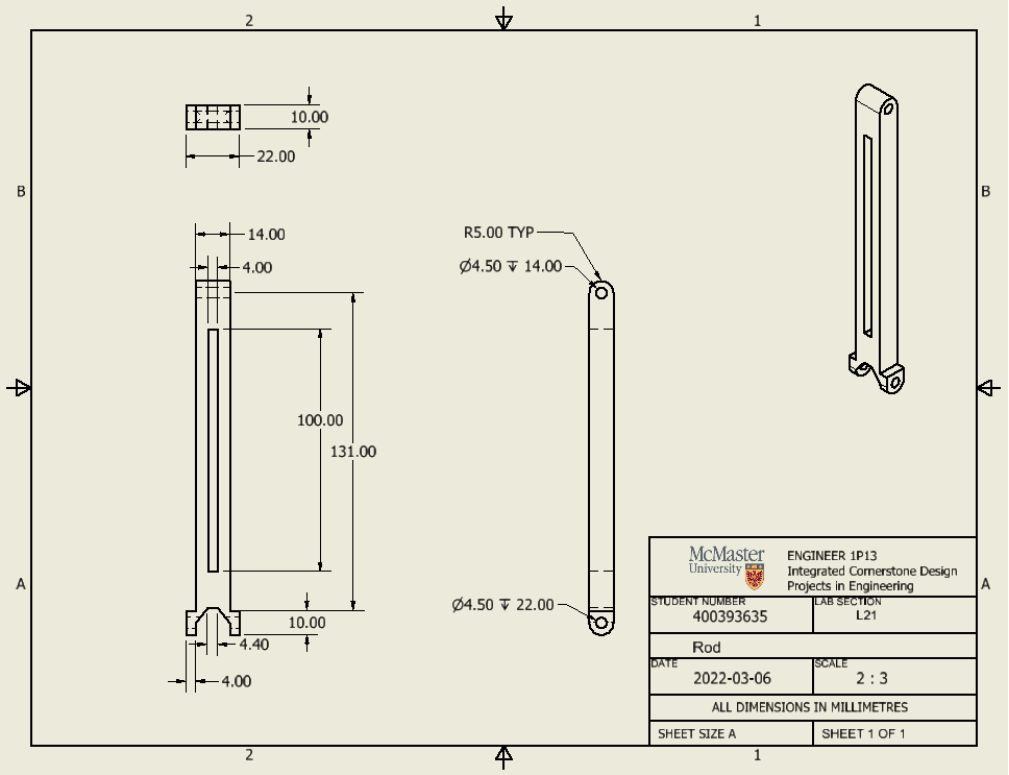
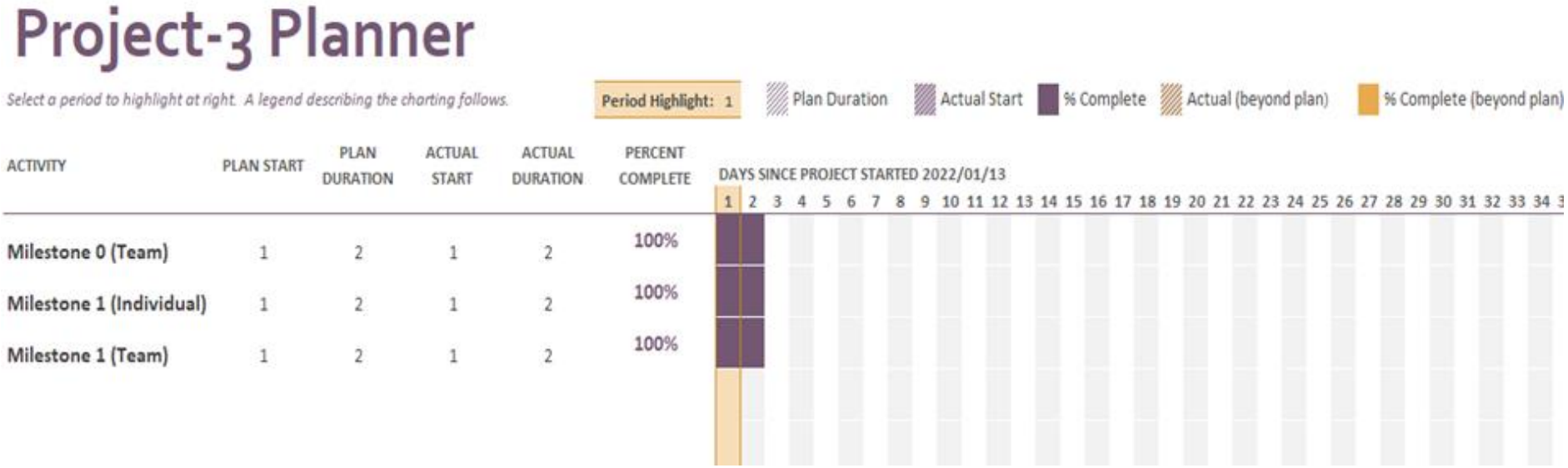


Figure 24. Engineering Drawing of the Rod

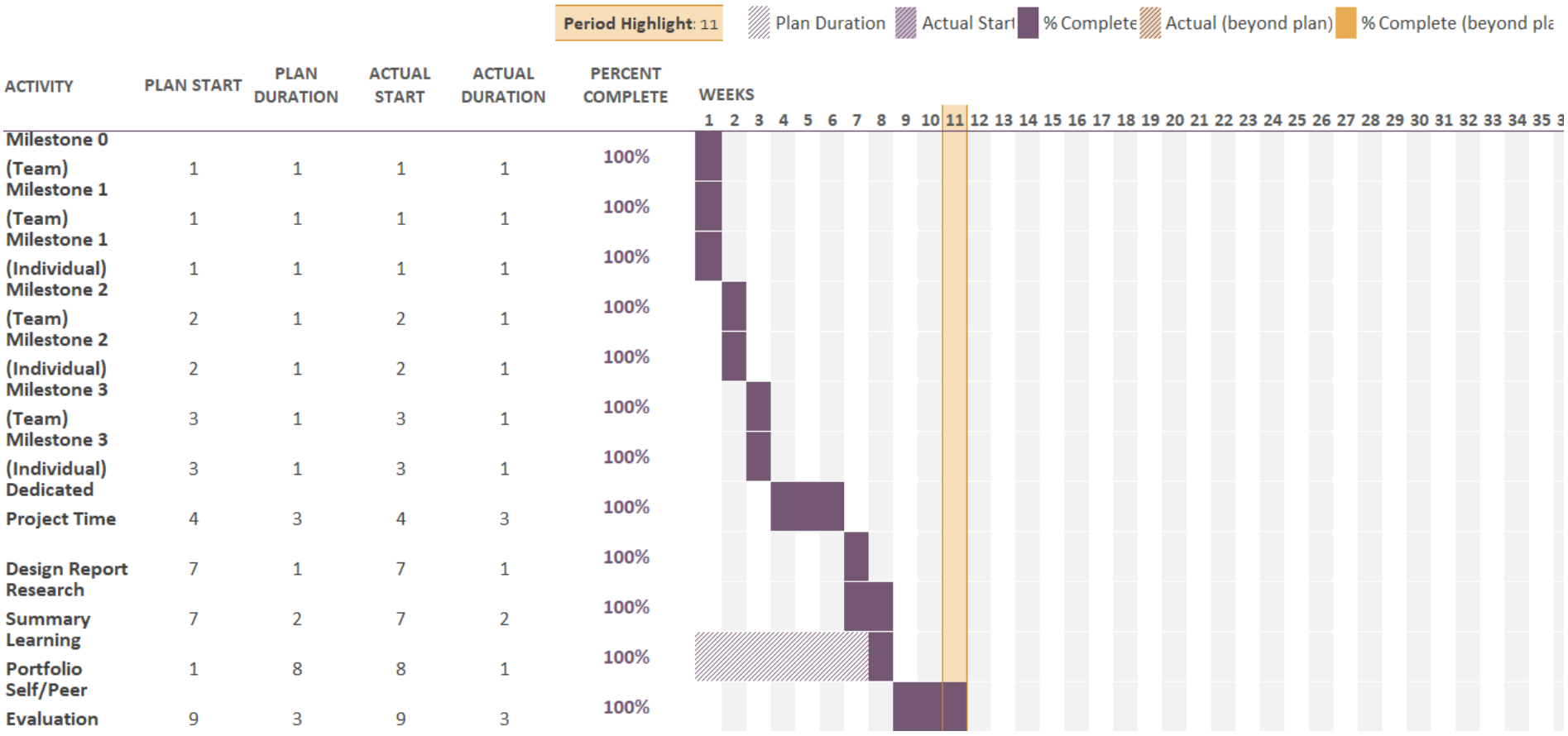
Appendix B – Project Schedule

Preliminary Gantt Chart



Final Gantt Chart

Final Gantt Chart



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)	2	1	2	1	100%
Milestone 2 (Individual)	2	1	2	1	100%
Milestone 3 (Team)	3	1	3	1	100%
Milestone 3 (Individual)	3	1	3	1	100%
Dedicated Project Time	4	3	4	3	100%
Design Report Research	7	1	7	1	100%
Summary Learning	7	2	7	2	100%
Portfolio Self/Peer	1	8	8	1	100%
Evaluation	9	3	9	3	100%

Logbook of Additional Meetings and Discussions: Computing Team

Date	Type of communication	Duration	Location	Members	Reason	Notes
1/13/2022	Discussion	5:20pm-6:40pm	Teams	Harnoor Kaur Harnoor Kaur, Jonah Dabu	Go over and complete pseudo code and flowchart	
1/21/2022	Discussion	3:30pm-5:30pm	Teams	Harnoor Kaur Harnoor Kaur, Jonah Dabu	Complete milestone 2 + raspberry pi troubleshoots	
1/25/2022	Discussion	3:30pm-5:30pm	Teams	Harnoor Kaur Harnoor Kaur, Jonah Dabu	Create code for one run (predesign studio task)	make q-bot path more efficient/ quicker? Will we be evaluated on how our program performs in the default environment?
1/26/2022	Discussion	3:30pm-7:30pm	Teams	Harnoor Kaur Harnoor Kaur, Jonah Dabu	Create code for one run (pre design studio task)	Trying to complete return_home function
2/03/2022	Discussion	2:30pm – 3:30pm	Michael G. DeGroote Centre	Harnoor Kaur Harnoor Kaur, Jonah Dabu	Pre design studio refinement	

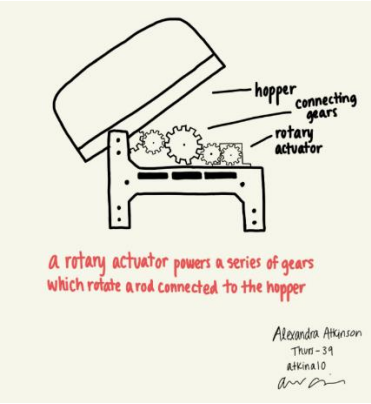
Logbook of Additional Meetings and Discussions: Modelling Team

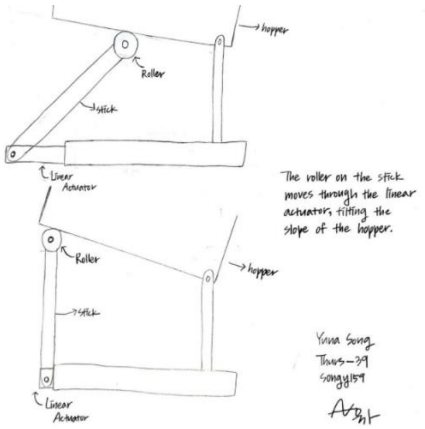
Date	Time In	Time Out	Purpose	Destination
January 13th	5:20 pm	6:00 pm	Create concept sketches for the mechanism that will deposit containers into a recycling station bin	MS Teams
January 21st	12:30 pm	1:30 pm	Decide which actuator to use, discuss what to supplement, divide the part of the sketch, and discuss what part to draw	MS Teams

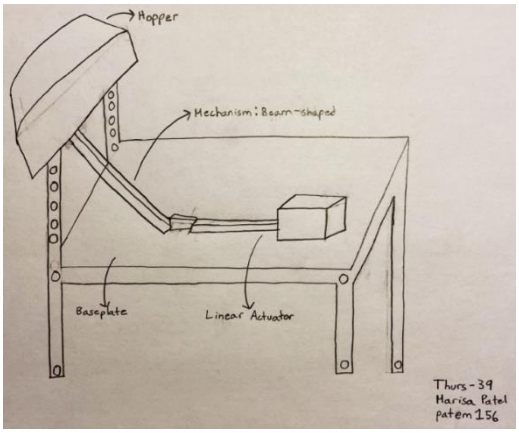
January 23rd	2:30 pm	4:40 pm	Prepare a design of our mechanism, modelling and assembling components in Autodesk Inventor	MS Teams
January 24th	10:30 am	12:00 pm	Prepare a complete design of our mechanism, modelling and assembling all components in Autodesk Inventor	MS Teams
January 25th	3:00 pm	4:30 pm	Still working on completing design of our mechanism, modelling and assembling all components in Autodesk Inventor	MS Teams
January 26th	12:00 pm	1:30 pm	Combine all the part of the modelling in Autodesk Inventor	MS Teams
January 26th	4:30 pm	10:00 pm	Prepare for the tutorial and revise the slider and combine all the part of the modelling	MS Teams
January 30th	12:00 pm	2:30 pm	Revise the design's interference.	MS Teams
January 31th	10:30 am	12:30 pm	Fix some of the constraints that do not fit well and finish the design	PGCLL
March 2nd	8:30 pm	11:30 pm	Preparing for the interview and do the final review of our design	MS Teams

January 13th:

Preliminary sketches

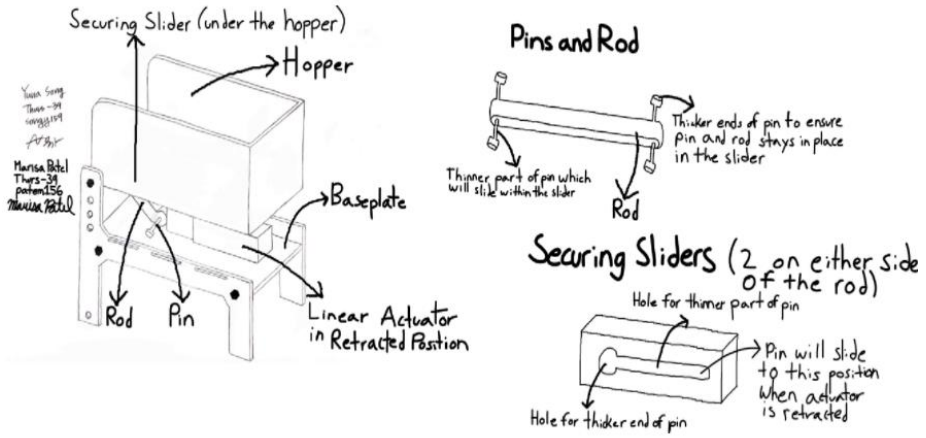


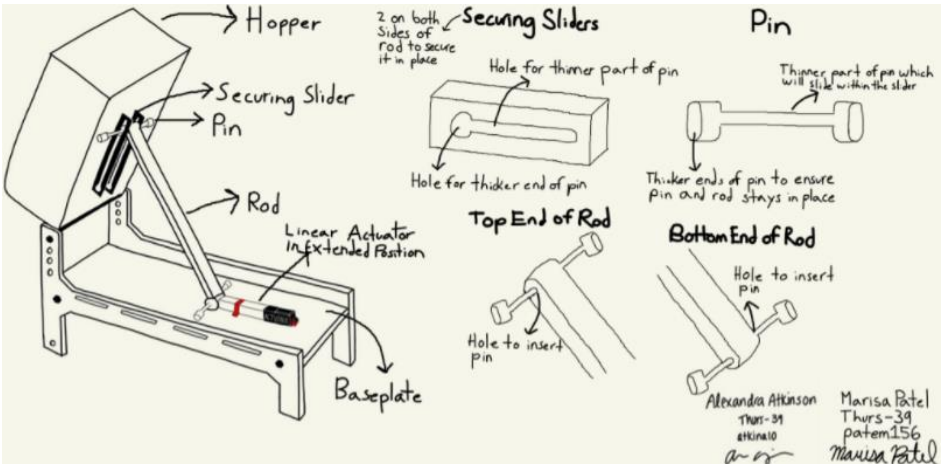




January 21st:

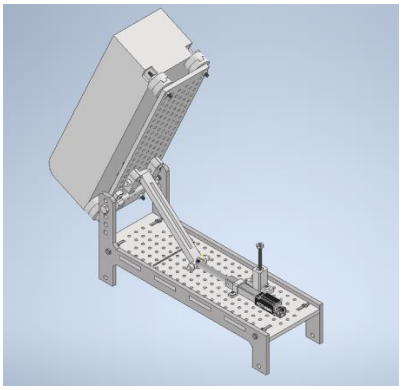
Refined sketches





January 26th:

Mechanism model in Inventor



Appendix C – Weekly Meetings

Weekly Design Studio Agendas and Meeting Minutes

ENGINEER 1P13

MEETING WITH TEAM 39 Thursday, JAN. 13, 2022

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Marisa Patel**	**patem156**	**Yes**
Administrator 1	**HarnoorKaur HarnoorKaur**	**harnoorh**	**Yes**
Administrator 2	**Alexandra Atkinson**	**atkina10**	**Yes**
Coordinator 1	**Jonah Dabu**	**dabuj**	**Yes**
Coordinator 2	**Yuna Song**	**songy159**	**Yes**
TA	**Sainan Chelvarajah**	**chelvars**	**Yes**

AGENDA ITEMS

1. Attendance & Updates
2. Issues from this week
3. Cooperation and Discussion
4. Action Items for next meeting
5. Final Notes

MEETING MINUTES

1. Attendance & Updates
   a. Everyone attended the meeting
   b. Completed Milestone 0 and still working on Milestone 1
   c. Computing sub team completion of initial flow chart
2. Issues from this week
   a. At first, the design team didn't understand a little how to sketch, but with TA's explanation, we understood it.
3. Cooperation and Discussion
   a. Everyone presented their opinions well, and cooperatively understood their roles when deciding their roles.
   b. We shared our understanding of what principles we need to create a design for the actuators.
4. Action Items for next meeting
   a. Each modeling team must draw a revised version from the first linear actuator and rotary actuator before the next design studio.
   b. Computing sub-team will choose the two sensors
   c. Computing sub-team will create flow charts for each function
5. Final Notes

a. Need to work on preparing for next weeks design studio

POST-MEETING ACTION ITEMS

1. *Check avenue looking forward into next design studio [Everyone]*
2. *Modeling Team: Complete each one's concept sketch [Yuna, Marisa, and Alexandra]*
3. *Computing Team: Finish their pseudocode and explore the capabilities of each sensor [Jonah and HarnoorKaur]*

ENGINEER 1P13

MEETING WITH TEAM 39 Thursday, JAN. 20, 2022

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Marisa Patel**	**patem156**	**Yes**
Administrator 1	**HarnoorKaur HarnoorKaur**	**harnoorh**	**Yes**
Administrator 2	**Alexandra Atkinson**	**atkina10**	**Yes**
Coordinator 1	**Jonah Dabu**	**dabuj**	**Yes**
Coordinator 2	**Yuna Song**	**songy159**	**Yes**
TA	**Sainan Chelvarajah**	**chelvars**	**Yes**

AGENDA ITEMS

1. Attendance & Updates
2. Issues from this week
3. Cooperation and Discussion
4. Action Items for next meeting
5. Final Notes

MEETING MINUTES

1. Attendance & Updates
   a. Everyone attended the meeting
   b. Completed Individual Milestone 2 and still working on Team Milestone 2
2. Issues from this week
   a. We did the TA meeting and there are some errors that can be found in actuators.
      - Try to look for the designs that may not work (principle), and they have to be linked together.
      - We do not have to rely on too much friction due to tolerance issues because if there is too much tolerance, it might be too tight.
      - Keep in mind that if printing the design, it might not be exactly same as the design.
   b. There is a bug in the return_home() function for the computing team
3. Cooperation and Discussion
   a. Everyone prepared their revised sketches well, and cooperatively discussed what to supplement, divide the parts of the sketch, and discuss what part to draw.
   b. We shared our understanding of what principles we need to create the designs for the actuators.
   c. Came discussed ways to debug the return_home() function
4. Action Items for next meeting
   a. Each modeling team must be done for the final sketches and prepare for the 3D modeling before the tutorial.
   b. Fix the return_home() function
5. Final Notes

a. Continue to schedule meetings out of design studio if needed, to work on the design/code

POST-MEETING ACTION ITEMS

1. *Modeling Team: Make the model in Inventor with the final sketches [Yuna, Marisa, and Alexandra]*
2. *Computing Team: Make the Code of the program and make sure return_home() is working [Jonah and HarnoorKaur]*

ENGINEER 1P13

MEETING WITH TEAM 39 Thursday, JAN. 27, 2022

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Marisa Patel**	**patem156**	**Yes**
Administrator 1	**HarnoorKaur HarnoorKaur**	**harnoorh**	**Yes**
Administrator 2	**Alexandra Atkinson**	**atkina10**	**Yes**
Coordinator 1	**Jonah Dabu**	**dabuj**	**Yes**
Coordinator 2	**Yuna Song**	**songy159**	**Yes**
TA	**Sainan Chelvarajah**	**chelvars**	**Yes**

AGENDA ITEMS

1. Attendance & Updates
2. Issues from this week
3. Cooperation and Discussion
4. Action Items for next meeting
5. Final Notes

MEETING MINUTES

1. Attendance & Updates
   a. Everyone attended the meeting
   b. Got feedback for the modelling with the checklist in Team Milestone 3
   c. Computing team made transfer_container() more efficient
2. Issues from this week
   a. We got the mentor comments and there are some things to be considered.
      - Make sure there is no interference between the rod and the actuator
      - Consider minimizing material for 3D printing by rounding edges/making parts smaller when possible
      - Work on actuator constraints/movement
      - Move forward with purchasing the materials we need to put together the design.
   b. Transfer_container() was inefficient and did not consistently load the containers properly
   c. Bin locations were incorrect
3. Cooperation and Discussion
   a. Everyone prepared the questions for TA and decided the action items that we will do for final design
4. Action Items for next meeting

   Modeling Team

   a. Analyze interference in Autodesk Inventor to ensure parts are not interfering
   b. Make the rod skinnier or create cut-outs to reduce material

c. Purchase additional parts such as our fasteners (screws, nuts, dowels)
d. Fix the constraints around the actuator and base of the rod to allow the actuator to move
e. Make the supporting blocks connected to the baseplate of the hopper smaller or round out the edges to further minimize the amount of material used

Computing Team

a. Correct the bin locations
b. Fix transfer_container()

5. Final Notes
   a. Keep working on completing the model and code!

POST-MEETING ACTION ITEMS

1. *Modeling Team: Try to action items based on mentor comments [Yuna, Marisa, and Alexandra]*
2. *Computing Team: Revise the Code of the program based on mentor comments [Jonah and HarnoorKaur]*

ENGINEER 1P13

MEETING WITH TEAM 39 Thursday, FEB. 3, 2022

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Marisa Patel**	**patem156**	**Yes**
Administrator 1	**HarnoorKaur HarnoorKaur**	**harnoorh**	**Yes**
Administrator 2	**Alexandra Atkinson**	**atkina10**	**Yes**
Coordinator 1	**Jonah Dabu**	**dabuj**	**Yes**
Coordinator 2	**Yuna Song**	**songy159**	**Yes**
TA	**Sainan Chelvarajah**	**chelvars**	**Yes**

AGENDA ITEMS

1. Attendance & Updates
2. Issues from this week
3. Cooperation and Discussion
4. Action Items for next meeting
5. Final Notes

MEETING MINUTES

1. Attendance & Updates
   a. Everyone attended the meeting
   b. Tried the testing station (1 hour)
   c. Did some part of the 3D printing (1 hour)
2. Issues from this week
   a. We had issues from the printing time for the part (the rod) as it takes 1 hour and 5 minutes to print which is over 5 minutes from the limitation (we could use just 1 hour).
   b. Identified a bug in transfer_container() the bot would not dump to bin 2 properly
3. Cooperation and Discussion
   a. Design team prepared the final design and started to print the 3D model and tried the testing station to know how the linear actuator works.
4. Action Items for next meeting
   a. Print the rest part of the 3D model
   b. Prepare for M4 nuts
   c. Finishing up the code
5. Final Notes
   a. Need to make sure the modelling sub team finds all the fasteners needed as soon as possible!

POST-MEETING ACTION ITEMS

1. *Modeling Team: Print the rest part of the 3D model that did not print yet [Yuna, Marisa, and Alexandra]*
2. *Computing Team: Complete the code and come with the final code, start thinking about bonus code [Jonah and HarnoorKaur]*

ENGINEER 1P13

MEETING WITH TEAM 39 Thursday, FEB. 10, 2022

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Marisa Patel**	**patem156**	**Yes**
Administrator 1	**HarnoorKaur HarnoorKaur**	**harnoorh**	**Yes**
Administrator 2	**Alexandra Atkinson**	**atkina10**	**Yes**
Coordinator 1	**Jonah Dabu**	**dabuj**	**Yes**
Coordinator 2	**Yuna Song**	**songy159**	**Yes**
TA	**Sainan Chelvarajah**	**chelvars**	**Yes**

AGENDA ITEMS

1. Attendance & Updates
2. Issues from this week
3. Cooperation and Discussion
4. Action Items for next meeting
5. Final Notes

MEETING MINUTES

1. Attendance & Updates
   a. Everyone attended the meeting
   b. Already printed all the parts of the modelling before tutorial
2. Issues from this week
   a. We must reprint the pin securing piece smaller than prior one (the prior ones are too loose)
   b. Bug in return_home(), bot sometimes loses line after dumping to fourth bin
3. Cooperation and Discussion
   a. Design team already printed all the parts of the model before tutorial and look at the parts that must be reprinted
   b. Design team needs to poke out the parts' holes that are blocked
   c. Computing team has no concerns as the problems are small and can easily be fixed
4. Action Items for next meeting
   a. Design team must make the hole that is being blocked
   b. Design team must cut out or grind out the messy parts that pop out
   c. Make sure that the program can complete one run
5. Final Notes
   a. Consider doing the bonus assignment

POST-MEETING ACTION ITEMS

1. *Modeling Team: Make the hole that is being blocked and cut out the part that interferes with putting it in [Yuna, Marisa, and Alexandra]*
2. *Computing Team: debug return_home() function [Jonah and HarnoorKaur]*

ENGINEER 1P13

MEETING WITH TEAM 39 Thursday, FEB. 17, 2022

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	**Marisa Patel**	**patem156**	**Yes**
Administrator 1	**HarnoorKaur HarnoorKaur**	**harnoorh**	**Yes**
Administrator 2	**Alexandra Atkinson**	**atkina10**	**Yes**
Coordinator 1	**Jonah Dabu**	**dabuj**	**Yes**
Coordinator 2	**Yuna Song**	**songy159**	**Yes**
TA	**Sainan Chelvarajah**	**chelvars**	**Yes**

AGENDA ITEMS

1. Attendance & Updates
2. Issues from past week
3. Discussion changes from last week
4. Action Items for next meeting
5. Final Notes

MEETING MINUTES

1. Attendance & Updates
   a. We are all here today (Yuna online)
   b. We all are working on finishing with printing and sourcing our screws and nuts, and finishing up the python program
   c. Code is nearly complete, ready for bonus
2. Issues from past week
   a. From the modelling sub team, we were having some trouble working with the 3D printer, however we were able to finish printing all the parts of our mechanism
   b. From the computing sub team, small things to fix like commenting and editing the code to make it more efficient
3. Discussion changes from last week
   a. From the modelling sub team, we made a change with the size of our pin securing piece, so it has a tighter fit against the pins
   b. Transfer_container(), return_home() was fixed
4. Action Items for next meeting
   a. For next week, we will have completed everything
5. Final Notes
   a. Continue integrating the bonus
   b. Book the interview (Marisa)
   c. Prepare for the interview

d. Begin putting together the final report

POST-MEETING ACTION ITEMS

1. *Modeling Team: Complete all the things such as continuing integrating the bonus or preparing for the interview [Yuna, Marisa, and Alexandra]*
2. *Computing Team: formulate bonus code [Jonah and HarnoorKaur]*

Appendix D – Worksheets

Milestone 0 Team Worksheet

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

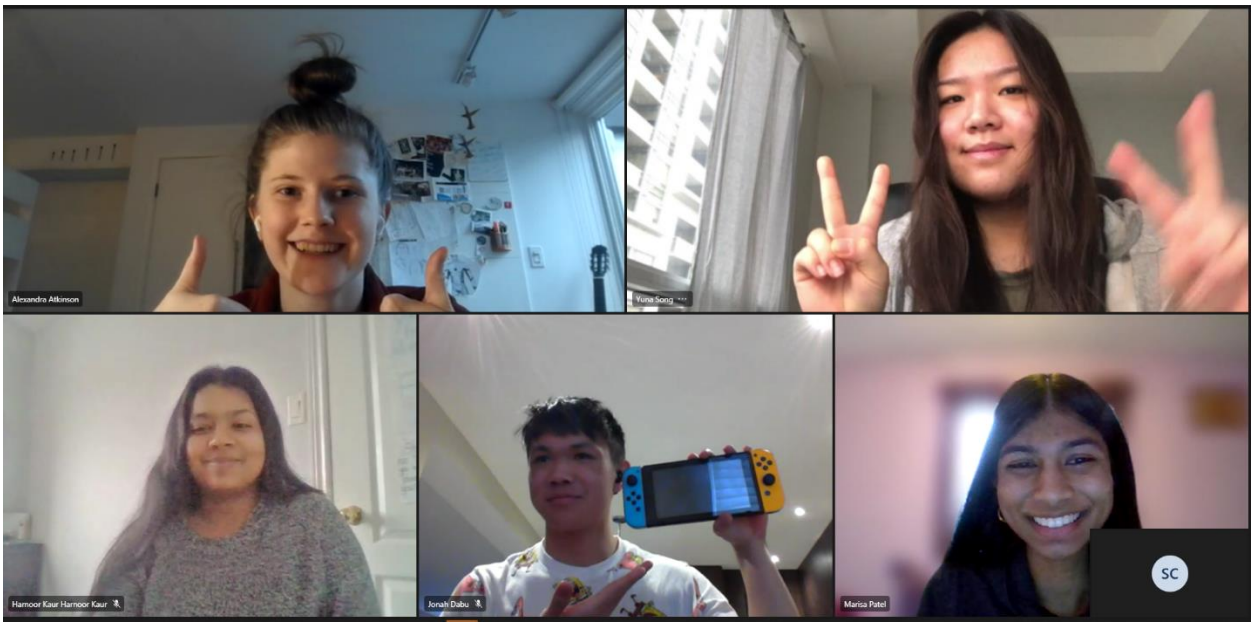
PROJECT THREE: MILESTONE 0 – COVER PAGE

Team Number: Thurs-39

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

Full Name:	MacID:
Yuna Song	songy159
Marisa Patel	patem156
Alexandra Atkinson	atkina10
Jonah Dabu	dabuj
HarnoorKaur HarnoorKaur	harnoorh

Insert your Team Portrait in the dialog box below



MILESTONE 0 – TEAM CHARTER

Team Number: Thurs-39

Incoming Personnel Administrative Portfolio:

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

	Team Member Name:	Project Leads
1.	Alexandra Atkinson	☐M ☒A1 ☐A2 ☒C
2.	HarnoorKaur HarnoorKaur	☐M ☒A1 ☐A2 ☒C
3.	Jonah Dabu	☒M ☐A1 ☒A2 ☐C
4.	Yuna Song	☒M ☒A1 ☐A2 ☐C
5.	Marisa Patel	☐M ☒A1 ☐A2 ☒C

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.

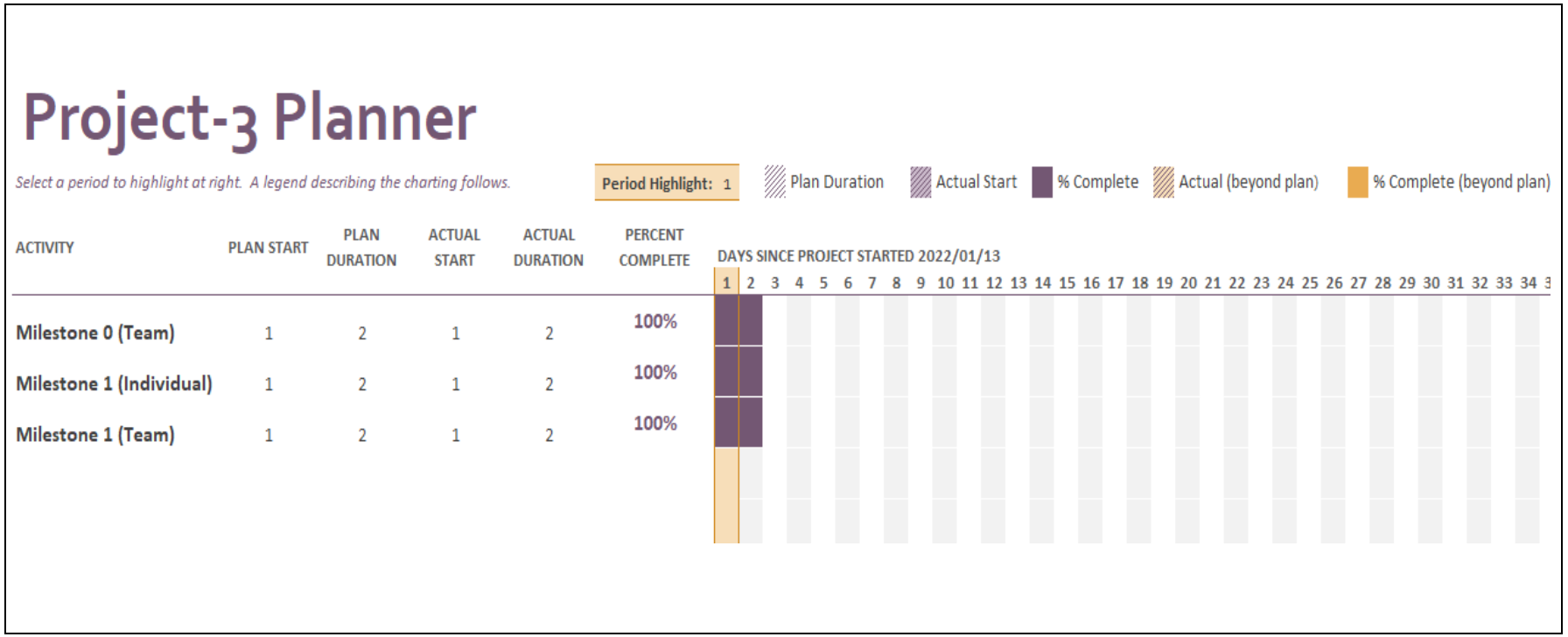
Role:	Team Member Name:	MacID
Manager	Marisa Patel	patem156
Administrator 1	HarnoorKaur HarnoorKaur	harnoorh
Administrator 2	Alexandra Atkinson	atkina10
Coordinator 1	Jonah Dabu	dabuj
Coordinator 2	Yuna Song	songy159

MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

Team Number: Thurs-39

Full Name Of Team Manager:	MacID:
Marisa Patel	patem156

Preliminary Gantt chart



Milestone 1 Team Worksheet

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

PROJECT THREE: MILESTONE 1 – COVER PAGE

Team Number: Thurs-39

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

Full Name:	MacID:
Yuna Song	songy159
Marisa Patel	patem156
Jonah Dabu	dabuj
Alexandra Atkinson	atkina10
HarnoorKaur HarnoorKaur	harnoorh

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

MILESTONE 1 (STAGE 1) – INITIAL PROBLEM STATEMENT, OBJECTIVES AND CONSTRAINTS

Team Number: Thurs-39

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.

Name	Alexandra Atkinson
Objectives	-Should be efficient -Should be effective -Should minimize error -Should be accurate -All components should function together smoothly -Should be long-lasting
Constraints	-Mechanism must connect to the base plate at two locations: a rung mounted on the pivot legs and an actuator mounted on the base plate -Mechanism must be mounted within a given area of the base plate -Mechanism must be designed to deposit containers into the bin -Q-arm and Q-bot must begin and end at their home positions

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Name	Yuna Song
Objectives	1. Identify, classify, and verify containers for recyclability 2. Design a mechanism for depositing containers into a recycling bin 3. Design a computer program for transferring containers to a bin in the Recycling Station 4. Evaluate your design for functionality and correctness
Constraints	- The mechanism must be designed such that it connects to this base plate at 2 locations. - The mechanism is required to connect to an actuator mounted on the base plate. - The mechanism is required to connect to the connecting plate of the hopper to rotate about a chosen rung. - Connecting plate has to consist of a grid of 21x6 holes. - The mechanism must be designed to deposit containers into the bin. - The assembly model of mechanism should be properly constrained to the base plate, the actuator that has been provided to our team, and the connecting plate. - Code should be written for determining specific container attributes and assigning to a variable. - The container should be dispensed and positioned in the Sorting Station for pick-up. - A function should be written for controlling the Q-arm joints to pick-up and load containers onto the Q-bot. - A function should be written for moving the Q-bot to the Recycling Station and stopping once it has reached the location of the correct bin. - A function should be written for positioning the Q-bot hopper immediately adjacent to the bin and rotating the hopper to deposit the containers into the bin. - Code should be written for controlling movement of the Q-bot until it has returned to the Sorting Station.

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Name	Jonah Dabu
Objectives	Program should Identify, classify, and verify containers for recyclability Program should transfer containers from a sorting station to its bin Mechanism should deposit containers into bins Should be automated
Constraints	Components of the mechanism must be compatible with a given baseplate and hopper Motion of the mechanism must be instigated by an actuator Total mass of the container cannot exceed 90g Number of containers cannot exceed 3 Bin differentiation is limited to ultrasonic sensor, colour sensor, LDR, and IR sensor Qbot is must follow a closed path

Name	HarnoorKaur HarnoorKaur
Objectives	• Should be portable on the Q-bot • Should be lightweight • Should maximize accuracy for the code with efficiency • Should maximize storage • Should be reusable • Should be corrasion resistant • Should be a fit for different size of containers
Constraints	• Must have the mechanism connected to the Base plate at two following locations: at the end of the base plate and with the actuator (page 15-16)

	• Must have less than 90 grams of weight on the Q-bot • Must have less than or equal to 3 containers on the base plate at one time • Must have containers destined to be in the same bin on top of the Q-bot

Name	Marisa Patel
Objectives	• Should be secure and stable • Should be accurate • Should be portable • Should be quick • Should be compact • Should be scalable • Should be reusable • Should be efficient • Should minimize friction • Should be lightweight • Should be adaptive for different sized containers
Constraints	• Must use a linear or rotary actuator • Must withstand less than 90 grams of load • Must hold 3 containers or less • Mechanism must be mounted to baseplate at 2 locations • Mechanism must connect to the connecting plate of the hopper • Mechanism must connect directly to the actuator • Mechanism must axially connect to a rung mounted on the pivot legs of the baseplate • Actuator must be directly mounted on the baseplate within a grid of 10x7 holes (127.00 mm x 97.71 mm) • Actuator must allow mechanism to rotate about the rung

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

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

4. Each team member needs to submit their work with the **Milestone 1 Individual Worksheet** document so that it can be ***graded***
5. Compiling your individual work into this **Milestone 1 Team Worksheet** document allows you to readily access your team member's work
    1. This will be especially helpful when completing ***Stage 3*** of the milestone

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

MILESTONE 1 (STAGE 2) – REFINED PROBLEM STATEMENT

Team Number: Thurs-39

Refined Problem Statement

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

Design an automated system for sorting and recycling materials that identifies, classifies, and verifies containers for recyclability, and transfers materials from a sorting station to their appropriate bins. The design should make recycling more efficient and effective for recycling facilities to help reduce the amount of waste caused by unrecognized recycling problems.

MILESTONE 1 (STAGE 3) – COMPUTER PROGRAM WORKFLOW (COMPUTATION SUB-TEAM)

Team Number: Thurs-39

- **One sub-team** member should write out a pseudocode outlining the *high-level workflow* of your computer program on the following page
    - Be sure to clearly indicate the Team Number, Name and MacID of the sub-team member who completed the pseudocode

2. **The other sub-team member** should create a flowchart or storyboard outlining the workflow of your computer program on the following page
    - Be sure to clearly indicate the Team Number, Name and MacID of the sub-team member who completed the flowchart/storyboard
    - Insert your photo as a Picture (Insert > Picture > This Device)

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

Name: HarnoorKaur HarnoorKaur	MacID: harnoorh

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

Functions of the Arm:	Functions of the Q-bot:
- Goes to home position - Picks up the container - Drops off the container	- Goes to home position - Holds Containers - Checks the materials - Checks the weight - Checks the number of containers - Goes to the correct bin - Dumps off the container in the bin

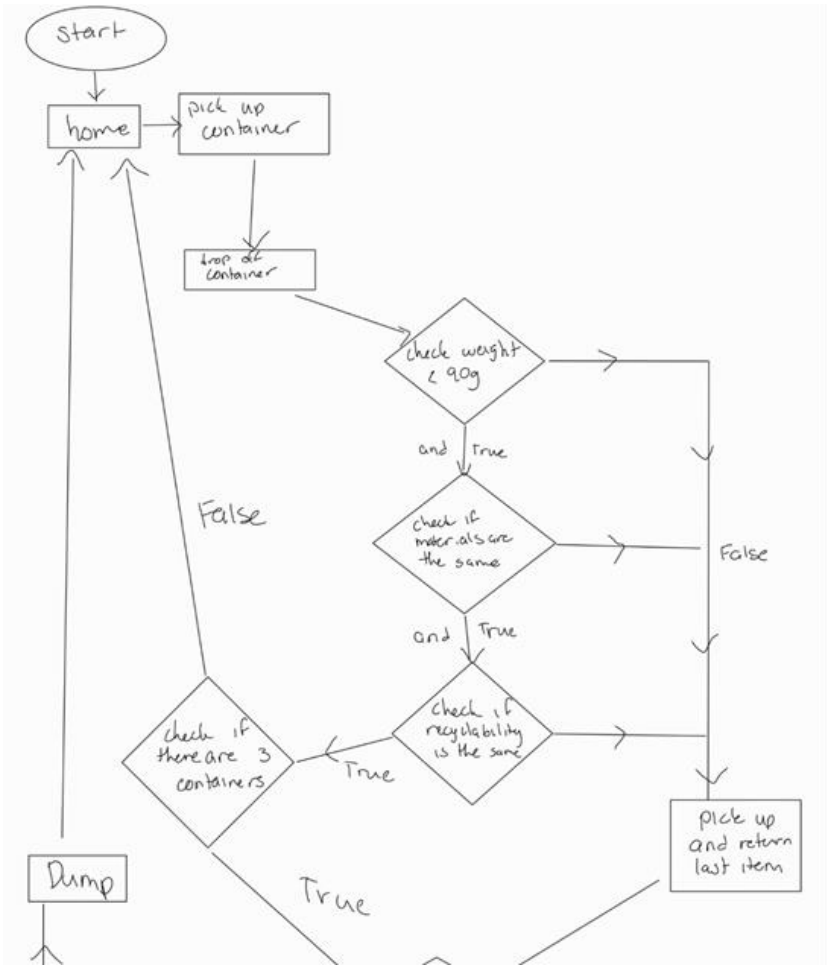
1. Arm goes to its home position
2. The Q-bot goes to its home position
3. Start a Infinite loop that only ends when the user terminates the program
4. The arm picks up the dispensed containers
5. The arm drops off the container on the Q-bot
6. The arm returns to its home position
7. The Q-bot checks the weight of the container
8. The Q-bot checks the type of material of the last container
9. The Q-bot checks the recyclability of the container
10. Check if the material, weight and recyclability conditions are met :
11. If the above conditions are met:
    - Check if there are 3 containers
        - If there are 3 containers than the Q-bot goes to the appropriate bin and dumps the container(s)
        - If there are less then 3 containers than the Qbot keeps loading the material while abiding the conditions
12. If the material OR weight OR recyclability of the last container differs than:
    - The Arm picks up the last container from the Q-bot and holds it until the Qbot comes back again
    - The Qbot goes to the appropriate bin and dumps the containers and returns back to its home position

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

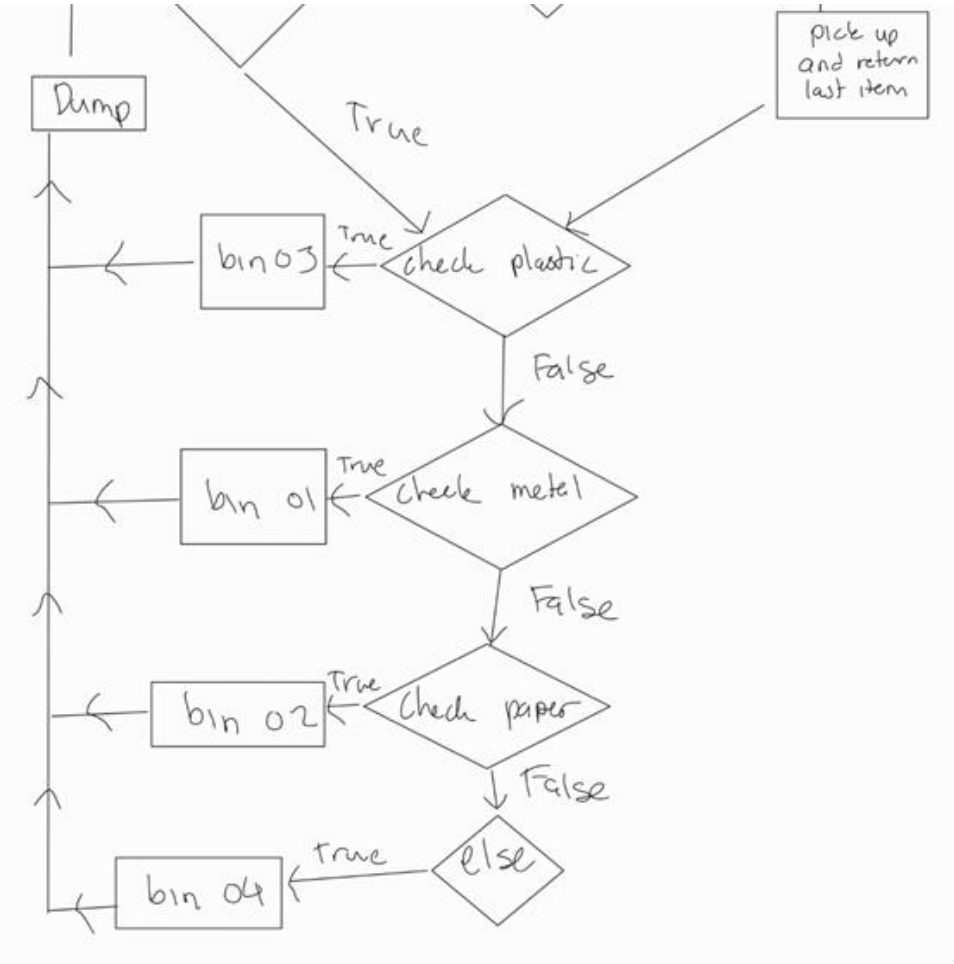
Team Number: Thurs-39

Name: Jonah Dabu	MacID : dabuj

Insert picture of your flowchart or storyboard below



ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*



ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

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

Team Number: Thurs-39

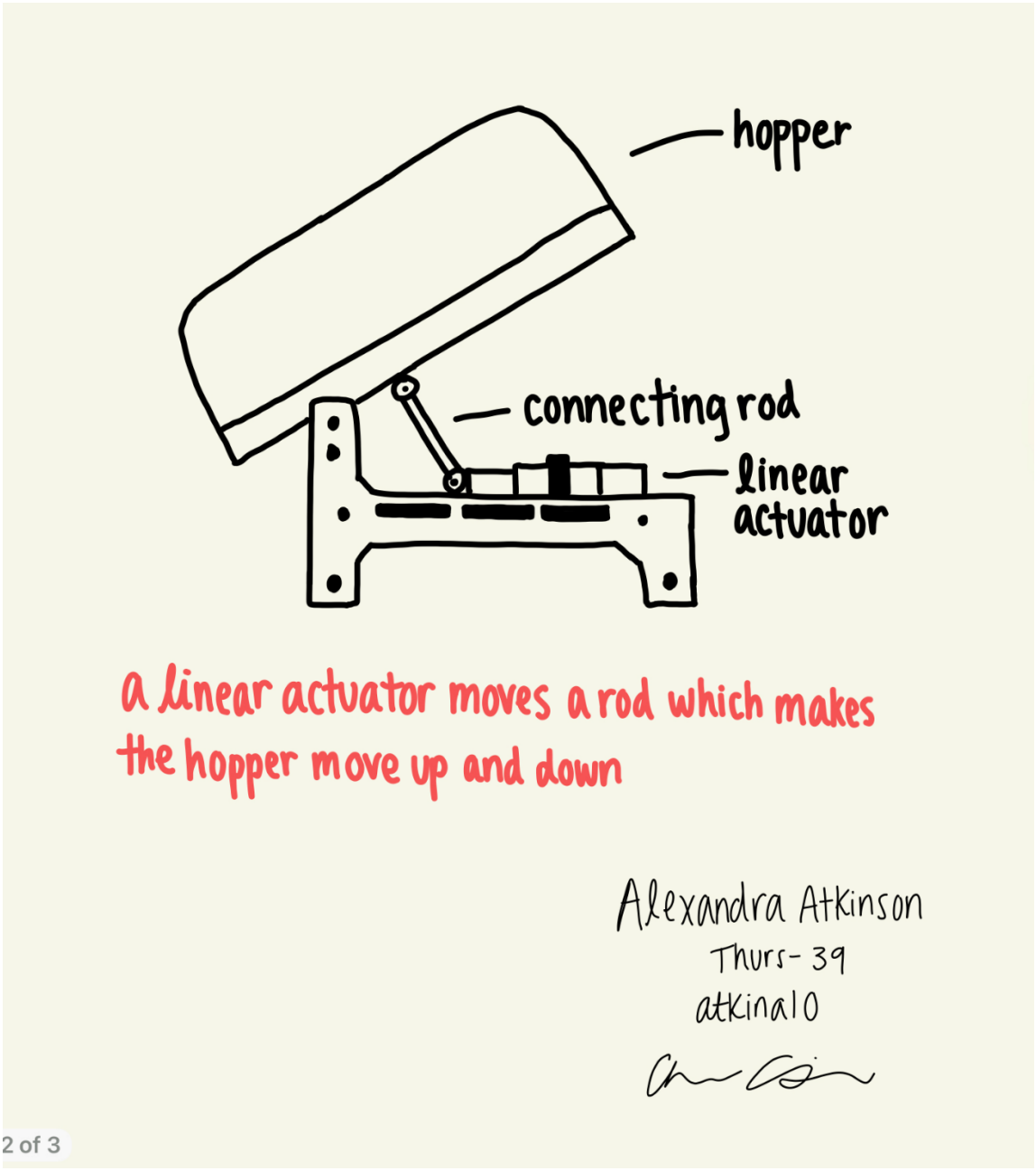
- Each team member is required to complete **two (2)** preliminary concept sketches for the mechanism design. You should incorporate a different actuator for each sketch.
  - Each sketch should be on a separate piece of paper
  - Be sure to clearly write your Team Number, Name and MacID for each sketch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

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

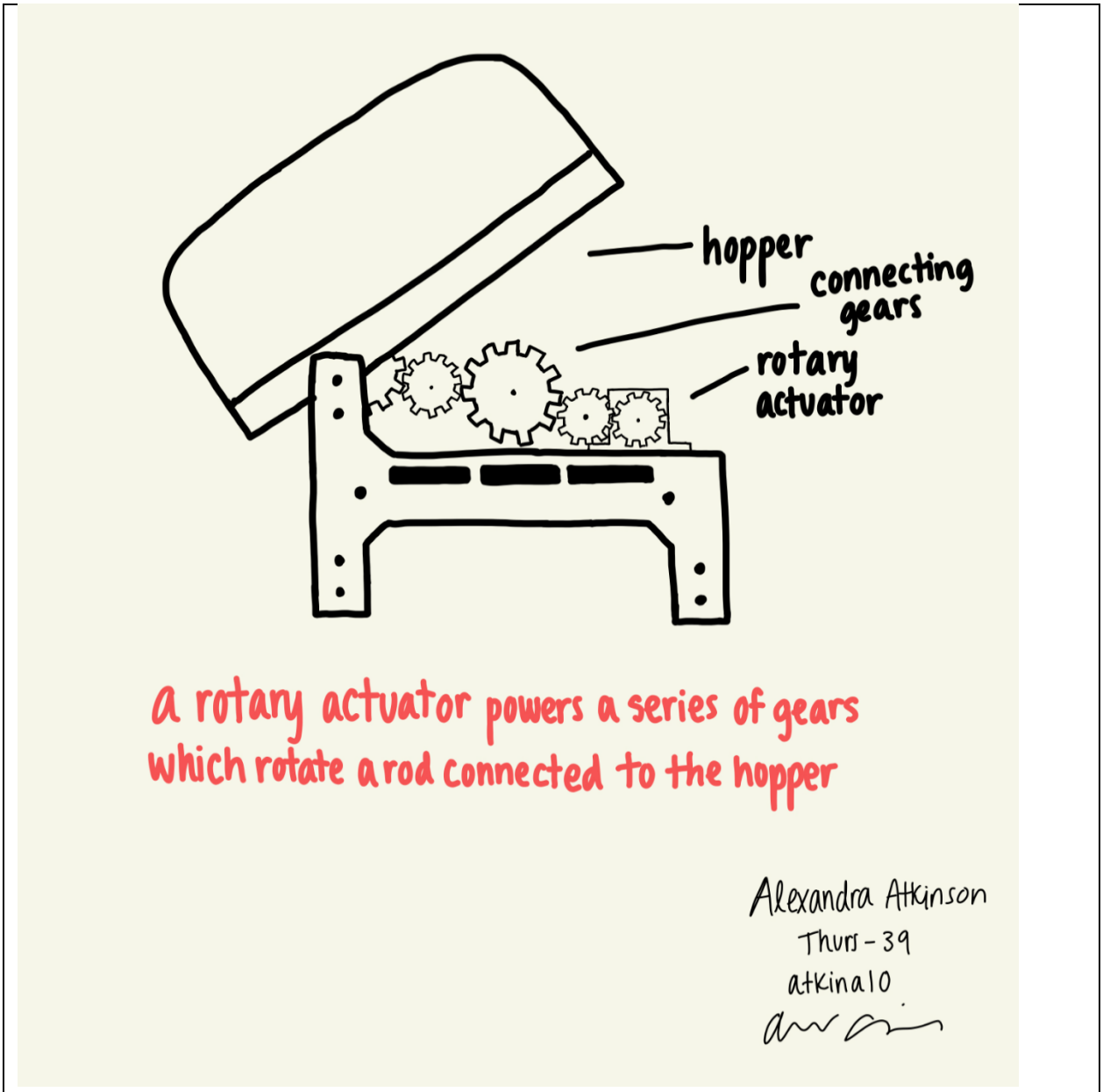
Team Number: Thurs-39

Name: Alexandra Atkinson	MacID: atkina10

Insert picture of preliminary concept sketch below



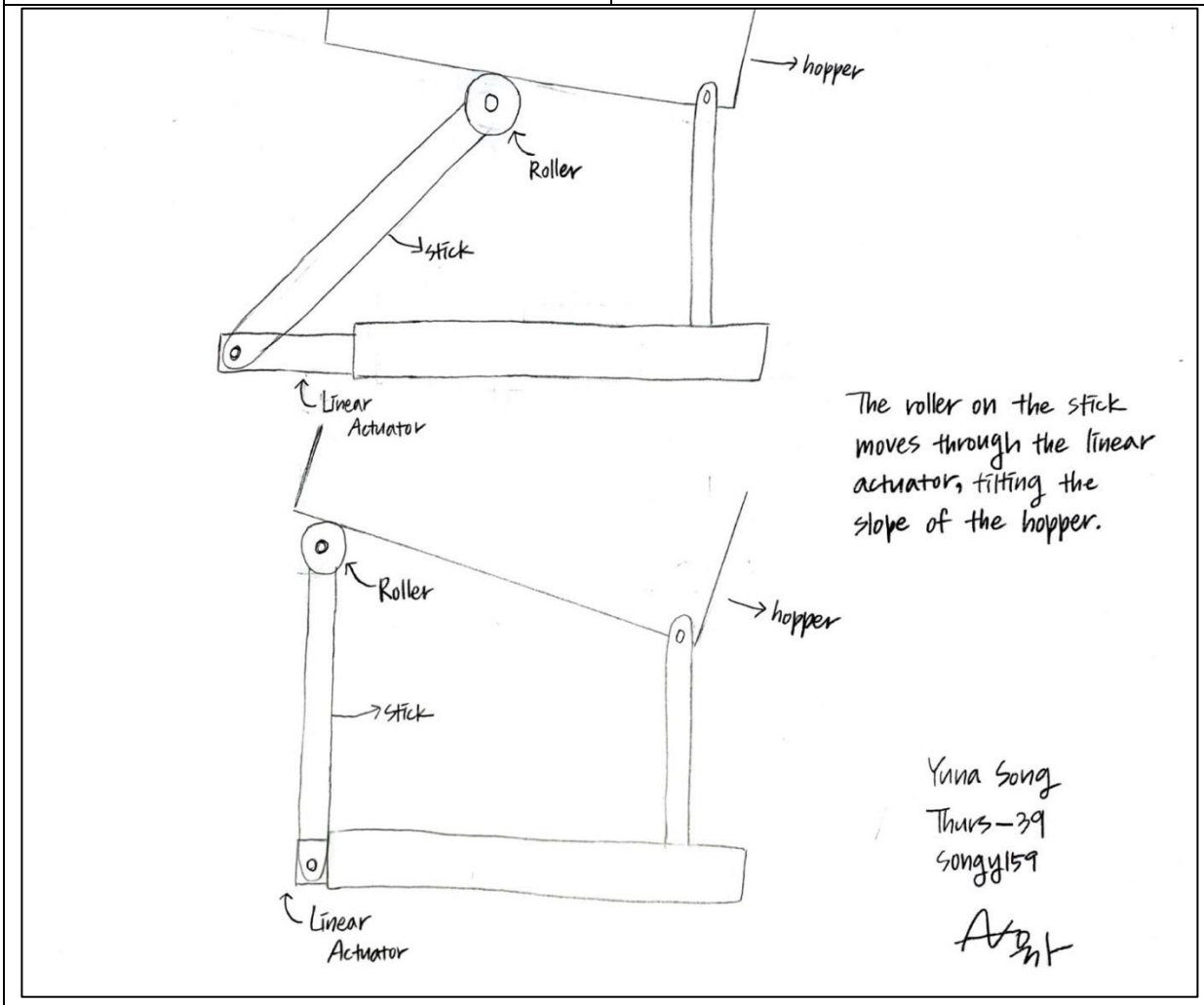
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*



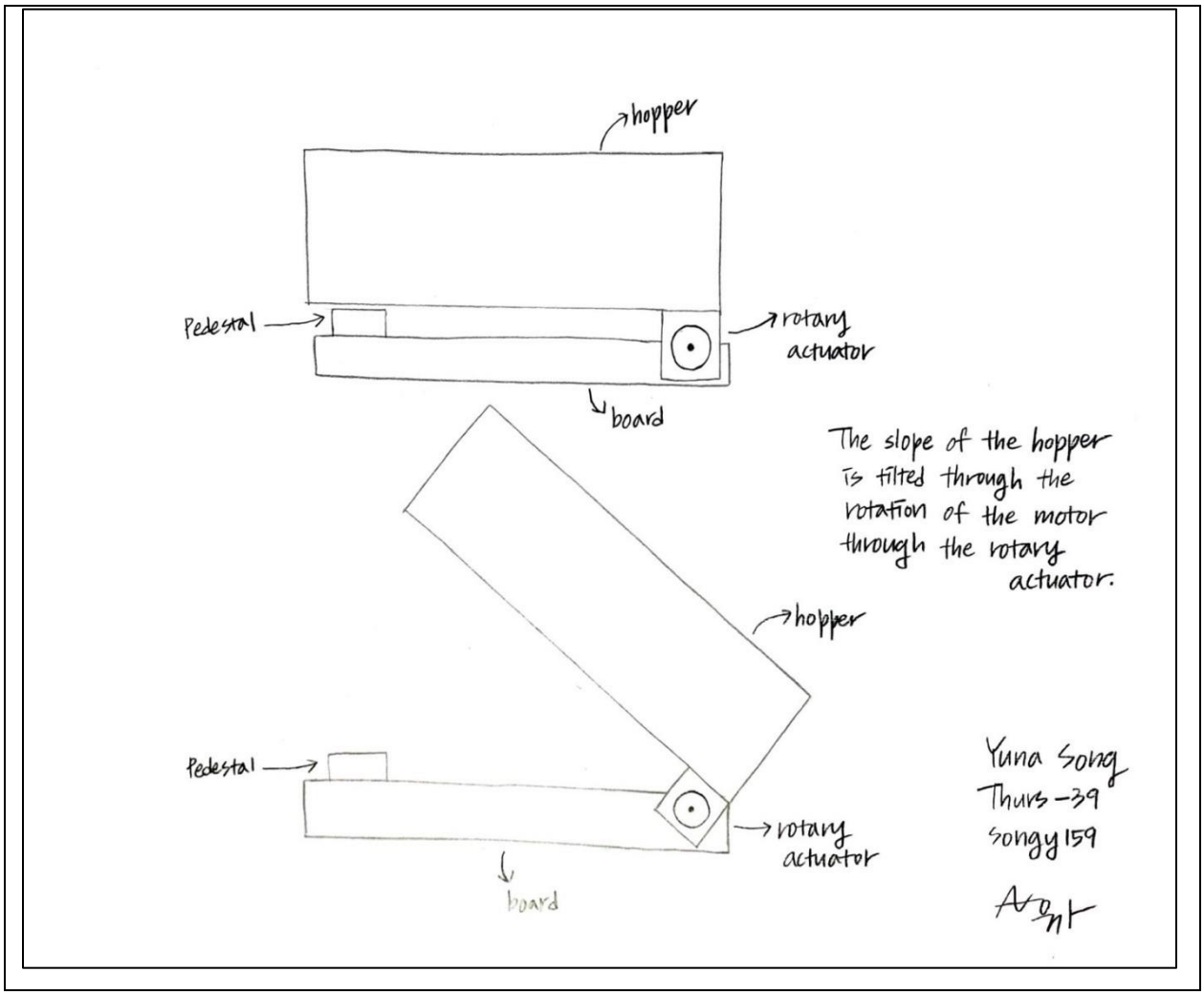
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

Name: Yuna Song	MacID: songy159



ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

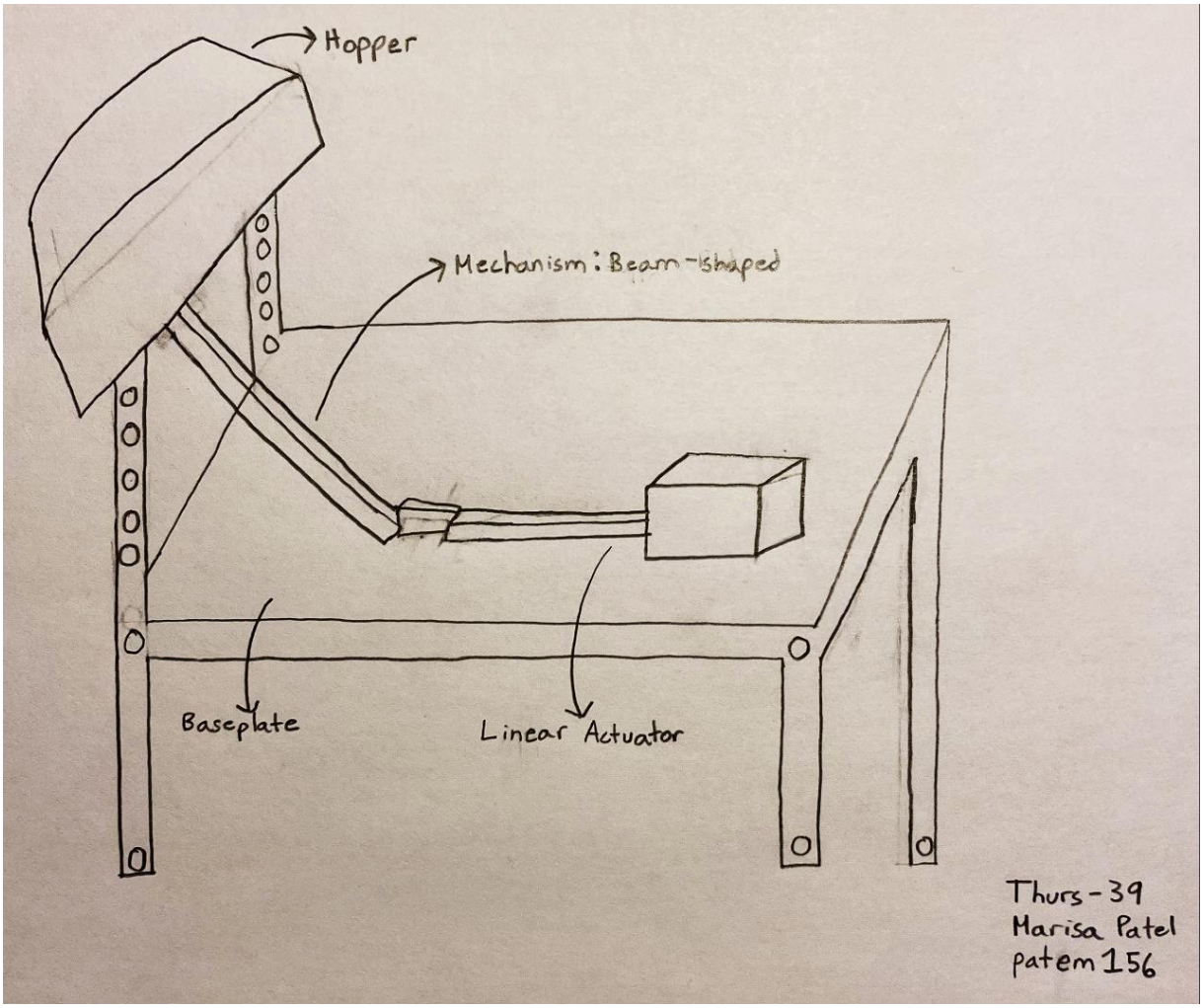


ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

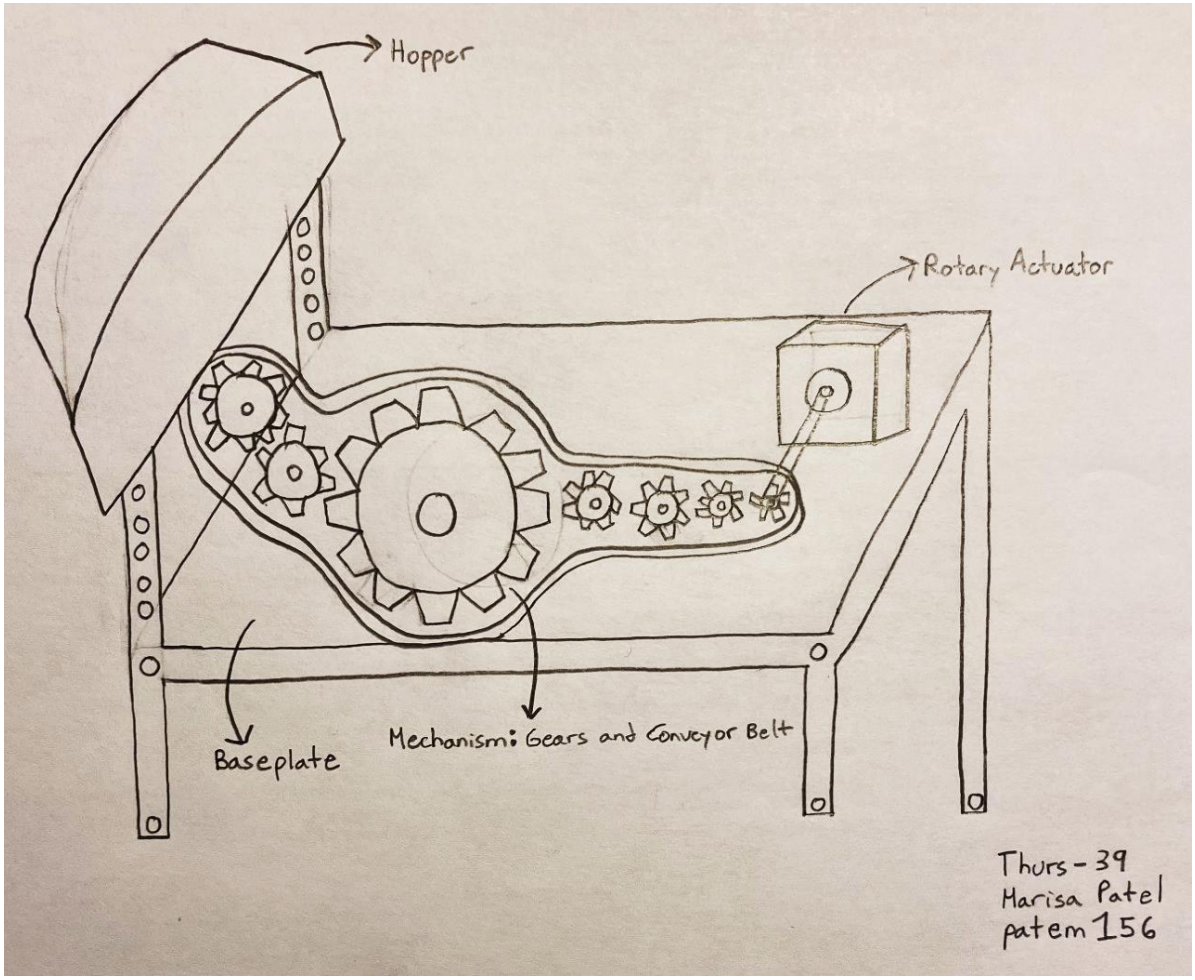
Team Number: Thurs-39

Name: Marisa Patel	MacID: patem156

Insert picture of preliminary concept sketch below



ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*



Milestone 2 Team Worksheet

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

PROJECT THREE: MILESTONE 2 – COVER PAGE

Team Number: Thurs-39

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

Full Name:	MacID:
HarnoorKaur HarnoorKaur	harnoorh
Yuna Song	songy159
Alexandra Atkinson	atkina10
Jonah Dabu	dabuj
Marisa Patel	patem156

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

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

Team Number: Thurs-39

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

1. Each team member is expected to research two (2) types of sensors 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. Copy and paste each sub-team member's sensor research onto the following pages
   → Be sure to clearly write your Team Number, Name and MacID

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

- Each team member needs to submit their sensor research with the **Milestone 2 Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone 2 Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 3*** of the milestone

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

Name: HarnoorKaur HarnoorKaur	MacID: harnoorh

Sensor Type	Description	Attribute(s)
IR (Active Infrared Sensor)	It measures the distance to the nearest object it senses by emitting infrared waves that reflect to the senor after coming in contact with an object.[1] Based off the reflected wave intensity, the sensor is able to calculate the approximate distance to an object. In addition, it detects movement in the environment its placed inside of. [2] It is not the most accurate sensor as different colors send-off different color wavelengths and in case of dealing with a dark color like black, it will not be able to receive too big of a wavelength compared to light colours such as yellow.	- It can be used to detect the line/ the path to follow by the Q-bot while transferring the containers to the correct bins. - It can be useful for identifying the bin during the process of transferring.
Light Dependant Resistor (LDR)	Used to measure the intensity of light or even to detect the light.[3] Brighter the light, lower the resistance and vice versa. Shadows cause the readings of the sensor to change by a lot. [1] D.Jost, "What is an IR sensor?," Fierce Electronics[Online].Available: https://www.fierceelectronics.com/sensors/what-ir-sensor. [Accessed: January 20,2022]. [2] L. Ada"IR sensor,"adafruit[Online]. Available: https://learn.adafruit.com/ir-sensor. [Accessed Jan. 19, 2022]. [3] WatElectronics," What is a Light Dependent Resistor and Its Applications," WatElectronics.com[Online]. Available: https://www.watelectronics.com/light-dependent-resistor-ldr-with-applications/. [Accessed: January 20,2022].	- It can be used to detect different bins based off of their colours.

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

Name: Jonah Dabu	MacID: Dabuj

Sensor Type	Description	Attribute(s)
Colour sensor	A colour sensor identifies a colour by measuring red, green and blue light [1]. The colour sensor emits white light onto a surface (white light is a combination of red, green, and blue light) [1]. When the white light hits the surface of a material, some red, green, or blue waves are absorbed and the rest is reflected back [1]. The sensor has receivers that determine how much of each colour was returned, and finds the ratio between the RGB waves [1]. Additionally, the readings can be converted into a voltage value that corresponds to a colour [1]. It was observed in week 2 lab B that colour sensors may have difficulty distinguishing blue from green	Colour of the bin
Ultrasonic sensor	An ultrasonic sensor measures distance. It does this by sending and receiving high frequency waves [2]. The sensor uses the difference in time from emitting the wave to receiving the wave and multiplies it by the speed of the wave [2]. This sensor may fail if the surface that it is emitting a wave at is not directly facing the sensor, as the wave will not be reflected back properly [2] [1] "Color sensor - Description, Working Principle & Applications." https://www.elprocus.com/color-sensor-working-and-applications/ (accessed Jan. 19, 2022). [2] "All About Ultrasonic Sensors & How They Work with Arduino | Arrow.com." https://www.arrow.com/en/research-and-events/articles/ultrasonic-sensors-how-they-work-and-how-to-use-them-with-arduino (accessed Jan. 19, 2022).	Distance from bin

**Copy and paste this table on a new page below for Computing Sub-Teams of 3 members.*

ENGINEER 1P13 – Project Three: *Revenge Of The Recycling System*

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

Team Number: Thurs-39

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

1. Each team member is required to complete two (2) refined concept sketches for the design
   → Each sketch should be on a separate piece of paper
   → Be sure to clearly write your Team Number, Name and MacID
2. Copy and paste each sub-team member's refined sketches on the following pages (1 sketch per page)
   → Be sure to indicate each team member's Name and MacID

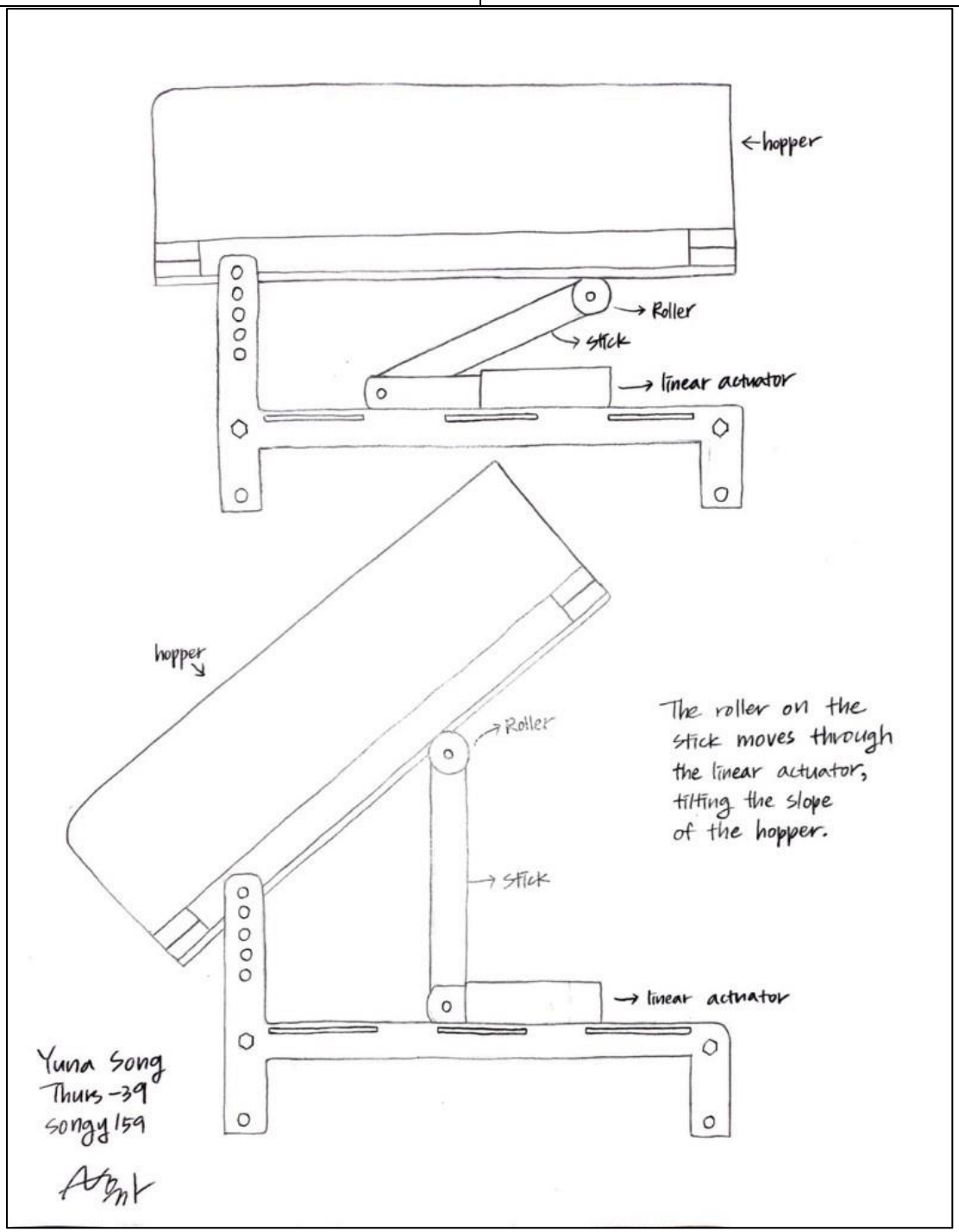
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

- Each team member needs to submit their concept sketches with the **Milestone 2 Individual Worksheets** document so that it can be ***graded***
- Compiling your individual work into this **Milestone 2 Team Worksheets** document allows you to readily access your team member's work
  - This will be especially helpful when completing ***Stage 4*** of the milestone

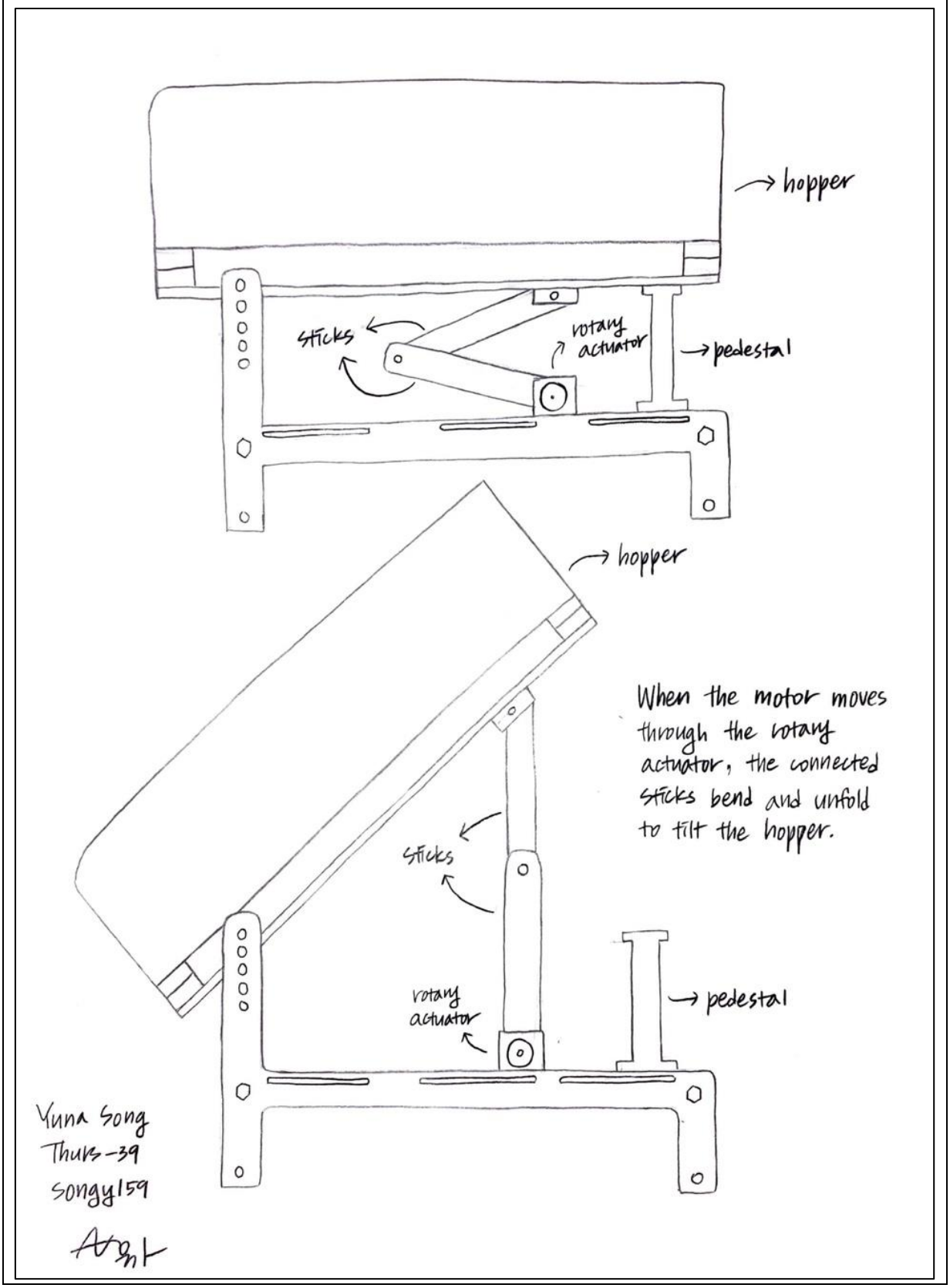
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

Name: Yuna Song	MacID: songy159



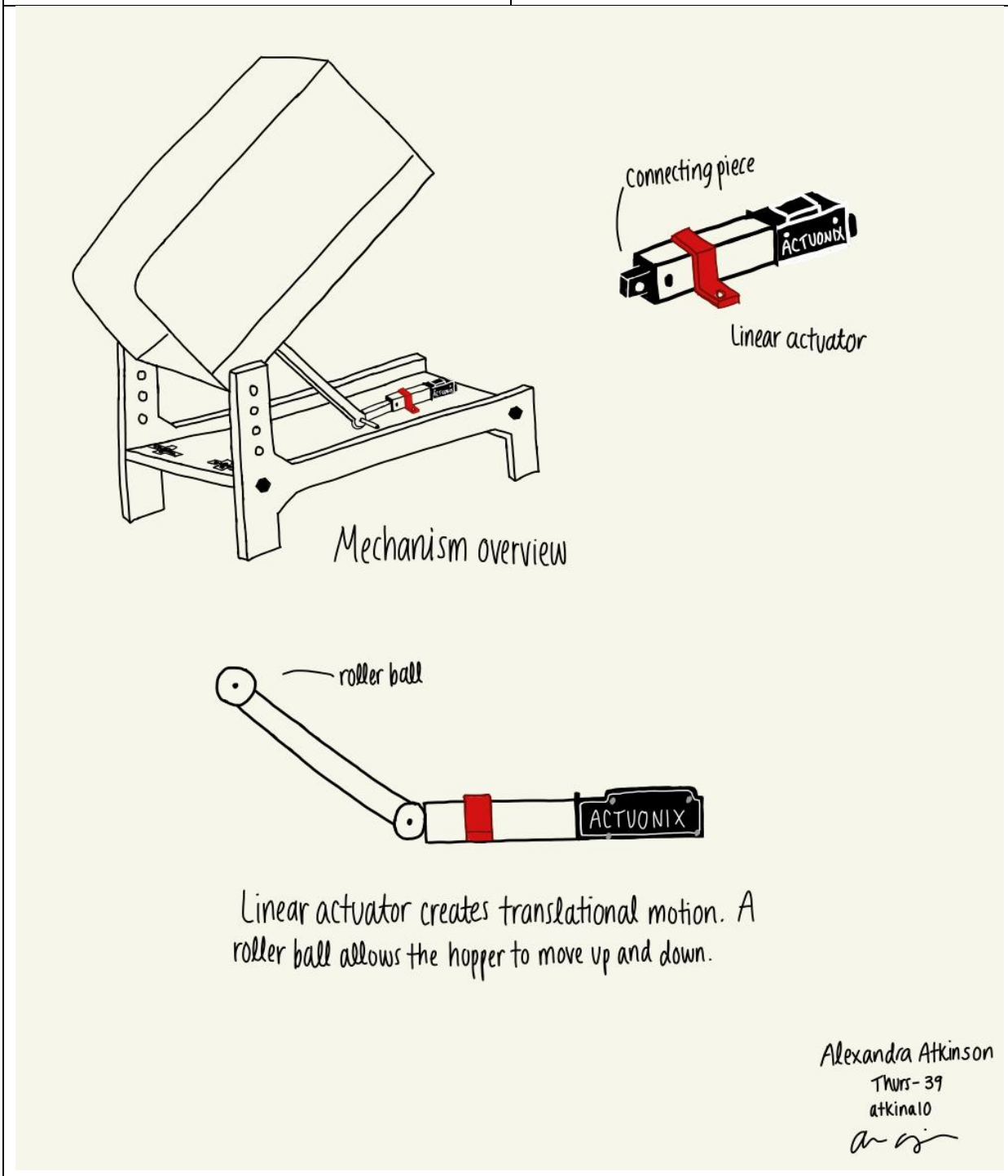
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*



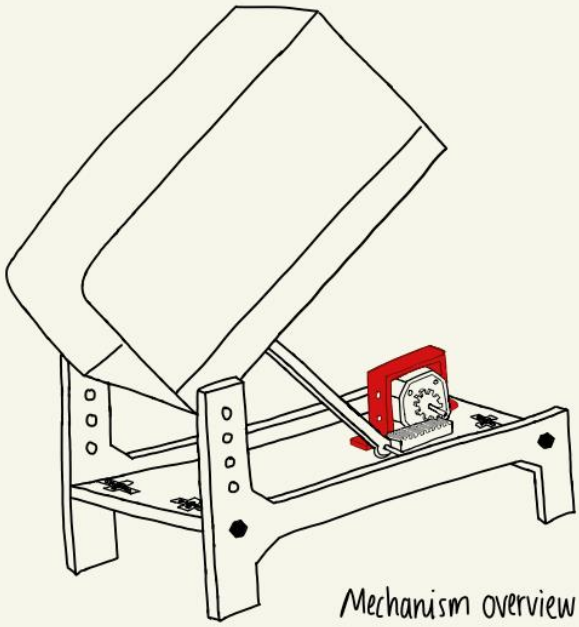
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

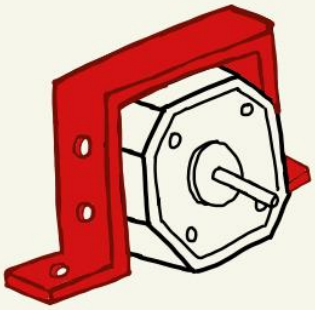
Name: Alexandra Atkinson	MacID: atkina10



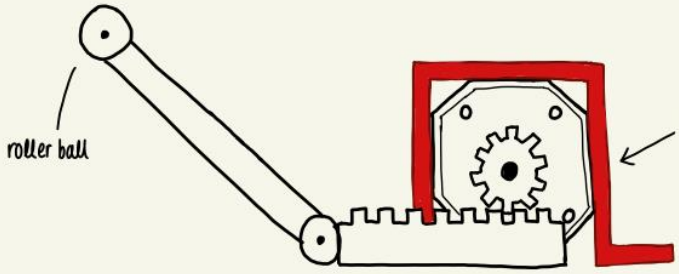
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*



Mechanism overview



Rotary actuator



Rotary actuator controls a pinion, which creates linear motion using a rack. A roller ball allows the hopper to move up and down.

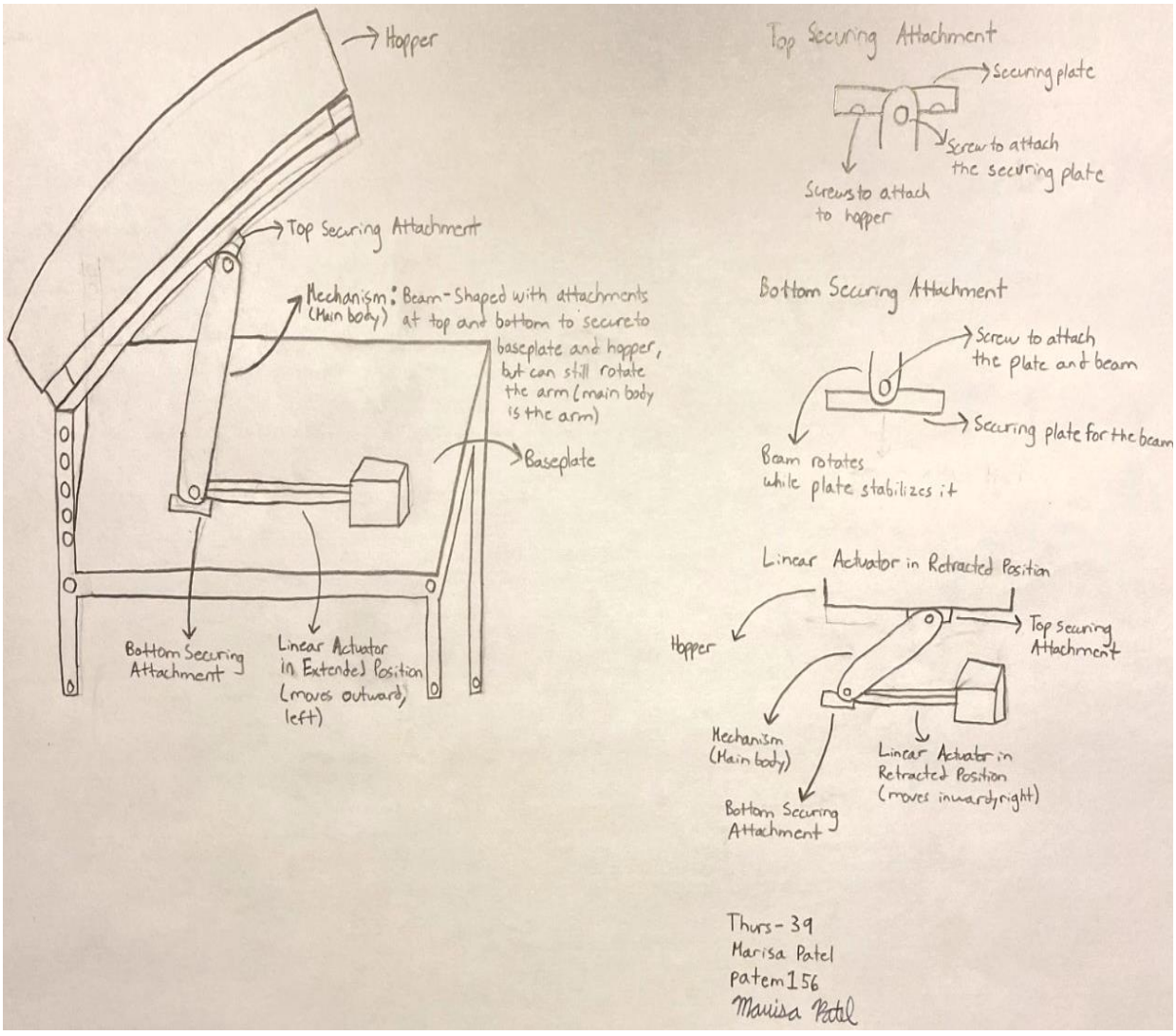
Alexandra Atkinson
Thurs-39
atkinal0

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

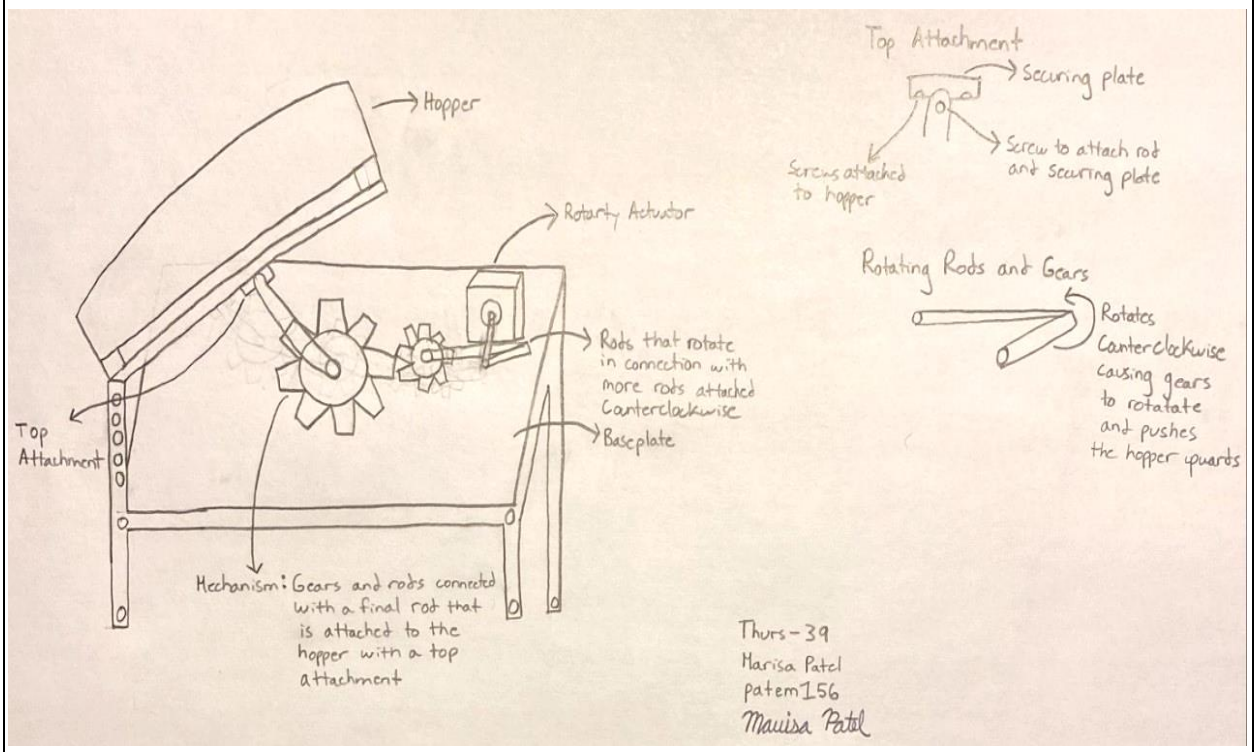
Team Number: Thurs-39

Name: Marisa Patel	MacID: patem156

Insert picture of refined concept sketch below



ENGINEER 1P13 – Project Three: *Revenge Of The Recycling System*



ENGINEER 1P13 – Project Three: *Revenge Of The Recycling System*

MILESTONE 2 (STAGE 3) – SENSOR SELECTION AND PROGRAM TASK PLANNING (COMPUTATION SUB-TEAM)

Team Number: Thurs-39

1. As a sub-team, discuss the results of your individual sensor research 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): Ultrasonic Sensor and the IR

Decision-making tools and/or justification:

Ultrasonic Sensor is really accurate in terms of measuring the distance where the IR sensor would be very helpful for the Q-bot to follow the yellow line while transferring or returning to the home position as well as determining a safe distance from the Q-bot to the bin during the drop off process. The Ultrasonic Sensor will be helpful as it's capable of taking the Q-bot to the correct bin location after being assigned the appropriate coordinates with minimum uncertainty. In week 2 Lab B, the colour sensor was not working at all. It was also observed that colour sensors can get confused between identifying blue and green. This raises a reliability issue, and the identification of bins can be accomplished by predetermining the coordinates instead.

ENGINEER 1P13 – Project Three: *Revenge Of The Recycling System*

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 (Insert > Picture > This Device) under the appropriate task

Dispense Container

```
While the identification tower detects a container (infinite loop):
        Rotate the servo table by increments of 45 degrees counterclockwise
Rotate the servo table counterclockwise by 90 degrees counterclockwise
Record the intitial weight on the servotable
Dispense a bottle into the empty slot
Record the final weight that is on the servo table
Return the difference in weight
```

Load Container

```
Fully open gripper so that it can firmly grip onto the container
Rotate the base of the arm by a defined angle so that it can pick up the container from the servo table
Rotate shoulder of by an angle so that it can pick up the container from the servo table
Rotate elbow of the arm by an angle so that it can pick up the container from the servo table
Close gripper
Rotate the elbow of the Q-arm by an angle so that the arm can safely put the containers on the Q-bot
Position the arm so that it reaches distinct coordinates each time a new container is being placed
Open gripper to drop the container onto the Q-bot
The arm goes to its home position
```

Transfer Container

```
Start infinite loop:
While desired coordinates are not achieved
        Start infinite loop:
                Read left and right IR sensors
                If right sensor does not detect yellow:
                        increase speed of right wheel
                Elif left sensor does not detect yellow:
                        increase speed of left wheel
                Else:
                        set both wheels to be the same speed
```

Deposit Container

Rotate the Q-bot 90 deg clockwise so that it's adjacent to the bin

Go forward until desired distance from the bin is reached

Rotate the Q-bot 90 deg counter-clockwise so that it can drop the containers inside the bin

Dump the containers into the bin by tilting the hopper

Return Home

Rotate 90 deg counter clockwise

Keep moving forward until the circular path is reached

If the Q-bot is on the left side of the circular path:

Turn 90 deg in the clockwise direction

Start infinite loop:
Read left and right IR sensors
If right sensor does not detect yellow:
increase speed of right wheel
Elif left sensor does not detect yellow:
increase speed of left wheel
Else:
set both wheels to be the same speed

If the Q-bot is on the right side of the circular path:

Turn in 90 deg counter-clockwise direction

Follow the yellow line until home position is reached:

Start infinite loop:

Read left and right IR sensors
If right sensor does not detect yellow:
increase speed of right wheel
Elif left sensor does not detect yellow:
increase speed of left wheel
Else:
set both wheels to be the same speed

Stop when the Q-bot reaches the predetermined home Coordinates
Turn 180 deg in the clockwise direction

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

MILESTONE 2 (STAGE 4) – DETAILED SKETCHES OF MECHANISM ASSEMBLY (MODELLING SUB-TEAM)

Team Number: Thurs-39

1. As a sub-team, review your refined 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: Yuna, Alexandra, Marisa	MacID: songy159, atkina10, patem156
Show your decision-making process below, and clearly identify which mechanism concept your team will pursue. For our mechanism, we have decided to incorporate a linear actuator. We decided to pursue Yuna's linear actuator sketch. This design appeared to be the most printable, durable, secure, and feasible. These were the criteria we decided to use in our simple decision matrix. We will be using a rod that is connected to the linear actuator, along with some constraint pieces that will hold the rod in place and keep it attached to the hopper and actuator. This design is simple to print and does not have very small parts that would be extremely difficult to print or parts that are more prone to break. We will however be making some changes to this design. We will not be using a roller or a pedestal in our new design. We will be using a pin to connect the rod to the linear actuator and use a securing slider part to both keep the rod attached to the hopper and ensure the rod is stable while in motion.	

Scale: 1 to 5 (1 = poor, 5 = great)

Criteria	Linear actuator (Yuna)	Rotary actuator (Yuna)	Linear actuator (Alex)	Rotary actuator (Alex)	Linear actuator (Marisa)	Rotary actuator (Marisa)
Printability	5	5	5	4	4	2
Durability	4	5	4	4	4	2
Security of parts/stability	4	2	3	2	4	3
Feasibility	5	3	5	4	2	2
Total	18	15	17	14	14	9

ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

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 (Insert > Picture > This Device) in the space below

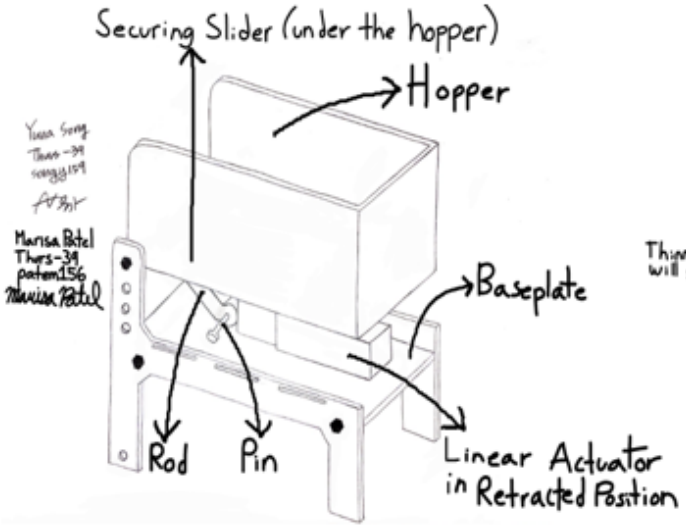
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

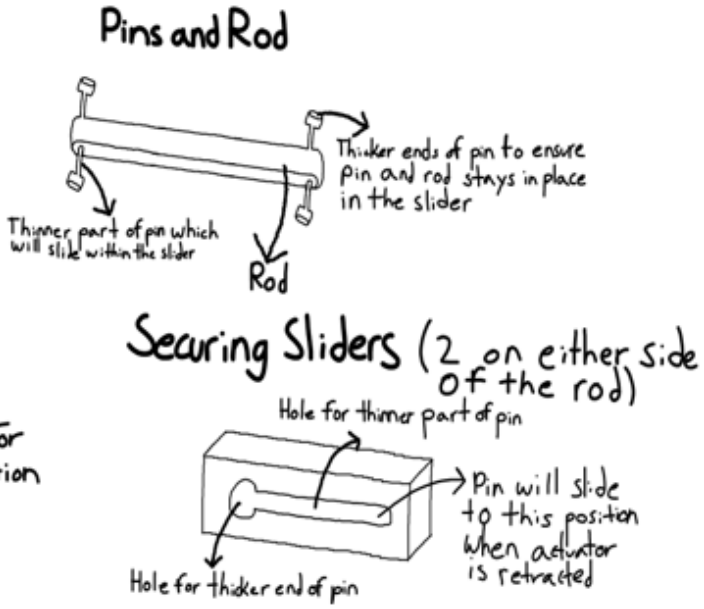
Team Number: Thurs-39

Name: Yuna Song, Marisa Patel	MacID: songy159, patem156

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

Labels, descriptors, constraints, and zoomed in parts of sketches were done by Marisa Patel





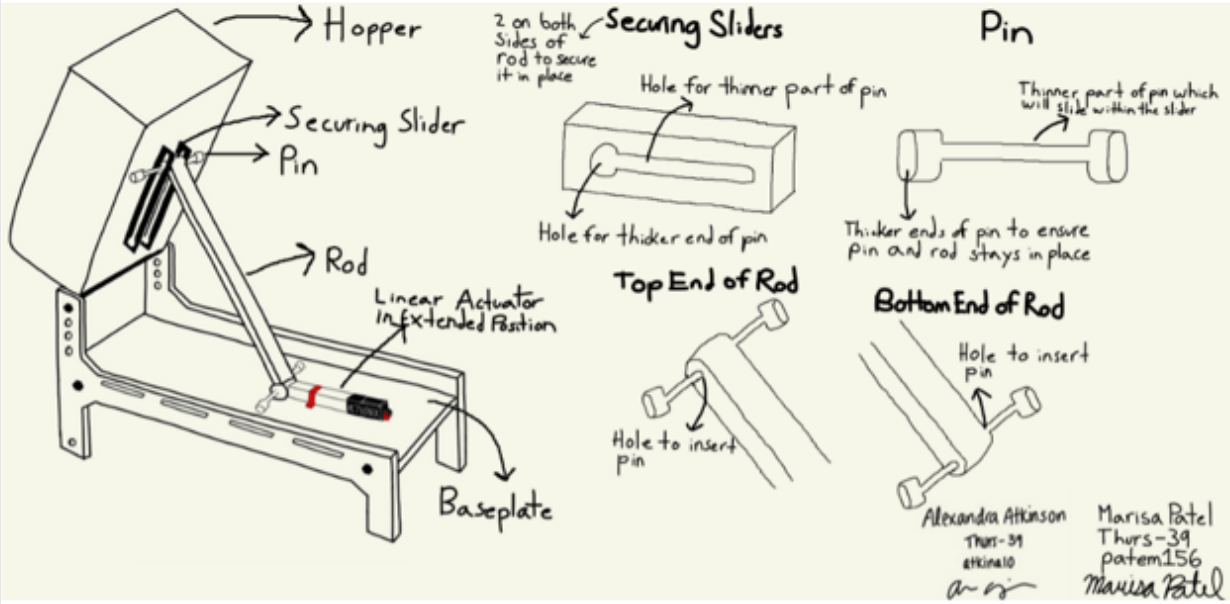
ENGINEER 1P13 – Project Three: *Revenge of the Recycling System*

Team Number: Thurs-39

Name: Alexandra Atkinson, Marisa Patel	MacID: atkina10, patem156

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

Labels, descriptors, constraints, and zoomed in parts of sketches were done by Marisa Patel



Milestone 3 Team Worksheet

PROJECT THREE: MILESTONE 3 – COVER PAGE

Team Number: Thurs-39

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

Full Name:	MacID:
Alexandra Atkinson	atkina10
Marisa Patel	patem156
Jonah Dabu	dabuj
HarnoorKaur HarnoorKaur	harnoorh
Yuna Song	songy159

MILESTONE 3 – DESIGN REVIEW FEEDBACK

MILESTONE 3 CHECKLISTS

Mentors and sub-teams will go through each checklist **together** and check off items if the design meets expectations. Mentors will give verbal feedback for each item on the checklists, and students will **summarize the feedback** before creating a list of **Action Items** to be completed before final project submission. *Note that these checklists are not project rubrics. They are tools to help guide students to successfully meet certain project requirements.*

MILESTONE 3 – DESIGN REVIEW FEEDBACK

Team Number: Thurs-39

(MODELLING SUB-TEAM)

☑ Design Meets Design Objectives

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

☐ Assembly model is complete and aesthetic, properly grounded and has no interference or errors

→ Includes baseplates. Actuator and mechanism placement in acceptable locations

☑ Mass of all components is considered

→ The design should intentionally minimize materials

☑ Total print time of **ALL 3D printed** components does not exceed 3 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, TA's will assist the sub-team in adding support.
→ Discuss potential for laser cutting components

☑ 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 and additional materials as necessary (ie. fasteners)

☑ **APPROVED FOR PRINTING AND/OR FABRICATION**

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

- Make sure there is no interference between the rod and the actuator
- Consider minimizing material for 3D printing by rounding edges/making parts smaller when possible
- Work on actuator constraints/movement
- Move forward with purchasing the materials we need to put together the design

MILESTONE 3 – DESIGN REVIEW FEEDBACK

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

- Analyze interference in Autodesk Inventor to ensure parts are not interfering
- Make the rod skinnier or create cut-outs to reduce material
- Purchase additional parts such as our fasteners (screws, nuts, dowels)
- Fix the constraints around the actuator and base of the rod to allow the actuator to move
- Make the supporting blocks connected to the baseplate of the hopper smaller or round out the edges to further minimize the amount of material used

MILESTONE 3 – DESIGN REVIEW FEEDBACK

Team Number: Thurs-39

(COMPUTATION SUB-TEAM)

☐ One cycle of pick-up/transfer/drop-off sufficiently executes

- → 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 30 and 31 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 TO CONTINUE REFINING AND DEVELOPING CODE**

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

- Fix bug in return_home() function so that the Q-bot stops at the home position
- Switch up the bin #1 to metal and bin# 2 to plastic
- Make sure that the Q-bot dumps the bin in the correct bin location
- Adjust gripper value so that the container is picked up every time
- Refine transfer_container() - make it more accurate
- Refine load_container() - make sure that it always picks up the container and puts it on the hopper

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

- Make the code more efficient
- Make sure that the Q-bot dumps the bin in the correct bin location
- Add comments to make the code more understandable
- Determine appropriate thresholds
- Make sure the bottles do not hit the dispenser before being transferred to the Q-bot