DTI PROJECT DOCUMENTATION

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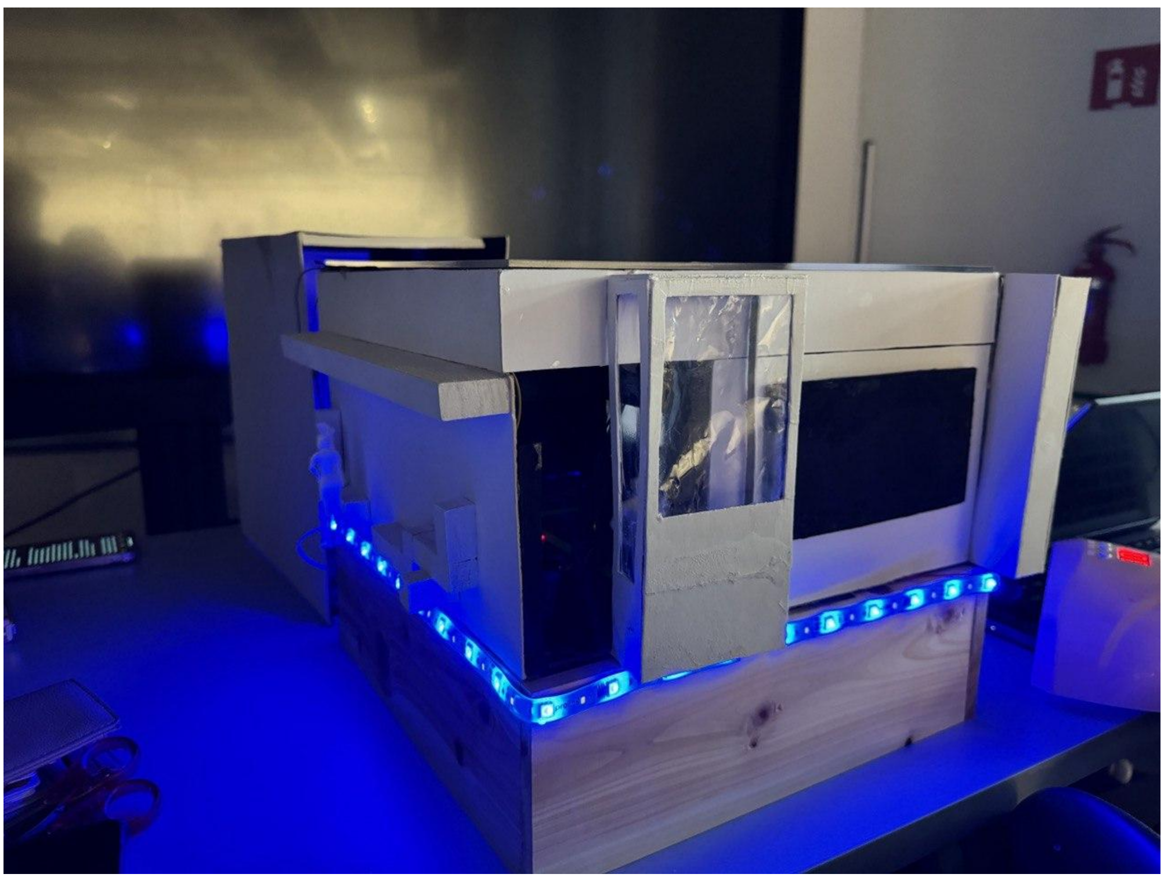
IX: DIMENSION



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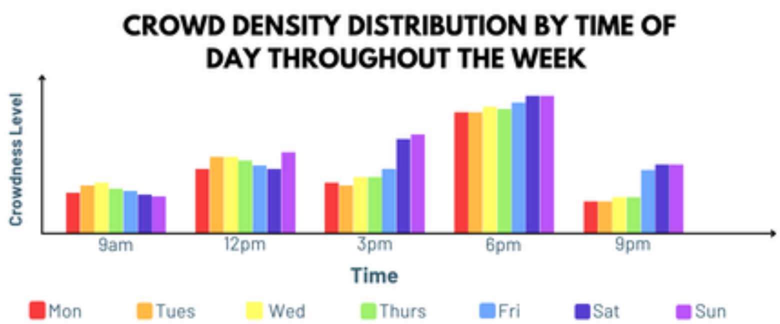
Background & The Problem

a. Outside Expo MRT EXIT D
The place where workers walk through to get to Changi City Point, or to simply walk through to go home after work. The open space provides infinite opportunities for social interaction in its large open area. Installations such as light displays or even games will encourage people to hang around and bond with their coworkers after a long day of work, or even in between their work timings.

b. The Problem
A large open space with no decorations and no purpose. What can we do to encourage more social interaction? What can attract people to come to hang out and hang around this area?



Our Solution

a. What's more to love than a maze that grants you vouchers when you finish it? When you're having a bad day at work and you want to have a nice night out with your team and have some fun, it's right outside your building. It's pitch-black, highly interactive, and rewarding. You go through the maze, solving mini-games with your partner-in-crime, getting to the end with the rest of your teammates, and are met with amazing rewards!

   Our team is positive that this maze will increase the social interaction level at this open space, fully maximizing its potential by creating an out-of-this-world experience for these business workers. It's near, it's fun, and it's definitely worth the time visiting.

b. Inspiration: This project was inspired by the potential our group saw with the open space outside Expo MRT. Workers often stand around or sit around doing nothing during the day, and when the night comes, all they do is walk through this empty space. With our maze, our goal was to light up the place and create an opportunity for these workers to have a good time in the midst or the end of their day-to-day work life. Video games or board games are always a great way to relax or have fun or even kill time with your friends or coworkers. We brought it to life using light projections onto the floor to create a thrilling effect.

Survey Results

To improve our solution, we came up with a survey to have a better understanding of how people felt about our site and how well our solution would tackle our chosen problem statement. The followings are the survey questions we arranged and the corresponding results.

1. Have you been to this area?
   (Outside CCP and Expo MRT Station Exit D)

More Details

Yes	33
No	5

2. Do you think there is a need for more seating areas here?

More Details Insights

Yes	20
No	18

The above questions show the familiarity of people with our site and the need for more seats. Especially the second, we decided to further improve our solution to solve this issue.

3. Would you like to play games with your friends for voucher prizes?

More Details

Yes	29
No	9

4. Do you think playing interactive games with friends is an effective way of enhancing social interaction?

More Details   Insights

Yes	33
No	5

We decided to add these above questions to gauge people's interest and how well vouchers will work as an incentive to participate in a game. Also, to have their opinion on interactive games as a method of promoting social interaction.

5. Now that you know more about IX Dimension, would you be interested in coming to play here with your friends?

More Details   Insights

Yes	31
No	7

6. Do you think that this is an effective way to enhance social interactions in this place?

More Details | Insights

Yes	32	
No	6	

After giving a brief explanation of our solution, we want to gauge their initial impression and interest in the game.

7. Do you know about this brand: Hey Long Cha?

More Details | Insights

Yes	22
No	16

8. Given promotional vouchers, would you patronize this store more?

More Details | Insights

Yes	27
No	11

Then finally, to further solidify their motivation to participate in the game, we gave a hypothetical collaboration with Hey Long Cha, and their interest in the brand.

System In Depth

How the maze works:

Absolutely, let's include that part:

Welcome to our thrilling maze adventure! Here's how the game unfolds:
As you and your three coworkers approach the maze, eager for a night of fun, you're greeted by the staff at the kiosk who provide you with instructions. The maze is designed to be tackled by two groups at the same time, ensuring there's always a sense of companionship and teamwork.

Upon entering the maze, you'll find yourselves in the first room where both sets of lasers are deactivated, allowing your groups to freely decide which path to take. Group 1 and Group 2 split off, each heading in a different direction, setting the stage for a truly unique adventure.

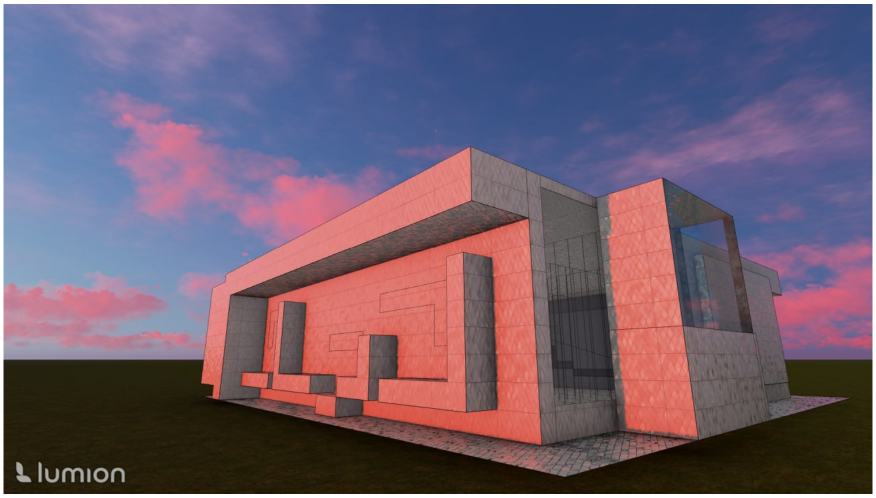
In the next room, each group encounters a different mini game, carefully curated to change every week, ensuring that no two visits to the maze are ever quite the same. Upon completing the mini game, a flash of numbers appears, which you're instructed to note down by the staff, adding an element of mystery to your journey.

After each mini-game, one wall of lasers will either light up or remain inactive, indicating the direction the game has chosen for your group to proceed. The maze comes to life, with one wall of lasers either lighting up with a crimson glow, indicating a path you cannot traverse, or remaining inactive, allowing you to progress. This dynamic feature adds an exciting twist to your exploration, as you must decipher the maze's cues to navigate its winding corridors.
Following these cues, you navigate through the maze, encountering new challenges and puzzles along the way.

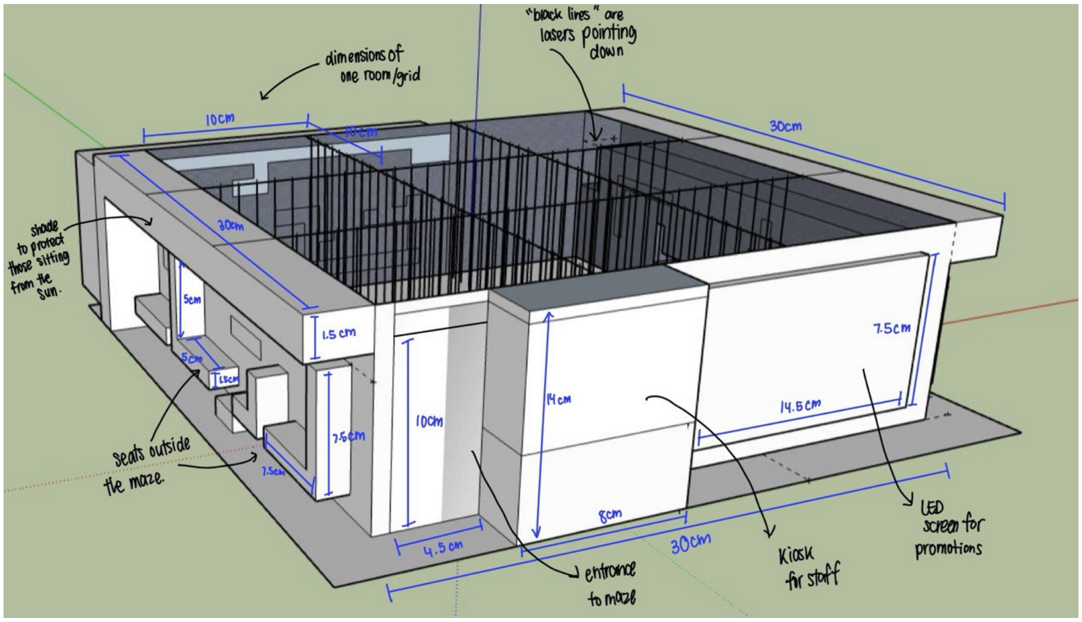
Once all four mini games are conquered by both groups, you'll find yourselves in the final room, where the last piece of the puzzle awaits. Here, a keypad challenges you to use the numbers gathered from the mini games to unlock the door. By solving all four sets of numbers and converting the final word into numerals, you gain access to the prize that awaits you beyond the maze.

With the game completed and the prize in hand, you and your coworkers can depart, filled with excitement and memories of a thrilling adventure shared together.

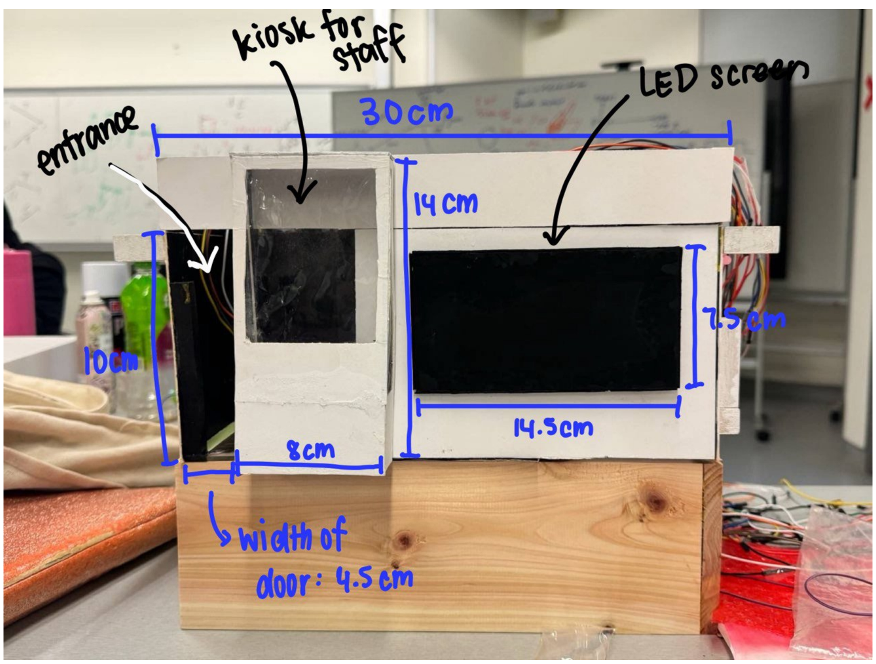
Key Images:

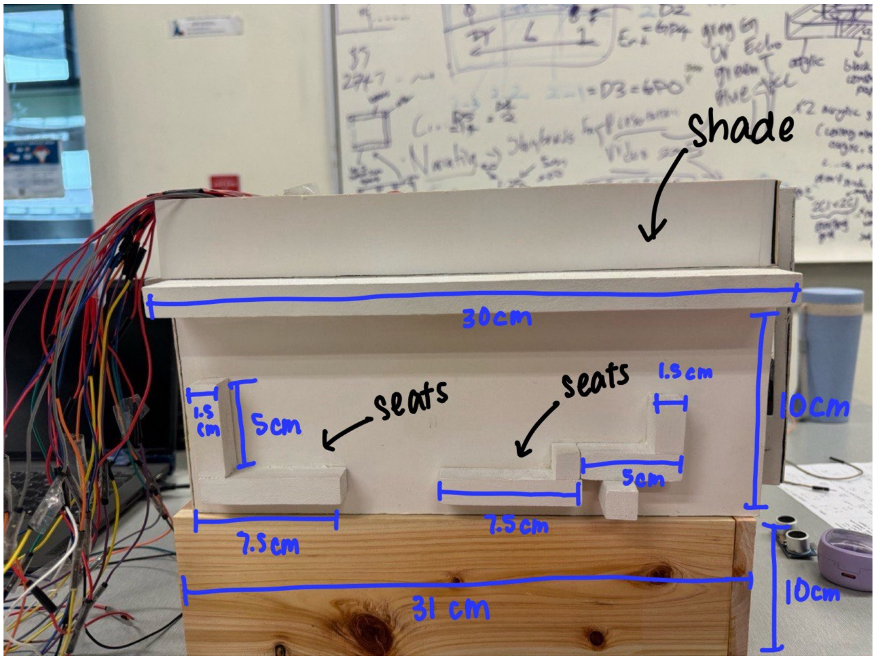


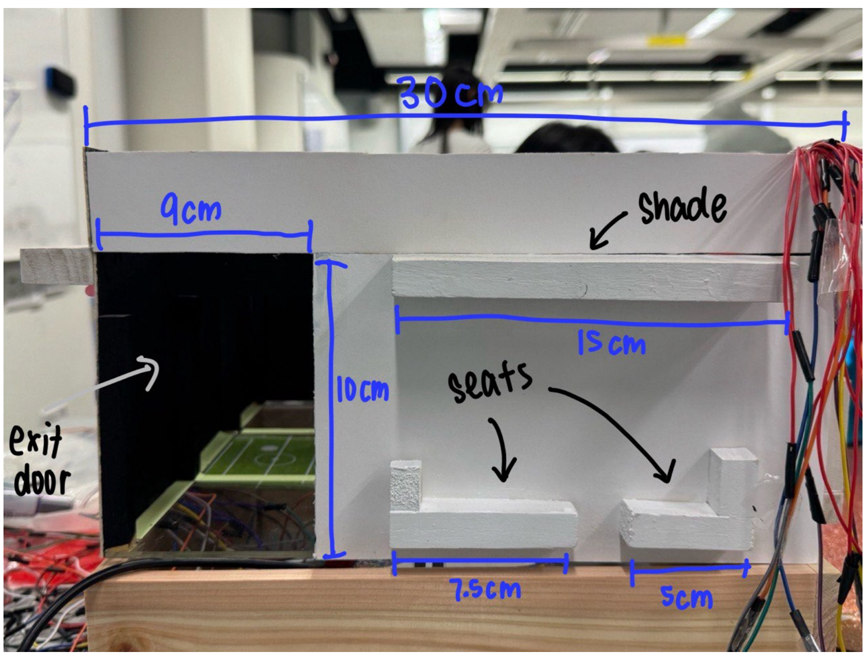
System Specifications



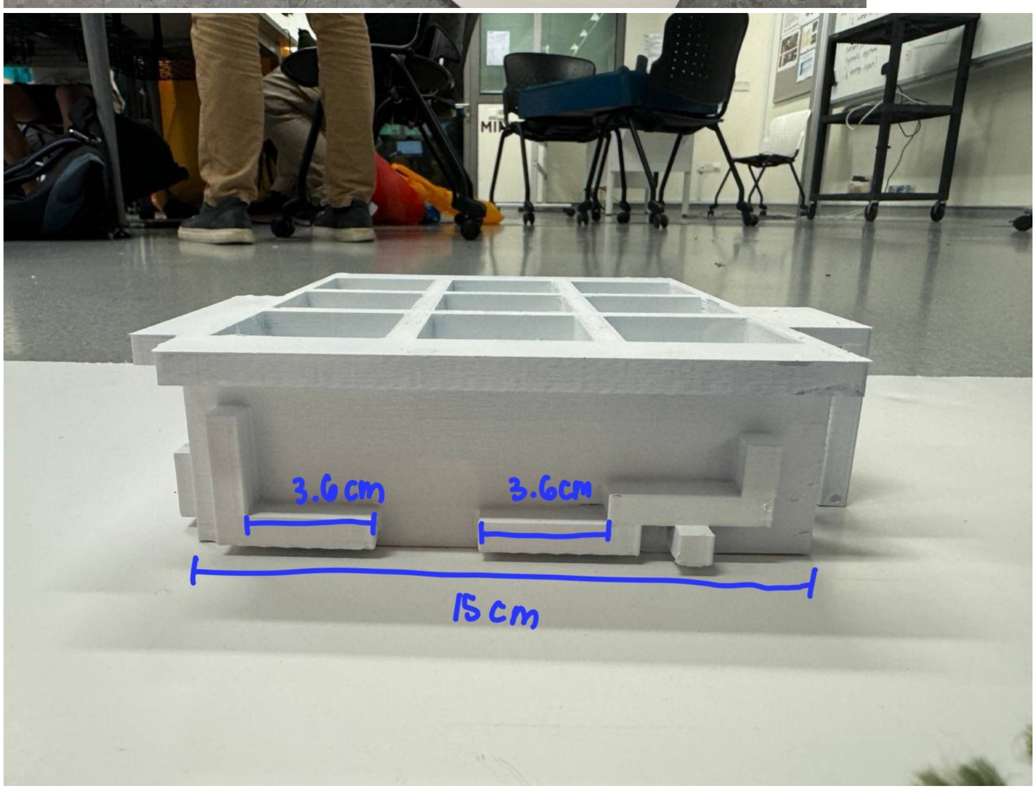
Functional Model Dimensions:

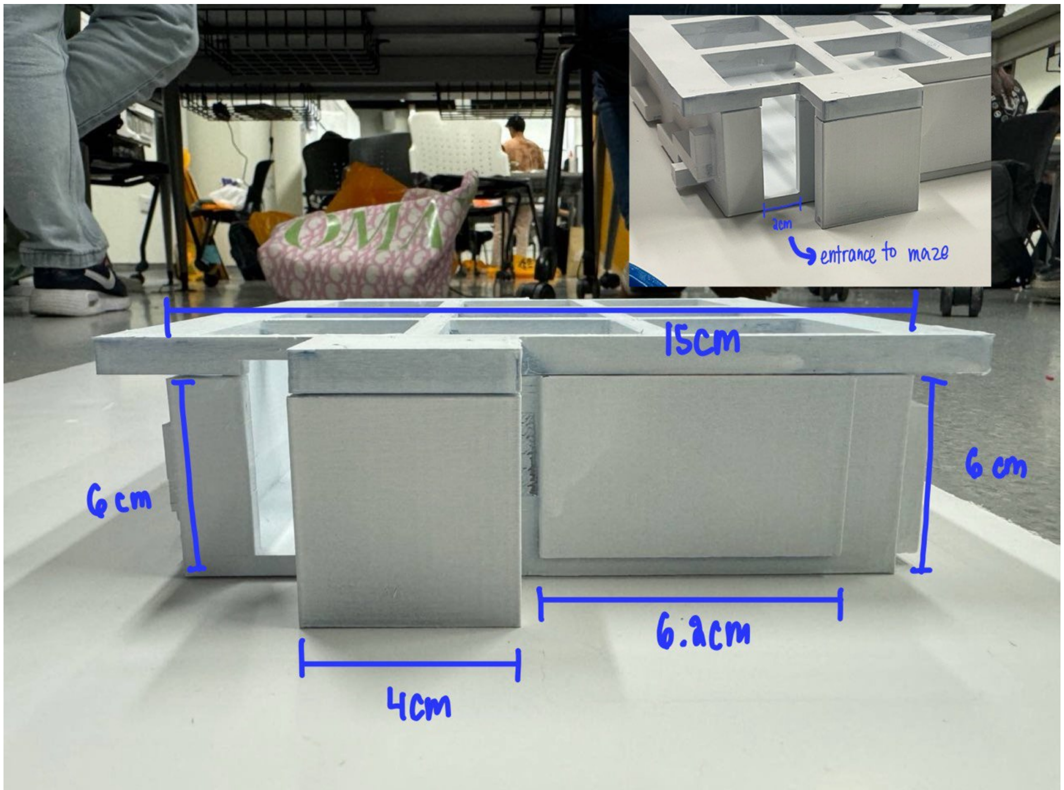



shade
30cm
seats
seats
1.5cm
1.5 cm
5cm
10cm
5cm
7.5cm
7.5cm
31 cm
10cm


30 cm
9cm
shade
15 cm
10cm
seats
exit door
7.5cm
5cm

Site Model Dimensions:



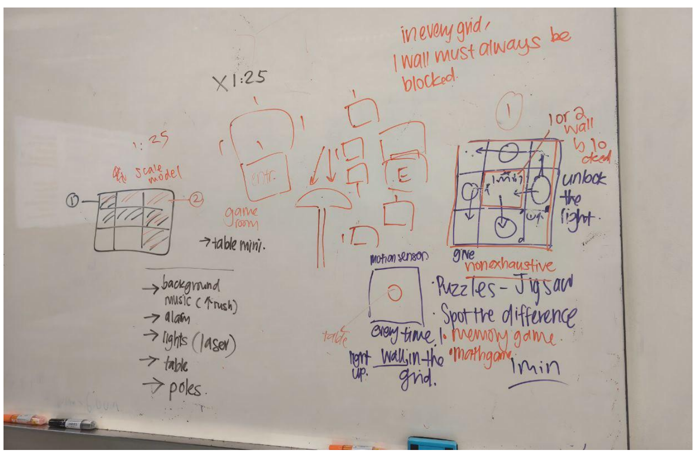

2cm
entrance to maze
15cm
6 cm
6 cm
4cm
6.2cm

1st Development Stage:

a. Decision-Making for the dimensions of one grid:

1st Iteration:
5m by 5m by 3.5m (height)
2nd Iteration:
3.5m by 3.5m by 3.5m (height)
3rd Iteration:
2.5m by 2.5m by 2.5m (height)

b. Decision-Making for the materials for maze functionalities:



1st Iteration:
Our original group maze idea was just complete darkness that unfolds once you enter. One group of people inside the maze would have to work their way through the maze and at the end, there are no rewards given as well.
This had a target end time of about 5 minutes.

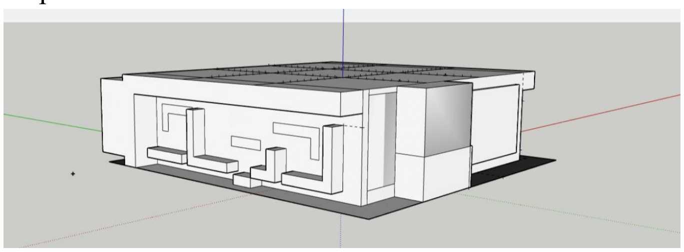
2nd Iteration:
We added in the minigames to extend the timing of finishing the maze to now about 15 minutes.

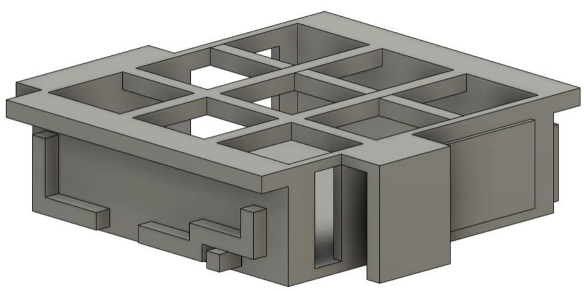
3rd Iteration:
4 minigames were to be put in 4 rooms out of the 3x3 room maze.
One group of people would have to split into two groups in order to finish it.
After each minigame is done, a set of numbers is flashed to one set of people and to be taken note of. 4 sets of numbers are set to have been collected by the time both groups reach the final room.
A keypad is added in the last room to add the mystery thrill for the numbers they gather to be solved at the end, to unlock the door that lets them exit the maze.

Prototyping

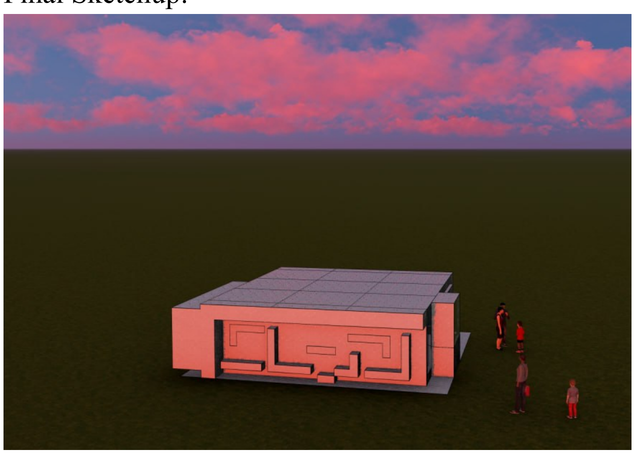
Our team first prototyped it using recycled cardboard and ice cream sticks to finalize the scaling and how the maze would look like. This step made it easier for us to visualize what we had to create in Sketchup and to make further decisions on the maze functionalities in the 1st Development stage.

Our team used SketchUp before going to the Fablab to get the woodwork done. This step also helped us create better ideas for our 3rd and 4th iterations - adding minigames and the keypad.





Final Sketchup:

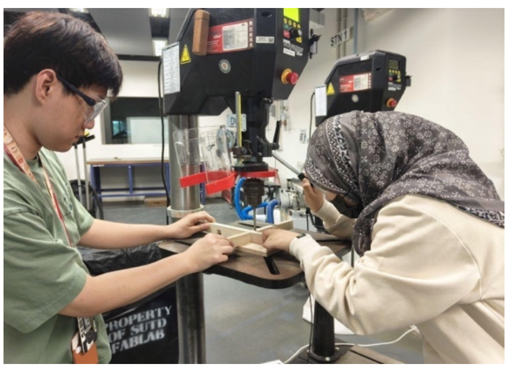


2nd Development Stage:

a. Components & Materials

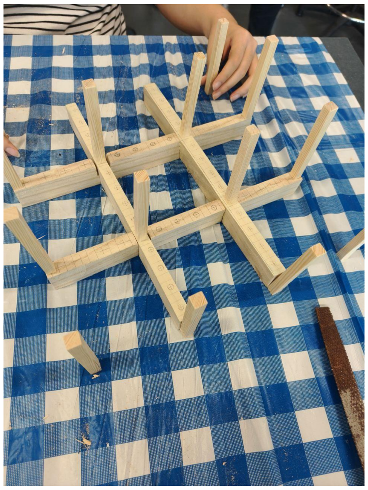
   i. Arduino
   ii. Breadboard
   iii. Laser diodes
   iv. ESP32
   v. Sensors
   vi. Acrylic Sheets
   vii. Craft Wood Plank
   viii. LED light
   ix. Plywood

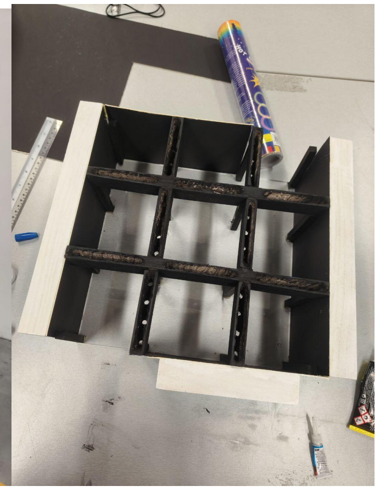
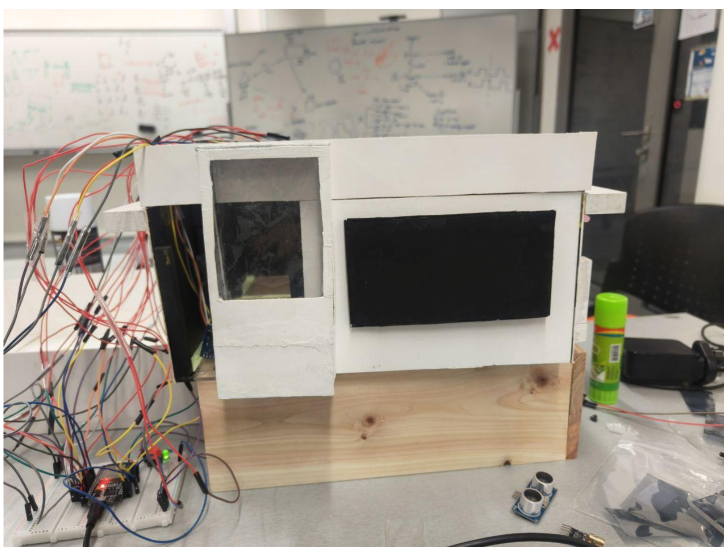
b. Fablab Experience

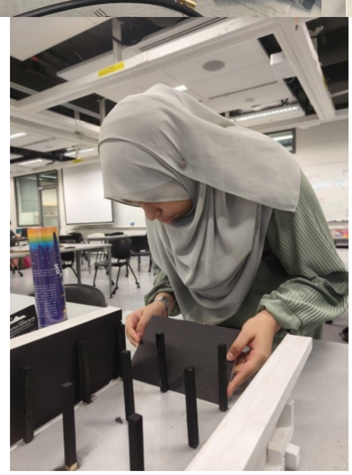
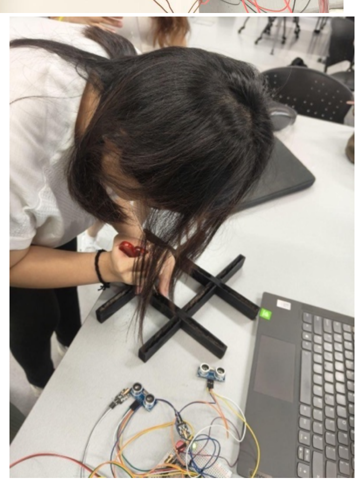



- Alysha, Lixuan and Jing Yang made magic in the fablab today, creating the beams and the base for our prototype. It went very smoothly, but they did encounter one problem: the beam was too long to fit in the cutter, leading them to do some "gymnastics" with the pole to cut it! In the end, no wood was wasted in this process and the mission was accomplished.

c. Making the Functional Model

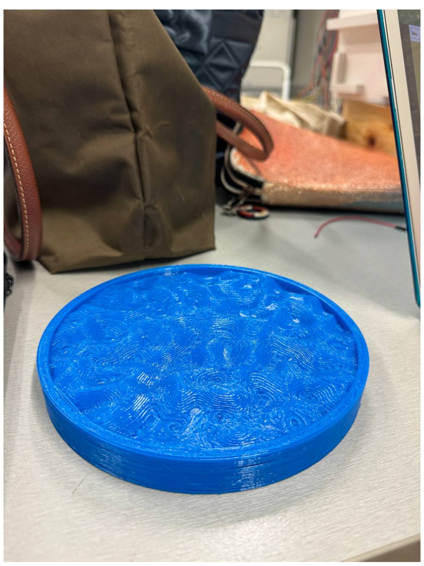


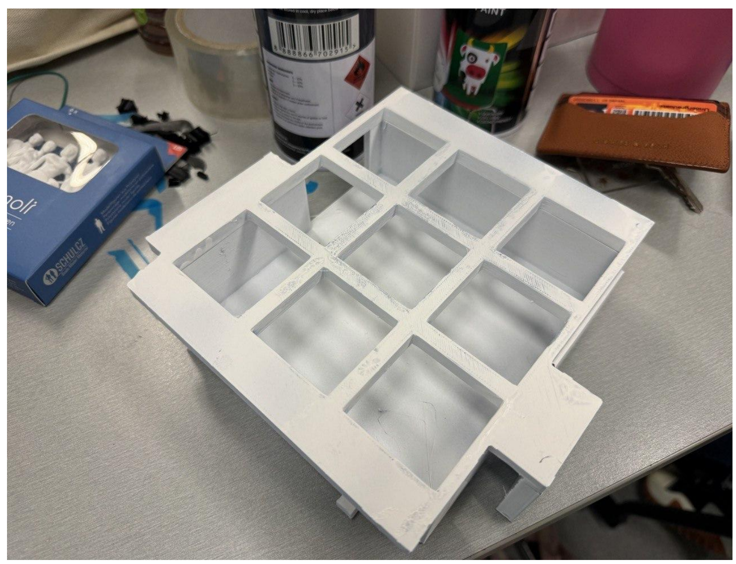



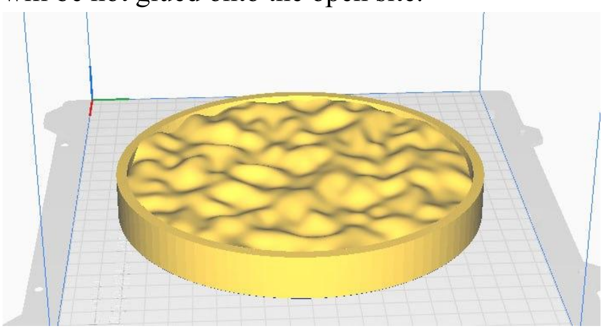
- First, we started with creating the beams from the wood, attaching it to our acrylic sheet base, and we proceeded to spray paint it black to get the dark vibe for our maze.
- Next, we used our construction board utilizing its hardness to create the walls for our maze. The exterior was spray-painted white, and its inside was painted black.
- Then, for the coding of the lasers, they were inserted into the holes on the horizontal beams that connect our standing beams together. These holes were meant to hold the lasers in place.
- Lastly, our functional model is placed at an elevated height from the floor. The top of the maze is covered by a white cardboard box to hide the wires, and ensure that it is dark inside for the lasers to be seen!
- The most crucial part was trying to get the laser lines to be seen: our group used multiple ways; deodorant, an electric pot cooker, and even a clothing iron. All of these items produce steam but only deodorant came through as it is portable and does not need to be plugged in. We will demonstrate this during the presentation.

d. Making the Site Model

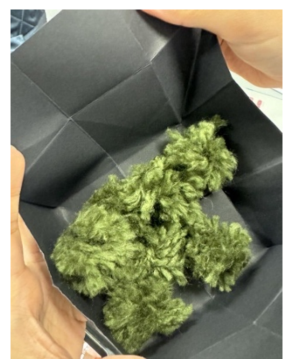




- First, we 3D printed a miniature version of our maze and the fountain in the open space. We maintained the scaling of our original functional model and made it as accurate as possible. These will be hot glued onto the open site.



- The leaves are green yarn that were handcrafted to look like bushes!



e. Coding the Keypad (Process Thinking)

```
#include "Keypad.h"
#include "Wire.h"
#include "LiquidCrystal_I2C.h"

LiquidCrystal_I2C lcd(0x27, 16, 2);

const byte rowCount = 4;
const byte colCount = 3;
const byte rowPins[rowCount] = { 11, 10, 9, 8 };
const byte colPins[colCount] = { 7, 6, 5 };
const char keys4x3[rowCount][colCount] = {
  { '1', '2', '3' },
  { '4', '5', '6' },
  { '7', '8', '9' },
  { '*', '0', '#' }
};

Keypad keypad = Keypad(makeKeymap(keys4x3), rowPins, colPins, rowCount,
colCount);

const int maxPwdLen = 16;
const String password = "5024";
String input;
String inputword;
char keypressed;
boolean success = false;
```

Declaration of necessary libraries and global variables

```
void setup() {
  Serial.begin(9600);
  input.reserve(maxPwdLen);
  inputword.reserve(maxPwdLen);
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Please enter the");
  lcd.setCursor(0, 1);
  lcd.print("passcode");
}
```

Initial setup for connection to Arduino and text display on the LCD

```
void loop() {
  readKeypad();
  if (!success) {
    if (input.length() > 0) {
      lcd.clear();
    } else {
      lcd.setCursor(0, 0);
      lcd.print("Please enter the");
      lcd.setCursor(0, 1);
      lcd.print("passcode");
    }
  }
  if (keypressed == '#') {
    if (input == password) {
      lcd.setCursor(0, 0);
      lcd.print("Access Granted");
      success = true;
      input = "";
      inputword = "";
      delay(1000);
      lcd.clear();
      delay(1000);
      lcd.print("You have escaped");
    } else {
      lcd.setCursor(0, 0);
      lcd.print("Access Denied");
      input = "";
      inputword = "";
      delay(2000);
      lcd.clear();
      delay(500);
      lcd.print("Please Try
Again");
      delay(2000);
      lcd.clear();
    }
  }
  if (keypressed == '*') {
    if (input.length() > 0) {
      int lastIndex =
input.length() - 1;
      input.remove(lastIndex);
      int lastIndexWord =
inputword.length() - 1;

inputword.remove(lastIndexWord);

      lcd.clear();
      lcd.print(input);
      lcd.setCursor(0, 1);
      lcd.print(inputword);
    }
  }
  lcd.setCursor(0, 0);
  lcd.print(input);
  lcd.setCursor(0, 1);
  lcd.print(inputword);
  delay(100);
}
```

Loop function to constantly check for pressed keys on the keypad and display corresponding messages

```
void readKeypad() {
  keypressed = keypad.getKey();
  if (keypressed != '#' && keypressed
!= '*' && (input.length() < maxPwdLen
|| inputword.length() < maxPwdLen)) {
    String key = String(keypressed);
    input += key;

    if (keypressed){
      int asciiValue = (keypressed -
'0') + 65;
      char asciiLetter =
char(asciiValue);
      inputword += asciiLetter;
    }
  }
}
```

Filtering out non-alphanumerical inputs and performing corresponding actions

Lines of code for the Keypad function. Please refer to the attached file named “Keypad” for a closer look.

g. Coding the Laser Diodes (Process Thinking)

```
#include "NewPing.h"

unsigned int distance6;
unsigned int distance2;
unsigned int irReading;
unsigned long startTime;
bool mazeActivated = false;
bool motionDetected = false;
bool buttonPressed = false;
bool wall2Activated = false;
bool wall6Activated = false;
bool wall7Activated = false;
bool wall5Activated = false;
bool wall1Activated = false;
bool countdown_over = false;
bool irdetected = false;


//declaring constant variables
const int trig_six = 4;
const int echo_six = 15;
const int trig_two = 19;
const int echo_two = 18;
const int max_dist = 10;
const int laser1 = 13;
const int laser1_1 = 23;
const int laser2 = 2;
const int laser5 = 26;
const int laser6 = 25;
const int laser6_1 = 33;
const int laser6_2 = 32;
const int laser7 = 27;
const int irSensor = 14;
const int pushBtn = 5;
const int ledPin = 22;

//declare ultrasonic
NewPing sonar6(trig_six,echo_six, max_dist);
NewPing sonar2(trig_two,echo_two,max_dist);
```

Declaration of necessary libraries, boolean states, and global variables for ultrasonic sensor, lasers, IR sensor, push button and LED pin.

```
void setup() {
 Serial.begin(115200);
 pinMode(trig_six, OUTPUT);
 pinMode(echo_six, INPUT);
 pinMode(trig_two, OUTPUT);
 pinMode(echo_two, INPUT);
 pinMode(pushBtn, INPUT);
 pinMode(ledPin, OUTPUT);
 pinMode(laser1, OUTPUT);
 pinMode(laser2, OUTPUT);
 pinMode(irSensor, INPUT);
 pinMode(laser5, OUTPUT);
 pinMode(laser6, OUTPUT);
 pinMode(laser7, OUTPUT);
 pinMode(laser6_1, OUTPUT);
 pinMode(laser6_2, OUTPUT);
 pinMode(laser1_1, OUTPUT);
}
void startCountdown() {
 // Start the countdown from 10 to 1
 for (int i = 10; i >= 1; i--) {
   // Display the current count (optional)
   Serial.println(i);

   // Blink the LED for each second
   digitalWrite(ledPin, HIGH);
   delay(500);
   digitalWrite(ledPin, LOW);
   delay(500);

   // set countdown_over boolean val = true
   if (i == 1) {
     countdown_over = true;
   }
 }
}
```

ESP32 sets up serial, ultrasonic, laser, button, LED, and IR pins. **startCountdown()** counts 10 to 1, blinks the LED, and sets **countdown_over** to true.

```
void loop() {
 delay(50);
 int push_btn_state = digitalRead(pushBtn);
 irReading = digitalRead(irSensor);
 distance6 = sonar6.ping_cm();
 distance2 = sonar2.ping_cm();

 if (irReading == LOW){
   Serial.println("Motion Detected, Visitors entered the
maze");
   mazeActivated = true;
   irdetected = true;}
 if (mazeActivated == true){
     if (distance6 > 0 && distance6 < 4 && wall6Activated ==
false && irdetected == true) {
       //wall 6 should be open!
       Serial.println("Countdown of 10s have started");
       startCountdown();
       if (countdown_over = true){
         Serial.println("It is now safe to close off the
wall");
         trapGrid6();
         wall6Activated = true;
         Serial.println("All walls of grid 6 is closed!");
       }}
      if (distance2 > 0 && distance2 < 5 && wall2Activated ==
false && irdetected == true){
       //wall2 should be open!
       Serial.println("Countdown of 10s have started");
       startCountdown();
       if (countdown_over = true){
         Serial.println("It is now safe to close off the
wall");
         digitalWrite(laser2,HIGH);
         digitalWrite(laser1_1,HIGH);
         wall2Activated = true;
         Serial.println("All walls of grid 2 is closed!");
       } }
```

The loop function checks the IR sensor and ultrasonic distances. If motion is detected by IR, `mazeActivated` is set. Depending on distances from the ultrasonic sensors, countdowns start and walls activate. Once countdowns end, walls close and activation flags are set.

```
      if (push_btn_state == HIGH) {
         digitalWrite(ledPin, HIGH);}
     else {
     digitalWrite(ledPin, LOW);
     buttonPressed = true;}
   if (wall6Activated == true && buttonPressed == true){
       Serial.println("User successfully finished the mini
game");
       Serial.println("Grid 6 Deactivated, You can now enter
either wall 5 or 7!");
       releaseWall5();
       releaseWall7();
       wall6Activated = false;
       Serial.println("Countdown of 10s have started");
       startCountdown();
       if (countdown_over = true){
         Serial.println("It is now safe to close off the wall");
         trapGrid6();
         wall6Activated = true;
         buttonPressed = false;
         Serial.println("All walls of grid 6 is closed!");
         //wall6 to be opened to allow new users to enter
         releaseWall6();
         releaseWall2();
         mazeActivated = false;
         irdetected = false;
       }
     }
     if (wall2Activated == true && buttonPressed == true){
       Serial.println("User successfully finished the mini
game");
       Serial.println("Grid 2 Deactivated");
       releaseWall2();
       wall2Activated = false;
       buttonPressed = false;
       mazeActivated = false;
       irdetected = false;
     }}}
```

The continuation of the loop is for after the completion of each mini-game, if the button is pressed then it will cause the lasers to OFF and start a countdown. After the countdown, it will be safe to close off the walls. Once deactivated, new users can enter the maze.

```
void trapGrid6(){
 digitalWrite(laser1,HIGH);
 digitalWrite(laser6,HIGH);
 digitalWrite(laser5,HIGH);
 digitalWrite(laser6_1,HIGH);
 digitalWrite(laser6_2,HIGH);
 digitalWrite(laser7,HIGH);
 wall6Activated = true;
 }

void releaseWall5(){
 digitalWrite(laser5,LOW);
 digitalWrite(laser6_1, LOW);
 Serial.println("Wall 5 is released");
}

void releaseWall7(){
 digitalWrite(laser7,LOW);
 digitalWrite(laser6_2,LOW);
 Serial.println("Wall 7 is released");
}

void releaseWall6(){
 digitalWrite(laser6, LOW);
 digitalWrite(laser1, LOW);
 Serial.println("Wall 6 is released");
 wall6Activated = false;
}

void releaseWall2(){
 digitalWrite(laser2, LOW);
 digitalWrite(laser1_1,LOW);
 Serial.println("Wall 2 is released");
 wall2Activated = false;
}
```

Callable functions to easily release the lasers of the walls or trap/switch on the lasers

```
const int laser2_1 = 2;
const int laser2_2 = 4;
const int laser2_3 = 0;
const int laser3_1 = 14;
const int laser3_2 = 13;
const int laser2_4 = 15;

void setup() {
  pinMode(laser2_1, OUTPUT);
  pinMode(laser2_2, OUTPUT);
  pinMode(laser2_3, OUTPUT);
  pinMode(laser3_1, OUTPUT);
  pinMode(laser3_2, OUTPUT);
  pinMode(laser2_4, OUTPUT);
}
void loop() {
 digitalWrite(laser2_1,HIGH);
 digitalWrite(laser2_2,HIGH);
 digitalWrite(laser2_3,HIGH);
 digitalWrite(laser3_1,HIGH);
 digitalWrite(laser3_2,HIGH);
 digitalWrite(laser2_4,HIGH);
```

Another ino file that just powers the lasers to turn on.

Lines of code for the laser diodes function

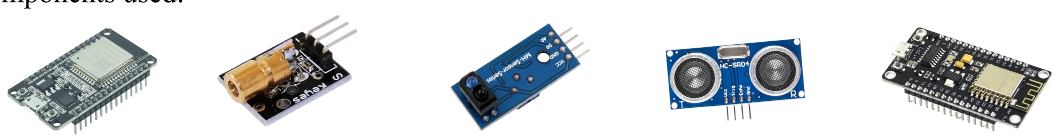
Please refer to the attached file named “Arduino_Lasers.ino” for a closer look.

```
if (distance6 > 0 && distance6 < 4 && wall6Activated == false && irdetected == true) {
  //wall 6 should be open!

  Serial.println("Countdown of 10s have started");
  startCountdown();
  if (countdown_over = true){
    Serial.println("It is now safe to close off the wall");
    trapGrid6();
    wall6Activated = true;
    Serial.println("All walls of grid 6 is closed!");
  }

}
```

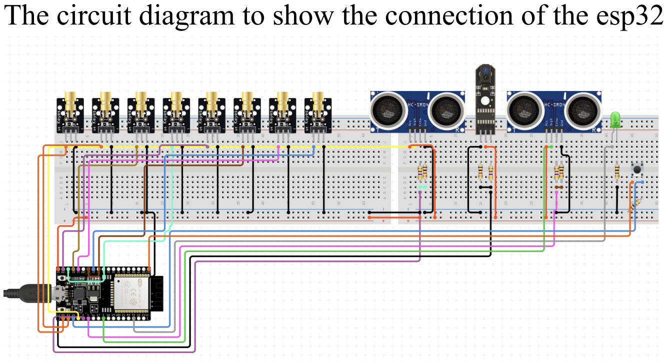
The full code has this part twice (one for grid 2 and one for grid 6) and the reason to restrict the distance in the condition is because the code was initially detecting the motion as the pillar. To overcome that, we calculated the distance between the ultrasonic sensor and the pillar (10cm) and ran a couple of tests to see the range of numbers that it is detecting when there is a person detected.

For every switching on and switching off the lasers, the countdown is set from 10 to 1 to allow the safety of the users to enter and leave within the timeframe of the countdown. This is to prevent any injuries or accidents.

Components used:



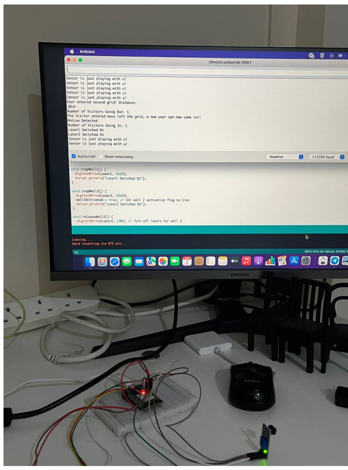
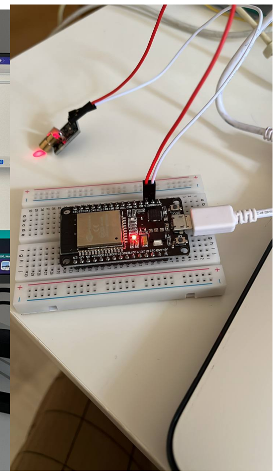
We used the ESP32, ESP8266, Laser Diodes, IR sensors and ultrasonic sensors for coding the laser codes. The ESP8266 is used only for laser displays at maze dead ends and doesn't include motion sensors.
The circuit diagram to show the connection of the esp32 to the lasers and the sensors:



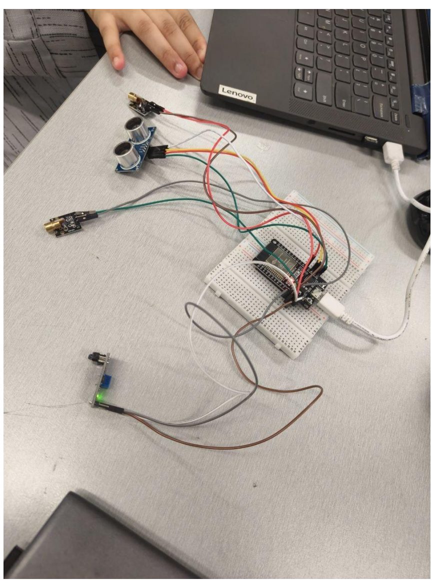
Note: The circuit diagram doesn't specify the exact connections between the sensors and the ESP32 since they're automatically configured when components are added. Resistors are used only on the button side and aren't needed for the sensors.

Functional Prototype Testing

1. Our first-ever breakthrough for the code that enables our laser diodes to work. This was our first small prototype testing back in Late March and it was also our first time touching and using laser diodes.

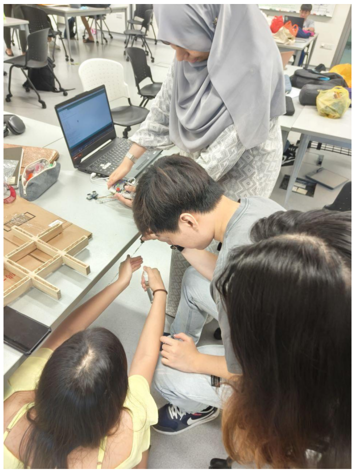



2. A week later, we proceeded to small test our prototype of our motion sensor being able to capture one's movement to turn on the laser diode. Here is a video on YouTube.



[Half a Dozen - Motion Sensor Working for the first time with laser diodes! - YouTube]

3. Next, we started testing our laser diodes' visibility level by using deodorant. Do we have other options? We will be using dry ice for our demo presentation.
https://youtube.com/shorts/bVuocyx2ArY?feature=share

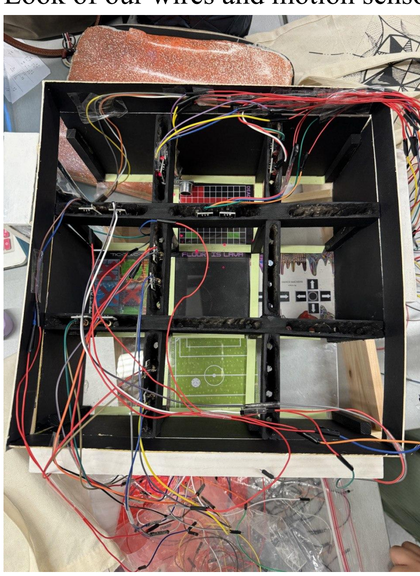
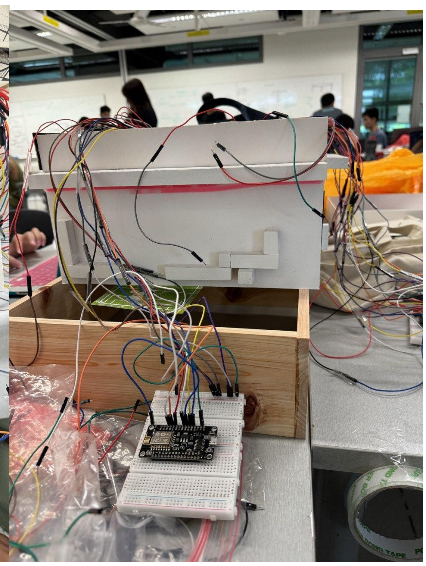


4. For our keypad, its testing first started in early April. This was our first breakthrough in getting our keypad to work correctly.

5. After some tweaks to our code, we made it process right or wrong keyed in numbers! https://youtube.com/shorts/khPMkFoAklg?feature=share

6. Here is us on our final testing day two days before presentation day. This is a video of our motion sensors and our lasers working properly after processing trials and errors with how we should place them inside our maze. It took multiple tries but here is our final result. https://youtube.com/shorts/Ae-v7QIC1P8?feature=share

   Look of our wires and motion sensors inside our functional model:

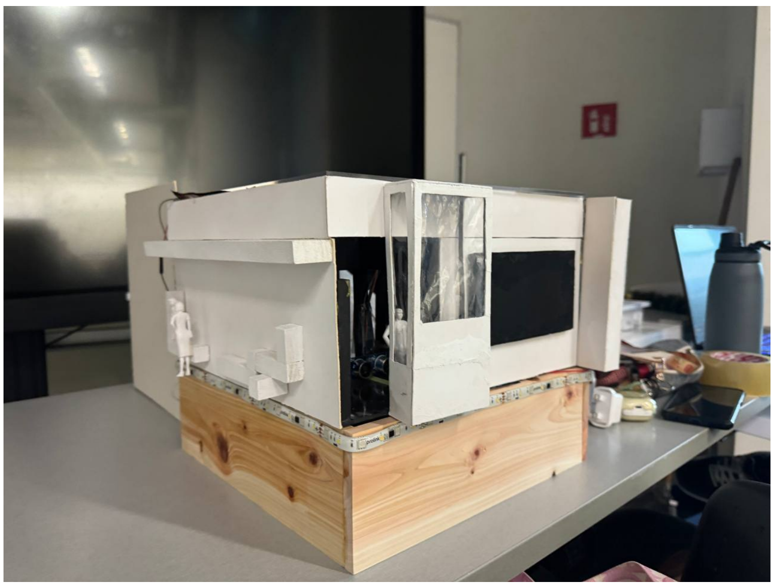



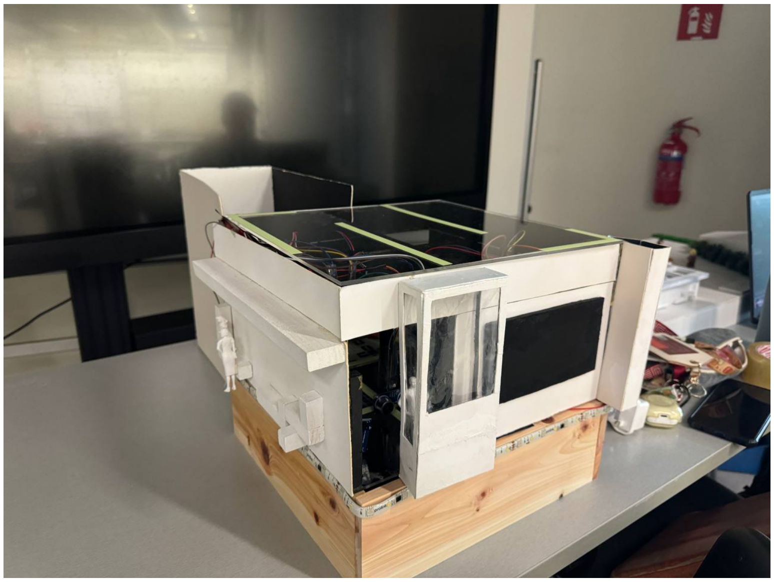
7. For our wires, we find that there were too many seen at the sides, and hence created covering for the sides which covers the wires and taped the wires with black insulation tape which was on the top to allow most of the wires to be hidden.

8. To make sure our laser lines are seen, we bought dry ice and also a backup deodrant spray to show that the laser lines to simulate the behaviour of a mist machine.

Final Functional Model

Scale: **[1:25]**

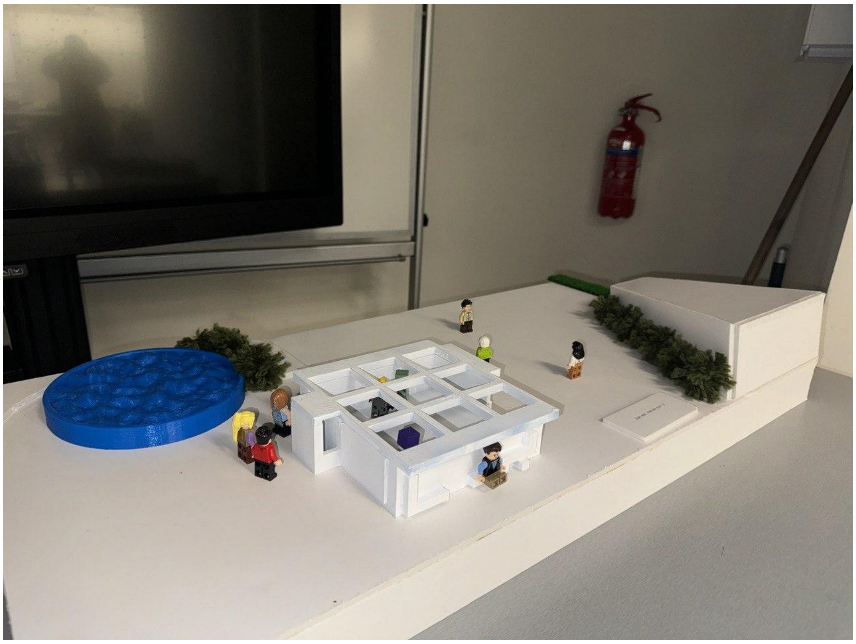




Video of the Lasers with Dry Ice: https://youtube.com/shorts/FJeFzbVyrAk?feature=share
Video and pictures of the lights of the models:https://youtube.com/shorts/Mhld2n_RMzE?feature=share

Final Site Model

Scale: **[1:50]**



SSW Component

IX:DIMENSION,2D:SSW

MATERIALS USED:

1. Acrylic Base (PMMA)
   a. The base must be transparent, and durable to simulate the projections of minigames.
2. LED Strips
   a. LED strips use 50% less energy than traditional fluorescent, incandescent, and halogen lights; small electric bill.
3. Wood
   a. Lasts a long time and also biodegradable; eventually decomposing. Recyclable to reduce carbon footprint.

2D COMPONENT:

IX dimension is an out-of-this-world maze to encourage social interaction in the open space outside EXPO MRT! Lasers/LED lights inside the maze indicate the options for directions players can go. In this 3x3 maze, there are 4 rooms with mini games that must all be completed before you can leave the place with vouchers! Are you up to the challenge?

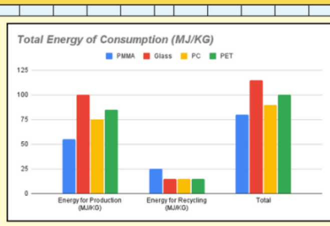
PROBLEM STATEMENT:

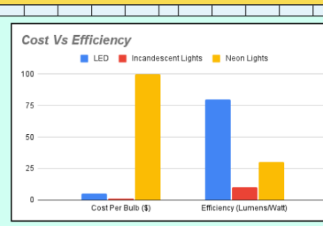
How can we revamp the open space outside EXPO MRT for workers in Changi BizPark to enhance their social interaction with an interactive maze?

LIFE CYCLE ANALYSIS

1. Acrylic Base (PMMA)
   a. Acrylic sheets are not only recyclable, but they are also energy efficient. The manufacturing process of glass is far more complicated, extensive, and expensive than acrylic plastic. Glass is made from a combination of sand, soda ash and limestone, heated to roughly 1700°C and combined. It takes a greater amount of energy to reach this temperature than in production of acrylic.
   b. One of the most beneficial properties of acrylic plastic is its optical clarity. Interestingly, clear acrylic is easier to see through than glass, with a 92% optical clarity rate compared to 90% of glass.
   c. Produced with less energy when compared to other materials, such as glass or metal, and are also lightweight, making them easy to transport and work with.
2. LED Strips
   a. LED Strip Lights vs Incandescent Energy Consumption: LEDs draw up to 85% less electricity.
   b. LED Strip Light Power Consumption Per Meter: A one-meter LED strip consumes only around 5W of power.
   c. LED Strip Light Lifespan Comparison: They last from 30,000 to over 50,000 hours.
   d. Eco-Friendly LED Strip Lighting Solutions: LEDs help in reducing carbon emissions.
3. Wood
   a. Wood is renewable, while metal are typically extracted from finite ore deposits.
   b. Wood production generally requires less energy compared to metal reducing greenhouse gas emissions.
   c. Wood products tend to have a lower carbon footprint as trees absorb carbon dioxide while growing, sequestering carbon.
   d. Recyclability and Biodegradability: Wood is recyclable and biodegradable, offering end-of-life options that contribute to soil health, whereas metal recycling processes can be complex, and metals may not degrade easily.

GRAPHS FOR ENERGY CONSUMPTION AND EFFICIENCY





END OF LIFE

ACRYLIC:

Recycled acrylic sheets can be reprocessed through thermoforming techniques to create new molded products, such as packaging trays, containers, and automotive components

LED STRIPS:

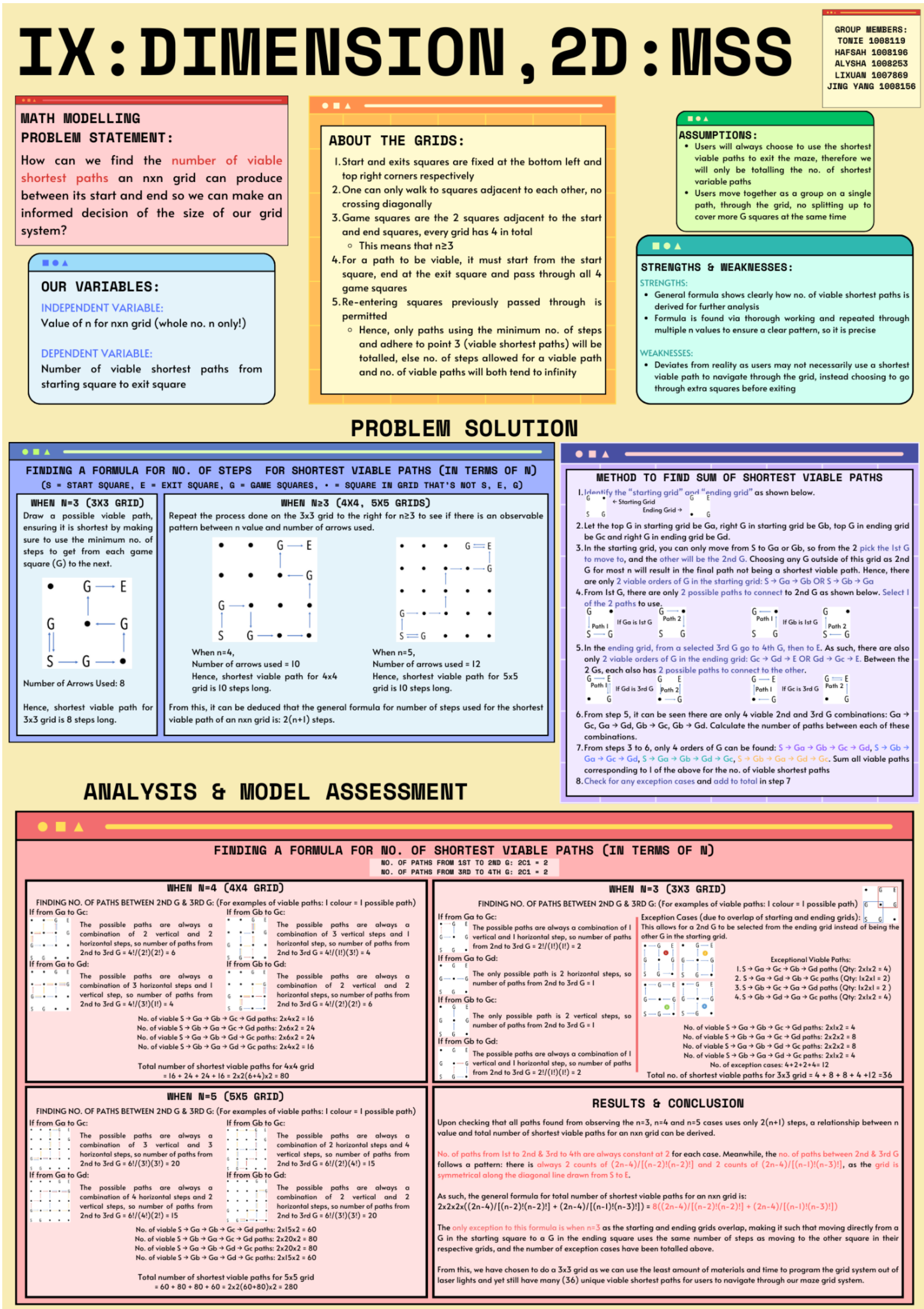
LED lights can be reused in DIY projects such as lighted signs, illuminated furniture, and custom lighting fixtures in our own homes.

COMPOST:

Wood is biodegradable so it will biodegrade in a landfill. Recycling wood helps conserve resources, reduce the need for virgin timber, and minimize waste sent to landfills.

GROUP MEMBERS:
TONIE 1008119
HAFSAH 1008196
ALYSHA 1008253
LIXUAN 1007869
JING YANG 1008156

MSS Component



Further Improvements

a. **Integration with a mobile app:** Allows people to activate and let them in without the supervision of a kiosk staff. More companies can collaborate with us at one time; more stores will benefit from this maze installation via promotion. People can see the real-life queue time so they know when to come down and there is no need for a big queue to form up.
b. **Accessibility Features:** If people with disabilities come in, there can be audio automated instructions for them to follow through the maze which can be activated through a button outside of the maze.
c. **Interactive Challenges**: Incorporate more interactive challenges where both groups must collaborate to progress. For example, a room could contain a large puzzle that requires input from both groups simultaneously to solve, fostering communication and teamwork.
d. **Dynamic Maze Layouts**: Introduce rotating or shifting maze walls to change the layout periodically, keeping participants on their toes and adding an element of surprise to each visit.
e. **Shared Rewards**: Create opportunities for both groups to earn rewards that are beneficial to the entire team. For instance, finding hidden tokens or keys that unlock bonus areas or shortcuts, encourages cooperation and strategic thinking.
f. **Live Leaderboards**: Implement a live leaderboard system where participants can track their progress and compare their performance with other groups, adding a competitive edge to the experience and promoting friendly rivalry.
g. **Thematic Events**: Introduce themed events or challenges that coincide with holidays or pop culture trends, adding variety and excitement to the maze experience. For example, a Halloween-themed maze could include spooky challenges and decorations.
h. **Virtual Integration**: Offer a virtual version of the maze experience for remote participants to join in the fun. Utilize augmented reality (AR) or virtual reality (VR) technology to simulate the maze environment and allow remote players to interact with those on-site.
i. **Customizable Difficulty Levels**: Allow participants to choose their preferred difficulty level before entering the maze, catering to both casual and experienced players. Advanced levels could feature tougher puzzles and obstacles for added challenge.
j. **Feedback Mechanism**: Implement a feedback system where participants can provide input on their maze experience, including suggestions for improvement. This feedback can help refine future iterations of the maze and enhance overall satisfaction.