Gruffydd Gozali
Selected Works
Portfolio
2018-2024

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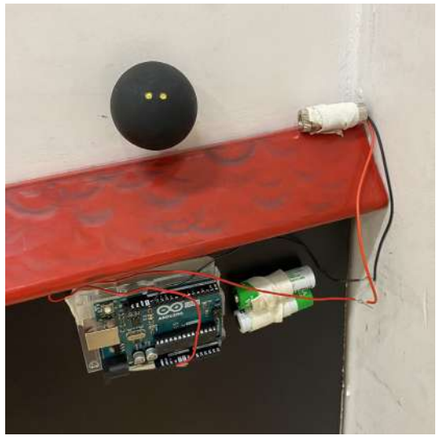


# Squaser

## Lancaster University/London
## 2022 - Current

Squaser is a line sensing system for the sport of Squash. It uses two modules, a laser receiver and laser emitter. The laser sits over the top of the line, and if a ball blocks it the players and referee are alerted that the ball is out. I started a limited company to pursue the idea as a startup.


# The Problem


Is this ball out? It's impossible to tell, especially for a referee sitting 80 feet away. Even with a slo-mo replay it's difficult.

In the sport of Squash, if the ball touches certain lines it is called out.

In certain situations the referees and players cannot see and make the correct call. Referees are under extreme pressure, as the call could decide the match (which happened in the match above). Professional players have been unhappy about the situation for a long time.

Tennis has Hawk-eye, Cricket has Snicko. But there is no line calling system for Squash.

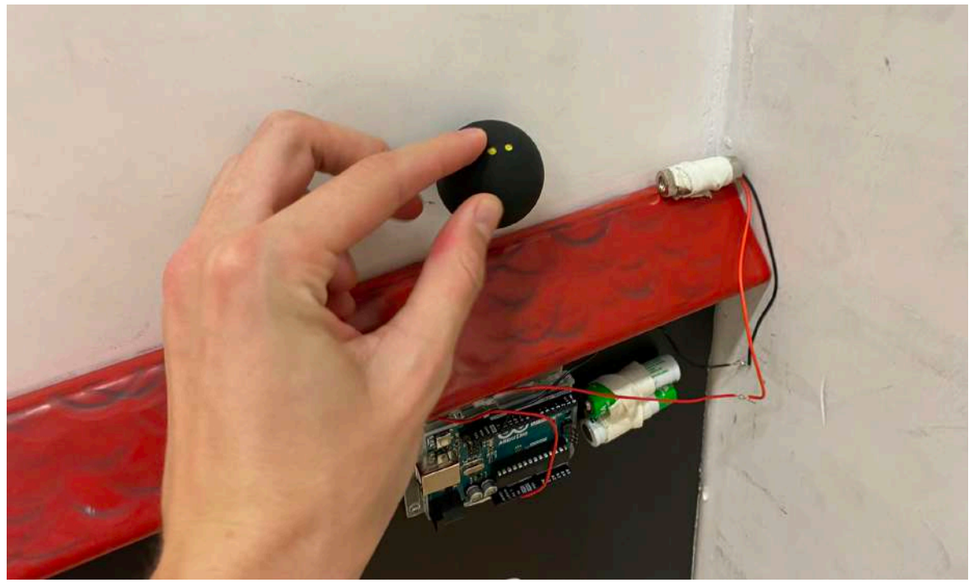
So I designed Squaser.

# Proof of Concept

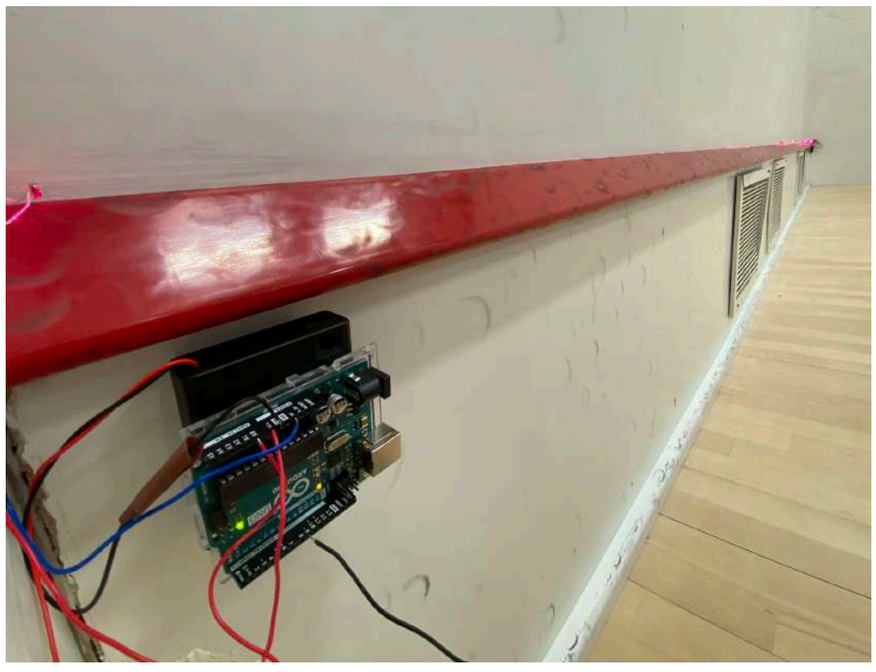
I designed a simple proof of concept, taping it to the Lancaster University squash courts.

At one end was the laser, and the other a photoresistor as a sensor, with a speaker and battery pack, all programmed by an Arduino.

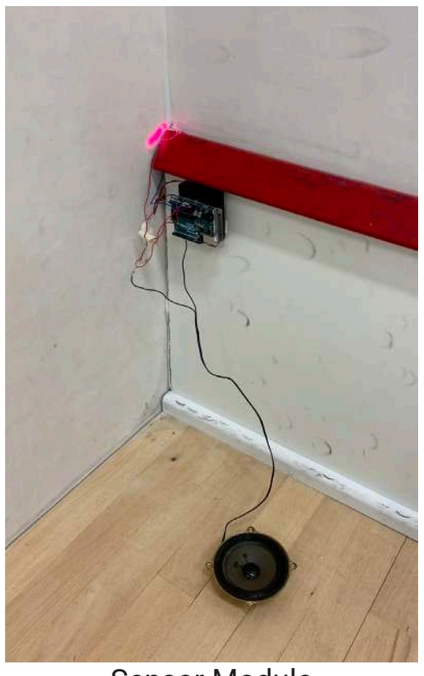
It had many issues, but showed that the idea could work. I realised building a version for glass courts was more viable.



Laser Module



View of Both



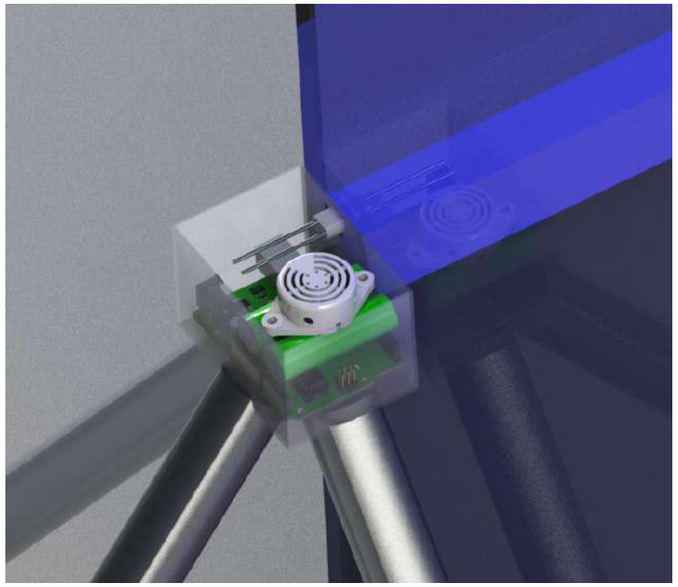
Sensor Module

# Designing and Building the Prototype

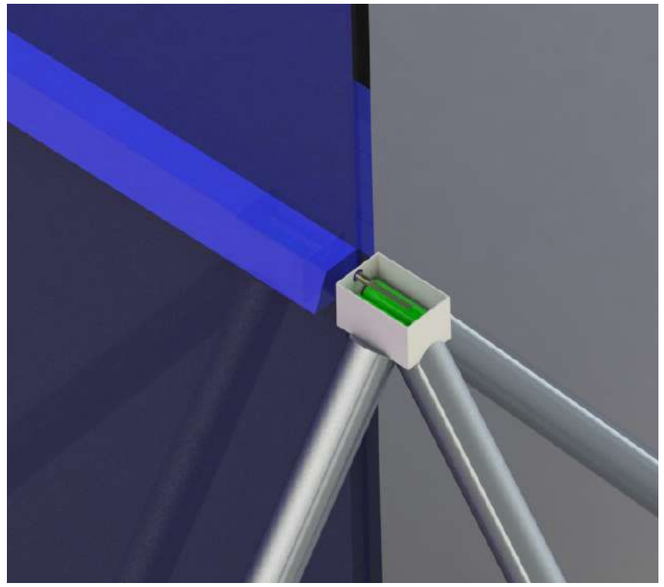
I told the Professional Squash Association (PSA) about the idea, and they were happy for me to go ahead and build a prototype for a trial on the glass courts at their tournaments.

I created a limited company, Squaser Limited, to manage it.

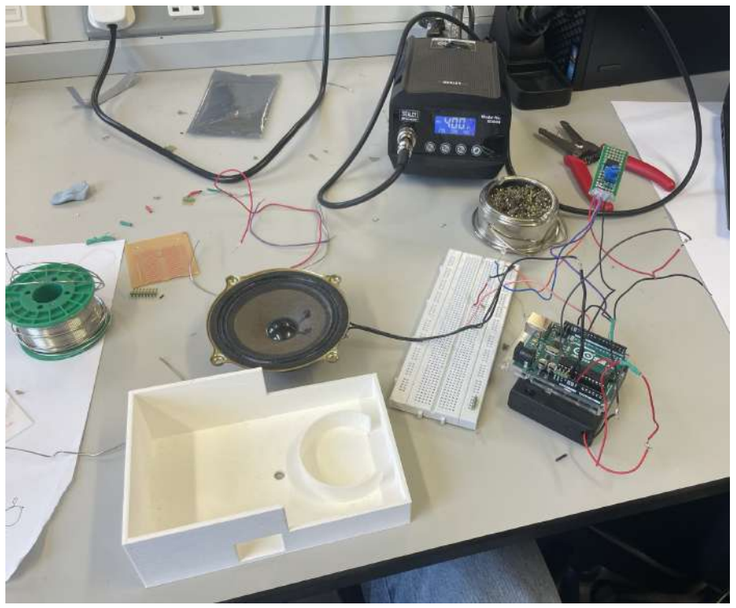
The Engineering Department at Lancaster provided £500 for material purchases, and in two months I designed and built the prototype.



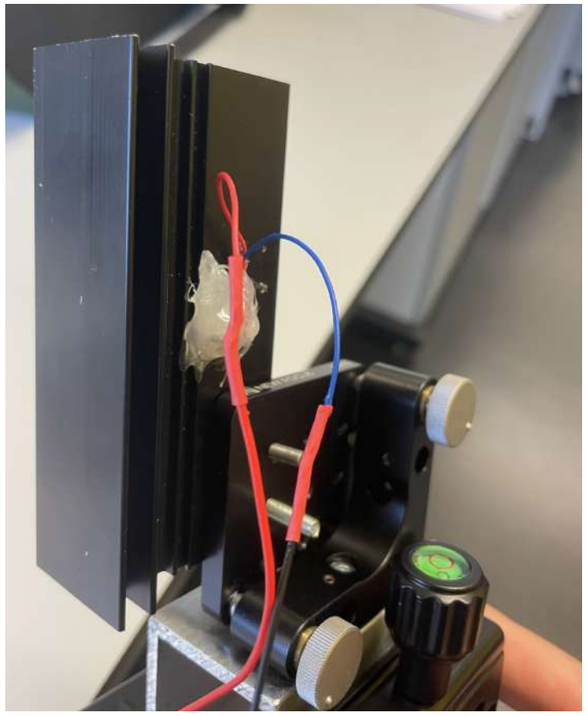
Solidworks render of the sensor module.

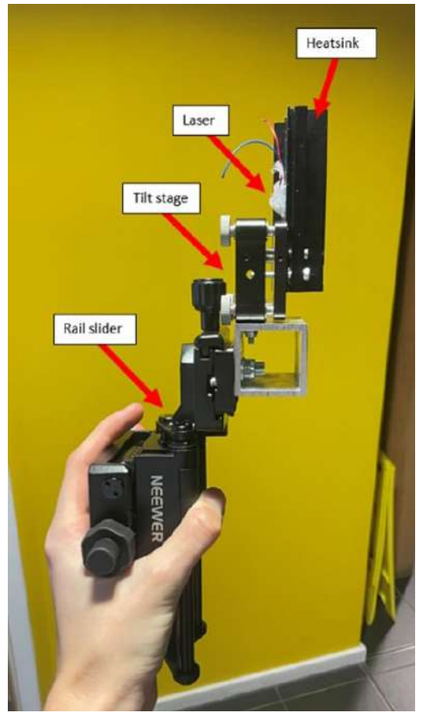


Laser module.



Late nights wiring the electronics.






Aligning the laser to sit perfectly over the line was one of the trickiest problems. I used a rotary stage to finely adjust the angle in two degrees of freedom, and a macro photography tool to do the translation in two degrees of freedom.

To dampen the impact vibrations of players on the court, I built a heavy base from waterjet cut steel with concrete embedding the tripod.

Gruffydd Gozali

Lancaster University/London

# Testing and Trial

After finishing the prototype, I tested it at the National Squash Centre in Manchester.

I then did the first trial at the Canary Wharf Classic professional squash tournament (one of the largest tournaments of the season), in front of a crowd of 500 and on live TV, where it succeeded.

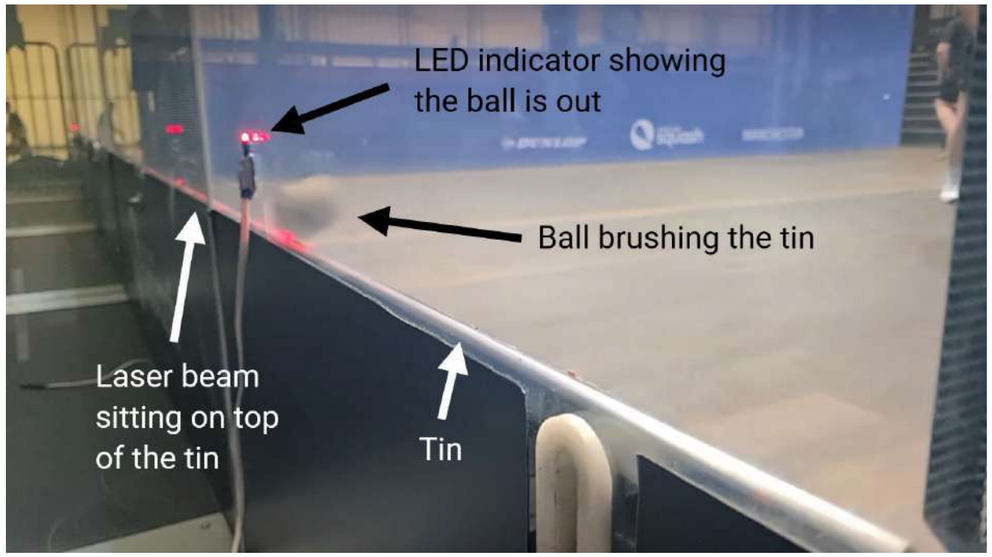
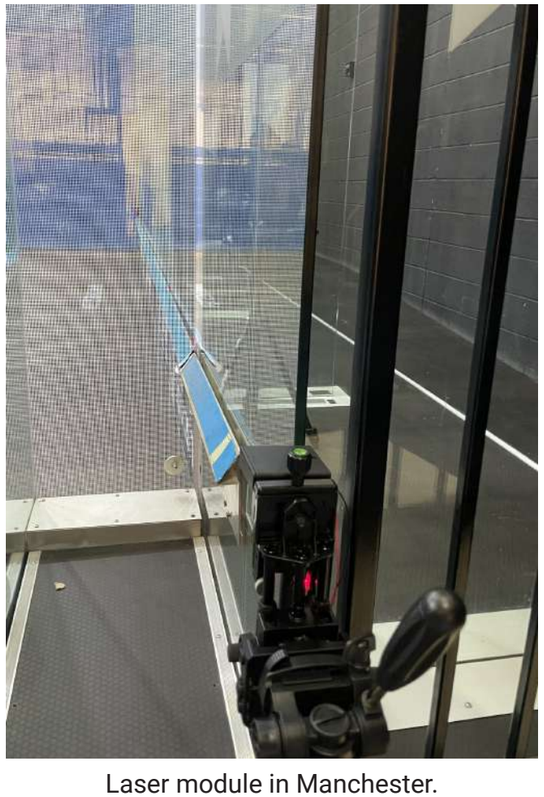
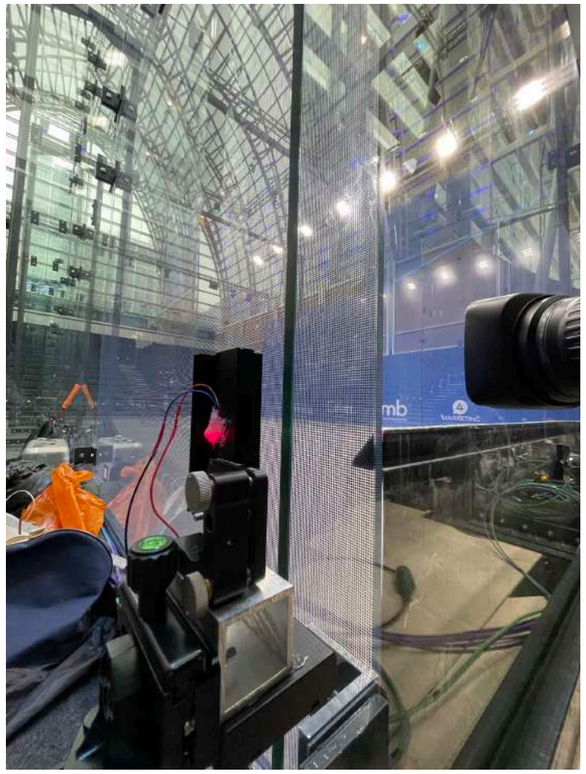


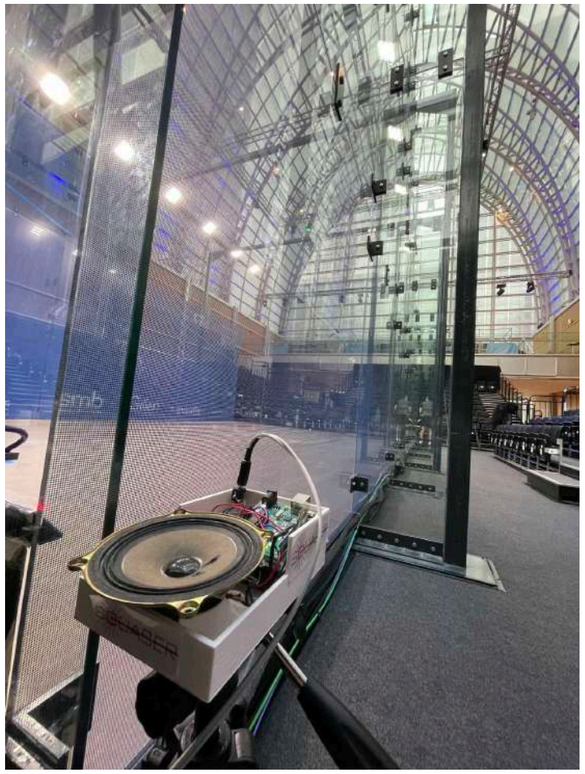

Diagram showing the system in action.



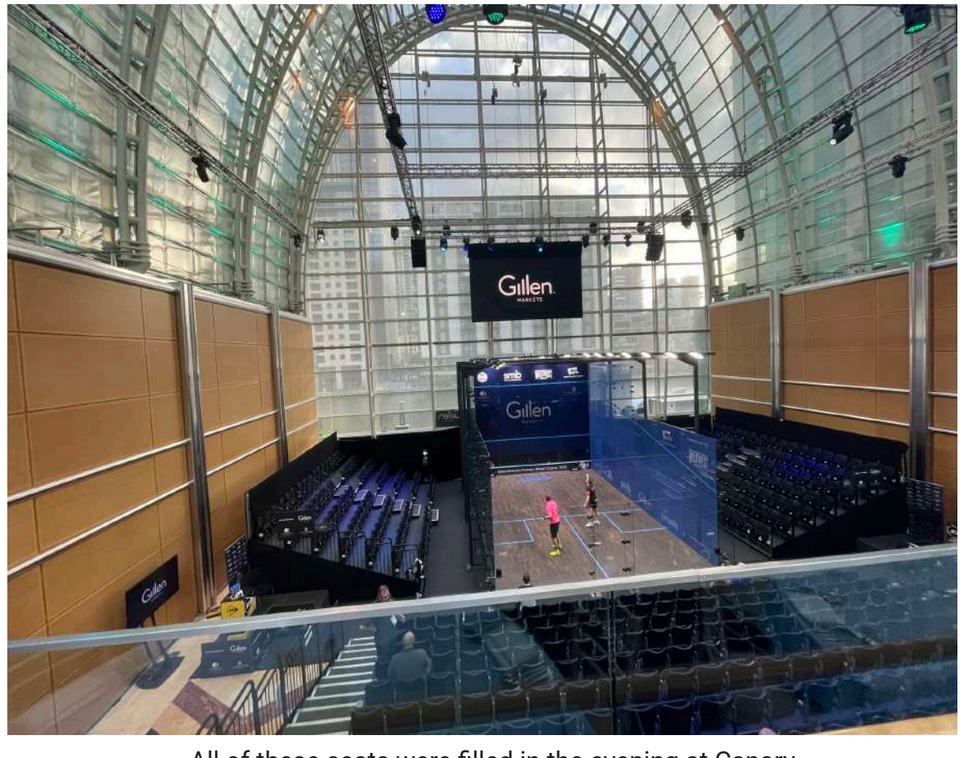
Laser module in Manchester.



Laser module.



Sensor module.



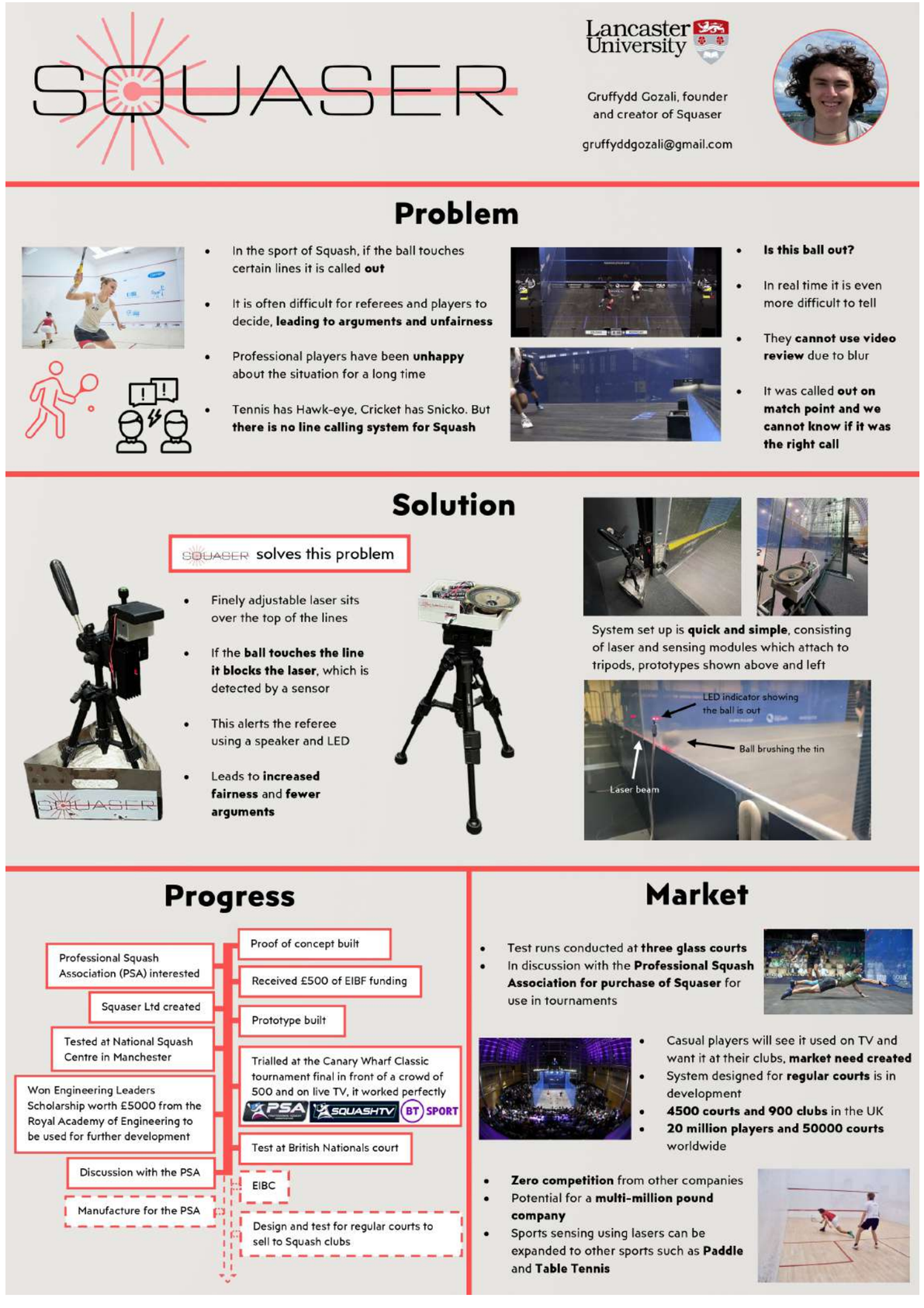

All of these seats were filled in the evening at Canary Wharf, it was the most pressure I've ever felt.

# EIBF Award and other Prizes

I entered into the Engineering in Business Finals, and presented in October 2023. I came runner-up, winning £1500. I also received £2500 from Lancaster University, and it contributed to winning a £5000 grant from the Royal Academy of Engineering (Engineering Leaders Scholarship).


Award ceremony at the Engineering in Business Finals.


Presenting at the Engineering in Business Finals.




Poster I designed for the competition.

# The Future

I will be doing another trial in March at the Optasia tournament in Wimbledon, after which the PSA will likely purchase the system for full use in their tournaments.

I will be installing a system on the standard courts at my local club (this is more complex than a glass court as it requires drilling into the wall), and I will be looking to sell to other clubs and court manufacturers. I have already got interest from multiple other clubs.

The goal has been to improve the playing experience and relieve the pressure on referees, and at the same time reinvigorate interest in Squash through the inclusion of technology. I am on my way to achieving this.

SQUASER


# Timeline

- *May 2022* — Proof of concept built
- *October 2022* — Professional Squash Association (PSA) interested
- *December 2022* — Received £500 of EIBF funding
- *December 2022* — Squaser Ltd created
- *February 2023* — Prototype designed and built
- *February 2023* — Tested at the National Squash Centre in Manchester
- *March 2023* — Trialled at the Canary Wharf Classic tournament final in front of a crowd of 500 and on live TV, it worked perfectly
- *April 2023* — Won Engineering Leaders Scholarship worth £5,000 from the Royal Academy of Engineering to be used for further development
- *August 2023* — Test at the British Nationals court
- *September 2023* — Discussion with the PSA
- *October 2023* — £2,500 Santander Enterprise Award
- *November 2023* — Engineering in Business Champion of Champions Winner, winning £1,500
- *March 2024* — Final trial with the PSA at the Optasia Championships
- *March 2024 Onwards* — Manufacture and sell to the PSA
- *In progress* — Build and test for regular courts to sell to Squash clubs

Gruffydd Gozali

Lancaster University/London

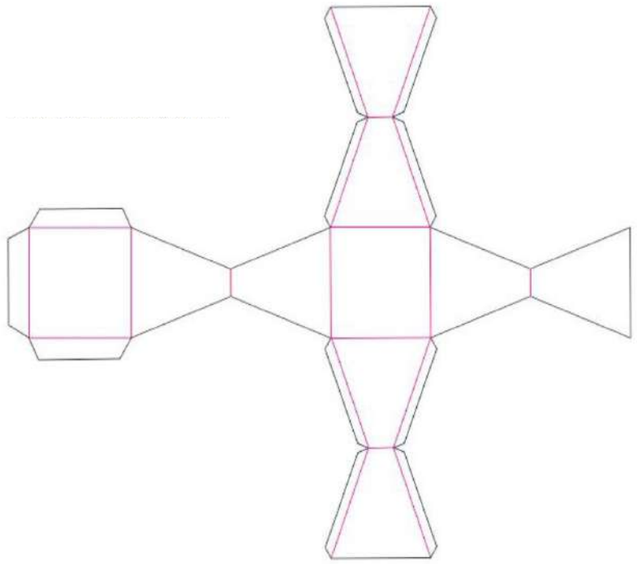
# Segment Coffee Table

UCS
2019

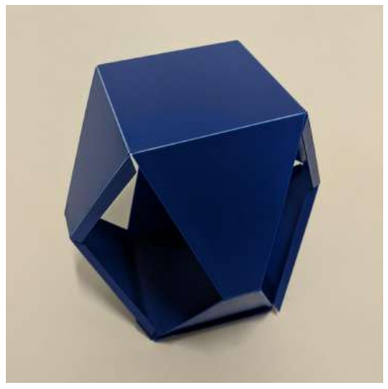
I designed this during the first year of DT A-level. It can be split into two separate tables for more useable area.

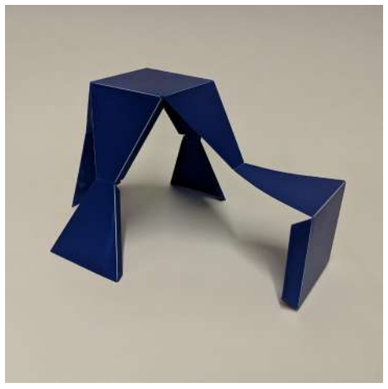
# Design

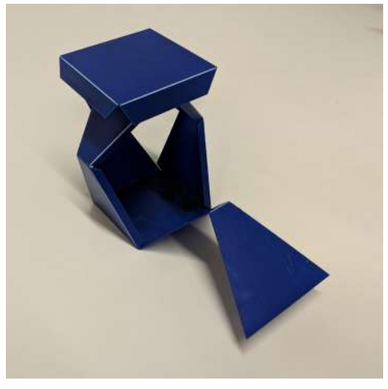
I began with experiments of 2D nets bent into different structures, progressing to models before I was happy with the overall dimensions and built the full size table.

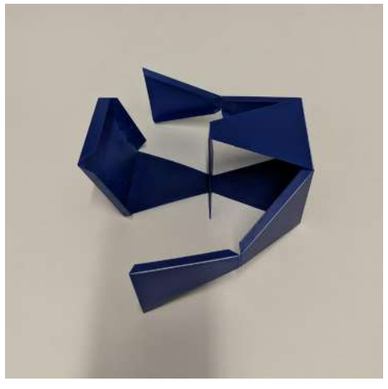


The original net which was lasercut.



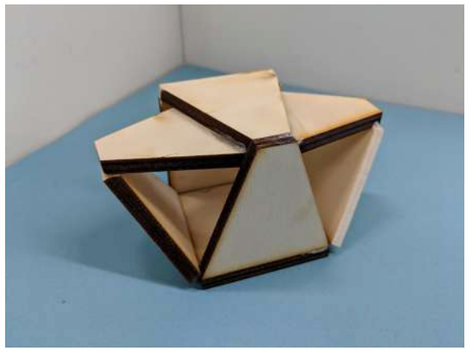




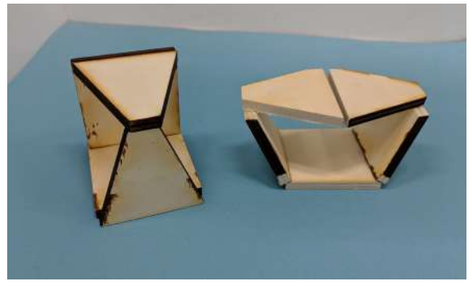


Various experimental shapes made from the net.

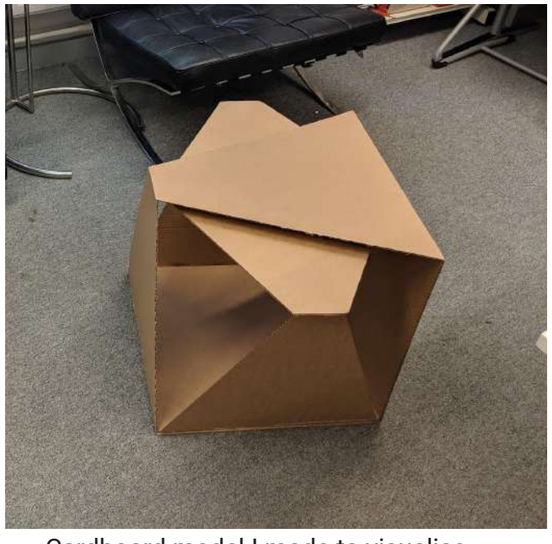
Various models of potential designs made from foamboard.



I settled on the triangular design, and then experimented with adding modularity.



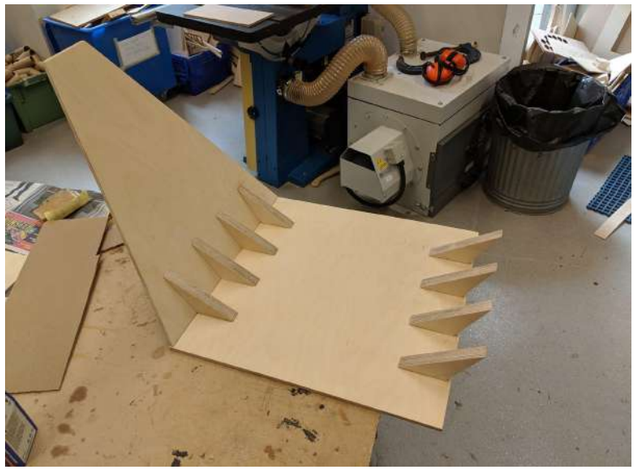
Fusion 360 renders to see the aesthetics of different wood types.

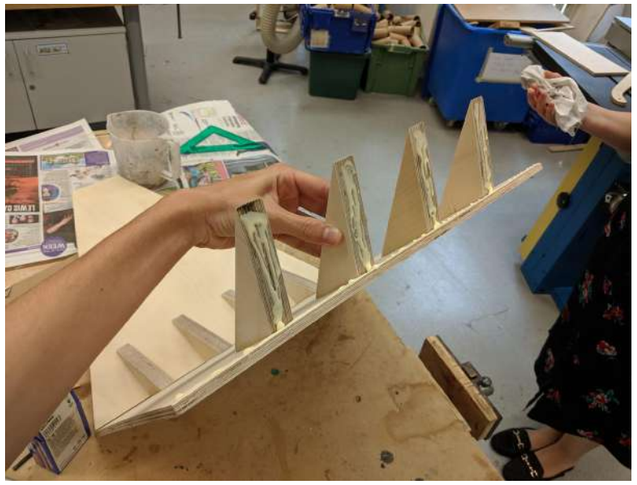


Cardboard model I made to visualise the dimensions.

# Building and Use

I used standard woodworking techniques to build the table, with supports being drilled and glued in. It was made from plywood. On the right is the table in use.





Testing different stains.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UCS

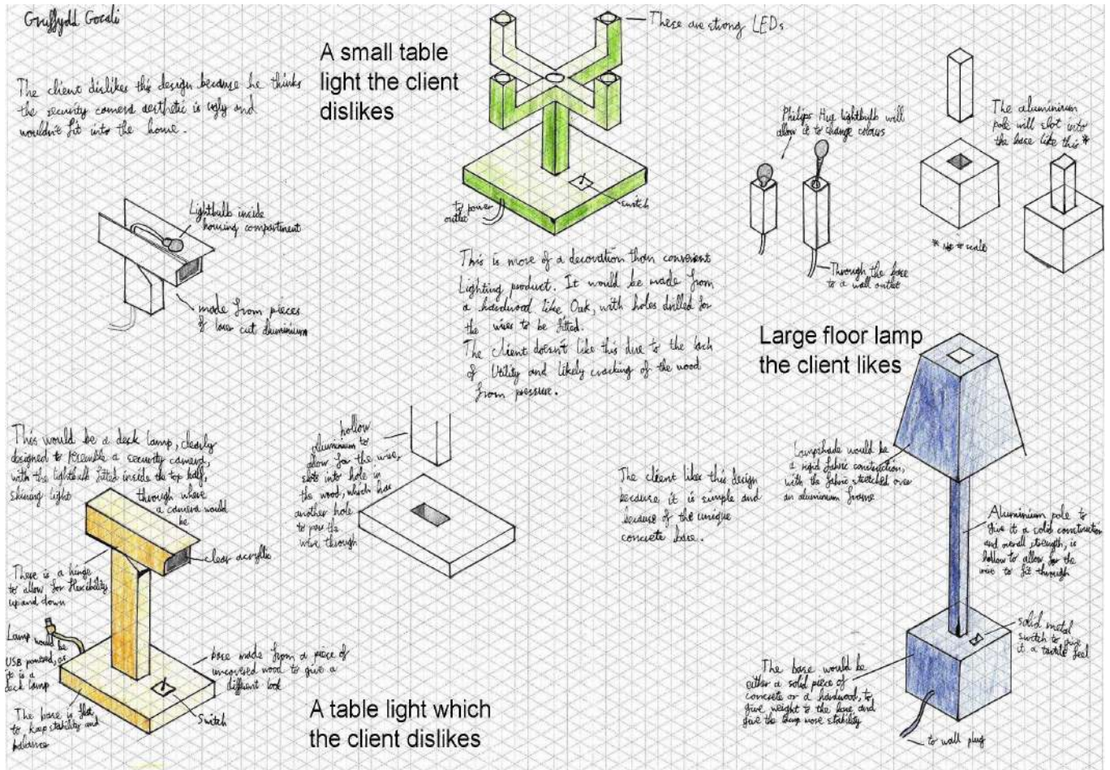
# S-Lamp

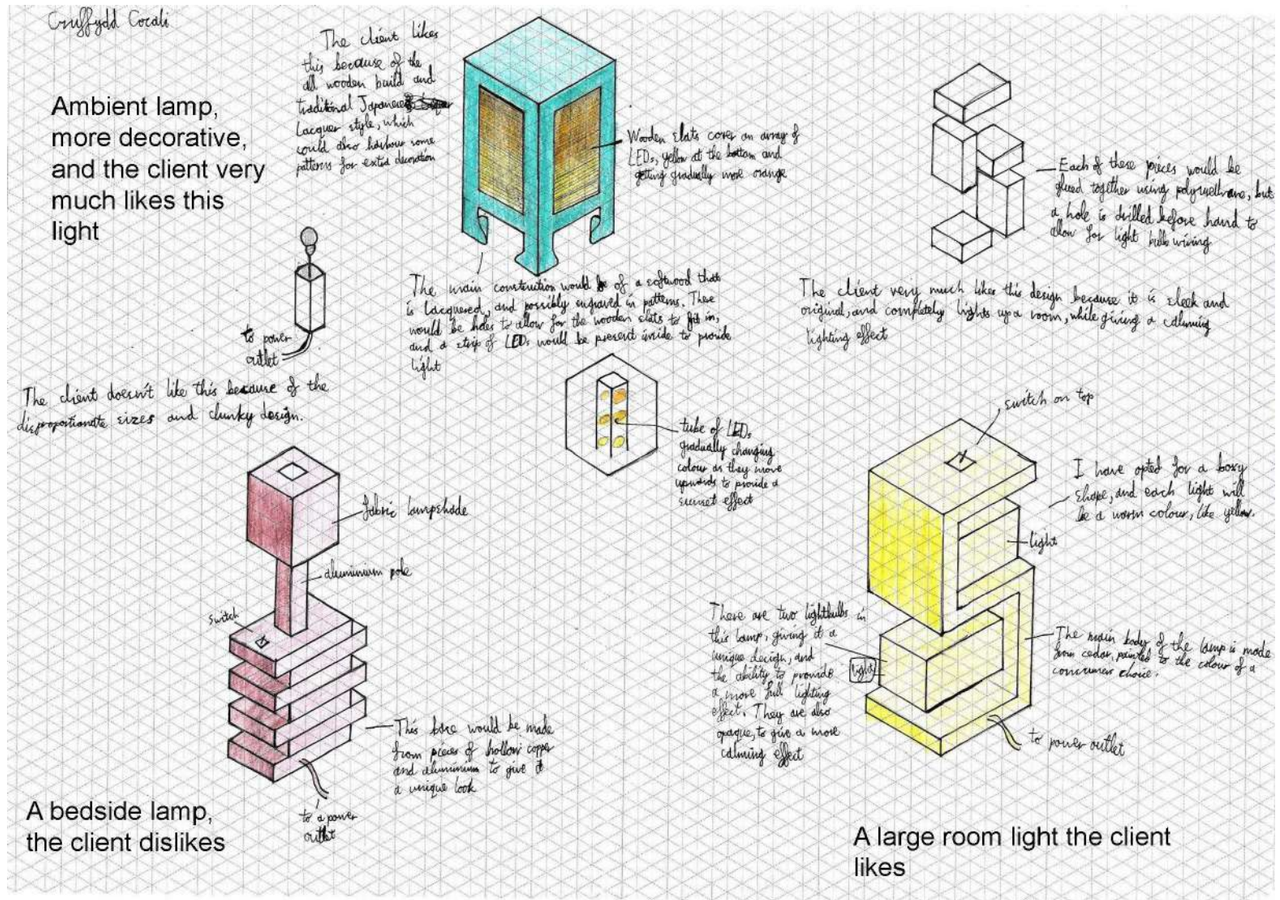
UCS
2018

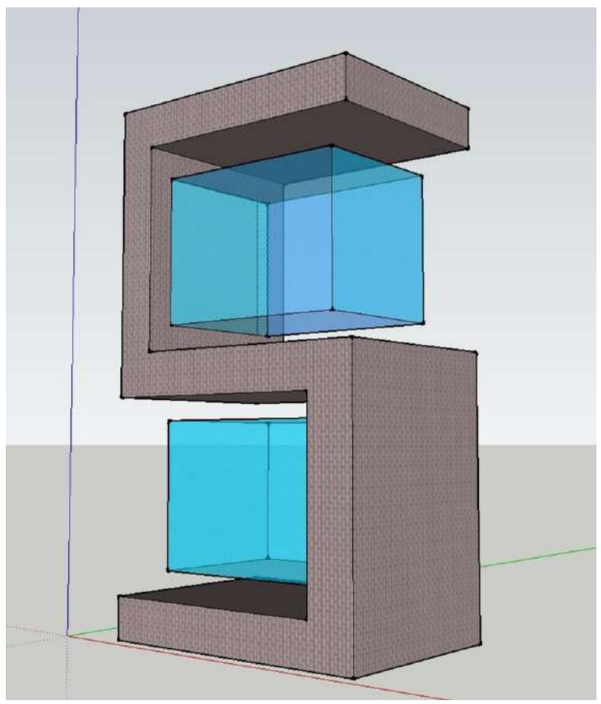
I designed and built the S-Lamp as my final project for GCSE DT. The lamp used acrylic sandwiched between plywood sheets. LEDs were embedded inside and wired up through the build, to give the impression of light spilling out the side.

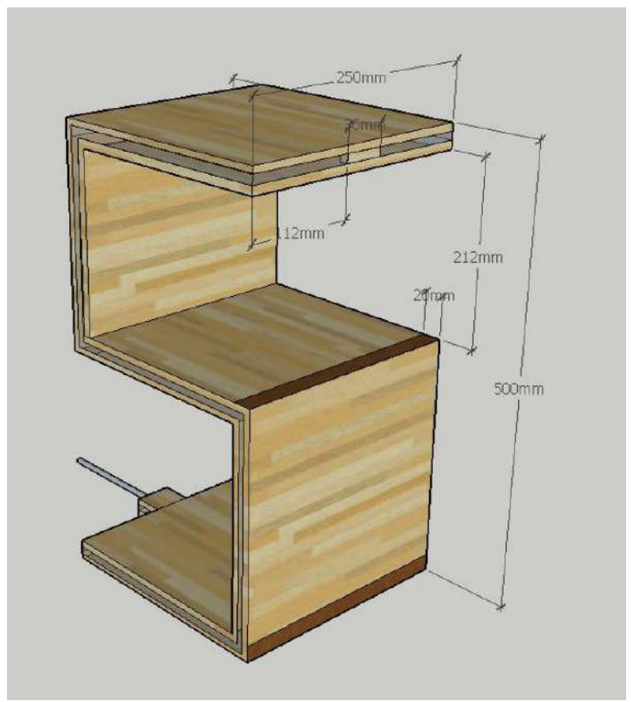
# Design

I sketched ideas out first, prototyping and then 3D modelling the leading option.



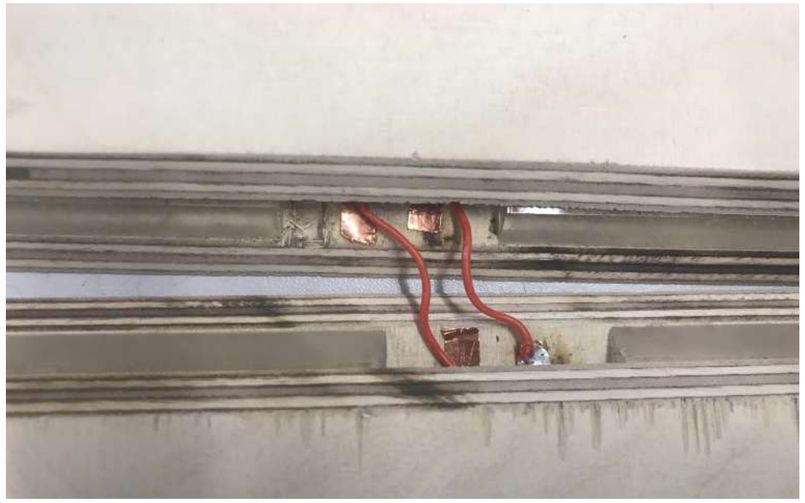



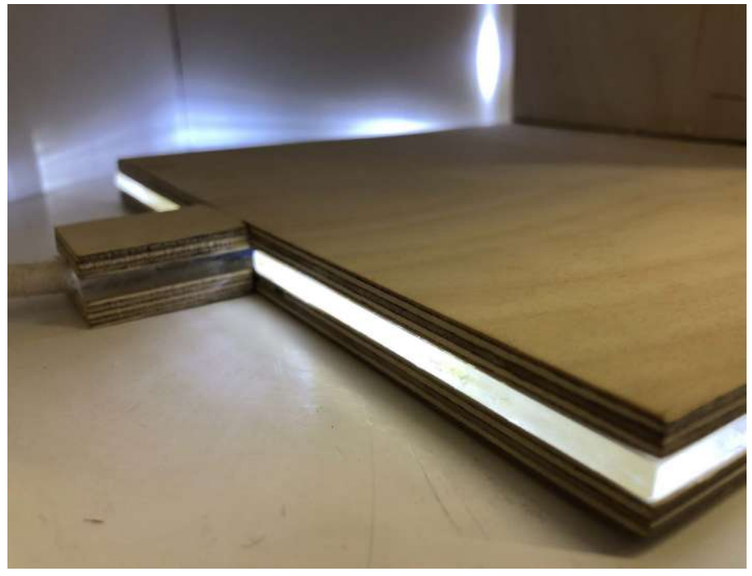



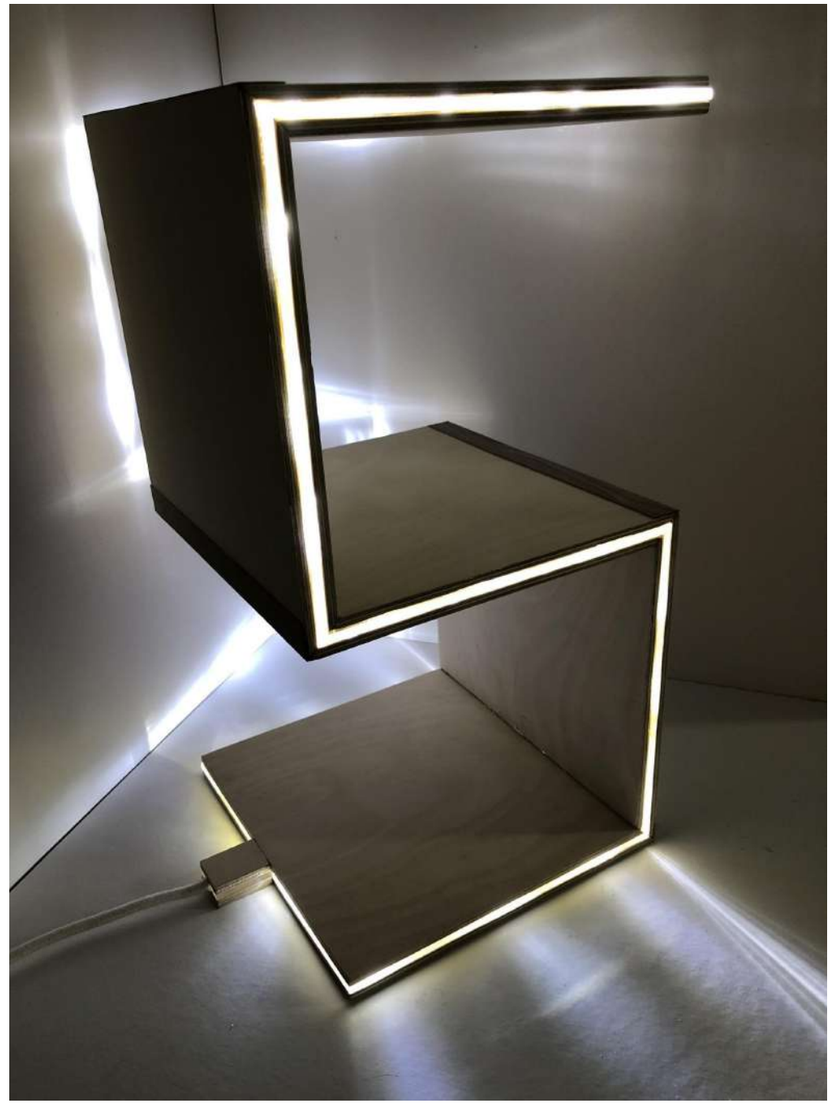


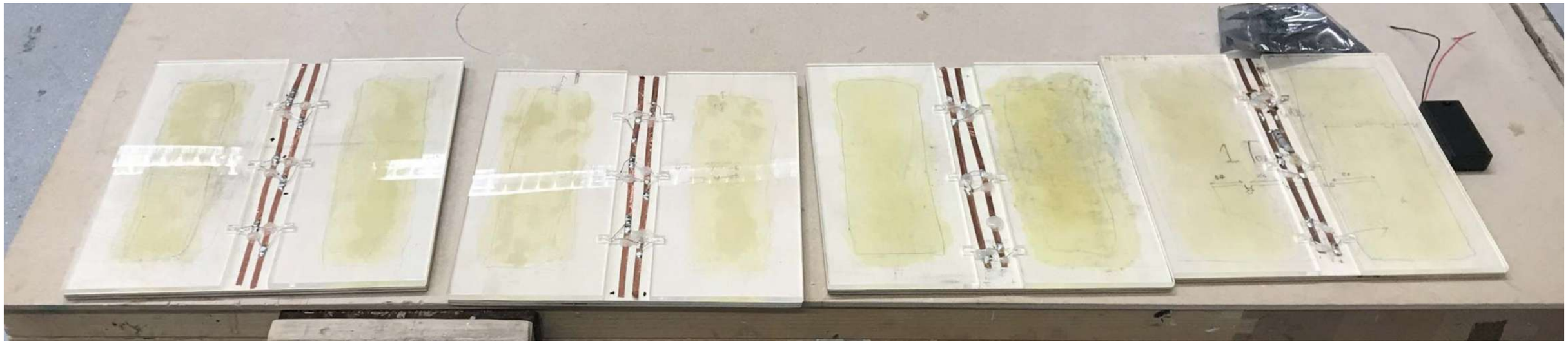
# Building

Acrylic was glued to layers of plywood, with a central channel for LEDs.









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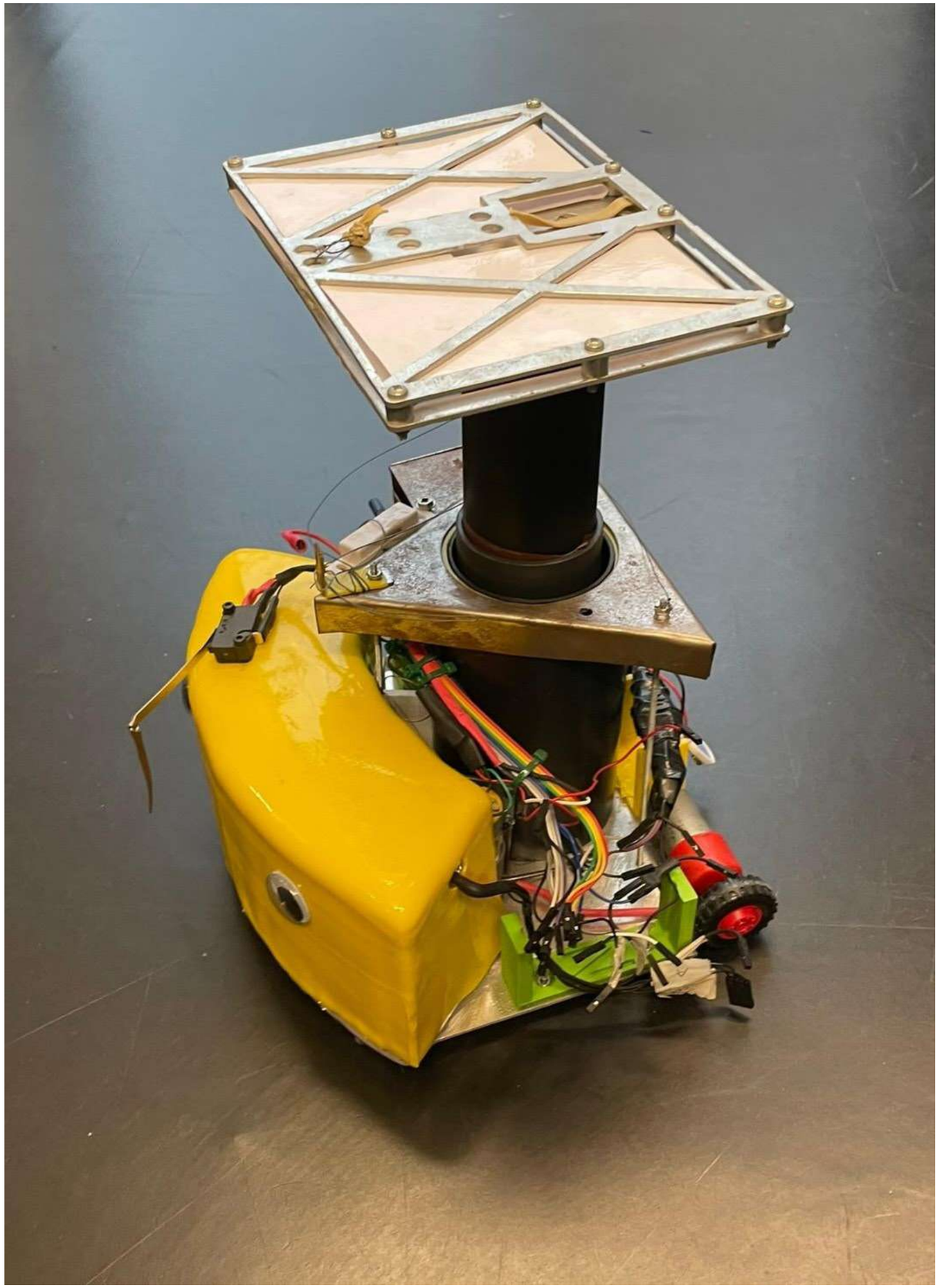
# Robot Project

## Lancaster University
## 2022

This was a group project to design and build a robot which would follow a line and deliver an envelope onto a shelf. Our robot was the fastest in the year by an order of magnitude.

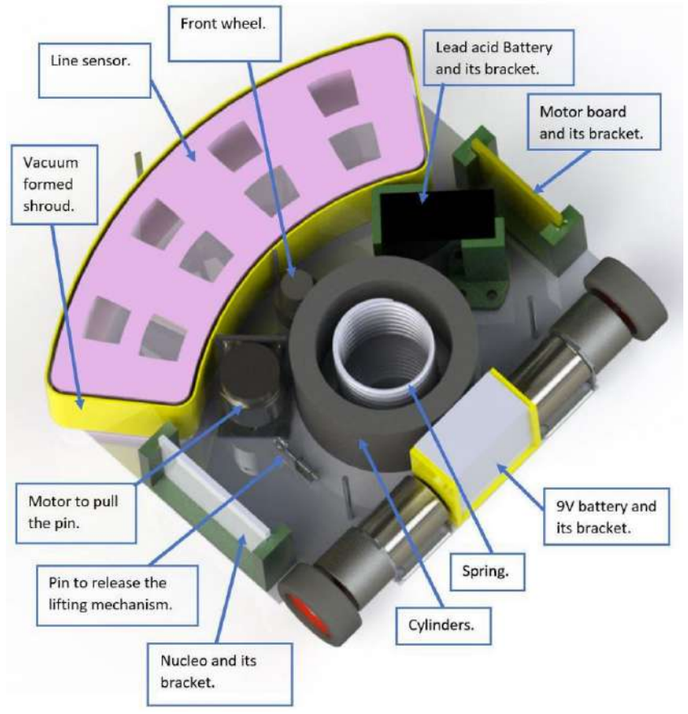


Lancaster University

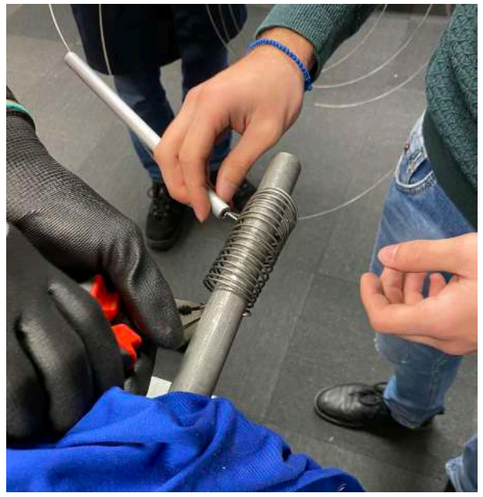
# Design and Building Process

I was in charge of the CAD and the mechanism for lifting and firing the envelope. Using a powerful spring for lifting came with issues, namely the robot tearing itself apart on multiple occasions! But it meant the envelope could be lifted and fired very quickly, a worthwhile tradeoff.

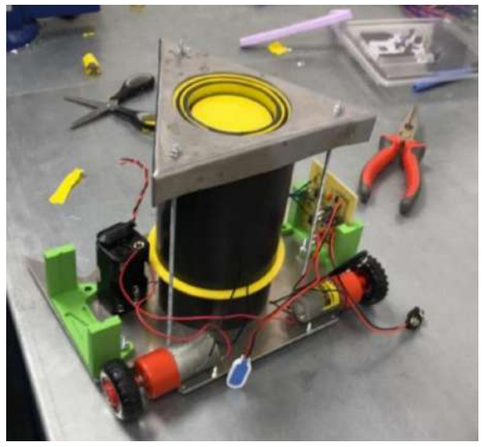
Solidworks render in the extended mode.



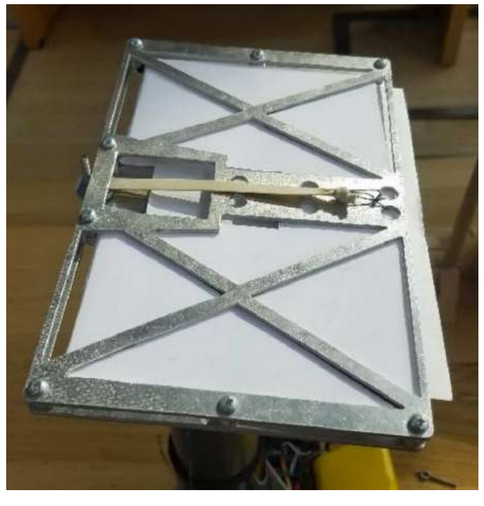

Solidworks render with labelled components.



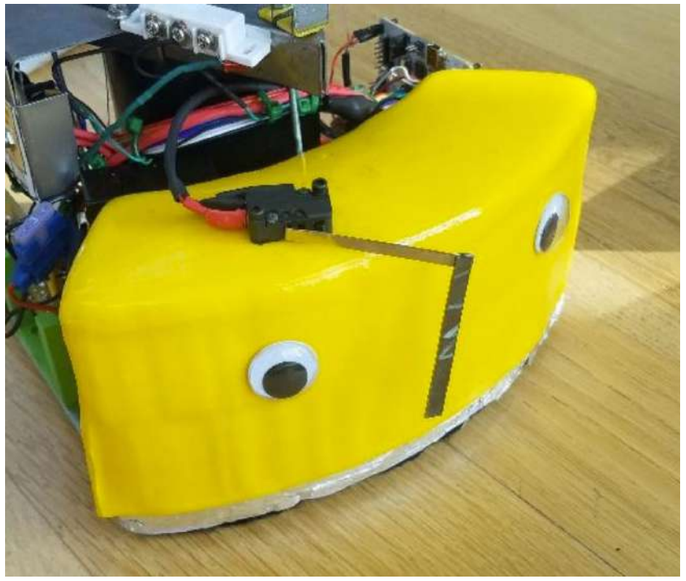
We created a custom spring by bending a piece of steel wire around a pole. This sat inside a series of PVC tubes which extended to lift the envelope.



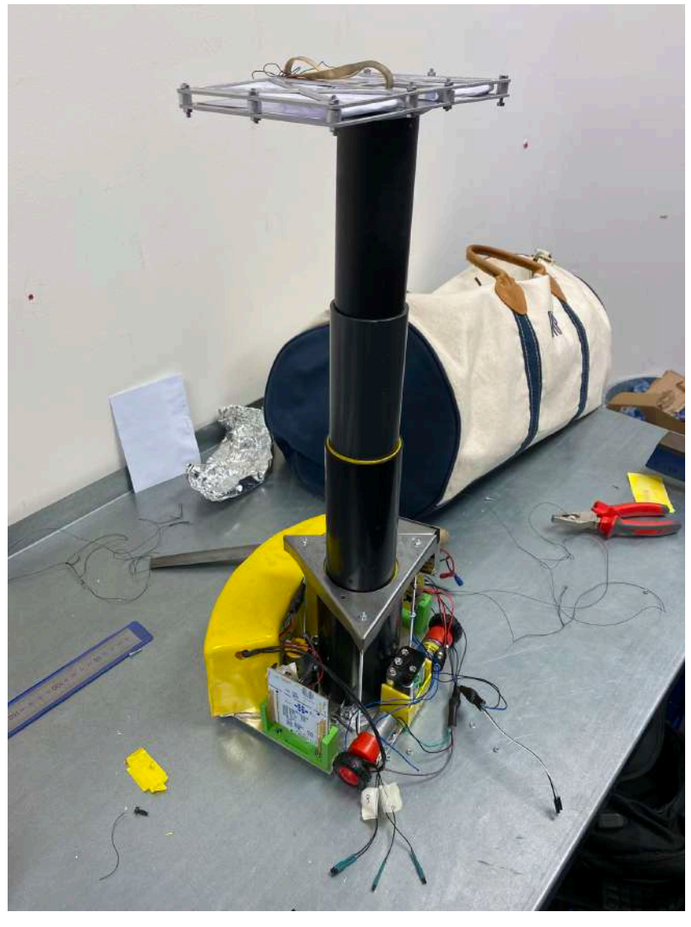
The spring was held in it's compressed state in the lowermost tube, which was compressed against the baseplate by the triangular frame seen here.



The frame used to hold the envelope during transport, made as light as possible. The elastic band used to shoot the envelope can be seen here.



We chose to add eyes to the robot, making it more anthropomorphic and friendly to the user.



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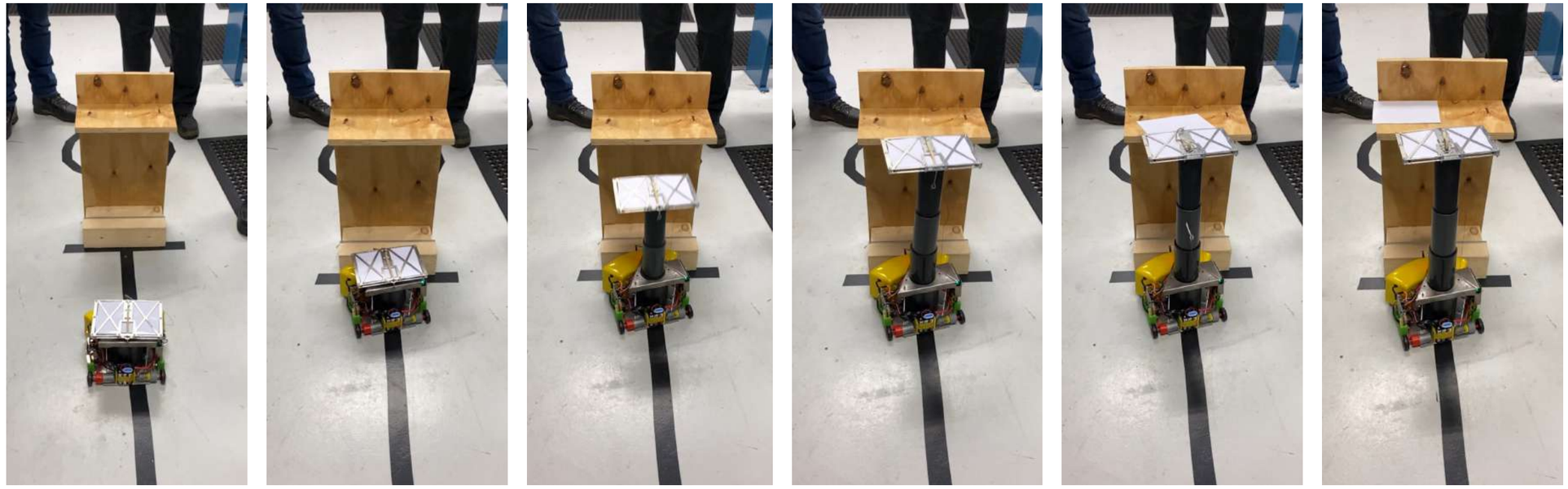
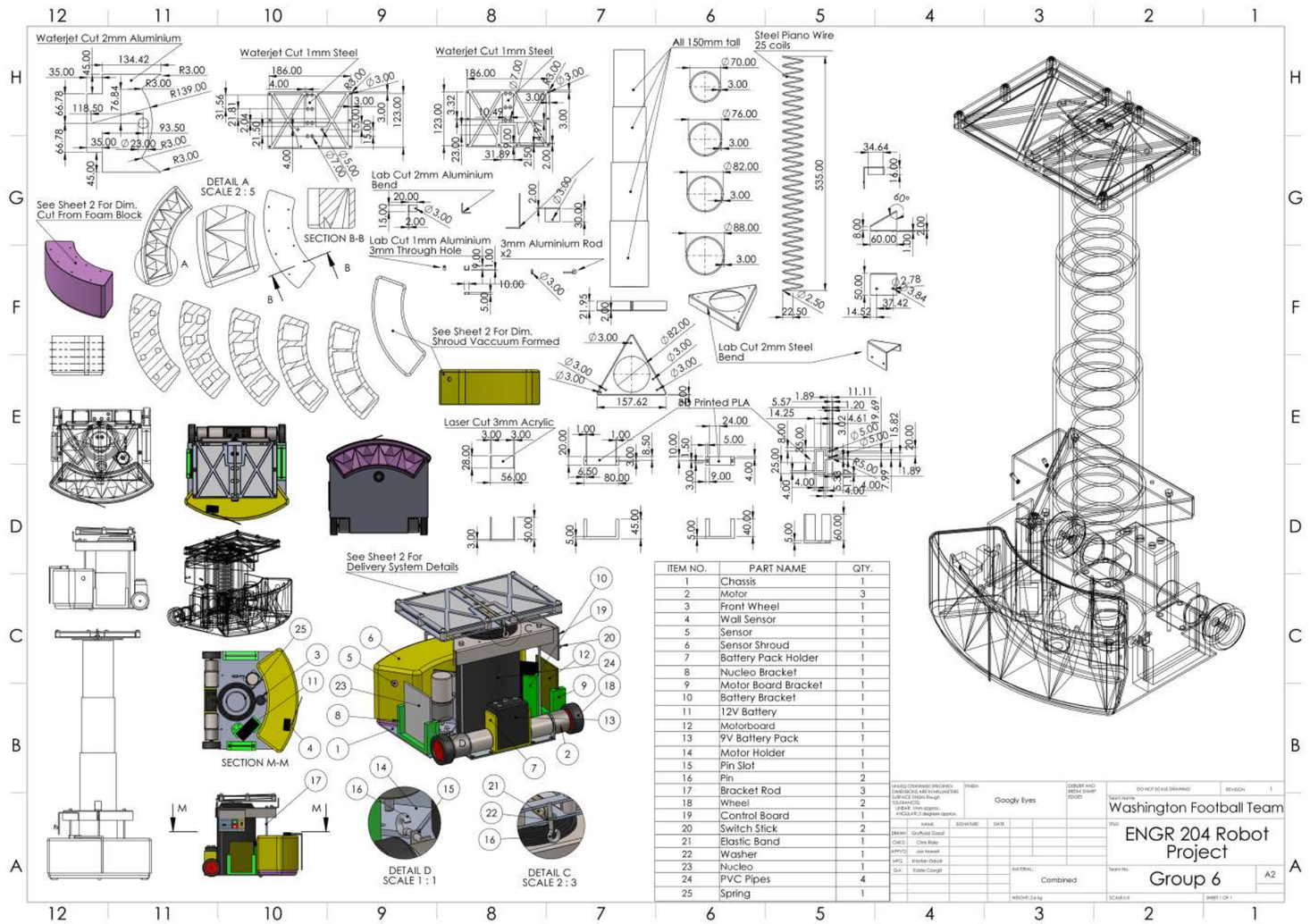
# Results

Reliability was difficult to achieve with an elastic band. But through large amounts of testing we were able to consistently deliver the envelope. Here is a series of frames from a slo-mo.






| ITEM NO. | PART NAME | QTY. |
|---|---|---|
| 1 | Chassis | 1 |
| 2 | Motor | 3 |
| 3 | Front Wheel | 1 |
| 4 | Wall Sensor | 1 |
| 5 | Sensor | 1 |
| 6 | Sensor Shroud | 1 |
| 7 | Battery Pack Holder | 1 |
| 8 | Nucleo Bracket | 1 |
| 9 | Motor Board Bracket | 1 |
| 10 | Battery Bracket | 1 |
| 11 | 12V Battery | 1 |
| 12 | Motorboard | 1 |
| 13 | 9V Battery Pack | 1 |
| 14 | Motor Holder | 1 |
| 15 | Pin Slot | 1 |
| 16 | Pin | 2 |
| 17 | Bracket Rod | 3 |
| 18 | Wheel | 2 |
| 19 | Control Board | 1 |
| 20 | Switch Stick | 2 |
| 21 | Elastic Band | 1 |
| 22 | Washer | 1 |
| 23 | Nucleo | 1 |
| 24 | PVC Pipes | 4 |
| 25 | Spring | 1 |

# Poster

After the project was finished, I created a poster with every angle, part, and dimension. NB. Many of these dimensions and views are irrelevant/inaccurate. I created this purely for artistic purposes, it is hanging on my wall.