PROJECT THREE: MILESTONE 2 – COVER PAGE

Team Number: Fri-35

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

Full Name:	MacID:
Harikashan Thayeswaran	thayeswh
Joshua Currie	currij15
Buu Ha	hab8
Muhammad Danyal Afzal	afzalm7

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

Team Number: Fri-35

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

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

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

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

Team Number: Fri-35

Name: Harikashan Thayeswaran	MacID: thayeswh

Sensor Type	Description	Attribute(s)
Color Sensor	- A color sensor releases a white light onto a surface and detects the light reflected from the object [1]. - The light from releases different wavelengths that is detected by the sensor [1]. - The wavelengths allow the color sensor to differentiate the colour of an object through an RGB light spectral system [1]. [1] H. M. M. El-Hageen, "A New Technique for Improving the Estimation of a Reflective Optical Color Sensor," *Sensing and Imaging*, vol. 21, no. 1, pp. 1–19, Dec. 2020, doi: 10.1007/s11220-020-0276-5.	Detects the colors of the can and plastic bottle
LDR (Light-Dependant Sensor)	- An LDR Sensor (Photoelectric Sensors) measures the intensity of light by measuring the radiant energy that exists in frequencies (the frequencies vary between each object) [2]. - The LDR Sensor is implemented into electronic circuits [2]. - The LDR sensor converts the light energy into electrical signals [2]. [2] "Light Sensor including Photocell and LDR Sensor," *Basic Electronics Tutorials*, 15-Feb-2018. [Online]. Available: https://www.electronics-tutorials.ws/io/io_4.html. [Accessed: 19-Jan-2021].	Detects light in the environment
Retro-Reflective Photoelectric Sensor	- Photoelectric Sensors detects the changes in surface condition of an object to identify what kind of object it is [3]. - A Photoelectric Sensor is made up of emitter and a receiver [3]. - A Photoelectric sensor releases light, and the amount collected back into the receiver is affected by an object, and the sensor differentiates what an object is based on that interruption [3].	Has the ability to detect the reflective features of the can to differentiate which can it is

	[3] “Photoelectric Sensors,” OMRON. [Online]. Available: https://www.ia.omron.com/support/guide/43/introduction.html [Accessed: 19-Jan-2021].	

Team Number: Fri-35

Name: Joshua Currie	MacID: currij15

Sensor Type	Description	Attribute(s)
Ultrasonic sensor	-Ultrasonic sensors use ultrasonic waves to measure distance. -Ultrasonic waves can reflect off of glass or liquid surfaces, making ultrasonic sensors useful for detecting transparent objects along with complex shapes. -Depending on the reflected ultrasonic waves, the sensor can detect the distance from an object, including complex surfaces. [4] [4] "What is an ultrasonic / level sensor?," *KEYENCE*. [Online]. Available: https://www.keyence.ca/ss/products/sensor/sensorbasics/ultrasonic/info/. [Accessed: 22-Jan-2021].	-distance
Hall sensor	-Hall sensors are used to detect the magnitude of the electric field of an object. -Using the output voltage, called the Hall Voltage, the strength of the magnetic field passing through the sensor can be measured. -Since Hall sensors measure magnetic field, they are useful for detecting metals. [5] [5] D. Jost, "What is a Hall Effect Sensor?," *FierceElectronics*, 08-Oct-2019. [Online]. Available: https://www.fierceelectronics.com/sensors/what-a-hall-effect-sensor. [Accessed: 22-Jan-2021].	-magnitude of magnetic field
Active Infrared (IR) sensor	-Active infrared sensors transmit and receive reflection levels of infrared light in order to measure distance. -When there is a change in the properties of the reflected light, it indicates that there is an object within the detection area of the sensor. -Active infrared sensors are often used to detect moving objects within the sensor area. [6] [6] Hotron, "Infrared Motion Sensors for Automatic Doors," Hotron, 26-Nov-2020. [Online]. Available: https://hotron.com/technology/active-infrared-door-sensors/. [Accessed: 22-Jan-2021].	-motion -proximity

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

Team Number: Fri-35

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

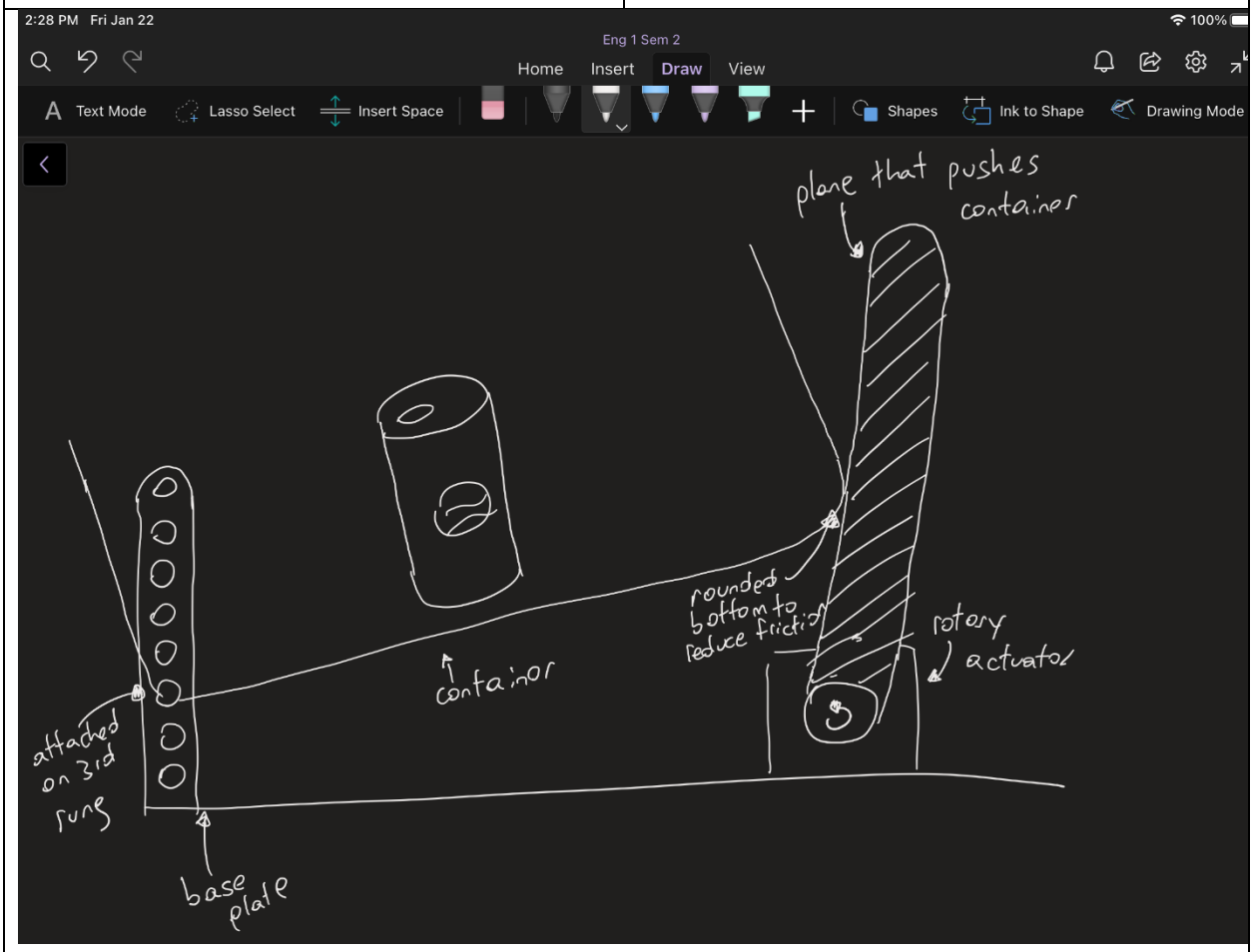
1. Copy-and-paste each sub-team member's refined sketch on the following pages (1 sketch per page)
   → Be sure to indicate each team member's Name and MacID

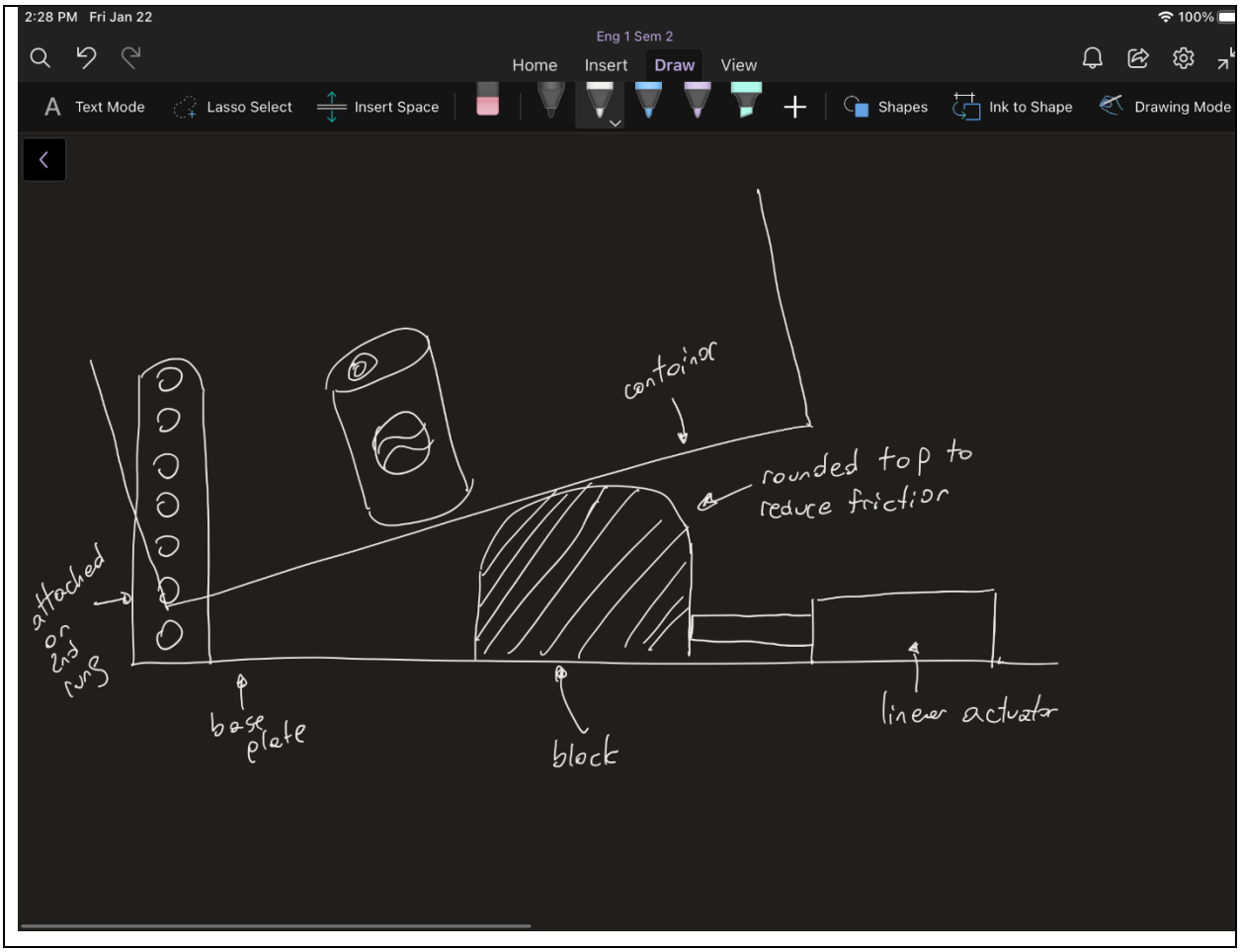
We are asking that you submit your work on both worksheets. It does seem redundant, but there are valid reasons for this:

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

Team Number: Fri-35

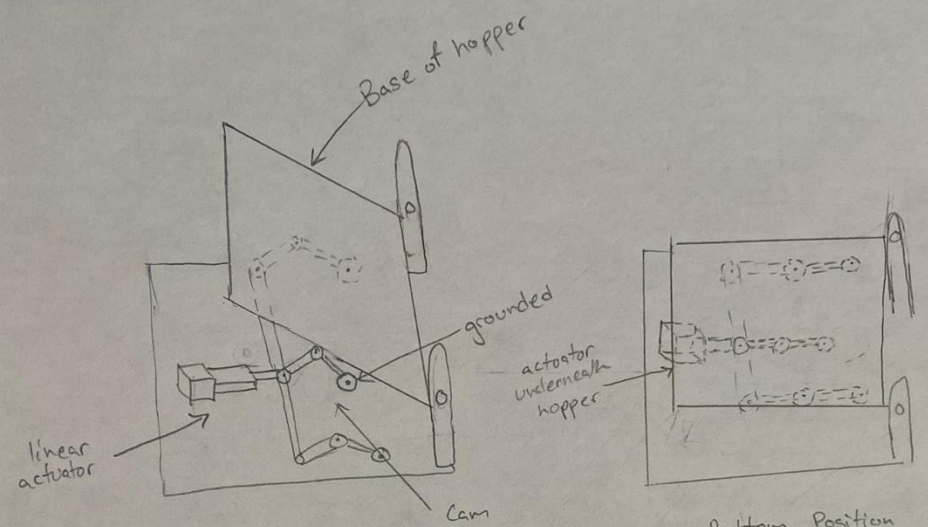
Name: Buu Ha	MacID: hab8




2:28 PM Fri Jan 22
100%
Eng 1 Sem 2
Home
Insert
Draw
View
Text Mode
Lasso Select
Insert Space
Shapes
Ink to Shape
Drawing Mode
container
rounded top to reduce friction
attached or 2nd rung
base plate
block
linear actuator

Team Number: Fri-35

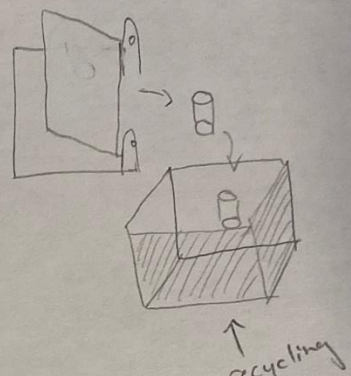
Name: Muhammad Danyal Afzal	MacID: afzalm7

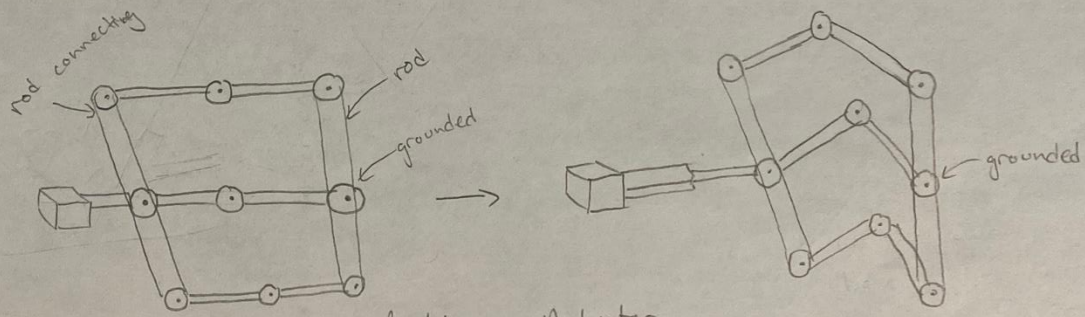


Upright Position

Bottom Position

Deposit of Containers:

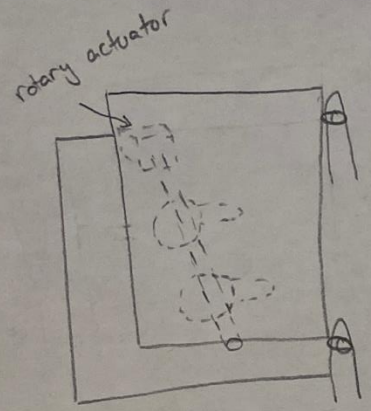




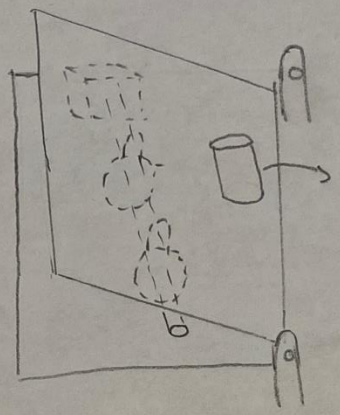
Motion of Linear Actuator

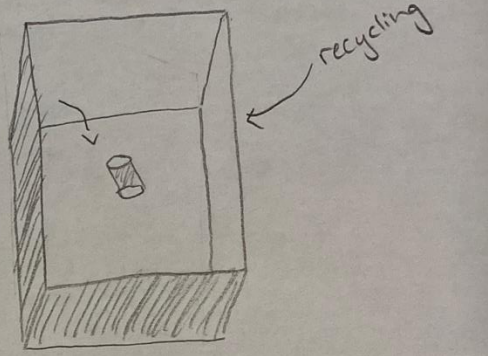
↳This mechanism will lift the base of the hopper

Muhammad Danyal Afzal
afzal m7

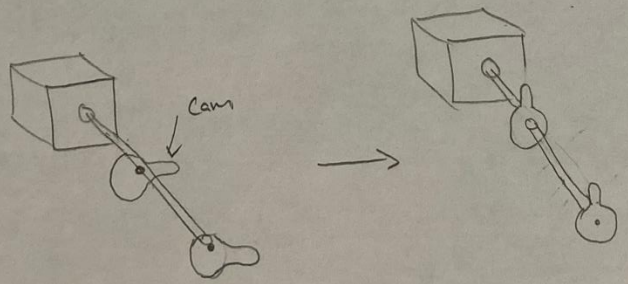


Down Position





Upright position



Motion of Rotary Actuator

Muhammad Danyal Afzal
afzalm7

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

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

Team Number: Fri-35

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

Sensor Type	**Findings and Appropriateness for Application**
Colour sensor	• Detecting the colour of the bins (red/green/blue) • Differentiating each can/bottle based on color
LDR (Light-dependent-sensor)	• Detecting amount of light reflected by each can or bottle
Retroreflective photoelectric sensor	• Detects the reflective features of each can/bottle and differentiates them (reflection of plastic bottle vs aluminum can)
Ultrasonic sensor	• Detecting transparent objects (clear bottles) • Measuring the distance between objects (such as the bin and the q-bot) to prevent any interference
Hall sensor	• Detect magnitude of magnetic field of an object • Useful for differentiating between metal and non-metal objects (aluminum can vs plastic bottle)
Active infrared (IR) sensor	• Detects objects within sensor area • Useful for detecting motion and proximity of objects (moving cans/bottles)

2. Identify one sensor to incorporate into your computer program

- The sensor we decided to use is the color sensor as it works efficiently to differentiate the cans and bottles along with the bins. Each can/bottle is a different color so the color sensor will manage to detect which can/bottle is which based on its color. The color sensor will also be efficient for the Q-arm placing the cans/bottles in its's assorted bin as each bin is a different color. This will allow the color sensor to perform well and do its job effectively.

***none of the above sensors seem to be able to detect contamination of the container, which is something we will need to take in account for differentiating between contaminated and non-contaminated containers

3. Identify an attribute value for each bin

Bin ID	**Attribute Value**
Bin01: Metal Bin	• Colour for metal bin is different from other bins (no color) • Note: The sensor won't be able to pick up a different color, so we have to consider the metal bin a non-color bin
Bin02: Paper Bin	• Colour for paper bin is different from other bins (green)
Bin03: Plastic Bin	• Colour for plastic bin is different from other bins (blue)
Bin04: Garbage Bin	• Colour for garbage bin is different from other bins (red)

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

Team Number: Fri-35

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

   → Add additional rows/columns as needed

	Consistent performance	*Ease of production*	*Energy Efficient*	Cost to implement	Time Efficient	*Durability*	**Score**
Consistent performance	-	1	1	1	1	1	5
Ease of Production	0	-	0	1	0	0	1
Energy Efficient	0	1	-	0	1	0	2
Cost to Implement	0	0	1	-	1	0	2
Time Efficient	0	1	0	0	-	0	1
Durability	0	1	1	1	1	-	4

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

	Weight	*Concept 1*		*Concept 2*		*Concept 3*		*Concept 4*	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Consistent performance	5	4	20	4	20	**5**	**25**	5	25
Ease of Production	1	5	5	5	5	**4**	**4**	3	3
Energy Efficient	2	3	6	3	6	**4**	**8**	3	6

Cost to Implement	2	4	8	4	8	**5**	**10**	5	10
Time Efficient	1	3	3	3	3	**4**	**4**	4	4
Durability	4	2	8	4	16	**4**	**16**	3	16
TOTAL	15	22	50	23	58	**26**	**67**	23	60

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

Based on our evaluation of various concepts, we have decided to go with concept 3 due to its high ranking on the following factors:

1. Consistent Performance
2. Ease of Production
3. Energy Efficiency
4. Cost to Implement.
5. Time Efficiency
6. Durability

Concept 3 maximizes all these factors due to various reasons. Firstly, its skeletal model reduces the amount of friction between components, maximizes durability, time efficiency, and energy efficiency. Also, while using linkages, it helps to allow a simple, yet efficient system which should work harmoniously and accurately. The minimal and simple parts lower the cost and maximizes the ease of production. Due to these factors, concept 3 superseded all the other designs.