MEC2402 Year 2025 Semester 1
WARMAN Preliminary Report

Prepared by

Group ‘SWAR12’

Members

Lim Yap Khye (34541896)
Chong Zheng You (33520720)
Kieran Paul Bhasker (34022104)
Keziah Sinnadurai (34789642)

March - April 6

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Student's name	**Lim**	**Yap Khye**	
Student's I.D. number	**34541896**	Student I.D. 34541896	
Unit name	Engineering design 1	**Unit code**	**MEC2402**
Lecturer's and/or tutor's name	Dr. Chiew Yeong Shiong	**Lab day:**	**Lab time:** 2pm to 4pm
Type of submission (eg Assignment 1)	Pre-lim	**Group Assignment** (tick box) ☑ Note, each student must attach their own signed cover sheet to the assignment.	

Due date: 6/4/2025	**Date submitted:** 6/4/2025	**Extension granted** (tick box) ☐

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Student's name	**Bhasker**	**Kieran Paul**	
Student's I.D. number	**34022104**	Student I.D. 34022104	
Unit name	Engineering design 1	**Unit code**	**MEC2402**
Lecturer's and/or tutor's name	Dr. Chiew Yong Shiong	**Lab day:**	**Lab time:**
Type of submission (eg Assignment 1)	Pre-lim	**Group Assignment** (tick box) ☑ Note, each student must attach their own signed cover sheet to the assignment.	

Due date: 06.04.2025	**Date submitted:** 06.04.2025	**Extension granted** (tick box) ☐

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Student's name	**Chong**	**Zheng You**	
Student's I.D. number	**33520720**	Student I.D. 33520720	
Unit name	Engineering design 1	**Unit code**	**MEC2402**
Lecturer's and/or tutor's name	Mr Chiew Yeong Shiong	**Lab day:** Tuesday	**Lab time:** 2p.m. – 4p.m.
Type of submission (eg Assignment 1)	SWAR12 Prelim Submission	**Group Assignment** (tick box) ☑ Note, each student must attach their own signed cover sheet to the assignment.	

Due date: 6-4-2025	**Date submitted:** 6-4-2025	**Extension granted** (tick box) ☐

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Student's name	Sinnadurai	Keziah	
Student's I.D. number	34789642		
Unit name	Engineering design 1	Unit code	MEC2402
Lecturer's and/or tutor's name	Dr. Cheiw Yong Shiong	Lab day: Tuesday	Lab time: 2pm - 4pm
Type of submission (eg Assignment 1)	Pre - Lim	Group Assignment (tick box) ☑ Note, each student must attach their own signed cover sheet to the assignment.	
Due date: 6/4/2025	Date submitted: 6/4/2025	Extension granted (tick box) ☐	

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Date: ..6../..4../..2025.. Signature: ....

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Executive Summary

This preliminary report outlines the problem analysis, concept development, and design decisions of our team's system, built for the 2025 WARMAN Design & Build Competition. Set on the island of Gondwana, a critical shortage of non-sustainable fuel has forced the search for a renewable alternative. The island's rapidly increasing temperature further contributes to an expanding list of design constraints. Meteorites, varying in size, that have been found in unpredictable locations across the island have been confirmed as the most viable energy source. This year, we are tasked with designing an autonomous system capable of collecting and depositing three model meteorites into their storage bunker.

The general prerequisites for the operation of the system are as follows:

- Build a reduced-scale, proof-of-concept transport system
- The system must start from the designated Start Zone
- Collect three distinct balls simulating meteorites (tennis ball, racquetball, table tennis ball)
- Collect balls placed randomly within a 3 × 3 grid
- Navigate obstacles, including narrow gaps and an unstable seesaw
- Deliver all three balls to the Ball Deposit Zone (storage bunker)

The specifications for the dimensions of the system are as follows:

- Fit within a 400 mm cube before activation
- Be initiated via a single starting action
- Operate fully autonomously once activated
- Complete the entire task within 120 seconds

Our conceptual design complies with all of these constraints, from the external chassis to the internal electronics. We have conducted detailed analysis of proposed concepts and have selected an approach that best satisfies the criteria in the most efficient manner.

1.0 Introduction

The Warman Design and Build Competition is a prestigious, annual national engineering event coordinated by Engineers Australia, aimed at undergraduate students across the country. It challenges teams to apply fundamental engineering principles in a hands-on, team-based project that simulates real-world engineering problems. The competition emphasizes design innovation, practical prototyping, systems thinking, and compliance with real-world constraints such as cost, manufacturability, and autonomous operation.

The 2025 challenge, titled Project SEESAW, tasks participants with designing and constructing a reduced-scale autonomous system capable of completing a multifaceted logistics task within a 120-second time limit. The system must autonomously initiate operation, detect and collect three different types of spherical objects (representing meteorites) placed in random positions within a 3×3 grid, navigate across a pivoting SEESAW obstacle, and accurately deposit the collected objects into a designated bunker — all without any external input once activated.

This project simulates the integration of autonomous robotics into hazardous or unstable terrain, mirroring challenges in fields such as space exploration, disaster response, and warehouse automation. As such, the design solution must account for variable terrain, object variability, system robustness, autonomous navigation, and precise actuation under time and spatial constraints.

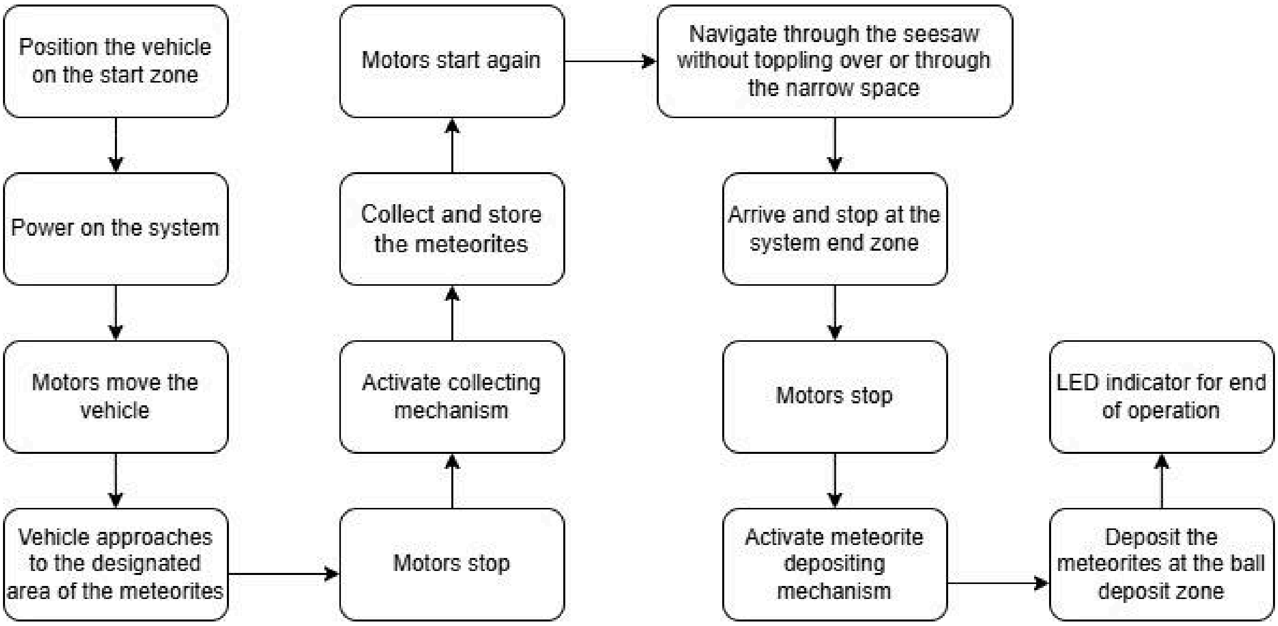
This report documents the complete engineering design process undertaken by the team — from initial problem analysis using the OFFERS framework, through creative solution generation using tools like the Morphology Method, to concept evaluation and final selection using composite criteria. It further details the technical implementation of the final design, which integrates a mecanum-wheel drivetrain for omnidirectional control and an excavator grapple to collect the meteorites and store them in a dedicated compartment in the vehicle.

2.0 Problem Definition (OFFERS Analysis)

2.1 Objectives:

The objective of the WARMAN project is to create an autonomous transport system capable of gathering three types of model meteorites (tennis ball, racquetball, and ping-pong ball) from a randomly assigned 3×3 grid. This system must navigate unstable terrain, which is a seesaw or a narrow gap, and deposit the collected meteorites into a storage bunker on the opposite side of the seesaw within 120 seconds.

2.2 Functions:



2.3 Factors:

Category	Considerations
Men	● Easy for students to assemble and debug hands-free during run ● Must not injure users or damage track
Money	● Use of off-the-shelf parts (Arduino, servos)
Machines	● Compact system using commercial electronic parts and 3D-printed components
Methods	● Autonomous programming ● No remote control ● Safe ● Efficient ball-handling ● Load-tested release mechanisms
Minutes	● System must complete task in ≤120 seconds ● Quick setup (≤2 minutes) ● Minimal debugging time
Materials	● Lightweight frame ● Durable during impact ● Good traction on painted SEESAW surface ● Non-hazardous

2.4 Effects:

1. Promotes autonomous and sustainable robotic engineering solutions
2. Enhances student problem-solving, innovation, and prototyping skills
3. May inspire solutions for energy/resource retrieval in hazardous environments
4. Encourages environmentally friendly, material-efficient designs

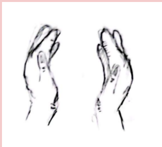
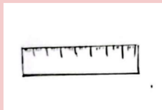
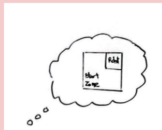
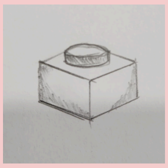
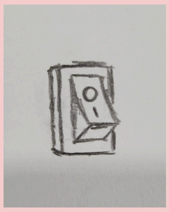
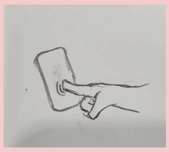
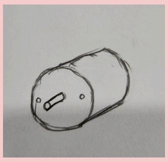
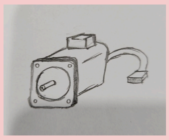
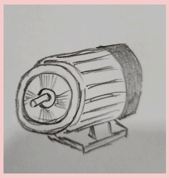
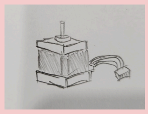
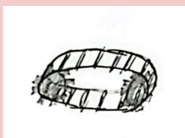
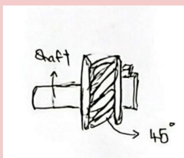
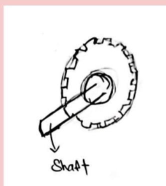
2.5 Requirements & Specifications:

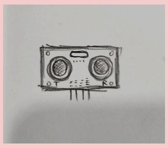
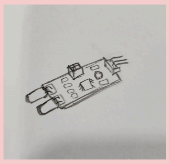
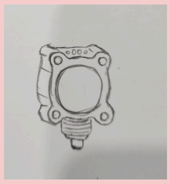
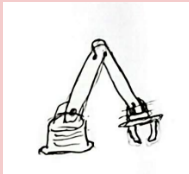
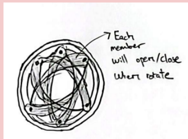
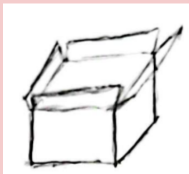
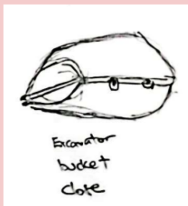
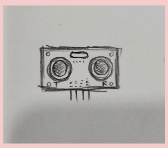
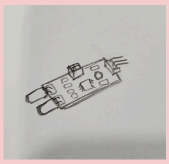
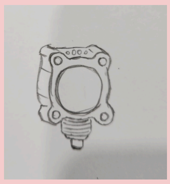
Requirement	Criteria	Weighting	Specification
Collect all the meteorites (balls)	Number of balls moved by the system	10	All three balls were collected without dropping.
Accurate deposition	Balls are fully released into the deposit zone	10	All balls are inside the deposit zone without being in contact with the vehicle.
Seesaw navigation	Ability to cross SEESAW without tipping off	8	System fully supported throughout.
Time performance	Total run duration in seconds	7	≤ 120 seconds
Autonomous operation	No external control after started	10	Operations should start with one button (wireless).
Compact design	Size of vehicle within the constraints given	4	Fits within 400 × 400 × 400 mm cube
Mass constraints	The mass of the vehicle within the constraints given in kilograms	4	≤ 6 kg
Ease of assembly	Time taken to set up vehicle on track in seconds	3	Setup ≤ 2 minutes
Safety compliance	No exposed hazards	5	Fuse in system
Cost feasibility	Using common parts available, DIY assembly in Ringgit	6	Must avoid professional/turnkey kits; budget is RM400

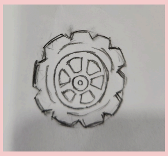
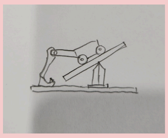
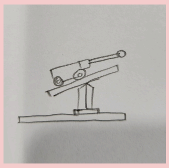
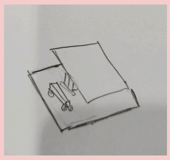
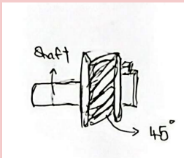
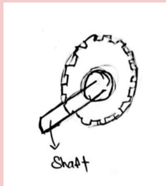
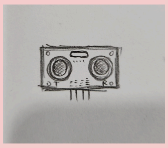
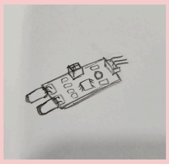
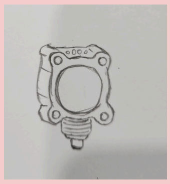
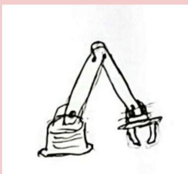
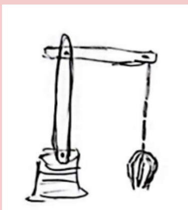
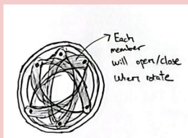
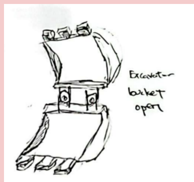
2.6 Sub-Problems:

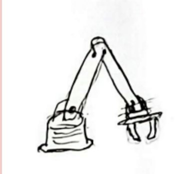
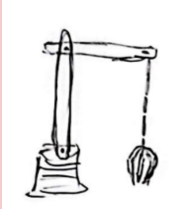
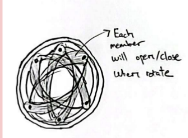
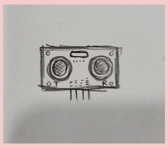
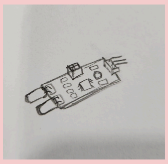
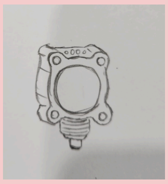
- How do we find the meteorites (balls) of different sizes on a 3 x 3 grid?
- How do we securely store the meteorites (balls) during the run?
- How do we collect & deposit the balls (meteorites) securely?
- As the SEESAW tilts, how do we control the movement of the vehicle?

3.0 Creative Solution Generation (Morphology Method)

No	Function	Alternatives			
		A	**B**	**C**	**D**
1	**Position the vehicle on the start zone**	Manually using hands by intuition 	Manually using hands by utilizing a ruler for perfect alignment 	Manually using hands by utilizing cardboard box as reference 	Manually using hands by utilizing the Start Zone as reference 
2	**Power on the system**	Button 	Lever/Switch 	Touch Screen 	Voice command 
3	**Motors move the vehicle**	DC motors 	Servo motors 	AC motors 	Stepper motors 
4	**Vehicle approaches to the designated area of the meteorites**	Caterpillar tread/Tank thread 	Mecanum wheels 	Treaded wheels 	Omni wheels 

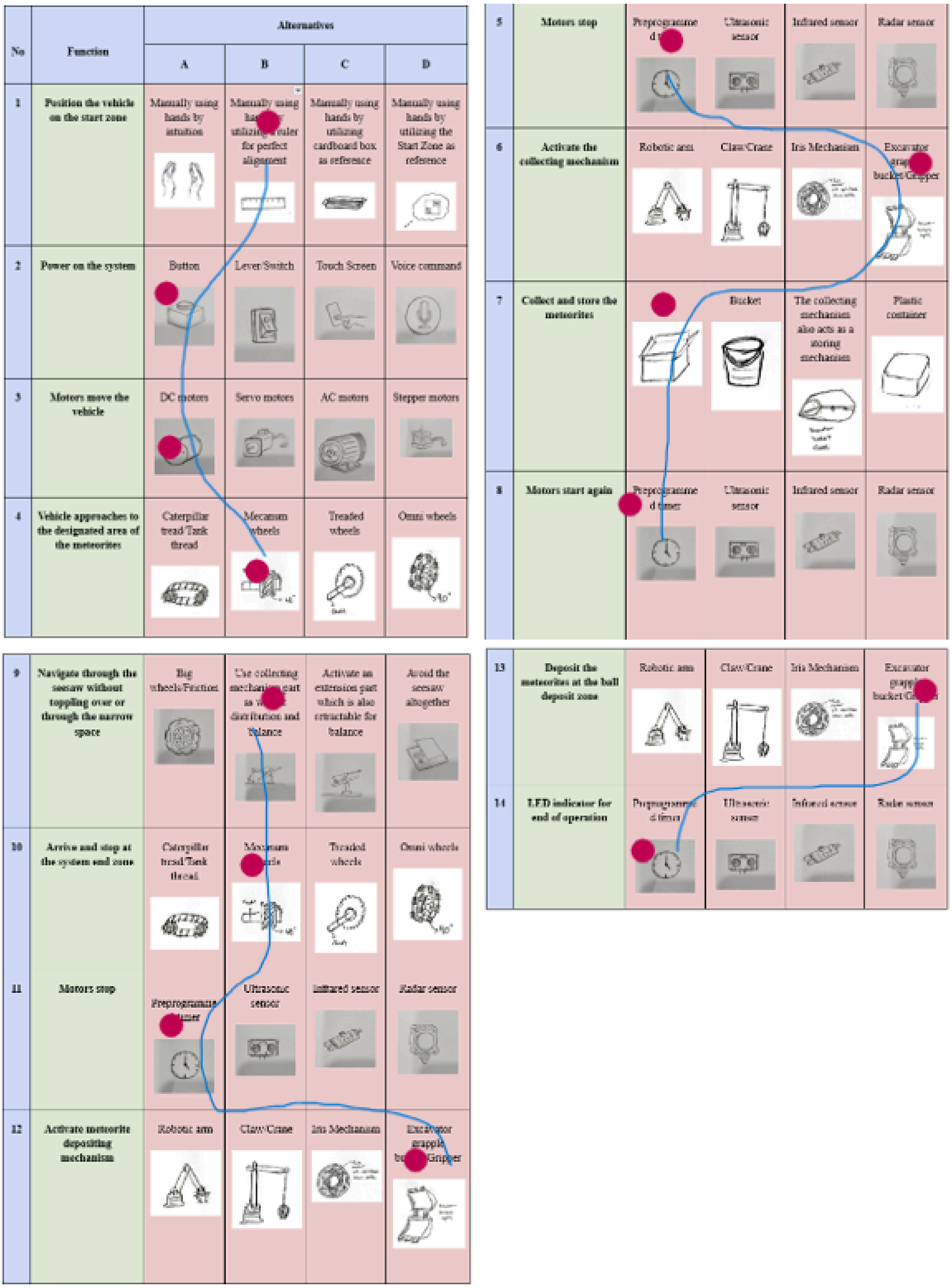
5	**Motors stop**	Preprogrammed timer 	Ultrasonic sensor 	Infrared sensor 	Radar sensor 
6	**Activate the collecting mechanism**	Robotic arm 	Claw/Crane 	Iris Mechanism 	Excavator grapple bucket/Gripper 
7	**Collect and store the meteorites**	Box 	Bucket 	The collecting mechanism also acts as a storing mechanism 	Plastic container 
8	**Motors start again**	Preprogrammed timer 	Ultrasonic sensor 	Infrared sensor 	Radar sensor 

9	**Navigate through the seesaw without toppling over or through the narrow space**	Big wheels/Friction 	Use collecting mechanism part as weight distribution and balance 	Activate an extension part which is also retractable for balance 	Avoid the seesaw altogether 
10	**Arrive and stop at the system end zone**	Caterpillar tread/Tank thread 	Mecanum wheels 	Treaded wheels 	Omni wheels 
11	**Motors stop**	Preprogramme d timer 	Ultrasonic sensor 	Infrared sensor 	Radar sensor 
12	**Activate meteorite depositing mechanism**	Robotic arm 	Claw/Crane 	Iris Mechanism 	Excavator grapple bucket/Gripper 

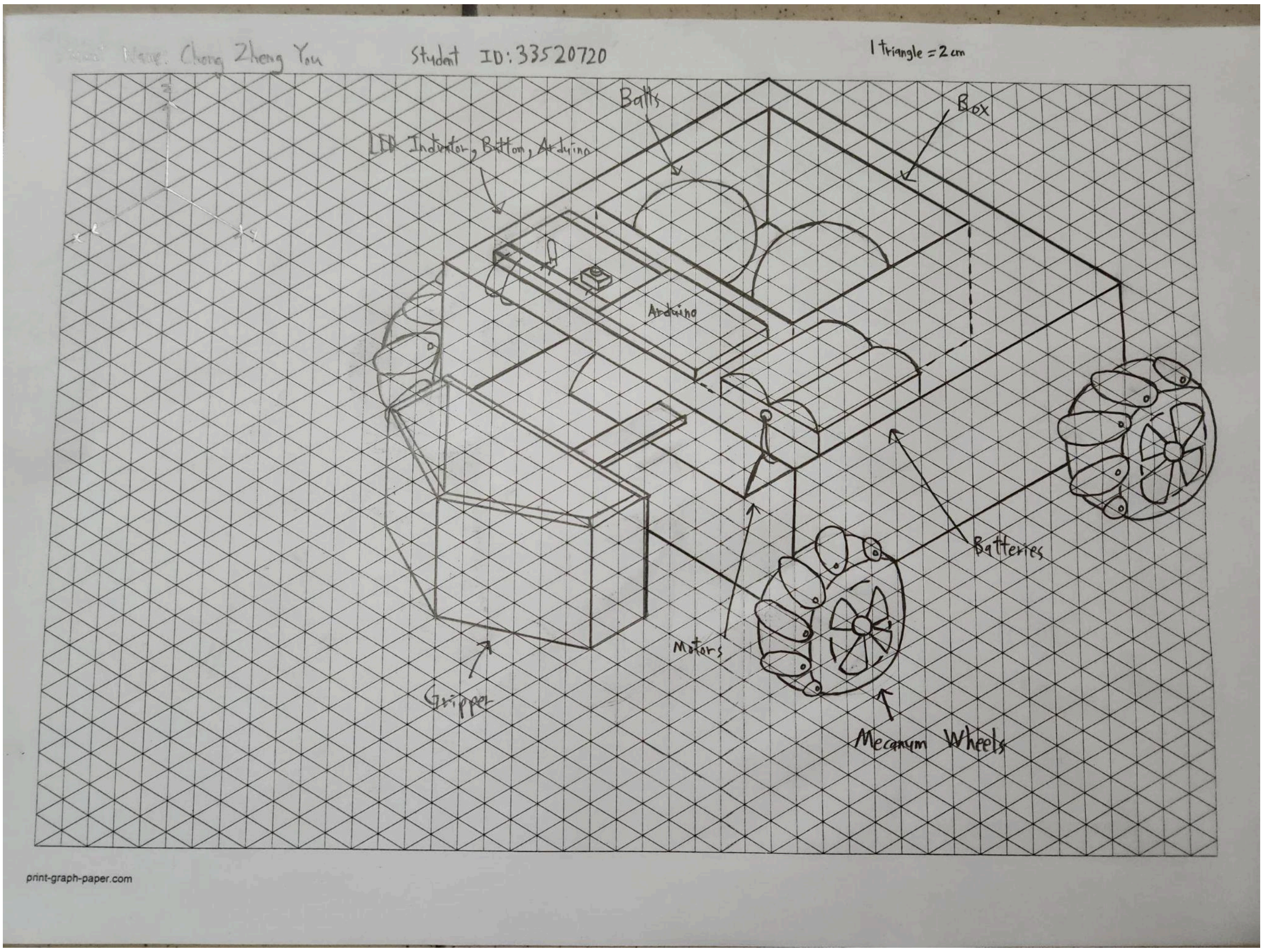
13	**Deposit the meteorites at the ball deposit zone**	Robotic arm 	Claw/Crane 	Iris Mechanism 	Excavator grapple bucket/Gripper 
14	**LED indicator for end of operation**	Preprogramme d timer 	Ultrasonic sensor 	Infrared sensor 	Radar sensor 

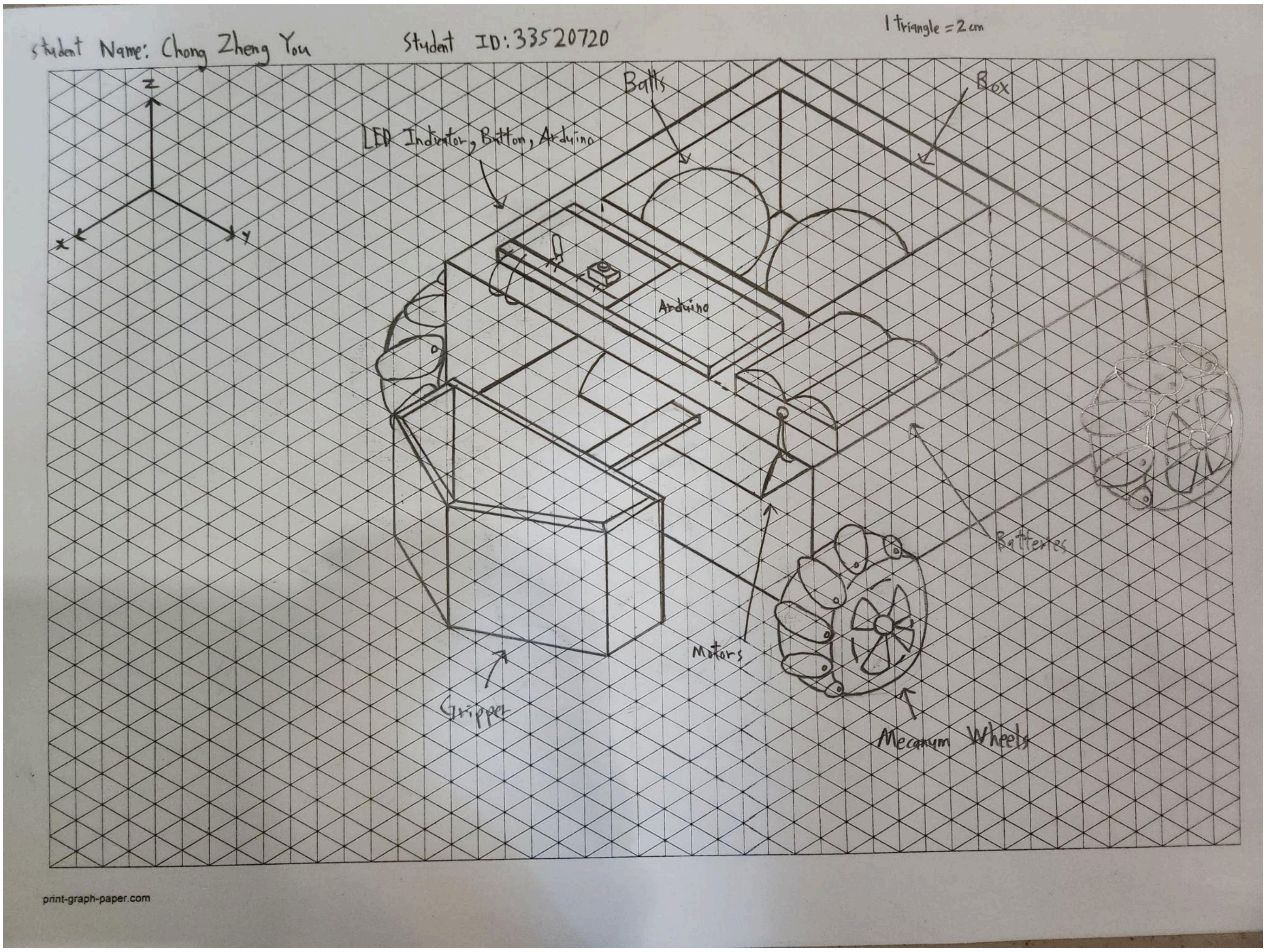
4.0 Isometric Sketches

4.1 Isometric Sketch 1

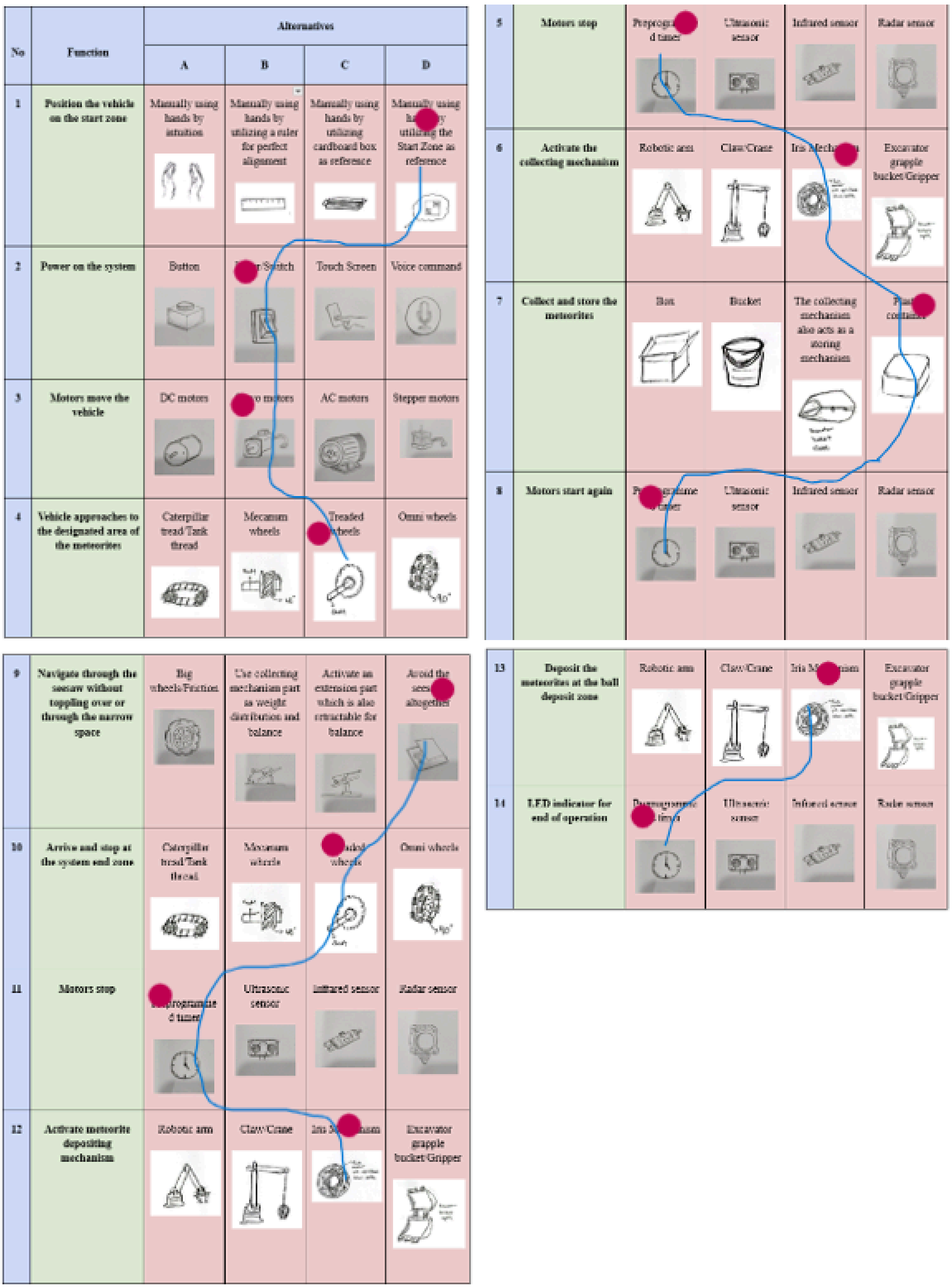


No	Function	Alternatives A	B	C	D
1	Position the vehicle on the start zone	Manually using hands by intuition	Manually using hands by utilizing a ruler for perfect alignment	Manually using hands by utilizing cardboard box as reference	Manually using hands by utilizing the Start Zone as reference
2	Power on the system	Button	Lever/Switch	Touch Screen	Voice command
3	Motors move the vehicle	DC motors	Servo motors	AC motors	Stepper motors
4	Vehicle approaches to the designated area of the meteorites	Caterpillar tread/Tank thread	Mecanum wheels	Treaded wheels	Omni wheels
5	Motors stop	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
6	Activate the collecting mechanism	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
7	Collect and store the meteorites		Bucket	The collecting mechanism also acts as a storing mechanism	Plastic container
8	Motors start again	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
9	Navigate through the seesaw without toppling over or through the narrow space	Big wheels/Friction	Use collecting mechanism part as weight distribution and balance	Activate an extension part which is also retractable for balance	Avoid the seesaw altogether
10	Arrive and stop at the system end zone	Caterpillar tread/Tank thread	Mecanum wheels	Treaded wheels	Omni wheels
11	Motors stop	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
12	Activate meteorite depositing mechanism	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
13	Deposit the meteorites at the ball deposit zone	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
14	LED indicator for end of operation	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor

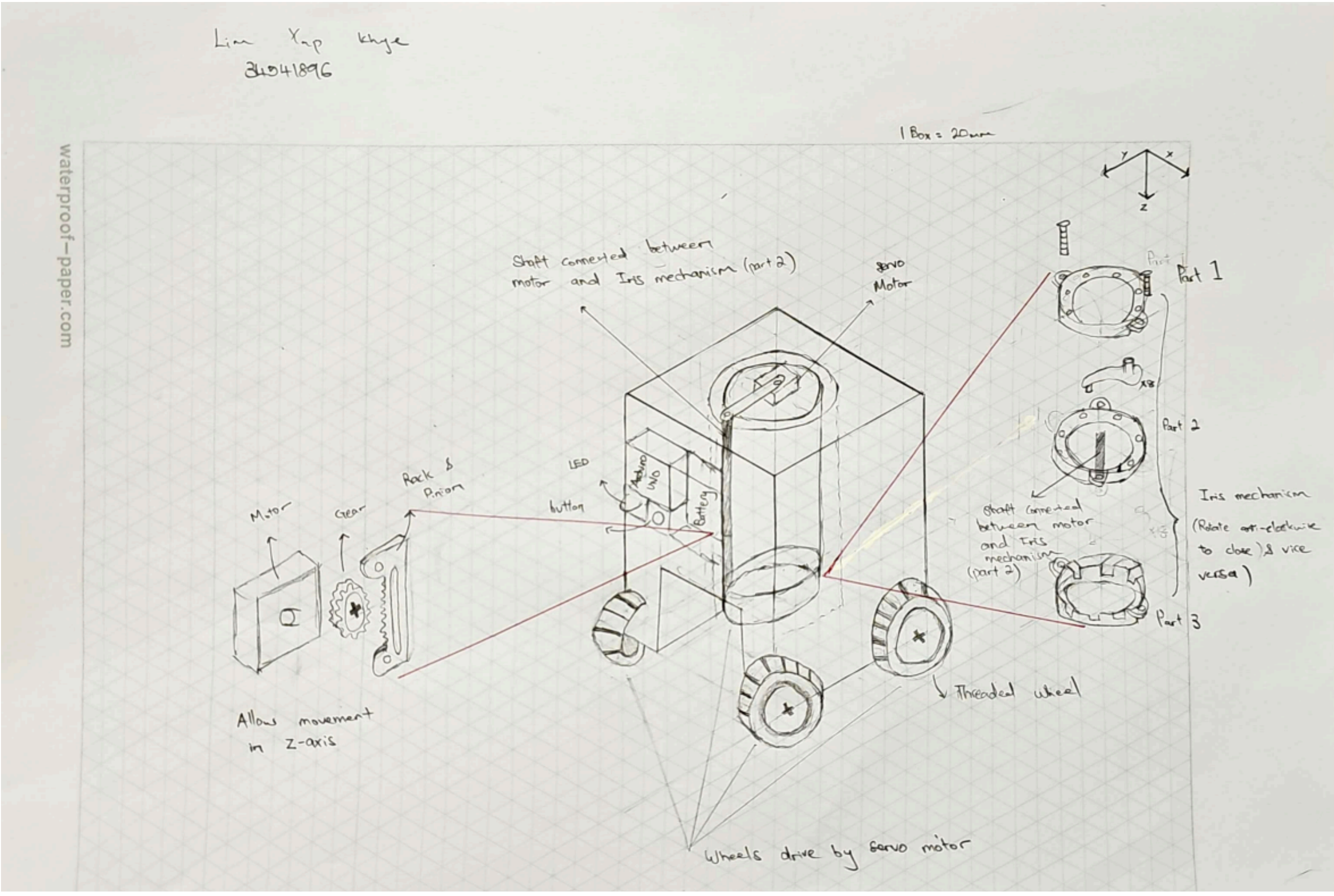

Name: Chong Zheng You
Student ID: 33520720
1 triangle = 2 cm
Balls
Box
LED Indicator, Button, Arduino
Arduino
Batteries
Motors
Gripper
Mecanum Wheels
print-graph-paper.com


student Name: Chong Zheng You
Student ID: 33520720
1 triangle = 2 cm
z
x
y
Balls
Box
LED Indicator, Button, Arduino
Arduino
Batteries
Motors
Gripper
Mecanum Wheels
print-graph-paper.com

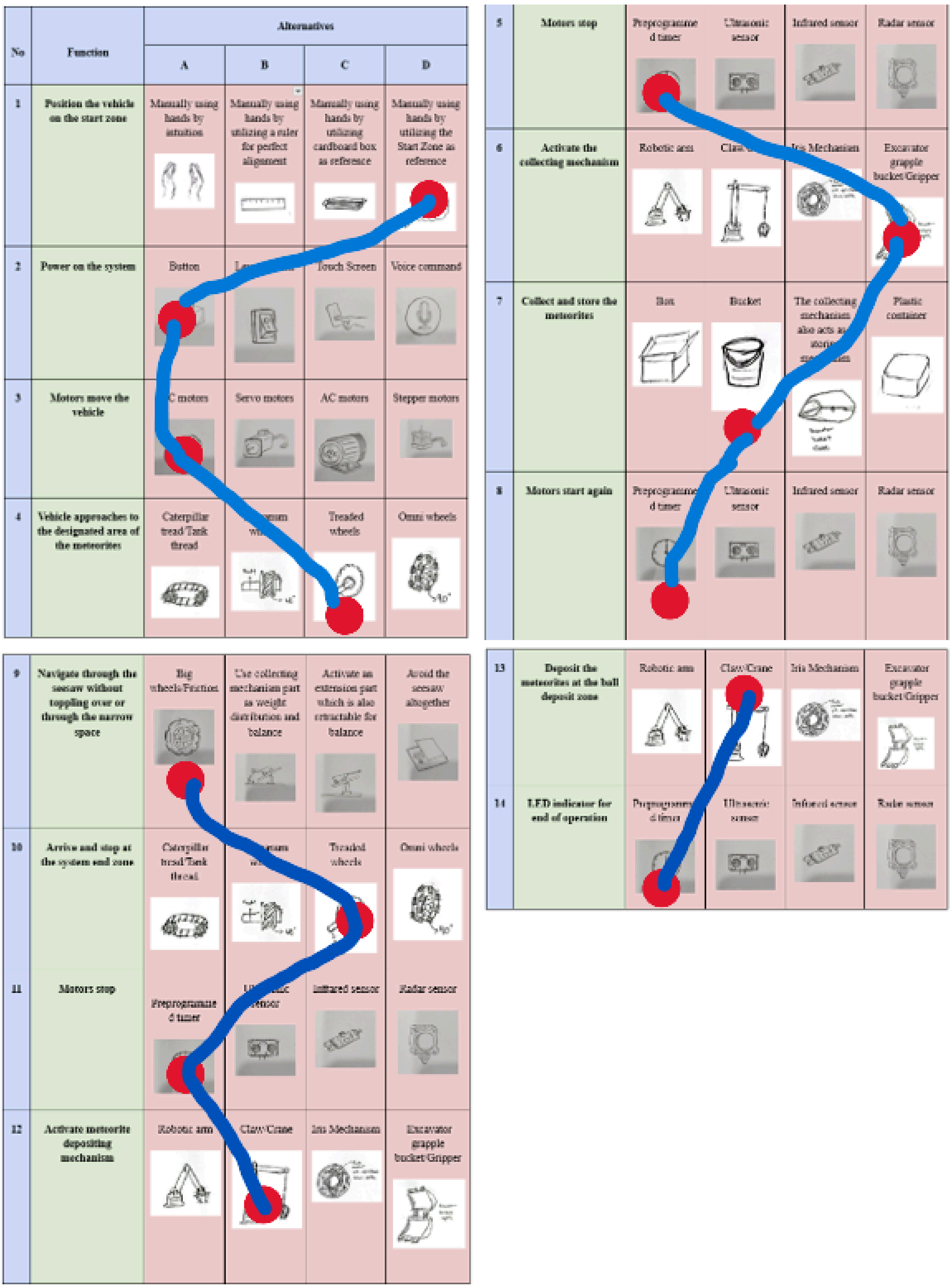
4.2 Isometric Sketch 2



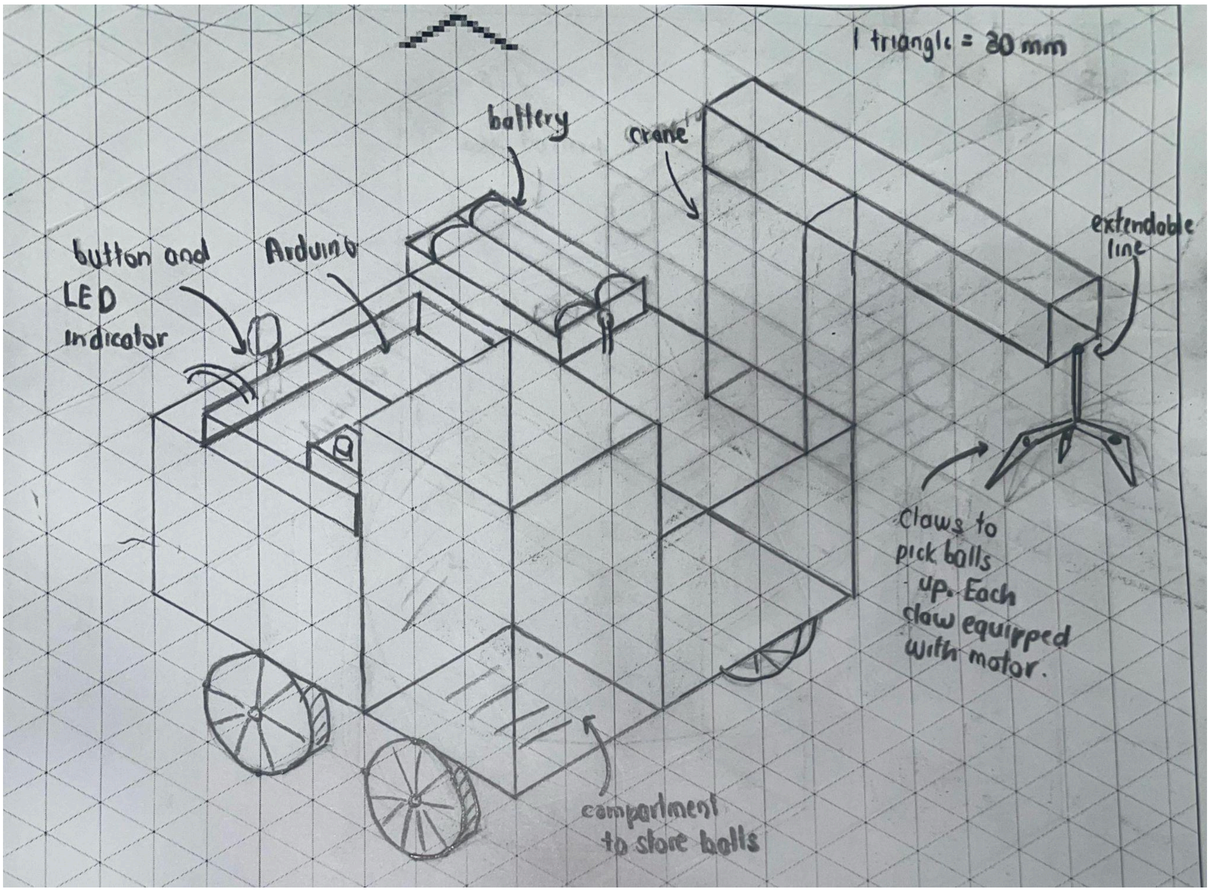
No	Function	Alternatives A	Alternatives B	Alternatives C	Alternatives D
1	Position the vehicle on the start zone	Manually using hands by intuition	Manually using hands by utilizing a ruler for perfect alignment	Manually using hands by utilizing cardboard box as reference	Manually using hands by utilizing the Start Zone as reference
2	Power on the system	Button	[illegible]r Switch	Touch Screen	Voice command
3	Motors move the vehicle	DC motors	[illegible]o motors	AC motors	Stepper motors
4	Vehicle approaches to the designated area of the meteorites	Caterpillar tread/Tank thread	Mecanum wheels	Treaded wheels	Omni wheels
5	Motors stop	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
6	Activate the collecting mechanism	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
7	Collect and store the meteorites	Box	Bucket	The collecting mechanism also acts as a storing mechanism	Plastic container
8	Motors start again	Preprogramme d timer	Ultrasonic sensor	Infrared sensor	Radar sensor
9	Navigate through the seesaw without toppling over or through the narrow space	Big wheels/Friction	Use collecting mechanism part as weight distribution and balance	Activate an extension part which is also retractable for balance	Avoid the seesaw altogether
10	Arrive and stop at the system end zone	Caterpillar tread/Tank thread	Mecanum wheels	Treaded wheels	Omni wheels
11	Motors stop	Preprogramme d timer	Ultrasonic sensor	Infrared sensor	Radar sensor
12	Activate meteorite depositing mechanism	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
13	Deposit the meteorites at the ball deposit zone	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
14	LED indicator for end of operation	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor


Lim Yap Khye
34041896
1 Box = 20mm
Shaft connected between motor and Iris mechanism (part 2)
servo Motor
Part 1
x8
Part 2
Iris mechanism (Rotate anti-clockwise to close) & vice versa)
Shaft connected between motor and Iris mechanism (part 2)
Part 3
LED
Arduino UNO
button
Battery
Motor
Gear
Rack & Pinion
Allow movement in Z-axis
Threaded wheel
Wheels drive by servo motor

4.3 Isometric Sketch 3



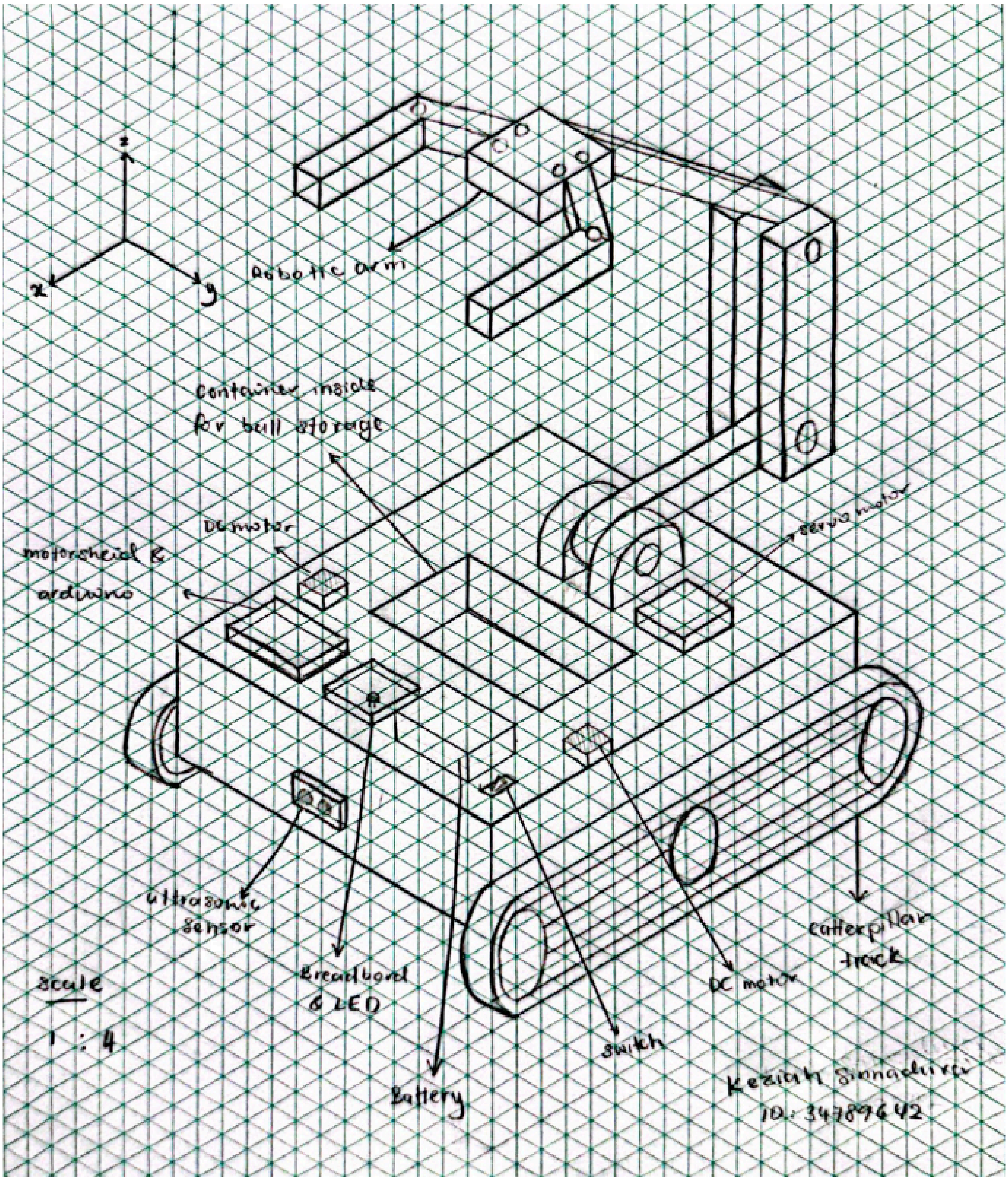
No	Function	Alternatives A	Alternatives B	Alternatives C	Alternatives D
1	Position the vehicle on the start zone	Manually using hands by intuition	Manually using hands by utilizing a ruler for perfect alignment	Manually using hands by utilizing cardboard box as reference	Manually using hands by utilizing the Start Zone as reference
2	Power on the system	Button	L[illegible]	Touch Screen	Voice command
3	Motors move the vehicle	[illegible]C motors	Servo motors	AC motors	Stepper motors
4	Vehicle approaches to the designated area of the meteorites	Caterpillar tread/Tank thread	[illegible]	Treaded wheels	Omni wheels
5	Motors stop	Preprogramme d timer	Ultrasonic sensor	Infrared sensor	Radar sensor
6	Activate the collecting mechanism	Robotic arm	Claw[illegible]	Iris Mechanism	Excavator grapple bucket/Gripper
7	Collect and store the meteorites	Box	Bucket	The collecting mechanism also acts as [illegible]	Plastic container
8	Motors start again	Preprogramme d timer	Ultrasonic sensor	Infrared sensor	Radar sensor
9	Navigate through the seesaw without toppling over or through the narrow space	Big wheels/Friction	Use collecting mechanism part as weight distribution and balance	Activate an extension part which is also retractable for balance	Avoid the seesaw altogether
10	Arrive and stop at the system end zone	Caterpillar tread/Tank thread	[illegible]	Treaded wheels	Omni wheels
11	Motors stop	Preprogramme d timer	[illegible] sensor	Infrared sensor	Radar sensor
12	Activate meteorite depositing mechanism	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
13	Deposit the meteorites at the ball deposit zone	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
14	LED indicator for end of operation	Preprogramme d timer	Ultrasonic sensor	Infrared sensor	Radar sensor



1 triangle = 30 mm
battery
crane
button and
LED
indicator
Arduino
extendable
line
claws to
pick balls
up. Each
claw equipped
with motor.
compartment
to store balls

4.4 Isometric Sketch 4

No	Function	Alternatives A	B	C	D
1	**Position the vehicle on the start zone**	Manually using hands by intuition	Manually using hands by utilizing a ruler for perfect alignment	Manually using hands by utilizing cardboard box as reference	Manually using hands by utilizing the Start Zone as reference
2	**Power on the system**	Button	Lever/Switch	Touch Screen	Voice command
3	**Motors move the vehicle**	DC motors	Servo motors	AC motors	Stepper motors
4	**Vehicle approaches to the designated area of the meteorites**	Caterpillar tread tank thread	Mecanum wheels	Treaded wheels	Omni wheels
5	**Motors stop**	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
6	**Activate the collecting mechanism**	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
7	**Collect and store the meteorites**	Box	Bucket	The collecting mechanism also acts as a storing mechanism	Plastic container
8	**Motors start again**	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
9	**Navigate through the seesaw without toppling over or through the narrow space**	Bi[illegible] wheels [illegible]ction	Use collecting mechanism part as weight distribution and balance	Activate an extension part which is also retractable for balance	Avoid the seesaw altogether
10	**Arrive and stop at the system end zone**	Caterpillar tread tank thread	Mecanum wheels	Treaded wheels	Omni wheels
11	**Motors stop**	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor
12	**Activate meteorite depositing mechanism**	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
13	**Deposit the meteorites at the ball deposit zone**	Robotic arm	Claw/Crane	Iris Mechanism	Excavator grapple bucket/Gripper
14	**LED indicator for end of operation**	Preprogrammed timer	Ultrasonic sensor	Infrared sensor	Radar sensor


z
x
y
Robotic arm
container inside
for ball storage
DC motor
motorsheild &
arduino
servo motor
ultrasonic
sensor
Breadboard
& LED
Battery
switch
DC motor
catterpillar
track
scale
1 : 4
Keziah Sinnadurai
ID: 34789642

5.0 Decision Making (Composite Criterion Method)

5.1 Decision Making Table

Requirement	Specification		Weight (/10)	Criteria	Isometric Sketch 1			Isometric Sketch 2			Isometric Sketch 3			Isometric Sketch 4		
	min	max			Mag.	Score (/10)	Value (WxS)	Mag.	Score (/10)	Value (WxS)	Mag.	Score (/10)	Value (WxS)	Mag.	Score (/10)	Value (WxS)
Collect all the meteorites (balls)	1	3	10	Number of balls moved by the system	3	10	100	3	10	100	3	10	100	3	10	100
Accurate deposition	1	3	10	Balls are fully released into the deposit zone	3	10	100	3	10	100	3	10	100	3	10	100
Seesaw navigation	-	-	8	Ability to cross SEESAW without tipping off	-	7	56	-	8	64	-	7	56	-	7	56
Time performance	1	120	7	Total run duration in seconds	36	7	49	48	6	42	72	4	28	60	5	28

Autonomous operation	-	-	10	No external control after started	-	10	100	-	10	100	-	10	100	-	10	100
Compact design	1000	64000	4	Size of vehicle within the constraints given in cm^3	11040	8.25	33.00	3072	9.5	38.00	15488	7.54	30.16	22400	6.44	25.76
Mass constraints	1.5	4	4	The mass of the vehicle within the constraints given in kilograms	1.75	9.00	36.00	1.50	10.00	40.00	2.30	6.80	27.20	2.50	6.00	24.00
Ease of assembly	10	30	3	Time taken to set up vehicle on track in seconds	16	7	21	14	8	24	14	8	24	16	7	21
Safety compliance	-	-	5	No exposed hazards	-	8	40	-	8	40	-	8	40	-	8	40
Cost feasibility	400	600	8	Using common parts available, DIY assembly in Ringgit	420	9	72	460	6	48	540	3	24	520	4	32
Overall Value					607.00			596.00			529.36			526.76		

5.2 Decision Making Graph

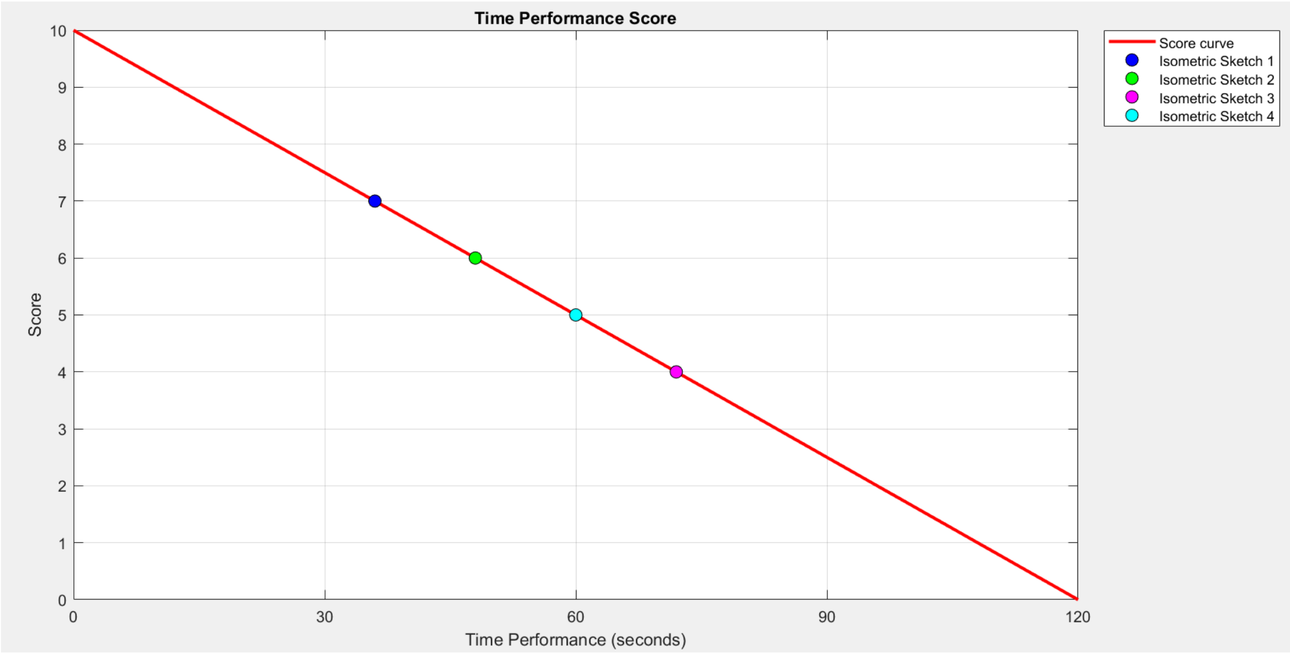


Figure 1 (Time Performance Score)

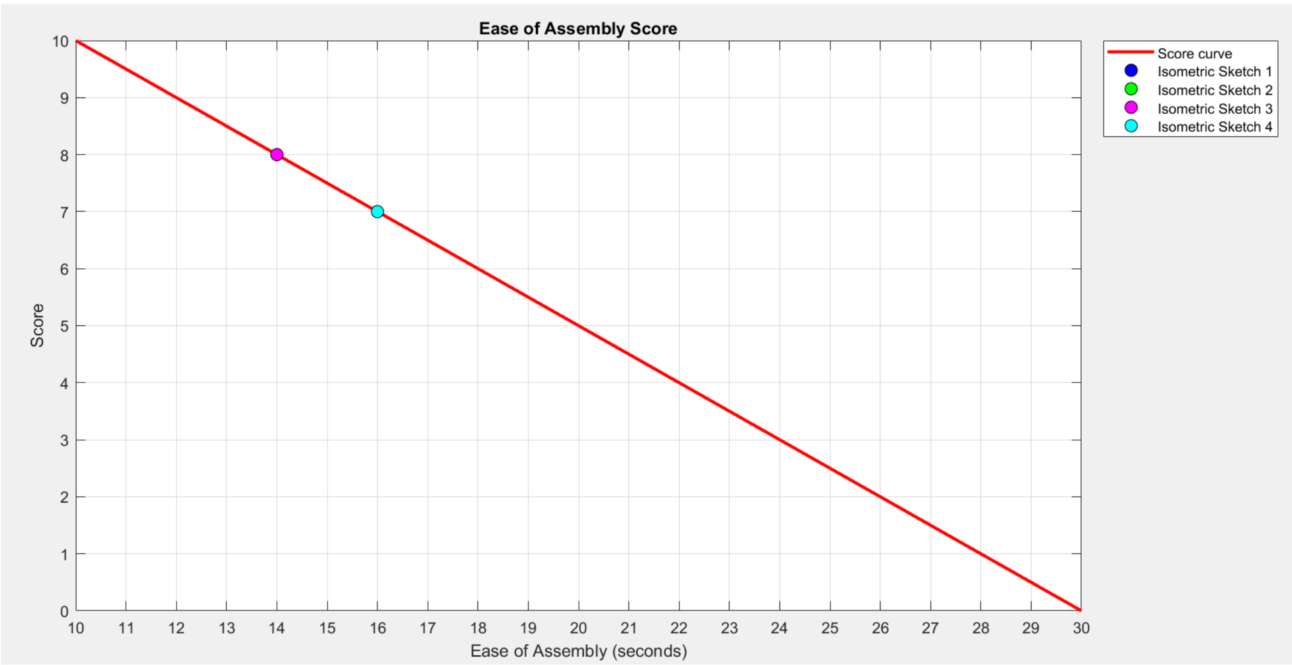


Figure 2 (Ease of Assembly Score)

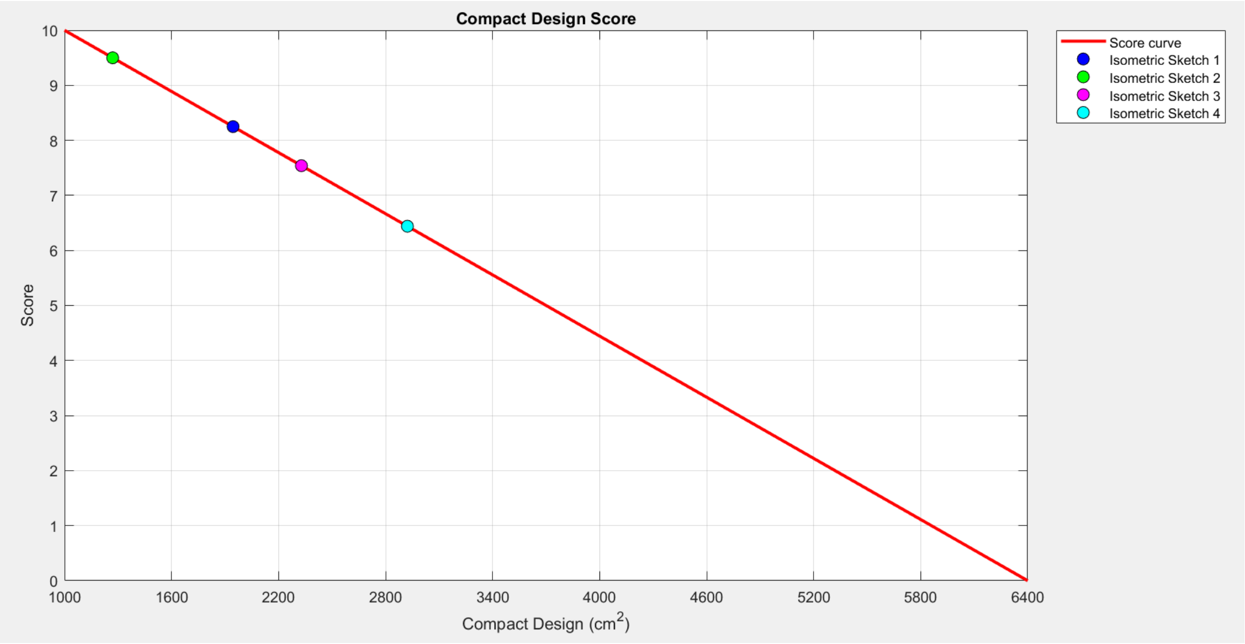


Figure 3 (Compact Design Score)

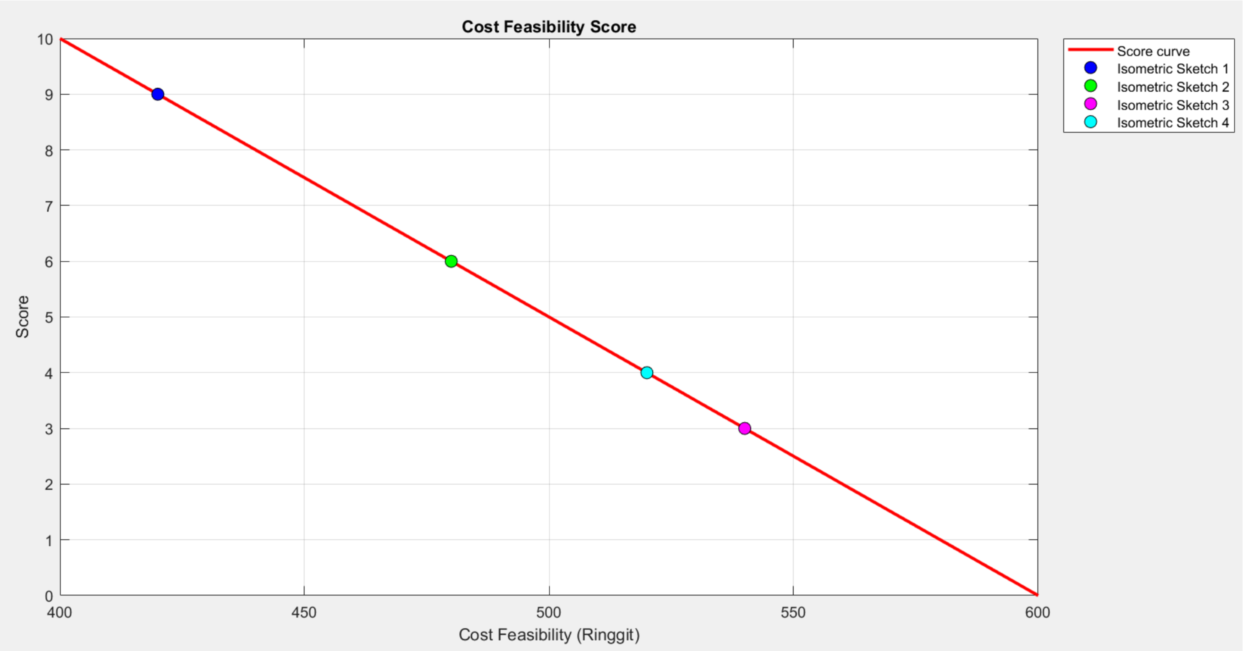


Figure 4 (Cost Feasibility Score)

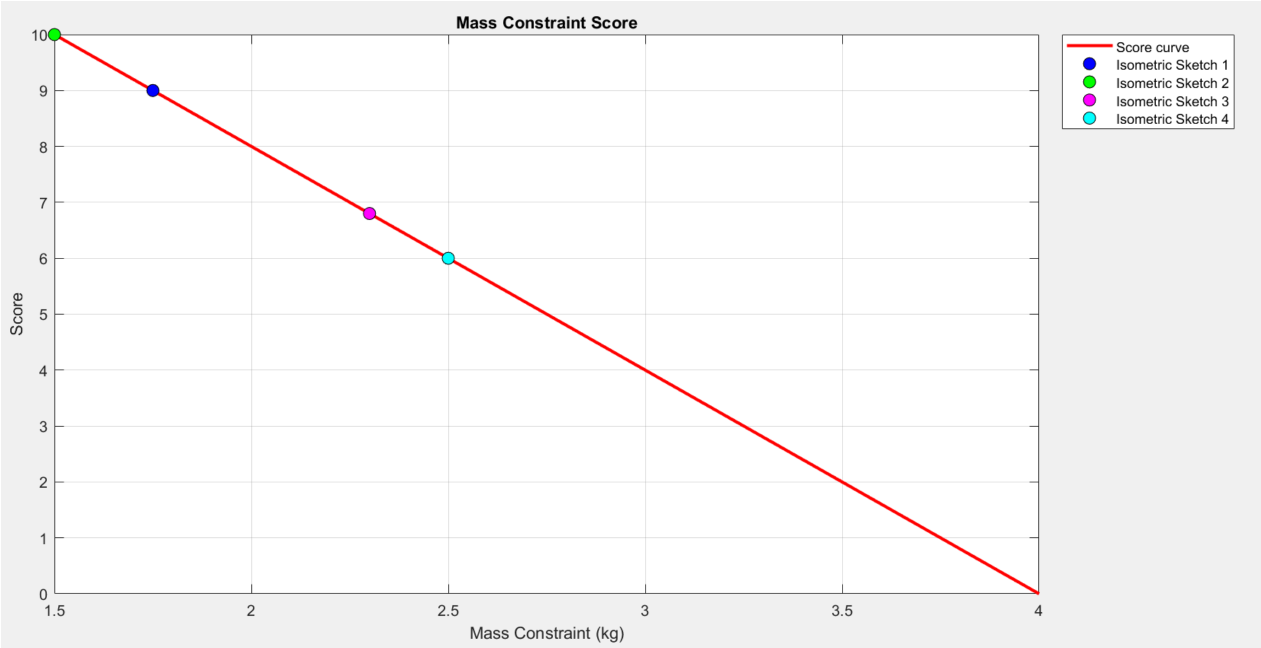


Figure 5 (Mass Constraint Score)

5.3 Explanation

What is the sensitivity of the final solution? (Largest Weighting X Incremental Score)
- The sensitivity of the final solution is 607.

When taking the sensitivity into account, is there a clear winner?
- Yes, isometric sketch 1 is the best solution.

Is the final solution the right choice? Why?
- Yes, the final solution is the right choice as it has the highest sensitivity score and is approved by the entire team after a thorough discussion.