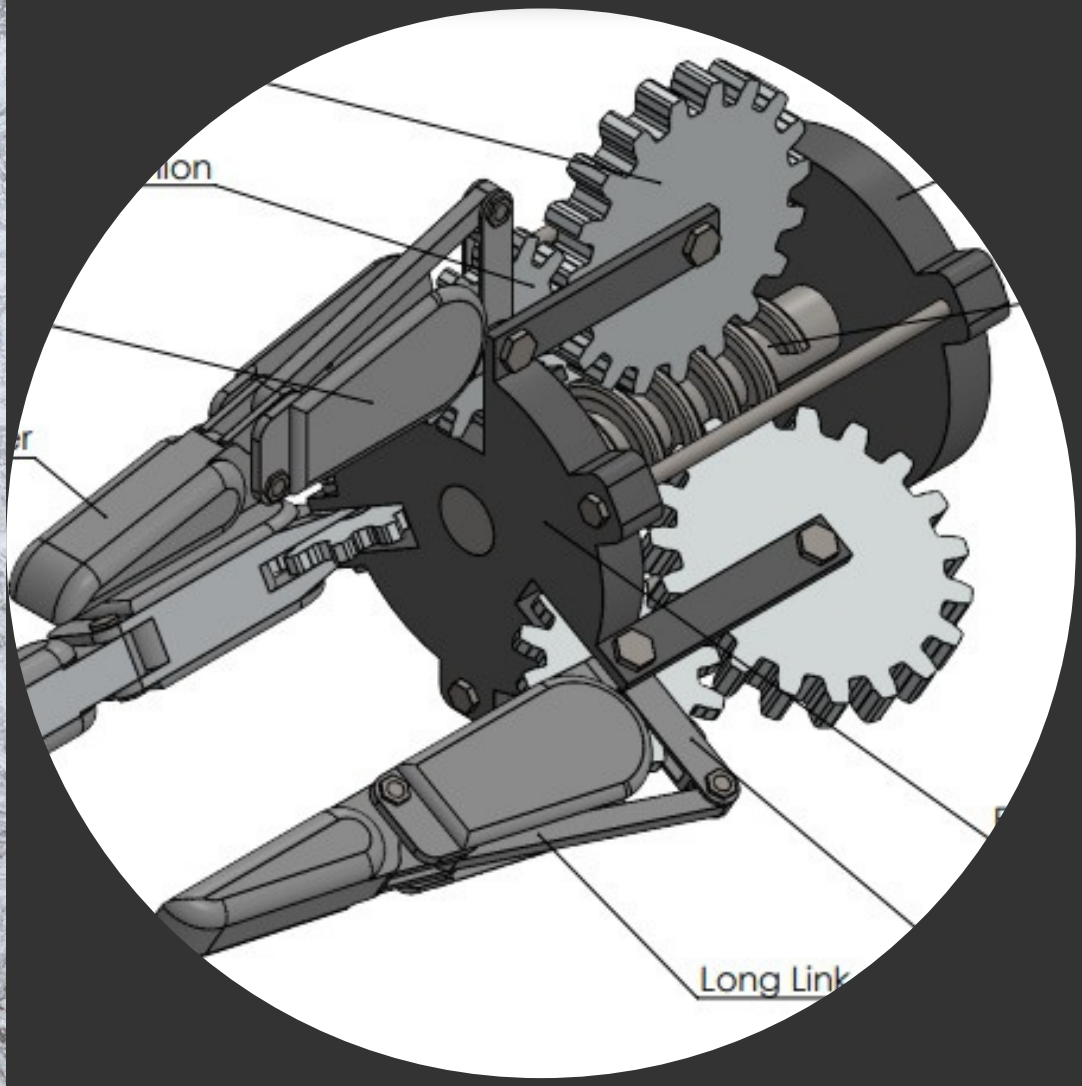
UNIVERSITI TEKNOLOGI MALAYSIA

Palm Harvesting Vehicle



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A20EM4015

Background

Introduction

Palm oil production is vital for the economy of Malaysia, which is the world's second- largest producer of the commodity. The Malaysian Palm Oil Board (MPOB) is a government agency responsible for the promotion and development of the palm oil sector in the country. Oil palm fruit harvesting is a lengthy and straining process carried out by plantation workers which harvest the fruit using manual tools and transport it to be processed for palm oil production.

Design Brief

Problem Description

Current techniques to harvest palm fruits are inefficient and require too much energy and labor. An innovative and effective harvesting system is needed to enhance the productivity of plantation workers. Furthermore, the system should cut, collect, and carry the fruits.

Client Description

Sime Darby Plantation, one of the world's largest producers of sustainable palm oil (CSPO) with a very high production per year. SDP is a globally integrated plantation company and is involved in various activities. Their operations extend to multiple countries like Malaysia, Indonesia, Papua New Guinea and Solomon Islands, along with various other downstream operations existing in 14 countries

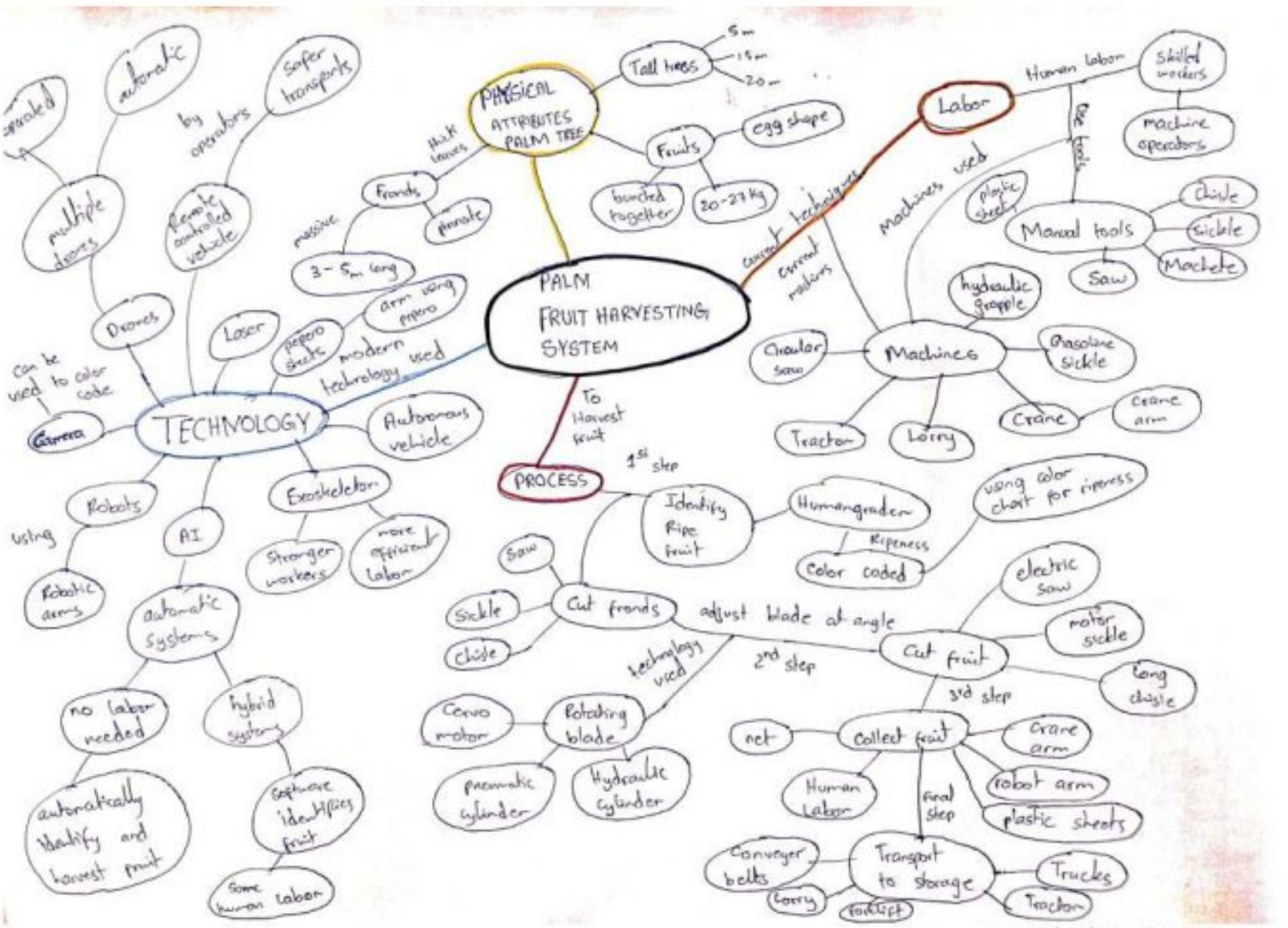
Client Requirement

A harvesting system to aid workers in plantations. The main functions include cutting fruit, collecting fruits, and carrying them to storage. The system should aid in labor and provide an effective solution to the current issue of labor shortage and long harvesting times.

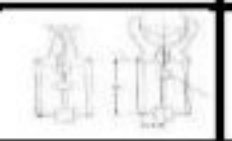
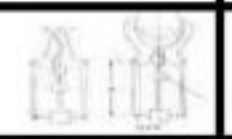
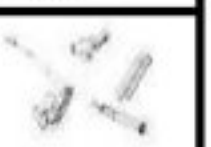
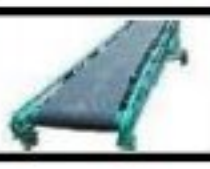
Approach

Our group began with brainstorming about all current techniques used to harvest palm fruit, the process used to harvest the fruit, as well as any potential technologies or machines that could be utilized in our design. Specifications of the palm trees were included such as height, weight of the fruit etc. The brainstorming is generated below, and a morphological chart with product design specification was created.

Brainstorming



Morphological Chart

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								

Product Design Specification

Product Design Specification:

The palm fruit harvesting system is a machine that allows us to efficiently harvest palm fruits from trees within plantations, by cutting it from the tree, successfully transporting using a mechanism and then storing them to be processed. The purpose of this machine is to either aid the plantation workers and improve their performance by utilizing new technology or to create an alternative system for harvesting palm fruits altogether.

Performance:

The machine must be able to cut the fronds of the palm tree accurately to expose the fruit, the machine must be able to cut the fruit from the tree, it must collect the fruit and then relay it towards storage.

The machine arm must be able to extend till 25m towards top of tree.

The machine will be operated in oil palm plantations on rough and perhaps wet terrain.

The machine will either be operated by human or fully automatic.

The machine will be attached to a truck / lorry based on requirement.

The machine must be able to pick up the palm fruit weighing 20-27 Kg.

Size:

No limitation on the length or width of the machine.

The recommended length and width will be dependent on the site specifications with regards to plantation/plot layout and maximum working environment tolerances with regards to maneuverability.

No limitation on the height of the machine.

Whilst no limitation is necessary, necessary height considerations can be made in consideration of maximum and average oil palm tree height when harvesting. A safe estimate can be assumed to be not in excess of 25m in extendable height to account for all oil palms.

Weight:

Maximum allowable weight of the machine to not be in excess of 5000kg.

Material:

Must be corrosion and rust proof. Environmentally friendly and sustainable in tropical / humid conditions.

The material must be lightweight and durable. Strong enough to withstand the weight of the fruit and its own tensile forces. Examples of such material would include Aluminum, Aluminum alloys and Magnesium alloys.

Environment:

Hot, humid, tropical atmosphere, rainy.

Terrain in oil palm plantations is typically rocky and dusty and uneven. It is often raining which can cause terrain to be muddy. Water and dust resistance for material is necessary to prevent rusting or erosion.

Temperature range -20°C to 100°C; resistant to water, salt, dust, wind, rocks, common solvents, oil, gasoline and the like; shock proof to 10 g; wind speeds up to 25 mph.

Quantity:

Number of units specified by customer to be used in plantation.

Maintenance:

Simple routine maintenance/checks done by the operator.

All components of the machine must have at least 1 spare part.

Frequently moving parts should be checked and deemed adequate before operating.

Repairs and proper maintenance to be done monthly by professional aides/persons.

Lubricate the mechanical components to prevent friction.

Product life span:

10 to 15 years provided periodic maintenance is being conducted.

Competition:

Current fruit harvesting machine available on the market such as Yongkong Tech, companies that provide fruit harvesting attachments etc.

Standards:

Occupational Safety and Health Act 1994 ("OSHA")

Factories and Machinery Act 1967 ("FMA 1967")

ISO 4254-1:2013 - Agricultural machinery - Safety - Part 1: General requirements

BS EN ISO 12100 parts 1 and 2 – Safety of machinery. Basic concepts and principles for design.

BS EN ISO 14121-1 – Safety of machinery. Risk assessment. Principles

Patents:

None yet.

Service Life:

Machine should aim to achieve a minimum of 10 years' service, or 7,000 to 10,000 working hours with adequate maintenance.

Parts that are deemed faulty or non-operational will need to be replaced within this time period.

Shipping:

Machine will be transported to customer within container. Shipping cost varied based on location.

Ergonomics

Must be easy and convenient to handle and store when needed. Set up and operation of the machine should be capable by one person.

Controls and operating aides should be positioned in a natural and comfortable position as to provide minimal physical stress on the body. Screens and seating if applicable should be adjustable to comply with these requirements.

Safety:

The product is safe to be used within oil palm plantations on rough and uneven terrain as well as rainy and windy weather.

The blade positioned at the top is enclosed within safety to not accidentally damage the operator.

The operation of the machine must obey local safety and health laws.

Safely secure all sharp components to not cause accidents.

Must have safety lights and night strips attached to alert workers to its position.

Audible alarms/warnings should be present in the event of reversing

Operators must be first trained in using the machine.

Aesthetic/Appearance:

The machine must appear robust and reliable as well as simple and easy to use.

It should have a vivid color as to alert workers to its position if operated at night. Should have safety lights and strips visible at night.

Processes:

Machine should have anti-corrosion and rust-preventing coating to protect from water and rough tropical weather.

Testing:

Humidity Testing. Temperature testing. Water testing.

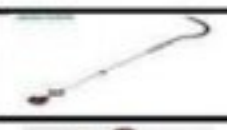
Company Constraints:

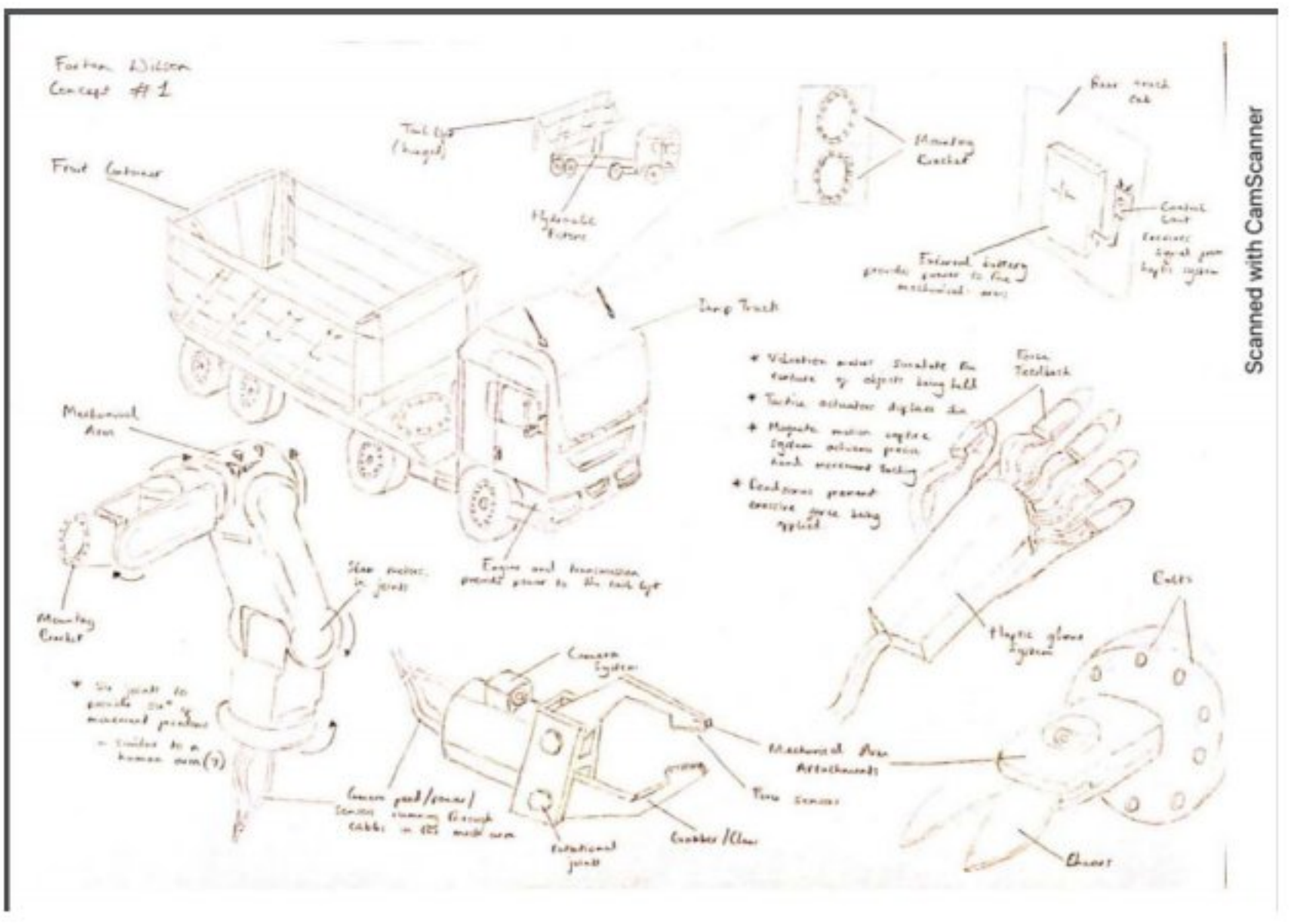
Product must be viable, realistic, and efficient.

Conceptual Design:

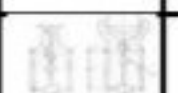
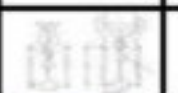
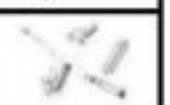
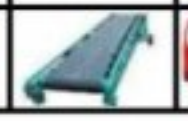
Each member generated 3 concept sketches using the morphological chart and (PDS) created. The 18 concepts were then evaluated using pugh concept selection method, and the marking criteria is listed below.

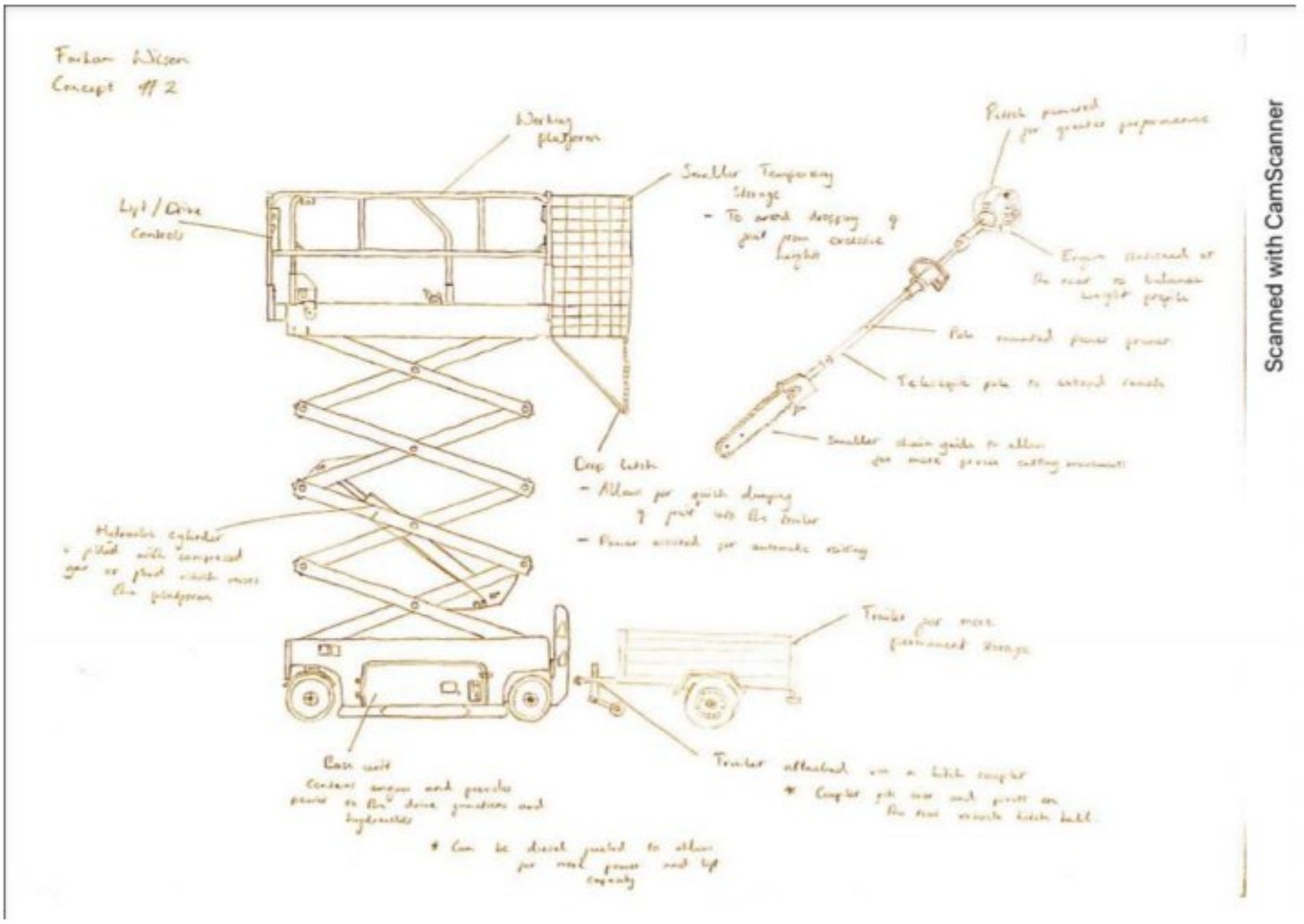
Concept (DATUM)

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								

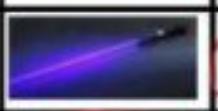
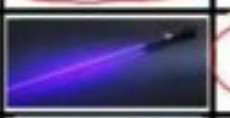
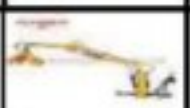
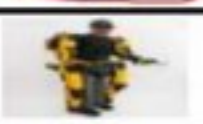
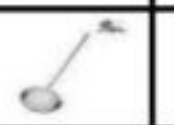
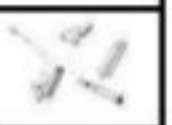


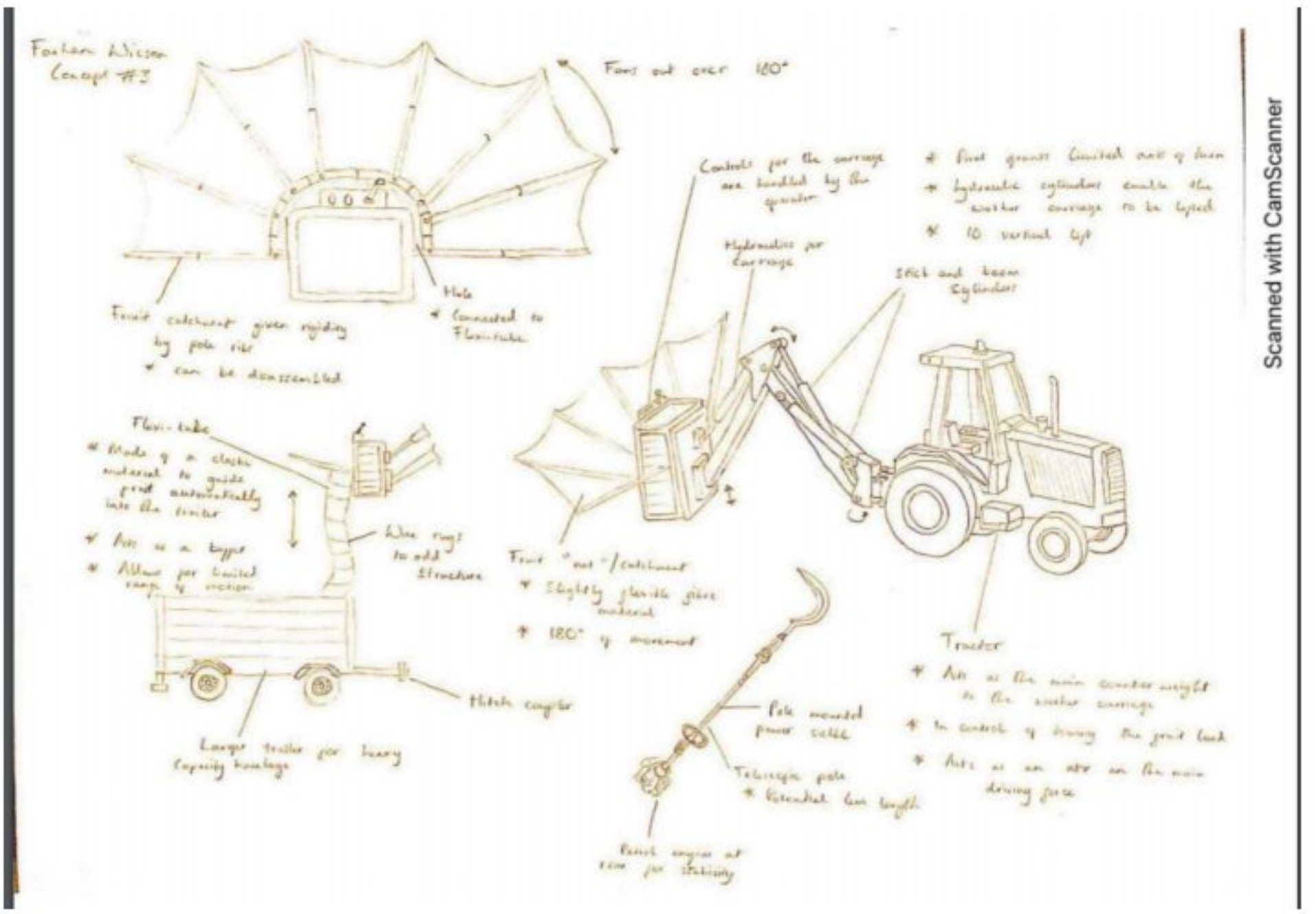
Concept 1

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								

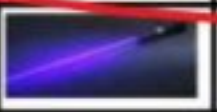
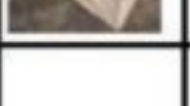
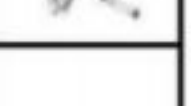


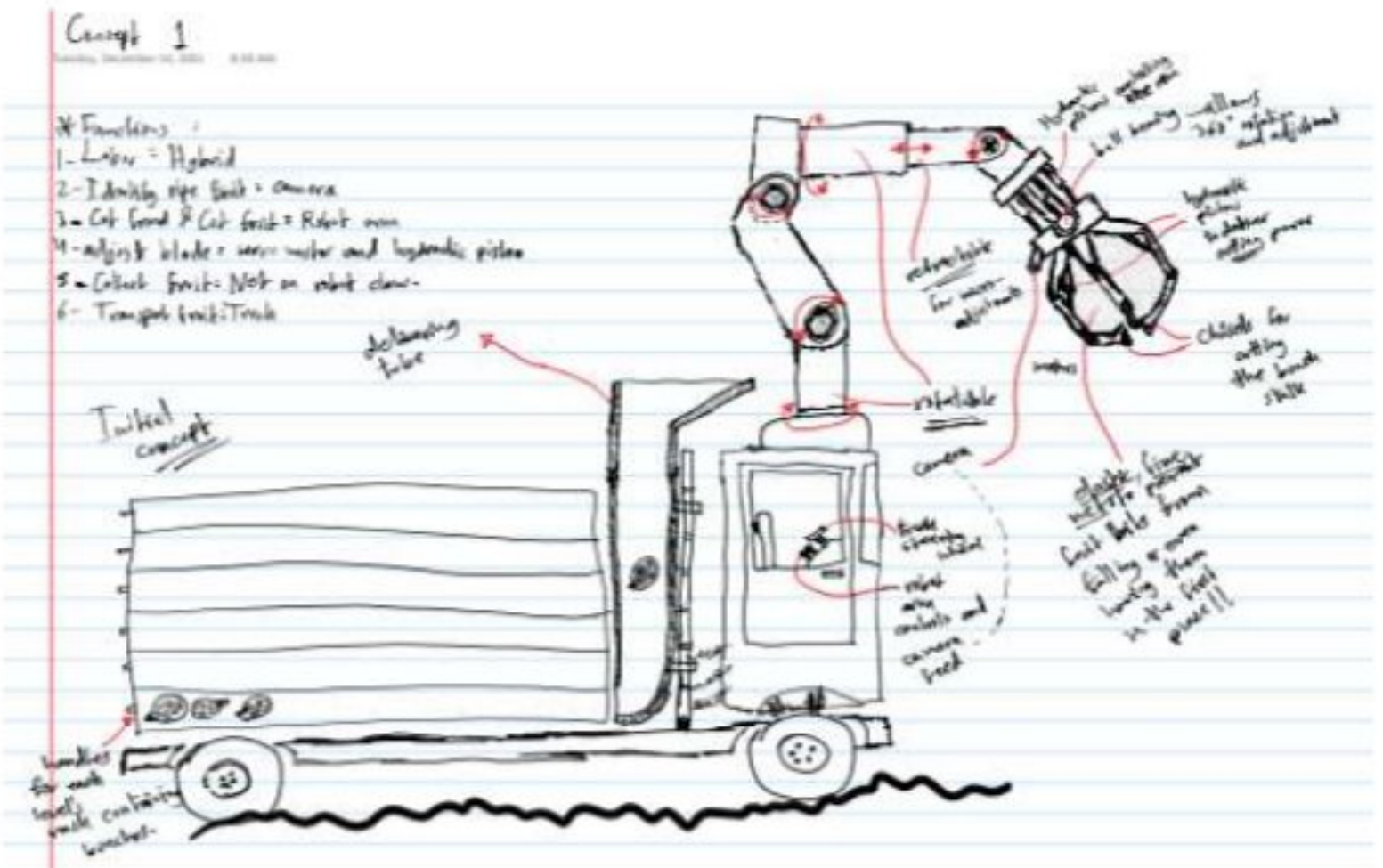
Concept 2

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								



Concept 3

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								



* Modified Truck

* Trade storage compartment will be modified to have racks with handles.

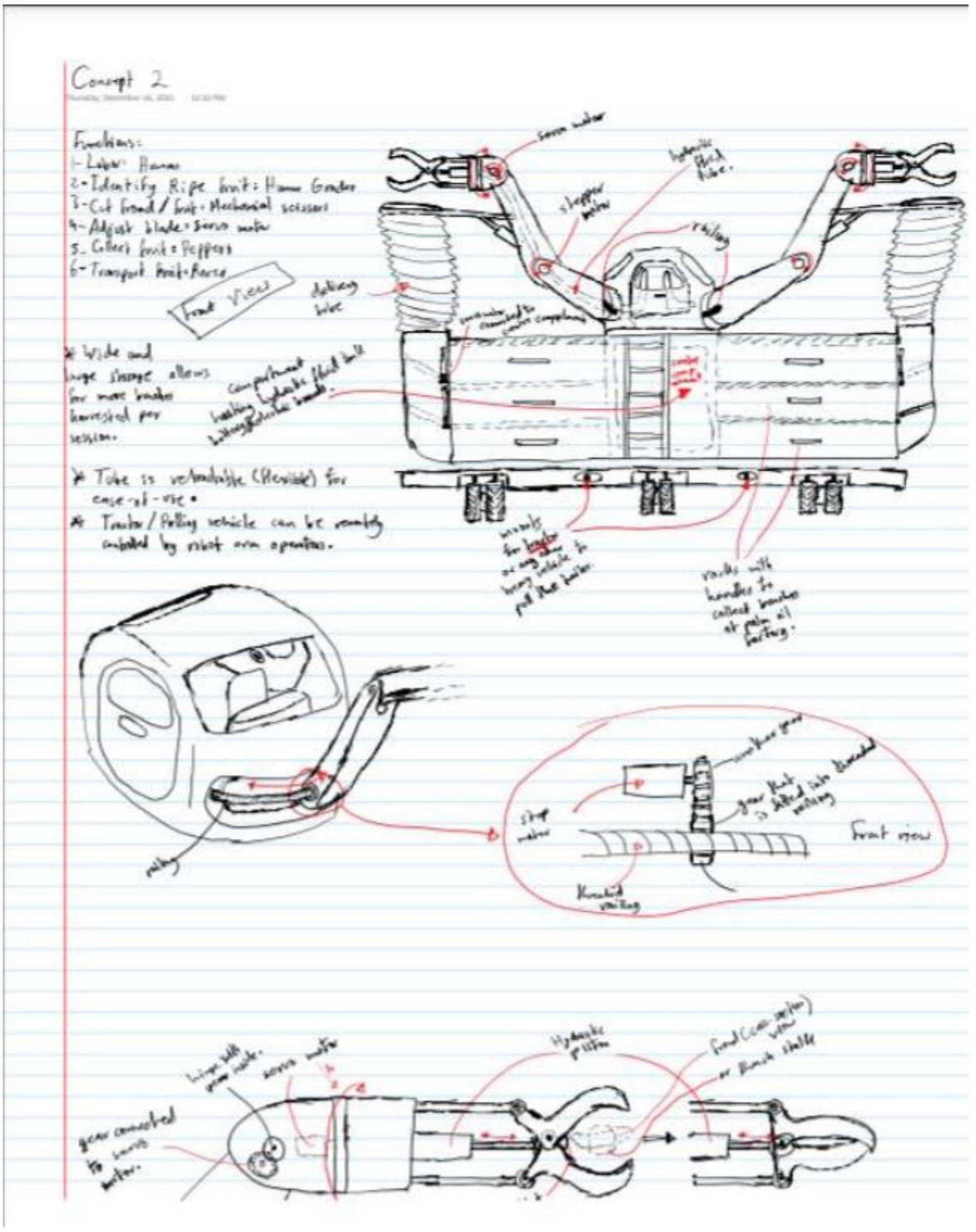
* It will have a wide opening on the top for the robot arm to drop the bunches into the delivering tube.

* Racks of bunches can be pulled from the back of the truck.

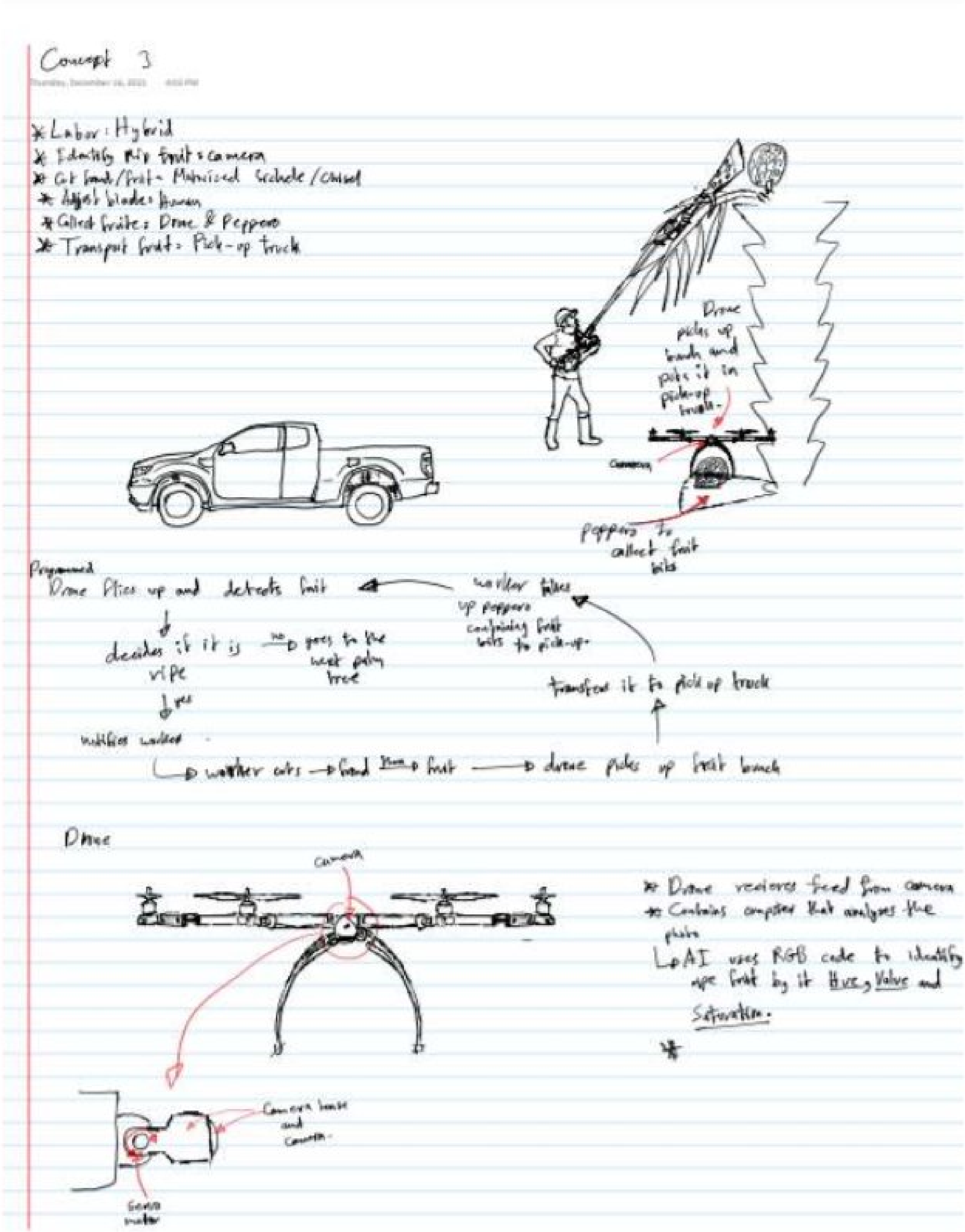
* Delivery tube has power operated or manually operated, hinged flaps that gate activated by a sensor that detects the truck reaching bit capacity.

* Robot arm:

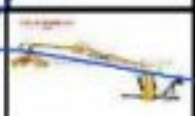
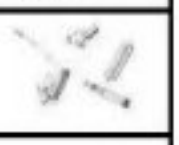
Concept 4

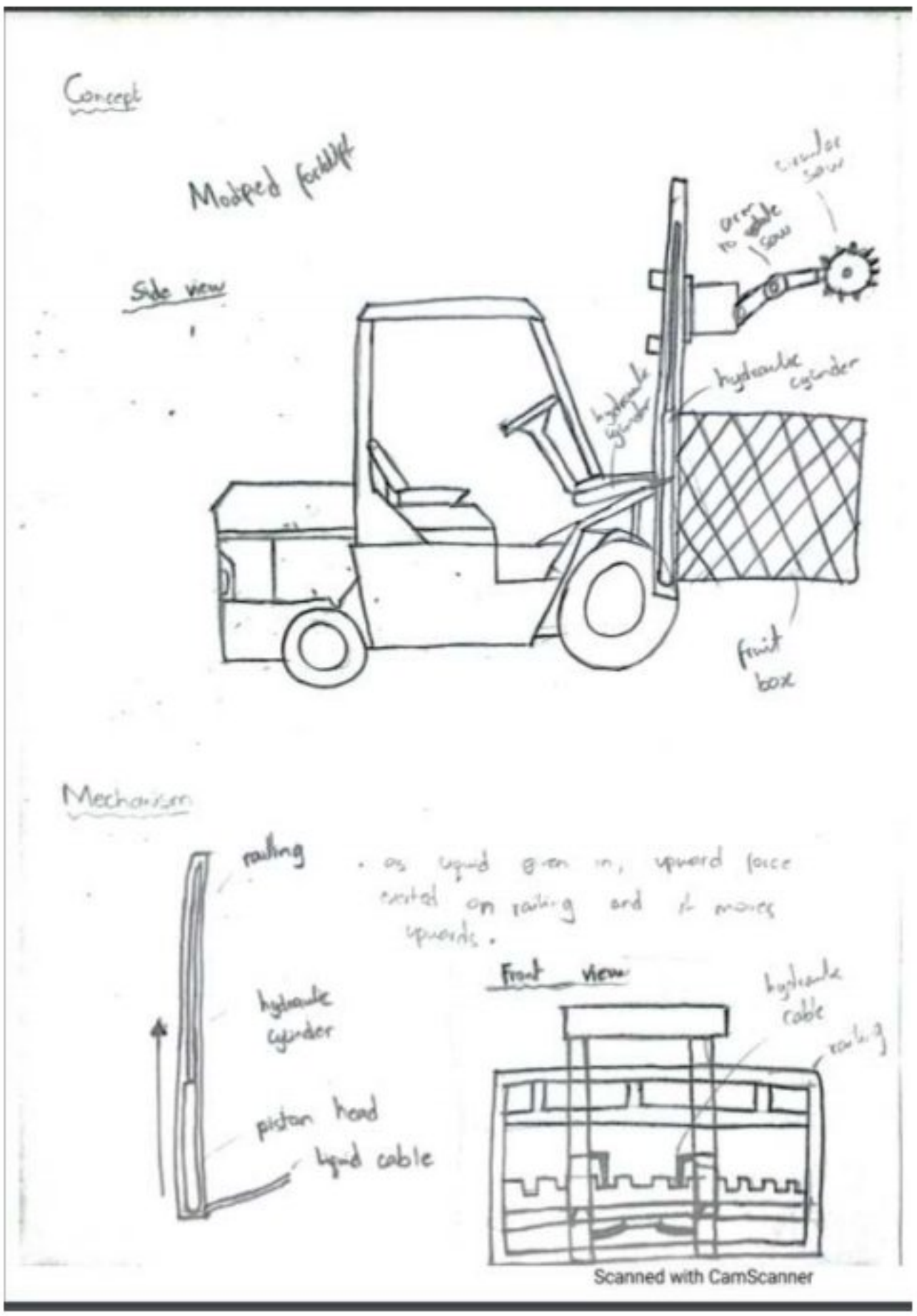

Concept 2
Functions:
1- Labor: Human
2- Identify Ripe fruit: Human Grader
3- Cut Grand / fruit: Mechanical scissors
4- Adjust blade: Servo motor
5- Collect fruit: Peppers
6- Transport fruit: Basket
Front View
delivery hose
* Wide and large storage allows for more baskets harvested per session.
* Tube is retractable (flexible) for ease-of-use.
* Tractor / Pulling vehicle can be remotely enabled by robot arm operator.
wheels for tractor or any towing vehicle to pull the trailer.
racks with handles to collect baskets at palm oil factory.
pulley
Front view
Hydraulic pistons
gear connected to worm motor.

Concept 5


Concept 3
* Labor: Hybrid
* Identify ripe fruit = camera
* Adjust blade = Human
* Transport fruit = Pick-up truck
Drone picks up bunch and puts it in pick-up truck.
Camera
Programmed
Drone flies up and detects fruit
decides if it is ripe
goes to the next palm tree
transfers it to pick up truck
drone picks up fruit bunch
Drone
Camera
* Drone receives feed from camera
* Contains computer that analyzes the photo
AI uses RGB code to identify ripe fruit by it Hue, Value and Saturation.
Camera base and camera.
Servo motor

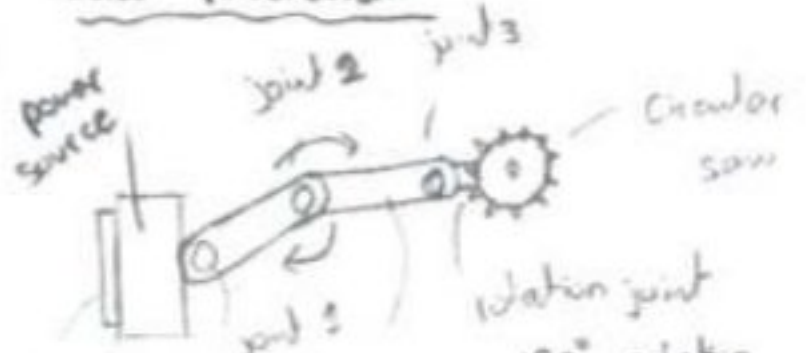
Concept 6

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								



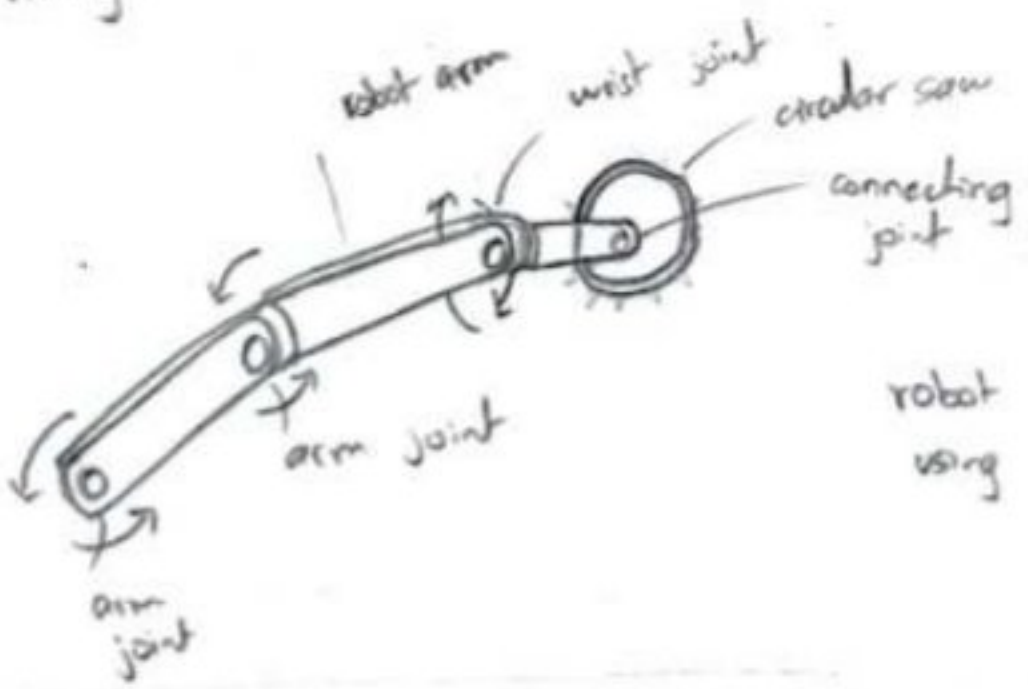
• gears or most pressed against roller chains, the mechanism moves upwards.

Saw mechanism

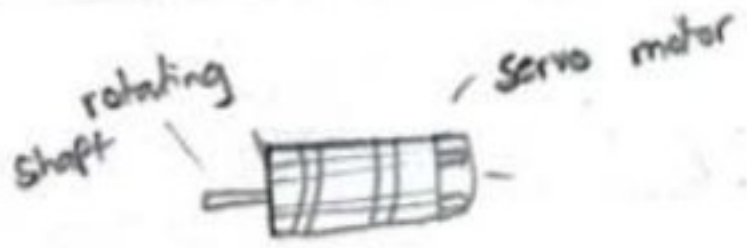


joined to rating

• robot saw has 3 joints that allow us to control its movement, as well as 1 rotational joint.



robot arm works using servo motor

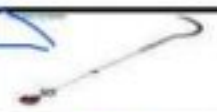


• Motor can be precisely controlled to move arm as necessary

Front view

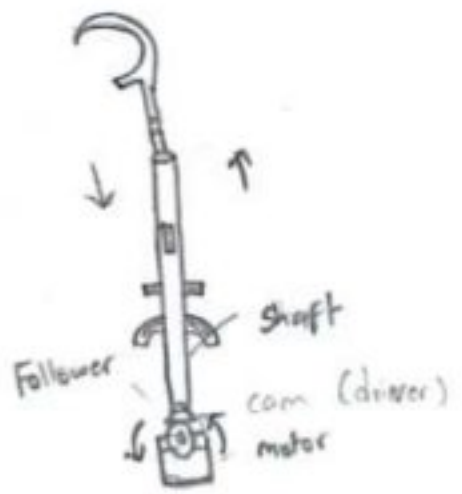
resolver detects rotor position. allows rotational torque to be kept constant.

Concept 7

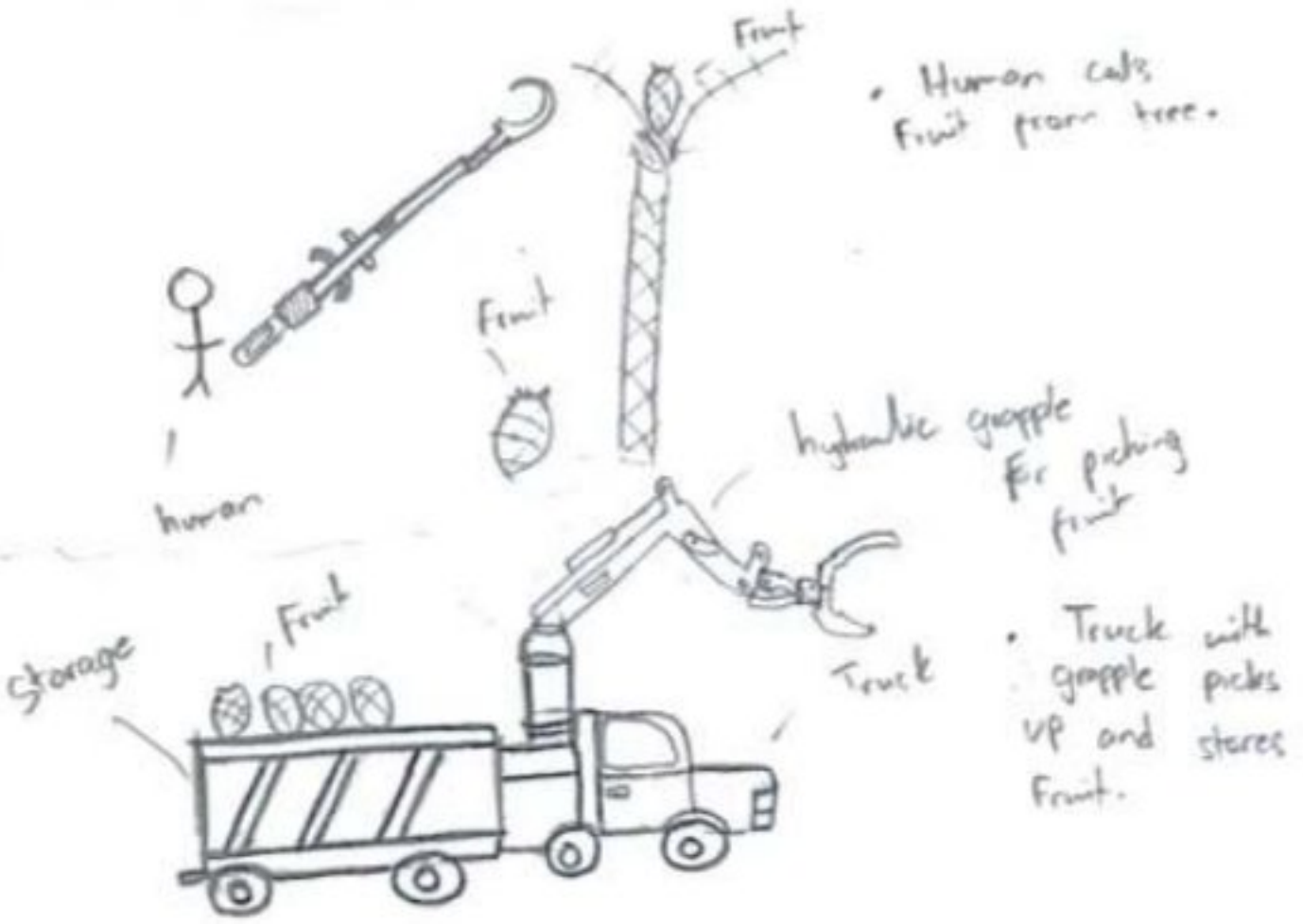
FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								

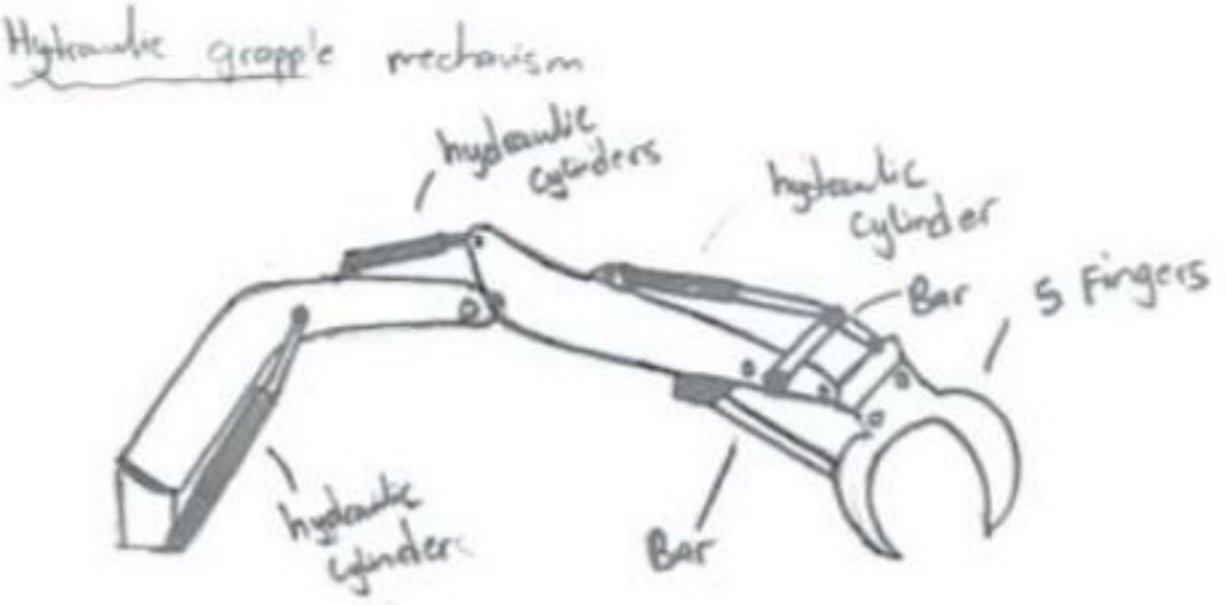
Concept Arslan Babur

Mechanism



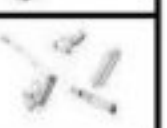
- organic shape of driver displaces shaft vertically, hence oscillating the blade.
- Blade cuts through Fronds easily.
- Motor is gas powered.

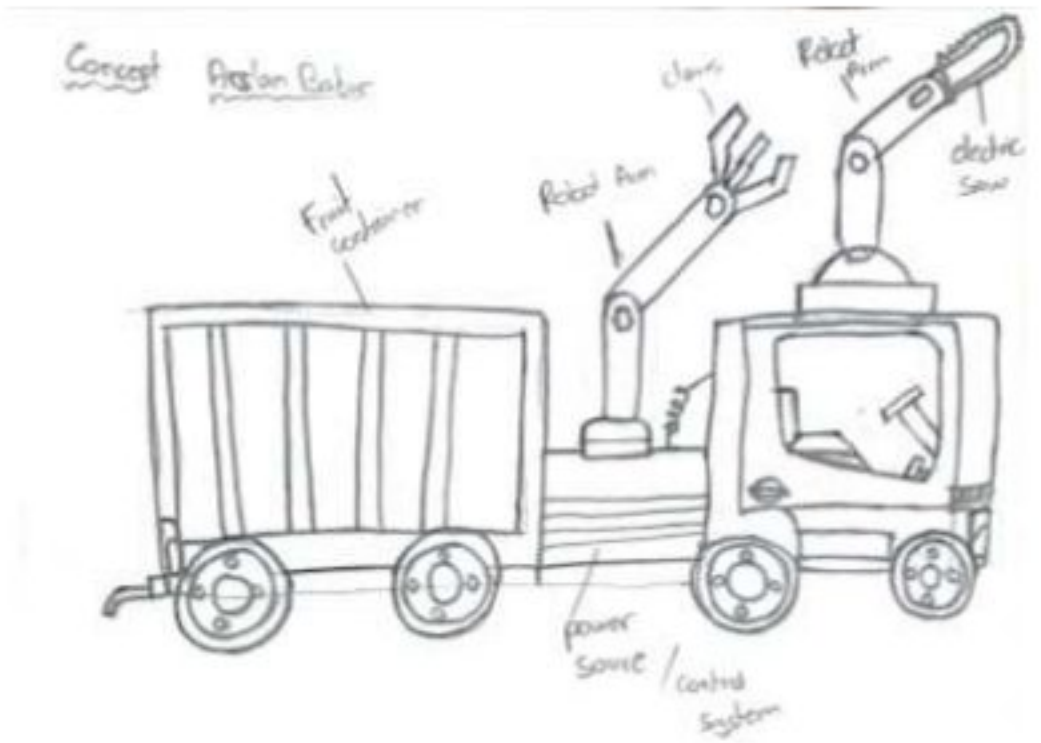




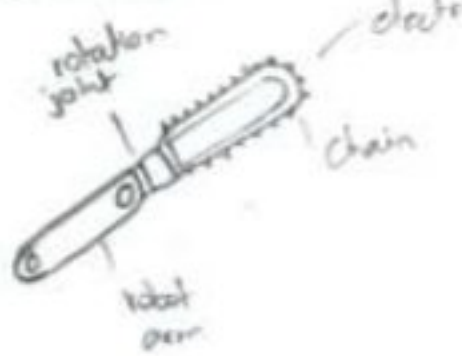
. hydraulic cylinder
has liquid that exerts pressure on
an area (piston) which moves the arm.
And also contract or open the fingers.

Concept 8

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								

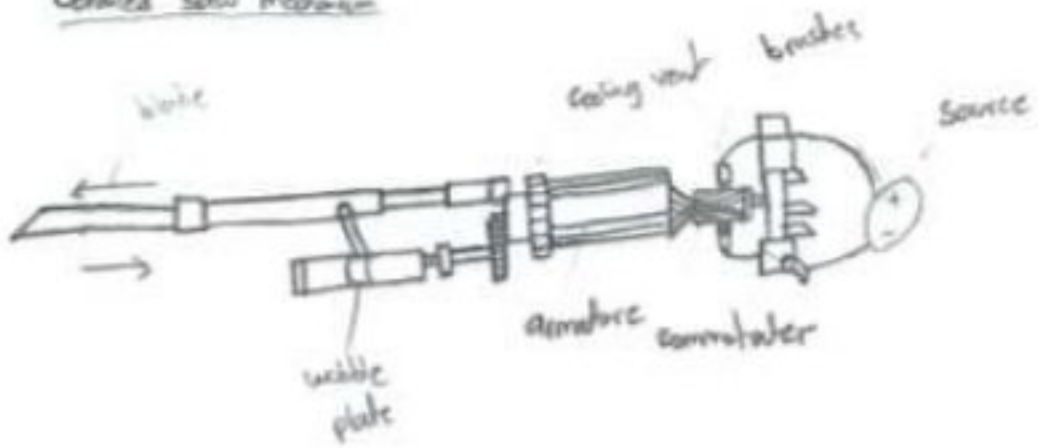


Blade Mechanism



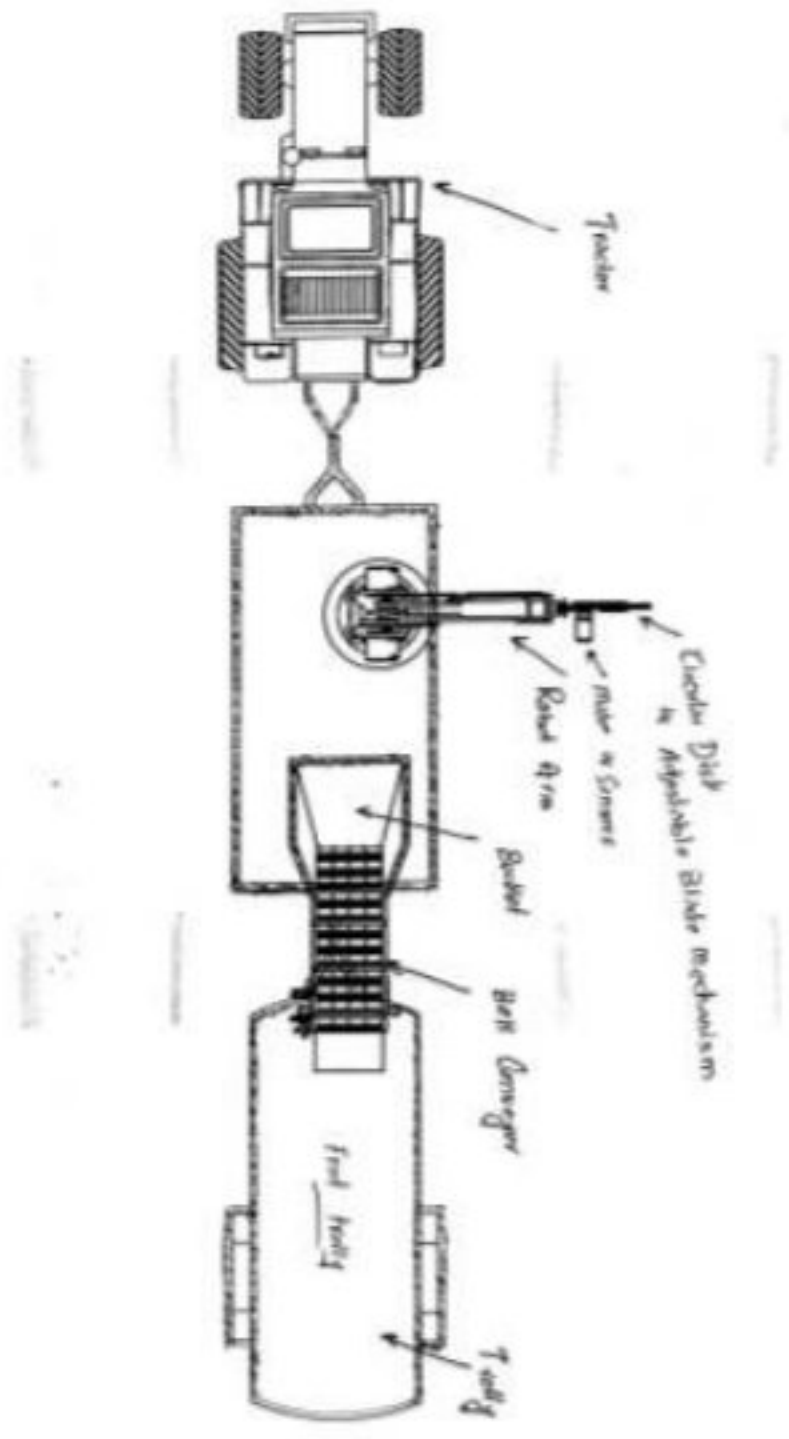
- Arm rotates using servo motor.
- Saw powered through power source in middle compartment.

Detailed saw mechanism



- Source powers commutator, which charges armature creating a magnetic field, that collides with a permanent magnet, hence creating a torque.
- Wobble plate transfers the linear motion to the saw.

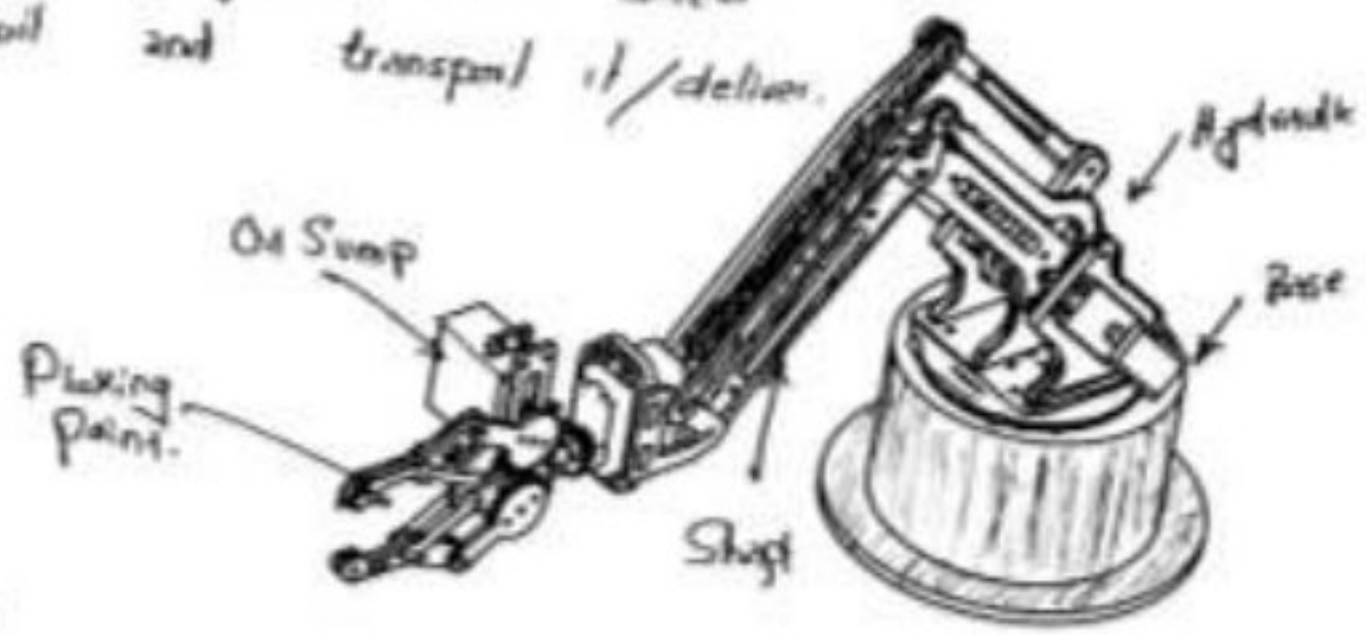
Concept 9



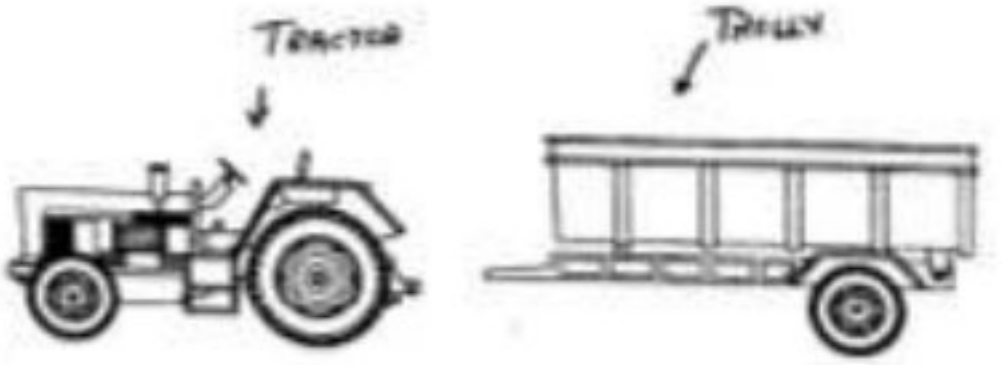
Collect Fruit

Objective

Objective is to Collect fruit and transport it/deliver.

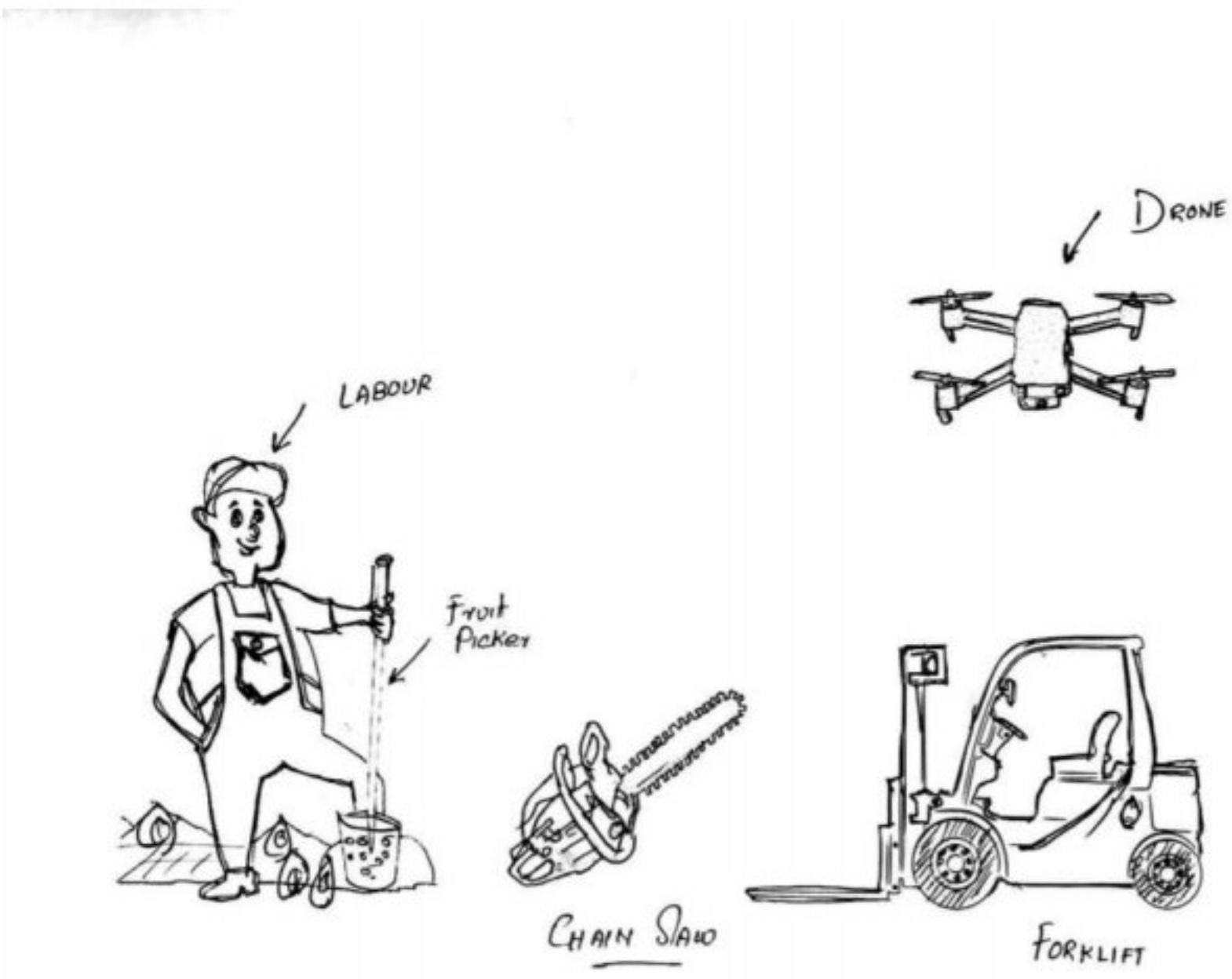


Transportation

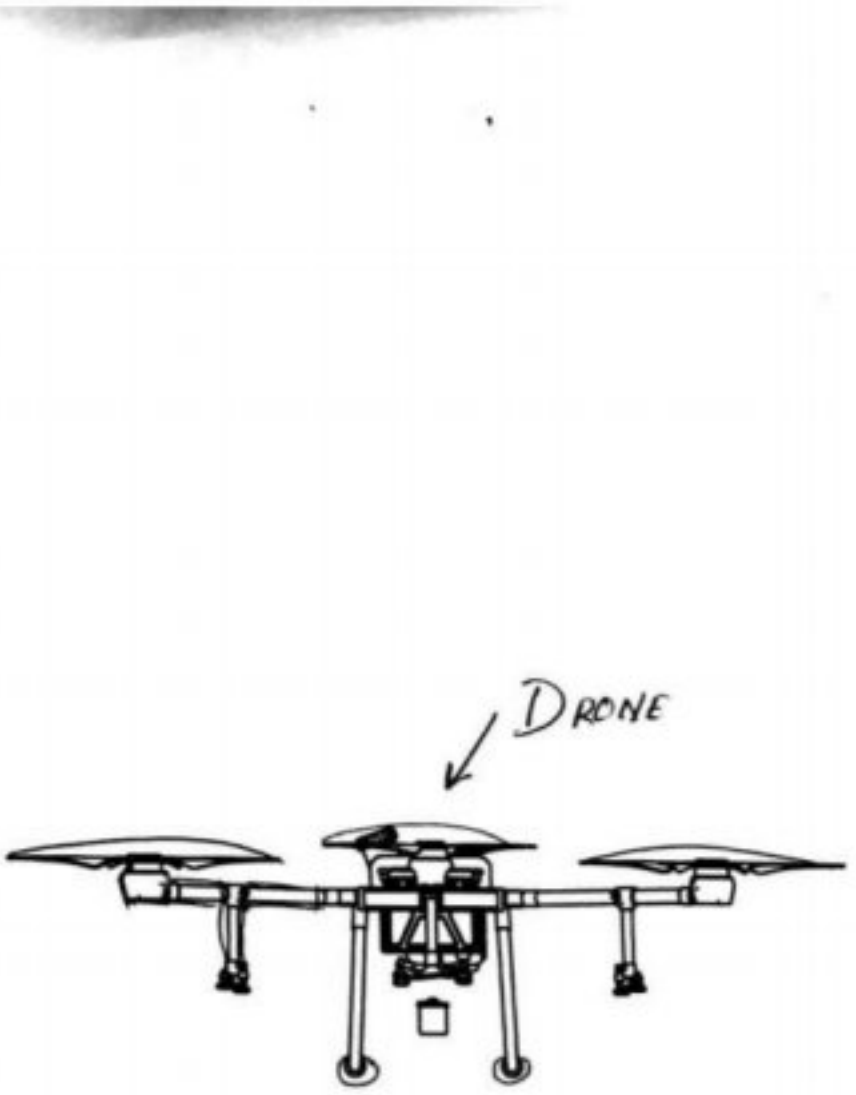


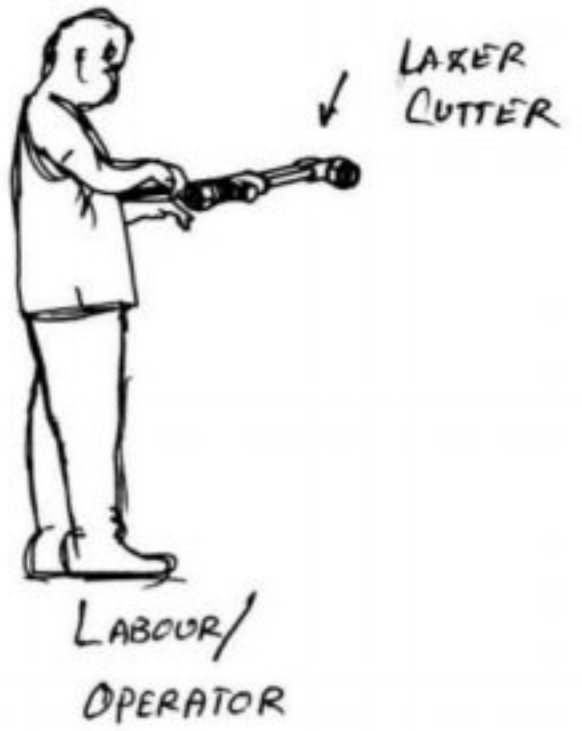
Transportation

Concept 10

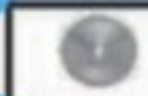
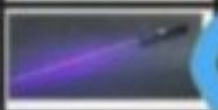
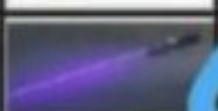


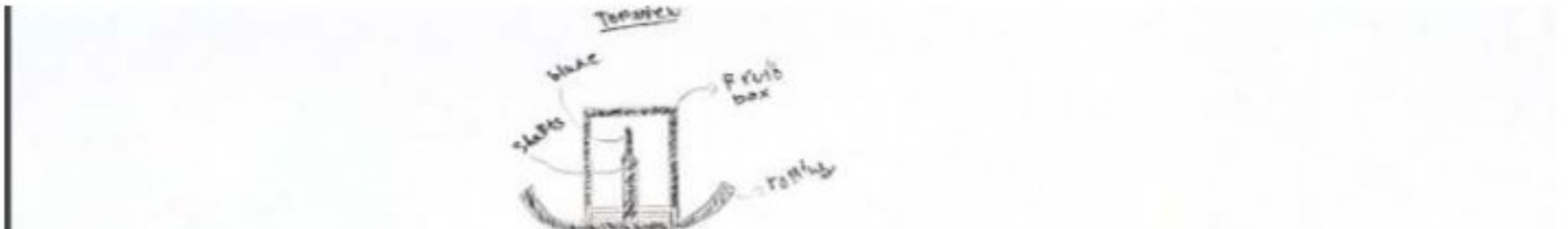
Concept 11

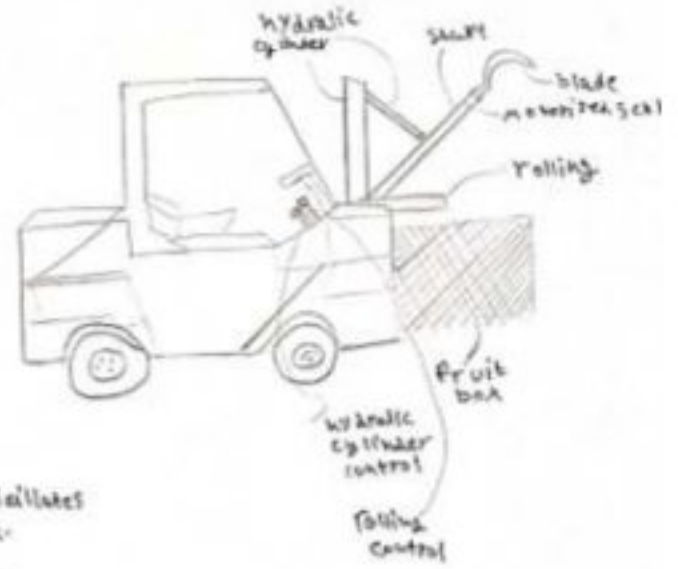




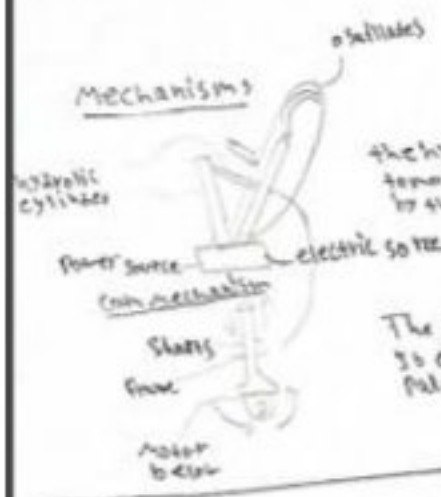
Concept 12

FUNCTION/ SOLUTIONS	NO.1	NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADER							
CUT FRONT								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								





Mechanisms



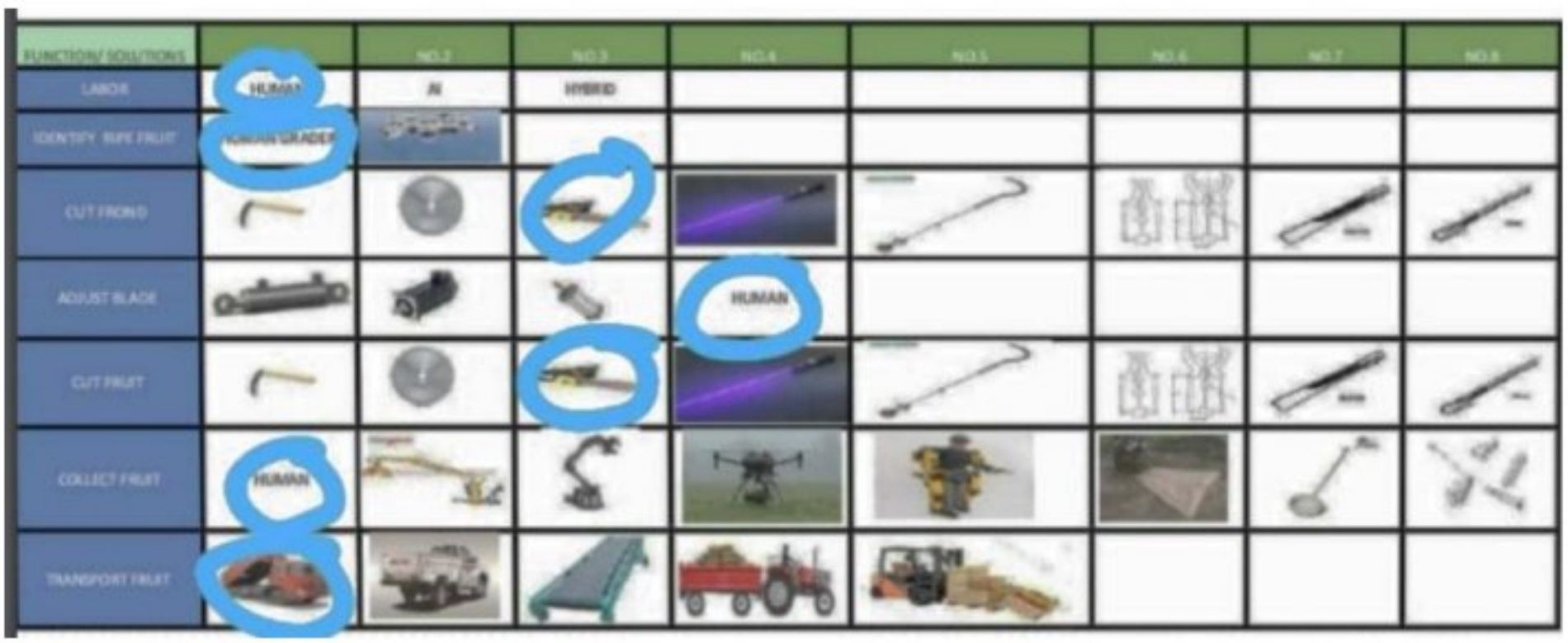
the hydraulic cylinder gave the force to move the blade to and down by the hydraulic cause

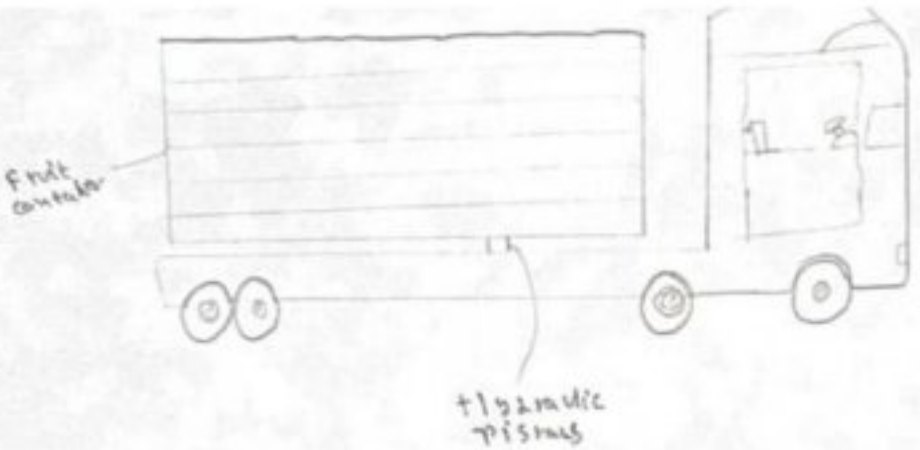
The blade at high frequency is can easily cut through palm

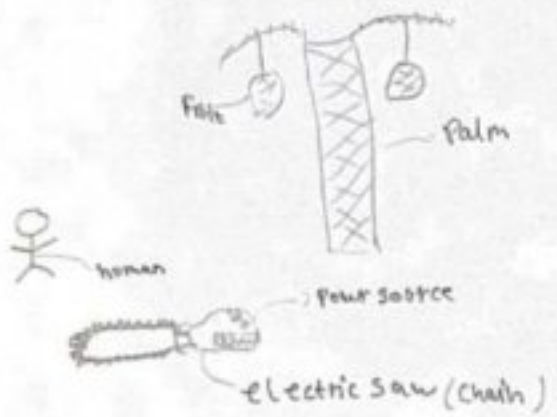
The rolling can control the oscillates by moving in right order.
The power source is from the vehicle by the battery

First human will control the vehicle to cut the fruits and collects by the Fruit box he can control the oscillates up, down, right and left after that trunk starting fruit to the Factory

Concept 13

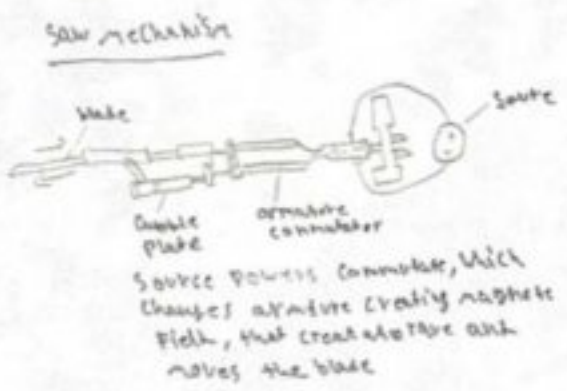






Mechanisms

Saw mechanism

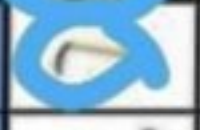
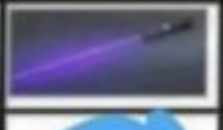
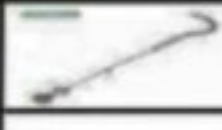
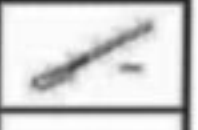
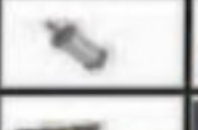
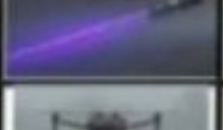
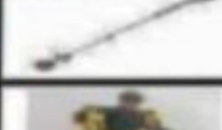
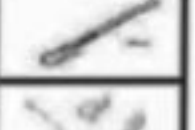
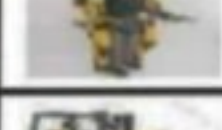
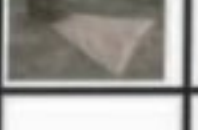
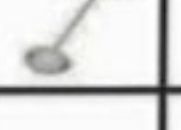
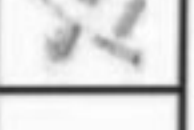


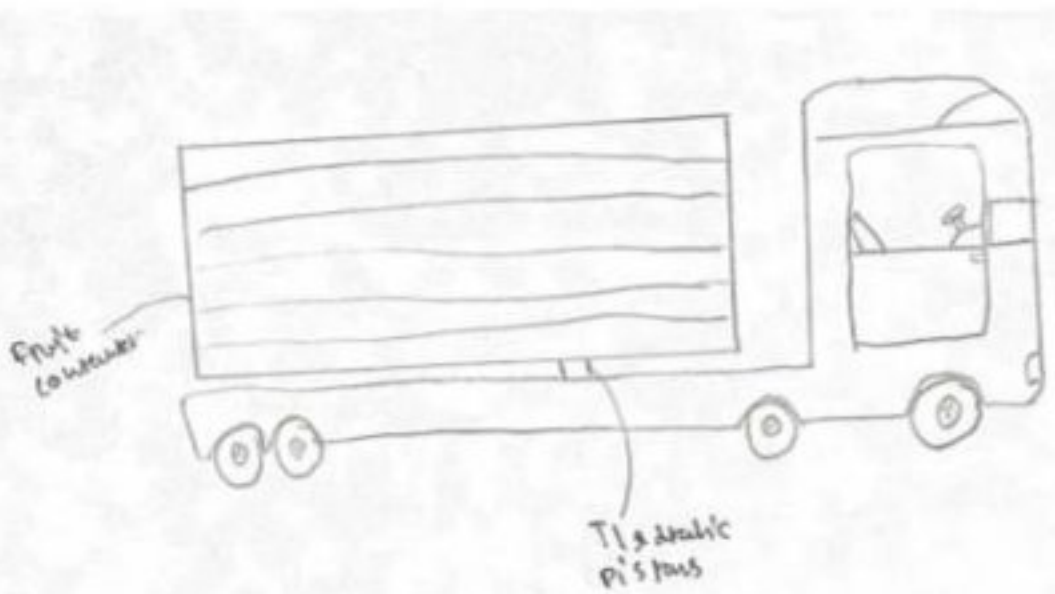
Source powers commutator, which changes armature creating magnetic field, that creates torque and moves the blade

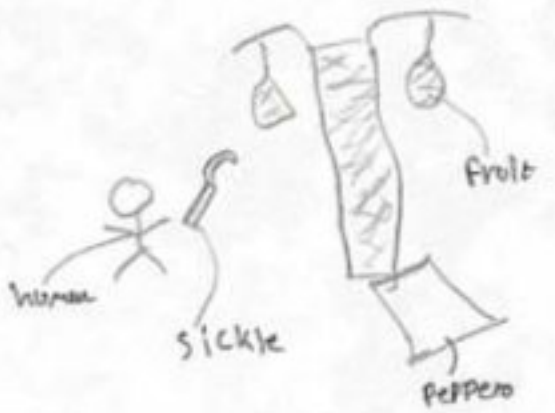
the hydraulic pistons push the fruit container to drop fruit

man will operate chainsaw and cut the fruit after that the driver will transport the fruit to the factory after the farmer collects the fruit

Concept 14

FUNCTION/ SOLUTIONS		NO.2	NO.3	NO.4	NO.5	NO.6	NO.7	NO.8
LABOR	HUMAN	AI	HYBRID					
IDENTIFY RIPE FRUIT	HUMAN GRADE							
CUT FROND								
ADJUST BLADE				HUMAN				
CUT FRUIT								
COLLECT FRUIT	HUMAN							
TRANSPORT FRUIT								

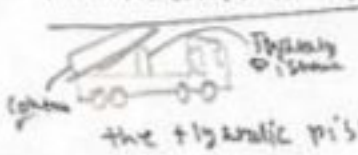




mechanisms

This is the simplest system because there is no technology depends on iron human power to cut the fruit

First human cuts the fruit by using sickle then collect in in peppero then transport it by the truck



Concept 15

Group Project [INTRO TO DESIGN] MD MASHIUR RAHMAN 1421
CONCEPT - 1 (CA2DEM3009)

Labor :	Human
Identify ripe fruit	Human Grader
Cut Fruad	Disk Blade
Adjust blade	Human
Cut fruit	Disk Blade
Collect fruit	Bag
Transport fruit	Pick up truck

- More suitable for ~~shorter~~ shorter trees.

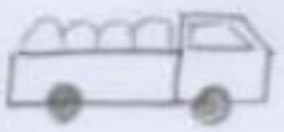
(1) LABOR and IDENTIFICATION of fruit will be done by humans.
→ It is cost effective
→ Human judgement is more accurate

(2) CUTTING Process of the ~~fruit~~ fronds and the fruit will be done by a disk blade, and adjusted by humans.
→ Automated disk blade will reduce human effort.
→ The blad will be motorized.

(3) The fruit will be collected in a large collapsable bag or net.

→ It is cost effective, and a large amount of ~~fruit~~ fruit can be collected.

(4) The Fruits will be transported by pickup truck.
→ Cost effective compared to other transports.
→ Efficient and saves time.



Concept 16

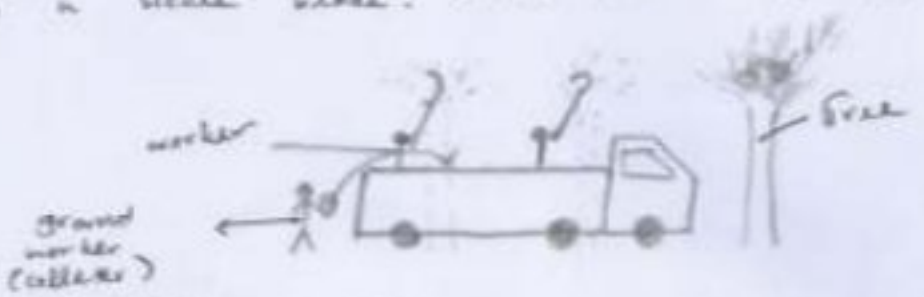
Group Project — INTRO TO DESIGN — MD HABIBUR RAHMAN WAZI (A20EM3009)

Concept - 2

LABOR	Hybrid
Identify Ripe Fruit	Human Caraidar
Cut Fruit	Sickle Blade
Adjust Blade	Human
Cut Fruit	Sickle Blade
Collect Fruit	Human
Transport Fruit	Large Truck

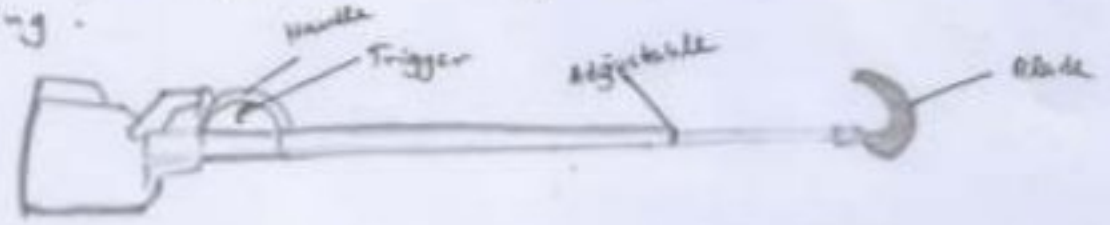
- Here suitable for taller trees.

① LABOR will be hybrid. A large truck will carry a worker/workers with a sickle blade. workers will identify the ripe fruit.



② CUTTING process of the fronds and the fruit will be done by sickle blade.

→ It is most effective and manual
→ the blade can reach great ~~at~~ heights (upto ~~40cm~~ 20 cm)
→ the sickle ~~of~~ shape is good for flexible and easy cutting.



③ The fruit will be collected by ~~workers~~ humans.

→ the fruits will be transported to the ~~same~~ lorry
→ Using humans ~~is~~ is the most cost saving

④ the same large truck/lorry that brought the workers will be used to transport the fruit.

→ less time consuming ~~and~~
→ high efficiency
→ cost effective.

Concept 17

Group Project — INTRO TO DESIGN — MD HASIBUR RAHMAN (1421 7424 EM3 009)

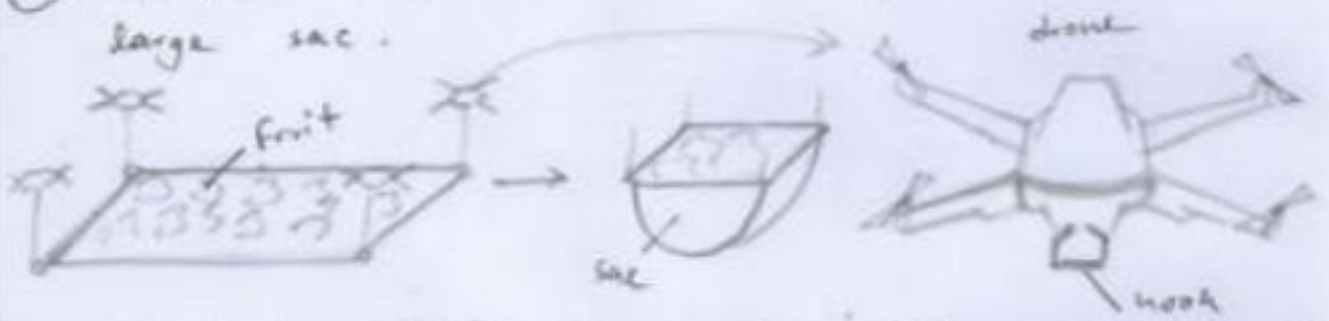
Concept - 3

LABOR	Hybrid
Identify Ripe Fruit	Human
Cut Fronds	sickle blade (sword)
Adjust Blade	~~sickle blade (sword)~~ Human
Cut Fruit	~~the~~ sickle ~~blade~~ (small)
Collect fruit	Drones + sac
Transport Fruit	large truck / lorry

(1) LABOR and IDENTIFICATION of fruit will be done by humans.
→ It is not effective
→ Human judgement is more accurate

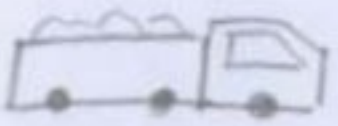
(2) CUTTING process of the fronds and the fruit will be done by small sickle blades.
→ very ~~cost~~ cheap
→ easy to ~~do~~ use

(3) The fruits will be collected by drones and a large sac.



→ The fruits will lay on a net with ~~collapsable~~ wires and stretchy fabric.
→ The drones will carry the sac attached to hooks and transport the fruit to the truck.
→ It reduces ~~labour~~ human effort by a huge margin
→ It increases ~~effici~~ efficiency and saves times.

(4) The fruits will be transported by a large truck / lorry.



Concept Evaluation

Scoring Criteria

Detailed Criteria		
Manufacturing Cost	**Ease of Manufacturing**	**Ease of maintanance**
-Number of parts needed to be bought / custom made	-Number of different parts needed to assemble	Time taken for regular maintenance
	Parts with advanced manufacturing techniques	Ease of removing / replacing parts within the machine
	Parts that require special post processing	Ease of access to key components of the machine
		Ease of acquiring repair parts
Safety of Machine	**Accuracy of control**	**Performance/ Efficiency**
Safety of the operator while operating the machine	Ease of accuracy while operating	Time taken to cut fronds of palm tree
Safety issues with components that are prone to fail	Precision of controls for operator	Time taken to collect fruit
Number of unlocked sharp edged components	Capability of precise/smooth movement from machine	Overall efficiency of operation for palm fruit harvest
Safety precautions to help operator		
Number of fail-safe to prevent accidents.		
Reliability	**Environmentally friendly**	**Product Lifespan**
Stability of product while operating	Key components are resistant to corrosion and water	Time product lasts without needing to replace key components
Product operatable in various terrains	Does not produce too much pollution	
Product operatable in different weather conditions	Relying on renewable energy rather than gas/oil	
Ease of operation	**Customizability**	
Ease of learning machine operation	Different parts can be interchanged to adapt to environment	
Training required to operate effectively	Functions as intended after customizing	
Ergonomic/ Simple/ Easy controls		
Physically easy to operate		

Scoring Sheet

Each concept was evaluated by different members of the group to prevent bias, and the detailed scoring criteria was taken into account for each concept. DATUM is as mentioned previously.

Scoring Sheet

Marking Criteria/ Concepts		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Manufacturing Cost		+	=	-	=	++	+	+	=	++	+	=	++	++	++	++	++	++
Ease of manufacturing		=	+	+	=	+	++	+	=	++	+	=	+	++	++	++	++	++
Ease of maintanance		+	+	+	+	++	+	=	=	++	+	=	+	++	++	++	++	+
Safety of machine		=	+	=	=	-	-	+	+	--	--	--	-	-	=	-	-	-
Accuracy of control		+	+	-	-	=	=	+	+	-	=	+	-	-	-	+	+	+
Performance/ Efficiency	Datum	+	+	+	+	-	+	+	++	-	=	-	-	-	--	--	=	--
Reliability		=	-	+	+	-	-	-	=	+	-	-	-	-	-	-	-	--
Environmentally friendly		+	=	=	=	+	+	+	-	=	+	+	+	=	+	+	-	=
Product Lifespan		+	-	+	+	+	=	+	+	+	=	=	--	-	--	=	-	--
Ease of operation		=	-	=	+	=	++	+	=	+	+	=	=	--	-	+	++	--
Customizability		+	-	-	=	-	+	+	+	-	--	-	=	--	--	-	=	-
Net		7	1	3	4	3	7	8	3	4	0	-3	-1	-3	-2	4	5	-4

Concepts	*Evaluator*
Farhan: 1, 2	Arslan
Ahmed: 3, 4, 5	Tarek
Arslan: 6, 7, 8	Mazen
Tarek: 9, 10, 11	Farhan
Mazen: 12,13,14	Hasib
Hasib: 15, 16, 17	Ahmed

Scoring Matrix

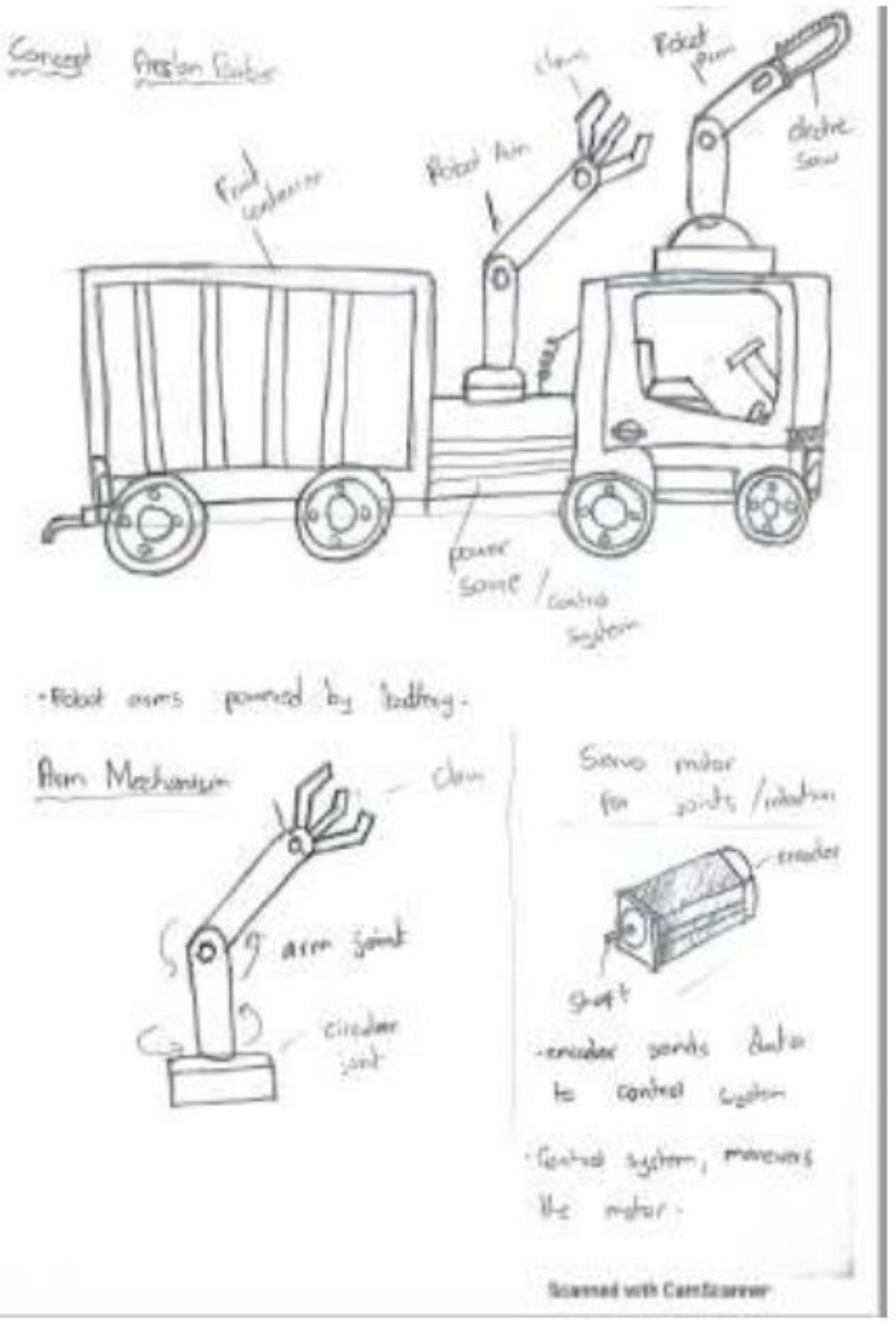
Criteria	weightage		1		2		3		4		5		6		7		8		9
			Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks
Manufacturing Cost	0.05		1	0.05	0	0	0	0	0	0	2	0.1	1	0.05	1	0.05	0	0	2
Ease of manufacturing	0.07		0	0	1	0.07	1	0.07	0	0	1	0.07	2	0.14	1	0.07	0	0	2
Ease of maintanance	0.07		1	0.07	1	0.07	1	0.07	1	0.07	2	0.14	1	0.07	0	0	0	0	2
Safety of machine	0.1		0	0	1	0.1	0	0	0	0	-1	-0.1	-1	-0.1	1	0.1	1	0.1	-2
Accuracy of control	0.1	DATUM	1	0.1	1	0.1	-1	-0.1	-1	-0.1	0	0	0	0	1	0.1	1	0.1	-1
Performance/ Efficiency	0.2		1	0.2	1	0.2	1	0.2	1	0.2	-1	-0.2	1	0.2	1	0.2	1	0.2	-1
Reliability	0.1		0	0	-1	-0.1	1	0.1	1	0.1	-1	-0.1	-1	-0.1	-1	-0.1	2	0.2	1
Environmentally friendly	0.08		1	0.08	0	0	0	0	0	0	1	0.08	1	0.08	1	0.08	-1	-0.08	0
Product Lifespan	0.07		1	0.07	-1	-0.07	1	0.07	1	0.07	1	0.07	0	0	1	0.07	1	0.07	1
Ease of operation	0.1		0	0	-1	-0.1	0	0	1	0.1	0	0	2	0.2	1	0.1	0	0	1
Customizability	0.06		1	0.06	1	0.06	-1	-0.06	0	0	-1	-0.06	1	0.06	-1	-0.06	1	0.06	-1
Sum Weightage	1			0.63		0.33		0.35		0.44		0		0.6		0.61		0.65	

	10		11		12		13		14		15		16		17	
Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total	Marks	Total
0.1	1	0.05	0	0	2	0.1	2	0.1	2	0.1	2	0.1	2	0.1	2	0.1
0.14	1	0.07	0	0	1	0.07	2	0.14	2	0.14	2	0.14	2	0.14	2	0.14
0.14	1	0.07	0	0	1	0.07	2	0.14	2	0.14	2	0.14	2	0.14	1	0.07
-0.2	-2	-0.2	-2	-0.2	-1	-0.1	-1	-0.1	0	0	-1	-0.1	-1	-0.1	-1	-0.1
-0.1	0	0	1	0.1	-1	-0.1	-1	-0.1	-1	-0.1	1	0.1	1	0.1	1	0.1
-0.2	0	0	-1	-0.2	-1	-0.2	-1	-0.2	-2	-0.4	-2	-0.4	0	0	-2	-0.4
0.1	-1	-0.1	-1	-0.1	-1	-0.1	-1	-0.1	-1	-0.1	-1	-0.1	-1	-0.1	-2	-0.2
0	1	0.08	1	0.08	1	0.08	0	0	1	0.08	1	0.08	-1	-0.08	0	0
0.07	0	0	0	0	-2	-0.14	-1	-0.07	-2	-0.14	0	0	-1	-0.07	-2	-0.14
0.1	1	0.1	0	0	0	0	-2	-0.2	-1	-0.1	1	0.1	2	0.2	-2	-0.2
-0.06	-2	-0.12	-1	-0.06	0	0	-2	-0.12	-2	-0.12	-1	-0.06	0	0	-1	-0.06
0.09		-0.05		-0.38		-0.32		-0.51		-0.5	4	0	5	0.33	-4	-0.69

Final Design

Final selection

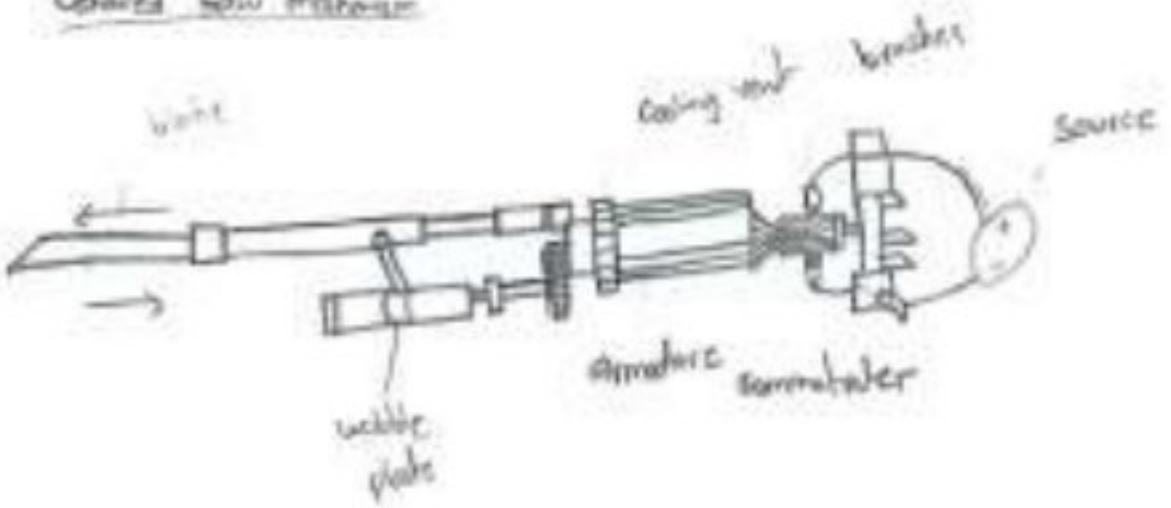
After all scoring matrix are analyzed, the concept with the highest score is concept#8 as displayed below in detail.



Blade Mechanism

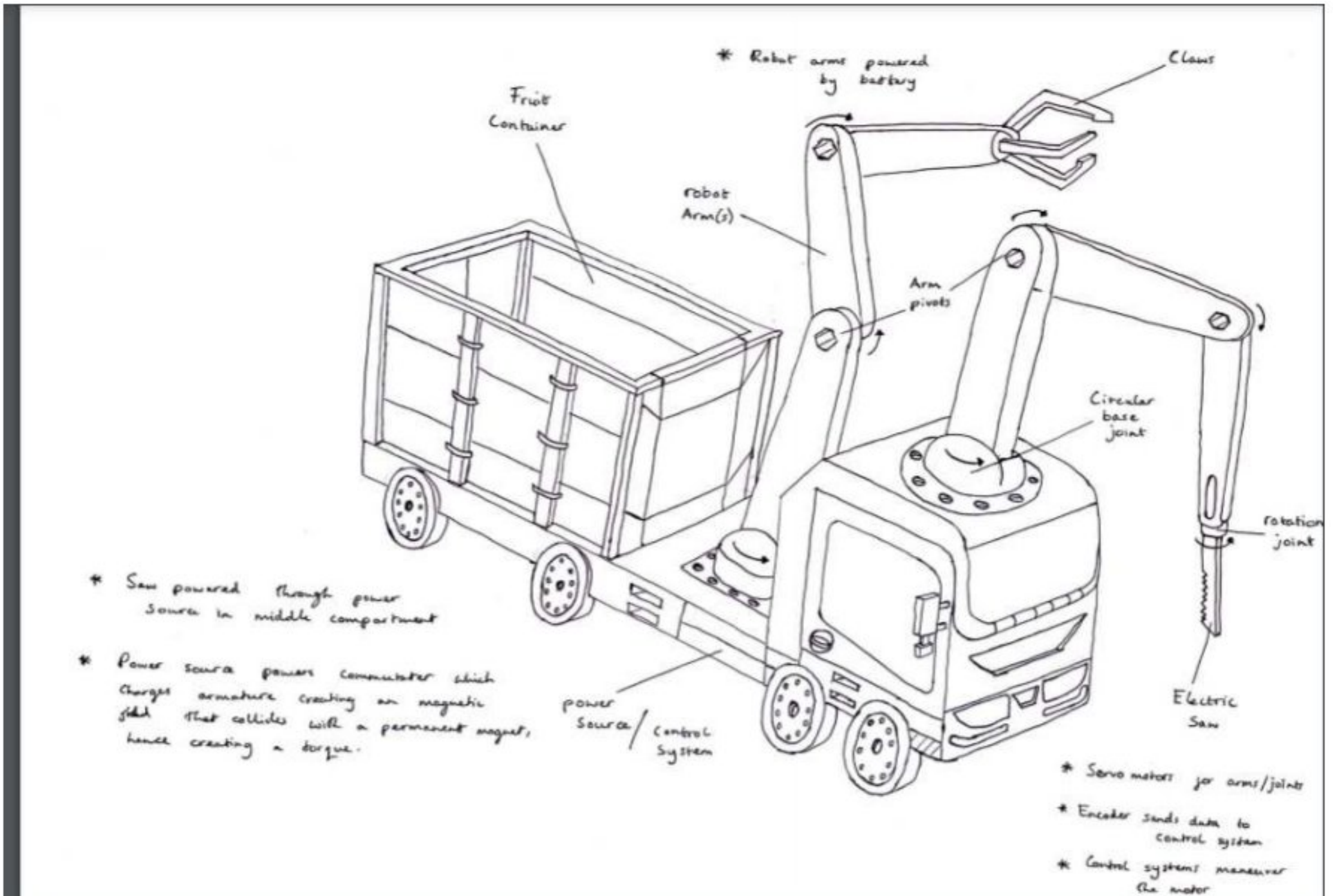
- from rotation using Servo motor.
- Saw powered through power source in middle compartment

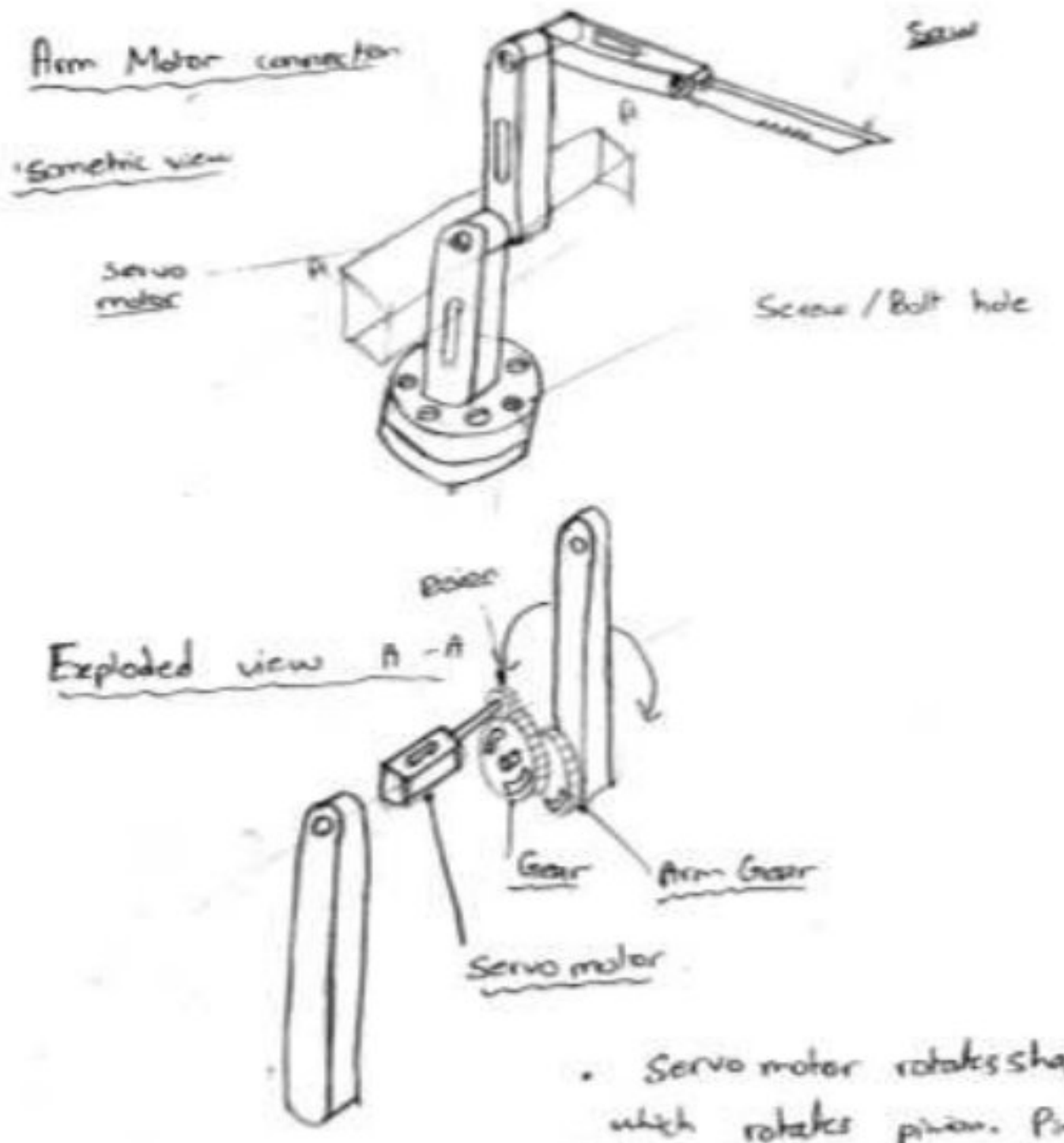
Detailed saw mechanism



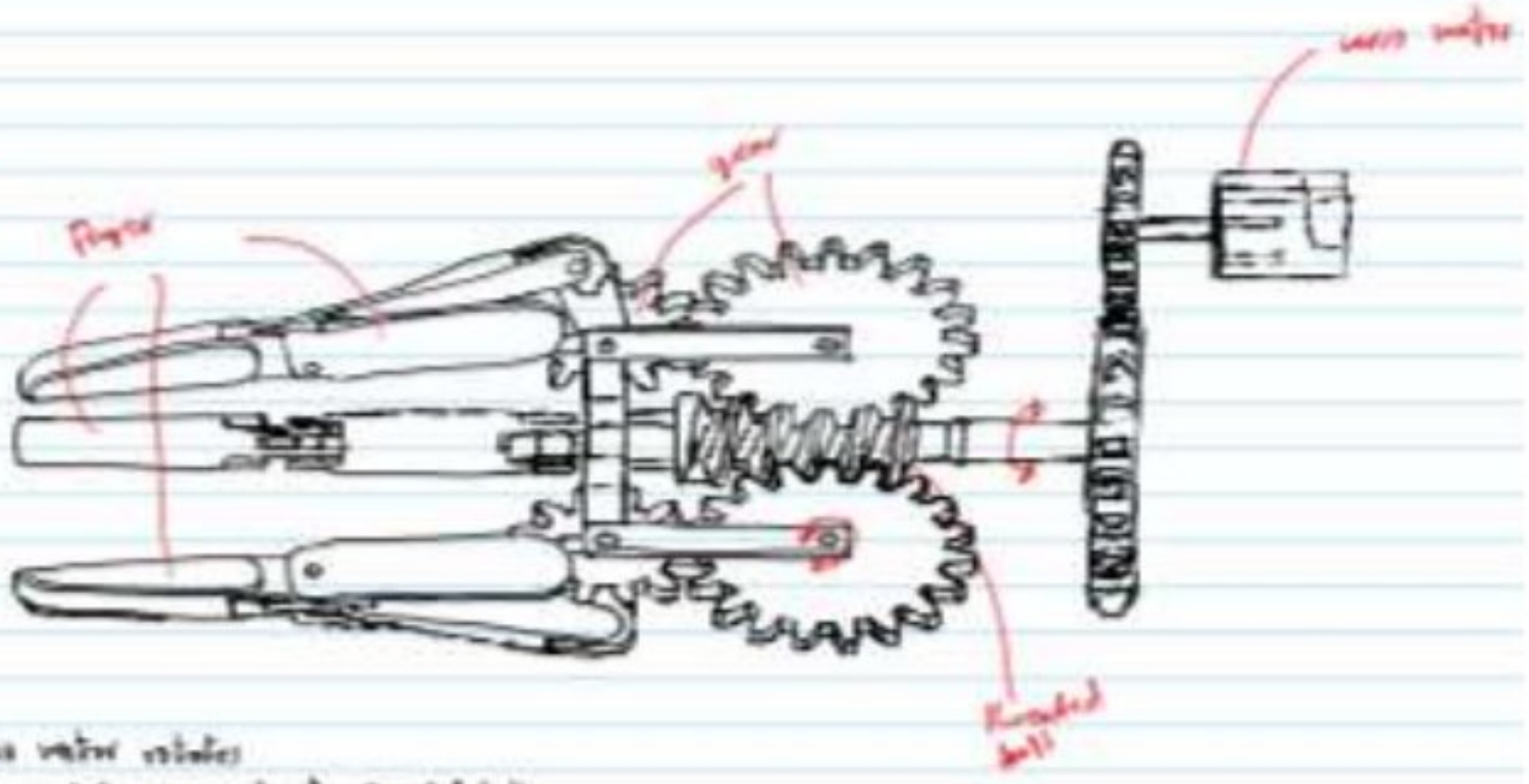
- Source powers commutator, which charges armature creating an magnetic field, that collides with a permanent magnet, hence creating a torque.
- Wobble plate transfers the linear motion to the saw.

Final Design Detailing



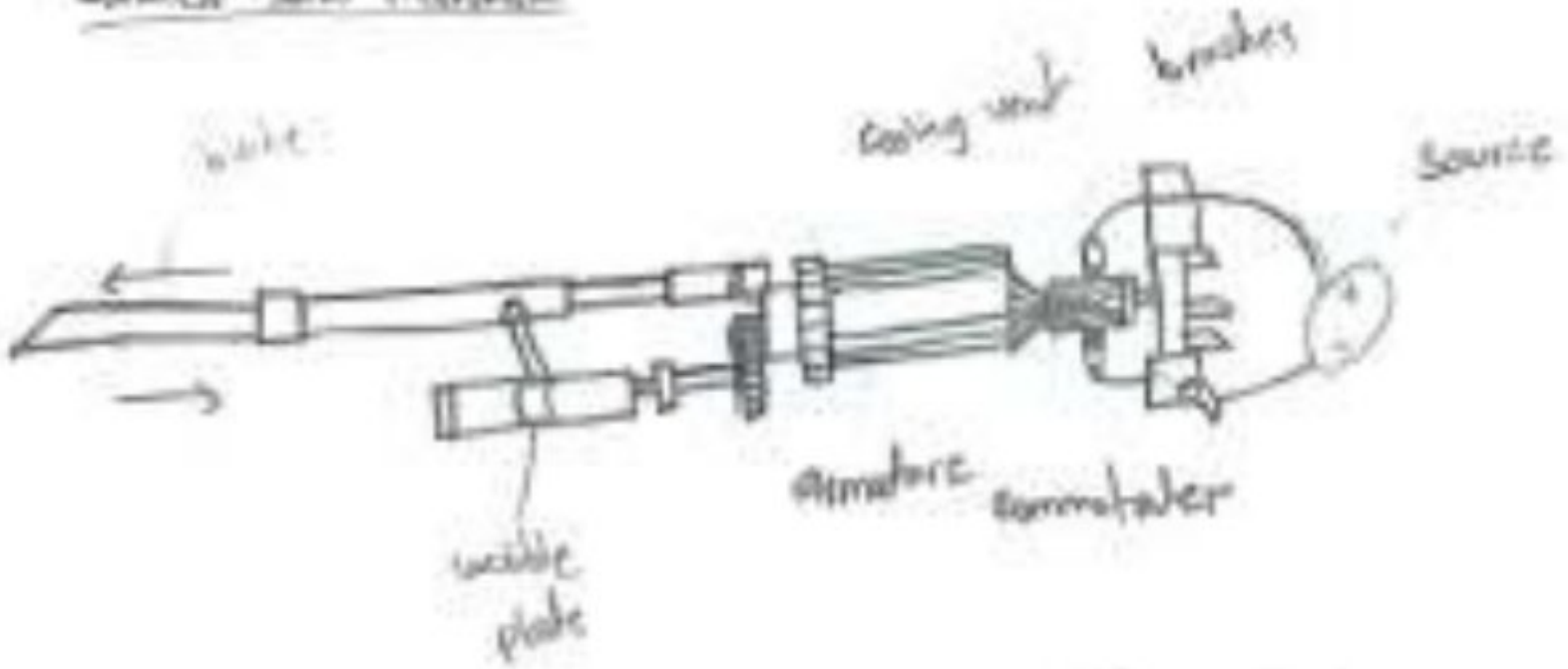


- Servo motor rotates shaft which rotates pinion. Pinion hence rotates Gears which controls arm position.



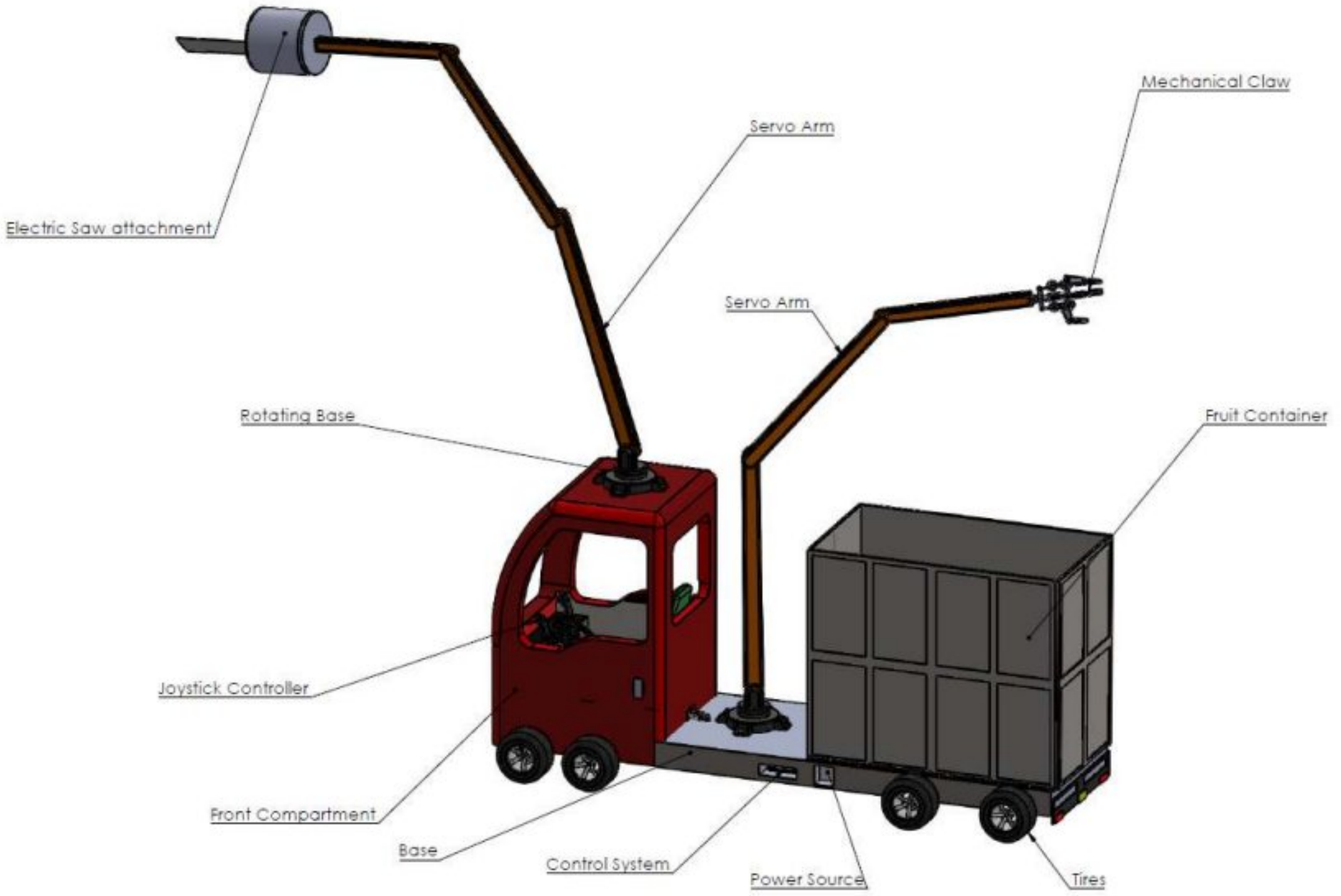
→ Servo motor rotates
→ Screw driver connected to threaded bolt
→ Threaded gears rotate to open the claw fingers

Detailed saw mechanism



- Source powers commutator, which charges armature creating a magnetic field, that collides with a permanent magnet, hence creating a torque.
- Variable plate reverses the linear motion to the saw.

Solidworks 3D Modeling



Explanation on Operation / Features

Height

Robot arm with saw attachment can reach up to 15m in length, added with the 5m height of the front compartment, total length is 20m, which allows it to easily reach palm fronds and palm fruit. Therefore, allowing the operators to cut the fruit from the trees efficiently.

Cutting Mechanism

The cutting mechanism for this system is the electric saw attached at the end of the servo arm. The electric saw works by translating rotational motion input by a servo motor into linear motion using a wobble plate mechanism, hence the blade attached at the end of this wobble plate oscillates rapidly from left to right creating a cutting motion.

Collecting Mechanism

The mechanical claw serves as the collecting mechanism, it operates by a servo motor attachment that rotates the worm gear shaft coincidentally rotating the connected finger gears, hence, this opens and closes the claw simulating a gripping motion which is used to collect the fruit and lift it to the fruit container at the back to store for transport. The mechanical claw is attached at the end of a servo arm which allows an operator to rotate and move the arm to use the claw mechanism effectively anywhere around the lorry.

Transporting Mechanism

The fruits once loaded into the back compartment can easily be transported by using the lorry everything is mounted on, the lorry can easily carry a few tons. Therefore, there would be no issues carrying a large number of palm fruit since each bunch weighs around 20-27 Kg.

Operation Explanation

Procedures

To utilize this harvesting system perfectly, the following procedures must be followed:

1. Locate Ripe palm tree fruit.
2. Drive the lorry near the tree.
3. Position the arm adequately and operate it to extend towards the tree.
4. Using the electric saw, cut off palm tree fronds.
5. Using the electric saw, cut off the palm fruit from the tree.
6. Operate the Claw servo arm to position itself near the dropped fruit
7. Using Servo motor, open grip of mechanical claw, and adequately grip the fruit using the mechanism
8. Lift the fruit and rotate the arm towards the fruit container
9. Store the Palm fruit inside the fruit container and continue repeating the process until the maximum capacity of the fruit container is reached.

Explanation

Both robot arms work by utilizing servo motors. When the operator uses the joystick to move the arm, the encoder within the servo motor sends its location to the control system, the control system sends a low voltage signal using the power source to the motor which changes its position accordingly, and it is connected to the joints of the arm links. Hence, the robot arm rotates accurately.

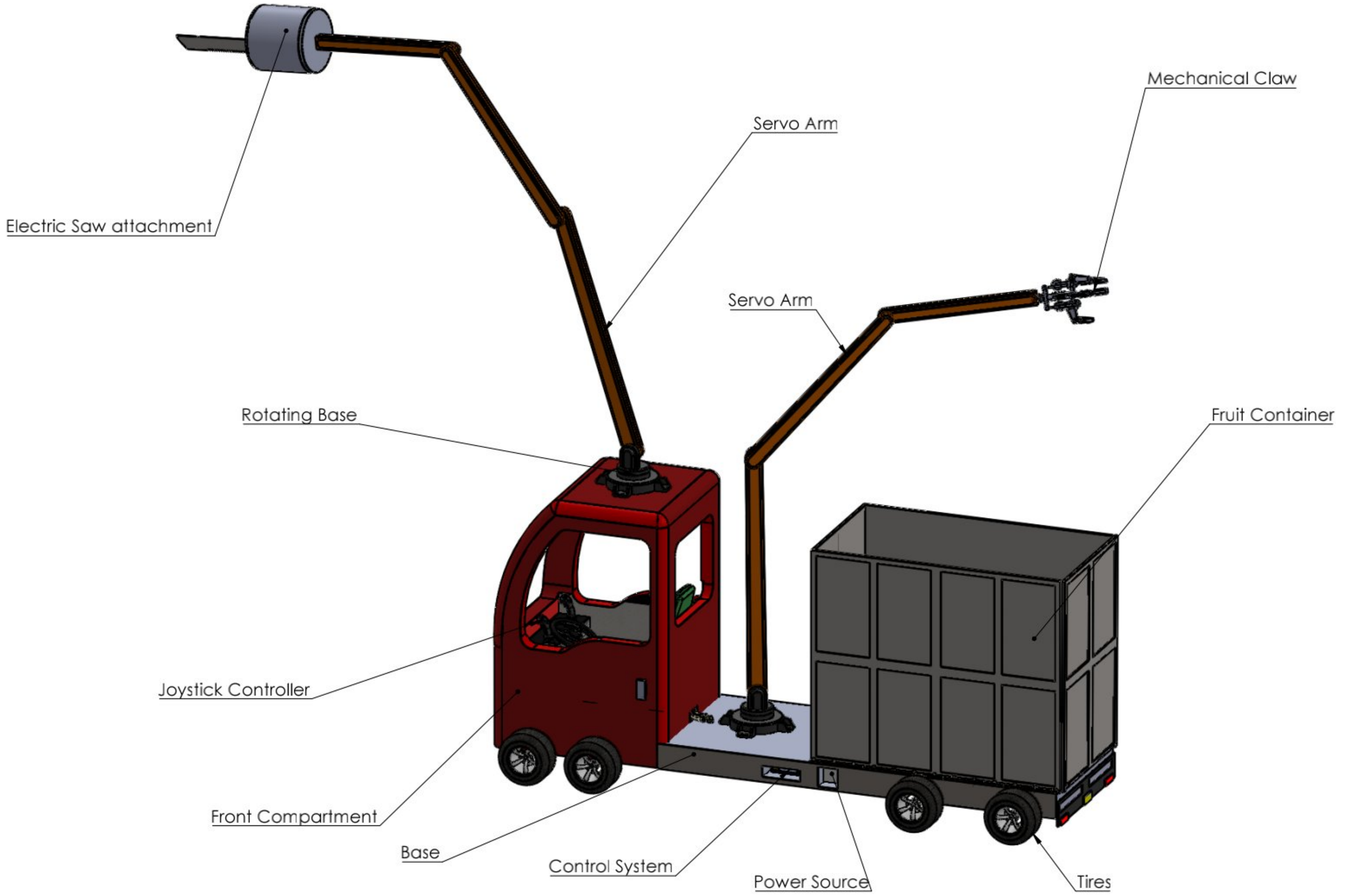
To operate the saw mechanism, the servo motor receives the instruction to rotate at a constant speed such as 500 RPM etc. This will rotate the shaft containing the wobble plate and hence oscillate the saw accordingly.

To operate the mechanical claw mechanism, the servo motor rotates by a certain degree or distance, which will adequately rotate the gears of the mechanical claw and hence close or open the fingers. Clockwise rotation of the gears will close the fingers, whereas anti-clockwise rotation would open them up.

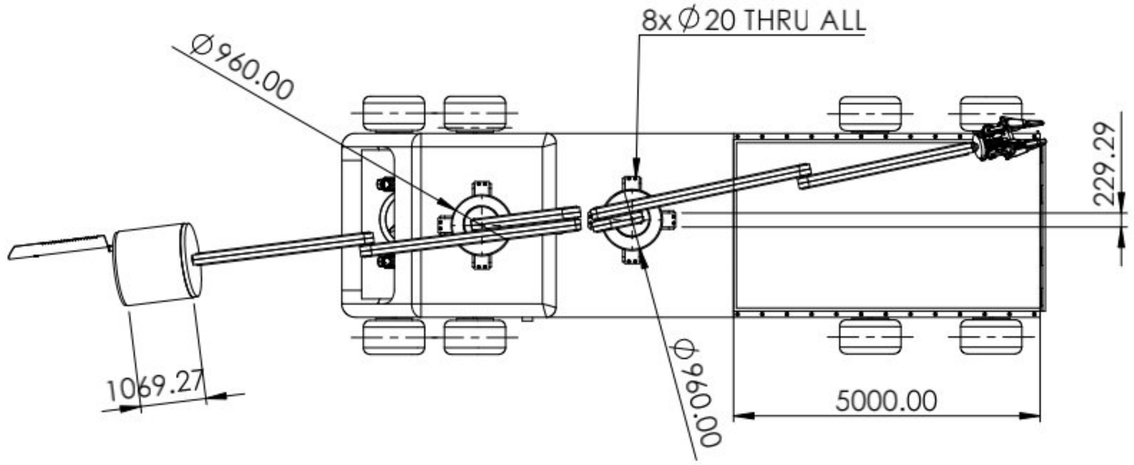
Advantages:

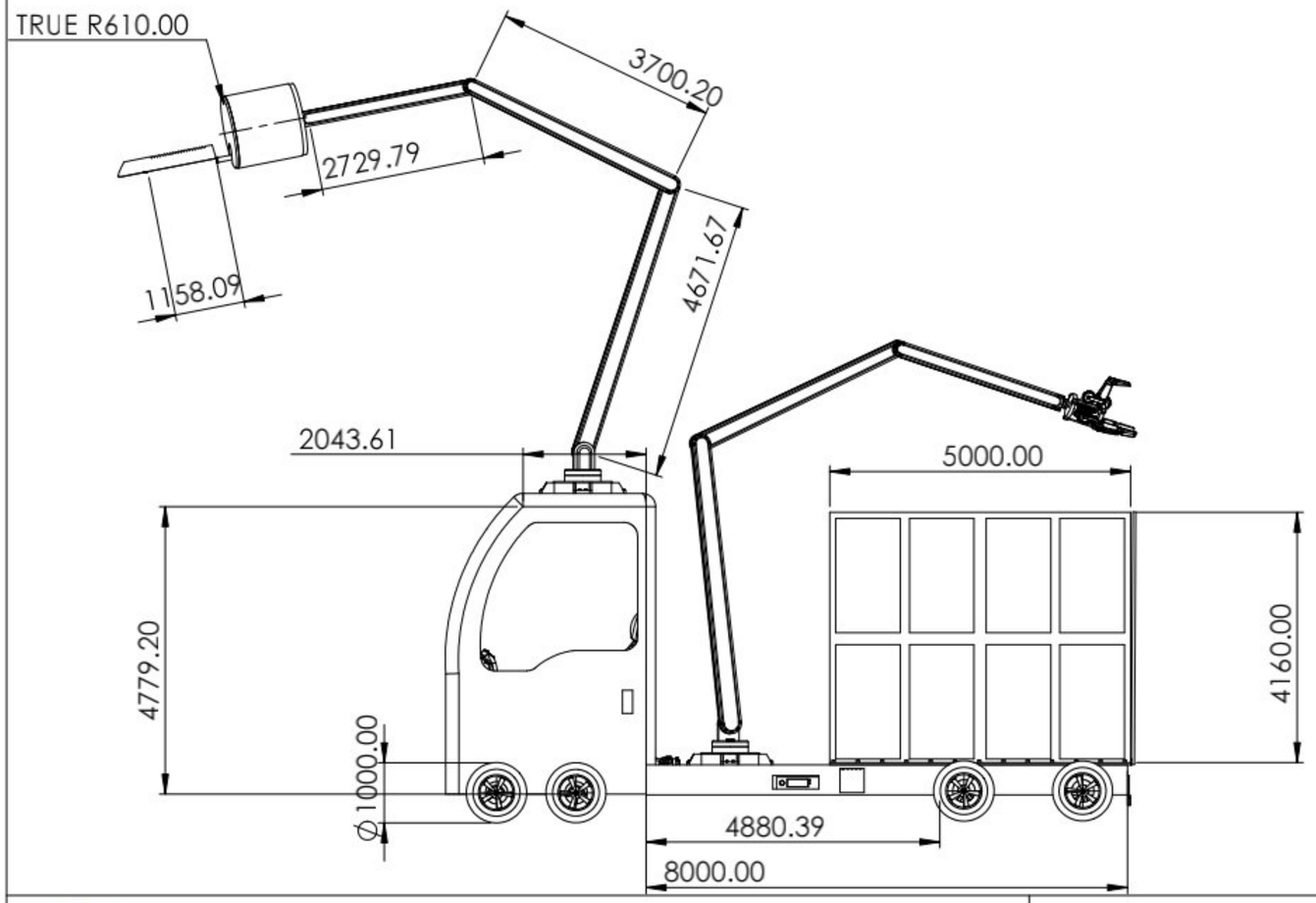
1. Ergonomic Controls
2. Easy to operate as joystick controls are common
3. Accurate and precise operation using servo motors
4. Safe as servo motors can easily be stopped at any time using control system
5. Less time required to train workers as system overall incorporates basic skills which are easy to master

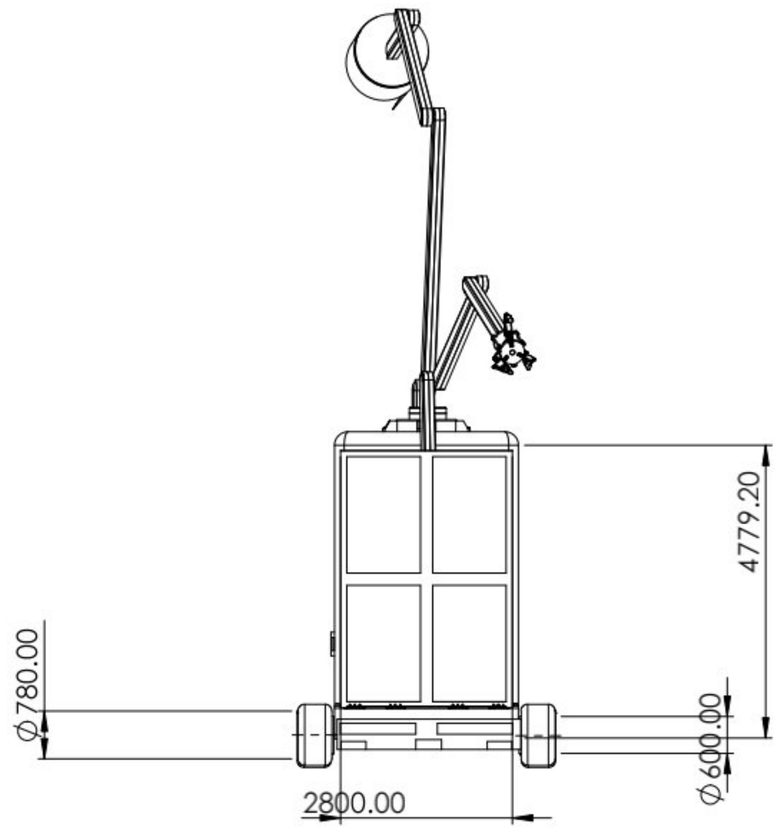
Orthographic Drawings



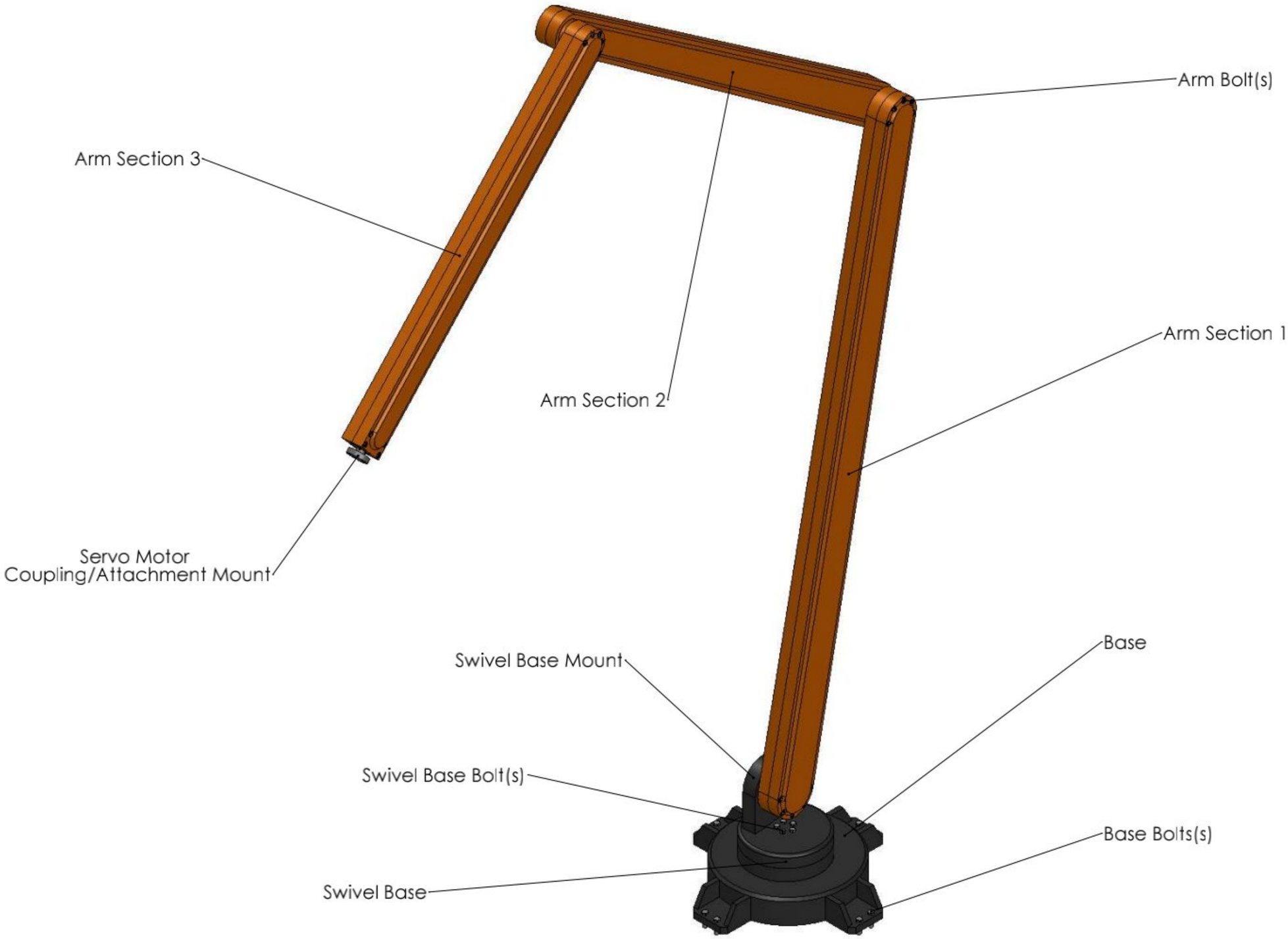
UTM UNIVERSITI TEKNOLOGI MALAYSIA UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: 3D Labelled	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:70



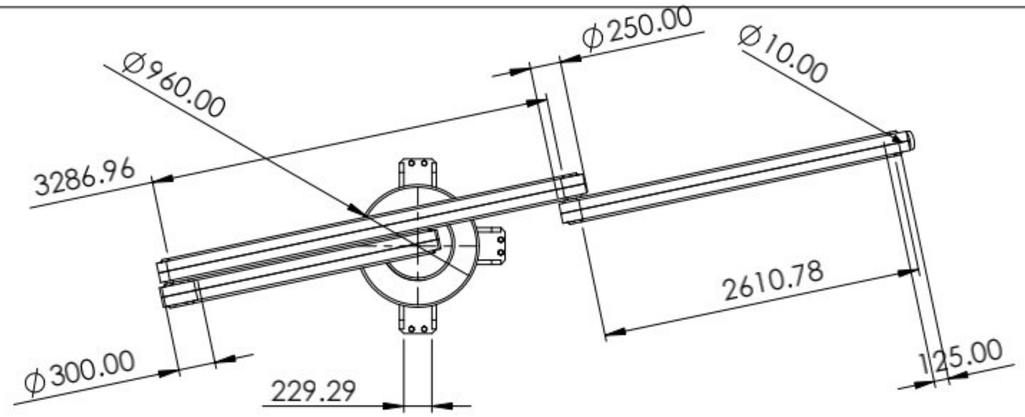


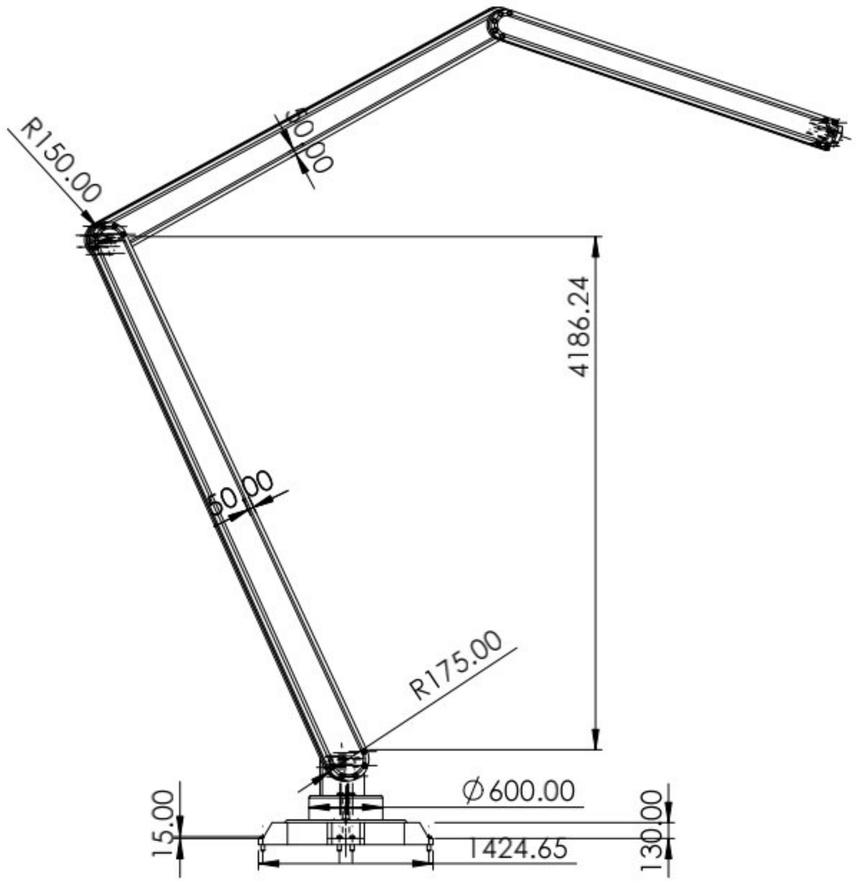


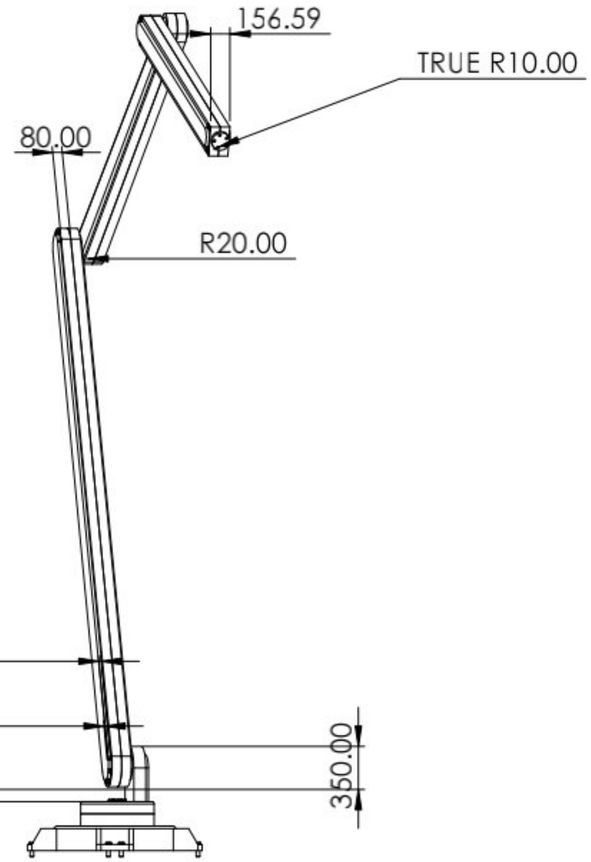
UTM UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Assembled Lorry	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:100



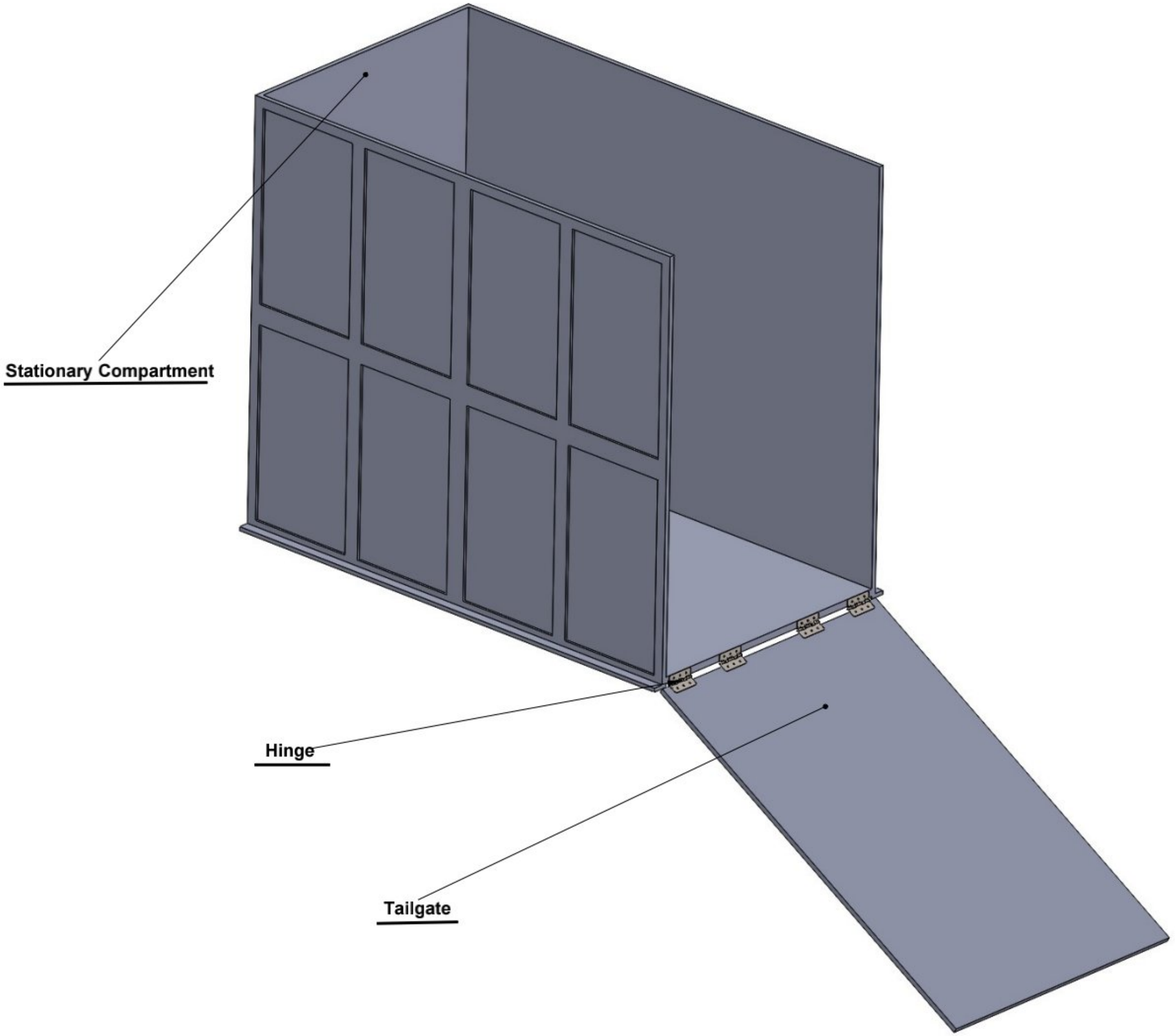
UNIVERSITI TEKNOLOGI MALAYSIA **SCHOOL OF MECHANICAL ENGINEERING**	**TITLE:** Robot Arm 3D Shaded View	**NAME:** Group 1 **SECTION:** 01	**DATE:** 26/01/22 **SCALE:** 1:25



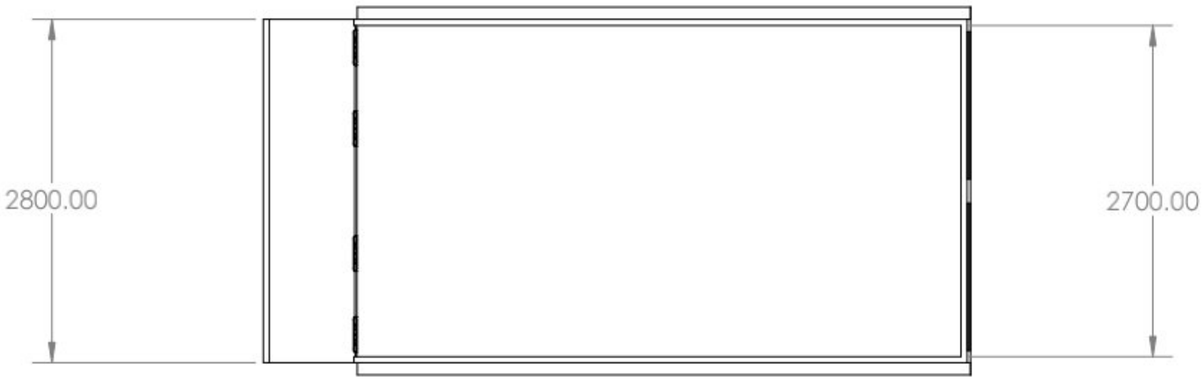


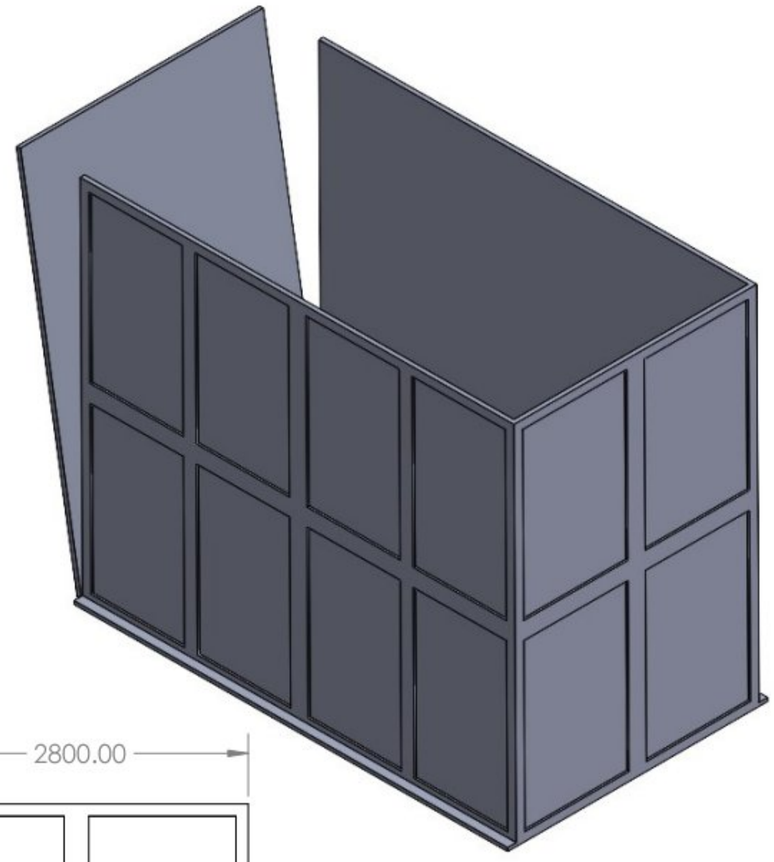


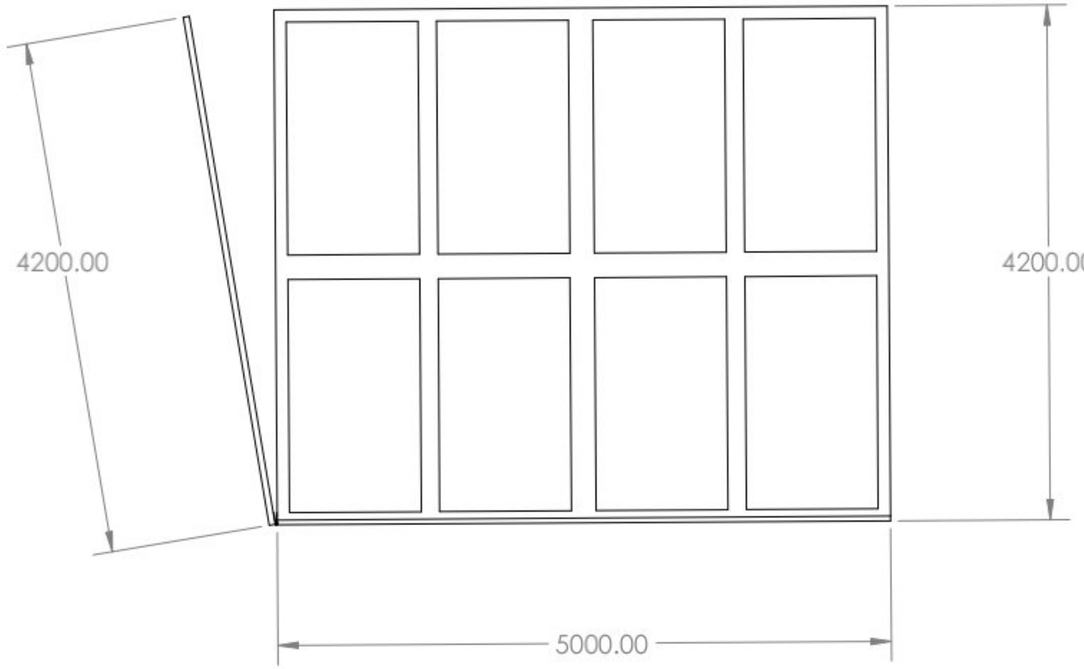
UTM UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Robot Arm	Group No: 1 SECTION: 01	DATE: 27/01/2022 SCALE: 1:50

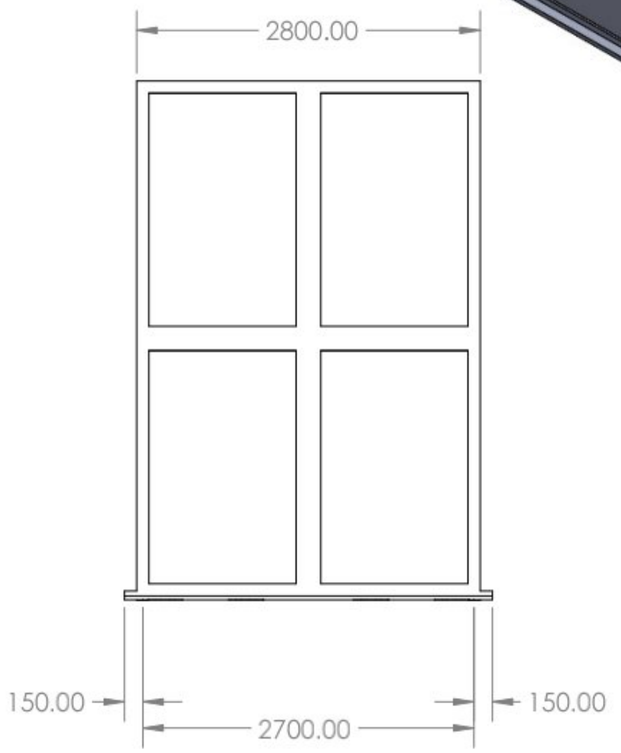


UNIVERSITI TEKNOLOGY MALAYSIA SCHOOL OF MECH. ENG	TITLE: ISOMETRIC	NAME: Group-1 SECTION:	DATE: SCALE: 1 : 37.5

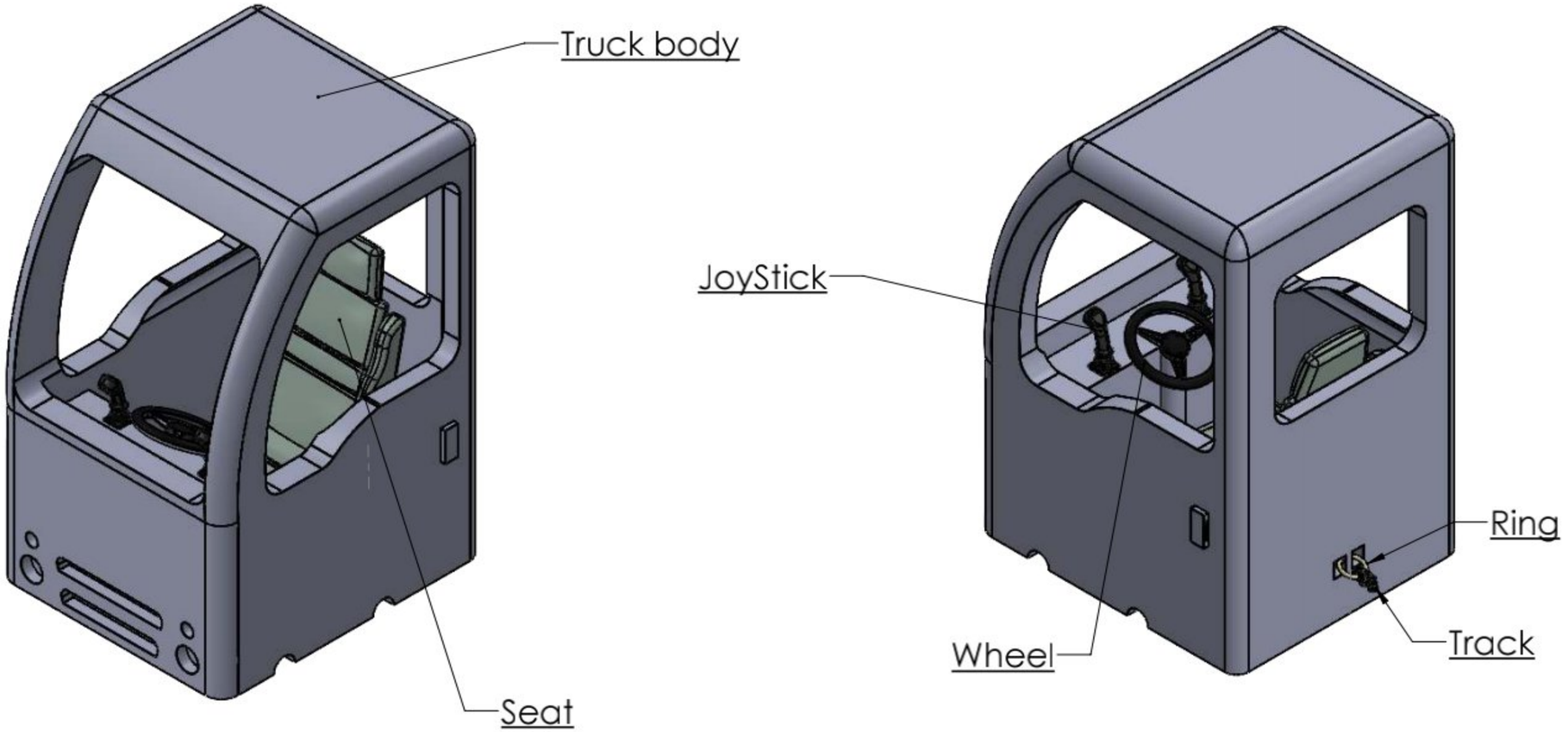




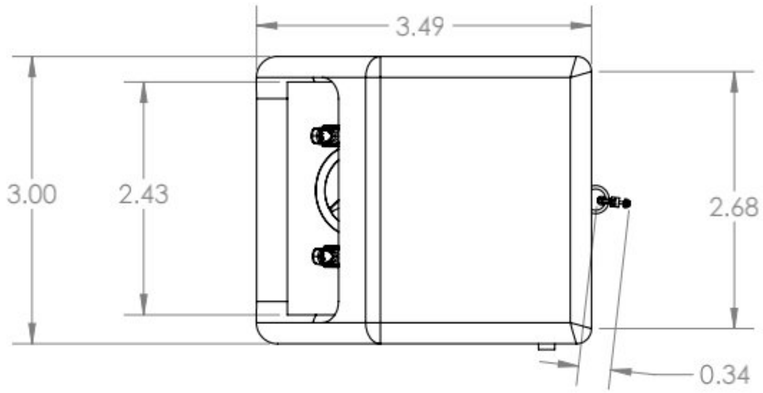


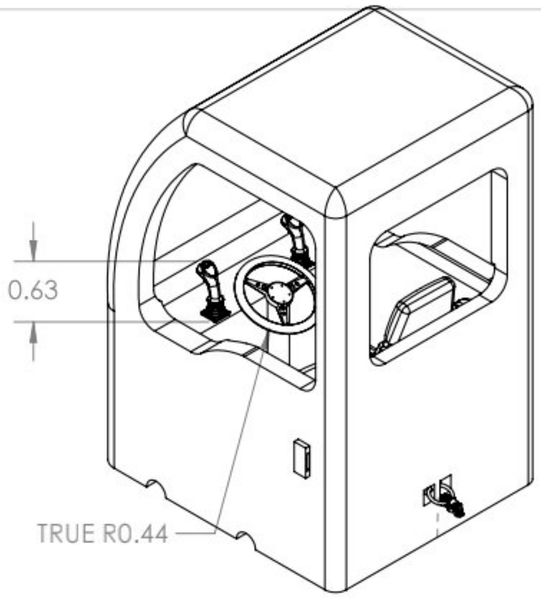


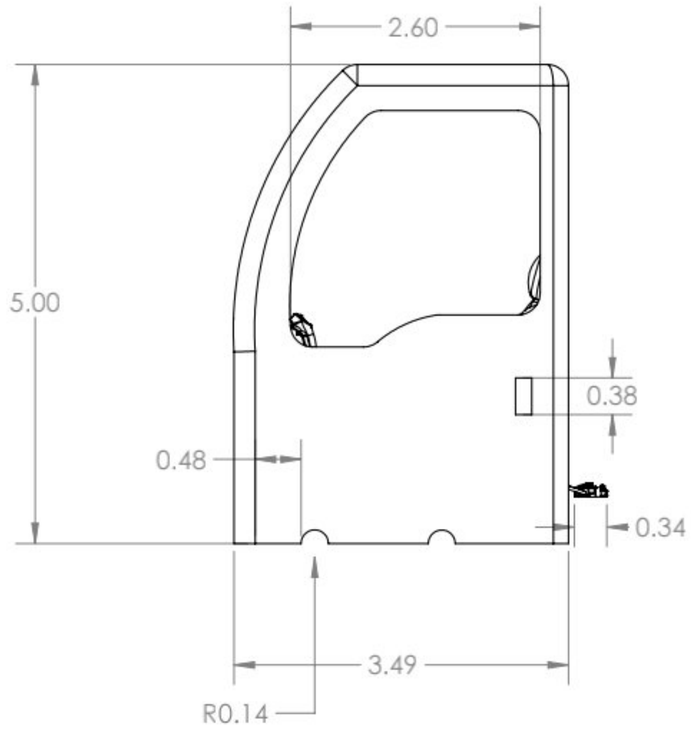
UNIVERSITI TEKNOLOGY MALAYSIA SCHOOL OF MECH. ENG	TITLE: ORTHOGRAPHIC	NAME: GROUP-1 SECTION:	DATE: SCALE: 1 : 37.5

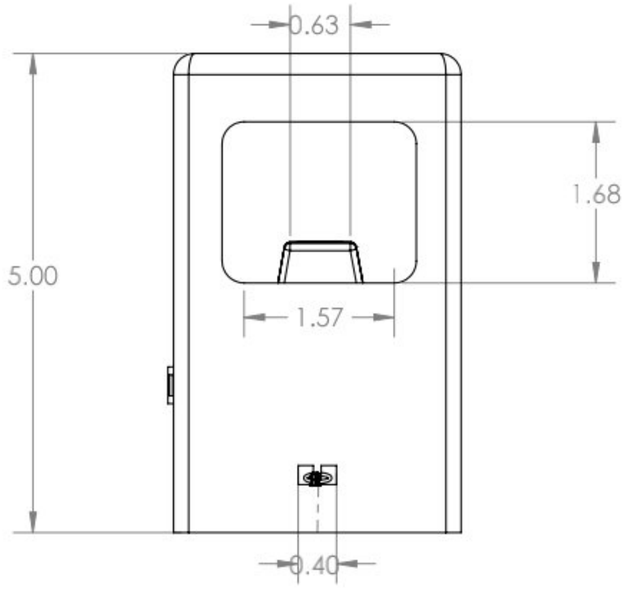


UTM UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Truck- 3D Shaded View	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:50









UNIVERSITI TEKNOLOGI MALAYSIA

SCHOOL OF MECHANICAL ENGINEERING

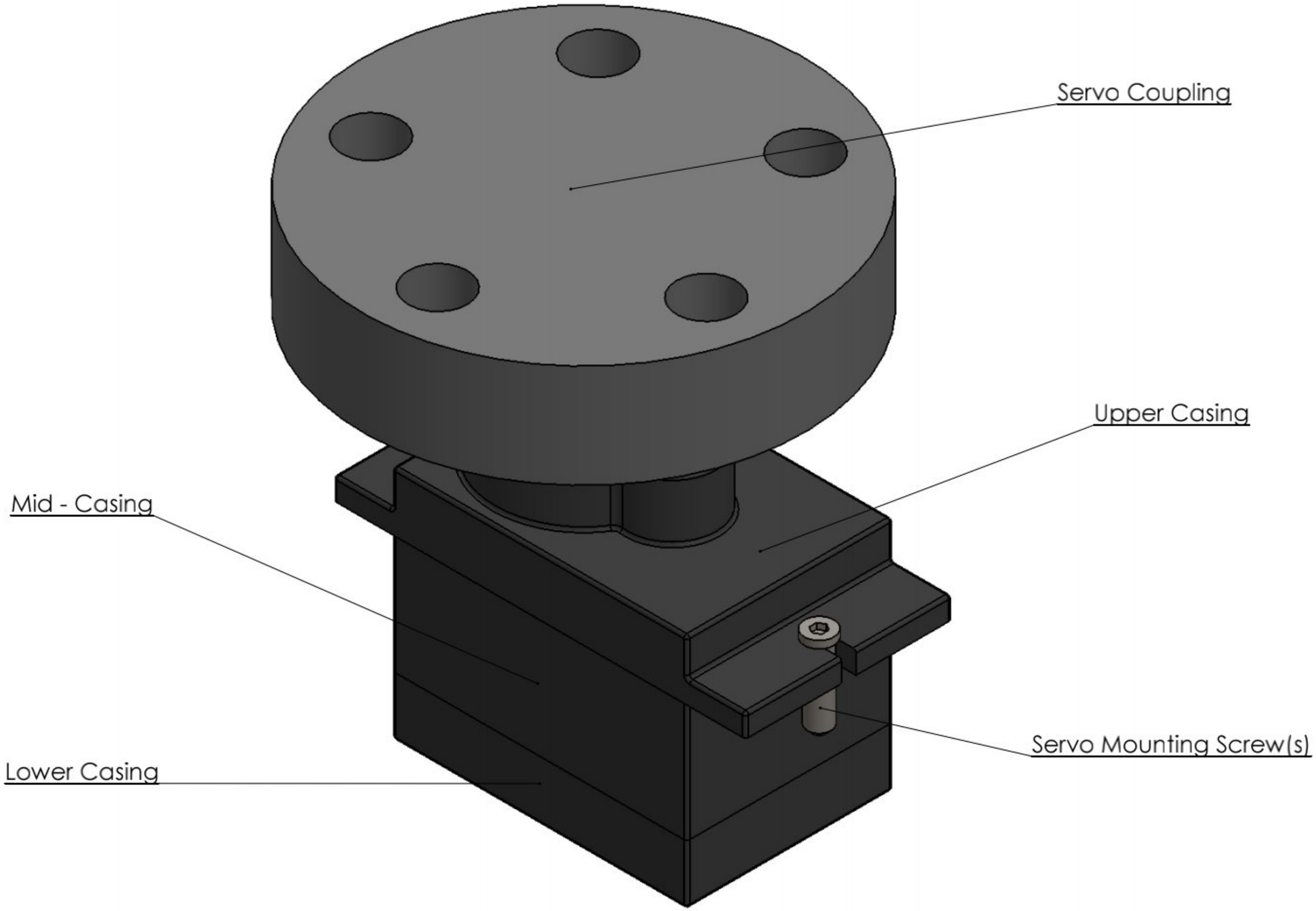
TITLE: Truck-
Orthographic View

Group No.: 1

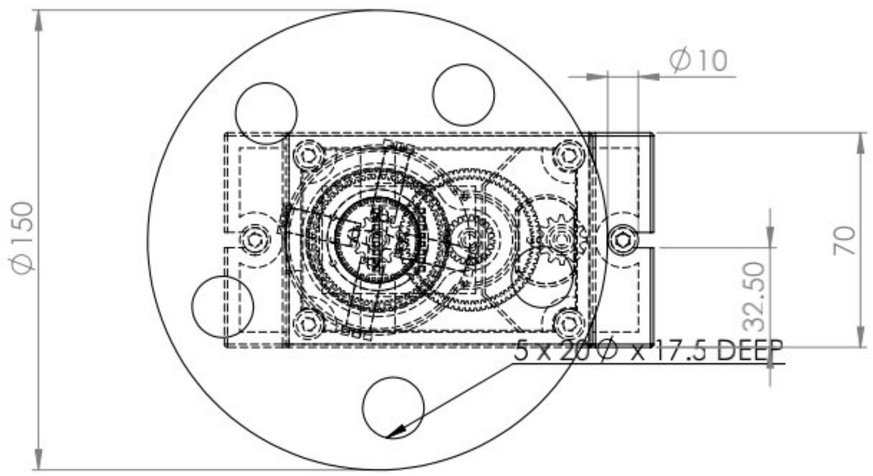
SECTION: 01

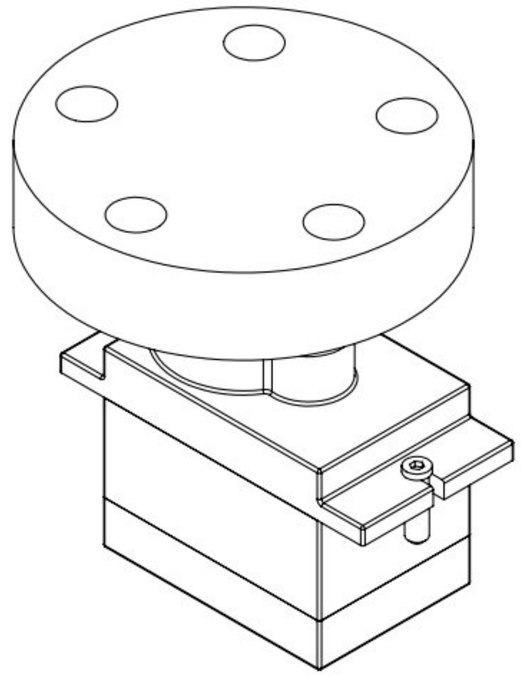
DATE: 26-Jan-2022

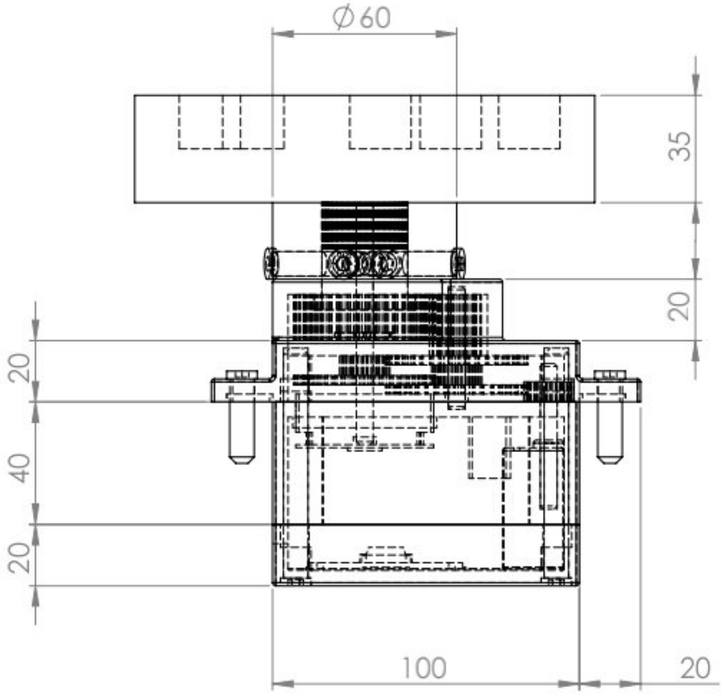
SCALE: 1:50

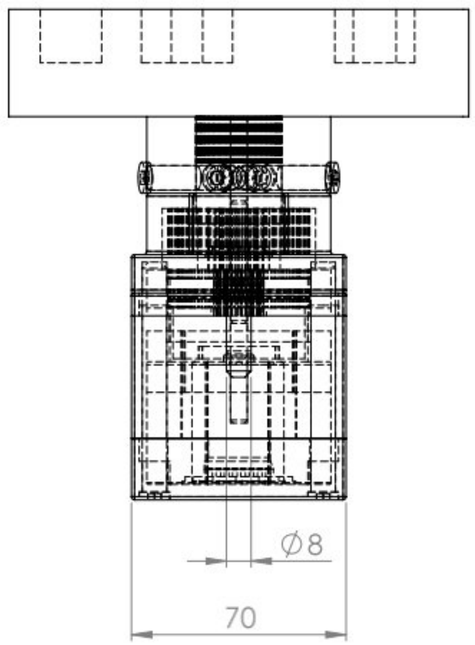


UNIVERSITI TEKNOLOGI MALAYSIA **SCHOOL OF MECHANICAL ENGINEERING**	**TITLE:** Servo Motor 3D Shaded View	**NAME:** Group 1 **SECTION:** 01	**DATE:** 26/01/22 **SCALE:** 1:1









UNIVERSITI TEKNOLOGI MALAYSIA

SCHOOL OF MECHANICAL ENGINEERING

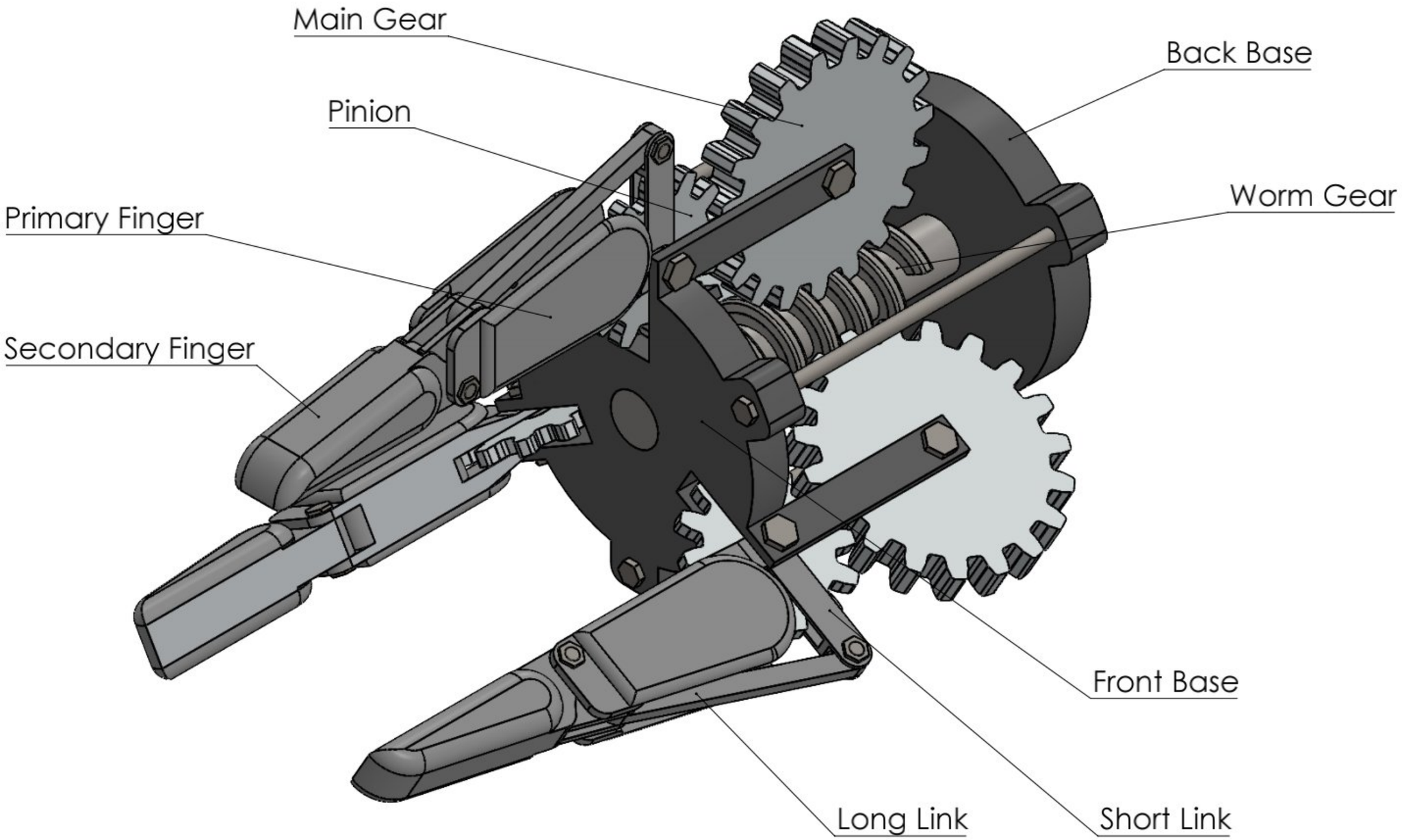
TITLE: Servo Motor Orthographic View

NAME: Group 1

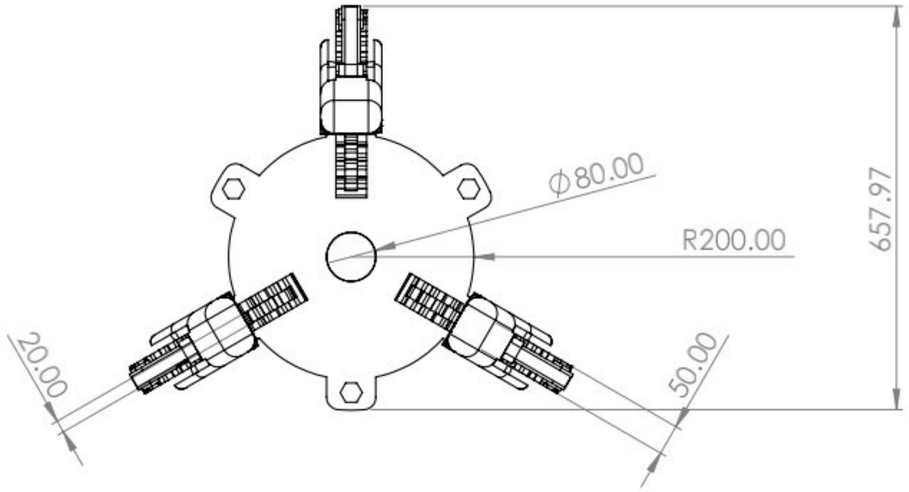
SECTION: 01

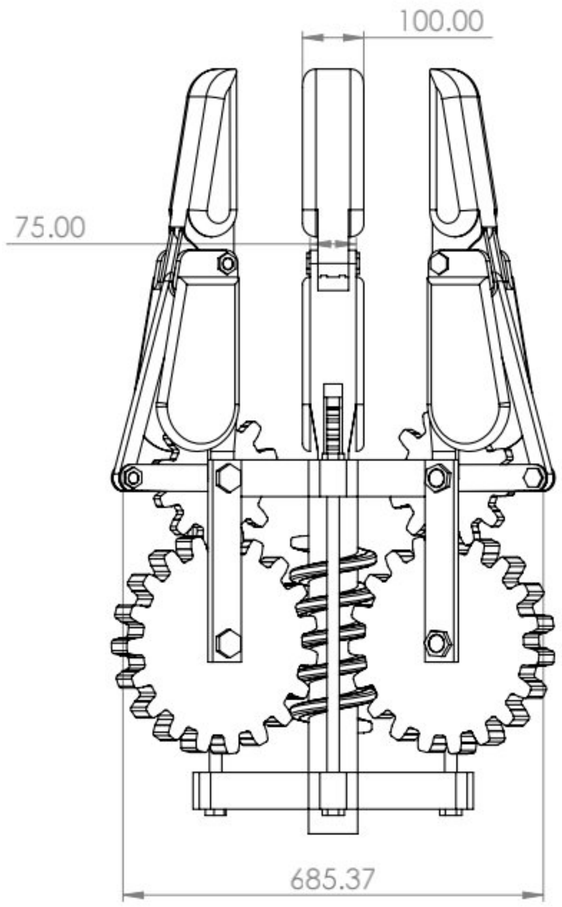
DATE: 26/01/22

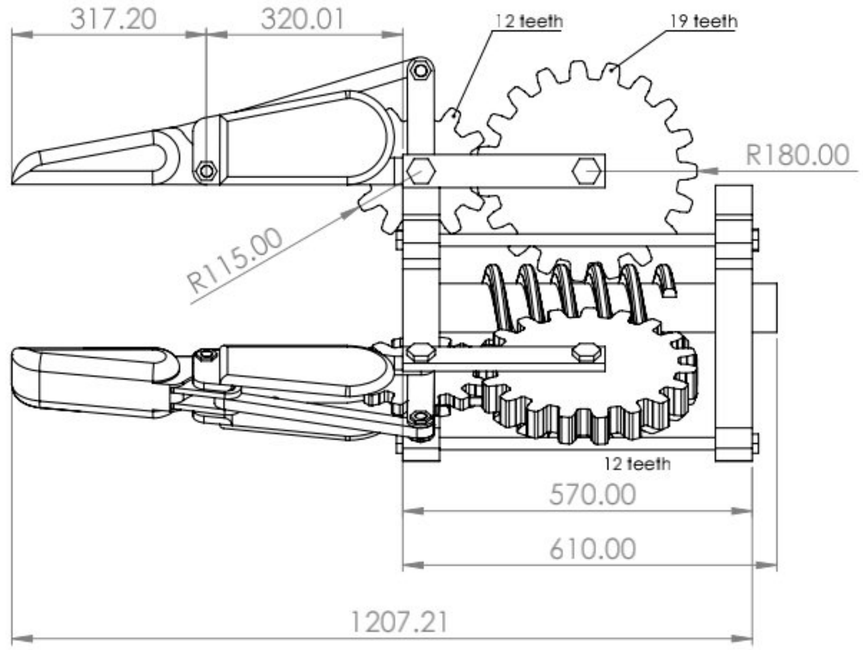
SCALE: 1:2

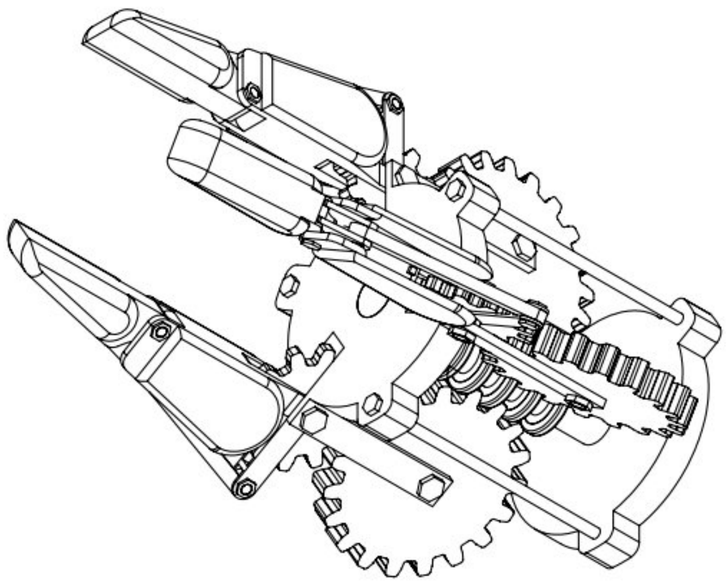


UTM UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Claw Grabber - 3D Shaded View	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:5

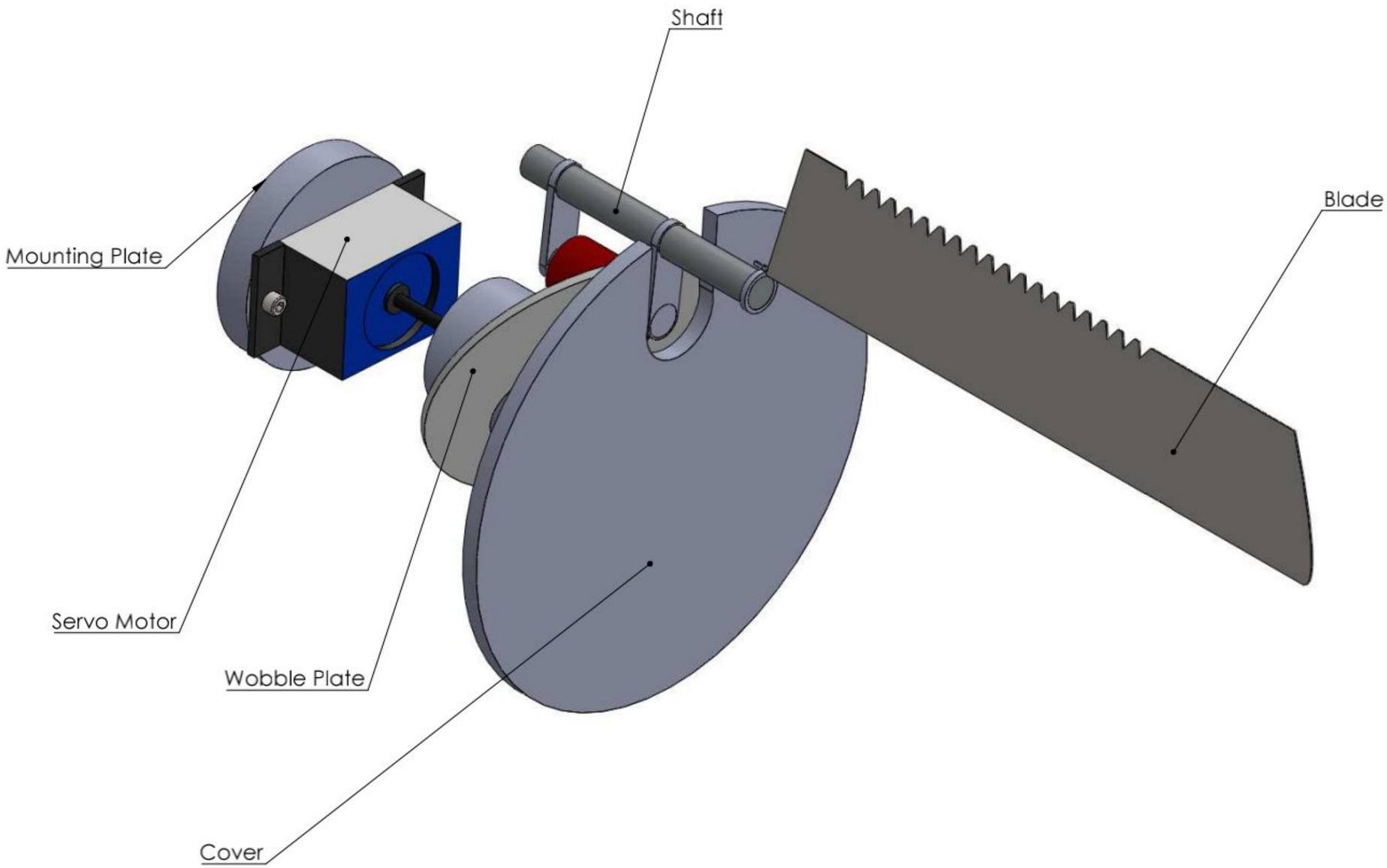




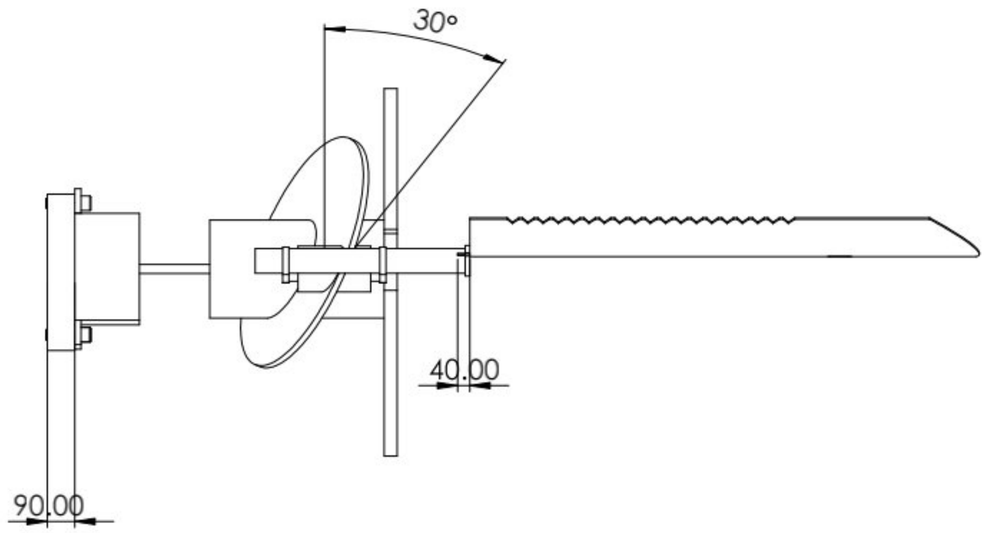


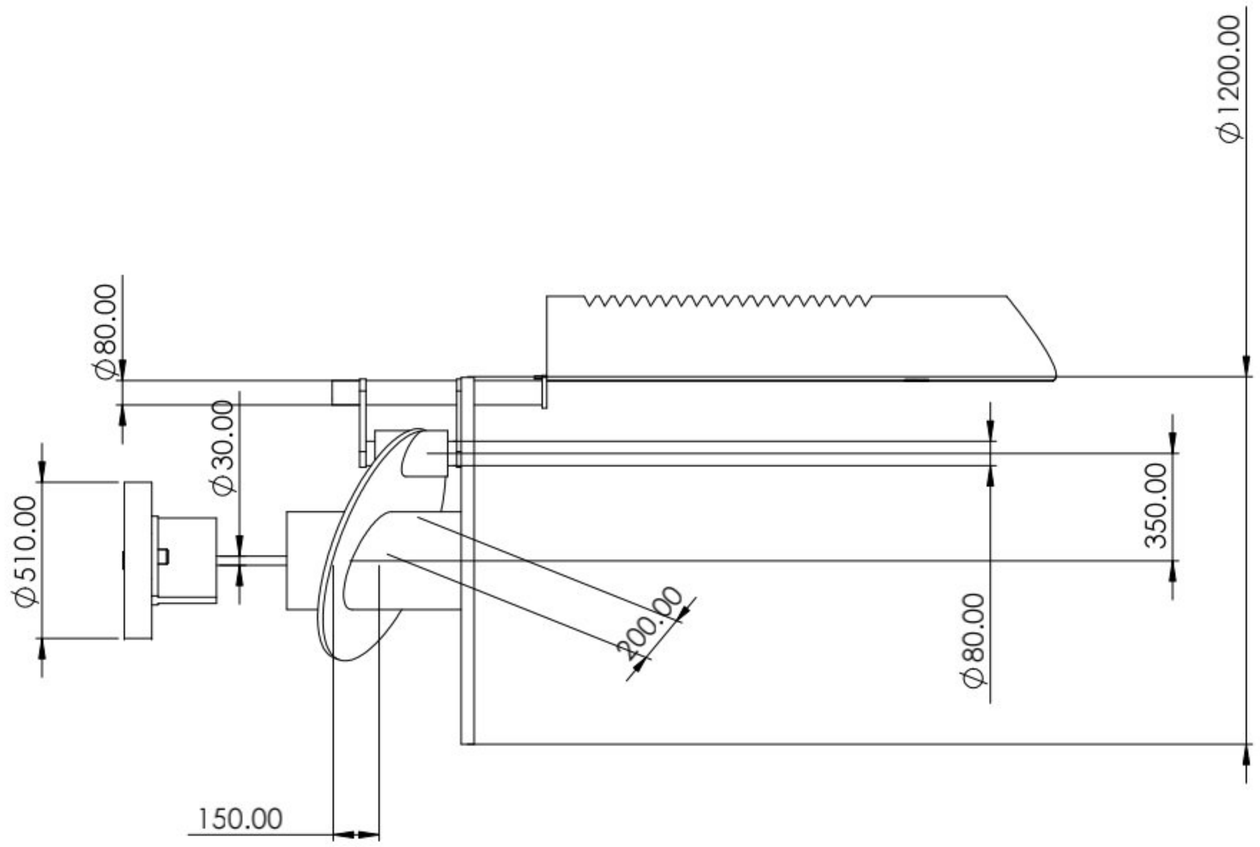


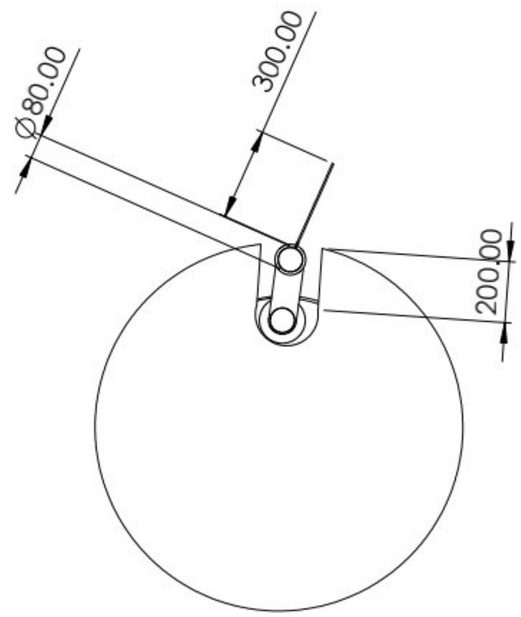
UTM UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Claw Grabber - Orthographic View	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:10



UTM UNIVERSITI TEKNOLOGI MALAYSIA UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Saw Shaded	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:10

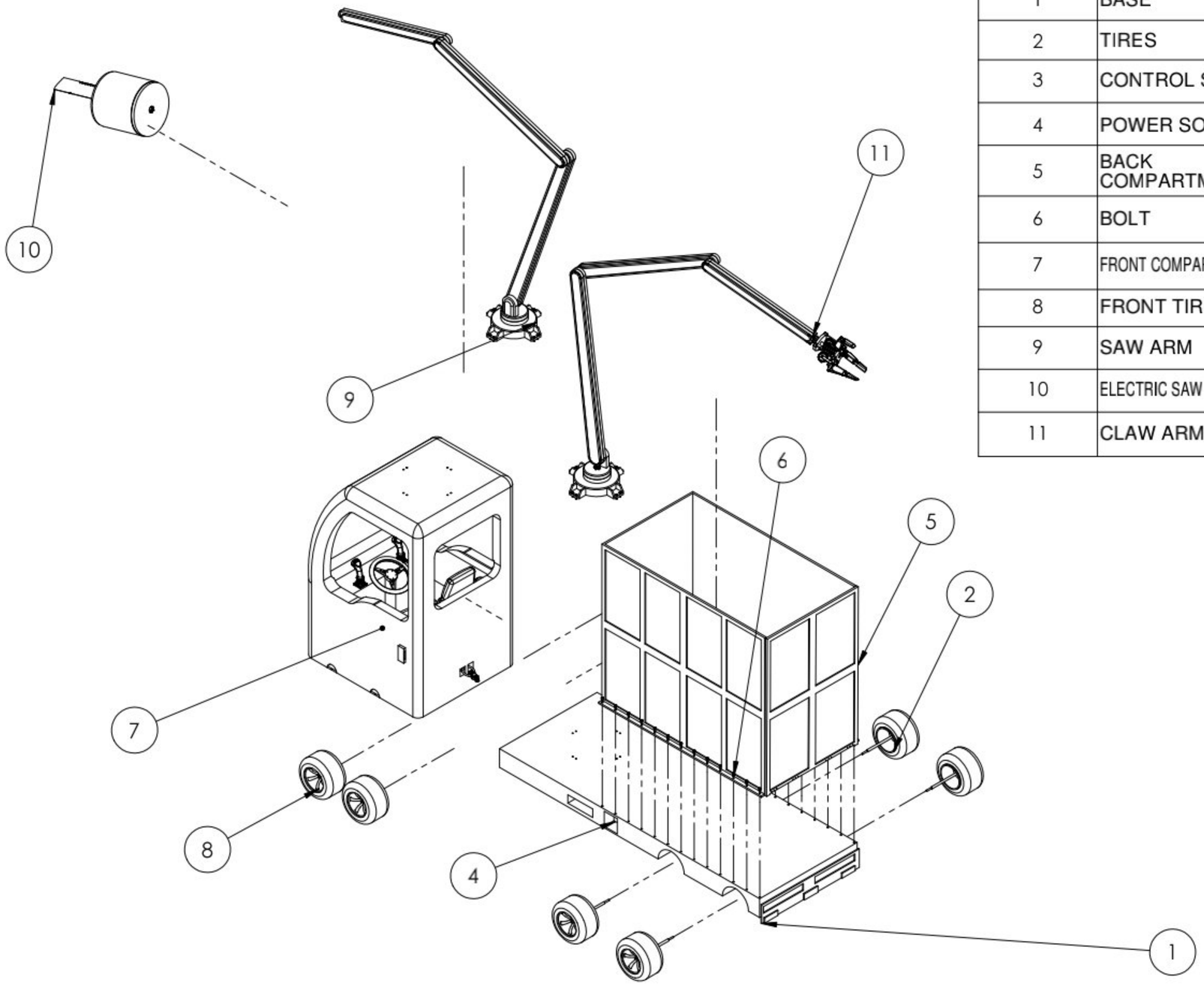






UTM UNIVERSITI TEKNOLOGI MALAYSIA SCHOOL OF MECHANICAL ENGINEERING	TITLE: Saw Mechanism	Group No.: 1 SECTION: 01	DATE: 26-Jan-2022 SCALE: 1:20

Exploded Views



ITEM NO.	PART NAME	Description	QTY.
1	BASE	Lorry Base	1
2	TIRES	Assembled Tires	4
3	CONTROL SYSTEM	Servo Control System	1
4	POWER SOURCE	Servo Power Source	1
5	BACK COMPARTMENT	Fruit Container	1
6	BOLT	Compartment Bolt	26
7	FRONT COMPARTMENT	Driving Compartment	1
8	FRONT TIRES	Front Tires Assembly	4
9	SAW ARM	Robot Arm Assembly	1
10	ELECTRIC SAW	Saw Mechanism Assembly	1
11	CLAW ARM	Claw Arm Assembly	1

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SCHOOL OF MECHANICAL ENGINEERING

TITLE: Main Exploded View

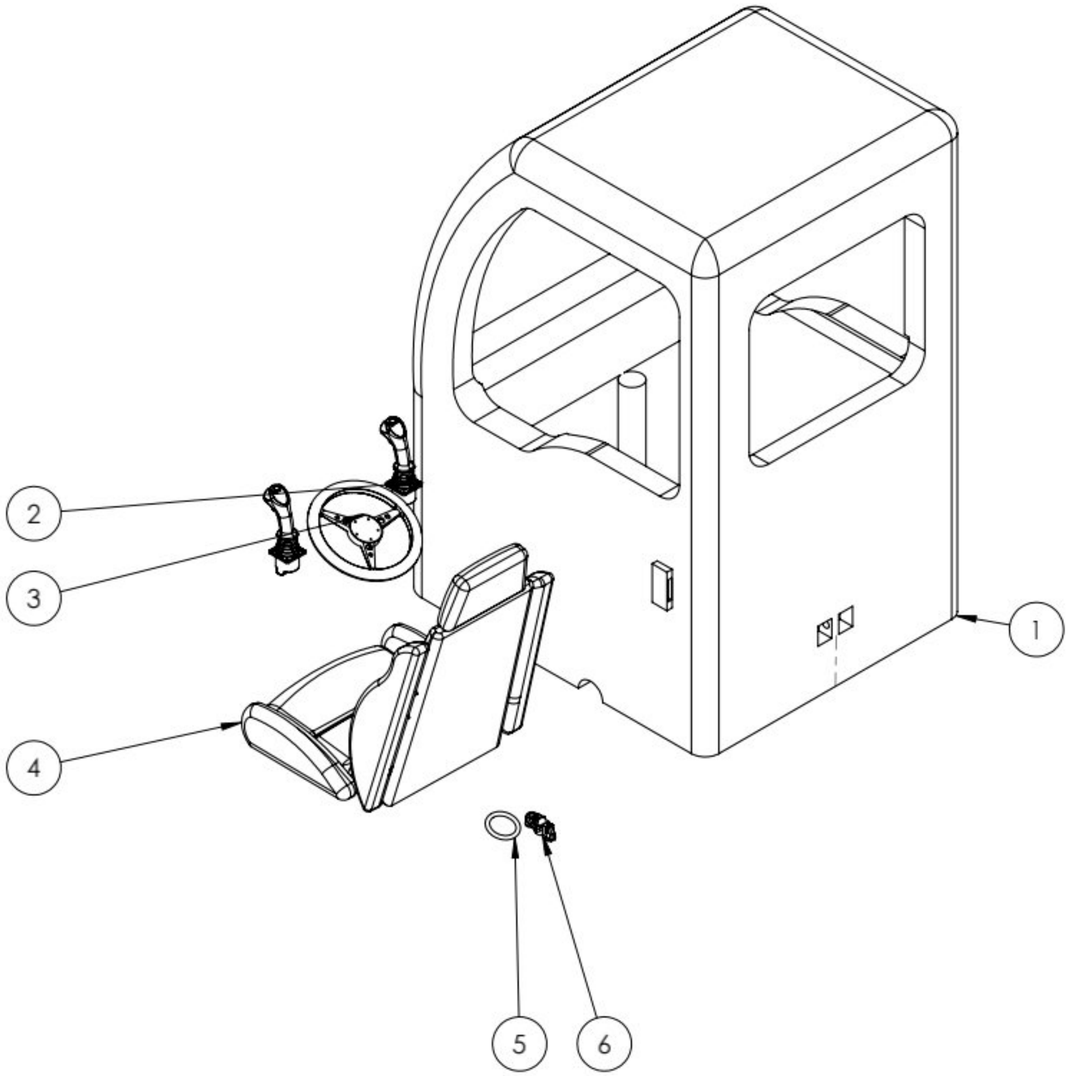
Group No.: 1

SECTION: 01

DATE: 26-Jan-2022

SCALE: 1:100

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Truck body		1
2	JoyStick		2
3	Wheel		1
4	Seat		1
5	Ring		1
6	Track		1



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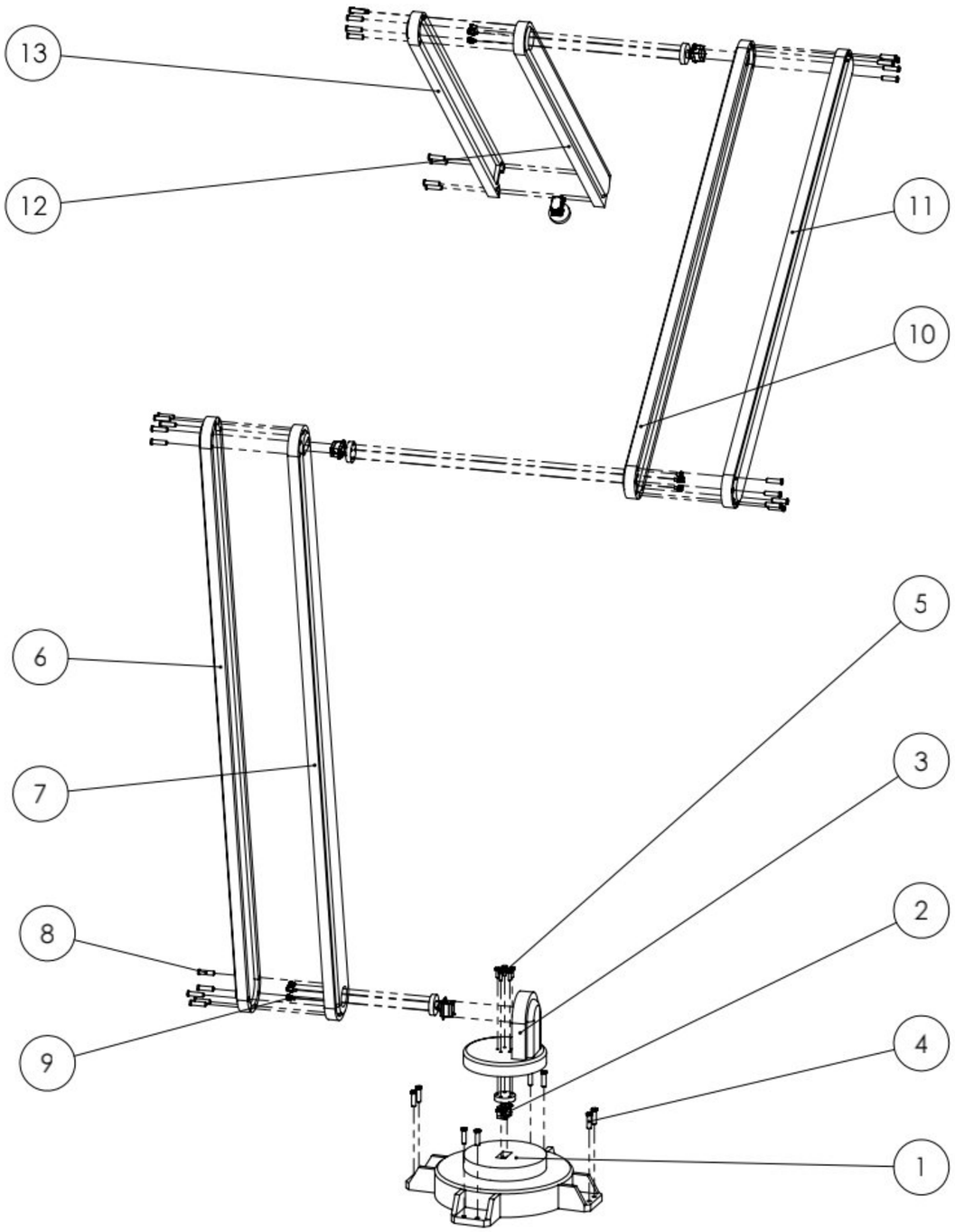
SCHOOL OF MECHANICAL ENGINEERING

TITLE: TRUCK-Exploded View

Group No.: 1
SECTION: 01

DATE: 26-Jan-2022
SCALE: 1:50



ITEM NO.	PART	Material	QTY.
1	Mounting Base	Steel	1
2	Servo Motor(s)	Composite Assembly	5
3	Swivel Base	Steel	1
4	Mounting Base Bolt(s)	Steel	8
5	Swivel Base Bolt(s)	Steel	5
6	Arm Section 1 Partition (LHS)	Steel	1
7	Arm Section 1 Partition (RHS)	Steel	1
8	Arm Bolt(s)	Steel	29
9	Coupling Arm Bolt(s)	Steel	15
10	Arm Section 2 Partition (LHS)	Steel	1
11	Arm Section 2 Partition (RHS)	Steel	1
12	Arm Section 3 Partition (RHS)	Steel	1
13	Arm Section 3 Partition (LHS)	Steel	1

UNIVERSITI TEKNOLOGI MALAYSIA

SCHOOL OF MECHANICAL ENGINEERING

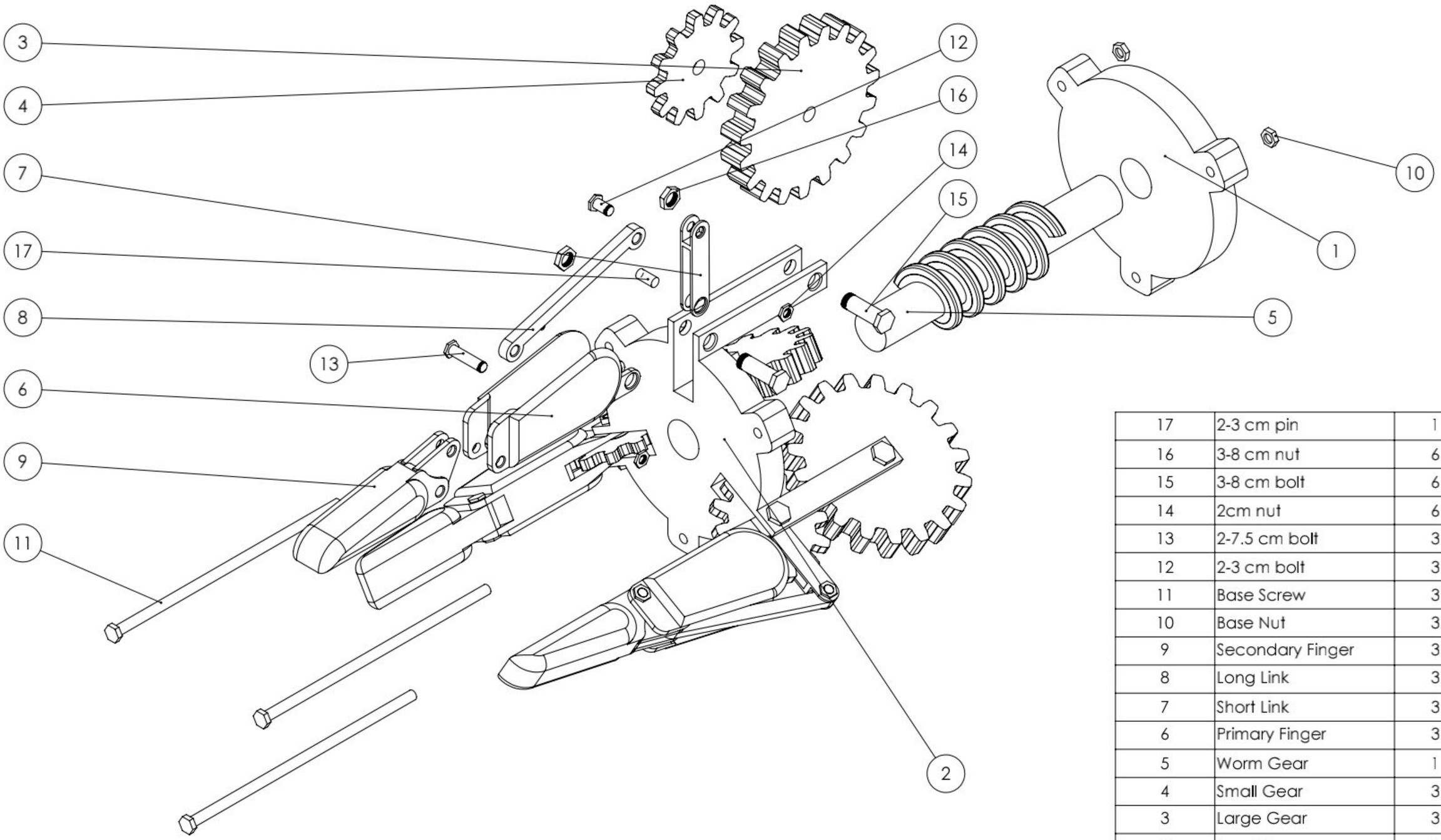
TITLE: Robot Arm Exploded View

NAME: Group 1

SECTION: 01

DATE: 26/01/22

SCALE: 1:40



ITEM NO.	PART NUMBER	QTY.
17	2-3 cm pin	1
16	3-8 cm nut	6
15	3-8 cm bolt	6
14	2cm nut	6
13	2-7.5 cm bolt	3
12	2-3 cm bolt	3
11	Base Screw	3
10	Base Nut	3
9	Secondary Finger	3
8	Long Link	3
7	Short Link	3
6	Primary Finger	3
5	Worm Gear	1
4	Small Gear	3
3	Large Gear	3
2	Front Base	1
1	Back Base	1

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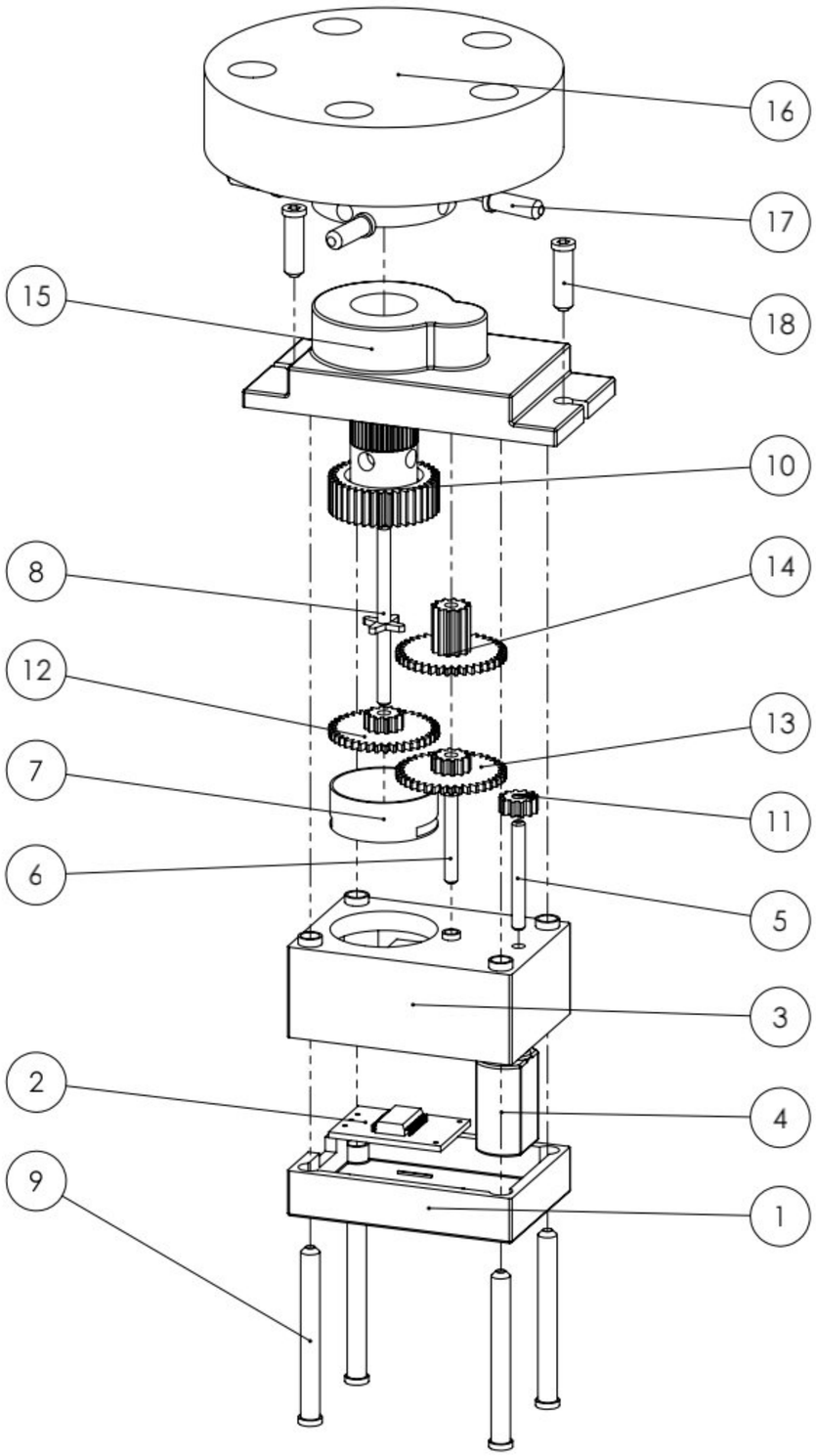
SCHOOL OF MECHANICAL ENGINEERING

TITLE: Claw Grabber - Exploded View

Group No.: 1
SECTION: 01

DATE: 26-Jan-2022
SCALE: 1:7



ITEM NO.	PART	MATERIAL	QTY.
1	Lower Casing	ABS	1
2	PCB	Copper/Silkscreen	1
3	Mid - Casing	ABS	1
4	DC Motor	Iron	1
5	Rod 3	Steel	1
6	Rod 2	Steel	1
7	Potentiometer	Anodized Aluminium	1
8	Rod 1	Steel	1
9	Casing Screw(s)	Steel	4
10	Spur Gear 1	Stainless Steel	1
11	Spur Gear 2	Stainless Steel	1
12	Spur Gear 3	Stainless Steel	1
13	Spur Gear 4	Stainless Steel	1
14	Spur Gear 5	Stainless Steel	1
15	Top Casing	ABS	1
16	Coupling	Stainless Steel	1
17	Coupling Screw(s)	Steel	4
18	Mounting Screw(s)	Steel	2

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SCHOOL OF MECHANICAL ENGINEERING

TITLE: Servo Motor Exploded View

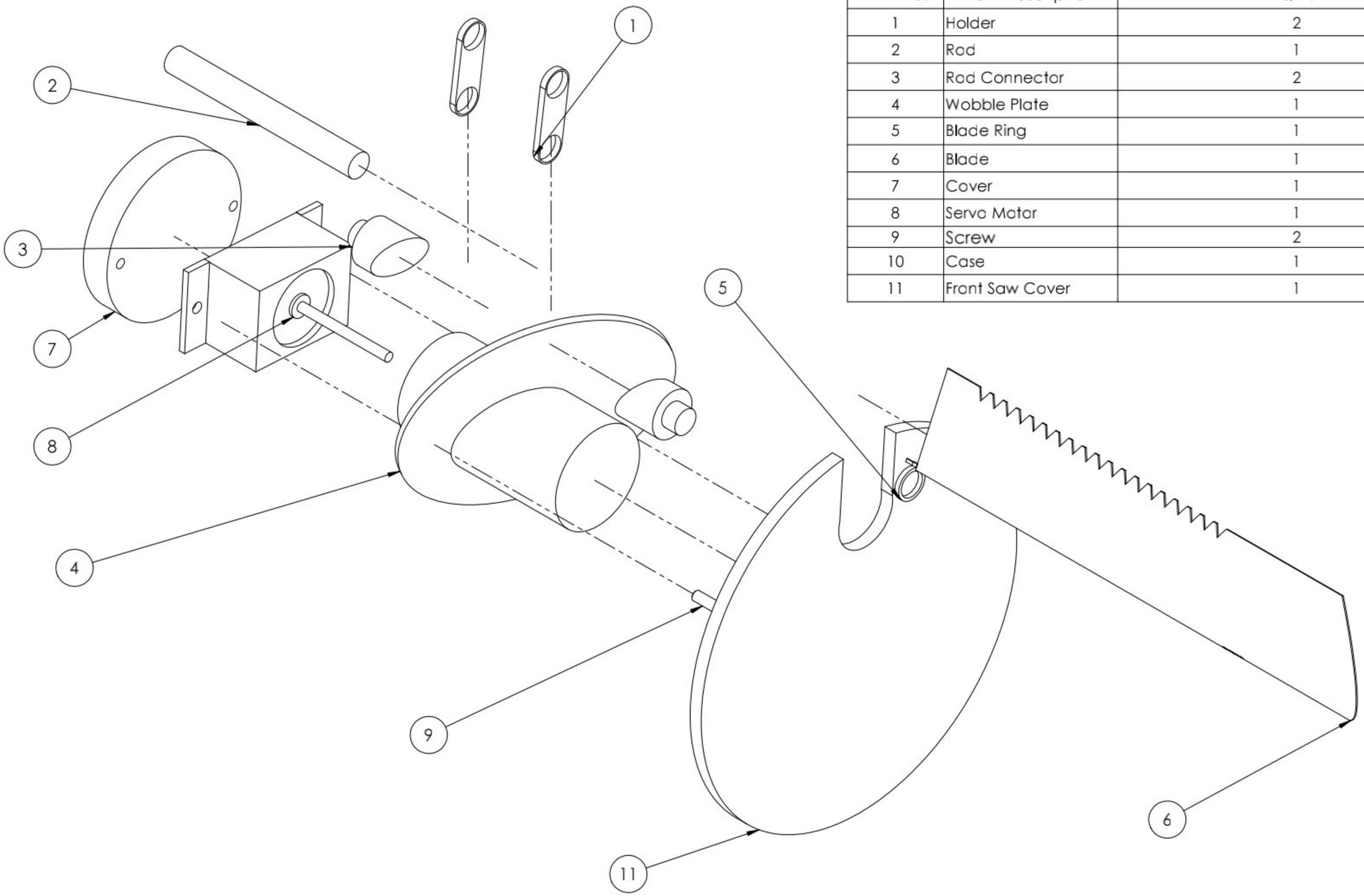
NAME: Group 1

SECTION: 01

DATE: 26/01/22

SCALE: 1:2.5

ITEM NO.	Part Description	QTY.
1	Holder	2
2	Rod	1
3	Rod Connector	2
4	Wobble Plate	1
5	Blade Ring	1
6	Blade	1
7	Cover	1
8	Servo Motor	1
9	Screw	2
10	Case	1
11	Front Saw Cover	1



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SCHOOL OF MECHANICAL ENGINEERING

TITLE: Saw Exploded View

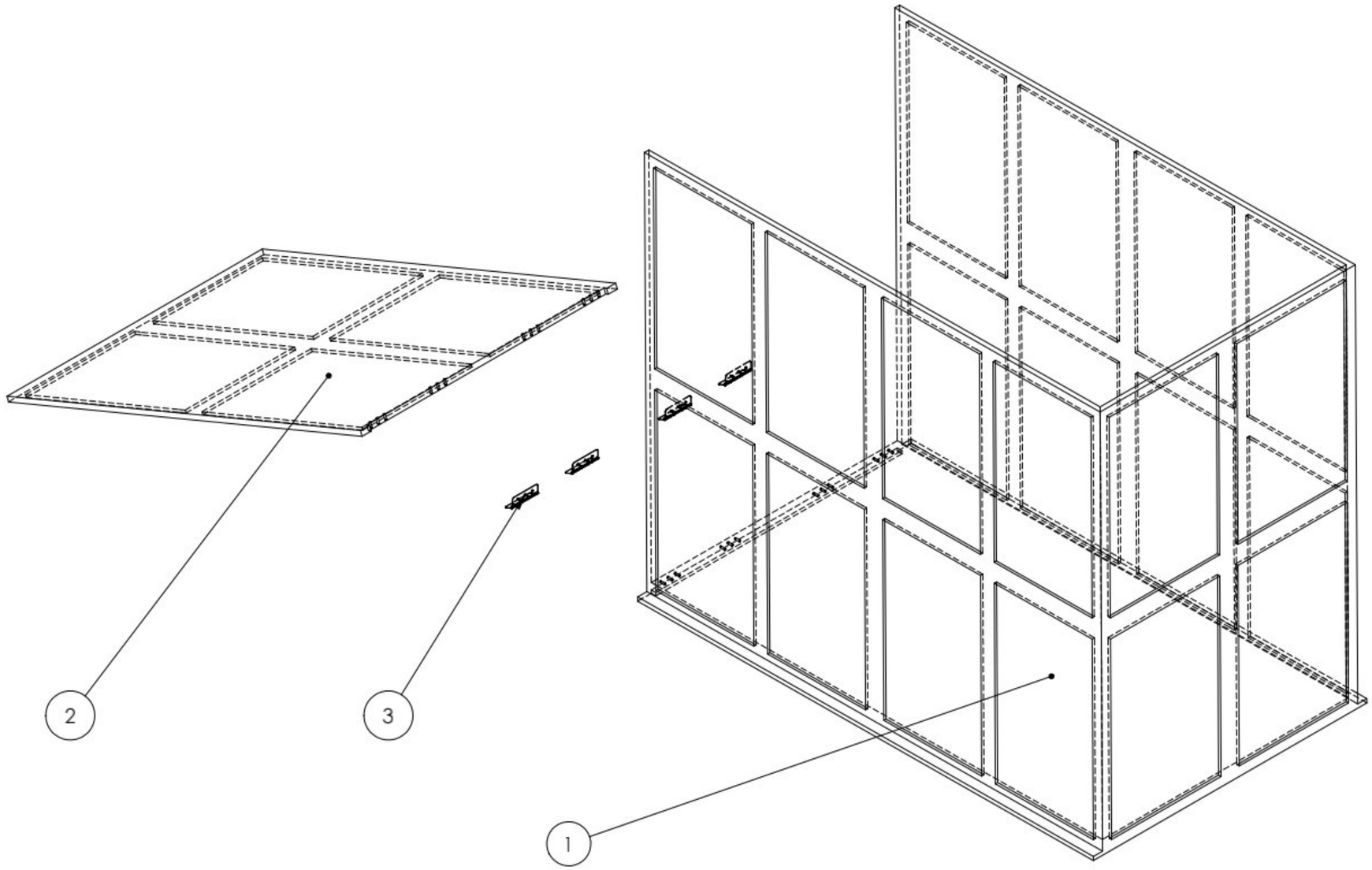
Group No.: 1

SECTION: 01

DATE: 26-Jan-2022

SCALE: 1:10

ITEM NO.	DESCRIPTION	MATERIAL	QTY.
3	Hinge	Brass Alloy	4
1	Stationary Compartment	Al Alloy	1
2	Tailgate	Al Alloy	1



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SCHOOL OF MECH. ENG

TITLE: EXPLODED

NAME: GROUP-1

SECTION:

DATE:

SCALE: 1 : 37.5

Conclusion/Discussion

Palm fruit harvesting produces a lot of byproducts such as fronds and loose fruit, the system is not equipped to harvest or collect those in any form. However, these products are essential to collect because they can be recycled and processed, otherwise they might hinder new cycles of plantation. Therefore, a meaningful addition to the system might be a front container that can easily collect the dropped fronds and any loose fruit from the palm tree. This will speed up the harvesting process because workers don't have to collect those manually later on.

Overall, the fruit harvesting system was a complex project that taught us a lot and educated our group on detailed mechanisms and machines used for harvesting. The process to derive our concept and design process was very beneficial as it introduced how design works in a professional setting. Moreover, the pugh selection method also showed us how to integrate weightage / scores into our concept criterias and quantify certain parameters which we consider important for a design.

In conclusion, the design chosen by our group using pugh selection method clearly satisfies all criteria set by the client, it aids the workers in fruit harvesting efficiently and integrates current technology and machinery into the system. Therefore, the design was successful and achieved all requirements.