



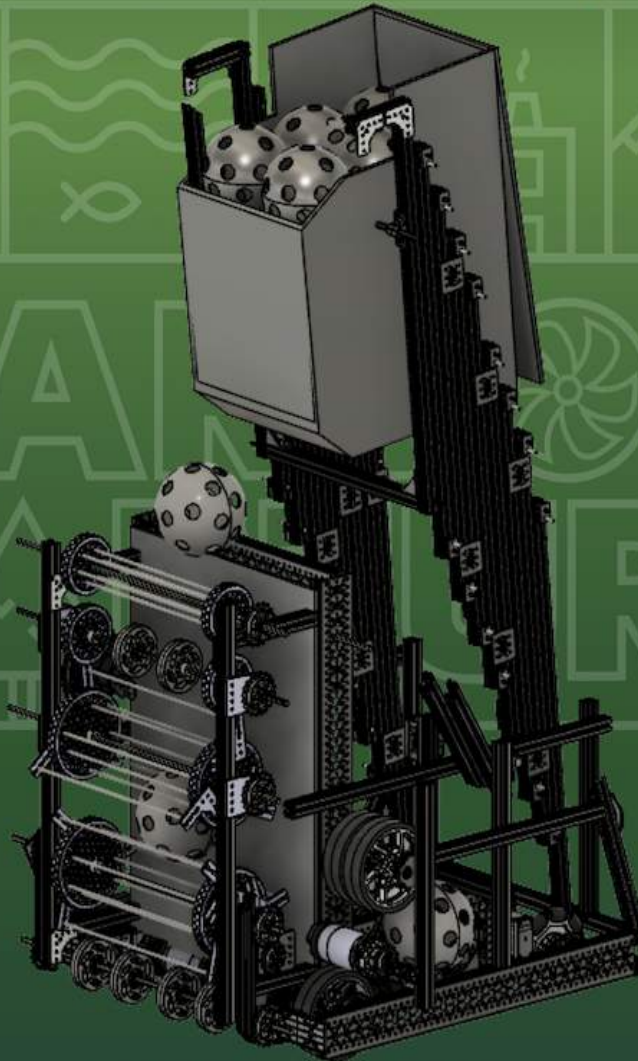
FIRST GLOBAL CHALLENGE
GENEVA
2022



FIRST
GLOBAL

TEAM INDONESIA ENGINEERING NOTEBOOK

The Design and Build of Carbon Capture Robot
proposed for
Katherine Johnson Award for Engineering Documentation



DRYOMATIKA
THE CARBON SINKER

1. TEAM SUMMARY

Team Indonesia R2045 is a youth robotic team based in Depok, West Java which will take part in FIRST Global Challenge 2022, competing and collaborating with over 180+ teams representing their own countries. R2045 members of the team have different passions, in which some of them are, designing, engineering, science, arts and of course we share the same big passion. The passion to make the world a better place, by inspiring other youths to have a passion in STEAM. So the world will benefit from the advancement of technical works. But most importantly, to help Indonesia master technology and embrace Indonesia's 100 year of independence. Therefore, an initiative in shaping the golden generation of Indonesia in welcoming its 100 Years of independence, was initiated by the school, and codenamed "R2045", The Rendezvous 2045. All R2045 members will be expected to assist, develop, improve technological progress in Indonesia, and help create projects that will help Indonesia in the future.

Our team is a dynamic group of high schoolers that was formed together due to a common passion for robotics. Throughout the season, we've made a lot of progress in terms of experience and overall bonding with each other.

The team experiences a Project-based way of learning, one of the best approaches to STEAM education, as it allows team members to understand real problems, design, test solutions, analyze and communicate their insight and new findings/innovation. This approach gives a link between real problem solving, and appreciate the relevancy of their work to the world around them. In this project, programming and innovative exploitations, all STEAM aspects as well as team work collaboration, creativity and entrepreneurial skills and social sciences are blended. We are grateful for the Challenge given by FIRST Global, and we thank you for having made our life meaningful, feel engaged, connected to purpose, and able to connect our gifts and passions with our highest values.



Figure 1. R2045 Team Indonesia for FGC Geneva 2022

2. PROBLEM EXPLORATION

2.1. GAME DESCRIPTION

The first 2 minutes when the game starts, 240 imaginary black balls of carbon dioxide will be released to be taken by the intake robots of alliances and work together to put as many black balls into the sink as possible. Or, the alliance team robot can also put carbon into the compressor in the corner of the arena. Team players/controllers can also help put carbon into the sink, or pass it into the robot's intake. Points are scored at a height of 1 cm as the carbon fills the sink.

In the last 30 seconds, the game is divided into 2 alliance countries. Then, the robot secures color indicator balls from the human player, then returns to the sink platform area. If the robot enters the platform, the team's points increase by 0.25 or robot must be hung on a bar located on the sink. If the robot hangs on the lowest sink (low bar), points will be added by 0.25, middle bars 0.75, and the highest bar gets a point increase of 1.0

2.2. CARBON CAPTURE ROBOT NEED EXPLORATION

In answering the challenge of Carbon Capture, the team reviewed the kickoff video and analyzed the manual, then started to define the overall function and break down the overall function into a number of sub functions, then the team started to weight each function importance in correlation to get the highest score .

Basic functions on the Carbon Capture Robot;

1. Capturing CO₂
2. Storing CO₂ it in the sink
3. Achieving long term storage levels ;
 - a. Securing indicator
 - b. Hanging in the high bar

2.3. FUNCTION TREE

Tackling the problem by principles, searching for possible solutions, and studies on current technology before they define the objective of their design.

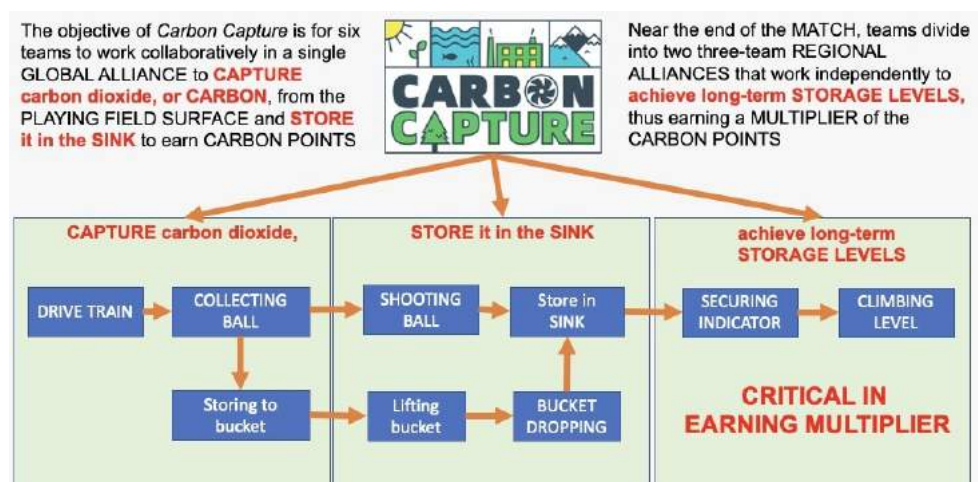


Figure 2. Function Tree of 'Carbon Capture' Robot

2.4. STRATEGIC CONSIDERATION

Hanging the high bar and medium bar to win and get a higher multiplier and scoring by putting as many black balls into the carbon sink is the way to win the match. We could go directly to the securing indicator and climbing to higher bar without putting any balls to the sink just to win the match, but if we do that we might win the match but the point gain is low, since the ranking point will be taken from average of score points, then as a whole we will have lower ranking matches due to low score points.

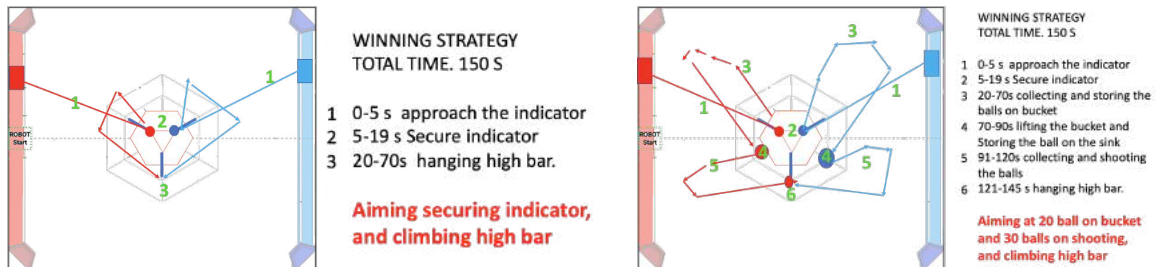


Figure 3. Strategic Consideration

Taking this into consideration, our strategy starts off by collecting the balls, storing it into a bucket, then after the bucket is full, lifts it and drops the balls into the sink. If time permits we could do twice ball dropping otherwise the the collecting balls can continue and scoring by send balls to sink by shooting it. Then secure the indicator and finally climb the high bar to get the highest score possible.

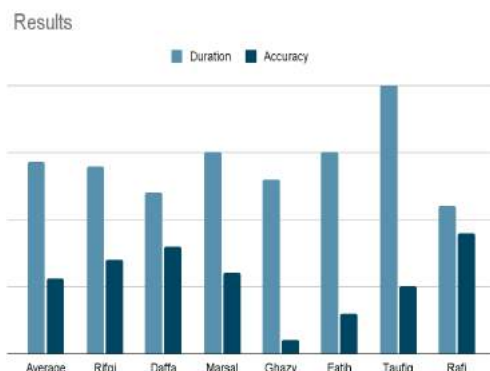


Figure 4. Human player benchmark of the design on shooter performance

2.5. DESIGN REQUIREMENT AND OBJECTIVES

- Able to move forward and backward with 1.4 m/s speed in flat surface
- Able to slide / turn left and right accurately at least 0.3 m/s
- Able to secure the indicator in 20 seconds
- Able to pick up and store 20 balls in a 40 seconds
- Able to shoot 20 balls in a half a minute 1.5 seconds per ball..
- Able to bucket drop at least 20 balls into the sink in 30 seconds .
- Able to hang on the high bar or medium bar in 20 seconds.

3. DESIGN PROCESS

After knowing the requirements and objectives of the design as well as the limitations and the constraints of the design, the team starts deploying brainstorming to develop ideas and solutions in order to meet the requirements and objectives. This is accomplished in a group setting. The possible solutions are sketches by hand which enables them to tap their creative side. When ideas of each part were matured and the best promising ideas were selected and combined, the sketches were translated into 3D CAD, using Fusion 360 by Autodesk.

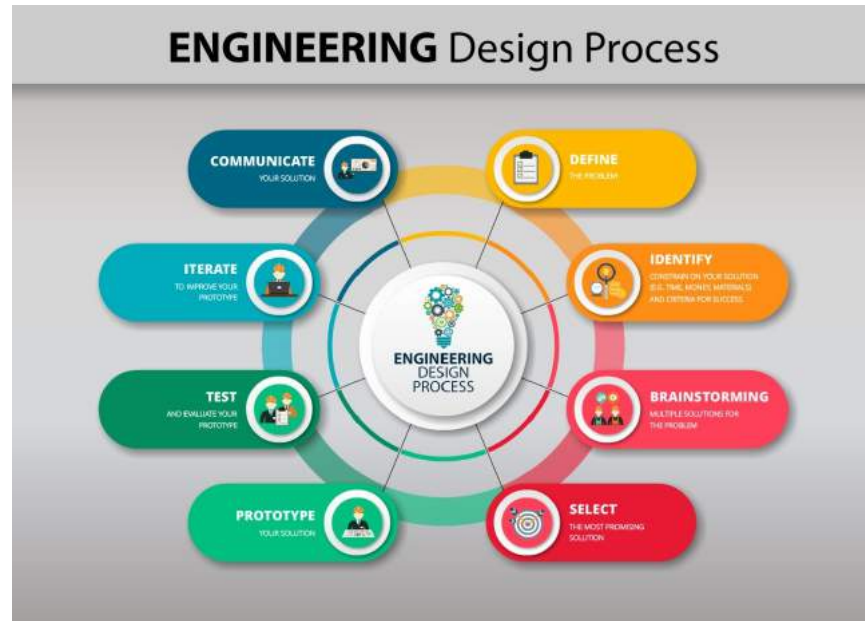


Figure 5. Engineering Design Process undergone by Team Indonesia R2045

Further on, after designs were sketched and drawn on 3D, the team assembled the parts of the FGC 2022 kits in a system level design, made prototypes, and then developed programs for robot movements and mechanism using onBot Java. All parts of the design were materialized towards prototyping as well as in full robot assembly. The team tested the part mechanism first before it went in a complete system. The iteration comes after the test, in refining number mechanisms and in the coding algorithm. The team progresses as the final design begins to take shape, and finally the team carries out the match test 2.5 minutes drill on the final solution to be analyzed and reviewed its performance against the target.

4. BRAINSTORMING AND IDEAS DEVELOPMENT

We develop ideas by deploying brainstorming sessions, which is a group problem-solving technique that involves spontaneous contribution of ideas from all members of the group. There are a number of ideas or solutions proposed during brainstorming however we choose each sub function with 3 or 4 best solutions and present them here. Along with basic calculations for each sub function.

4.1. IDEAS DEVELOPMENT FOR DRIVEBASE SUBFUNCTION

The drivetrain consists of a series of parts that work together to transfer the rotational power that's produced in the motors to the wheels. By doing so, the wheels begin to turn, and the robot moves. We proposed a number of drivebase configurations, here are three configurations out of many that we made for Carbon Capture ;

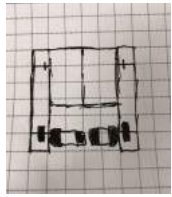
Design	Attribute	Sketching	3D Drawing
1	DUAL MOTORS WITH OMNI WHEEL		
2	DUAL MOTOR GEARS AND CHAIN WITH COMBINATION OF OMNI WHEELS AND GRIP WHEEL		
3	FOUR MOTORS WITH INDEPENDENT WHEELS		

Figure 6. Sketching and 3D Design of Drivetrain solutions

4.1.1. ROBOT SPEED CALCULATION

Some calculations are needed to make the right decision in achieving 1.4 m/s speed on a flat surface. What motors can be used and at what speed will the robot run. The calculations below were carried to get the physics and math correct on our design. It was found the robot was able to move with HEX Motor with gearbox ratio of 15, and with angular speed of 400 m/s and linear speed of 1.89 m/s.



Figure 7. Speed calculation on Flat Surface

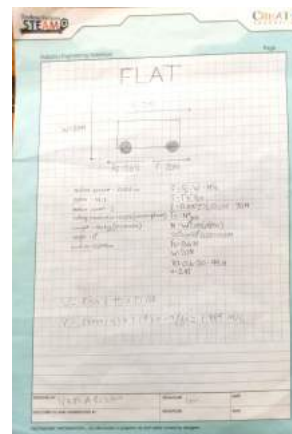


Figure 8. Speed calculation on Angled Surface

4.2. IDEAS DEVELOPMENT FOR INTAKE SUBFUNCTION

Intakes are one of the most common, versatile, and useful mechanisms in Robotics. Intakes manipulate small regular-shaped game objects, such as balls to be secured or possessed by the robot. In targeting to pick up and store 20 balls in a 40 seconds herewith our design proposal combines the intake and lifter into the storage. Here are three designs that we made in the table below ;

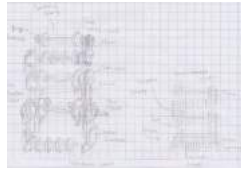
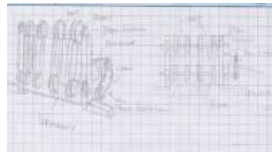
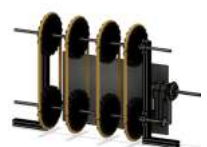
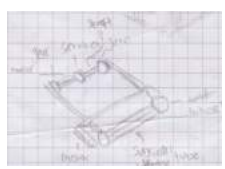
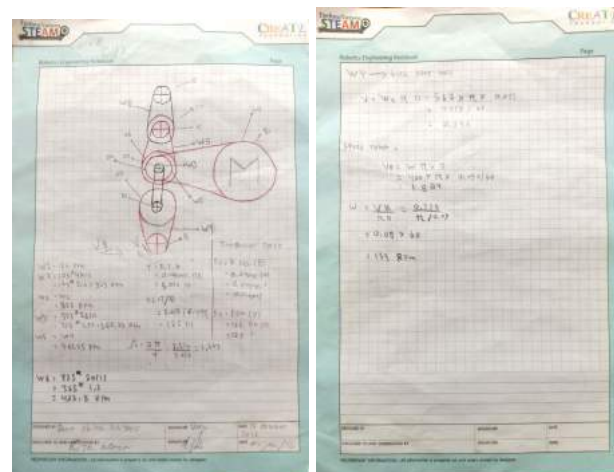
Design	Attribute	Sketching	3D Drawing
1	ROTATION WHEEL		
2	PULLEY		
3	CAPTURE AND LIFTER SWINGER		

Figure 9. Sketching and 3D Design of Intake solutions

4.2.1. INTAKE SPEED CALCULATION

To be able to pick up and store 20 balls in 40 seconds, Some calculations were carried out. It was found that the angular speed of the lowest part of intake is 562 rpm and creating translation speed of, 0.735 m/s and since the robot is able to move with linear speed of 1.89 m/s.so in order for intake to work the motor drive of robot should not move with speed higher than 155 rpm



4.3. IDEAS DEVELOPMENT FOR SHOOTER SUBFUNCTION

A shooter scores game pieces from a distance. Many mechanisms can be deployed to create a shooter. With a target of shooting 20 balls in 30 seconds and 2,5 m high , several design ideas for the shooter are proposed. Three of them which were expanded upon ;

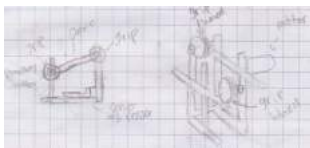
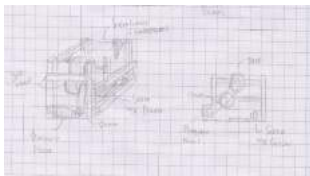
Design	attribute	Sketching	3D Drawing
1	SINGLE FLYWHEEL		
2	DUAL FLYWHEEL		
3	DUAL FLYWHEEL WITH OPPOSITE ROTATION		

Figure 12. Sketching and 3D Design of Shooter solutions

4.3.1. SHOOTER CALCULATION

To be able to shoot 20 balls in 30 seconds- 1.5 seconds per ball, some calculation on the motors and elevation need to be carried out.. The calculation below shows the calculation of the speed of the balls leaving the robot and achieving the height of the sink.

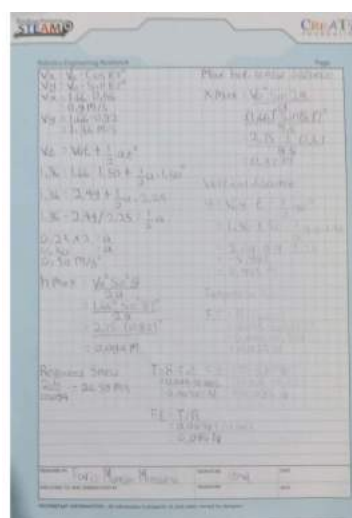


Figure 13. & Figure 14. Shooter Speed Calculation

4.4. IDEAS DEVELOPMENT FOR BUCKET LIFTER / DROPPER SUBFUNCTION

A bucket dropper becomes a potential solution if the robot is able to drop 20 or more balls within 20-30 seconds as it will beat the human player performance of 1.4 balls per seconds but with 100% accuracy, the design of the lifter's primary use is to lift bucket with 20-30 balls. We planned to lift the bucket of balls using ropes and linear extrusion, to drop at least 20 balls into the sink in 20 seconds. The climber has a dropper used for dropping balls in the sink. Two designs that we developed with that in mind;

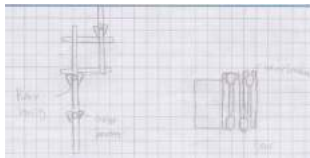
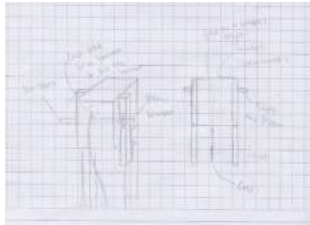
Design		Sketching	3D Drawing
1	SINGLE LINEAR MOTION LIFTING MECHANISM		
2	DUAL LINEAR MOTION LIFTING MECHANISM		

Figure 15. Sketching and 3D Design of Climber and Lifter solutions

4.4.1. BUCKET LIFTER POWER CALCULATION

To be able to bucket drop at least 20 balls into the sink in 20 seconds, we required a set of motors with the proper gearbox configuration to achieve the correct speed in lifting the box into the sink. With 20 balls x 40 gram = 800 grams and with 16 extrusions of 30 gram, and the bucket weight 156 gram, the total mass to be lifted is 5.75 Kg, then the total force needed is equal to 57,5 N. And the work from 2 motors with ratio Gearbox of 100 is equal to $\text{Force} = T \times \text{Gearbox ratio} \times n/r = 0.157 \times 5 \times 4 \times 5 \times 2 \times 0.03 = 1026 \text{ N}$ the force given by 2 motors is higher than needed.

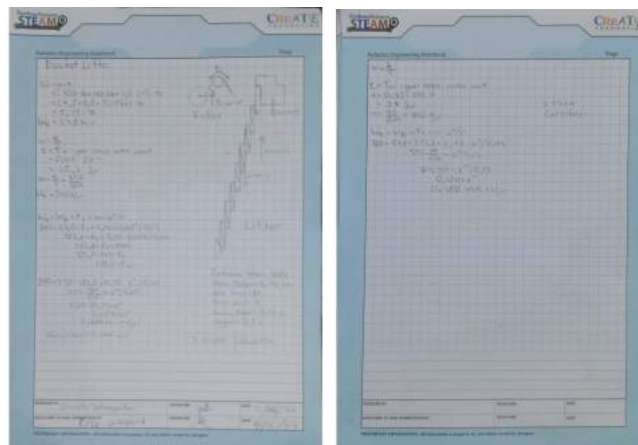


Figure 16. & Figure 17. Bucket Lifter Calculation

4.5. IDEAS DEVELOPMENT FOR ROBOT LIFTER SUBFUNCTION

A climber may be used for the robot to climb in the endgame for scoring points. Robots may climb using ropes, bars, and sometimes traverse along the bar. There are many ways to design a lifter and here are three ideas in this table below ;

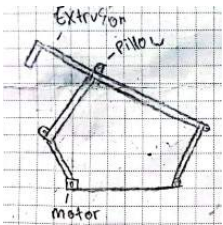
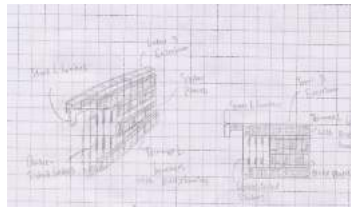
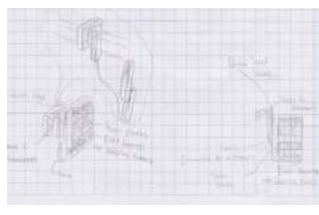
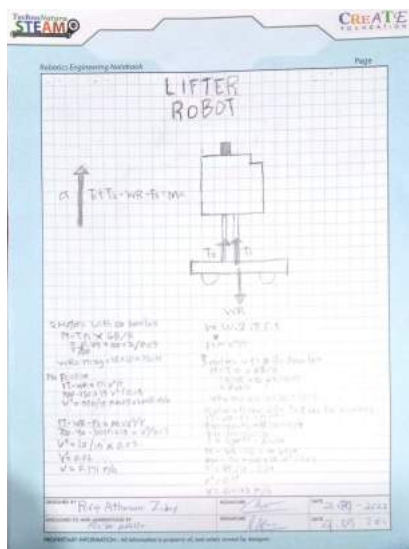
Design		Sketching	3D Drawing
1	4 BAR LINKAGE		
2	LINEAR MOTION		
3	CABLE HANGER		

Figure 18. Sketching and 3D Design on Robot Lifter solution

4.5.1. ROBOT LIFTING CALCULATION



To be able to lift the robot with 20 Kg weight at a height of 1.4 meters in 20 seconds, we need a set of motors with the right gearbox configuration to achieve the proper speed of lifting. With workload force equal 250N. And the force given by 2 motors is 1026 N , higher than needed. With power needed power of $= F \times s = 250 \times 1.4 = 350 \text{ watt}$

Power = Torque x RPM (x a constant)

$= 0.105 \times \text{gB ratio} \times n \times \text{Rpm}$

$= 0,105 \times 100 \times 2 \times 600 = 12600 \text{ watt}$ more than enough to lift the robot using two motor HD hex with 5x4x5 gear ratio reduction

Figure 19. Robot Lifting Calculation

4.6. IDEAS DEVELOPMENT FOR SECURING INDICATOR SUBFUNCTION

A pre-positioned indicator may be secured by one robot from each regional alliance when the match starts. We integrated the system onto our lifter / dropper. Wiith that in mind, we developed four ideas on securing the indicator.

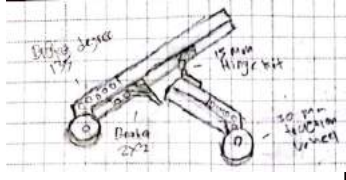
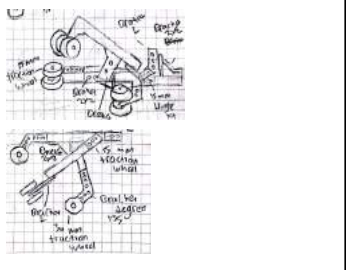
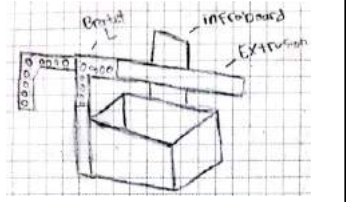
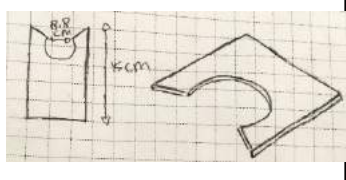
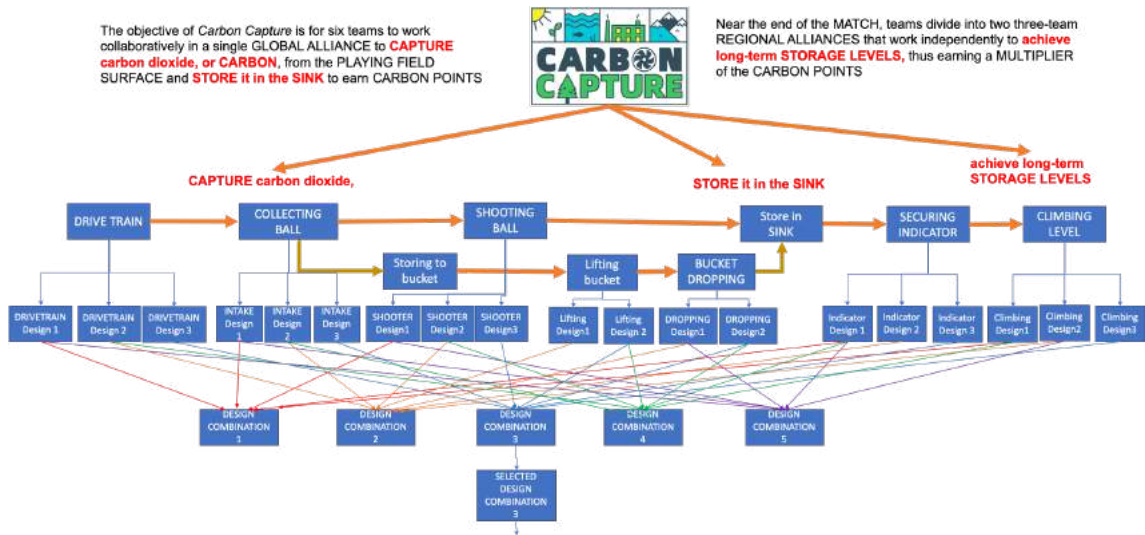
Design	attribute	Sketching	3D Drawing
1	DESIGN 1		
2	DESIGN 2		
3	DESIGN 3		
	DESIGN 4		

Figure 20. Sketching and 3D Design on Securing Indicator solution

5. SELECTION OF IDEAS

With 2-4 ideas for each sub-function, plenty of combined solutions can be developed by mixing all the solutions.



Combining the drivetrain, with intake collecting and storing balls in the bucket, lifting the bucket and storing the balls in the sink, then shooting the ball to the sink. As the idea is to achieve the highest score by all possible means, i.e. shooting, dropping, human player shooting, then the robot is designed to be able to shoot as well as dropping balls into the sink.

6. BUILDING PROTOTYPE

The primary goal of prototyping is to test, record results, and improve the concept. Using the 2022 FGC Kit, we are able to build the design into a prototype, the chains were cut and linked back appropriately, extrusions and wheels were assembled to form the drive train. The intake was built by assembling the hex shafts, wheels, with sprockets and chains. Similarly the shooter was built using extrusion, wheel and a motor, the lifter assembly was built using 18 extrusion and linear motion mechanism kits and finally the bucket was built using a stitched corrugated plastic sheet given.

6.1. PARTS & BUILDING ASSEMBLY



Figure 21. Part prototyping and assembly of Carbon Capture robot

6.2. ROBOT WIRING AND CONTROL

The wiring of a robot serves two primary purposes. To provide electrical power to the devices on a robot and to provide a communication network for the many devices that make up a robot's control system. The the wiring and human controls is shown as below;

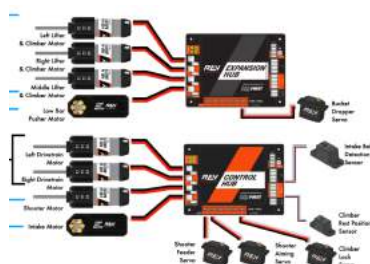


Figure 22. Wiring design on robot solution



Figure 23. Design on control of robot solution

6.3. PROGRAMMING

After designing and assembling the parts by following the design. The team built the prototype, developed flowcharts and programs for the robots movements and mechanism. All parts of the design were then materialized towards prototyping as well as in full robot assembly. The main program was divided into 4 subsystems ;

1. Drivetrain Subsystem
2. Intake Subsystem
3. Shooter Subsystem
4. Lifter Subsystem

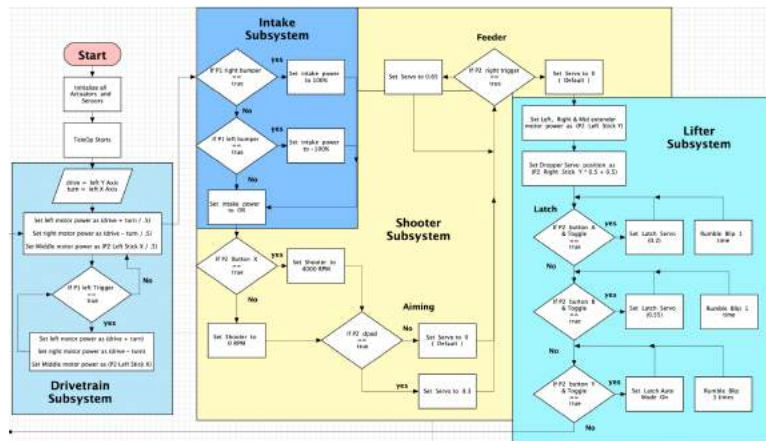


Figure 24. Flowchart of Carbon Capture Robot

CODE LISTING

```
package org.firstinspires.ftc.teamcode;

import com.qualcomm.robotcore.eventloop.opmode.Disabled;
import com.qualcomm.robotcore.hardware.DcMotorSimple;
import java.util.Locale;
import org.firstinspires.ftc.robotcore.external.navigation.Orientation;
import org.firstinspires.ftc.robotcore.external.navigation.AxesReference;
import org.firstinspires.ftc.robotcore.external.navigation.AxesOrder;
import com.qualcomm.hardware.bosch.BNO055IMU;
import org.firstinspires.ftc.robotcore.external.navigation.AngleUnit;
import com.qualcomm.robotcore.hardware.DcMotorEx;
import com.qualcomm.robotcore.hardware.Servo;
import com.qualcomm.robotcore.eventloop.opmode.OpMode;
import com.qualcomm.robotcore.eventloop.opmode.TeleOp;
import com.qualcomm.robotcore.hardware.DcMotor;
import com.qualcomm.robotcore.util.ElapsedTime;
import com.qualcomm.robotcore.util.Range;

@TeleOp(name="TEAM4", group="TEAM4")

public class TEAM4MAIN extends OpMode
{
    private ElapsedTime runtime = new ElapsedTime();
    private DcMotorEx leftMotor = null;
    private DcMotor rightMotor = null;
    private DcMotorEx FwMotor = null;
    private DcMotorEx zAim = null;
    private DcMotor intakeMotor = null;
    private DcMotor telescopicMotor = null;
    private DcMotor hangerMotor = null;
    private DcMotor hangerSupport = null;
    private Servo Feeder = null;
    private Servo xAim = null;
    private Servo indexer = null;
    private Servo rGuide = null;
    private Servo lGuide = null;

    private BNO055IMU imu;

    private Orientation angles;

    double power = 0;
    double xAimAngle = .5;
    double indexerPos = 0.5;

    double leftEnc = 0;
    double rightEnc = 0;
    double Heading = 0;
    double Circumference = 9 * Math.PI;
    double x_Pos = 0;
    double y_Pos = 0;

    boolean indexerToggle = false;

    // todo: write your code here
    @Override
    public void init() {
        BNO055IMU.Parameters parameters = new BNO055IMU.Parameters();
        parameters.angleUnit = BNO055IMU.AngleUnit.DEGREES;
        parameters.accelUnit = BNO055IMU.AccelUnit.METERS_PERSEC_PERSEC;
        parameters.calibrationDataFile = "BNO055IMUCalibration.json"; // see the calibration sample opmode
        parameters.loggingEnabled = true;
        parameters.loggingTag = "IMU";

        imu = hardwareMap.get(BNO055IMU.class, "imu");
        imu.initialize(parameters);

        leftMotor = hardwareMap.get(DcMotorEx.class, "leftMotor");
        rightMotor = hardwareMap.get(DcMotor.class, "rightMotor");
        FwMotor = hardwareMap.get(DcMotorEx.class, "Motor");
        zAim = hardwareMap.get(DcMotorEx.class, "zAim");
        intakeMotor = hardwareMap.get(DcMotor.class, "intakeMotor");
        telescopicMotor = hardwareMap.get(DcMotor.class, "telescopic");
        hangerMotor = hardwareMap.get(DcMotor.class, "hangerPull");
        hangerSupport = hardwareMap.get(DcMotor.class, "hangerSupport");
    }
}
```

```

leftMotor.setMode(DcMotor.RunMode.RESET_ENCODERS);
leftMotor.setMode(DcMotor.RunMode.RUN_WITHOUT_ENCODER);

rightMotor.setMode(DcMotor.RunMode.RESET_ENCODERS);
rightMotor.setMode(DcMotor.RunMode.RUN_WITHOUT_ENCODER);

leftMotor.setDirection(DcMotorSimple.Direction.FORWARD);
rightMotor.setDirection(DcMotorSimple.Direction.REVERSE);
intakeMotor.setDirection(DcMotorSimple.Direction.REVERSE);
fwMotor.setDirection(DcMotorSimple.Direction.REVERSE);

Feeder = hardwareMap.get(Servo.class, "Feeder");
xAim = hardwareMap.get(Servo.class, "xAim");
indexer = hardwareMap.get(Servo.class, "Indexer");
rGuide = hardwareMap.get(Servo.class, "rightGuide");
lGuide = hardwareMap.get(Servo.class, "leftGuide");

imu = hardwareMap.get(BNO055IMU.class, "imu");
telemetry.addData("Status", "Initialized");

xAim.setPosition(xAimAngle);

rGuide.setPosition(1);
lGuide.setPosition(0);
}

@Override
public void start() {
    rGuide.setPosition(0.3);
    lGuide.setPosition(0.6);
}

@Override
public void loop() {
    angles = imu.getAngularOrientation(AxesReference.INTRINSIC, AxesOrder.ZYX, AngleUnit.DEGREES);
    // DRIVETRAIN
    double leftPower;
    double rightPower;

    double drive = -gamepad1.left_stick_y;
    double turn = gamepad1.left_stick_x;
    leftPower = Range.clip(drive + turn, -1.0, 1.0);
    rightPower = Range.clip(drive - turn, -1.0, 1.0);

    leftMotor.setPower(leftPower);
    rightMotor.setPower(rightPower);

    // FLYWHEEL
    fwMotor.setVelocityPIDCoefficients(10, 3, 0, 0);

    if (gamepad2.a == true){
        fwMotor.setVelocity((4200/60)*28);
        xAim.setPosition(0.64);
    } else if (gamepad2.b == true){
        fwMotor.setVelocity((4100/60)*28);
        xAim.setPosition(0.6);
    } else if (gamepad2.x == true){
        fwMotor.setVelocity((4000/60)*28);
        xAim.setPosition(0.5);
    } else {
        fwMotor.setVelocity(0);
        xAim.setPosition(0.5);
    }

    // FEEDER
    if(gamepad2.right_trigger >= 0.5){
        Feeder.setPosition(0.8);
    } else {
        Feeder.setPosition(0.57);
    }

    if (Feeder.getPosition() > 0.7){
        indexerToggle = true;
    }

    if(Feeder.getPosition() == 0.57 && indexerToggle && indexerPos >= 0.25){
        indexerPos -= 0.008;
    }

    if (indexerPos <= 0.25){
        indexerToggle = false;
        indexerPos = 0.5;
    }

    indexer.setPosition(indexerPos);

    // INTAKE
    if(gamepad1.right_bumper){
        intakeMotor.setPower(0.7);
    } else if(gamepad1.left_bumper){
        intakeMotor.setPower(-0.5);
    } else {
        intakeMotor.setPower(0);
    }

    if(gamepad2.right_trigger == 1){
        rGuide.setPosition(0.3);
        lGuide.setPosition(0.6);
    } else if(gamepad2.left_trigger == 1){
        rGuide.setPosition(1);
        lGuide.setPosition(0);
    }

    // hanger
    if (gamepad2.dpad_up) {
        telescopicMotor.setPower(1);
    } else if (gamepad2.dpad_down) {
        telescopicMotor.setPower(-1);
    } else {
        telescopicMotor.setPower(0);
    }

    if (gamepad2.dpad_right) {
        hangerMotor.setPower(1);
    } else if (gamepad2.dpad_left) {
        hangerMotor.setPower(-1);
    } else {
        hangerMotor.setPower(0);
    }

    hangerSupport.setPower(gamepad1.right_stick_x);

    //odometry
    double CurrentLeftPos = (double)leftMotor.getCurrentPosition()/-26/28 * Circumference;
    double CurrentRightPos = (double)rightMotor.getCurrentPosition()/-26/28 * Circumference;

    double leftDelta = leftEnc - CurrentLeftPos;
    leftEnc = CurrentLeftPos;
    double rightDelta = rightEnc - CurrentRightPos;
    rightEnc = CurrentRightPos;

    double PosDelta = (leftDelta + rightDelta) / 2;

    double CurrentHeading = angles.firstAngle + 90;
    x_Pos = x_Pos + PosDelta * Math.cos(Math.toRadians(CurrentHeading));
    y_Pos = y_Pos + PosDelta * Math.sin(Math.toRadians(CurrentHeading));

    // Z AXIS AIMING
    double degrees = zAim.getCurrentPosition() * 0.216;
    int heading = (int)angles.firstAngle;

    double aimAngle = (Range.clip(Math.toDegrees(Math.atan2(Math.abs(350 - y_Pos), Math.abs(x_Pos))) - heading, 0, 180) /* 0.216*/);

    if(gamepad2.y){
        zAim.setTargetPosition((int)(aimAngle / 0.216));
        zAim.setMode(DcMotor.RunMode.RUN_TO_POSITION);
        zAim.setVelocity(500);
    } else {

```

```

        zAim.setMode(DcMotor.RunMode.RUN_WITHOUT_ENCODER);
        zAim.setPower(gamepad2.right_stick_x);
    }

    // zAim.setPower(gamepad1.right_stick_y);

    telemetry.addData("aim Deg", degrees);
    telemetry.addData("X", x_Pos);
    telemetry.addData("Y", y_Pos);
    telemetry.addData("MotorRPM", (leftMotor.getVelocity()/28)*60);
}

// formatting
String formatAngle(AngleUnit angleUnit, double angle) {
    return formatDegrees(AngleUnit.DEGREES.fromUnit(angleUnit, angle));
}

String formatDegrees(double degrees){
    return String.format(Locale.getDefault(), "%.1f", AngleUnit.DEGREES.normalize(degrees));
}

```

7. PERFORMANCE TESTING

Performance testings were carried out for individual subsystems as well as the full model assembling. By testing and analyzing the performance of the robot models, the team learns how to plan the experiment and exercise problem solving simultaneously to fix the problems and get them into the target. As the objectives of the robot have been stated out so the performance test will easily be correlated to these objectives.

7.1. DRIVETRAIN TESTING

Tests involving the drivebase show that the drivebase design we opted for succeeds in doing what we need it to do, with good stability in the starting form of the robot and decent maneuverability. While it lacks outright maneuverability, the simplicity of the design means that it allows more motors to be dedicated to things such as the lifter and gives space for aforementioned systems.

7.2. SECURING INDICATOR TESTING

Sliding on the drivetrain was a bit hard and made it difficult to secure the indicator. The indicator was located at the corner, so it was not easy to drive the robot into the right position to pick up the indicator.

7.3. INTAKE TESTING

Our early testing of the intake shows that the system is quite inconsistent as some balls get launched out of the intake and back into the field, and other times the balls get stuck in between the rollers. The intake was quite inconsistent, as sometimes the balls have difficulty passing through the first rotator.

7.4. SHOOTER TESTING

Testing of the shooter went well with good consistency, excluding the fact that some of the balls we were using to test are of differing sizes, the lack of z-axis aiming causes aiming on it requires rotating the whole robot, the smaller footprint meant that the space could be used to allow the dropper system to be as big as possible.

7.5. BUCKET DROPPER TESTING

It was discovered that during lifting, the robot has to be static, since movement will worsen the swaying and may break the lifter, the mechanism of linear movement is not strong enough to cope with such load and movement. Further to that if the rope pulling

is too fast, the rope get tight and bends the lifter forward and might which causes the relocation of the center of gravity which might topple the robot. We experienced this and cause the whole lifting structure broke and fell down.



Figure 25. The broken and fallen down lifter structure



Figure 26. & Figure 27. The torn part of the Slider Plates

7.6. HANGER TESTING

The hanger worked as expected successfully holding onto the bar while lifting and the hook also worked perfectly with it locking onto the bar with only some slight difficulty due to the weird angle in which the drivers view their robot and also general lack of practice utilizing this system. The hanger needs to be precise in the center of the hanger pole or else it wouldn't hang properly which potentially makes the robot fall. The lifter is capable of lifting the robot, although taking time to do so. The duration of lifting is dependent on the torque and the weight of the robot

8. DESIGN REFINEMENTS

8.1. ROBOT MECHANISM REFINEMENT

MECHANICS	IMAGE	DESCRIPTION
DRIVETRAIN		We added an additional motor and two small omni wheels in the middle of the drivetrain for sliding to aid in securing the indicator ball and making it easier to do so.

INTAKE		We make the position of first roller just a slightly a bit lower than the ball diameter and the roller able to move free go up down as the ball pass through it and we added a 2m Distance Sensor in the intake to tell us if the ball has been collected, this helps the drivers to collect the balls if the intake is out of the drivers viewpoint at ease.
INDICATOR		We've changed the securing indicator mechanism from a claw design to a pole for efficiency by poking the ball from below and dropping it to the bucket which lowers the risk of dropping the ball that is being secured.
BUCKET		We sewed the bucket with some of our cords to reduce the use of materials and increase our ball capacity which reached 25-27 balls.
BUCKET DROPPER MECHANISM		The Rope Trigger mechanism to drop the balls out of the bucket was modified and the rope was relocated to the inside of the robot and pulled by a servo from the outside and lower the risk of the rope from getting tangled.
LIFTER MECHANISM: LINEAR MOTION KIT V2	 	While using bolts from the Linear Motion Kit V2, it was discovered that the bolts were easily bent and offsetted the bearing, causing the linear movement to be stuck. We refined it by adding an extra bolt to disperse the load and propose a new double-screwed bearing system, along with a customized rope protector with symmetrical positioning for the slider. The screws now have second support, thanks to the double-screwed system. The bearing has smoother and more room for movement. The risk of the rope snapping is greatly reduce

8.2. ALGORITHMS REFINEMENTS

Some modification in the coding algorithm followed the change in mechanism, as well as addition of features to optimize the performance of the robot.

ALGORITHMS	DESCRIPTION
DUAL ROBOT CONTROLLER	The robot was programmed using the built-in OnBot Java from the control hub; it was first controlled with one joystick controller for early testing of each subsystem. After everything is all set, the controls get split into 2 players. The robot was too fast which makes it difficult for the driver to precisely position the robot when dropping, hanging or securing the indicator. So the solution was to create 2 speed profiles, the robot now normally runs on 50% power to maneuver around, and the left trigger can be pressed to enable maximum speed.
RUMBLE FEATURE OF JOYSTICK CONTROLLER AUTOMATIC LOCKING SYSTEM WITH SERVO	In the System Operator's control, there was a problem where the operator could not tell whether the hanger had been locked or not. The problem was solved by utilizing the rumble feature inside the joystick controller, every time the button to unlock and lock the hanger manually is pressed, it will vibrate once, and if the auto-lock button is pressed, it will vibrate twice, once the magnetic switch detects the magnet, the servo will lock the hanger and the operator will be informed by a vibration in the controller 3 times.
PID CONTROLLER	PID allows more precise control of a driving motor by predicting the moment the motor speed will go higher than the desired value and adjusts the power accordingly to reach the desired speed, maximizing efficiency and accuracy.
ODOMETRY	Odometry uses some simple math to calculate the distance the robot has traveled through and can be used to automatically adjust the angle of our shooter without human intervention and with higher consistency.

9. FINAL DESIGN

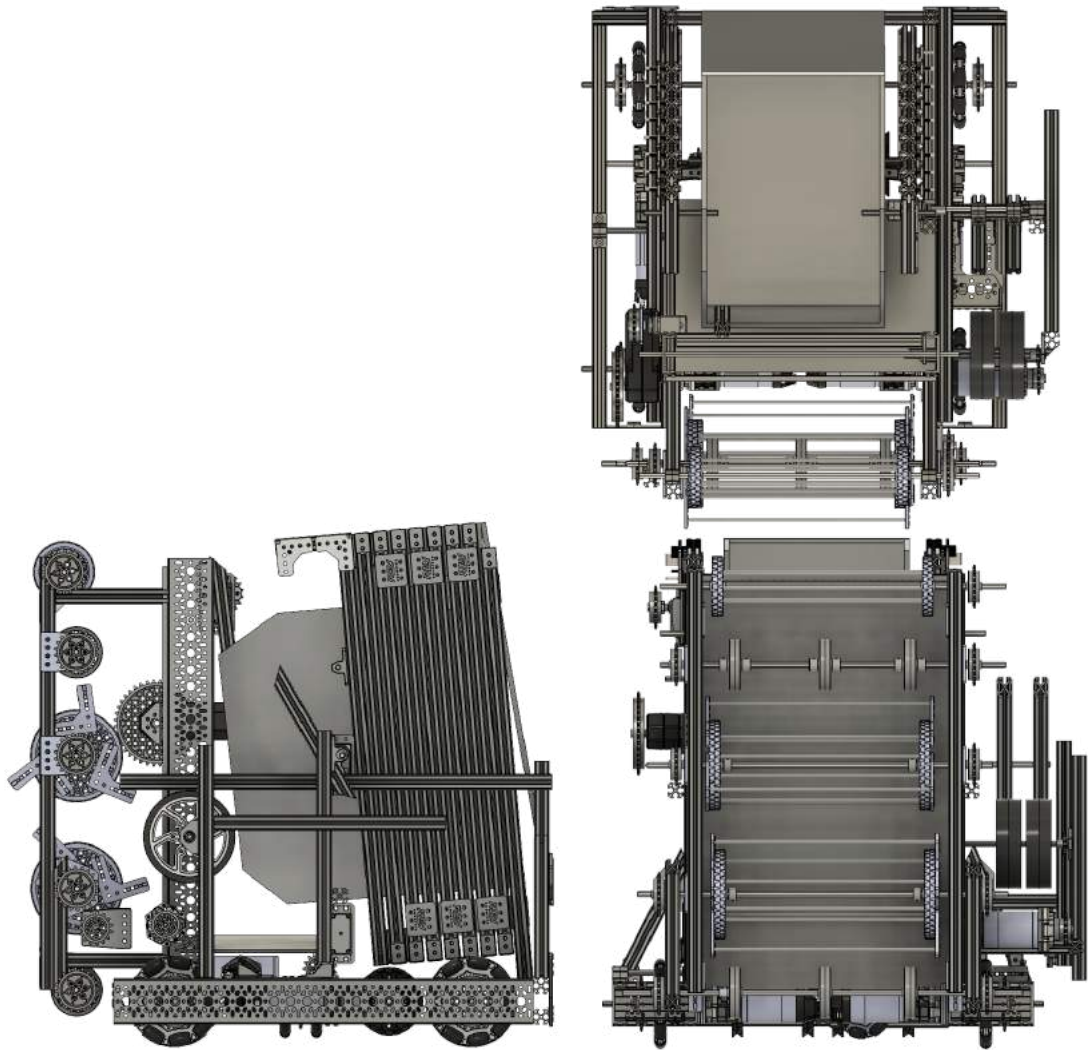


Figure 28 DRYOMATIKA FINAL DESIGN

For our final design we decided to settle with a features combination of drivetrain, intake mechanism, bucket storage system, shooting mechanism, bucket lifting and dropping, securing indicator and robot climbs and hanging system. Here each is shown in detail.

9.1. DRIVETRAIN



The drivetrain is a H tank drive layout but with four omni wheels powered by two hex HD motors with gearbox ratio of 5x3 and two small omni wheels powered by a single hex motor in the middle for better slide movement. The drivetrain moves with 1,5 m/s and 0,3 m/s in sliding. 6 motors (3 for movement and 3 for lifter) are located at the bottom to create a firm center of gravity.

9.2. INTAKE



For the intake, we used a combination of small and large traction wheels as well as compliant wheels. The wheels are confined by brackets tied with surgical tubing to collect the balls more efficiently which is controlled by a corehex motor. Linear Speed of intake with two row ball intake with 0.5 m/s intake per row.

9.3. SHOOTER



For the shooter, we used two standard flywheels and takes advantage of aiming on one axis for more predictability and precision when shooting. During the testing it was noted that its capable of shooting 1 ball/s.

9.4. BUCKET LIFTER & ROBOT HANGER



The hanger is located on the edge of the lifting system, of 2 sets of 9 extrusions that extends 3 meters reaching the tallest rod and emptying the funnel allowing the dropper to function properly. The actual claw that hangs on the bar is made of metal brackets so it can hook onto the bars with the upside down U shape allowing additional security when hanging on the bars. Speed of lifter in 0.15 m/s it reaches 2.5 m in 17 seconds .

9.5. BUCKET / STORAGE



The dropper uses the storage system with the lifter system allowing it to dump large amounts of balls at once into the sink. The storage system also doubles as storage for the shooter allowing the shooter to be fed without having to grab the balls every time when shooting. 27 balls can be contained inside the bucket.

9.6. WIRING AND CONTROL

The location of motors as well as the servo are designed to make an efficient wiring, 6 motors located at the bottom are easy to be wired as well as the other two motors. The 4 servo and the sensor are also designed to be easily wired. The placement, connections, and security of the wires are targeted to lead to improved robot performance, eliminate intermittent electrical problems, and allow for easy troubleshooting and resolution of electrical and/or signal-related problems.

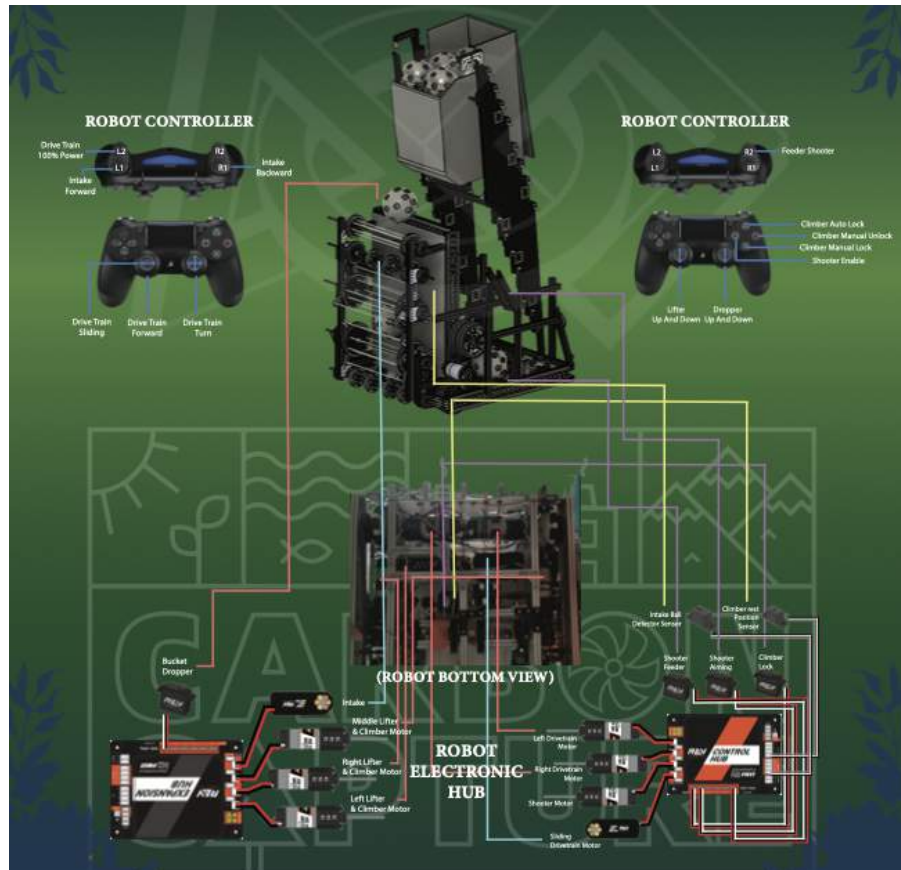


Figure 29. Final Design on electrical and control of robot solution

9.7. PROGRAMMING

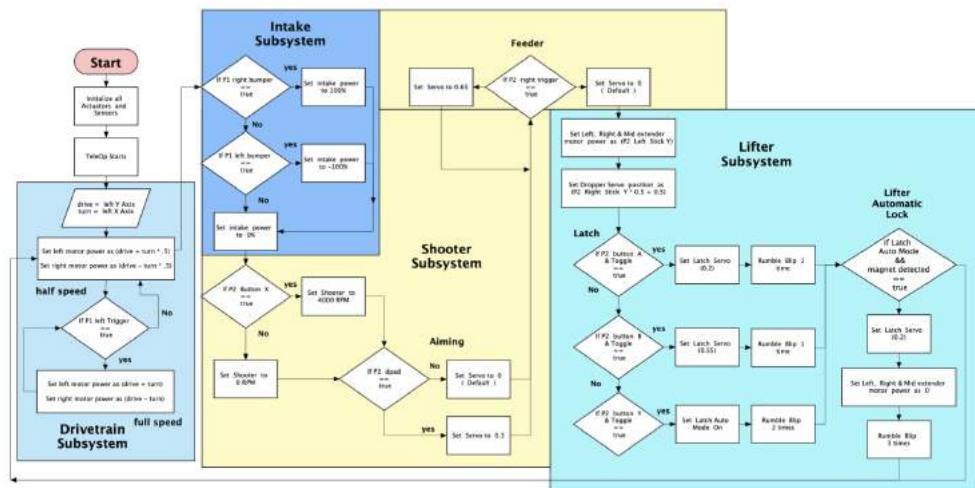


Figure 30. Final Design Dryomatika Flowchart

The coding and programming was carried out in iterate and to feel the human player experience and to adjust with the player feeling. The flowchart as well as the coding were updated to reflect with the latest refinement on mechanism and algorithm.

DRYOMATIKA

THE CARBON SINKERS

ROBOT ELECTRONIC HUB

21

10. OUR ART WORK DESIGNS DURING FGC 2022



Figure 32. Banner Designs



Figure 33. Proposal Cover, Bracelets and Pins designs



Figure 34. Jersey, Banner and Bucket designs

INDONESIA PROGRAM TOWARD CARBON EMISSION REDUCTION

Indonesia has to plant at least 8,000 Km square per year to reduce its carbon emission by 41 percent by the year 2030. There is a need to produce 640 million trees per year for planting

CRITERIA OF SUCCESS IN RESTORING ECOSYSTEMS

Planting trees in their native areas to increase their chances of growth and Planting trees that are supported by indigenous and rural communities, due to its by products that can be used for consumption and construction

HISTORICAL TREE IN INDOONESIAN ECONOMIC

Known as the Borneo Camphor, has been grown in natural forests, since the 7th century and became an international trade icon at that time. It was trade icon in the past, but due to excessive exploitation the tree now is in endangered status

VEGETATIVE PROPAGATION OF DRYOBALANOPS AROMATICA



BENEFITS

- Fostering Carbon Emissions Reduction
- Conserving Endangered Species Trees
- Building Long-Term Local Economy
- Improving Socioeconomic Development and Livelihoods for Indonesians

THE NEED FOR BIOTECHNOLOGICAL CLONING

With the need of 640 million trees per year for planting, the fast way to produce the tree is by cloning the tree. Cloning by means of tissue culture has advantages for producing large quantities of planting material

THE RIGHT TREE FOR REFORESTATION SUMATRA AND KALIMANTAN

Dryobalanops aromatica is the RIGHT TREE for reforestation because of its many useful contributions such as CARBON REDUCTION, BUILDING LOCAL ECONOMY, and IMPROVING SOCIOECONOMIC DEVELOPMENT for Indonesia

BUILDING LONG TERM LOCAL ECONOMY

Camphor tree possesses oil or crystals that contain Borneo, which used for production of fragrances and in various medicines for its antiseptic, anti-inflammatory, and analgesic properties. Its resin is collected and harvested by the local people

TEAM INDONESIA

2045

Team Indonesia 2045 is a youth robotic team based in Depok, West Java that takes part in FIRST Global, competing and collaborating with over 160+ teams representing their own country. Each member of the team has different passions, in which some of them are, designing, engineering, business and of course we share the same passion.

The passion to make the world a better place, by inspiring others, youths to have a passion in STEAM. So the world will have a chance in technical works, but most importantly, to help Indonesia to master technology and embrace Indonesia's 100 years anniversary. The R2045 Team hopes to compete in more upcoming robotic competitions



An initiative in shaping the golden generation of Indonesia in welcoming its 100 Years of independence, was initiated by the school, and codenamed "R2045". The Rendezvous 2045, R2045 promise to carefully observe global challenges of the future, as well as the way in transforming Indonesia toward Industry 4.0 and how important for them to master its disruptive technologies, and also how the youth promise to ensure Indonesia's rich biodiversity will still offer opportunity for the many next generation to come. R2045 promise to choose STEAM education in mastering 21st century skills and in disruptive technologies while simultaneously keeping and conserving the nature. Further the Team has mission to spread STEAM education by bringing FIRST* Robot competition program to Indonesia so becoming the activity that instilling FIRST* values in motivating and encouraging many Indonesian students as many as possible to dream and strive in science and technology leaders.









THANK YOU FIRST GLOBAL

For such an awesome challenge and project for us
To prepare us to be science and technology leaders in the future.

"Living In The World"

- Globalization
- Lib & Capital
- Personal Responsibility
- Social Responsibility

"Tools Of Working"

- Information Literacy
- ICT Literacy
- Industry 4.0

"Way Of Working"

- Communication
- Collaboration
- Competition
- Working

"Way Of Thinking"

- Critical Thinking
- Creative Thinking
- Problem Solving
- Teamwork
- Leadership
- Resilience
- Adaptability
- Flexibility
- Openness
- Curiosity
- Innovation

More Than Robots

- Technical Skills
- Soft Skills
- Character
- Leadership
- Teamwork
- Problem Solving
- Communication
- Collaboration
- Competition
- Working
- Communication
- Collaboration
- Competition
- Working

we would like to express our sincere gratitude for the generous donation to our team
Thank you to all our sponsors









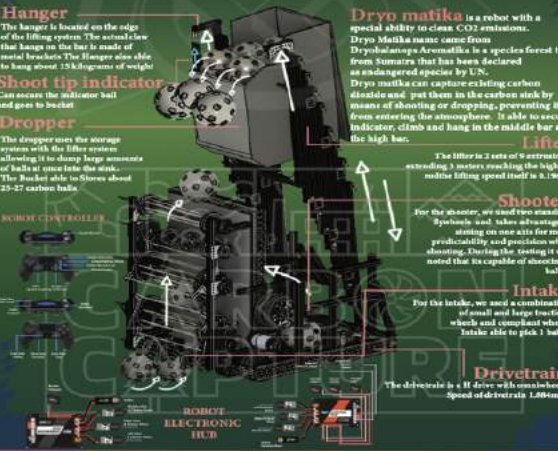


Youtube: R2045.id Instagram: r2045.id Twitter: Team R2045 Gmail: r2045@gmail.com

TEAM INDONESIA

DRYOMATIKA

THE CARBON SINKERS



Hanger
The hanger is located on the edge of the lifting system. The actual claw that hangs on the bar is made of metal brackets. The Hanger also able to hang about 15 kg/33 pounds of weight

Shoot tip indicator
Can access the indicator ball and goes to bucket

Dropper
The dropper runs the storage system with the lifter system allowing it to dump large amounts of balls at once into the sink. The Bucket able to store about 25-27 carbon balls

Robot Controller

Robot Electronic Hub

Dryomatika is a robot with a special ability to clean CO2 emissions. Dryo Matika name come from Dryobalanops Aromatica is a species forest tree from Sumatra that has been declared as endangered species by UNESCO. Dryo matika can capture existing carbon dioxide and put them in the carbon sink by means of shooting or dropping, preventing it from entering the atmosphere. It able to secure indicator, climb and hang in the middle bar and the high bar.

Lifter
The lifter is 2 sets of 6 actuators extending 3 meters reaching the highest middle lifting speed itself is 0.15m/s

Shooter
For the shooter, we used two standard 8mm air gun and take advantage of aiming on one axis for more predictability and precision when shooting. During the testing it was noted that its capable of shooting 1 ball/s

Intake
For the intake, we used a combination of small and large function wheels and compliant wheels. Intake able to pick 1 ball/s

Drivetrain
The drivetrain is a H drive with omniwheels. Speed of drivetrain 1.80m/s






TEAM INDONESIA

DRYOMATIKA CONTROLS & ELECTRICAL DIAGRAM



ROBOT CONTROLLER

ROBOT CONTROLLER

ROBOT ELECTRONIC HUB

ROBOT ELECTRONIC HUB







Figure 35 Pit Banners design

11. OUTREACH

During the Engineering session of FTC 2022-2023 kick off, R2045 presented the R2045 dream to bring FIRST to Indonesia, there were 8 FTC teams presented, and most of them are rookies. We announced an FTC exhibition and a scrimmage in November in Jogja and December in Jakarta. Wishfully we are having our official nation FTC competition by next year 2023. And R2045 will be the main team to do the outreach and the training for a new team.



Figure 36. The setting of Power Play FTC 2022-2023



Figure 37. FTC team present their support to R2045 Team Indonesia

12. CONCLUDING REMARKS

The design, build, test and iteration have been carried out by the R2045 team Indonesia in order to come up with a robotic configuration solution that is capable of meeting the requirements of design and objectives of the games. In the full 2.5 minutes the robot starts off by collecting the balls, storing it into a bucket, then after the bucket is full, lifts the bucket into a 2.5 meters high sink, and drops the balls into the sink. Then, the bucket climbs down until half way bucket lifting, to collect balls and send the balls to a second storage to be directed to the intake of shooting, the trigger was deployed to balls to sink by shooting it. When match end is arriving, quickly secure the indicator and finally climb the high bar to get the highest score possible.

R2045 team is extremely diverse from the many different students from different ethnic groups there are on our team from across Indonesia. All with different ideas and interests, unite, to design together, build together, and innovate together. Diversity on our team helps create ideas that are unique and special, because even if we are different, our interest in STEAM unites us.

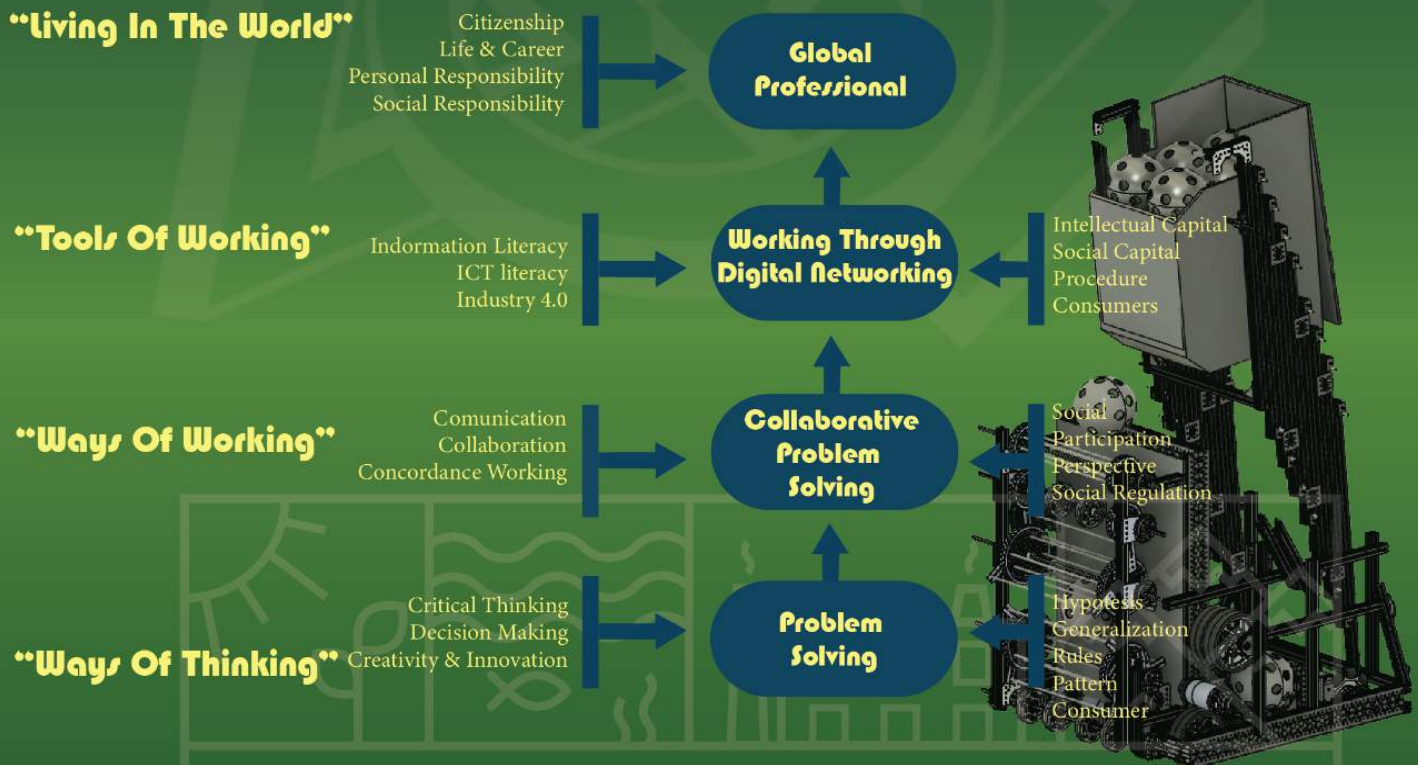
More than Robots, for more than 3 months we have practical contact with and observation of facts of FIRST's® core values. We found out that most of the team uphold the values. Team collaboration in online meetings, helping each other to improve each other, do coo-partition to become a better person and reach their potential. We also noted how hard the team prepared their proposal as well as presenting business proposals to the sponsor and we remarked how the team worked in their spare time to do the outreach, spread STEAM and give back to their community and present it to those younger than themselves.

It was clear that we learnt a lot during working in FIRST® Global Challenge, the beauty of becoming problem solvers by employing our gifted reasoning, critical thinking and creativity, During our process of creating the robot. We learnt to be collaborative problem solvers working collaboratively and communicating between us, we also learnt how to master the tools of working in the future such ICT, computer programming, Robotics and becoming a good global professional.

Thank you FIRST® GLOBAL for such an awesome challenge and project for us. We are really grateful and honored to have a chance to be the FIRST® GLOBAL participants, preparing us to be technology leaders in the future. It strengthening our mission to bring FIRST® Robotic Activities to Indonesia, so many young Indonesians get benefit from these activities, and hopefully the Next FIRST Global Challenge can be held in Indonesia. Where we could offer the world participants the warm hospitality of Indonesia.

THANK YOU FIRST GLOBAL

For such an awesome challenge and project for us
To prepare us to be science and technology leaders in the future.



we would like to express our sincere gratitude
for the generous donation to our team
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