MECHATRONICS DESIGN PROJECT

# AQUASTRIKE

S00349479 ESPRIT BROWN TECH211 DR. MATTHEW CHRISTIE 27/10/2024

# ABSTRACT.

This interactive game model “AquaStrike” features two players: one using a water pistol to shoot water at a target, and the other controlling the target's movement with a joystick connected to a stepper motor.
The key components include a water pistol for shooting, a target equipped with a water sensor detecting successful hits, and a servo motor that rotates the target based on the second player's joystick input.
The water sensor measures the amount of water collected in the target, and an LCD screen displays relevant game data, such as a count down, timer, and score.
The objective is for the shooter to land as many water hits as possible while the second player rotates the target to make it more challenging.

# CONTENTS PAGE

# SECTION 1: PROJECT PROPOSAL AND RESEARCH

## 1.1 DESIGN PROPOSAL -

AquaStrike offers a dynamic and engaging experience by combining skill and real-time competition, making it both challenging and fun for players. The combination of different components: water pistol, target, water sensor, servo motor, joystick, and LCD screen, creates an advanced system that promotes coordination, interactivity, and fast reflexes.

The water pistol adds an element of fun and physical engagement, encouraging the shooter to focus on timing and accuracy. By incorporating a target that filters water down to a water sensor, creates a measurable and reliable way to track the success of the shooter. This sensor provides data on the amount of water that has hit the target, which is crucial for monitoring performance and generating scores.

The stepper motor and joystick enhance the game's challenge by allowing the second player to control the movement of the target. The target rotates unpredictably based on the second player's input, forcing the shooter to adapt their aim and strategy. This real-time rotation adds an element of unpredictability, which makes each game exciting, opposing and competitive. The use of a stepper motor ensures smooth and precise movement of the target, making it challenging for the shooter but not impossible to hit.

The LCD screen serves as a central display for game data, offering clear visual scores of how much water is collected. It will display relevant game data, such as a count down, timer, and score. The immediate feedback displayed on the screen enhances user experience by keeping both players informed and engaged.

This model is well-designed as it combines physical activity with technology, creating a stimulating and interactive environment. It fosters competition between players by providing an evolving challenge, where one player must outmanoeuvre the other's attempts to avoid the water shots. Additionally, the model encourages fast reaction times, coordination and precision, making it not only a fun game but also a tool for developing hand-eye coordination and motor skills.

In conclusion, the integration of these components: water pistol, target, water sensor, servo motor, joystick, and LCD screen, creates a captivating and engaging model. It is suitable for a wide range of users, offering both entertainment and skill-based challenges.

# 1.2 EXPLORATION OF EXISTING IDEAS -

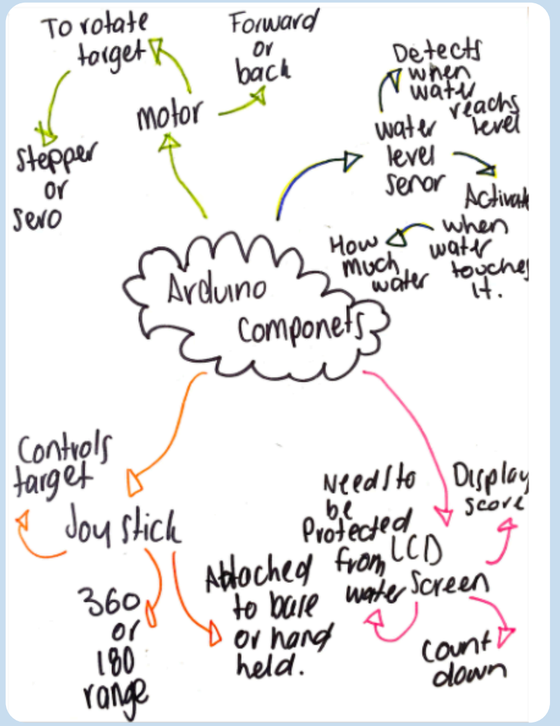

Aquastrike mood board

***On-going evaluation -***

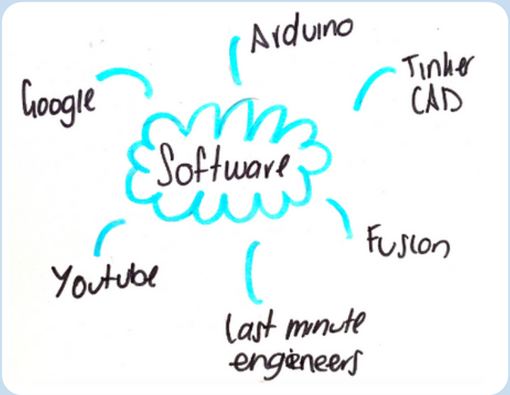
Through this mood board I was able to determine the key components of my model. When I went to an arcade I saw this dinosaur water shooting game called 'dinosaur era'. It was popular amongst the younger children and there was a constant line to play. It made me intrigued and wonder why this game was so popular and what are the key parts the kids are attracted to. I found that the physicality of there being water and not just a laser or a dot on the screen ect. It was also a two player game so the kids were able to verse their friends and at times they seemed to be very competitive. I feel as this was great inspiration and started braining storming the different comments I will need to create a similar style game.

# SECTION 2: PROJECT DEVELOPMENT AND REALISATION

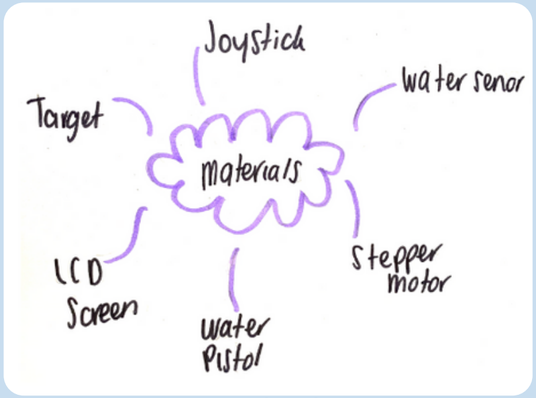
## 2.1 IDEATION -




Mind map of various Arduino components




Mindmap of useful softwares

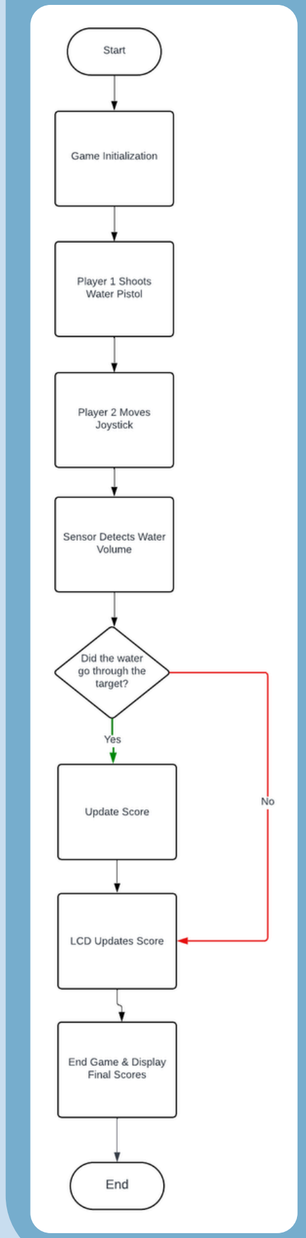



Mind map of useful materials

***On-going evaluation -***

Through these drawings I was able to identify different electronic materials, useful softwares like fusion and tinkerCAD and was able to visually understand the different ways each component will be functioning i.e joystick controls target, have 360 or 108 range and how it will be embedded into the final design.

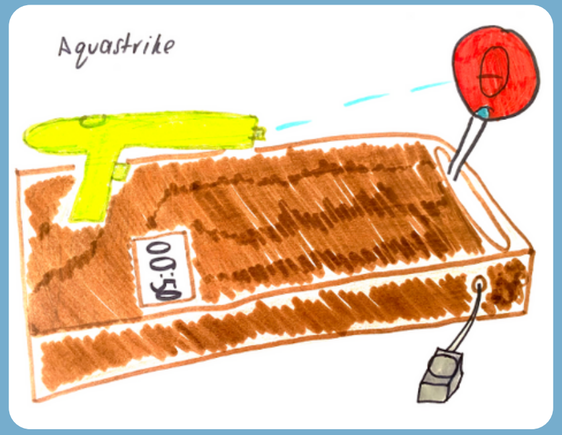
# PROCESS DIAGRAM -



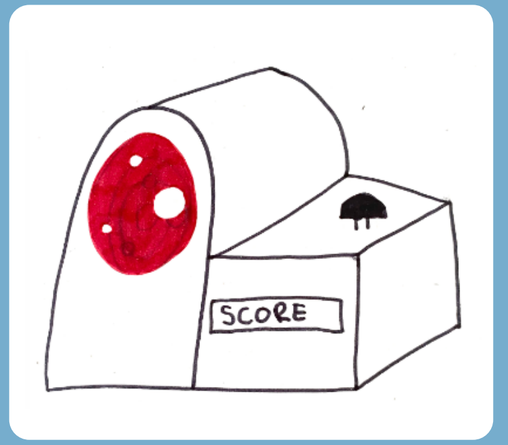

***On-going evaluation -***

By completing this process diagram allow to deeper understand the concept of the game and help me visualise the sequential steps. I used the program Lucidchart which is a very useful software when creating flowcharts. I have experience making flowcharts and using this program in Comp108 so I found it pretty easy to make. Within my process diagram I used a while loop to check is if has been detected through the target with yes or no output.

# DESIGN IDEAS -




Idea 1 for construction of the the game aquastrike




Idea 2 for construction of the the game aquastrike

***On-going evaluation -***

I sketched up 2 possible designs of aqua strike. I do like idea 1 but my main issue is that it wouldn't meet the project requirements that state the model must fit inside the volume of a 250x250x250mm cube (Christie, 2024). If the water pistol and target are both fixed it doesn't make it very exciting as there isn’t enough range only being >25cm. To combat this I thought with idea 2 to make only the target fixed and rotate clockwise and anti clockwise instead of left and right. This also means that player 1 with the water pistol and position themselves where they like that is in range of the distance the chosen water pistol can shoot. This allows the game to be more challenging and gives the players autonomy to create their own rules.

# AREAS OF INVESTIGATION -

1. Sensor Accuracy - Test different codes to see which is the most accurate and how the data will be displayed.
2. Target Movement - Experiment with various codes to determine the correct speed in a rotational pattern.
3. Safety - How to make the game save and water and electrical wires are present.

# 2.2 PROTOTYPING AND FABRICATION -

```
// Sensor pins
#define sensorPower 7
#define sensorPin A0

// Value for storing water level
int val = 0;

void setup() {
    // Set D7 as an OUTPUT
    pinMode(sensorPower, OUTPUT);

    // Set to LOW so no power flows through the sensor
    digitalWrite(sensorPower, LOW);

    Serial.begin(9600);
}

void loop() {
    //get the reading from the function below and print it
    int level = readSensor();

    Serial.print("Water level: ");
    Serial.println(level);

    delay(1000);
```

Snippet of water sensor code

```
// Sensor pins
#define sensorPower 7
#define sensorPin A0

// Value for storing water level
int val = 0;

void setup() {
    // Set D7 as an OUTPUT
    pinMode(sensorPower, OUTPUT);

    // Set to LOW so no power flows through the sensor
    digitalWrite(sensorPower, LOW);

    Serial.begin(9600);
}

void loop() {
    //get the reading from the function below and print it
    int level = readSensor();

    Serial.print("Water level: ");
    Serial.println(level);

    delay(1000);
```

Snippet of stepper motor code

```
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x3F,16,2);  // set the LCD address to 0x3F

void setup() {
  lcd.init();
  lcd.clear();
  lcd.backlight();      // Make sure backlight is on

  // Print a message on both lines of the LCD.
  lcd.setCursor(2,0);   //Set cursor to character 2 on line 0
  lcd.print("Hello world!");

  lcd.setCursor(2,1);   //Move cursor to character 2 on line 1
  lcd.print("LCD Tutorial");
}

void loop() {
}
```

Snippet of LCD screen code

```
// Arduino pin numbers
const int SW_pin = 8; // digital pin connected to switch output
const int X_pin = 0; // analog pin connected to X output
const int Y_pin = 1; // analog pin connected to Y output

void setup() {
  pinMode(SW_pin, INPUT);
  digitalWrite(SW_pin, HIGH);
  Serial.begin(9600);
}

void loop() {
  Serial.print("Switch:  ");
  Serial.print(digitalRead(SW_pin));
  Serial.print("  |  ");
  Serial.print("X-axis: ");
  Serial.print(analogRead(X_pin));
  Serial.print("  |  ");
  Serial.print("Y-axis: ");
  Serial.print(analogRead(Y_pin));
  Serial.println("  |  ");
  delay(200);
}
```

Snippet ofJoystick code

***On-going evaluation -***

Within my design I have 4 individual working parts that need to be coded. I sourced the water sensor code from the Arduino website and then the stepper motor, LCD screen and Joystick code from last minute engineers. Individually I tested to see if all the codes worked, which they did.  I did have trouble getting the LCD screen to work but I went and bought an affordable 12C screen online which made it so much more manageable with only 4 wires and not 16. The next step is no now merge them together to create one but taking out the most important parts from each.

***code:***


References

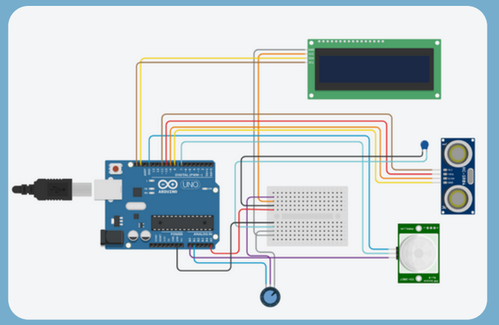
Arduino forum. (2024). Arduino and Stepper Motor Configurations | Arduino Documentation. Docs.arduino.cc. https://docs.arduino.cc/learn/electronics/stepper-motors

Last Minute Engineers. (2018, July 17). In-Depth: How 2-Axis Joystick Works? Interface with Arduino & Processing. Last Minute Engineers. https://lastminuteengineers.com/joystick-interfacing-arduino-processing/

Last Minute Engineers. (2020, November 8). In-Depth: Interfacing an I2C LCD with Arduino. Last Minute Engineers. https://lastminuteengineers.com/i2c-lcd-arduino-tutorial/#google_vignette

Last minute engineers. (2019, November 29). In-Depth: How Water Level Sensor Works and Interface it with Arduino. Last Minute Engineers. https://lastminuteengineers.com/water-level-sensor-arduino-tutorial/


# TINKERCAD -

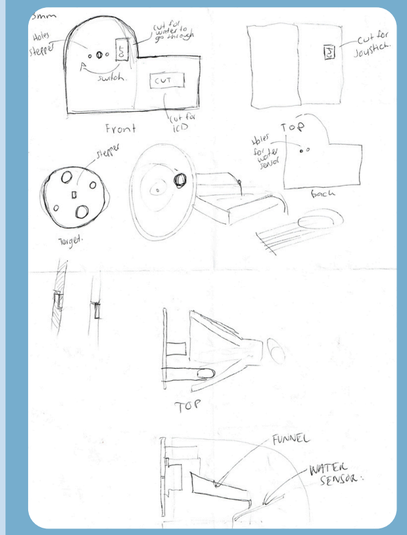


Tinkercad model

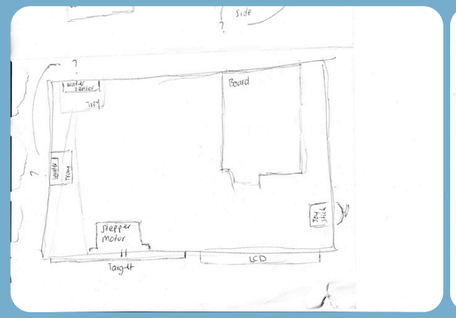
***On-going evaluation -***

TinkerCad was very useful to create a visual of my Arduino setup. It was good to be able to test my code without needed to physically construct it each time. To note that not all components were available in tinkercad so I replaced the LED, joystick, stepper motor and water sensor with items that have the same amount f pins.

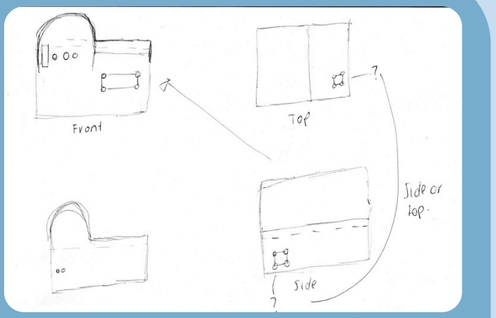
# SKETCHES -




Initial designs and funnel sketching




Top view of idea layout




Front, side and top view of model

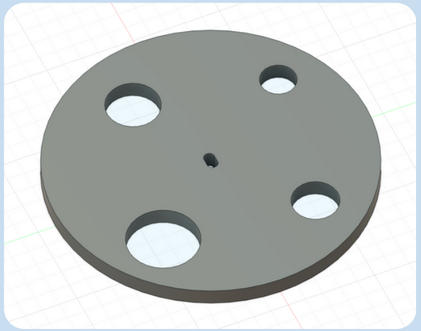
***On-going evaluation -***

Working through sketches was the most useful process for me during the fabric of my design as I could really visualise and see progress of how it was coming along. Originally I was really set on the semi circle design, I felt it completed the circular shape of the target and added to the aesthetics. As it was coming closer to the due date I was starting to fall behind and felt that it was to difficult to create in fusion. I traced the general shape of each Arduino component to get a rough draft of the size to start bringing my design to life in fusion. This was also useful to see how many holes and which pieces the holes with need to be cut out of to allow for the nuts and bolts.

Along with laser cutting a ‘house’ for the Arduino components I also decided to laser cut a target and 3d print a funnel. During prac class I worked with Danyon and brain stormed some possible solutions about how to funnel the water down to the sensor. We concluded that a funnel will run the width of the target and have a tired system to bring the water back towards the front so which will land in a draw so it can easily be drained.

# CAD -

## LASER CUT TARGET:



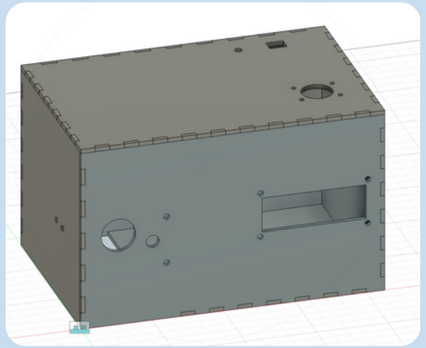
CAD model of the target

Target prototype

***On-going evaluation -***

I first made the target as I knew this would be one of the easier parts. I thought the target would be best suited laser cut with acrylic as it would be constantly hit with water. The acrylic is best suited as the water runs off plastic. The prototype was printed in ply to confirm the size. A 9cm diameter was large enough that all of the holes were positioned nicely but wasn't to big that it was going to be to easy to shoot water into.

## LASER CUT BASE:

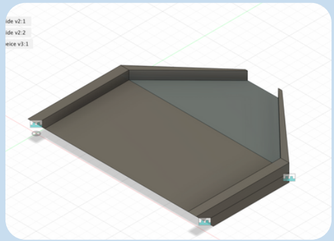


CAD model of the base

***On-going evaluation -***

Originally I wanted to have a semi circle design that replicates the circular shape of the target however I quickly realised that my skills in fusion weren't that advanced. In future if I had allowed myself more time to practice and learn it would be something that is more achievable. So instead I created a rectangular shape. Although it isn't as aesthetic it still has the same functions. I cut out holes for the all of the Arduino components to poke through and be bolted in. I am a little disappointed that my original design didn't come to fruition as I find it more aesthetic, so in the future I am going to need to allow for time to use CAD so I can expand my skill set.

## 3D PRINT FUNNEL + LED:

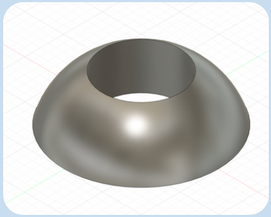


CAD model of the funnel

***On-going evaluation -***

As the funnel is a more technical design, I decided to 3D print this part. I made the base and the sides in separate files, imported them and then use the joint tool to create this shape. It did take me longer than I was hoping for and took lots of trial and error to get all the joins to line up correctly. I sent the file off to Danyon to print however there was an error. We both couldn't work out what I had done wrong but that I needed to remake it or choose something else to print. After careful consideration I decided that I would source something else to use as a funnel. I found this inexpensive hose tubing from Bunnings for just $3.50 which I thought I could just cut in half.

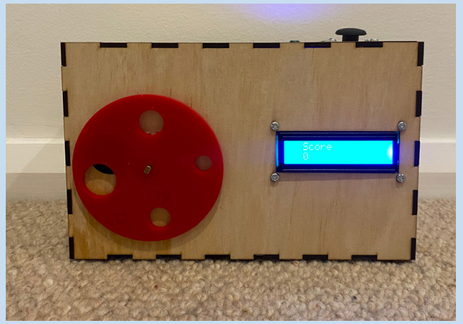

Bunnings. (2024). Pope 19mm x 90cm Clear Vinyl Tubing Bunnings. https://www.bunnings.com.au/pope-19mm-x-90cm-clear-vinyl-tubing_p3130572



***On-going evaluation -***

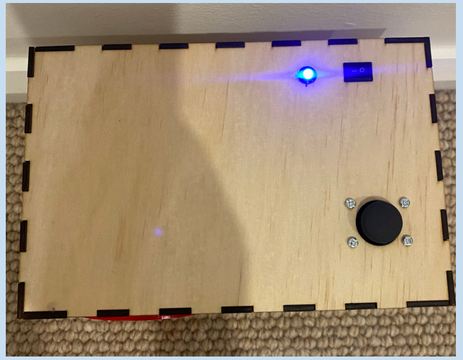
To satisfy the requirements of having a 3D printed component I decided to 3D print a 'guard' to go over the LED to give it a more finished look. This piece is only for aesthetic purposes.

# 2.3 FINAL DESIGN PHOTOS-



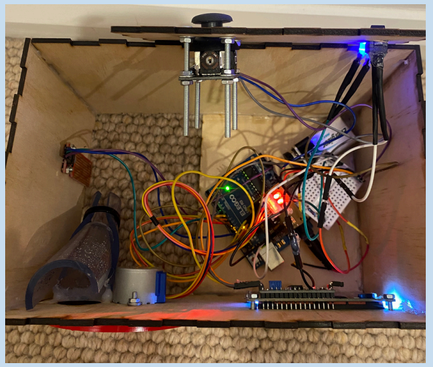
Front

Left side



Top

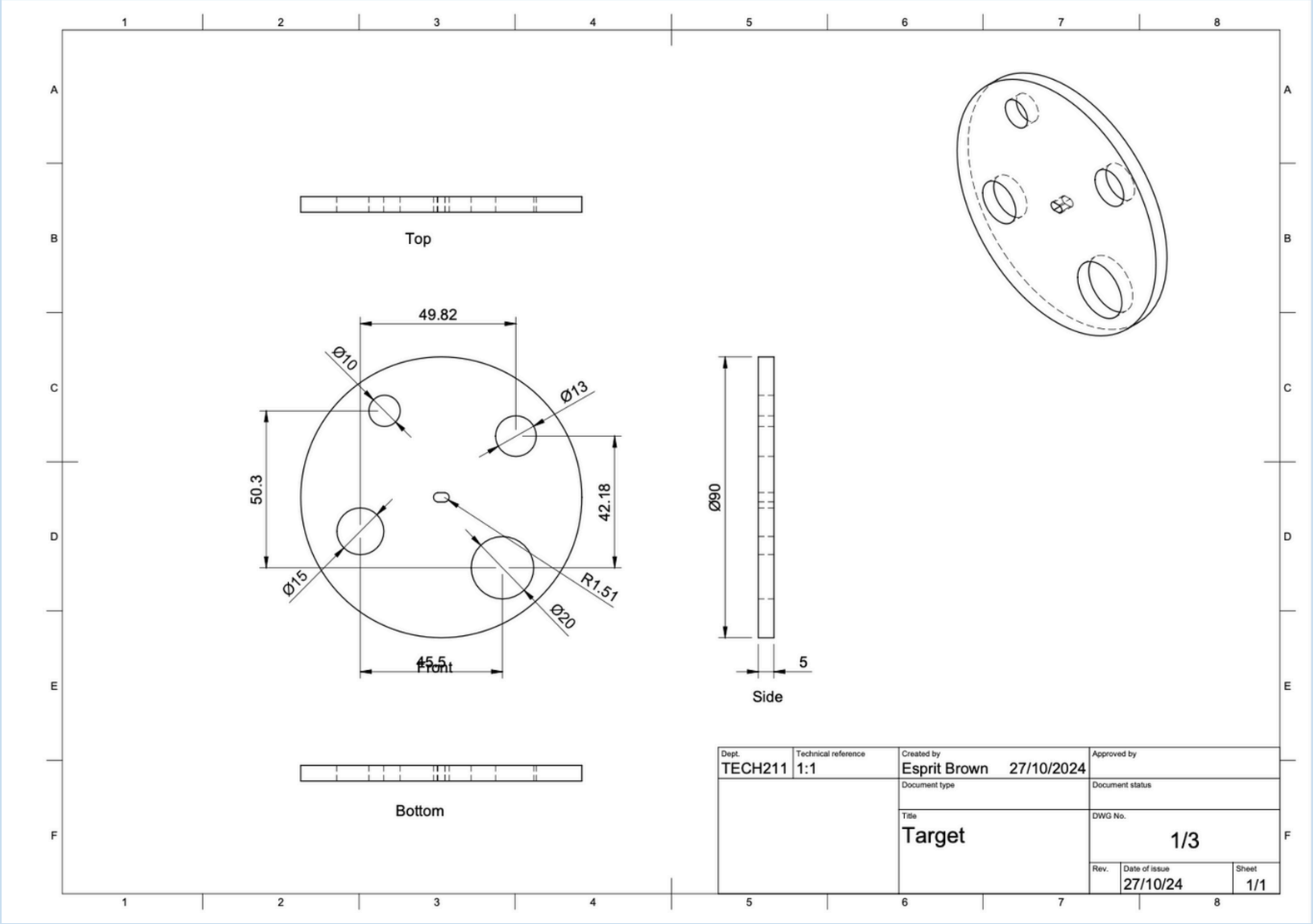
*Didn't include a photo of the back and right side because they are blank.



Top without lid

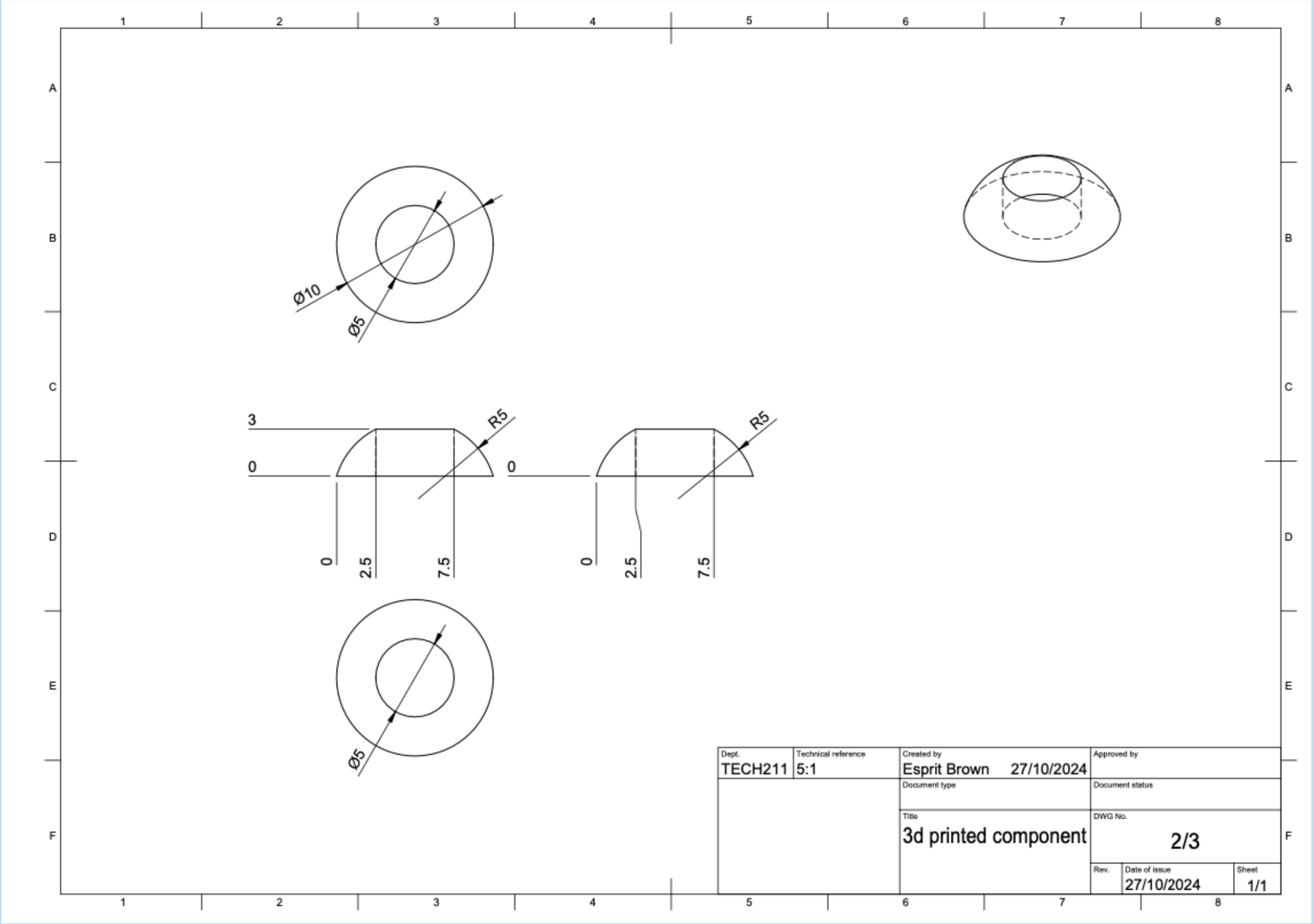
# SECTION 3: PROJECT PARTICULARS

## 3.1 FINAL DESIGN DRAWINGS -



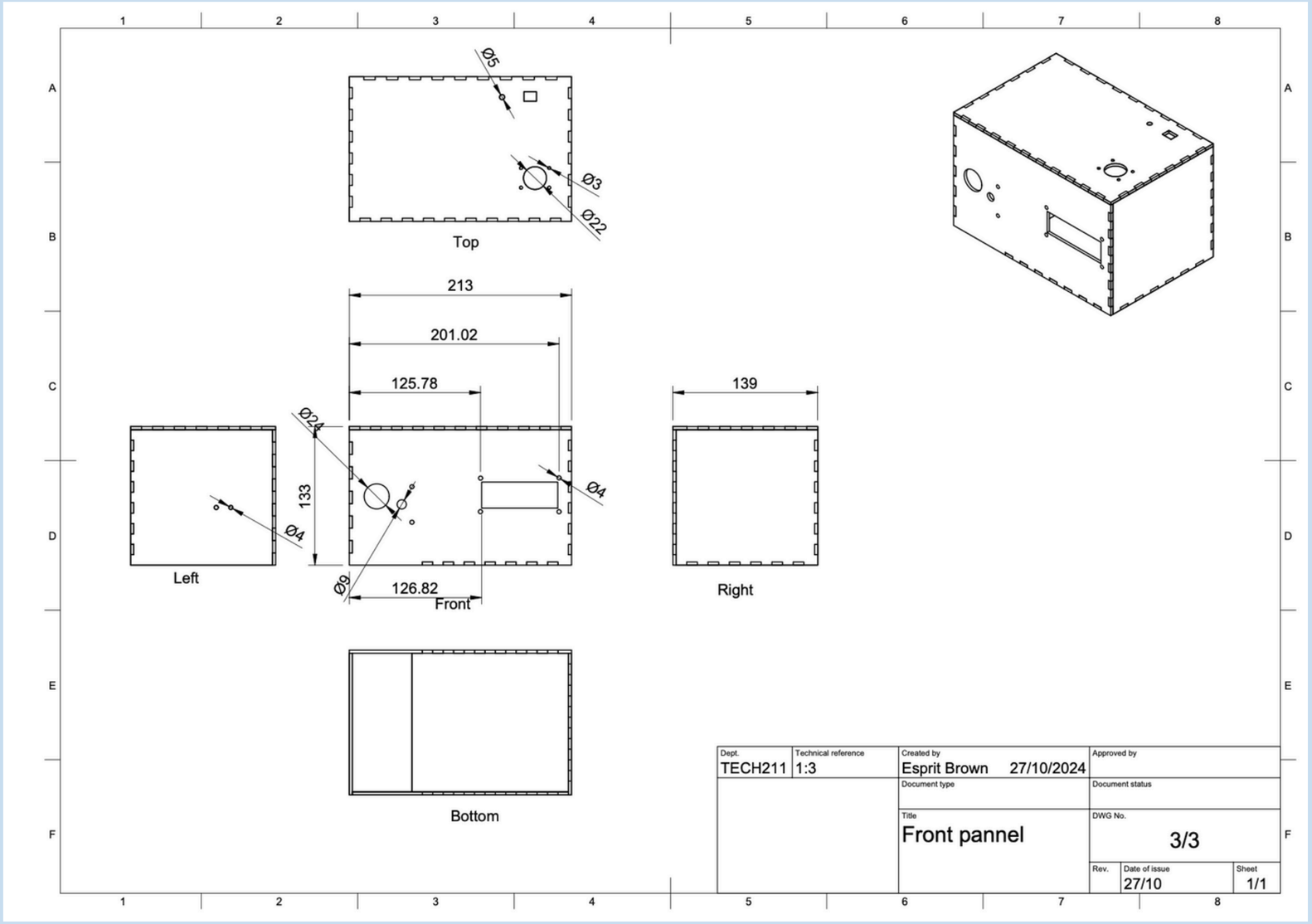

**DESIGN DRAWING FOR TARGET**

# 3.1 FINAL DESIGN DRAWINGS -



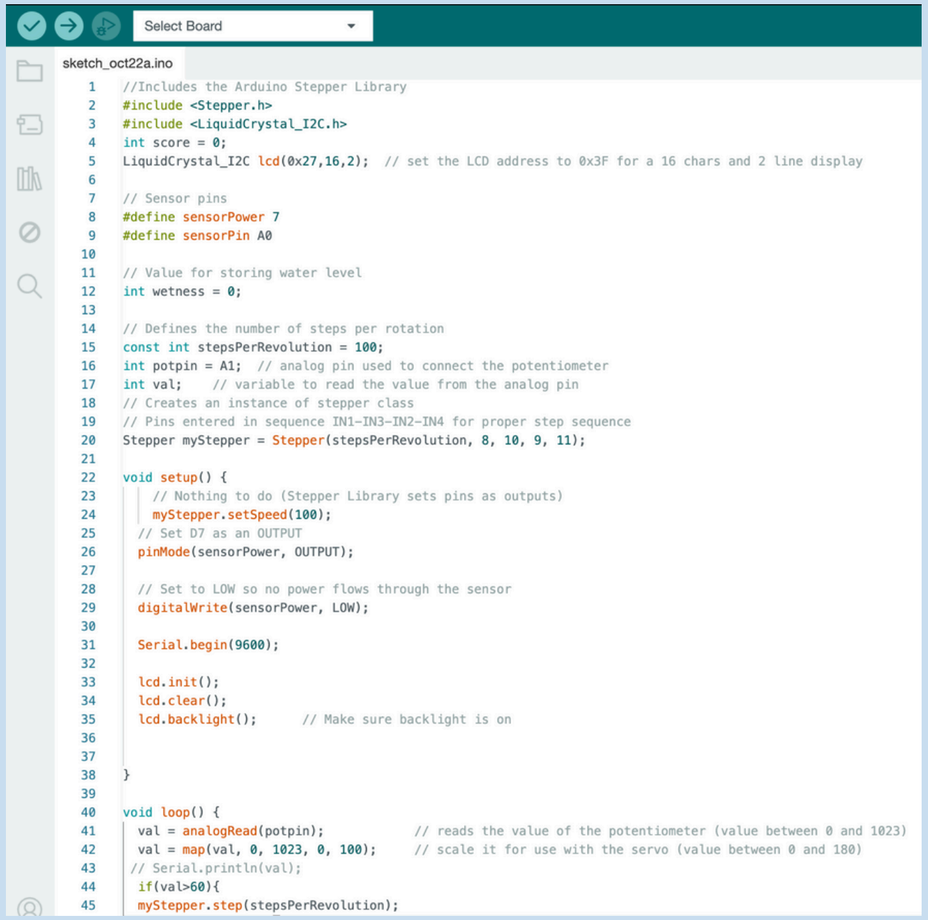

**DESIGN DRAWING FOR LED PEICE**

# 3.1 FINAL DESIGN DRAWINGS -

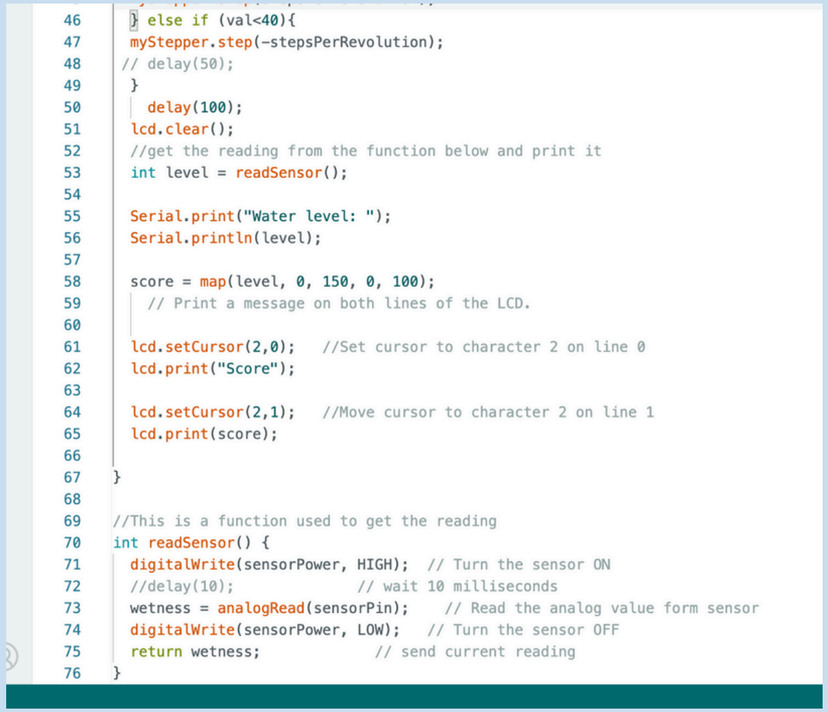



**DESIGN DRAWING FOR BASE**

# 3.2 ARDUINO CODE -




Completed working arduino code




Completed working arduino code continued

***code:***
Arduino forum. (2024). Arduino and Stepper Motor Configurations | Arduino Documentation. Docs.arduino.cc. https://docs.arduino.cc/learn/electronics/stepper-motors

Last Minute Engineers. (2018, July 17). In-Depth: How 2-Axis Joystick Works? Interface with Arduino & Processing. Last Minute Engineers. https://lastminuteengineers.com/joystick-interfacing-arduino-processing/

Last Minute Engineers. (2020, November 8). In-Depth: Interfacing an I2C LCD with Arduino. Last Minute Engineers. https://lastminuteengineers.com/i2c-lcd-arduino-tutorial/#google_vignette

Last minute engineers. (2019, November 29). In-Depth: How Water Level Sensor Works and Interface it with Arduino. Last Minute Engineers. https://lastminuteengineers.com/water-level-sensor-arduino-tutorial/

# 3.3 LIST OF PARTS -

- 3mm Ply - Used to laser cut the box.
- 3mm Acrylic - Used to laser cut target.
- 3d Print Filament - Used to illuminate LED.
- Hot glue - Used to glue together the ply and also used to keep wires in place.
- Wires - Used to created circuit.
- Arduino Board - reads input and stores code.
- Mini Bread board - used as extra space.
- Switch - used to cut the power to circuit.
- Battery - powers circuit.
- LED - turns on and off according to the power input.
- Joystick - determines the rotation of the target clockwise and anti clockwise.
- Stepper motor - rotates the target based on the input from the joystick.
- LCD Screen - Displays the score based on water detected.
- Water sensor - Detects water levels.
- Vinyl tubbing - Funnels water down to water sensor.
- Cable tie - Holds tubbing together.

# SECTION 4: PROJECT EVALUATION

## 4.1 DESIGN EVALUATION -

Throughout the construction of my project I have evaluated each step to best understand and improve my project.

Functionally Aqua strike meets all 3 requirements. 1. Aqua strike demonstrates automation through a sensor (water sensor), 2. When condition is meet, this should trigger an output (score being displayed on LCD screen and 3. this behaviour must be repeatable. Aqua Strike can be played endlessly simply by emptying the water container by lifting up the box.

Physically aqua strike also meets all 8 requirements. Aqua Strike fits within a 250x250x250mm cube, uses CAD software (fusion) to create models to 3D print, laser cut and design drawings. My model includes an Arduino board which is powered by a battery. The power is turned on and off with a power switch, LED to show when the power is on and incorporates a stepper motor to spin the target. Finally the the wires are suitably enclosed the the use of a laser cut box.

The aesthetics is where I feel I lacked the most. I feel my original design incorporating a semi circle would be must more visually appealing and engaging instead of a rectangle. I feel that due to time management I didn't leave myself time to learning the new skills that were requirement to construct that shape in fusion. To construct the model I used hot glue to stick all the components together, in future I would consider other methods or be more careful when doing so as the hot glue can look messy and tacky.

Overall  really like the final design of aqua strike, I believe there is mainly improvements to be made to the aesthetics of the design. I feel this area was sacrificed due to my bad time management.

## 4.2 RELEVANCE TO THE INDIVIDUAL, SOCIETY AND EDUCATION -

The mechatronic design project has influenced me in various ways, by enhancing my knowledge of automation, interactivity, and user centred design within the context of this unit's learning objectives. This project allowed me to gain practical experience in combining hardware components like sensors, motors, and feedback systems into an interactive model, strengthening my understanding of automation and feedback mechanisms. This project made me think critically about user engagement, system accuracy, and safety, which are all important factors in real-world automation technology applications.

Integrating automation projects in the classroom enhances student involvement and promotes critical thinking abilities. Majd indicates that interactive learning activities in STEM subjects increase students’ engagement and memory retention (Majd, 2018). In a high school environment, AquaStrike can be a beneficial resource for studying concepts of automation, physics, and user engagement. The project aligns well with STEM education goals years 7-10, as it combines physics (trajectory, timing, and force of water shots), mathematics (scoring algorithms), and computer science (sensor feedback loops, motor control) (DOE, 2023).