PROJECT THREE: MILESTONE 2 – COVER PAGE

Team Number:	Tues-33

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

Full Name:	MacID:
Nolan Cross	crossn3
Zareen Kabir	kabirz
Sude Sayyan	sayyans
Luigi Quattrociocchi	quattrl
Fondson Lu	luh57

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

Team Number: Tues-33

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:		Tues-33
Name:Zareen Kabir	MacID: kabirz	
Sensor Type	**Description**	**Attribute(s)**
LDR (Light Dependent Resistor)	• This sensor is used to detect light, and how high or low the brightness is.[1] • As it is able to measure light it can detect between: o Metals which reflect a lot of light o Plastic which reflects average light o Paper which reflects almost no light These will help characterize between the type of material and will allow for the containers to be separated to their appropriate bins	The reflective light from the bins. -Metallic bins will contain metals -Rougher bins are less shiny and will contain papers -Less rough bins are a little shiny and will contain plastics
Color Sensor	• Is able to detect the surface colour. The sensors cast light and calculates an RGB value[2] • This sensor will be able to differentiate between the containers because: o Plastics are attributed to white bottles o Metals are attributed to red cans o Papers are attributed to blue bottles	The colour of the bins will correspond with with the colours of the material types
Retro-reflective Photoelectric Sensor	• A retro-reflective photoelectric sensor emits a light beam and detects an object when it interrupts the light beam from reaching the reflector. [3] • Can be typically used to detect the position and distance of the container. Can be attached to the arm and detect how far a container is when picking it up	Measure the distance between the Q-bot and the bin with the corresponding bin ID

[1] "Light Dependent Resistor LDR, Photoresistor » Electronics Notes." https://www.electronics-notes.com/articles/electronic_components/resistors/light-dependent-resistor-ldr.php (accessed Jan. 17, 2021).

[2] "Color sensors | SICK." https://www.sick.com/ca/en/products-by-tasks/monitoring-and-controlling/quality/color-sensors/c/g113666 (accessed Jan. 17, 2021).

[3] "Seven uses for photoelectric sensors." https://www.rs-online.com/designspark/seven-uses-for-photoelectric-sensors (accessed Jan. 17, 2021).

Team Number:	Tues-33

Name: Sude Sayyan	MacID: sayyans

Sensor Type	Description	Attribute(s)
Ultrasonic	Measures the distance of the target object by emitting ultrasonic sound waves. The waves get reflected and are then transformed into electrical signals, which helps locate the object. They can also detect a wide range of materials and colours, as well as the mass (using sound waves)!	Target bin Q-Lab Render Material Mass
Hall	Measures the magnitude of the magnetic field. They could measure ferromagnetic metals such as iron and steel, and are also able to act as a proximity sensor.	Material Target bin
Active Infrared (IR)	These sensors are able to emit and detect infrared radiation (heat). They are made of a receiver and a light emitting diode. If an object has heat and is moving, the sensor is able to sense it.	Material

References:

"Custom Ultrasonic Sensors Detect Wide Range Of Materials," *FierceElectronics*, 11-Dec-2017. [Online]. Available: https://www.fierceelectronics.com/components/custom-ultrasonic-sensors-detect-wide-range-materials#:~:text=The%20ultrasonic%20sensors%20can%20detect,as%20mesh%20trays%20or%20springs. [Accessed: 18-Jan-2021].

"Detection based on 'Ultrasonic Waves'What is an ultrasonic / level sensor?," *KEYENCE*. [Online]. Available: https://www.keyence.ca/ss/products/sensor/sensorbasics/ultrasonic/info/. [Accessed: 18-Jan-2021].

"Hall Effect Sensor and How Magnets Make It Works," *Basic Electronics Tutorials*, 09-Feb-2018. [Online]. Available: https://www.electronics-tutorials.ws/electromagnetism/hall-effect.html. [Accessed: 18-Jan-2021].

"Infrared sensors - Sensor Technology," *Metropolia Confluence*. [Online]. Available: https://wiki.metropolia.fi/display/sensor/Infrared+sensors#:~:text=Active%20infrared%20sensors%20are%20the,photodiode%2C%20phototransistor%20or%20photoelectric%20cells. [Accessed: 18-Jan-2021].

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

Team Number:	Tues-33

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

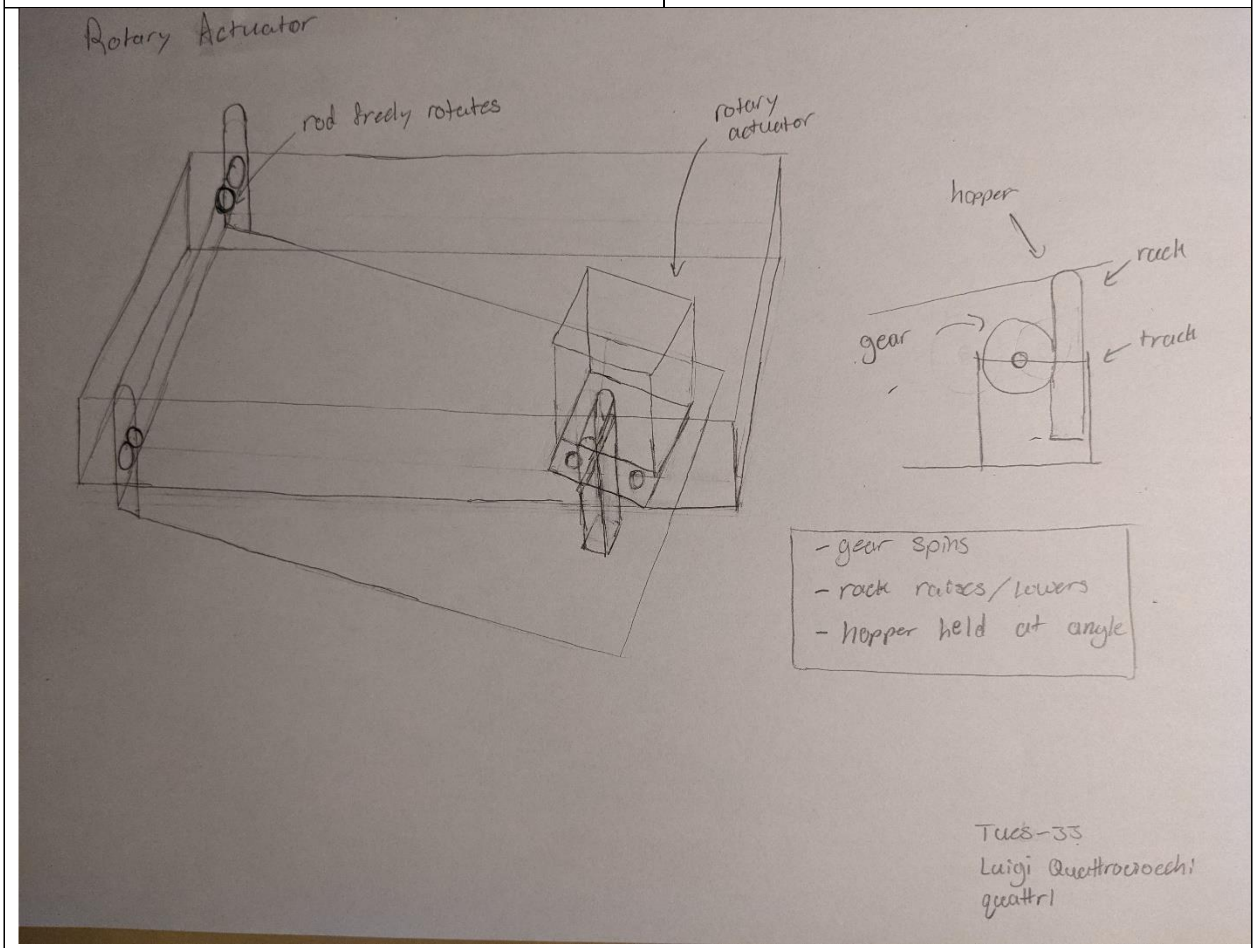
1. Copy-and-paste each sub-team member's refined sketch on the following pages (1 sketch per page)
   → Be sure to indicate each team member's Name and MacID

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

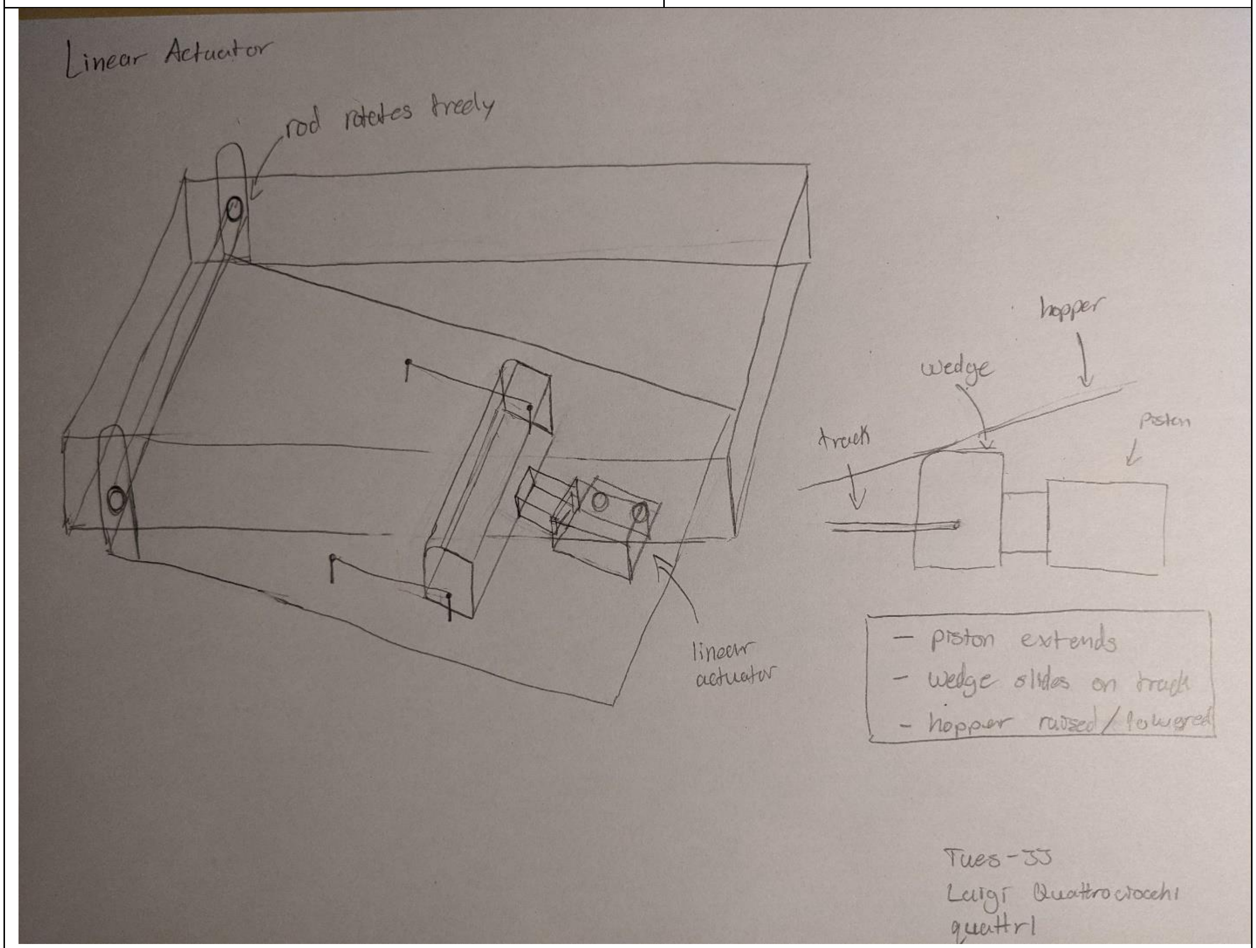
Team Number:	Tues-33

Name: Luigi Quattrociocchi	MacID: quattrl



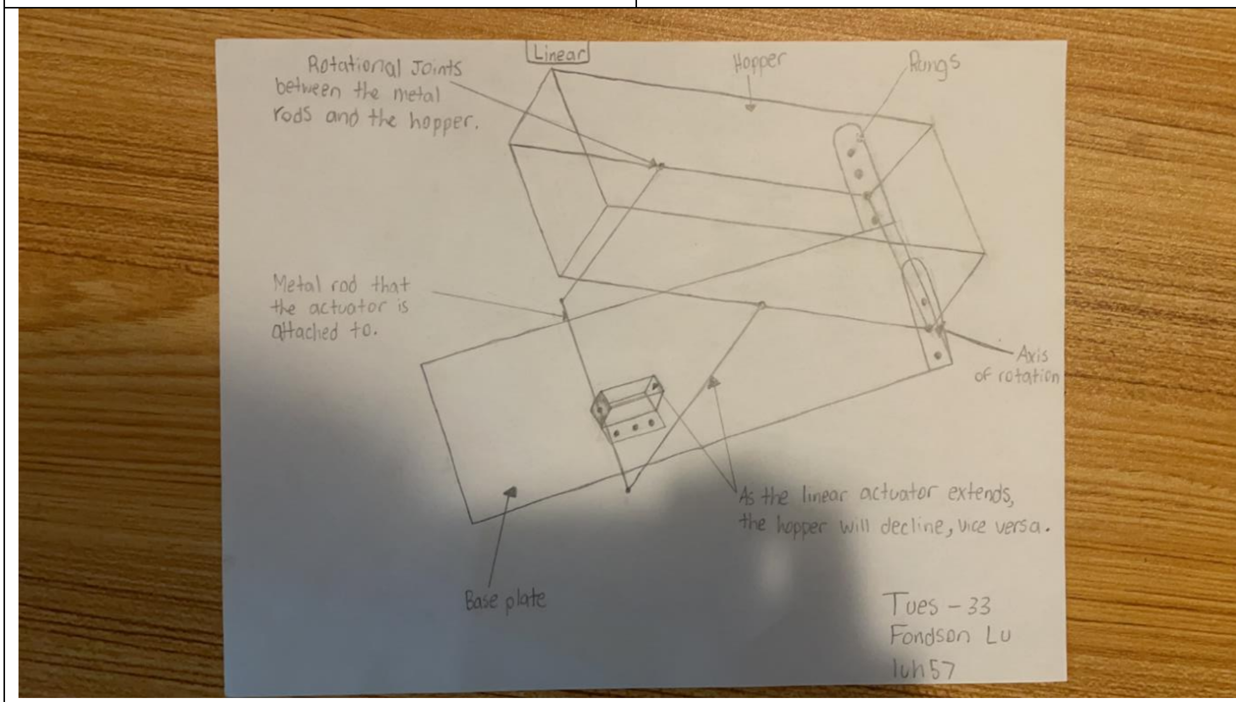
Team Number:	Tues-33

Name: Luigi Quattrociocchi	MacID: quattrl



Team Number:	Tues-33

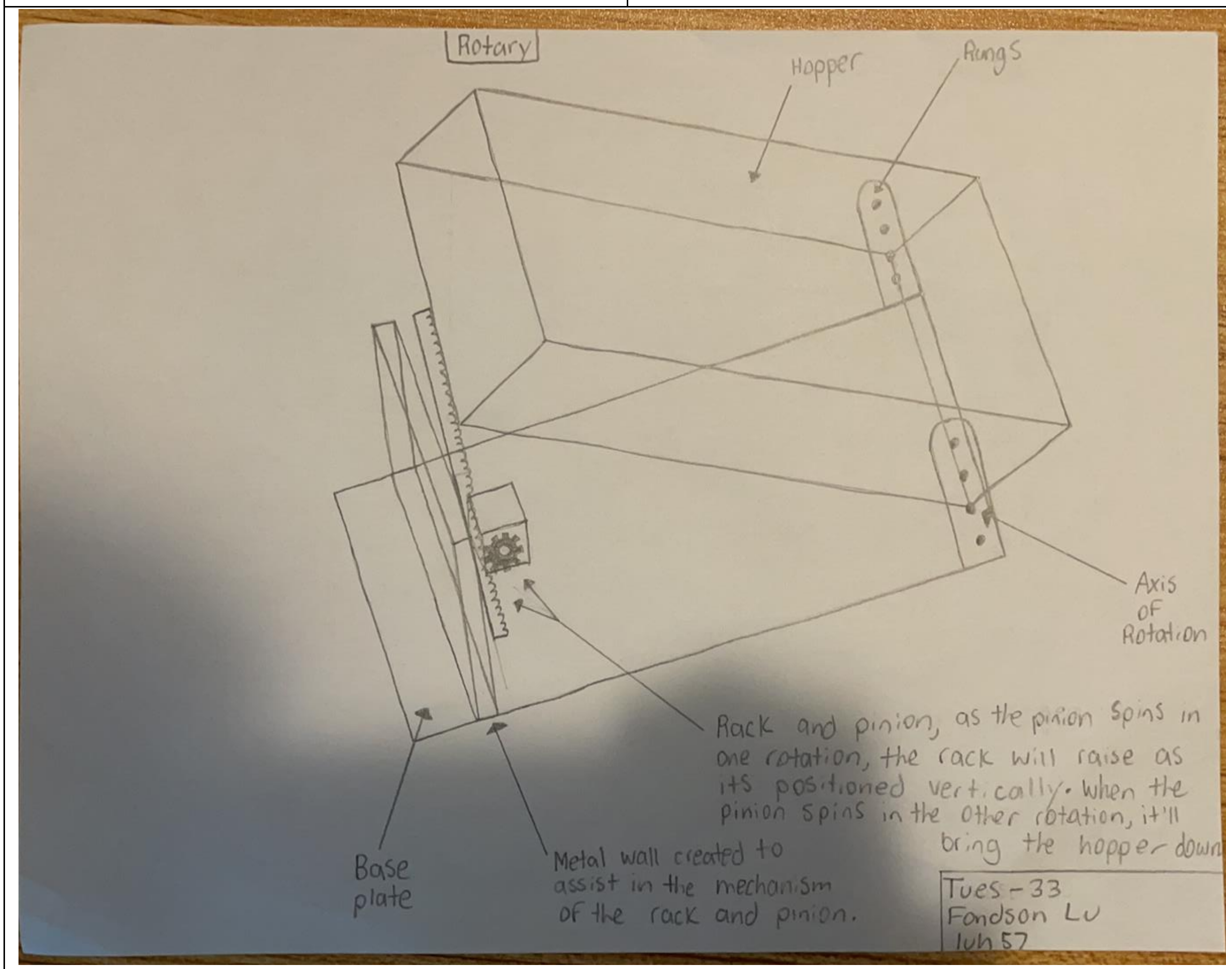
Name: Fondson Lu	MacID: luh57



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

Team Number:	Tues-33

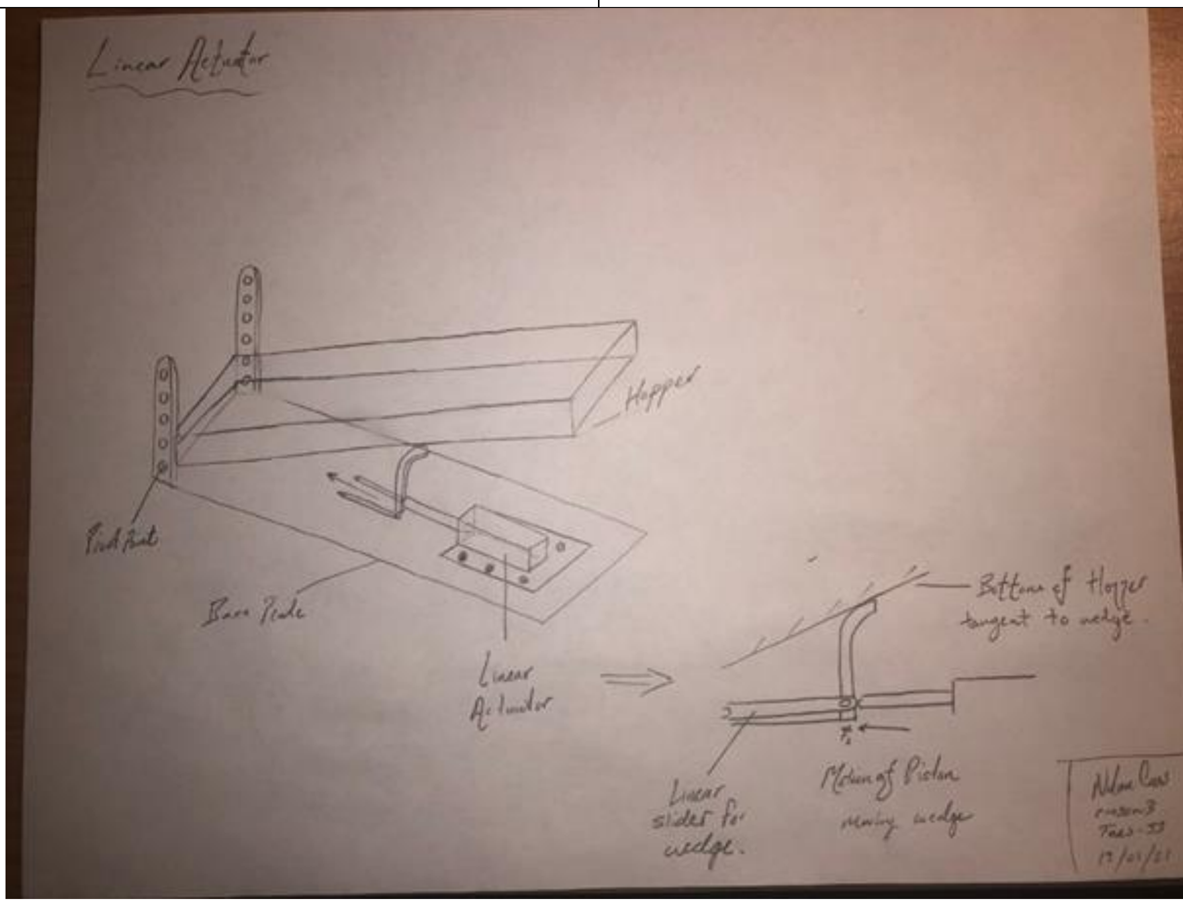
Name: Fondson Lu	MacID: luh57



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

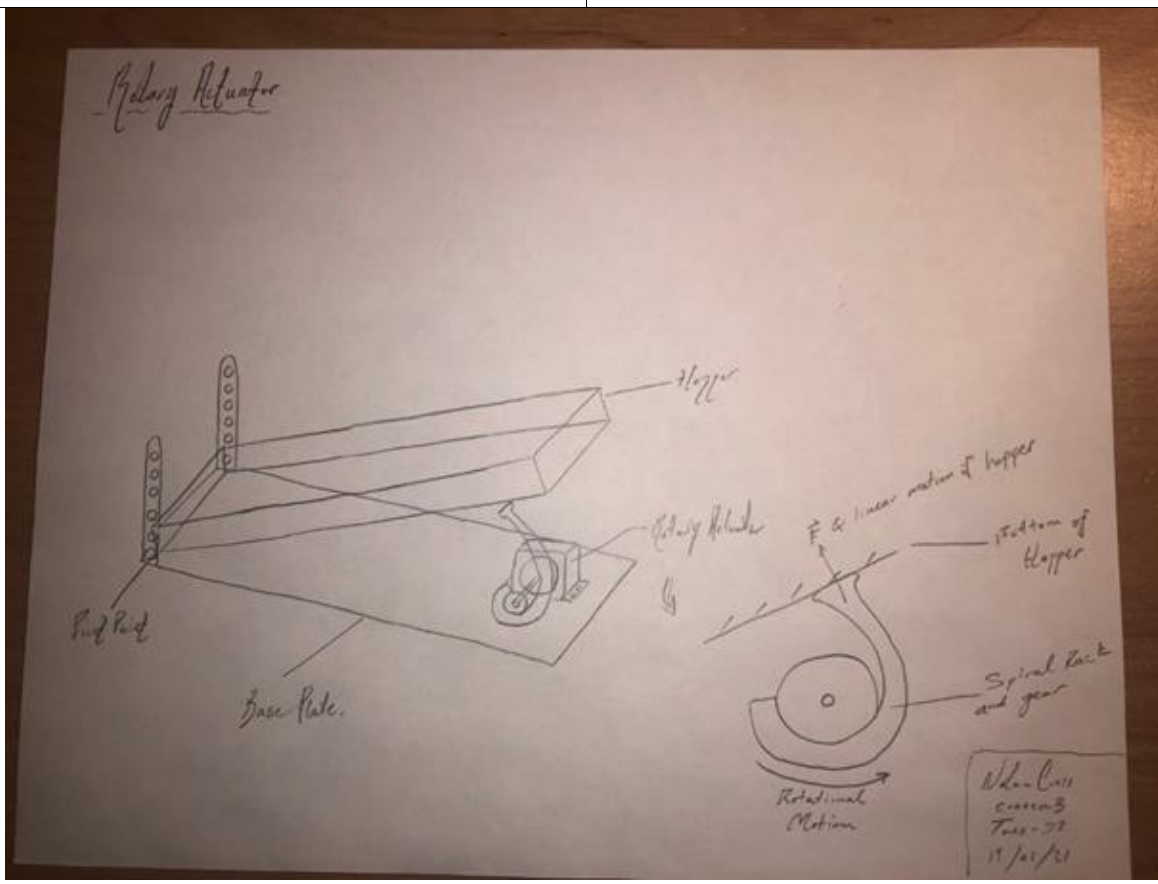
Team Number:	Tues-33

Name: Nolan Cross	MacID: crossn3



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

Name: Nolan Cross	MacID: crossn3



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

Team Number:	Tues-33

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**
Ultrasonic Sensor	• Ultrasonic measures the soundwaves and transforms it into electronic • Measures the distance from the q-bot sensor and the bins • Appropriate in measuring distance from the bin and binID
Hall Sensor	• Measures magnitude of magnetic field • Identifies ferromagnetic materials • Outputs high voltage for metallic and low voltage for others • Appropriate for distinguishing between metals and other bins • Inappropriate for differentiating between papers and plastics
Active Infrared (IR) Sensor	• Emits and detects infrared radiation(heat). • Includes two parts of a receiver and transmitter in the form of a LED and a sensor • Measures voltage and returns high voltage if it's at a close distance and low voltage at a far distance. • Appropriate in measuring distance from the bin and binID
LDR(Light Dependent Resistor)	• This sensor is used to detect light, and how high or low the brightness is. • Outputs high voltage readings fora specific duration if light is sensed around the Q-bot • Appropriate to measure the distance, as well as the light reflected of the bins with specific roughness attributes
Colour Sensor	• Is able to detect the surface colour. The sensors cast light and calculates an RGB value • Depending on the individual colour sensor that is activated, detects the colour by returning high voltages, and if it doesn't detect that specific colour returns a low voltage.

	• Appropriate in differentiating between all bins, by correlating the bin colour to the container colour, or designating dirty containers and clean containers to a specific bin colour.
Retro-reflective Photoelectric Sensor	• A retro-reflective photoelectric sensor emits a light beam and detects an object when it interrupts the light beam from reaching the reflector. • Used by emitting a high voltage if bin is within proximity and low voltage if it is out of range. • Appropriate in measuring distance from the bin and binID

2. Identify one sensor to incorporate into your computer program

We have chosen to use a colour sensor in order to distinguish our different bins. Discussing all the different types of sensors, we realized that the colour sensor is unique and more customizable. For example, we could customize the attributes of every bin, by assigning them all a different colour, in order to distinguish between them. Our main reason for choosing the colour sensor was because the other sensors did not offer a variety of customizable aspects. The ultrasonic sensor was able to measure the distance between each bin, but it had no unique way of distinguishing the bins. The hall sensor was only able to measure magnetic fields, so it would only be essential for determining the metal materials. The active IR, LDR, and retro-reflective photoelectric sensors return a voltage value based on how close the bins are, but once again, they have no way to customize the attributes. Finally, these discussions have led us to choose the colour sensor, for its effectiveness and uniqueness.

3. Identify an attribute value for each bin

Bin ID	**Attribute Value**
Bin01: Metal Bin	Red
Bin02: Paper Bin	Blue
Bin03: Plastic Bin	White
Bin04: Garbage Bin	Black

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

Team Number:	Tues-33

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

	Sturdiness of mechanism	*Range of motion of mechanism*	*Repeatability of function*	*Simplicity to model and simulate*	*Hopper can hold up to 3 containers*	**Score**
Sturdiness of mechanism	1	1	0	0	0	2
Range of motion of mechanism	0	1	0	0	0	1
Repeatability of function	1	1	1	0	0	3
Simplicity to model and simulate	1	1	1	1	0	4
Hopper can hold up to 3 containers	1	1	1	1	1	5

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

	Weight	*Luigi Linear*		*Luigi Rotary*		*Fondson Linear*		*Fondson Rotary*		*Nolan Linear*		*Nolan Rotary*	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Range of motion of mechanism	1	3	3	5	5	8	8	1	1	4	4	3	3
Sturdiness of mechanism	2	3	6	7	14	7	14	6	12	6	12	3	6
Repeatability of function	3	3	9	10	30	8	24	10	30	5	15	8	24
Simplicity to model and simulate	4	7	28	5	20	5	20	6	24	7	28	1	4
Hopper can hold up to 3 containers	5	10	50	10	50	10	50	10	50	10	50	10	50
TOTAL		26	96	37	119	38	116	33	117	32	109	25	87

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

The three highest scores were Fondson's Linear, Fondson's Rotary, and Luigi's Rotary designs, but ultimately the selected design was Luigi's Rotary design despite all scores being very close to each other. The advantages of Fondson's Linear design include a large range of motion and a sturdy mechanism, but it would not be as simple to model and simulate. Fondson's Rotary design and Luigi's Rotary design were very similar conceptually, so the winner between the two did not particularly matter. Both designs were comparatively simple, were sturdy, and were repeatable.

Luigi's Rotary design depicts a gear on the axle of a rotary actuator, as well as a rack which is raised or lowered by the gear. The rack being raised or lowered would also effectively raise or lower the back end of the hopper. Since the front end of the hopper is fixed on a rung attached to the baseplate, the hopper would be at an angle and the containers would be dropped out. This design was chosen because the rack and pinion method of converting rotational motion to linear motion is very flexible in implementation; it can potentially result in a large range of motion, while also staying relatively simple to model. To conclude, the decision we came to was to proceed with the concept proposed by Luigi's Rotary design.