

2024 VCE Systems Engineering Units 3/4 SAT

Chow-matic

Autonomous Dog Feeder



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Criteria 1

Design Brief

My sister Daisy is the sibling in my family tasked with feeding our dog Banjo, but she is often not home when the dog needs to be fed, or she forgets. The rest of the family doesn't know if the dog has been fed or not, which can lead to him not being fed or fed twice for one meal. To solve this problem, for my project I aim to build an automatic dog-feeder. This system aims to minimize how often Daisy must attend to the process of feeding the dog, and consistently regulating the amount of food that my dog is fed by dispensing food into a bowl at calculated intervals to ensure my dog is well fed and reduce stress for Daisy and the rest of the family.

The design will be a feeding dispenser connected to a hopper filled with dog food. This system will be controlled by a servo motor that will turn a paddle, connected to a controller and a clock chip that can run a timer and tell the current time. This will ensure that the right amount of dog food is dispensed through a funnel, down a chute, and into a bowl for breakfast and dinner every day. Ideally the only manual inputs will be refilling the hopper every few days, and then initializing the machine, as it will know how many feeds a full hopper contains and will stop dispensing once a certain number of feeds has been administered (i.e., the hopper is empty). My build could utilise a speaker to play a sound when it's feeding time, so my dog recognises when to come to the feeder to eat. This speaker could also play a sound when the dog feed has run out, so my sister knows when to refill the hopper. Similarly, I could utilise LED's or an LCD display to indicate if the machine is primed or possibly how many feeds are left. Ideally, the whole system will be powered by a 9V battery.

The budget for this project will be set at \$100, as this is as much as I am willing to spend on this project and it also pressures me to find more innovative solutions and not be wasteful. The dog feeder will reside on the floor of my laundry, as that's where my dog's kennel is and that's where he is usually feed. Because of this, the hopper will need to be easily and securely closed when not being refilled, otherwise my dog will eat the food out of the hopper. There also must not be any loose or exposed wires and the electrical or fragile components must be protected so my dog doesn't scratch or bite them and break them or injure himself. Ideally the system will fit inside a 500x500mm footprint, so it is not too much of an obstacle in my laundry, as members of my family are often in there doing the washing or fetching cleaning supplies.

I will aim to use recycled scrap timber from the woodwork room at school, as well as biodegradable PLA filament derived from corn for my 3D printed parts for sustainability purposes.

Client Profile

My client for this project is my sister Daisy. I conducted an initial client interview question in the hopes of understanding and answering these questions about my client:

- Description of the client to ensure that the need for the item is clearly identified.
- What is the problem they're facing?
- Client needs or wants that the solution must include (Constraints) and why.
- They may also suggest what the solution may include (Considerations) and why.

The following are the questions I asked my client and their answers written below:

1. First off, can you tell me a bit about yourself? Your age, year level and time commitments you have outside of school and at home.

I am in year 9 at school, and the subjects I enjoy the most are science and math related subjects. I play netball for South Bendigo JFNC. My weeks normally consist of homework, netball, social activities, hobbies and family time.

2. I understand that you are the one tasked with feeding our dog Banjo. How often do you have to do this?

I normally feed the dog twice a day when I am assigned the job, and Mum does the lunchtime shift.

3. Do you encounter any problems that stop you from completing this task?

Occasionally I am unable to feed the dog due to after school activities.

4. How do you currently attempt to or solve these problems? What affects do these problems have on others, including Banjo?

I normally ask one of my siblings or my parents to feed Banjo, which can be inconvenient and difficult for them and I. Banjo can usually be left last to eat, which he doesn't like much.

5. Keeping that in mind, what are some features a solution to this problem must include?

An automatic timer which can go off at convenient times and that can measure dog food appropriately.

7. Lastly, is there any other information or context you believe would be helpful for us to understand before proceeding with the project?

No.

Constraints

Following the interview, there are some constraints for my project that are non-negotiable to my client. These are, in order of importance:

Priority	Constraint	Justification
1	The feeder must be able to dispense food from a hopper into a dog bowl.	This is the fundamental function of my product. If it doesn't do this, it doesn't solve the problem at the lowest level.
2	The feeder must be able to dispense food without regular human input (less than daily attention), thus the feeder must be able to store multiple days' worth of feed in the hopper and the power source must last even longer than this.	If the product must be attended to as much as normally feeding the dog, there is not much convenience factor and thus the project is not a solution to the problem that my client will want to utilise.
3	The feeder must be able to fit in a 500x500mm square area in my laundry.	If the product is too large, it will be an inconvenience in our small laundry space, as it's a multi-purpose space where my dog's kennel, the washing machine and cleaning supplies reside, thus many family members are often in the area and will not want it there if it's getting in the way.

4	The product must have a fully sealed electronics box and feed hopper, as well as no exposed wires.	If the wires are exposed and my dog bites them he could get shocked and cause injury or death, which is clearly not wanted. Perhaps less of an issue but still unwanted is my dog eating the food out of the feed hopper. Thus, the hopper must have a secure lid so my dog can't open it or eat out of it.
5	The product budget is set at \$100	\$100 is the maximum budget for this project. My school will chip in approx. \$50. I believe some of the materials will cost next to nothing if I can recycle timber from my school's woodwork room. 3D printed parts will also be relatively cheap, as I can use recycled filament for that as well.

Considerations

- The features that would be nice to have but not necessary.
- The things that I would like to do if time permits.

Priorit y	Consideration	Justification
1	The product could have a dial or similar that can adjust the feeding portion and time of feeding,	These features would be beneficial to my client's goal of automating the dog feeding process. If my dog is looking too lean, my client can increase the feed portion for the time being to try and bulk him up and vice versa. If we find we need to feed him earlier or later in the day, that can also be adjusted.
2	I could implement aesthetically pleasing features like a cover for the whole machine or painted timber.	This makes the product more appealing and eye-catching to other potential clients who potentially could utilise this system.
3	I could utilise a speaker/whistle to alert the human when the hopper is empty, and to play a sound when it's feeding time for dog.	An alert system for when it's empty would further reduce the frequency of my client having to check the machine and attend to the dog feeding process. An alert system for the dog would ensure he always get's the food right away and doesn't not miss feeding time and get skinny.
4	I could implement an app that allows me to control the feeder remotely. This would mean I would have to host a server or something like that to achieve this.	An app would allow me to check if the hopper is empty while away in case I needed a family friend to go over and fill it up. It could also have a manual override feature.
5	Backup battery– if the primary power source goes out, there can be a backup battery for	This would further increase the periods between having to attend to the machine,

	when our family is away for long periods of time and the power source runs/cuts out.	meaning it can run on it's own for much longer.
6	The machine could be built out of more durable materials like metal and glass.	This would increase durability and be more aesthetically pleasing.

Evaluation Criteria

What is it?	Why do I need it? (Justification)	How will I test it?
Can my machine dispense dog feed?	This is the primary function of my project. It needs to dispense food for my dog to be fed without human assistance.	I will initiate the dispense mechanism (however that will be done depending on the design of my project) and observe whether any dog feed comes out.
Does it output the correct amount of dog food?	If the feeding portions are inconsistent, my dog could up end up becoming too skinny or too fat due to eating too little or too much food.	Once I determine what is the correct feeding portion (by weight or volume is TBD), I will get the system to dispense food and the measure the outputted feed amount to see if its correct. If it's within $\pm 10\%$ of the ideal amount I set out.
Is the total project cost within the set budget of \$100?	If I spend any more than this, it will be a significant financial commitment that I can't justify spending based on my current financial state.	I will keep a list of all parts and how much they cost and keep a running total, so I know if I'm on track or not.
Does the feeder go for multiple days without needing to be attended to?	The feeder must reduce the frequency that my client has to attend to the dog to feed him, this is the fundamental goal of the system as required by my client.	Once I know the ideal feed portion, I will make sure my system can hold enough days worth of food according to this formula I made: $\text{amount of feed in hopper} = 2 \times \text{ideal feed portion} \times \text{days}$ Also, the battery (or power source) must last for this long as well to ensure the machine can still dispense the duration of the feed hopper. This will require tests and calculations, especially if it's a battery.

Does my machine fit in a 500x500mm square area in the laundry?	If the product is too large, it will be an inconvenience in our small laundry space, as it's a multi-purpose space where my dog's kennel, the washing machine and cleaning supplies reside, thus many family members are often in the area and will not want it there if it's getting in the way.	I will measure the footprint when built and see if it fits in the 500mm square area.
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Criteria 2

Mind Map



Inspiration

These images have been collected as inspiration for a solution to my client’s problem.



This design utilises a servo motor controlled by an Arduino Nano. The motor is screwed to a spoked paddle that spins to dispense food through the chute. 3D printing is used to print the electronics, chute and mount and funnel for the hopper. The hopper in this design is bought online and made out of

This design is a more commercial build. It uses a plastic cover around the dispenser and the bowl is attached to the



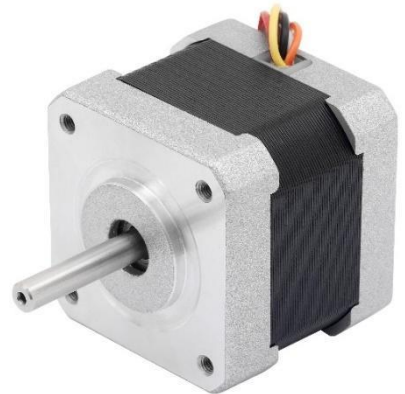
This is a very simple 3D printed DIY dispenser. It slides a plate out of the hole in the funnel to dispense food out. It uses a simple servo motor connected to an Arduino R3. The level of automation of this dispenser is unknown. The

This design uses a wheel with paddles to dispense the food. The hopper is held by a hole in the timber frame, which I think is a smart idea as it subtracts a part to hold it. The paddle is controlled by what seems to be a large servo, and this design has quite



Research
Motor

I need a motor to turn the paddle to dispense the food from the hopper. From my research of similar projects I need 0.65Nm of torque or equivalently 6.5kg/cm for this project.



Servo Motor

Price: \$30-\$50

Servo motors excel in precise control and high torque compared to DC and stepper motors which will likely ensure they dispense the correct amount of food every time. I believe they have enough holding torque to not spin under the weight of the food when at rest. However, their advanced features come at a higher cost compared to DC motors. I also am unfamiliar with how to code servos but this isn't a major drawback. An important note is that servos can be a continuous rotation servo aka spin 360 degrees or 180 degrees.

<https://core-electronics.com.au/feetech-fs5109r-standard-servo-10kg-cm.html>

<https://www.jaycar.com.au/servo-4-8v-6v/p/YM2760>

DC Motor

Price: \$10 - \$20

DC motors offer simplicity and affordability. While they lack the precision of servo motors, I can buy DC's that will provide sufficient torque for this project. However, I am unsure if the DC motor will be accurate enough to dispense the correct amount of food consistently given it doesn't have the precision of a servo or stepper. The DC may not have enough holding torque to not turn when at rest under the weight of the food in the hopper.

<https://www.omc-stepperonline.com/brushed-12v-dc-gear-motor-6-5kg-cm-12rpm-w-361-1-planetary-gearbox-pa25-24126000-g361>

Stepper Motor

Price: \$30-\$60

Stepper motors provide step-by-step control, ensuring precise positioning. They offer holding torque, advantageous for maintaining the feeder paddle's position when inactive, as I'm unsure if a DC motor in particular will hold enough stationary torque so it doesn't turn under the weight of the food when not moving. Steppers are also generally more expensive than DC motors.

<https://core-electronics.com.au/stepper-motor-with-cable.html>

Microcontroller



Arduino Nano

Price: \$40

The Arduino Nano packs the same functionality as the Uno into a smaller form factor, making it suitable for space-constrained projects like the automatic dog feeder. Its compact size enables integration into tight spaces within the feeder design. Despite its smaller size, it retains compatibility with most UNO libraries, ensuring flexibility in project development. However, its limited number of pins compared to the Uno may be an issue.

<https://store.arduino.cc/products/arduino-nano>

Arduino UNO R3

Price: Free (I own one)

The Arduino Uno R3 is a medium-sized microcontroller with plenty of functionality for motor and electronics control. I already own an Arduino UNO, so the cost is zero which is very appealing. The UNO takes 7-12 volts of power, and it is coded in Arduino language which I'm familiar with. Overall, its accessibility and adequate features make it a great choice.

<https://store.arduino.cc/products/arduino-uno-rev3>

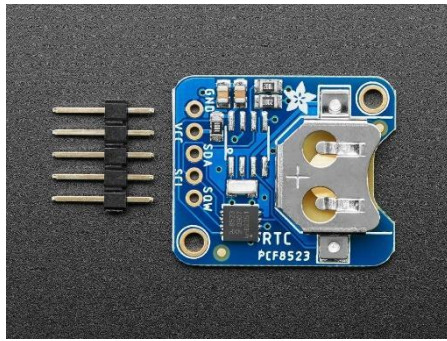
Raspberry Pi

Price: \$145

The Raspberry Pi offers significantly more computational power and features compared to Arduino boards. Its Linux-based operating system supports a wide range of programming languages and software libraries, enabling complex functionalities such as remote monitoring and control. However, its higher cost, complexity, and power consumption may be overkill for my feeder. I don't know much about the Pi and how they're programmed so it's not ideal for me and this project. Top of Form

<https://www.raspberrypi.com/prod>

Timer/Clock



Adafruit PCF8523 RTC Module

Price: \$15

The Adafruit PCF8523 Real Time Clock (RTC) is a battery backed will allow me to keep track of time even if it is reprogrammed or if the power is lost as, it has its own backup CR1220 coin cell battery. I chose this one as it can run off 5V or 3.3V power, which may come in handy if I must power my motor with 5V.

<https://www.adafruit.com/product/3296>

<https://forum.arduino.cc/t/problems-with-rtc/578249/8>

<https://learn.adafruit.com/adafruit-pcf8523-real-time-clock/rtc-with->

<https://core-electronics.com.au/adafruit-pcf8523-real-time-clock-assembled-breakout-board.html>

```
// Pin to be activated
const int outputPin = 13; // Example pin 13, connected to onboard LED

// Interval for activation in milliseconds
const unsigned long interval = 12UL * 60UL * 60UL * 1000UL; // 12 hours

// Variable to track the last activation time
unsigned long lastActivationTime = 0;

void setup() {
  pinMode(outputPin, OUTPUT);
}

void loop() {
  unsigned long currentTime = millis();

  // Check if it's time to activate the pin
  if (currentTime - lastActivationTime >= interval) {
    // Activate the pin
    digitalWrite(outputPin, HIGH);
    delay(1000); // Keep the pin high for 1 second (optional)

    // Deactivate the pin
    digitalWrite(outputPin, LOW);

    // Update last activation time
    lastActivationTime = currentTime;
  }
}
```

Coding the Arduino R3 with built in functions

Price: Free

The Arduino UNO has built-in timer functionality along with the millis() function for tracking time intervals. I can utilise this as my timer, but if my UNO runs out of power or crashes the time will be lost and I will have to reset it, which could result in my dog missing a feed.

Alert System



LEDs

Price: Free

I can use different colour LED's to indicate when the food has run out and to show when the system is powered on and running. These are easy to integrate into my design and I have access to dozens so they're free.

Piezo

Price: Free

A piezo buzzer could be useful to alert my dog when it's feeding time and the food is about to be dispensed. It could also be used to buzz when the food runs out in the hopper so a human can fill it up. I also have a few of these so it's free.

LCD Display

Price: Free

An LCD display could be used to display when the next feed is, and how many cycles remain, but this may be a bit overkill and not necessary if I utilise the other two alert systems. I have one of these so I could use it if I decide to.

Power Supply



Batteries

Non-rechargeable 9V batteries are the standard way to power Arduino projects as they are relatively cheap (approx.. \$7), safe and easy to use, however they usually have a lifetime capacity of around 500mAh, which may not power my setup for very long. Every time one of these runs out I would need to replace it with a new one which could incur some pretty high costs over the lifetime of my product, and it requires human intervention to change the battery.

I could use rechargeable 9V batteries, but these often trade reusability for capacity, and are far more expensive at around \$20-\$30. This would require more human intervention as well to recharge them.

Using a 12V battery is also a possibility, but most of them are too high current and high voltage due to varying manufacturing standards, which means they're not as safe and even more expensive versus 9V batteries, but they could possibly last for a long time.



AC to DC Power Supply

An AC to DC power supply plugs into a wall socket and converts 240V AC power into 9V DC power to provide power to my microcontroller. Despite it being more expensive upfront than a battery at \$30, in the long term it will likely be far cheaper, as this power supply will provide power if my house has power, meaning I don't have to ever charge it or attend to it unless the power goes out, which very rarely happens. I save money on replacement batteries as well.

<https://www.jaycar.com.au/9v-dc-500ma-ultra-slim-power-supply-7dc-plugs/p/MP3146>

Solar Panel

Price: \$15-\$25

A solar panel could be used to charge a reusable battery so it would be recharged without human intervention, however solar panels depend on how good the weather is, and I would have to wire it and mount it outside the laundry where my product will reside, which is not ideal. The combined cost of this plus a reusable battery will be quite expensive as well.



Frame and Parts Material



3D Printed Filament

3D printing parts of my project will allow the parts to be specifically designed for the system in that the components will be placed perfectly, and everything can be tailored to fit the design of the system. The strength of the filament is not as strong as other materials but the cost to 3D print some parts could prove to be cheaper than other alternatives. It may not be the best choice for structural framing as it takes a long time to print a large structure and again, it won't be as strong as timber.



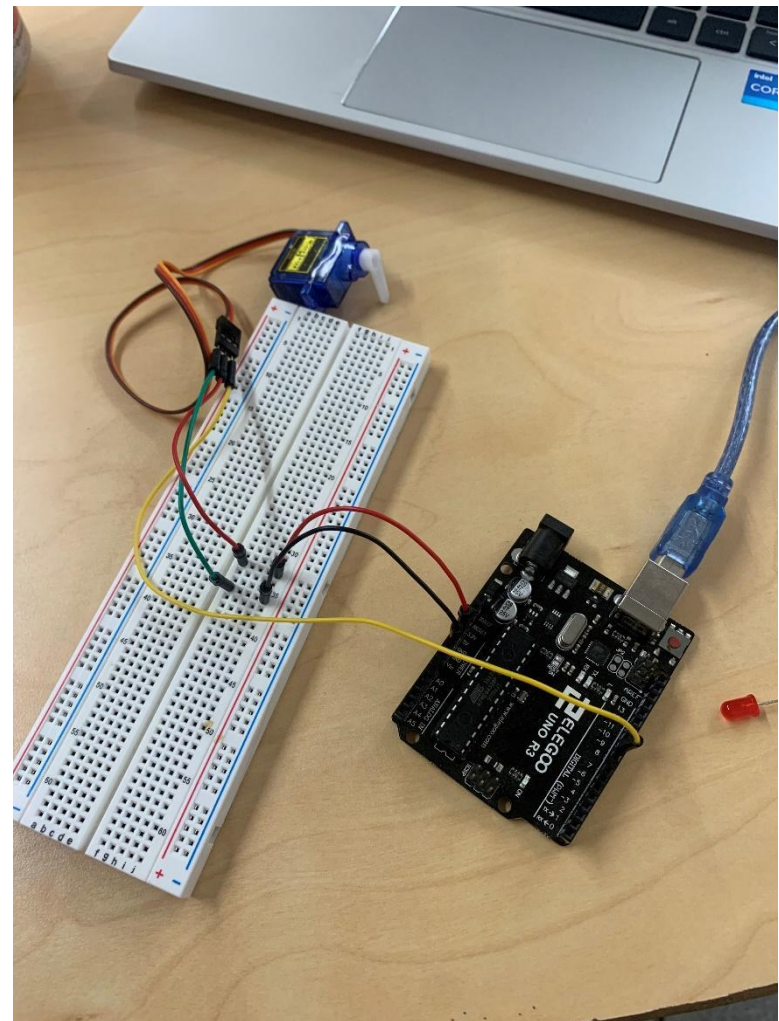
Timber

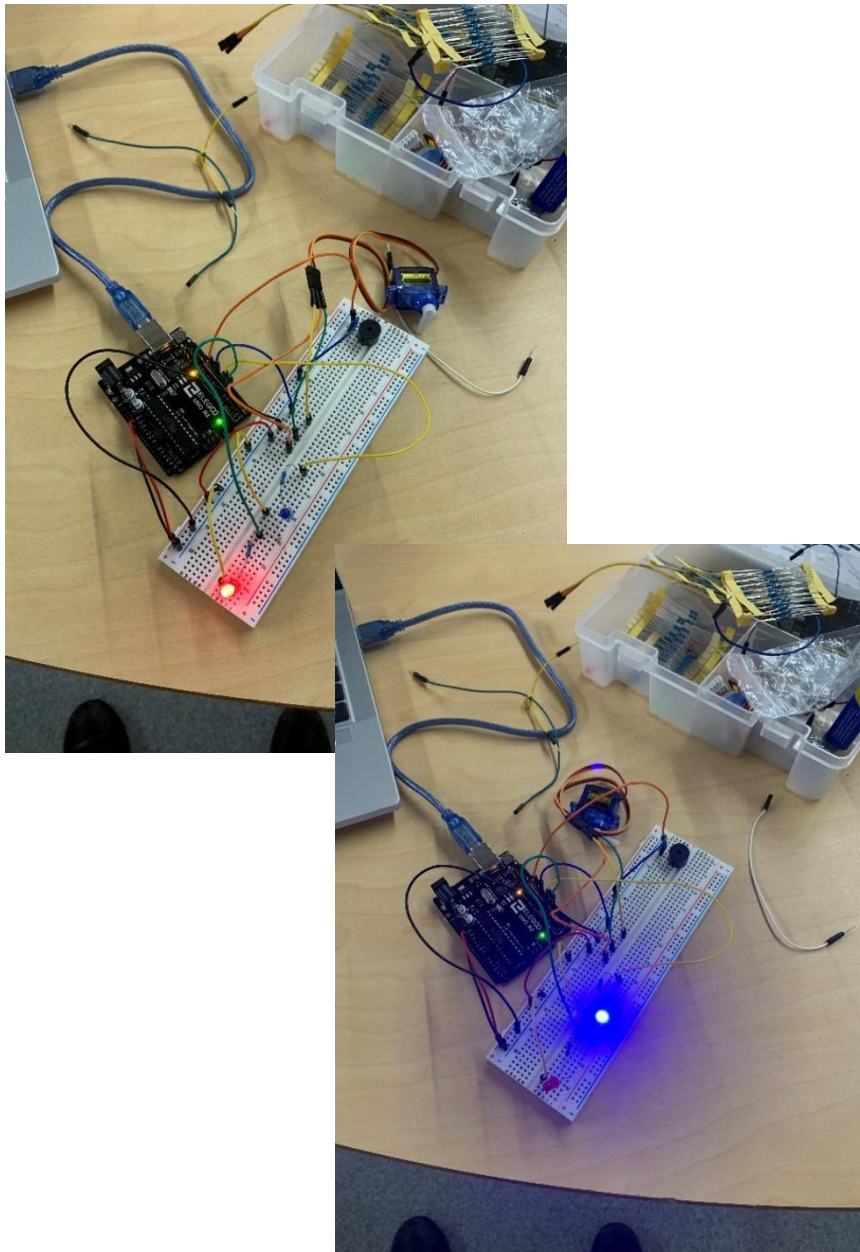
Timber offers less flexibility of manufacturing as 3D printed parts, but the strength is much higher and it has shape already and takes less time to work into what I want as it is as it's subtractive manufacturing versus additive manufacturing in 3D printing. Timber can be relatively cheap as well, especially if I use scrap timber from the school woodwork workshop. Timber may be a good choice to use for the frame and cladding of my build, and then 3D print the more intricate or custom parts of the project.

Prototyping and Testing

Test #1

The goal of my first test was to learn how to wire up a servo motor and how they function. I used a small servo in the workshop and my Arduino UNO. The servo was powered by the 5V pin on the board, and I controlled the servo movement through a digital pin on the Arduino. The main thing I learnt was that standard servos do not rotate a full 360 degrees, so I will need to make sure if I choose a servo motor for my product I keep this restriction in mind.





Test #2

The goal of my second test was to see if I could wire up my alert system in conjunction with the servo. I was able to have LEDs to indicate when the motor was running and when it wasn't. When the motor cycle was completed the LED flashed red and the piezo buzzer beeped, simulating when the food has run out and it's time for the hopper to be refilled. A blue LED was on when the motor was running to indicate when the system is up and running and the hopper has food remaining.

I was unable to test the clock module as I don't own one yet, but I used small delays in the Arduino code.



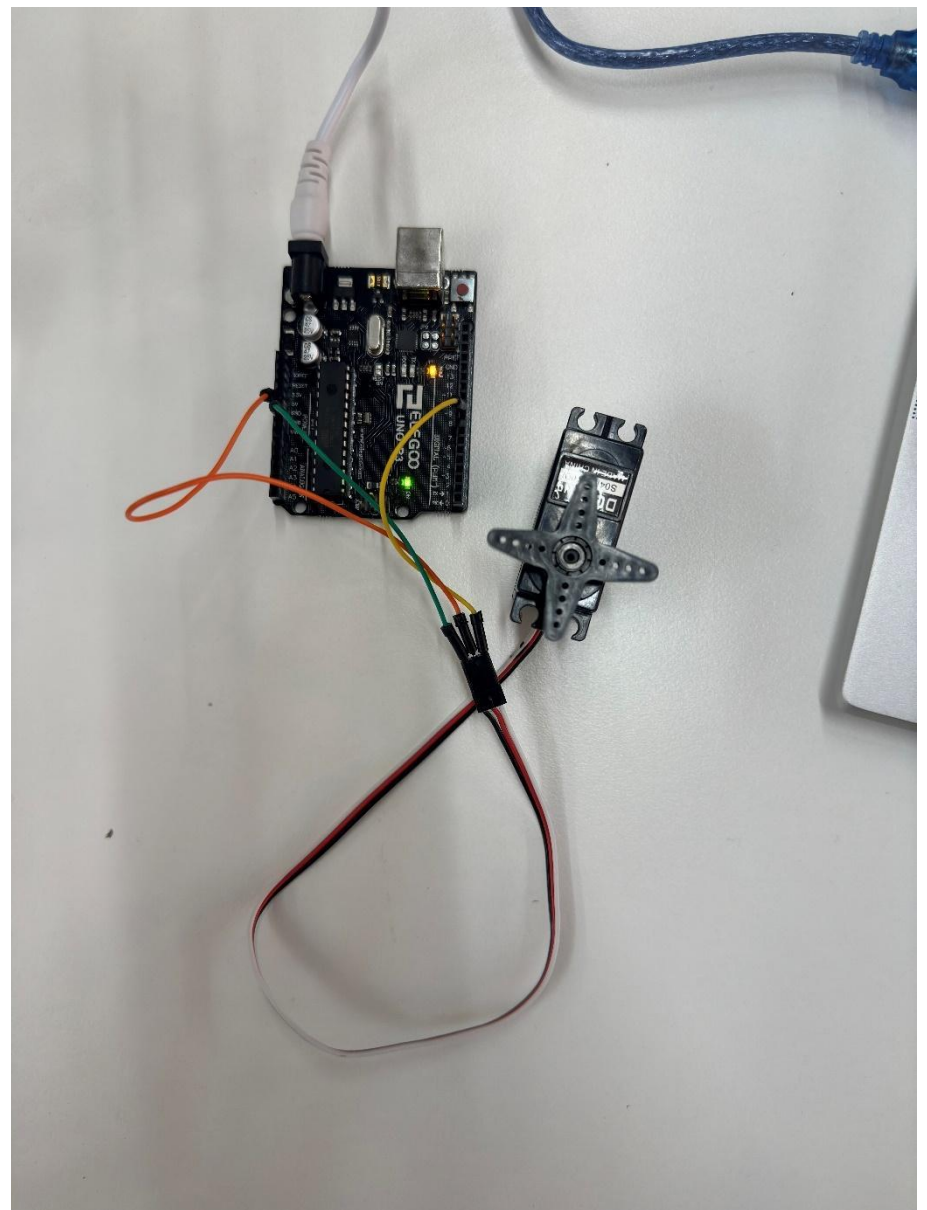
Test #3

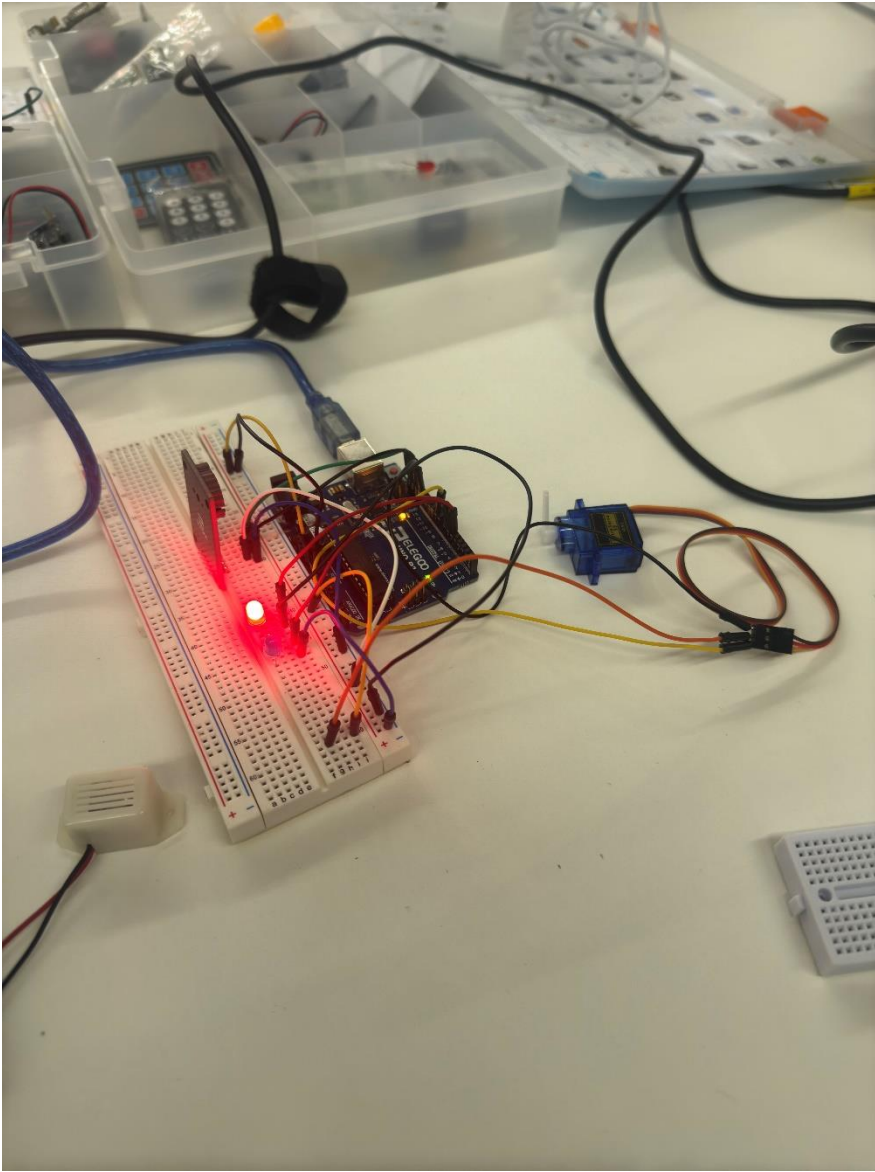
The goal of my third test was to hear if the buzzer's supplied by the workshop could be heard from 20m away. I placed the buzzer and turned it on down the hallway, then walked into the back corner of the systems room and listened while everyone was talking to see if I could hear it, and I easily could. This means it'll likely be loud enough so my client can hear it from her room or the kitchen/living room.

Test #4

The goal of my fourth test was to check out one of the servo's I found in the workshop. It turned out that this type of servo was continuous, meaning it could spin 360 degrees. This opens up more options for my design now I am not restricted to a 180 deg servo. The specifications I found online told me this servo was only 3.5kg/cm torque, which may not be enough depending on the weight of food.

<https://botland.store/withdrawn-products/3066-servo-dgs-s04nf-continuous-rotation-360-with-dagu-rs002d-wheel-6952581600350.html>





Test #5

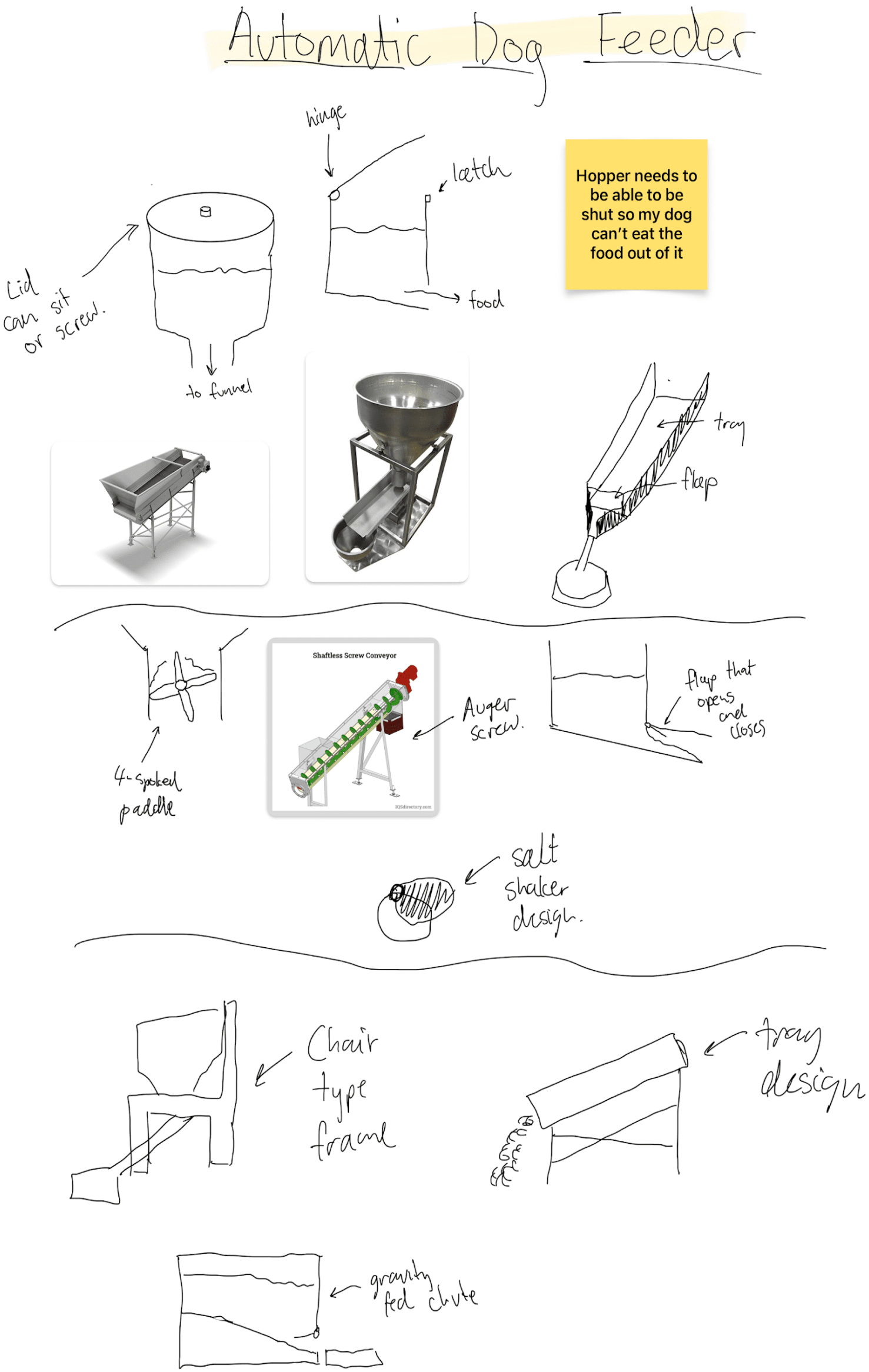
I found an RTC clock module like the one I need for my machine in my Arduino kit, so this test was to see if it worked and if I could integrate it into my other electronics. The test was successful, and I had the RTC signalling the Arduino to activate the LEDs and a servo every 30 seconds, and I tested 1-minute intervals as well. As the test was successful, I will use this RTC in my project.

Parts List

Description	Parts number	Supplier/Link	Quantity	Cost (\$AUD)	What will it be used for	Why I chose this part/material
Arduino UNO R3	n/a	n/a	1	Supplied from home	To control the electronic components of the circuit.	I already own one, meaning it's free, and I know how to use one. It provides enough power and has more than enough pins to run my project. It's also a small enough size so it's pretty easily integrated into my project frame.
Adafruit RTC Breakout Board	PCF8523	https://core-electronics.com.au/adafruit-pcf8523-real-time-clock-assembled-breakout-board.html	1	\$14.15	To keep time to input to the Arduino to know when to activate the servo to dispense food.	I need the RTC to keep the time, so my dog is fed on time. Using the delays built into the Arduino are nowhere near as reliable, and if my Arduino loses power the time will be lost and I will have to fix the code to set it again. An RTC has a backup battery, so it doesn't lose time when the power goes out. It also means I can set it to a time of day, versus setting a timer from that time of day, which will be more fiddly and inaccurate.
9V DC 1A Power Supply	n/a	n/a	1	Workshop supplied	To provide power to my board and project.	The AC to DC power brick will provide constant 9V power to my Arduino board from an AC outlet in my laundry. I chose this over a battery or solar panel because it's more reliable, regulated and requires far less maintenance. Despite the high upfront cost, in the long run it will be cheaper than buying batteries, and more sustainable.
Servo Motor - Standard 6 Volt with Metal Gear - 11kg	YM2765	https://www.jaycar.com.au/servo-motor-standard-6-volt-with-metal-gear-11kg/p/YM2765	1	\$36.95	To dispense the food from the hopper into the bowl.	I chose the servo because the #1 thing I need from my motor in this project is torque. A servo motor is the best option for enough torque and speed at the 5V my Arduino can provide. Even though servos can only rotate 180°, I can engineer around this limitation.

LED's	n/a	n/a	2	Supplied from home	To indicate the status of the system. Is the hopper empty or full.	I chose the LEDs as an addition to my project to indicate when the hopper has food remaining to show my client if they miss the buzzer alert system. I have a bunch of LEDs already from home so they're essentially free, meaning they don't cost much to add to my project.
Alarm Buzzer	n/a	n/a	1	Workshop supplied	To buzz when the food has been dispensed for my dog, also to alert the human when the hopper has run out.	I chose to add a buzzer to my project as I have one from the workshop, so it is low cost. This means I can play a sequence of sounds when it's time for feeding so my dog knows to come to the feeder. It could also play a sound when the food has run out, but this could be confusing for my dog.
Solderable Breadboard	n/a	n/a	1	Workshop Supplied	To be able to solder my components together.	A solderable breadboard is better than a non-solderable one similar to what I use for prototyping because pins are always connected and can't fall out, which would result in my dog possibly missing a feed.
Connecting electrical wires	n/a	n/a	30 approx.	Workshop supplied	The connecting wires, as per its name, serves the purpose of connecting the different components to each other and allowing the flow of electricity to power the whole circuit.	The wires were chosen purely to help power the circuit, with the workshop supplying the wires makes room in the budget to spend on other components.
3D printing filament	n/a	n/a	1 roll approx.	Supplied from outside school	To be used in the 3D parts of my project	I chose 3D printed parts for some of the more custom parts as it is more precise and offers more customization than timber for the frame.
Treated pine timber (or scrap)	n/a	n/a				

Visualisations



Design Options

Design Option 1 – ‘Magazine Holder’

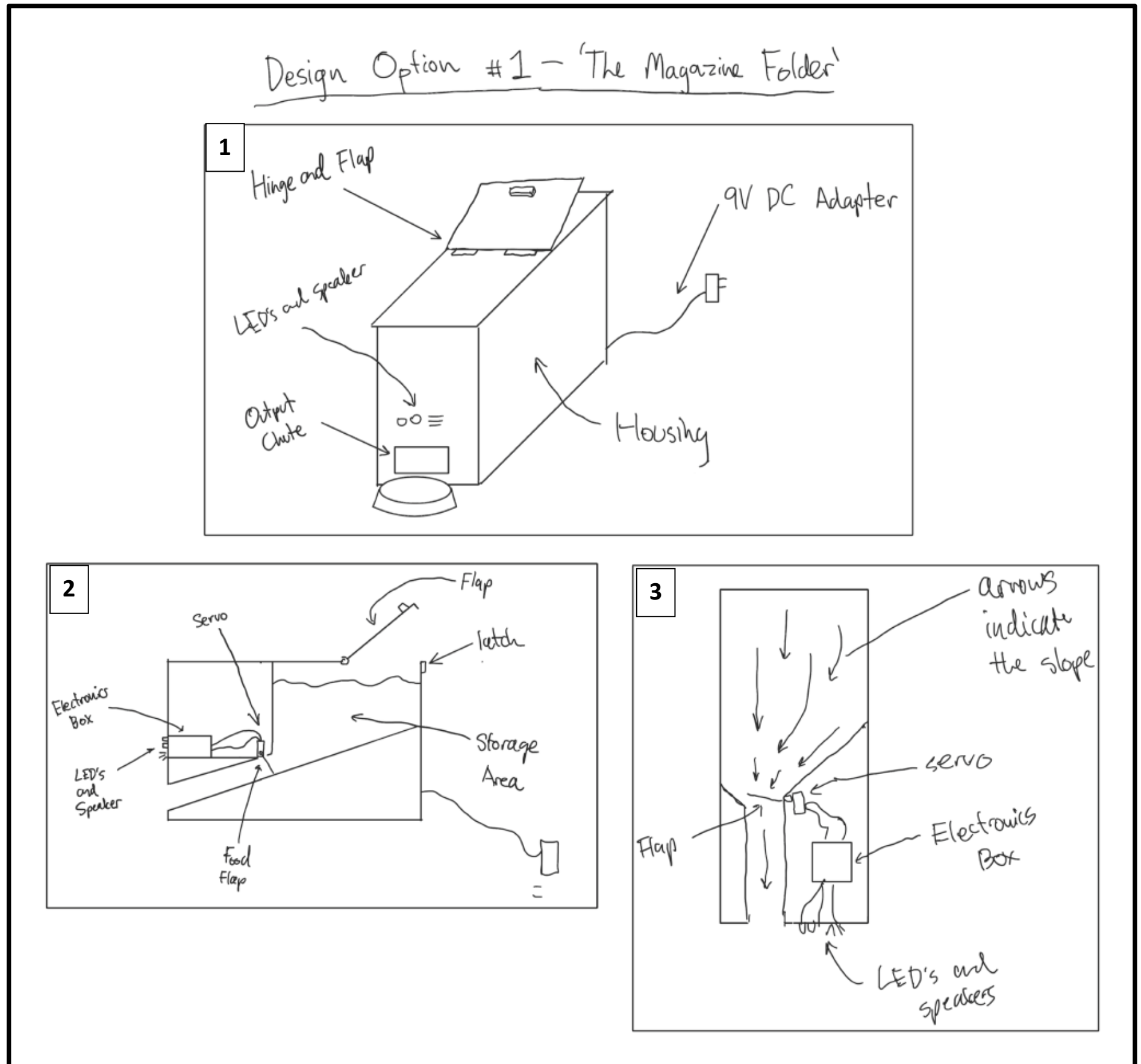


Image 1: Front 3-quarter view, Image 2: Side view cutaway, Image 3: Top view cutaway

Constraint	Evaluation of Design Option	Score
Dispensing	This design option is gravity fed. The slope of the storage compartment and chute mean the food will slide down and out when the flap is opened by the servo motor.	3
Autonomy	The slope will need to be quite steep to ensure enough food is dispensed and it doesn't get stuck, and thus the volume taken up inside the machine that cannot be filled with food is significant. This means the machine cannot run as long as other options without being filled up again, reducing the time it will run without human intervention.	3
Size	The area of the triangular section under and above the slope mean the system will be quite large to accommodate enough food. The design is more of a longer rectangular, and I can make it taller to fit more food	4

	instead of increasing the footprint. The narrow width means it could slide down between my dog’s kennel and the laundry door easily.	
Sealed hopper and electronics box	The electronics are wholly contained inside the frame safely away from my dog. The only exposed wire is the cord from the 9V power supply, but this can be stuck to the floor or wall to make sure it’s not loose. The flap on top will latch shut so my dog can’t get into the food, but it will be easily openable by my client to fill it up when empty.	5
Budget of \$100	This option uses a lot of timber and plywood for cladding and framing, which could be costly, but it should be under the budget. The design uses a servo, Arduino UNO and other components I already own which will keep costs down. The hopper and chute and electronics box will 3D printed to keep costs down as well. It should easily be under the \$100 budget.	3
Total Score		18/25

Design Option #2 – ‘Chair’

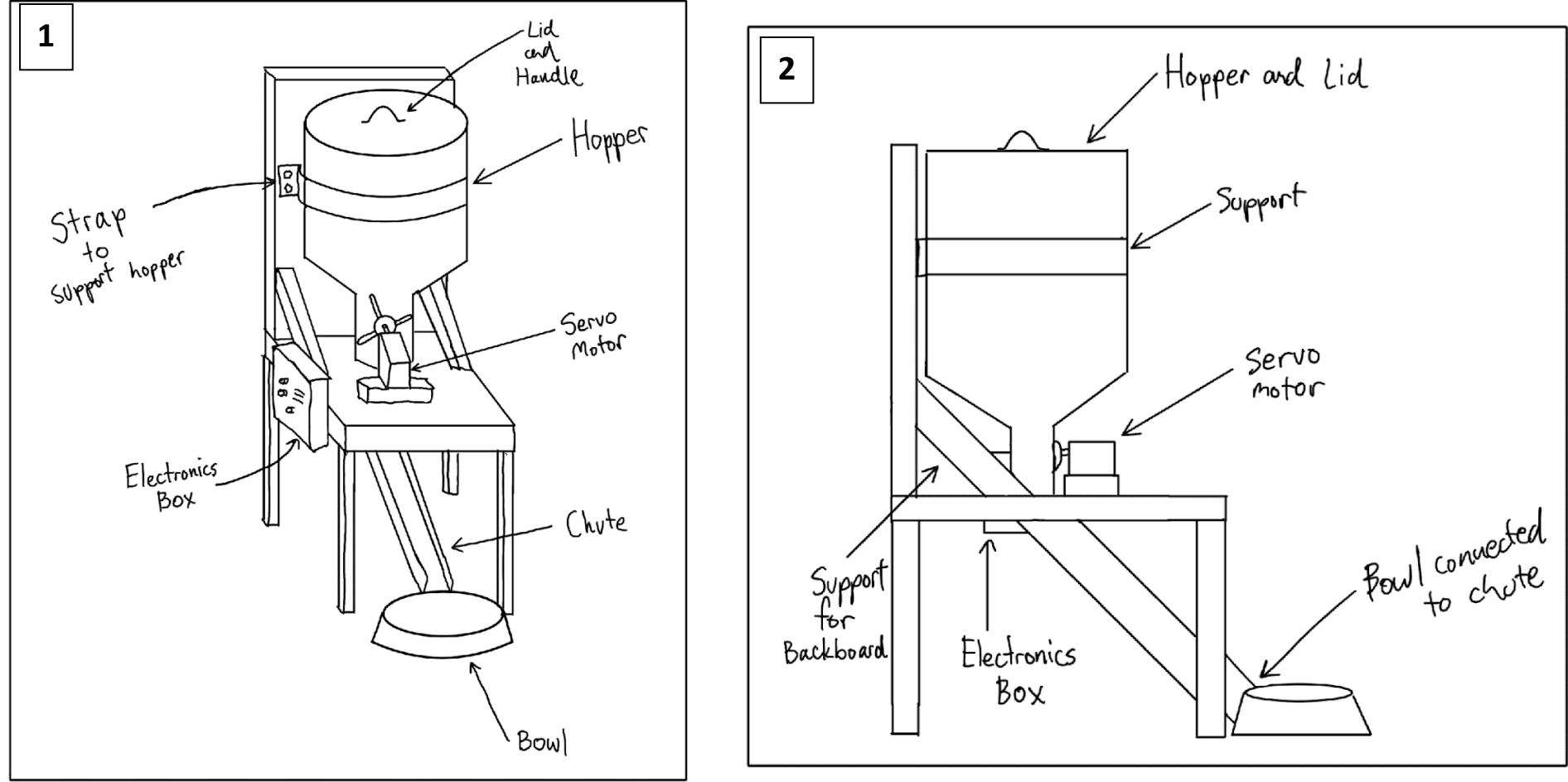


Image 1: Front 3-quarter view (cutaway around funnel area to show spoked wheel), Image 2: Side view

Constraint	Evaluation of Design Option	Score
Dispensing	This option uses a gravity fed hopper above a funnel. Inside the funnel is a spoked wheel that holds food back when stationary, but when it spins the gaps between the spokes will hold some food, which will fall out the funnel and down the chute into the bowl. The benefit of the spoked design is that it can stop the flow of food easier than a flap, as the force is spread out across 4 spokes instead of one flat area, meaning the feeding portions will likely be more accurate.	5
Autonomy	The hopper on this design can be quite large and can be as tall as is stable for the machine. Thus, the design should be able to run for a long period of time as it can hold a lot of feed portions, meaning my client	4

	does not have to attend to any process of feeding the dog for a longer time, which is the core goal of my product.	
Size	This design is square in footprint and is quite compact but can the height of the hopper and thus support backboard can be as tall as I need. The footprint of the legs may need to be larger if the hopper is made larger to ensure stability, so it doesn't tip over. Overall, this design should meet my client's constraints for size and will fit in her laundry easily without causing a nuisance.	5
Sealed hopper and electronics box	This design incorporates a lid on the hopper that can sit on top so my dog cannot get into the food supply. The electronics will be in a box on the side of the build so my dog can't damage them. The wires to the servo from the box will be exposed, but I could route them through some pipe or design a cover for that section, but I don't think it will be an issue. The cord from the DC power supply can be stuck to the frame so it isn't slack and causes a safety issue.	3
Budget of \$100	This design uses a lot of timber and the 3D printed hopper will use a lot of filament, but these materials aren't too costly especially if I use recycled scrap timber. The cost of the servo and clock module are the same as the other two designs. Overall, this design will likely fit the budget for my project.	4
Total Score		21/25

Design Option 3 – ‘Trough’

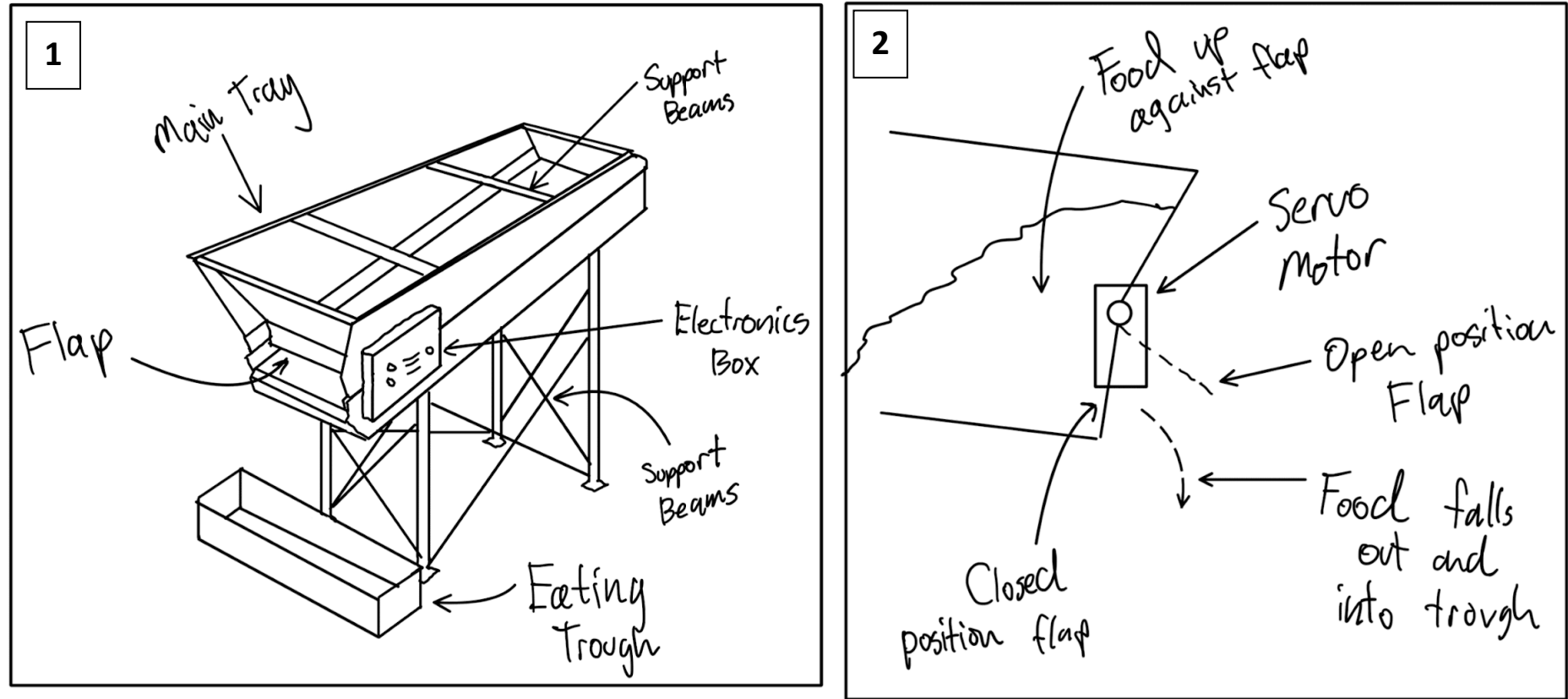


Image 1: Front 3-quarter view, Image 2: Side view cutaway around dispensing area

Constraint	Evaluation of Design Option	Score
Dispensing	This design uses a wide flap that opens and allows the food to flow out the hopper and down into the wide trough. This means the dispensing process will be much quicker than the other two, due to the volume of food that comes out. The efficiency of the feeding might not be as good as the food falls out and isn't guided into the bowl/trough like in other ones.	4

Autonomy	This has the largest capacity of any design, as the whole chassis is the hopper. This means this design will be able to run autonomously for a long period of time without running out of food. It will have full autonomous dispensing like the other two options and will have a reset button for when you refill the hopper, so the machine knows when it is full and needs to count out a new food cycle.	5
Size	This design is quite large, and it up on a frame so that it can be easily filled up at standing height of my client. Additionally, the extra width of the trough adds to the footprint of the design. This design may pose as a bit of a nuisance in the laundry.	2
Sealed hopper and electronics box	This design has a sealed electronics box and is raised above the ground quite far	4
Budget of \$100	This design uses the most amount of material of any designs, most of which would be timber plywood. The frame would also use pine slats. This would incur quite high costs and may be pushing the budget once I factor in the electronics and 3D printed parts (box and flap).	2
Total Score		17/25

Chosen Design Option

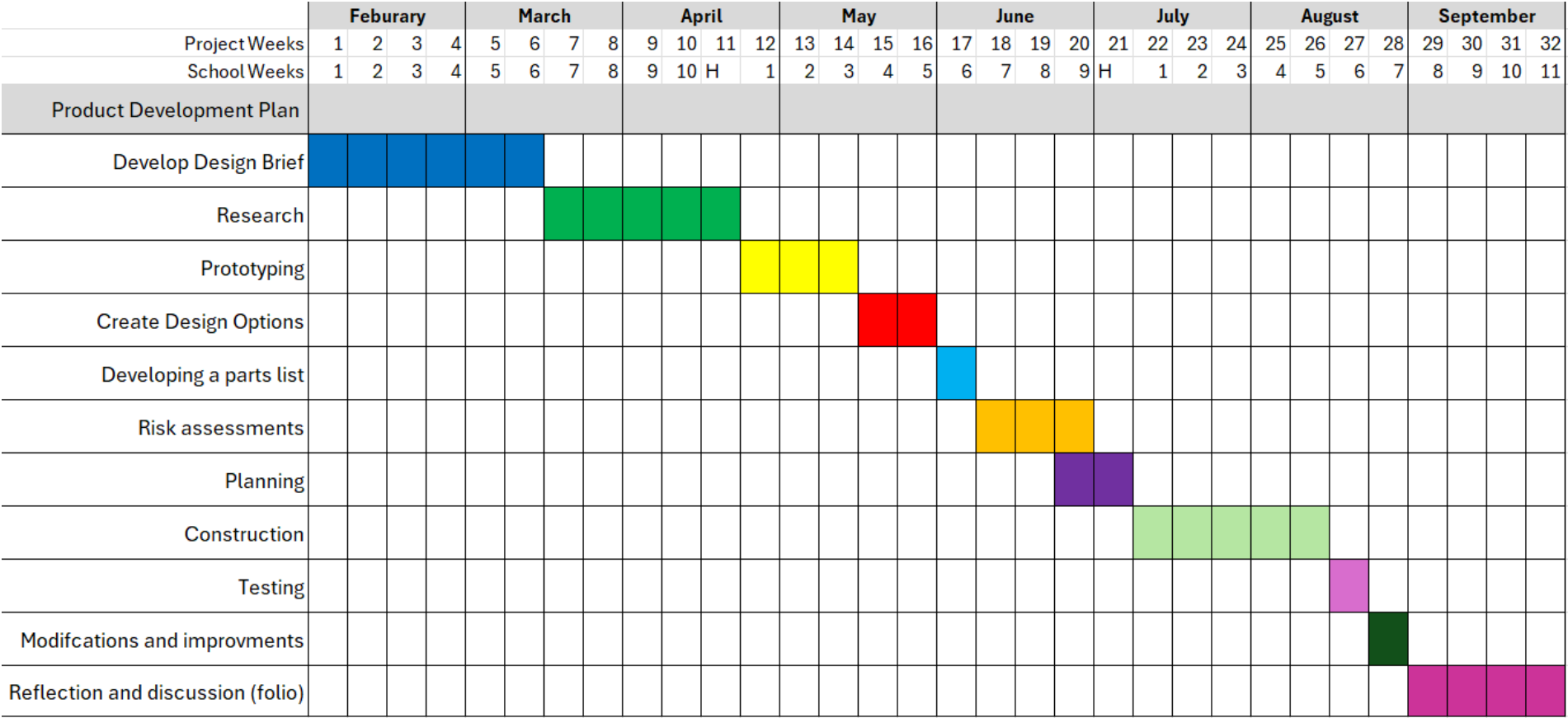
My chosen design option is Design Option 2 – ‘Chair’. My most preferred option, as well as my client’s most preferred option is Design 2. The ‘Chair’ design scored higher than my other two options on my rubric against my client’s constraints for the project.

This design uses a 9V AC to DC power supply, servo, clock module, Arduino UNO, LEDs, buzzer and a reset button. This combination of electronics maximizes the autonomy of the product and thus my client does not have to attend to feeding the dog for a long period of time. The servo motor has the most torque at the voltage I can supply from my Arduino at 5V, making it the best option for this project as speed of the motor is not a major factor. The clock module ensures long term and accurate timekeeping, so my dog is always fed at the right time and my client does not have to worry about if he has been fed. Similarly, the 9V AC-DC power supply ensures that my project always has constant power, unless of course the power goes out. This is still far better than a battery or solar panel as it supplies constant levels of power and will not run out or fluctuate. This reduces the time my client has to spend changing batteries and also reduces the stress she may feel when worrying if the machine is powered and the dog is getting fed. The buzzer was included to alert my dog when it is feeding time, so he doesn’t have to constantly check or beg for food when it has already been dispensed. This also helps my client to know that the dog has been fed. The LEDs similarly were included to indicate to my client if the hopper had feed remaining or not. When the Arduino calculates the food is empty, the red LED will be activated, when the hopper has only a day of feed remaining the orange LED will activate, and when the blue LED is on, it means there is more than a day of feed remaining. There will also be a button to reset the feeder when my client refills the hopper, so the Arduino knows to reset the counting of feeds and change to the blue LED.

The material cost and possible inaccuracy of feeding portions of Design Option 3 meant it lost out to Option 2. The inefficiency of material use and thus decrease in autonomy duration hurt Option 1’s score. Ultimately, Design Option 2 has the most balanced scores and highest overall score across the board, making it the best option for my client’s product.

Criteria 3

Gantt Chart



Project Plan

Single Period on Monday, Double Period on Wednesday and Thursday

Task #	Task Objective	Process	Start Date	Time Allocated	Actual Time Taken
1	Make wooden frame	- Gather two wooden boards of any suitable material to make the frame, as well at some thinner pieces to make the legs. - Get teacher to cut them to length with the table saw so it's quicker and more accurate than a manual saw - Using a drill, pilot hole and then screw together.	Wednesday 17 th July	5 periods	
2	Model 3D parts	Using Fusion 360 and callipers, create encoder wheel, hopper, lid, servo mount, chute, electronics box, food spoked wheel STL files so that I can print them later.	Wednesday 23 rd July	4 periods	

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3	Print 3D parts	Send off files and print parts at School the Bendigo Tech School.	Friday 25 th July	Outside of school (2 weeks)	
4	Test electronics setup on breadboard	- Ensure I have all electronic components prepared. - Using the school tub of wires and a breadboard wire up my final electronics setup. - Test that all features are working reliably and accurately by observation.	Monday 28 th July	2 periods	
5	Solder components to permanent breadboard	- Transfer the electronic system to a permanent breadboard in preparation for soldering. - Prepare the soldering iron and ensure I follow the risk assessment procedures. - Solder together my electronic system. - Test that is still working as planned like before.	Wednesday 29 th July	3 periods	
6	Attach 3D printed parts excluding servo to frame.	Using a drill and my 8mm head screws, attach the 3D printed parts to the wooden frame.	Monday 5 th August	5 periods	
7	Cut and attach servo to mount and then attach it to the frame	- Screw the servo onto the servo bracket using M4 nuts and bolts. - Determine the final measurement for the height my servo needs to be. - Get teacher to cut a narrow piece of	Monday 12 th August	3 periods	

		timber to the desired dimensions. Using a drill, screw the servo bracket its wooden mount to raise it level with the wheel inside the hopper.			
8	Wire up all components and connect to power.	- Using a soldering iron again, solder the Arduino wires to the breadboard and solder the servo wires to the breadboard. - Ensure all other components are still connected.	Thursday 15 th August	2 periods	

Risk Assessments

3D Printer

Use Case

3D printers will be used to print parts of the project.

Potential Risks

1. Burns and Heat Injuries: The extruder and heated bed can reach high temperatures.
2. Fumes and Emissions: Some materials release harmful fumes when melted.
3. Mechanical Injuries: Moving parts can cause injury if touched.
4. Electrical Hazards: There is a risk of electric shock from improper handling or faulty wiring.

Risk Matrix

Risk Matrix		Likelihood				
N.B. For more details regarding use of this matrix / definitions refer to final page of this document		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures

1. **Use Safety Gear:** Operators should wear heat-resistant gloves and ensure proper ventilation.
2. **Material Selection:** It is advisable to use low-emission materials and work in well-ventilated areas or use a fume hood.
3. **Maintain Clear Boundaries:** All moving parts should be shielded, and operators should not touch the printer while it is operating.
4. **Regular Maintenance:** Regular inspection and maintenance of the printer are necessary to prevent electrical faults.

Power Drill

Use Case

A power drill will be used to screw together the wooden frame of the project and attach parts to it.

Potential Risks

1. **Eye Injuries:** Debris can fly into the eyes during drilling.
2. **Hearing Damage:** Prolonged use can cause hearing loss.
3. **Electric Shock:** There is a risk of electric shock when using the drill in wet conditions or with damaged cords.
4. **Physical Injuries:** Accidental drilling into fingers or other body parts can occur.

Risk Matrix

Risk Matrix		Likelihood				
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	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures

1. **Wear Protective Gear:** Operators should use safety goggles and hearing protection.
2. **Proper Handling:** Users should ensure dry hands and check the condition of the power cord and plug before use.
3. **Secure Workpiece:** Clamping materials securely to prevent movement is recommended.
4. **Safety Training:** Understanding proper usage techniques and emergency stop procedures is crucial.

Electric Sander

Use Case

An orbital sander will be used to sand the wooden frame of the project and possibly to sand down the 3D printed parts.

Potential Risks

1. **Respiratory Issues:** Inhalation of fine dust particles can occur.
2. **Skin Abrasions:** Contact with the sanding surface can cause abrasions.
3. **Noise Damage:** Prolonged exposure to the sander's noise can cause hearing damage.
4. **Electrical Risks:** There is potential for shock if the sander is used improperly.

Risk Matrix

Risk Matrix		Likelihood				
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	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures

1. **Use Respiratory Protection:** Operators should wear a dust mask or respirator.
2. **Wear Protective Gloves:** Gloves can prevent skin abrasions.
3. **Hearing Protection:** Earplugs or earmuffs should be used.
4. **Inspect Equipment:** Regular checks of the electrical cords and connections for damage are essential.

Soldering Iron

Use Case

A soldering iron will be used to solder electrical components to the permanent breadboard.

Potential Risks

1. **Burns:** High temperatures can cause severe skin burns.
2. **Fume Inhalation:** Soldering can release toxic fumes, especially from lead-based solder.
3. **Fire Hazard:** High temperatures can ignite flammable materials.
4. **Electric Shock:** There is a risk of electric shock from improper handling.
5. **Eye Damage:** Hot solder filament could get into eyes and cause serious damage.

Risk Matrix

Risk Matrix

N.B. For more details regarding use of this matrix / definitions refer to final page of this document

Consequence

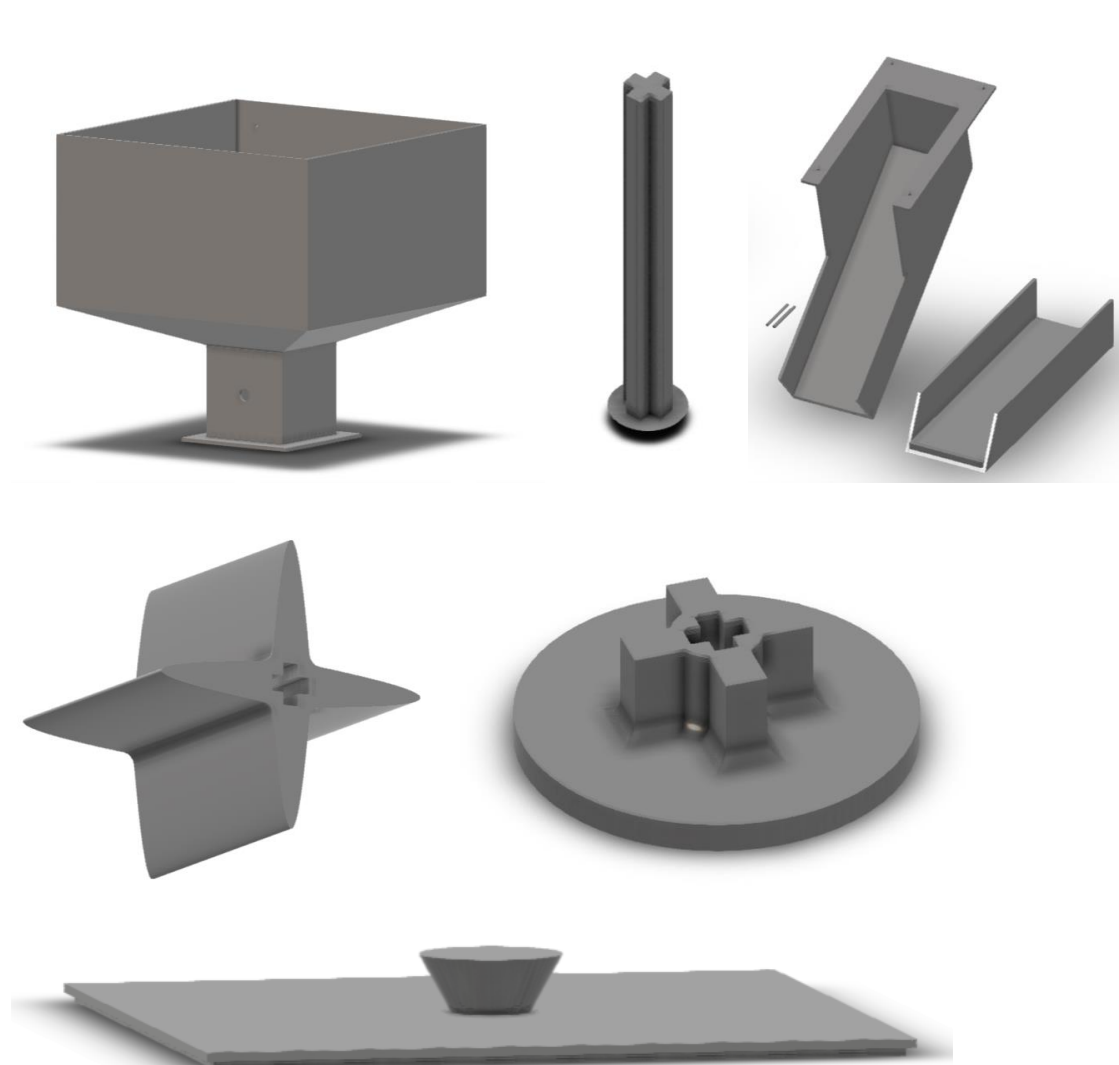
	Rare	Unlikely	Possible	Likely	Almost Certain
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Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures

- 1. Use a Stand: The soldering iron should always be placed in a safety stand when not in use.
- 2. Ventilation: Use of a fume extractor or working in a well-ventilated area is advisable.
- 3. Flame Safety: Flammable materials should be kept away from the soldering area.
- 4. Proper Handling: The iron should be used as intended and unplugged when not in use. Regular checks for damaged cords are also necessary.
- 5. Eye Protection: Wearing eye protection is necessary to prevent potential eye damage.

Criteria 4

Production Journal



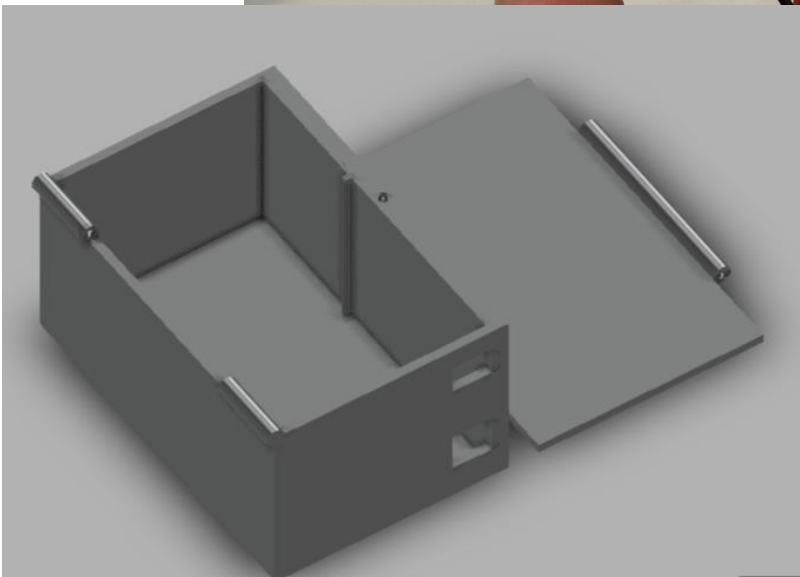
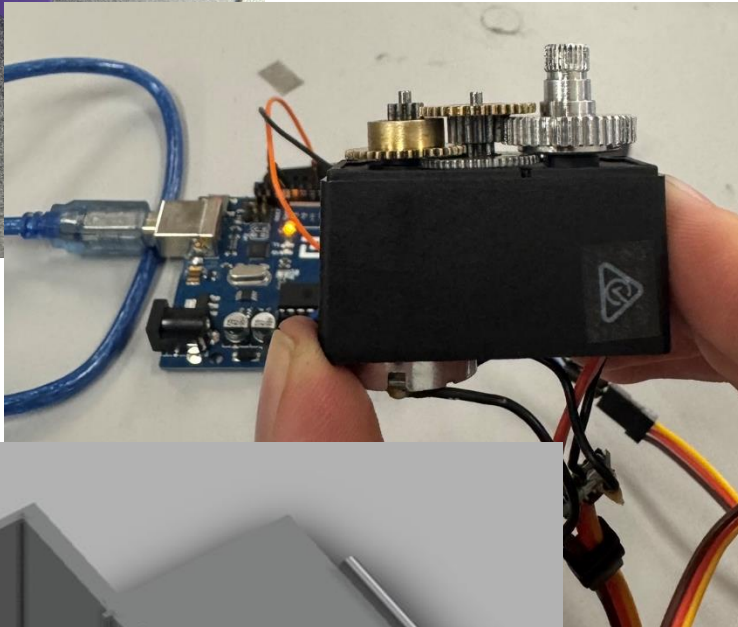
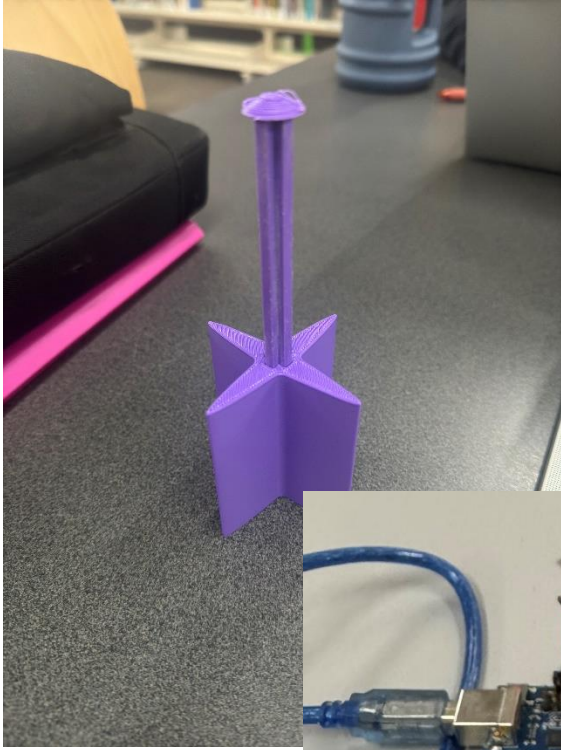
23-24th of June

Over the weekend I wanted to get started on my project before holidays, and since I didn't have access to the school woodwork workshop, I couldn't build my frame yet to follow my work plan. So, I skipped ahead and began modelling my 3D printed components in Autodesk Fusion360.

I modelled the feed hopper, hopper lid, dispensing wheel, servo encoder wheel, wheel axle and the feed chute.

Modifications

I made the hopper square instead of cylindrical, so it has more capacity and then I can screw it directly to the wooden backboard for support. I also had to split the chute into two parts which will join with dowels so that it can fit inside the 3D printer bed.

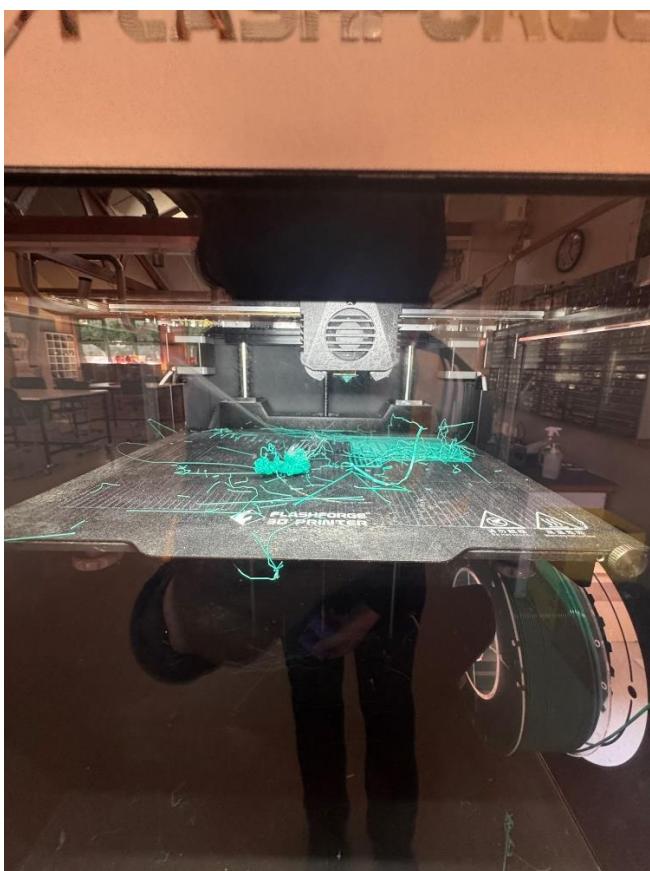


25th June

Today I 3D printed the feeder wheel and axle on the school 3D printer. Unfortunately, the tolerance between the two parts was too tight for the printer to render accurately, and thus they didn't fit together. I will try again with a slightly smaller sized axle.

I also tested my servo once again and it was suffering issues in the motor. I took it apart to try to fix it, but it was fried, and the gears were bent so it didn't spin anymore. I ordered another servo to replace it.

I also modelled the box to hold the electronics in Fusion360. It needs some modifications to fit the buzzer and led in the side.



26th June

Today I tried to print my feed chute, but the printer was not properly calibrated and it bird-nested and didn't work.

To solve the issue measure again how long the chute had to be, and it was smaller than I had initially found. This worked in my favour, as I shortened the chute so it could fit laying flat on the bed, reducing the need for large supports and reducing the print time by 12 hours.

I continued to model my electronics box with some updated measurements of the electronic components like the button, buzzer and LED's.

Some of my 3D prints I sent off to the Bendigo Tech School to be printed when the school printer was in use. Their printers were slightly smaller, so I had to shrink the size of the hopper to fit in a 220x220x220mm area.



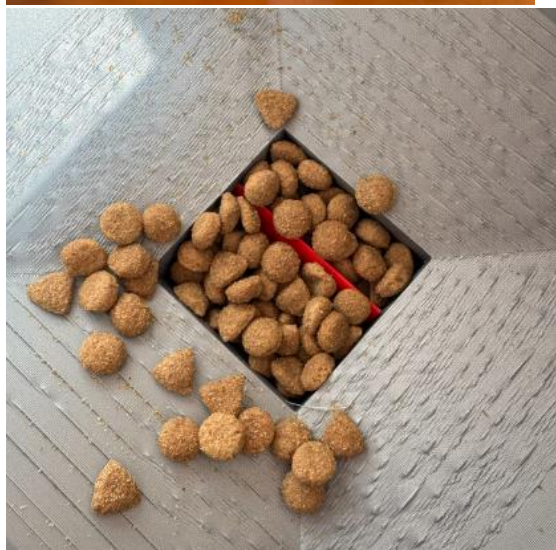
27th June

Today I sent off some of the updated prints to the BTS to be printed.

In class I measure out some MDF timber to be used for the base and back of the frame. I used MDF as it was the readily available timber I had, and it fit the needs of the project. My teacher cut the timber to size for me, and then I drilled holes and screwed the two together.

To ensure I met OHS requirements, I wore eye protection and clamped the timber in a vice and was supervised by my teacher when drilling the boards together.

I also started the 3D print at school for the chute with the updated design.



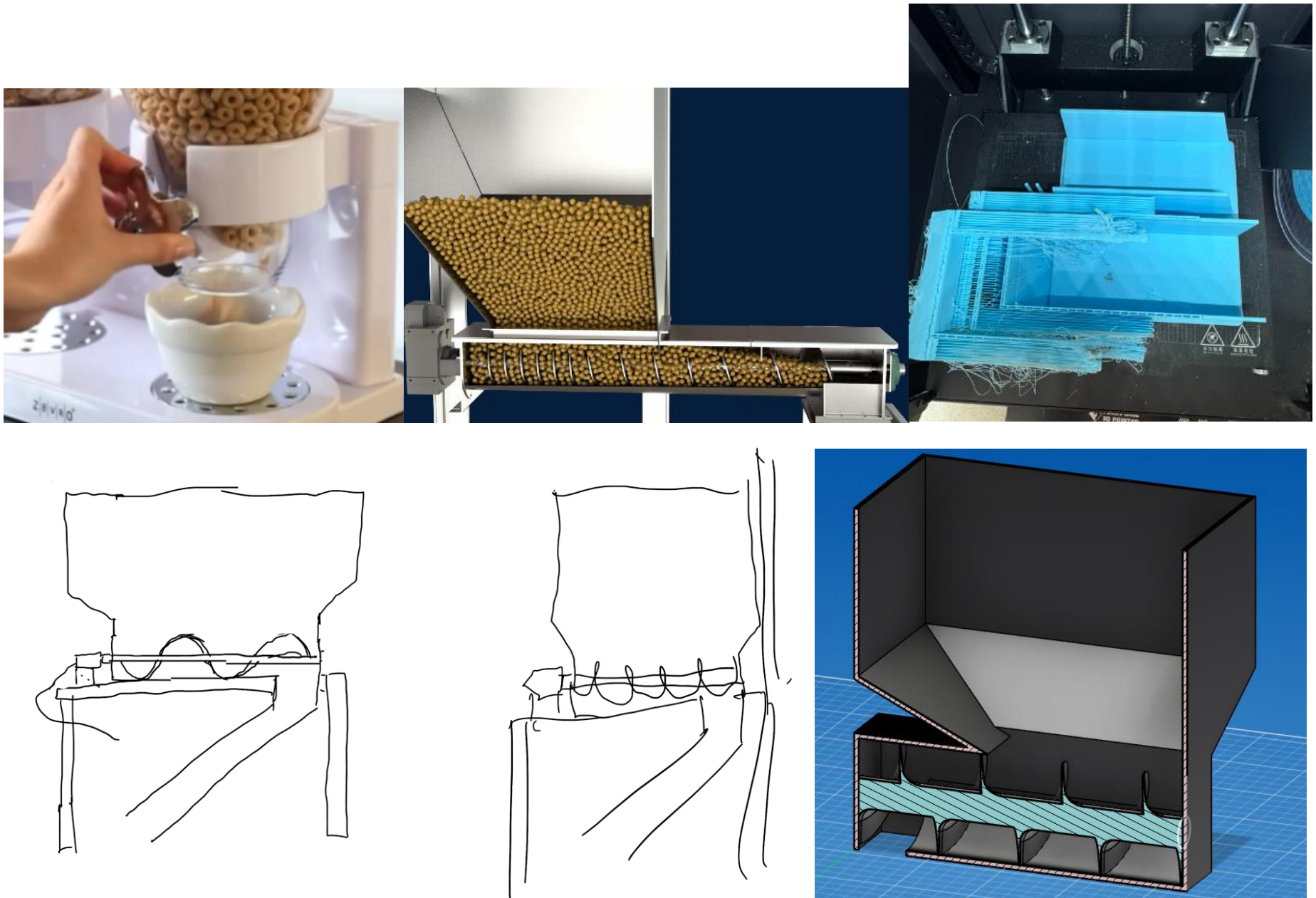
15th July

Today was my first day back home from holidays. I picked up the prints that run over the holidays from the Bendigo Tech School and took them home to test prior to school the next day.

The electronics box was a success! The Arduino fit in snugly after I sanded down the solder on the back of the board (I didn't account for this in my design). The buzzer fit well after I sawed off the flaps on the side, and the LEDs slotted in nicely. The lid opens and closes easily and there is plenty of room inside for wiring.

Unfortunately, the paddle didn't work inside the hopper. When there was more than a handful of food in the system, the food jammed against the wall and couldn't be ejected out.

My attempt at troubleshooting led me to cut down an old paddle, to see if a bigger gap between the walls of the funnel and spokes helped but didn't make much of a difference.



16th July

To fix the issue of the food getting jammed in the 4-spoke paddle design I chose in my design option, I researched cereal dispensers online that follow a similar design and use. From my research it seems a curved/tapered hopper-funnel design may mean food can be pushed out of the way easier and it won't get jammed against a vertical wall like my current design. Upon further research and reading reviews of these dispensers, it seems they still are not very functional or reliable.

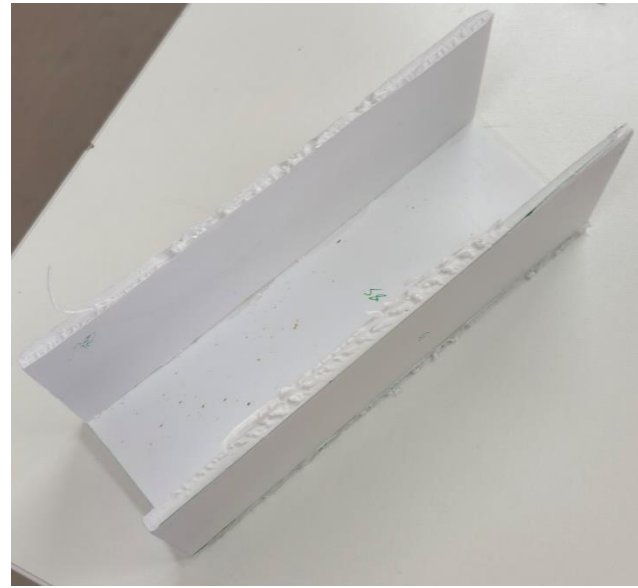
I set out researching alternatives in the method of dispensing food. My next step from cereal dispensers was in industrial farm feed machines. Most silos and feeders in agriculture utilise auger screws to dispense/move feed of all sizes and shapes.

I had explored auger screws in my visualizations and research but didn't choose to include them in my design options. Upon further research and consulting with my teacher, I chose an auger screw design as my new dispensing mechanism. So, I went about designing an auger screw, and hopper to fit it (bottom left picture is a cross section of the proposed design.) in Fusion 360.

Unrelated to this, my food chute print finished but it failed. The lower profile part on the upper half of the bed in the bottom right image was completed however, so I will hold onto this and maybe only reprint the failed half once I am fully sure of how my new design with the auger will piece together.

18th July

Today I added the cavity for an axle to go into the auger screw. I sent the print off to the tech school after consulting with their technician on the feasibility of 3D printing an auger screw. I also made a foam board mock-up at school so I can test my auger before printing the hopper.



19th July

Today I picked up the auger from the Tech School. Unfortunately, the print failed halfway through, but it was long enough to test. Even though I had a foam mock-up at school I didn't. So, I made a cardboard mock-up at home to test the auger screw before giving the go ahead for reprinting over the weekend to keep the project moving.

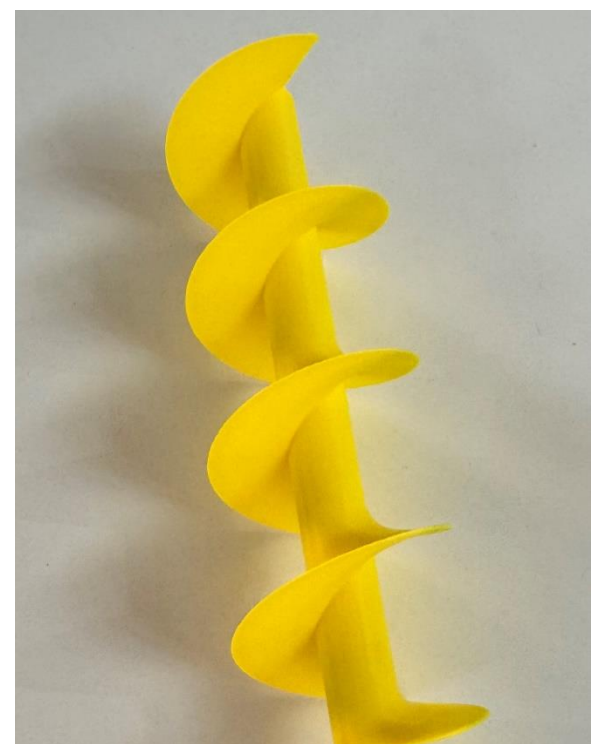
Fortunately, this design with the auger was extremely effective and reliable from me testing it with real dog food. I told the technician at the Tech School to go ahead with the reprint.

27th July

Today I picked up the final auger screw print from the Tech School. I realised that my 180-degree servo motors are not useful for my new design as the auger needs to spin 360 degrees continuously to dispense food. I had 3 options from here:

1. Use a DC motor with a gearbox to provide enough torque to spin the auger. I would have to research and design a way to attach the DC motor to the auger though.
2. Use a stepper motor to spin the auger, but I was unfamiliar with these, and they need a separate motor control board, which I wasn't sure I had.
3. Use a continuous servo motor, which I did have and had tested using. I also had the servo bracket and attachment wheel already designed so that meant I could quickly test to see if the servo was a viable option to power the auger.

I chose to go with the continuous servo first to see if it was a good option.



28th July

Today I modelled a gearbox in Fusion 360 while I wasn't at school in case I need to amplify the torque of the continuous servo or DC motor if I choose to use them. I designed a 3:1 gear ratio, so the 3.5kg/cm servo will become 10.5kg/cm (ignoring small efficiency losses) and the 2kg/cm DC motor would become around 6kg/cm.

I made room for the axles I had already designed to spin and screw holes for the box to be held in place on the wooden frame.

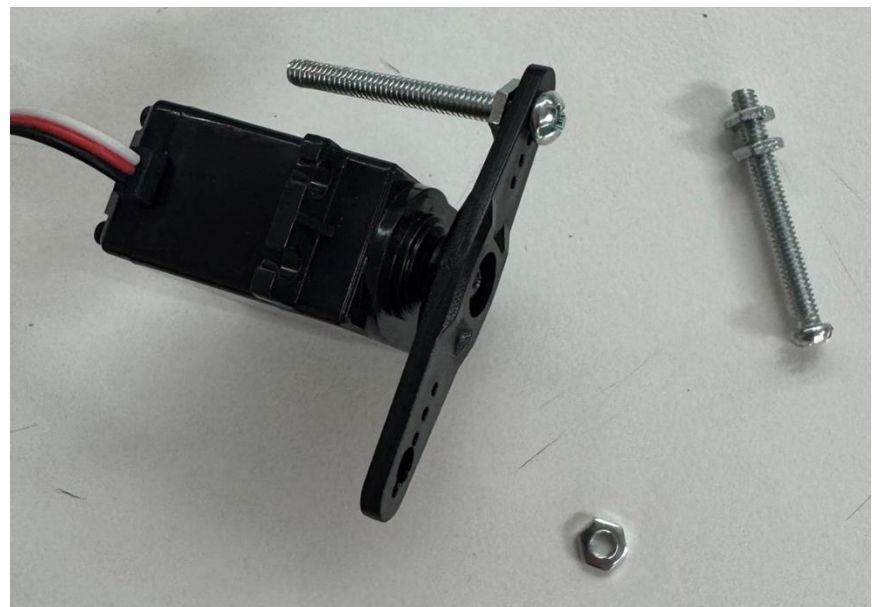


29th July

Today I dug around the systems and woodwork room to find some suitable bolts to attach my servo to the attachment wheel before I print in. I found some M4 hex nuts and bolts, which are also the perfect size because I can use them to attach the servo to the bracket later too.

The holes in the servo horn were too small to fit any bolts, so I drilled two holes in the biggest and most durable servo horn I could find so it's not too weakened by the holes in it.

I then threaded the bolts through the holes, and they fit well one tightened with the hex nut.



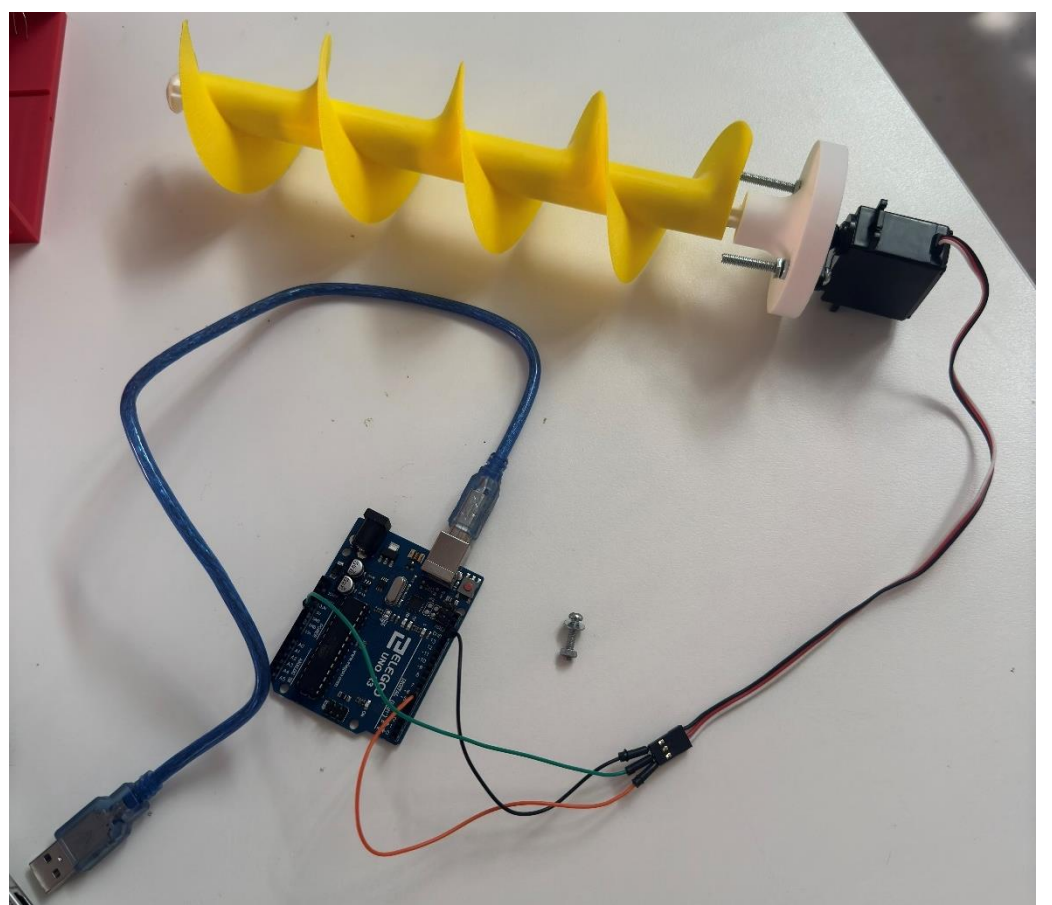
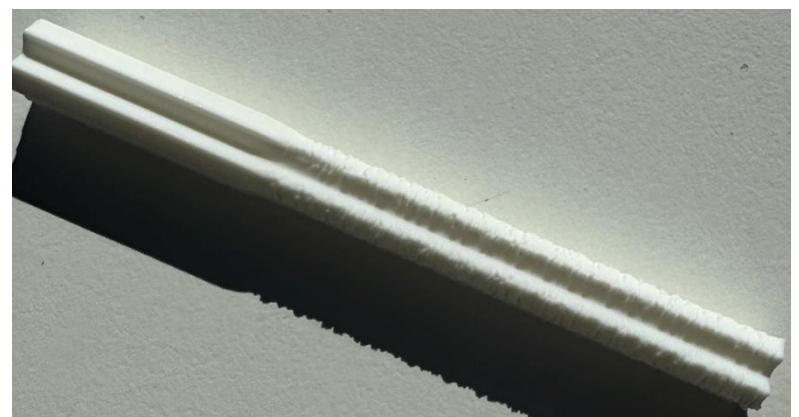
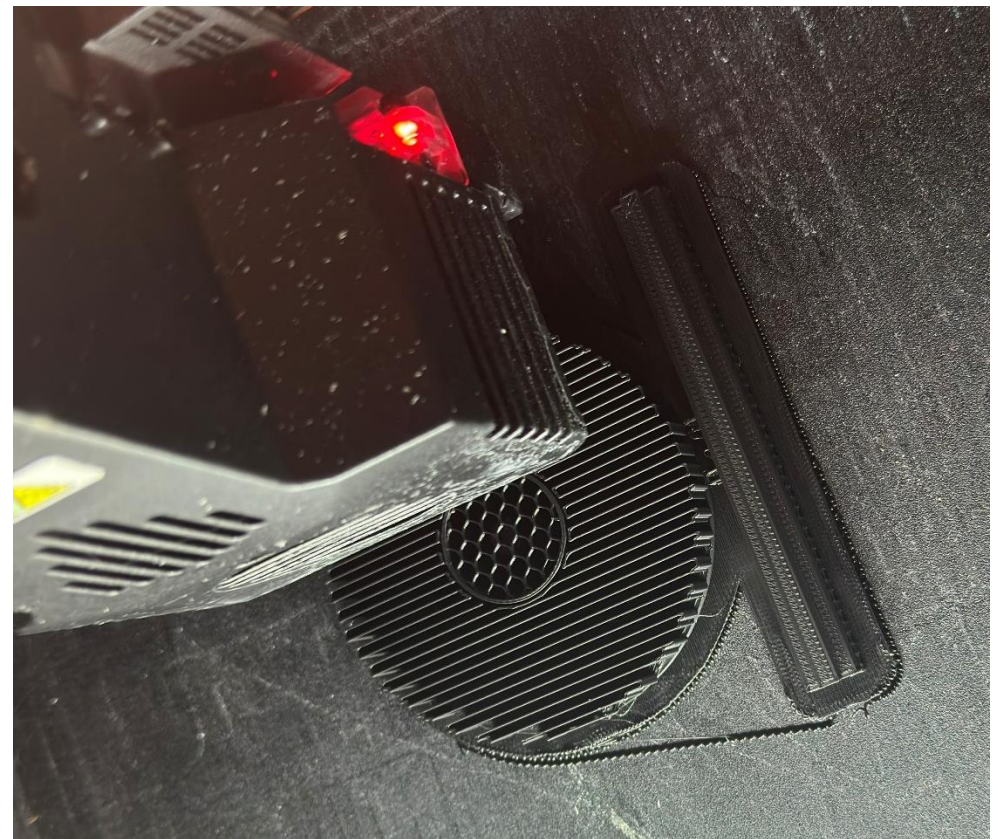
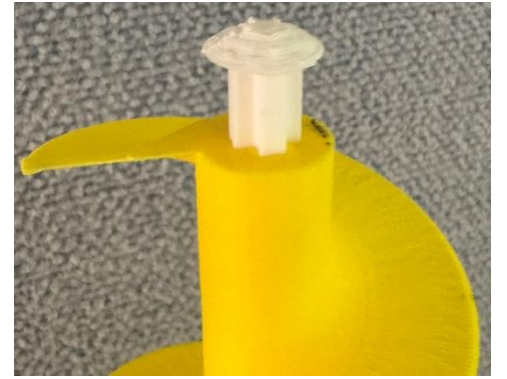
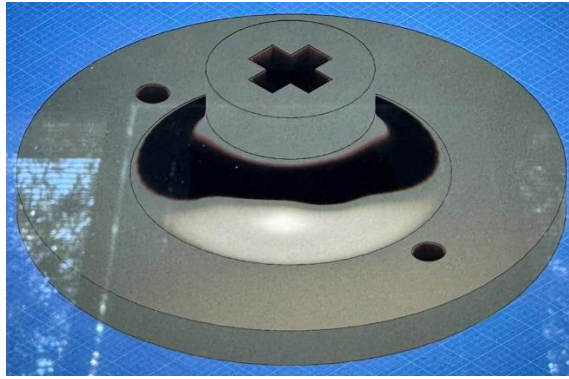
July 30th

After successfully finding bolts to attach the servo horn to the auger, I finalised the design of the servo attachment wheel in Fusion 360, adding the holes for the bolts to go through and a fillet edge for strength between the axle hole and disk. (top left image)

I also adjusted the size of the axle I use throughout my design, making it marginally smaller so there is a larger gap between the axle holes on the servo wheel and auger so I can more easily disassemble the project. I tested this in the auger and it fit much easier than previous versions. (top right image)

Following this, I made a longer axle for the driven end of the auger with the same footprint as the new design, so it fits perfectly. The printer started going too fast about 1/3rd of the way into the print, and so it was a bit rough on one end. (3rd image down) Fortunately, it still was as strong as the other axles from me testing it with my hands, and it still fit well. Nevertheless, I printed a new one and had the long side to the print bed so it went slower this time. (2nd image down) This worked, but the footprint wasn't as accurate so was too tight a fit into the auger. I ended up just using the rough axle.

Finally, I rigged it all up together. I attached the servo wheel to the servo horn with the bolts, then attached the auger to the servo wheel with the axle. I wired the servo up to the Arduino and got it spinning. All was working well. I can now move to printing the new hopper and building the new frame. (bottom image)

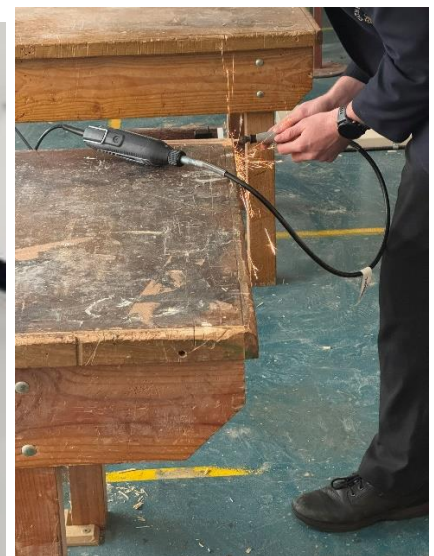


August 1st

Today I brought some dog food to school so I could test the auger and servo motor setup. (top left image) This worked well when I held it in place with my hands. It was hard to tell if the motor will have enough torque once a full load of food is in there, but it seemed to handle a single feed well.

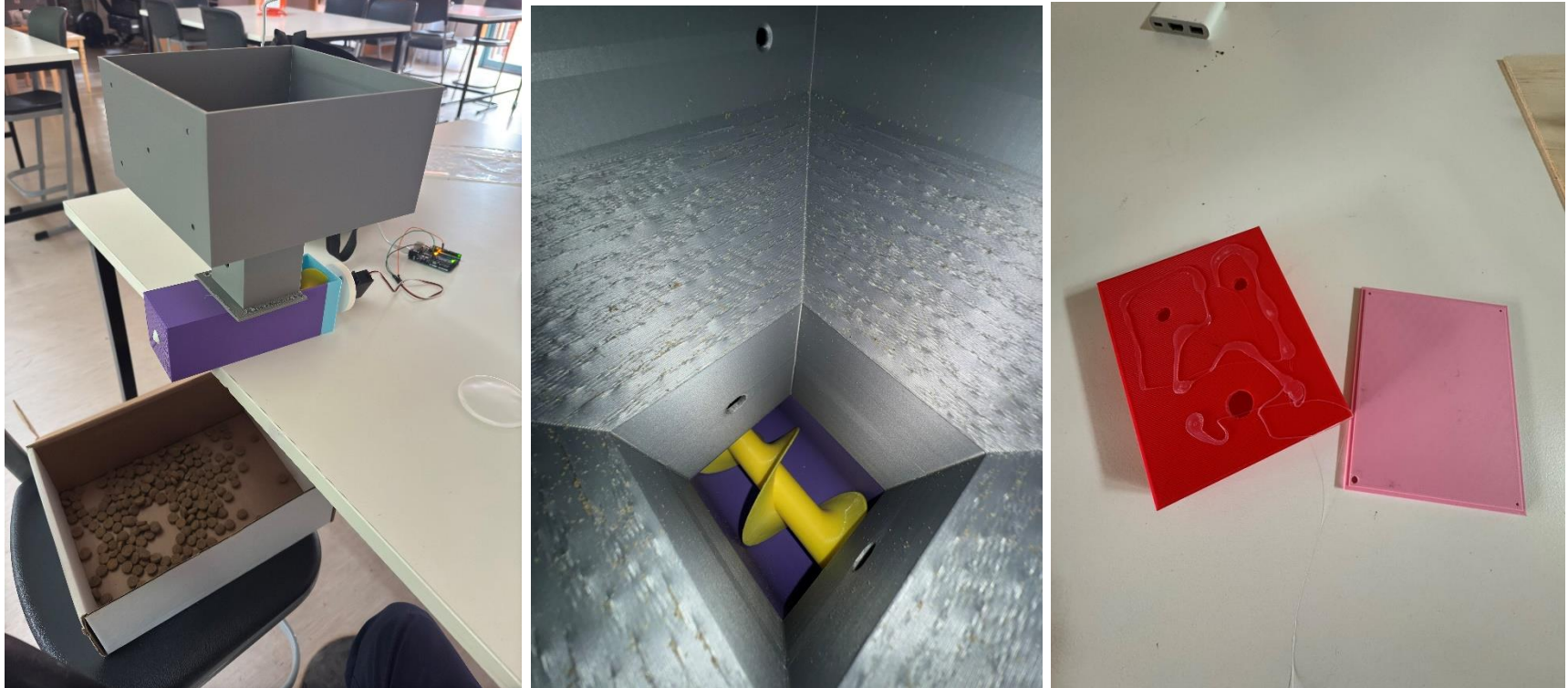
I also found some suitable pieces of timber for the legs of my frame, which I demonstrated on the old frame. (top right image).

Finally, I tested if the auger would be able to fit into the hopper. This was important because if it couldn't, I would need to design the hopper to open at one end to slide in the auger. Fortunately, it seems it will fit despite the overhang from the part that extends out in front. (bottom image)

**5th August**

Today the bottom half of the hopper finished printing, so I put the auger in and spun it around to see if it fit well. There was a bit of rubbing on one end as seen in the leftmost photo, so I used the linisher in the woodwork room to sand down one end of the auger so it would spin freely and not cause any unnecessary load on the motor.

The bolts that attached the servo wheel to the servo horn were too long so they would rub against the wall of the hopper as seen in the 2nd image from the right, so a fellow student angle grinded the bolts down so they fit.



6th August

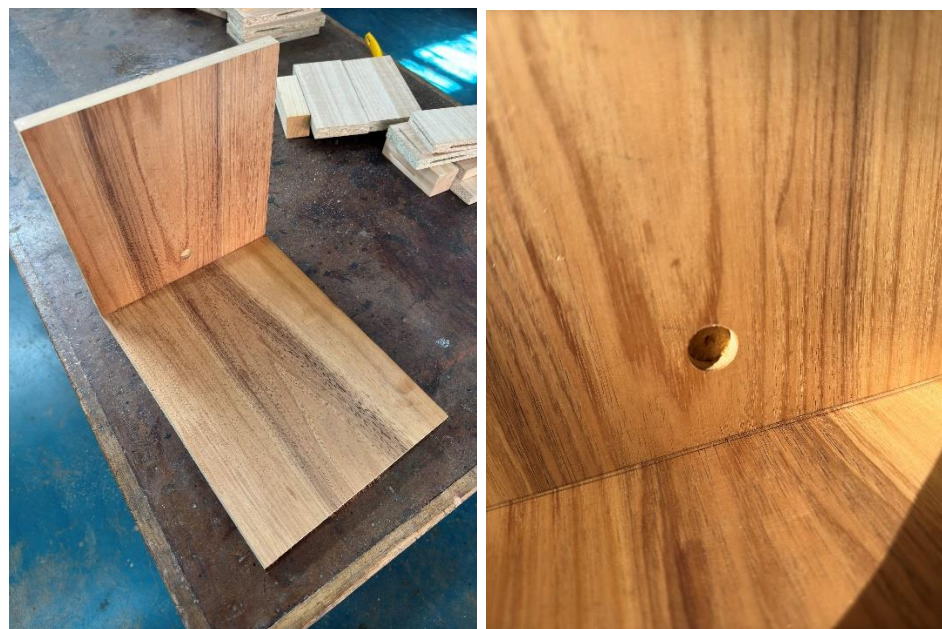
Today I used the old hopper to make sure food didn't get jammed between the top half hopper wall, auger and bottom half of hopper. All the food I used to test it came out and nothing got stuck, so I am satisfied with this new design. I went ahead and tried to print the new top half of hopper on the school 3D printer but the printer is not working so I will have to print it at the Tech School. I also tested the strength of hot glue with two scrap parts of 3D print to see how strong the bond is, as I am planning to use hot glue to join the halves of the hoppers. It was strong enough to my liking, so I will use hot glue.



8th August

Today I started by drilling another hole in my electronics box for the servo wires to run through. The servo bracket finished printing, but unfortunately it shifted on a layer so it was not going to be suitable for the final product. Instead, I used this failed print for testing to see if the screw holes I used throughout the design were suitable, and they were, as the servo bracket was easily attached to a piece of scrap timber with the four screws I used. However, there was some issues with the bracket design: firstly, the spacing of the holes for the servo to be bolted to were too far apart, and the prongs that have these holes were too thin, so they snapped off too easily.

So, I designed a new version, with thicker prongs that were closer together and no printed holes, as I figured I can drill through the servo holes to align them perfectly with the prongs after its been printed.



12th August

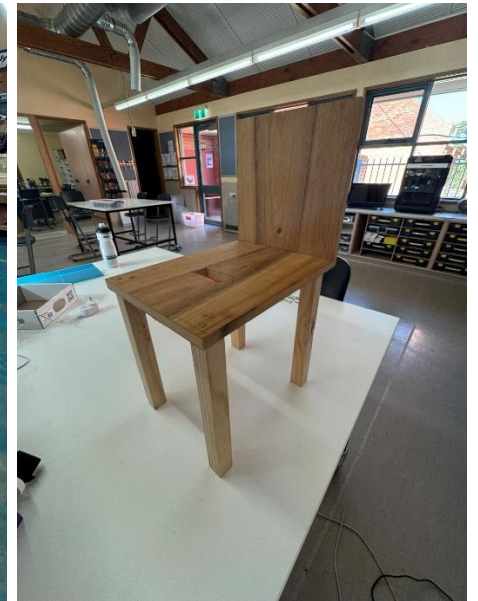
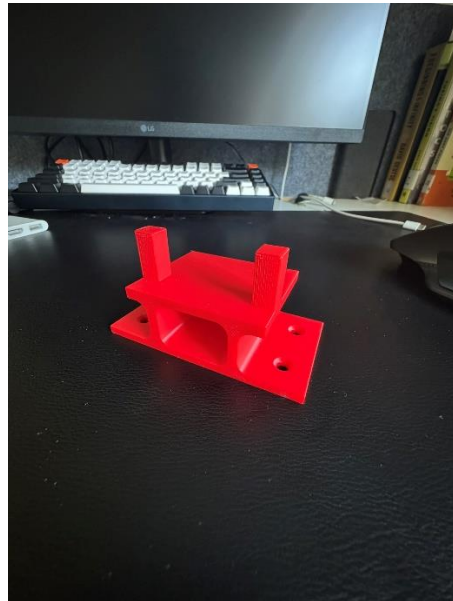
Today I made a new, bigger wooden frame to fit my new hopper design. I also used the drill press to make a clearance hole for the axle end of the auger to spin freely and ensure the hopper is flush against the backboard when I screw it down later.

14th August

Today I completed a lot of work on the wooden frame. I started off by getting Mr Tyzzer to cut some pine legs I found down to size so they're all the same length. Then to create the hole in the bottom for the dog feed to fall through I used the drill press to start the holes I had marked out. Then I cut between the holes with a jigsaw and sanded down the hole to complete it.

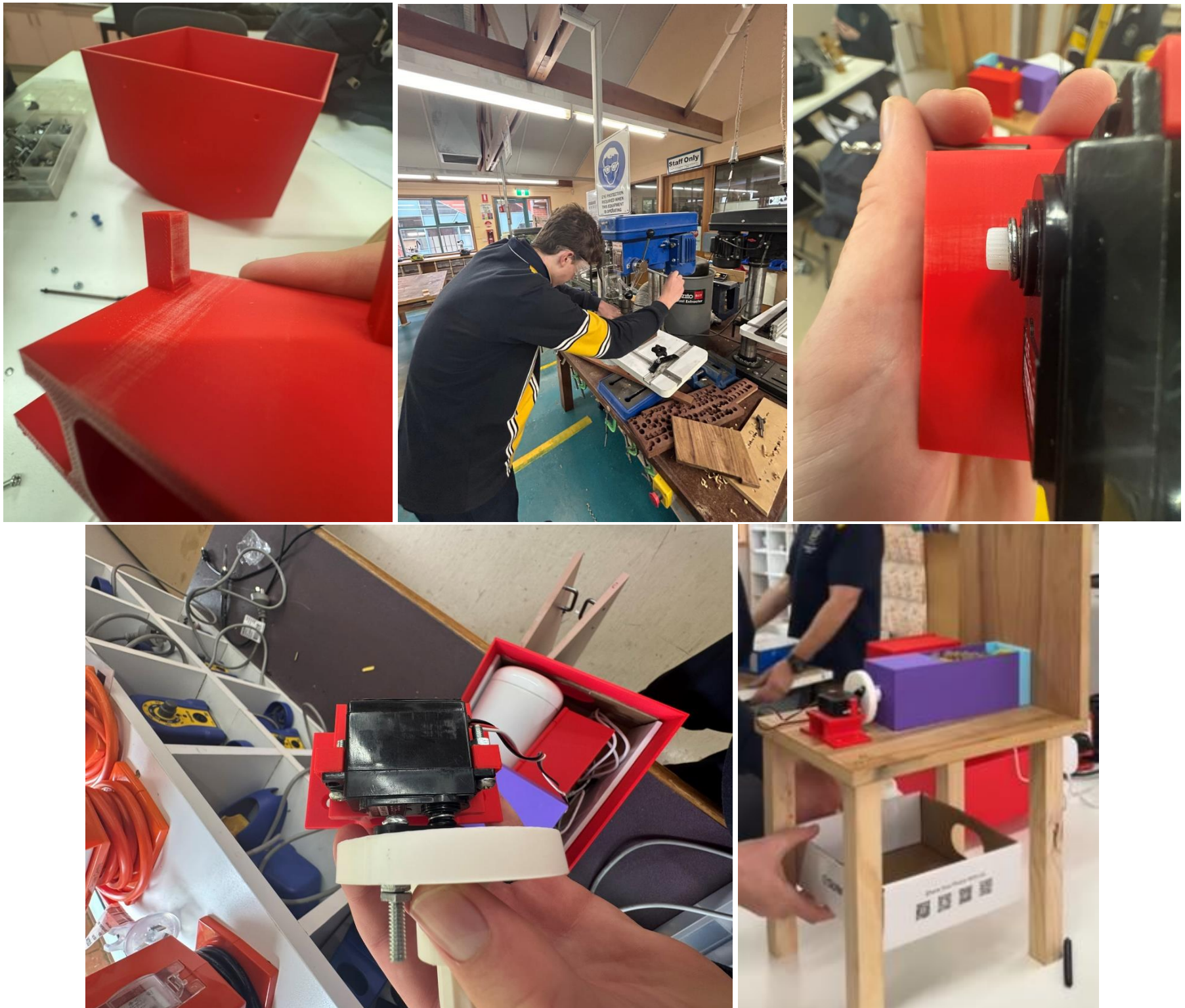
I had time to drill on my frame legs at lunch, so I used the impact driver and power drill to attach each leg with 2 screws so they don't twist.

I also picked up my new servo bracket from the Tech School and will drill holes into it next lesson to attach my servo. This time it was printed on a different axis, which made the prongs much stronger.



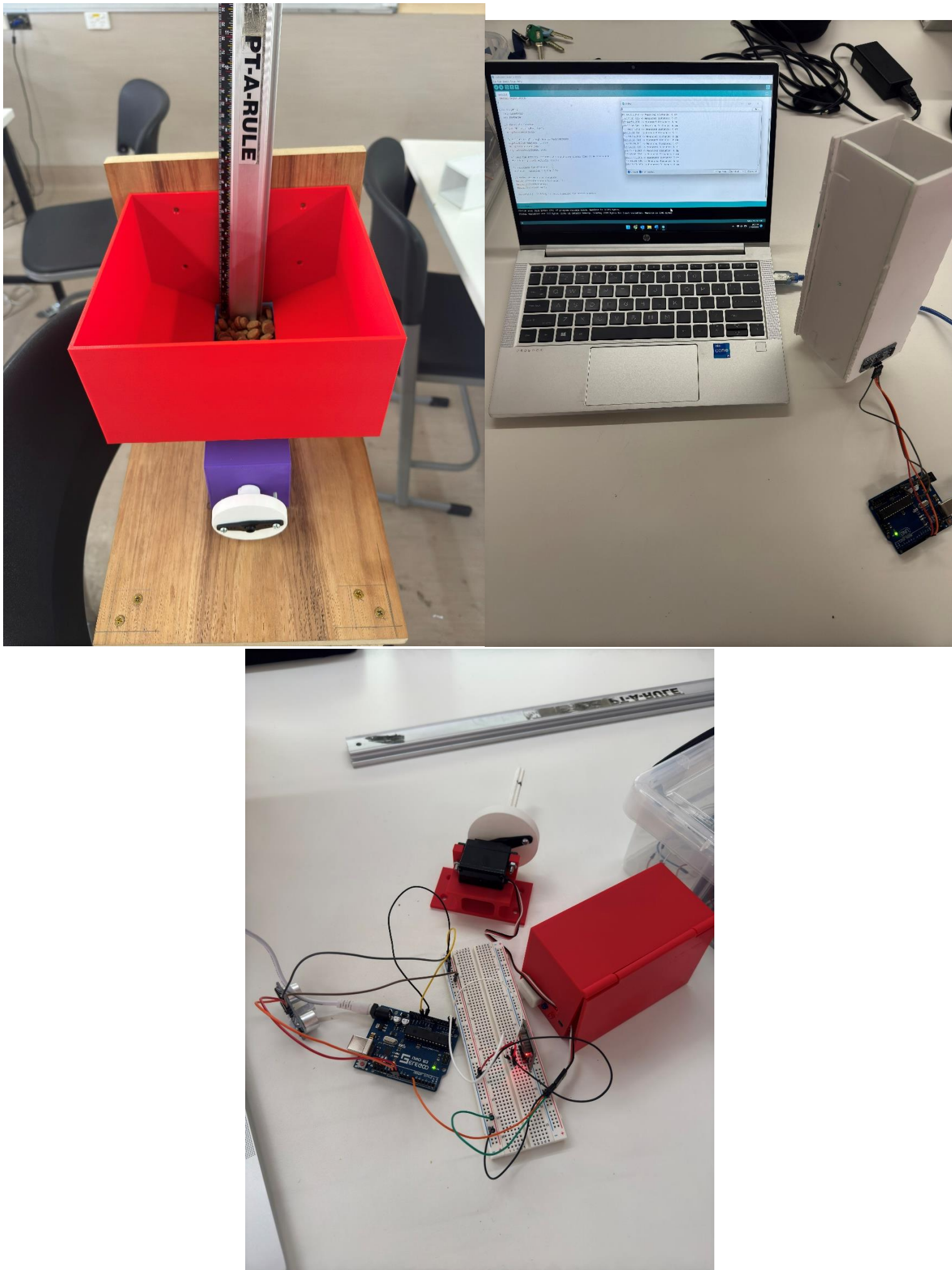
15th August

Today was focusing on attaching the servo motor to the bracket and then testing it on the frame. I first tested if my servo fit immediately into the new bracket, but the fit was little bit too tight, so I sanded down one prong with some sandpaper. I then used the drill press to drill through the servo holes and into the prongs so that the holes are perfectly lined up for the bolts to go through. Once I had attached my servo to the bracket with two M4 bolts I pressed on the servo wheel to test it. I noticed there was some give in the plastic axle of the servo. I found a small spring washer and stretched it over the axle so that it minimises how much give there is between the wheel and the servo. Then to test the system I placed the bracket on the wooden frame and used the plastic axle to attach it to the auger. I poured in some dog food and turned on the Arduino to power the servo, and it worked perfectly. The servo managed the force to move the food easily.



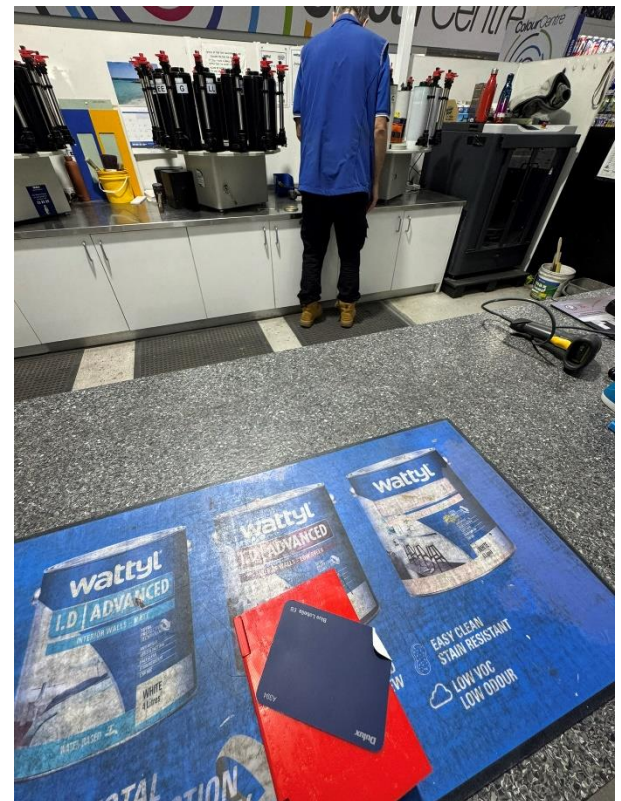
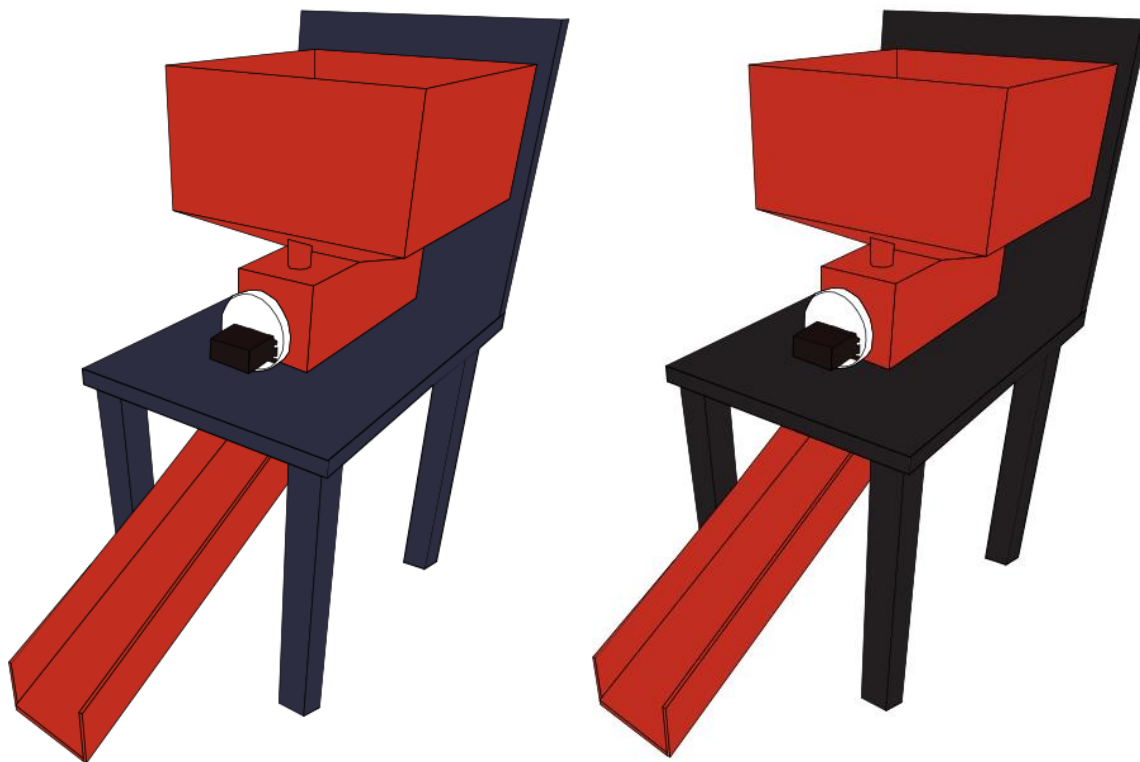
20th August

Today as I started coding the system, I realised I may need a better way of knowing when the hopper is nearly empty. I have had experience with ultrasonic sensors and knew I could integrate one to measure the depth of the food in the hopper. To find the threshold distance where there is only 1-2 feeds left, I filled the hopper up with food so it is only to the line where the bottom half joins the top half of the hopper, as I know this is approximately 1 feed. With a ruler I measured the distance and found it to be 14cm. I then used a mock-up foam hopper to test the ultrasonic in a closed environment. The distance it sensed was quite accurate and precise, and I wired up the whole system with the servo to see if I could activate the servo when the distance was less than 14cm and thus the hopper had more than 1 feed left. It worked, but I am yet to get the RTC clock module working in the code as well. This will take more work. The ultrasonic will have to go in the lid that I am yet to print and will require extended wires to reach from the electronics box and have room so that the lid can be lifted off.



Today I decided on the colour scheme for my project. I made a colour palette with the red colour of my 3D printed parts, and then did a side-by-side view of a dark blue colour and a charcoal colour. I used a graphics program called Inkscape to trace over a photo of my project and then coloured the respective parts in red and charcoal and then red and blue in another copy. This way I can get a gist of how they will look all together.

I chose the dark blue colour, as I thought charcoal would be too dark and not compliment the red very well. I went to Mitre 10 and bought a can of paint similar to the blue colour I mocked up and will begin painting this weekend at home.



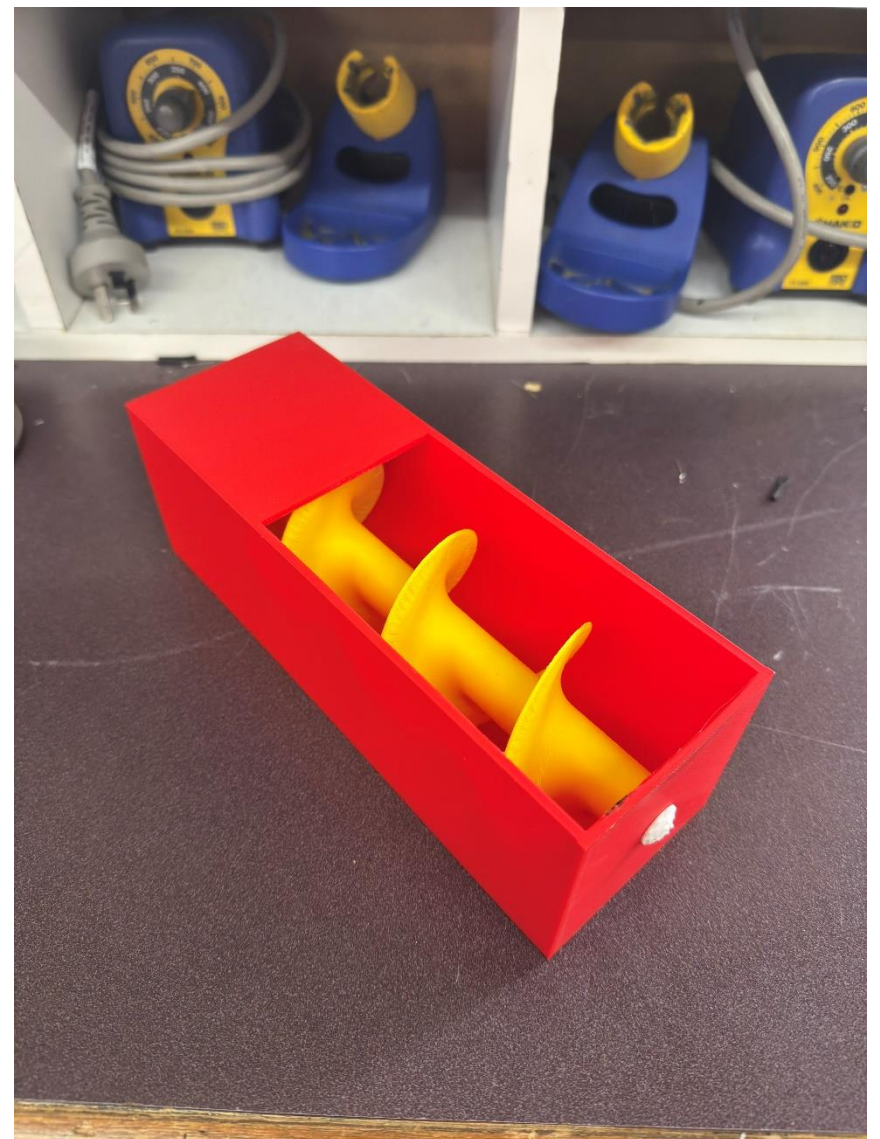
25th – 26th August

This weekend I set to work on painting my wooden frame. I first used putty to cover over the screws that were used to hold the frame and legs together, so that once I paint over them the screws are not visible. Once this putty had dried, I sanded it down, so it was smooth and flush with the wooden surface. Then I painted 3 coats of paint over the weekend to ensure the paint was thick and even all over the frame.



27th August

Today I printed a red bottom to the hopper, so it matches with the top. This way it saves me buying red paint and painting the purple one I had previously.

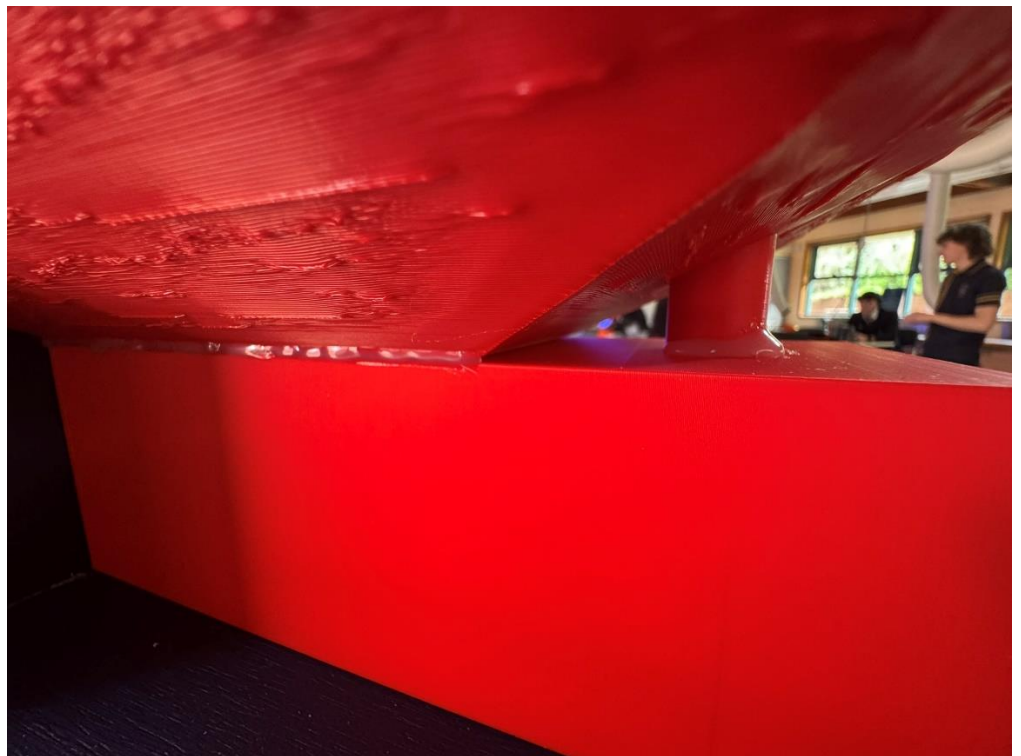
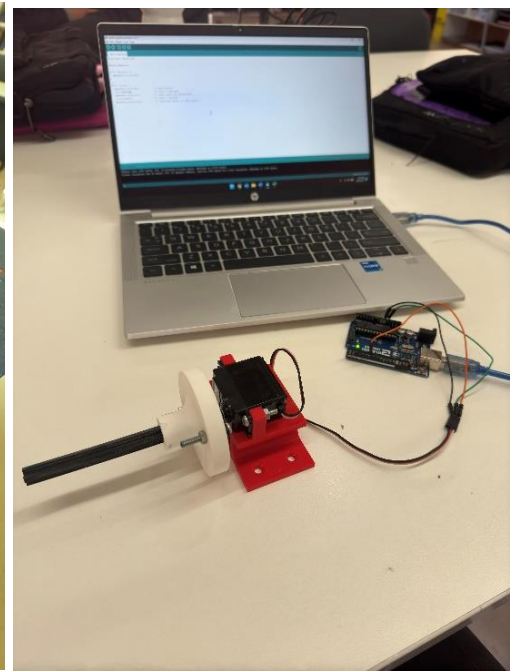
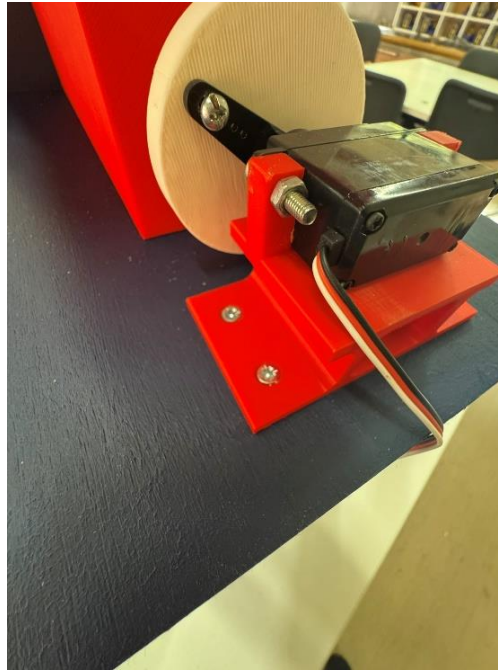


4th September

Today I did more work on the coding for my project. I was having issues with the servo as it's not the same as normal 180-degree servos. After researching more online, I found that you have to use `myservo.write(0)` to spin it counterclockwise (the way I need) but to stop the servo you have to use `myservo.detach(0)` as the way continuous servos interpret PWM signals is different to normal servos.

I also hot glued together the top of my hopper to the bottom.

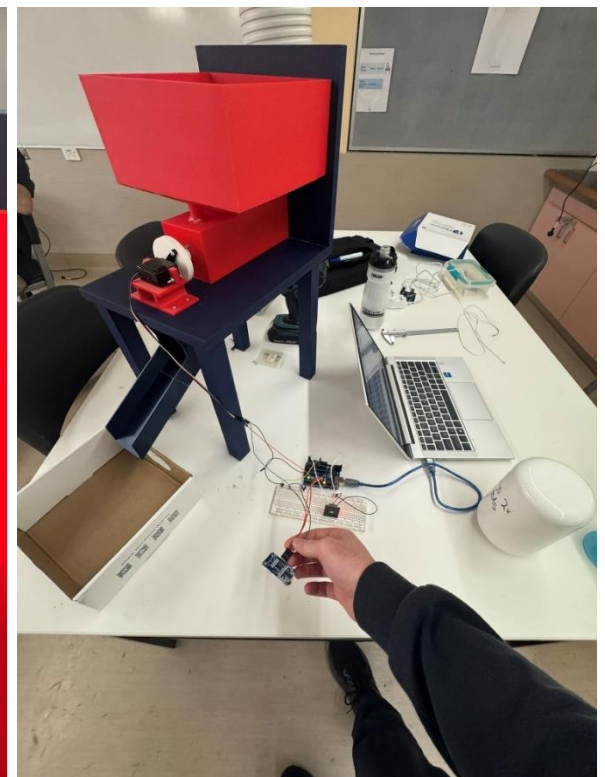
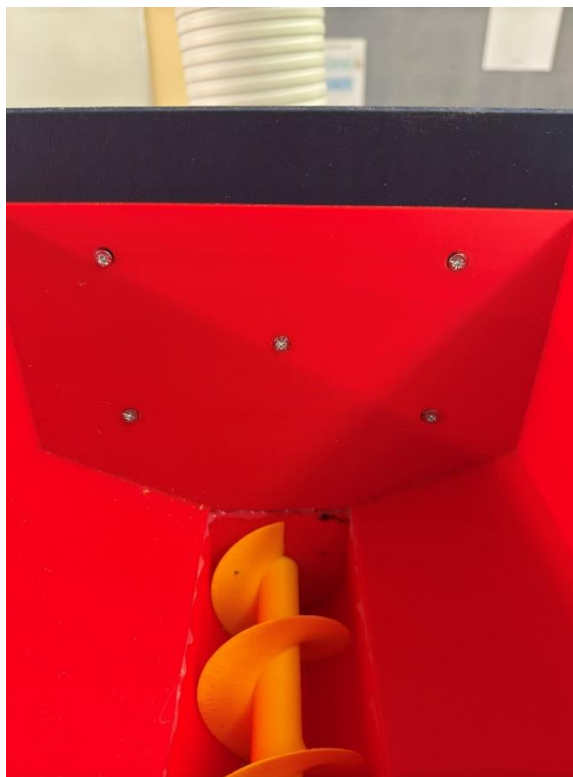
Then I screwed down the servo bracket onto the timber frame to hold it down with an impact driver.



5th September

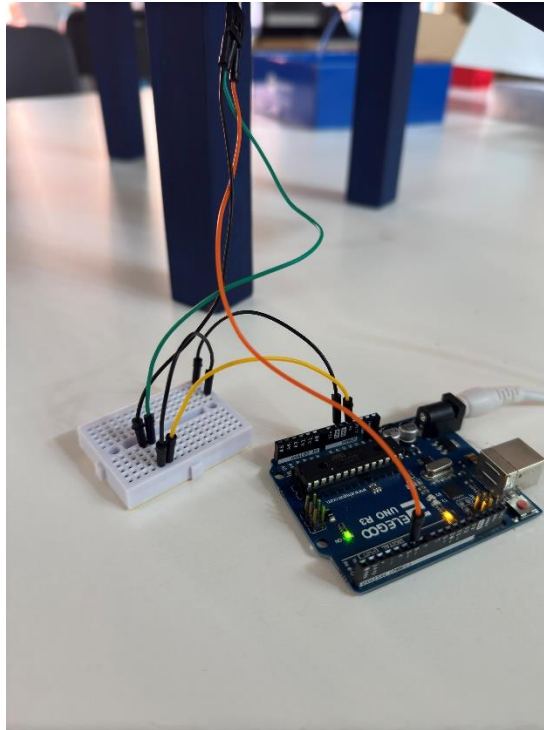
Today I screwed the hopper to the backboard of the wooden frame to hold it down with 5 screws.

Then I integrated the ultrasonic sensor and clock module with the servo code. I was able to get the clock module to check the distance at different times of the day, and if the distance is less than 14cm, dispense food. This is exactly what I want it to do, so I just have to wire up the buzzer and LED's and add some lines of code, so they go off accordingly.



11th September

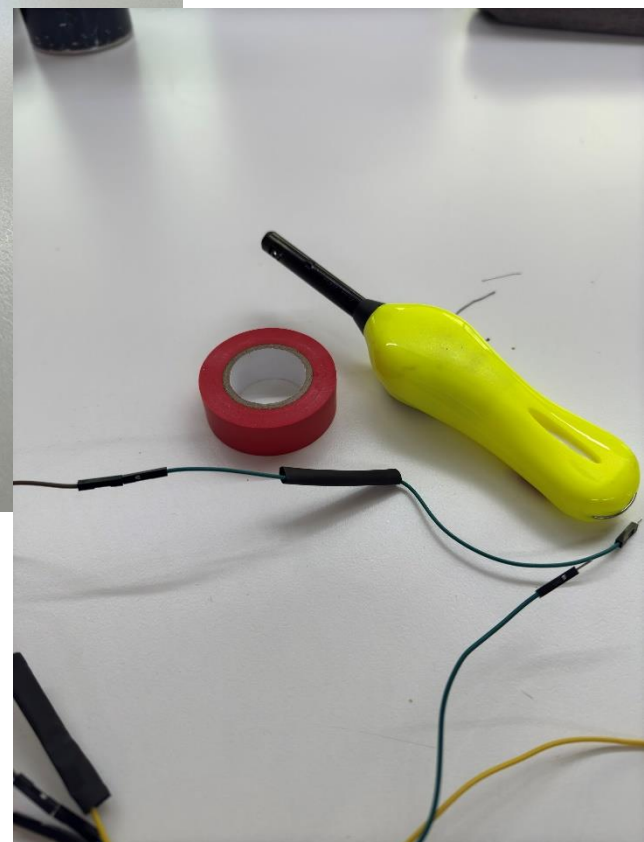
Today I tested a small breadboard to see if I could wire it up the same. It worked fine for just one component, but for multiple it was difficult because it did not have long power rails, so with my many components it was going to be difficult. I will have to find another way to connect my components. I also used a chute I had printed long ago that failed, because I realised if I cleaned it up it would be fine. So, I drilled some holes into it and drilled it onto the bottom of the wooden frame. It works well.



12th September

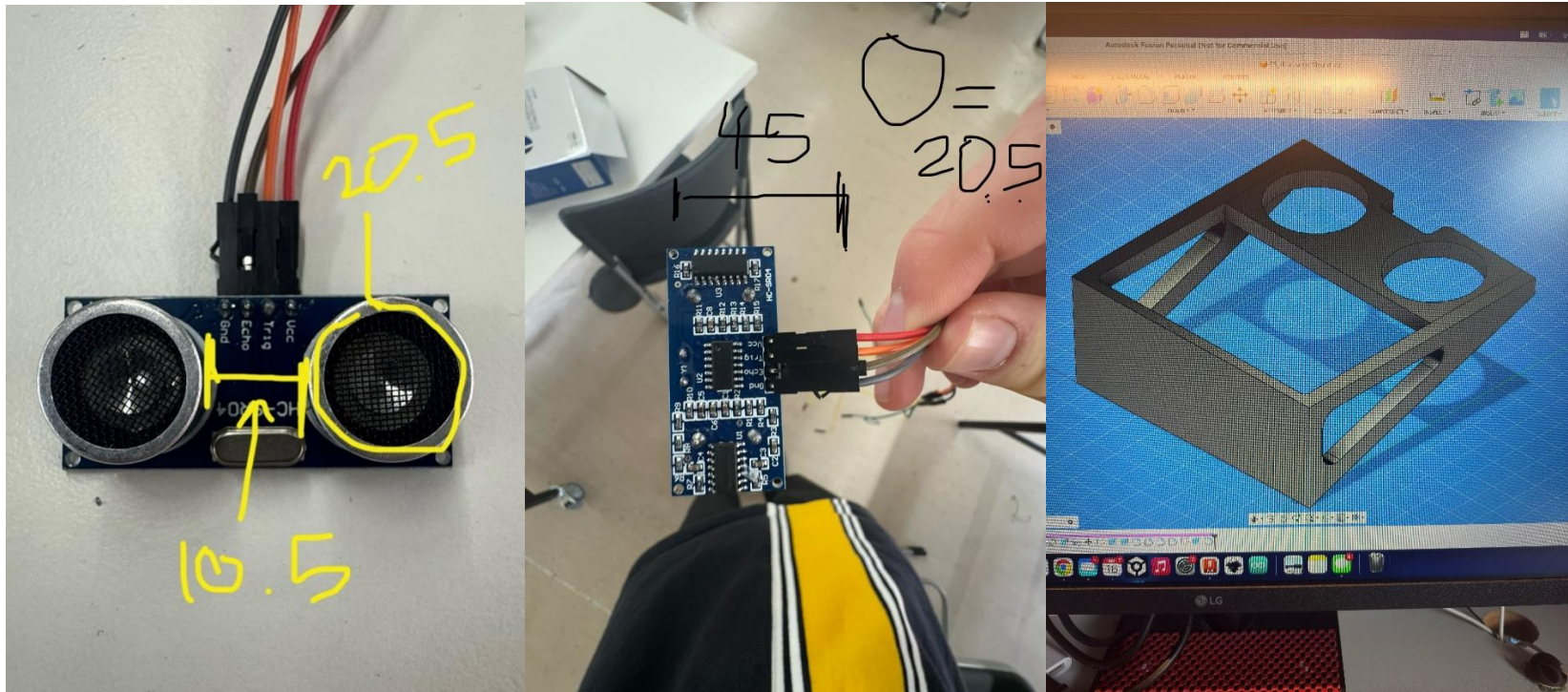
Today I used the guillotine to cut a breadboard that has power rails into a small size that would fit in my electronics box. Some of the metal pins were exposed, so I used some electrical tape to cover up the cut end of the breadboard.

I also found long cables to attach to the cables I already had for the ultrasonic sensor as it has to stretch quite far to be able to be on the lid of the hopper. I tried joining them with electrical tape and heat shrink, but neither did very well to hold the two connectors together. Instead, I just used some solder to stick them together.



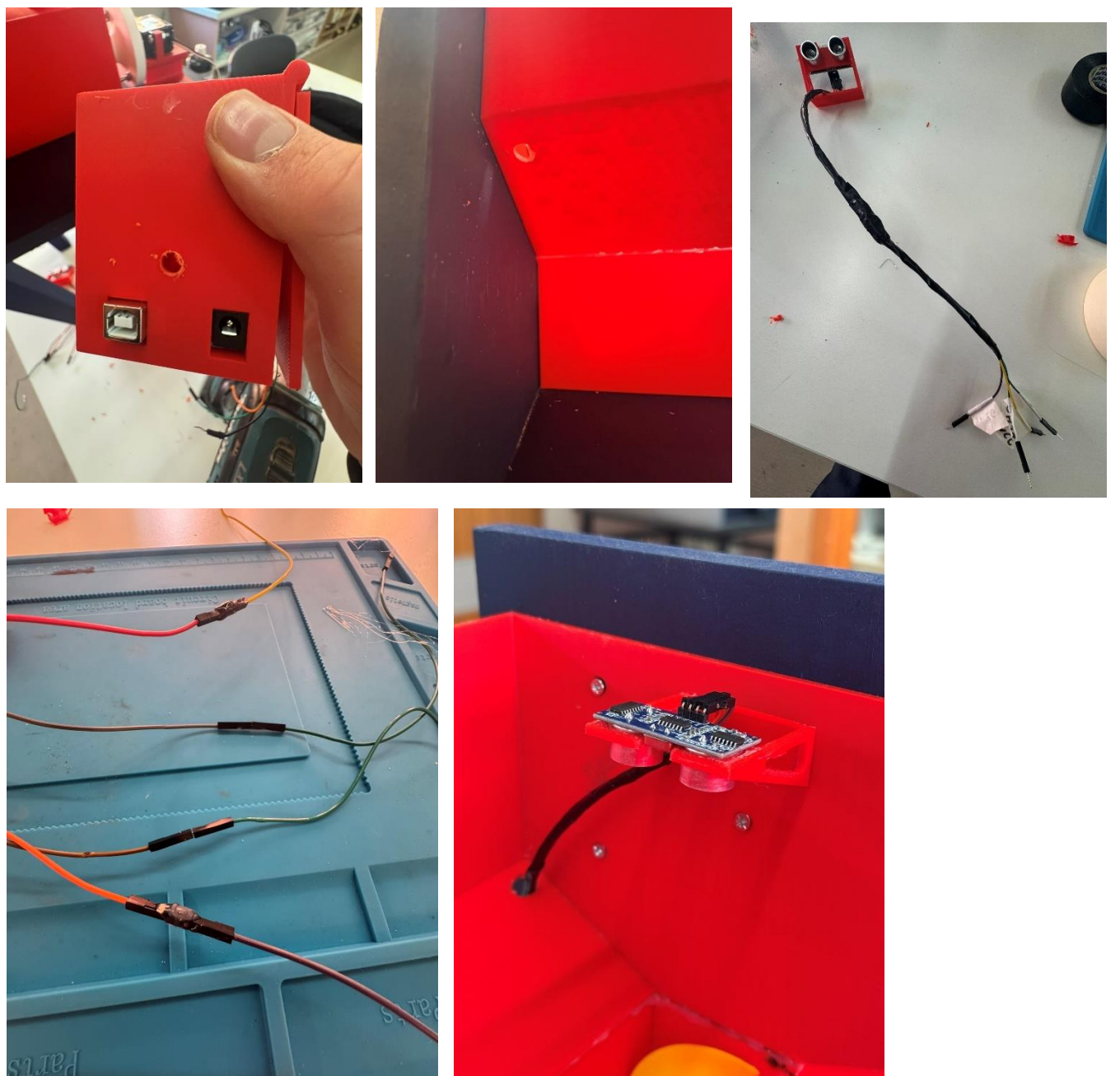
September 17th

Today I designed a mount for my ultrasonic sensor to go inside the hopper. I was originally going to integrate it into the lid, but I realised this would be a bit inconvenient when you have to lift the lid off, as the wires attached to the ultrasonic would limit the movement of the wires and they would probably break with the force of the lid. I realised I could just mount the servo inside the hopper and have the lid sit just above it, so I measure up the ultrasonic and found some schematics online and designed a mount to hold it.



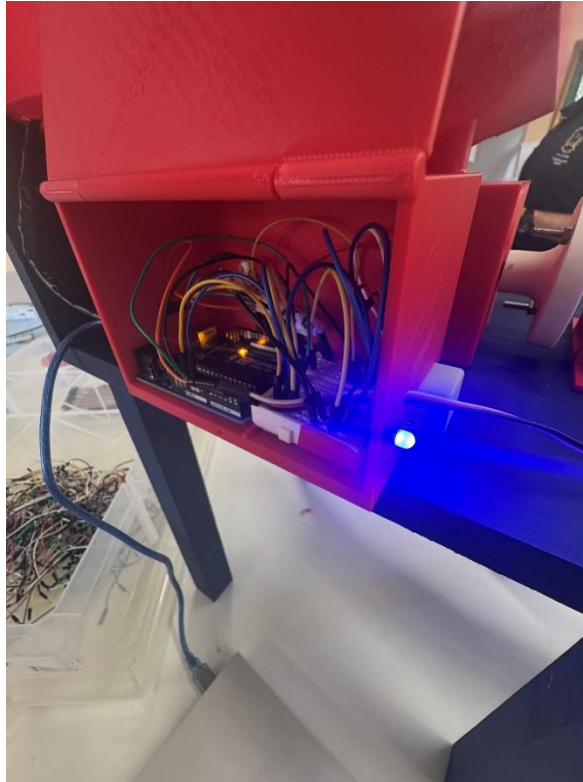
September 16th

Today I printed the ultrasonic bracket. Once it was done, I had to file/sand it down a little bit to get the fit nice and smooth. I then used the hot glue gun to stick it to the side of the hopper over the auger. I then drilled a hole in the corner of the hopper for the cables to run through with the power drill and a large drill bit. I also had to add a hole in the back of the electronics box so the wires could run into that. I wrapped electrical tape around the four wires which I had to hot glue extensions onto, for safety and aesthetics and wired it up to the Arduino and breadboard.



23rd September

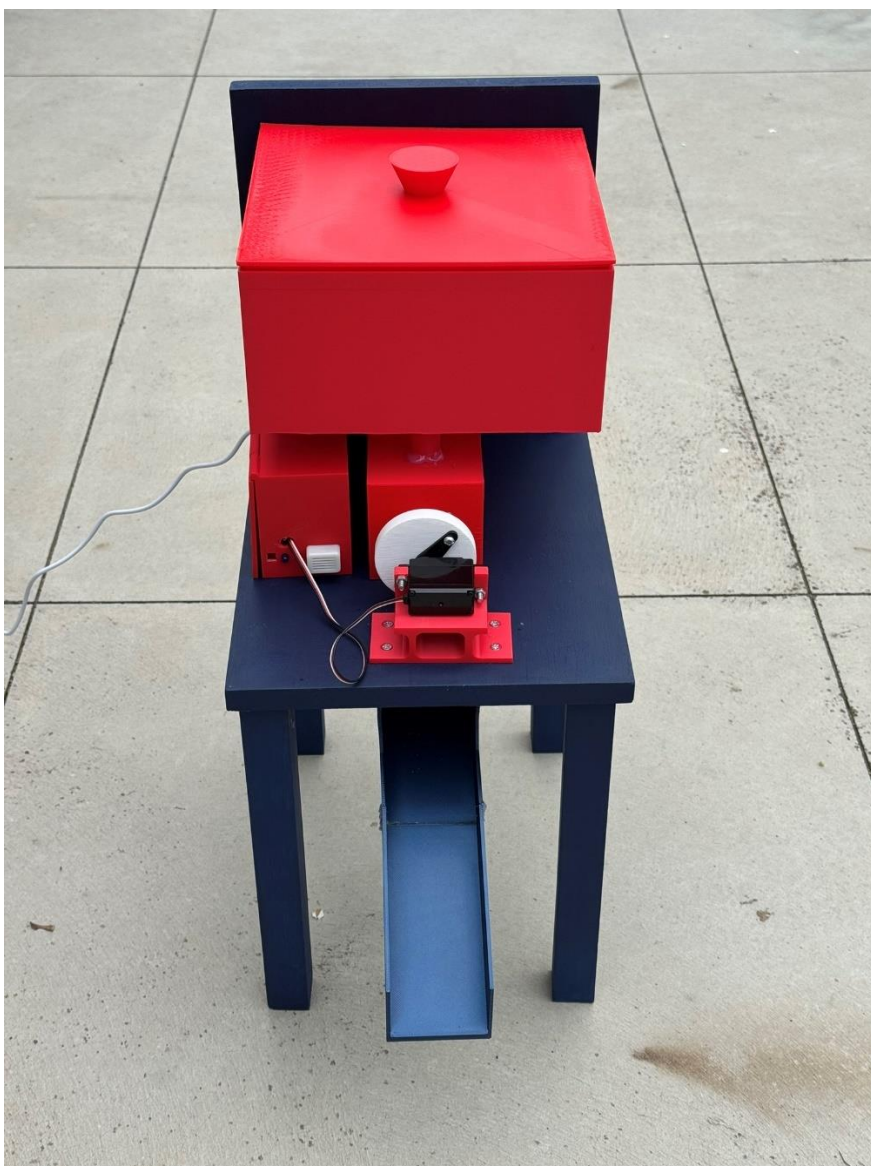
I wired up all other components and checked them. I started a hopper lid print but it failed because the filament got knotted. I fixed it and reprinted and it worked. This marks the end of my project.



END OF PRODUCTION JOURNAL

Final Showcase

These are photos of my finished product.



Criteria 5

Notable Modifications to the Design Option

Modification	Justification
Square hopper instead of a cylindrical hopper	I made the hopper square instead of cylindrical, so it has more capacity to hold food and thus increase the duration my client can go without having to refill the hopper. This also meant I can screw it directly to the wooden backboard for support as the back is flat instead of round, which is much easier than fashioning some sort of strap to attach it like my initial design called for. Finally, it makes it easier to 3D print and design in Fusion, by being square and not cylindrical.
Electronics box mounted on the frame instead of to the side	I designed the electronics box so it can just sit underneath the hopper to the side instead of being screwed onto the side of the frame or at the back. This reduced the footprint of the project and made it harder for my dog to potentially damage the electronics, as in line with my evaluation criteria
Deletion of 45 degree supports for the wooden frame	When I made both version 1 and 2 of the wooden frames, I found I didn't need the crossbeam supports between the base and backboard as planned in my design option. 3 long screws were more than strong enough to hold together the two pieces of MDF. This saved time and saved the cost of extra timber.
Auger instead of paddle design to dispense food	The largest change to my project arose when the paddle design failed to dispense food. The alternative I settled on was the auger screw design. This was far more consistent and efficient way to dispense the food. Although it did have flow on effects such as having to design a new hopper and frame, to me it was justified as it fulfills the core function of my product: to dispense dog food.
New 2-part hopper design to accommodate auger	As touched on above, the change to the auger design meant I had to change my hopper design. I had to make the thinner bottom part as long as the top part itself, instead of feeding into one smaller chute like in the first design. A positive side effect of this meant the weight of the food was spread over a larger area and meant it was easier for the motor to spin. This time, split it into two parts and glued them together later to make it easier to print (didn't take as long and easier to make supports as the shape wasn't as complex) and easier to test before putting it all together.
Use of a continuous servo instead of 180-degree servo	I initially planned to use a 180-degree rotation servo to turn the paddle back and forth. However, once I realised the paddle design was not going to work and chose the auger design, I needed a motor that could spin it 360 degrees continuously. The best option for this was a continuous servo I found in the systems room, as it has more torque than a DC motor and is easier to code and wire than a stepper motor.

Larger wooden frame design	When I had to design a new hopper to fit the auger, I realised that it was going to fill the length of my 220x220mm frame I had made in line with my design option, and thus leave no room for the servo motor and bracket out the front (and the gearbox if I had to include it). So, I had to make a longer frame of 250x350mm panels to leave enough room for these parts with some more scrap MDF the woodwork room had.
Updated servo bracket	The servo bracket had to be reinforced and slightly redesigned after I tested v1 and the prongs to attach the servo to were too far apart, and the prongs were too thin, so they just snapped off with little force. I thickened the prongs, made them closer together and deleted the printed bolt holes and opted to drill the holes out once it was printed so I could line them up accurately with the servo itself. This gave a much tighter and thus stronger and more reliable mounting point for the servo motor.
Inclusion of an ultrasonic sensor	A completely new addition to the project was the ultrasonic sensor. After testing and thinking about my initial plan to just count the number of feeds left based on how much the hopper holds, I realised this was a difficult and not robust solution, especially due to the fact my dog has different sizes of food from time to time. The simplest and easiest solution I could think of was to integrate an ultrasonic sensor mounted in the lid of the hopper that points down to measure the distance between it and the food, and then alert the Arduino when the distance was too far (food level too low). This proved to be a reliable solution and works for any type of food.
Painted the frame instead of leaving it as raw timber	Mainly an aesthetic choice, I bought some paint from Mitre 10 to paint the wooden frame with. I chose to do this for a couple reasons, firstly to seal in the MDF that is prone to swelling under moisture, and secondly to make the different types of timber I used come together and not draw attention away from the interesting parts of the machine printed in red filament. This made the product look far more professional and complete, so I think it was worth it despite being relatively quite expensive.
Use of prototyping breadboard instead of permanent solderable breadboard	I chose to use a cut-down prototyping breadboard instead of a permanent breadboard for a few reasons: firstly because it is just quicker and safer than soldering in all the components, and secondly because the risk of bridging or melting components is too high for my liking when using a solderable breadboard and I don't have spares of my servo motor or clock module.

Criteria 6

Testing and Diagnostics

Testing the accuracy and precision of my ultrasonic sensor

Aim

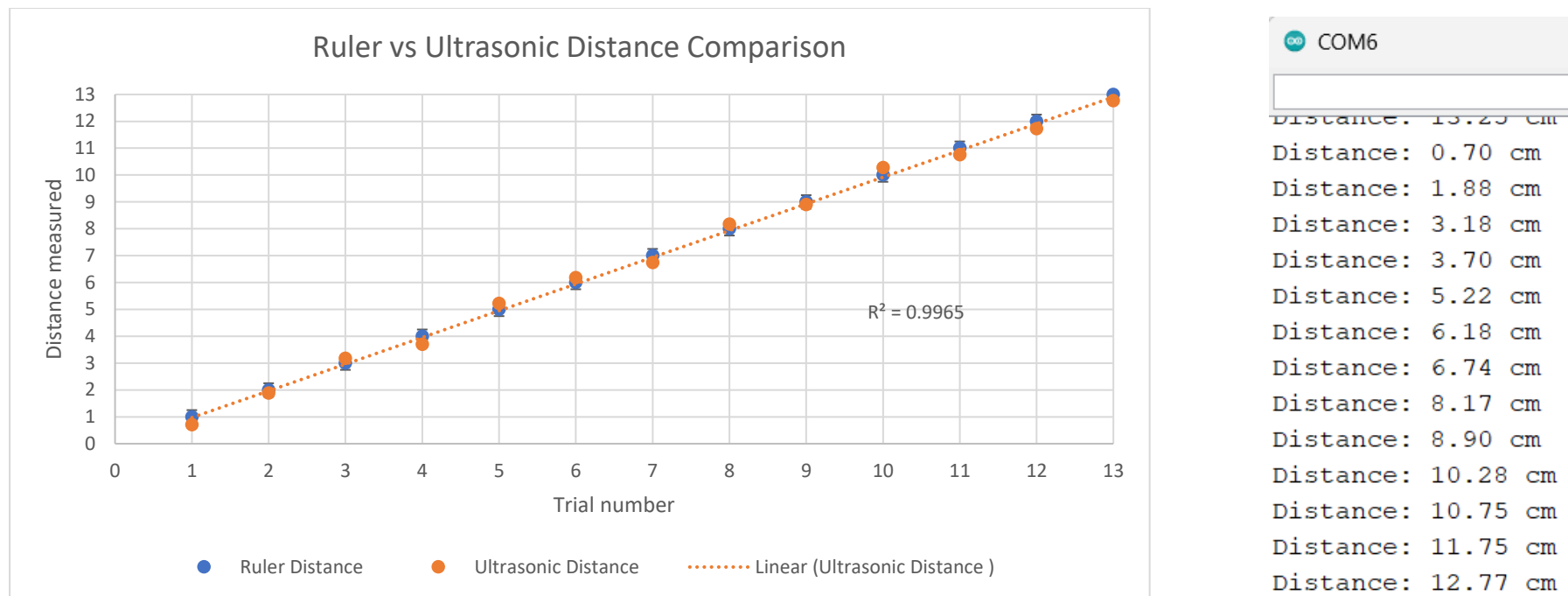
To determine the accuracy and precision of the ultrasonic distance sensor in detecting food levels.

Method

1. Start with the hopper empty
2. Using a ruler, measure the distance from the ultrasonic sensor to the bottom of the hopper/feed level and record the distance.

3. Run the Arduino code to measure the distance using the ultrasonic sensor. Record this distance.
4. Add some food to the hopper and repeat until the desired number of trials has been reached.

Results



The results revealed that the ultrasonic distance correlated with the ruler distance with an R-squared coefficient of 0.9965, revealing that the ultrasonic is 99.65% accurate to the ruler distance.

Discussion

The minor discrepancies observed between the ruler and sensor readings may be attributed to several factors. Ultrasonic sensors can be sensitive to environmental conditions, such as temperature and humidity, which can affect the speed of sound and slightly alter distance readings. Additionally, small misalignments between the sensor and the measurement surface could introduce minor errors, particularly at shorter distances where angular differences are more pronounced.

Despite these potential sources of error, the high accuracy of the sensor makes it a reliable tool for detecting food levels in the hopper. The linear relationship between the ruler and ultrasonic sensor measurements demonstrates that the sensor consistently tracks changes in the feed level. This consistency is crucial for practical applications where precise monitoring of food quantities is required.

Overall, the discrepancies are not significant enough to warrant seeking alternative sensors or trying to compensate for the differences in the code. It is more than accurate and precise enough to fulfill the requirements of the project.

Testing the success rate of completing a full feed

Aim

To determine the success rate of the automatic dog feeder in completing a full feed cycle using a single 200g portion of dog food.

Method

1. Measure out a single 200g portion of dog food.
2. Load the 200g portion into the automatic dog feeder.
3. Initiate a feed cycle.
4. Observe whether the feeder successfully dispenses the entire portion (marked as "Success") or fails to do so (marked as "Fail").
5. If successful, collect the dispensed food.

6. Regardless of the outcome, return the food to the feeder (either the dispensed amount or the amount remaining in the feeder).
7. Repeat steps 3-6 for a total of 20 trials, always using the same 200g portion of food.
8. Record the outcome (Success or Fail) for each trial.
9. Tally the total number of successful and failed attempts.
10. Calculate the success rate by dividing the number of successful attempts by the total number of trials.

Results

Out of 20 trials conducted:

- 5 trials resulted in successful completion of a full feed cycle.
- 15 trials resulted in failure to complete a full feed cycle.

This indicates that the automatic dog feeder successfully completed a full feed cycle only 25% of the time under the test conditions.

Discussion

These results were quite disappointing, although I believe they're explainable and partially solvable in the future. Based on my observations, the low success rate was caused by two issues:

1. The food sometimes got jammed against the thread of the auger and the front lip of the hopper.
2. The servo spun with inconsistent speed and power and at a generally lower speed than when I used it in prototyping by itself.

The jamming occurred only once in my trials however, where a food pellet got stuck in just the right spot to completely seize the mechanism. This was a very rare event though, so not worth my time to fix. The lack of servo power is a bigger issue though and would likely solve the first issue if it was solved first. Unfortunately, this problem breaks down into some more problems. The ultrasonic sensor and RTC module share the power from the 5V pin of the Arduino on the breadboard. This means that the servo is not able to draw the full current and thus struggles for torque and speed, causing it not to spin at all when multiple feeds are in the hopper or it encounters a minor struggle or jam. This issue could be solved with a relay and 9V battery or similar to power the servo separately but still control it via the Arduino PWM pin. It could also be that the servo I have is not strong enough, but it is too expensive and too big of an overhaul to buy a new one and change it out before the submission deadline.

Trial Number	Fail	Success
1	X	
2		X
3	X	
4	X	
5	X	
6		X
7	X	
8		X
9	X	
10	X	
11		X
12	X	
13	X	
14		X
15	X	
16	X	
17	X	
18	X	
19	X	
20	X	
Total	15	5

Measuring how many feeds my hopper can hold

Aim

To measure how many feeds my dog feeder can hold when filled to the top.

Method

1. Scoop dog feed out of the feed container and weigh it on the scales.
2. Record this weight.
3. Tip the food into the hopper.
4. Repeat steps 1-3 until the hopper is full.
5. Add the total amount of dog feed together and divide it by 200g or one feed portion to obtain the total amount of food.



Results

I found that my hopper holds 10 feeds or 2kg of food. This means it theoretically can feed my dog autonomously for 5 days without being filled.

Discussion

While this was a very simple investigation, I was pleased with the results. 5 days is a useful amount of time to not have to attend to feeding the dog for my client. There is not much else to discuss about these results, other than the capacity could have been improved by making the hopper larger. However, this was restricted by time and the size of the 3D printer.

Testing how long the servo motor must run to dispense a full feed (when successful)

Aim

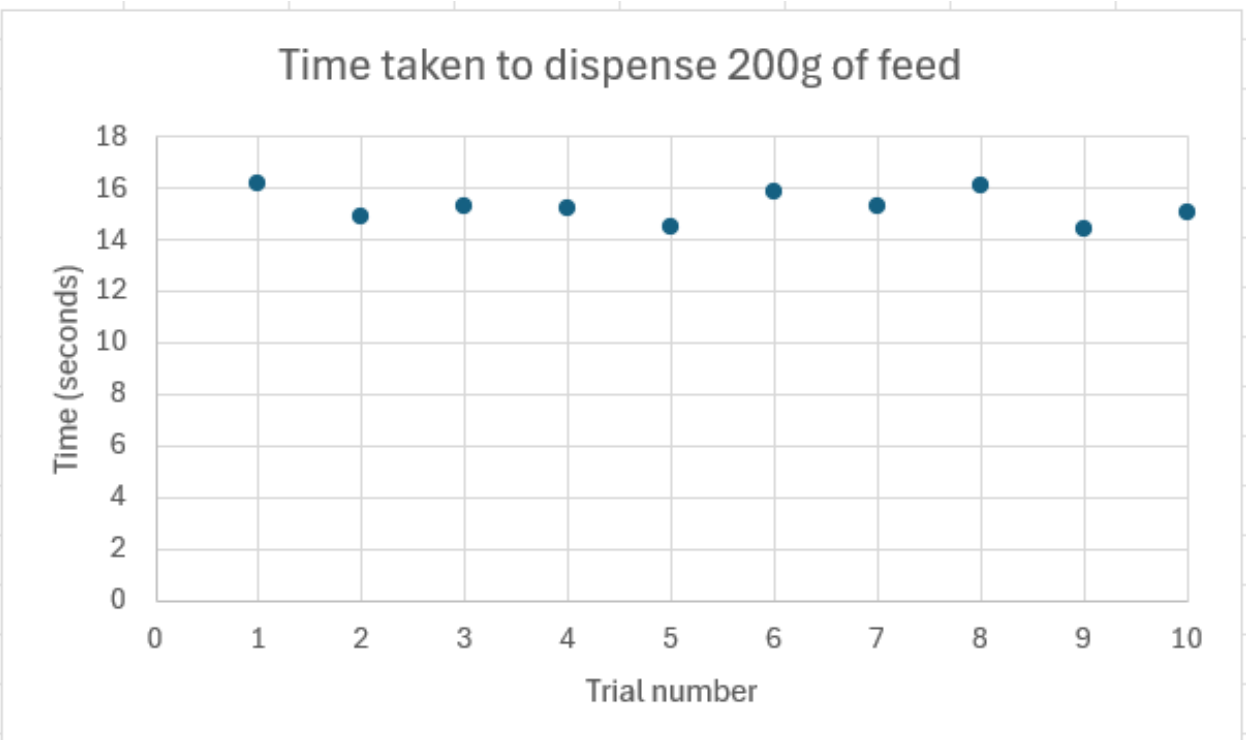
To measure how long it takes the machine to dispense a full feed portion.

Method

1. Prepare a 200g portion of dog food.
2. Load the 200g portion into the automatic dog feeder.
3. Set up a stopwatch or timer.
4. Initiate the feed cycle and immediately start the timer.
5. Stop the timer when the feeder has completely dispensed the 200g portion.
6. Record the time taken to the nearest hundredth of a second.
7. Repeat steps 2-6 for a total of 10 trials, reloading the same 200g portion each time.
8. Calculate the average time taken across all trials.

Results

Trial Number	Time
1	16.21
2	14.92
3	15.32
4	15.2
5	14.52
6	15.81
7	15.25
8	16.12
9	14.44
10	15.02
Average	15.281



**Note that this was only when the feeder successfully dispensed food, see earlier test.*

The results show that the automatic dog feeder takes an average of 15.281 seconds to dispense a 200g portion of dog food. This timing is relatively consistent across the 10 trials, with times ranging from 14.44 to 16.21 seconds.

Discussion

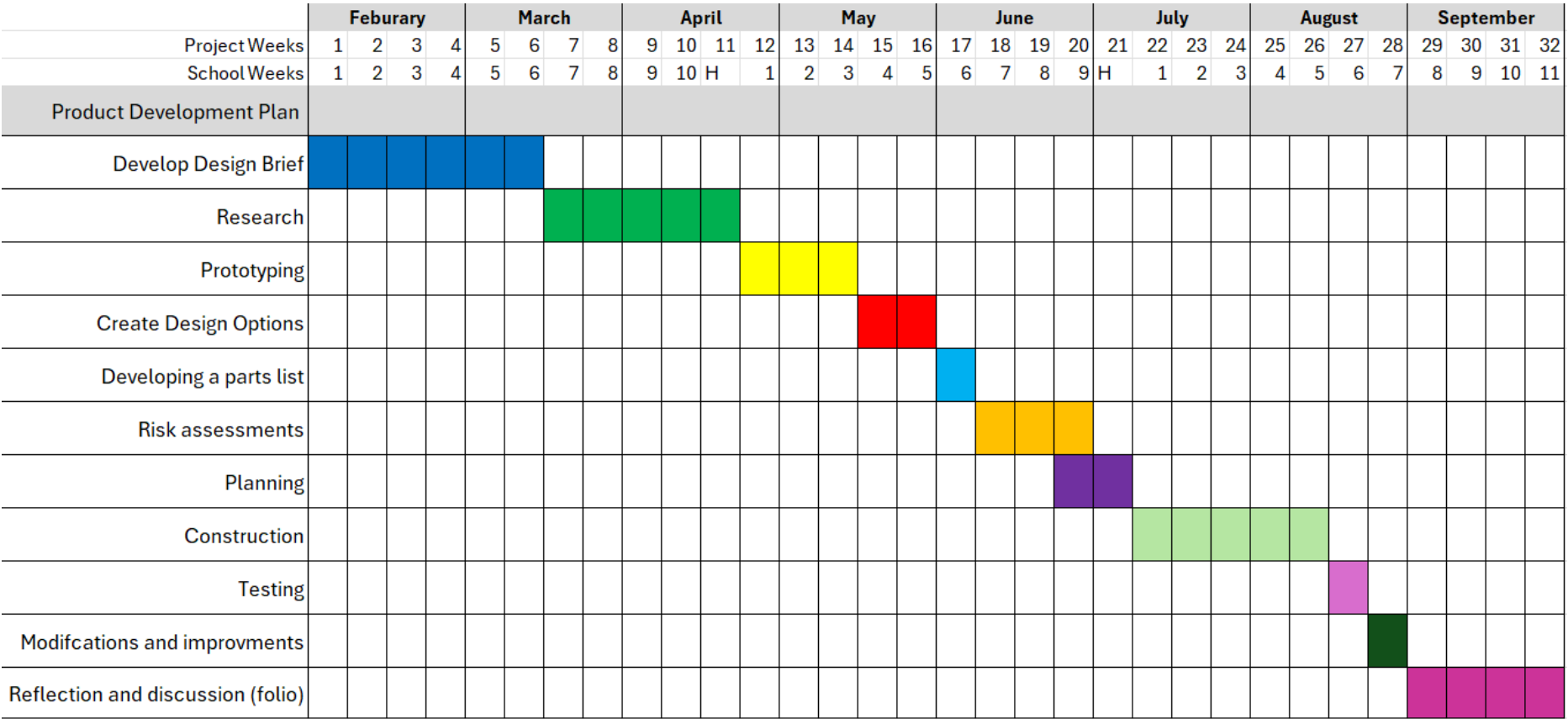
The consistency in dispensing time suggests that the feeder operates with a good level of reliability in terms of timing when it doesn't get jammed or stall. The small variations observed (about 1.77 seconds between the fastest and slowest trials) could be attributed to minor differences in how the food settles in the hopper between trials or slight inconsistencies in the machine's motor performance.

The average dispensing time of 15.281 seconds for a 200g portion is a reasonable duration. It's quick enough to be convenient for regular use but not so fast that it might risk overwhelming the dog or causing spillage.

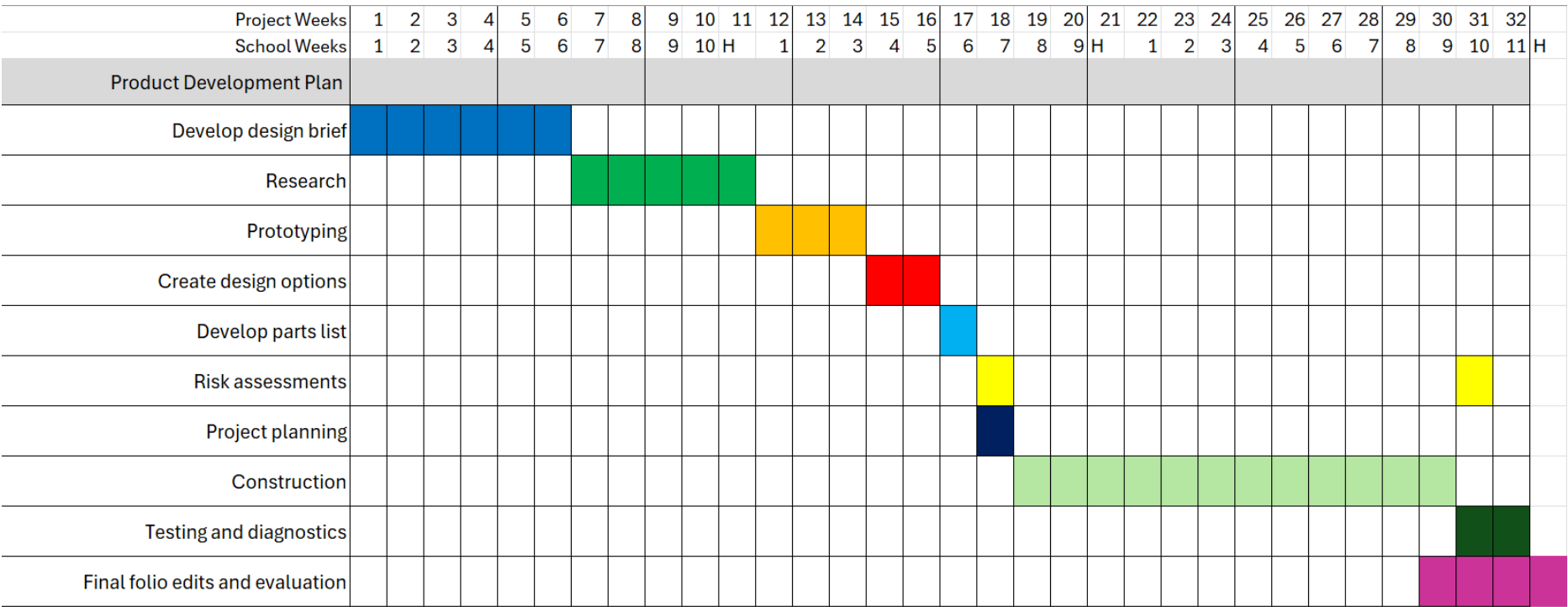
Criteria 7

Updated Gantt Chart

Initial Gantt Chart



Final Gantt Chart



Comments

- **Develop design brief:** This phase went as planned, taking up the first 6 weeks. I needed this time to fully understand the project requirements and set my goals.
- **Research:** My research phase extended slightly longer than expected, going from weeks 7-12 instead of 7-11. I found that I needed a bit more time to thoroughly investigate all aspects of my design, especially as I uncovered new information that required deeper exploration.
- **Prototyping:** Prototyping shifted slightly later, from weeks 12-14 to weeks 13-15. This was a direct result of my extended research phase. I wanted to ensure I had all the necessary information before beginning my prototypes.
- **Create design options:** This phase remained relatively unchanged, just shifting by a week due to the previous delays. I managed to complete this task within the planned two-week period.
- **Develop parts list:** The parts list development was condensed from a full week to just part of week 17. As I became more familiar with my design, I was able to streamline this process.
- **Risk assessments:** This was a significant change from my initial plan. I originally allocated weeks 18-20 for risk assessments, but I did an initial assessment in week 18 and then some updated ones

for the tools I used over the course of the project in week 32. I realized that ongoing risk evaluation was crucial throughout the project, especially as I neared completion.

- **Project planning:** My planning phase was shorter than initially anticipated, taking only part of week 18 instead of weeks 20-21. This was because I had already done a lot of implicit planning during my extended research and prototyping phases.
- **Construction:** This is where I saw the biggest deviation from my original plan. Construction was initially set for weeks 22-26, but it actually ran from week 19 all the way to week 30. As I got into the build, I encountered numerous challenges. Some components didn't integrate as smoothly as I'd hoped, and I had to make several design modifications on the fly. There were also some delays in getting certain crucial parts.
- **Testing and diagnostics:** Originally planned for weeks 27-28, testing got pushed back to weeks 31-32 due to my extended construction phase. I couldn't start proper testing until the build was mostly complete.
- **Final folio edits and evaluation:** This phase, initially called "Reflection and discussion (folio)" in my original plan, started earlier than expected (week 30) and continued through the end of the project. I realized it was more efficient to begin documenting and evaluating as I was finishing construction and testing, rather than leaving it all to the end.
- The "**Modifications and improvements**" phase from my original plan isn't explicitly shown in the final chart because these were done during my extended construction phase. I was constantly tweaking and improving as I went along.
- Despite all these changes, I managed to complete the project within my original 32-week timeframe.

New risk assessments for tools used in construction

Note that some tools mentioned, like the angle grinder and table saw were not included as I was not the person operating these machines.

Drill Press

Use Case:

Used for drilling precise holes wooden frame, servo bracket.

Potential Risks:

1. **Entanglement:** Loose clothing or hair can get caught in the rotating parts.
2. **Eye Injury:** Flying debris or chips from drilling.
3. **Pinch Points:** Hands or fingers may get pinched in moving parts.
4. **Hearing Damage:** Prolonged exposure to loud noise.
5. **Electric Shock:** Improper handling of the machine or damaged wiring.

Risk Matrix

N.B. For more details regarding use of this matrix / definitions refer to final page of this document

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures:

1. **Clothing Safety:** Secure loose clothing, hair, and accessories before use.
2. **Eye Protection:** Always wear safety goggles to protect from debris.
3. **Keep Hands Clear:** Avoid placing hands near the rotating bit.
4. **Hearing Protection:** Wear ear protection if using the machine for long periods.
5. **Electrical Safety:** Check wiring regularly and ensure the machine is properly grounded.

Linisher Sanding Machine

Use Case:

Used for sanding down plastic parts like the auger and wooden legs.

Potential Risks:

1. **Abrasions:** Skin can get caught and abraded by the sanding belt.
2. **Eye Injury:** Dust and small particles can fly into the eyes.
3. **Inhalation:** Sanding can create fine dust that is hazardous when inhaled.
4. **Burns:** Heat build-up from prolonged sanding.
5. **Electric Shock:** Risk of electric shock from faulty wiring.

Risk Matrix

N.B. For more details regarding use of this matrix / definitions refer to final page of this document

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures:

1. **Use Guards:** Keep guards in place and fingers away from the sanding belt.

2. **Eye Protection:** Wear safety goggles to prevent eye injury.
3. **Ventilation:** Use a dust extraction system or wear a mask.
4. **Work in Intervals:** Avoid prolonged use to prevent heat build-up.
5. **Electrical Safety:** Regularly inspect the machine for any damaged wiring.

Hot Glue Gun

Use Case:

Used to bond plastic parts of the hopper together as well as hold in various electronic components.

Potential Risks:

1. **Burns:** Hot glue or the gun nozzle can cause skin burns.
2. **Fume Inhalation:** Heated glue can release fumes that are harmful if inhaled.
3. **Fire Hazard:** Risk of ignition if the gun is left on or placed near flammable objects.
4. **Electric Shock:** Faulty cords can cause electric shock.
5. **Eye Injury:** Hot glue may splatter into the eyes.

Risk Matrix

N.B. For more details regarding use of this matrix / definitions refer to final page of this document

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures:

1. **Use Caution:** Be mindful of the hot glue and nozzle; wear gloves if necessary.
2. **Ventilation:** Work in a well-ventilated area to avoid inhaling fumes.
3. **Flame Safety:** Keep flammable materials away from the hot glue gun.
4. **Electrical Safety:** Inspect the cord and unplug the gun when not in use.
5. **Eye Protection:** Wear goggles to protect from potential splatter.

Hand Saw

Use Case:

Used to manually cut plastic parts, mainly for testing purposes.

Potential Risks:

1. **Cuts:** The sharp blade can cause deep cuts to hands and fingers.
2. **Strain:** Repetitive motion can cause muscle strain.

3. **Kickback:** The saw can kick back if it binds in the material.
4. **Eye Injury:** Sawdust and small particles can fly into the eyes.
5. **Splinters:** Material can splinter and cause injury.

Risk Matrix

N.B. For more details regarding use of this matrix / definitions refer to final page of this document

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures:

1. **Use Proper Technique:** Cut away from your body and keep hands clear of the blade.
2. **Take Breaks:** Avoid strain by using the saw in controlled intervals.
3. **Secure Material:** Use clamps to hold the material in place to prevent kickback.
4. **Eye Protection:** Wear goggles to avoid debris in the eyes.
5. **Gloves:** Consider wearing gloves to prevent splinters.

Electric Jig Saw

Use Case:

Used for cutting shapes and curves in wood, metal, and plastic.

Potential Risks:

1. **Cuts:** Contact with the fast-moving blade can cause serious injury.
2. **Kickback:** Blade binding can cause the saw to kick back.
3. **Eye Injury:** Sawdust or chips can fly into the eyes.
4. **Hearing Damage:** Loud noise can damage hearing over time.
5. **Electric Shock:** Risk of electric shock from improper handling or damaged wiring.

Risk Matrix		Likelihood				
N.B. For more details regarding use of this matrix / definitions refer to final page of this document		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures:

- 1. Blade Safety: Keep hands away from the blade and use proper grip.
- 2. Secure Material: Clamp the workpiece to prevent kickback.
- 3. Eye Protection: Wear safety goggles to protect from flying debris.
- 4. Hearing Protection: Use earplugs or earmuffs if noise is excessive.
- 5. Electrical Safety: Regularly check the power cord for damage.

Lighter

Use Case:

Used to ignite flames for various purposes.

Potential Risks:

- 1. Burns: Direct contact with the flame or lighter body can cause burns.
- 2. Fire Hazard: Can ignite flammable materials.
- 3. Explosion: Risk of explosion if exposed to heat or punctured.
- 4. Inhalation: Inhaling lighter fluid fumes can be harmful.
- 5. Eye Damage: Flame or debris could potentially reach the eyes.

Risk Matrix		Likelihood				
N.B. For more details regarding use of this matrix / definitions refer to final page of this document		Rare	Unlikely	Possible	Likely	Almost Certain
Consequence	Severe <i>Eg. Potential Fatality or Injury or Illness with permanent disability</i>	MEDIUM	MEDIUM	HIGH	EXTREME	EXTREME
	Major <i>Eg. Potential Lost Time Injury (but non-permanent disability)</i>	LOW	MEDIUM	MEDIUM	HIGH	EXTREME
	Moderate <i>Eg. Potential Medical Treatment injury or illness (but no lost time)</i>	LOW	LOW	MEDIUM	MEDIUM	HIGH
	Minor <i>Eg. Potential First Aid injury</i>	LOW	LOW	LOW	MEDIUM	MEDIUM
	Minimal <i>Eg. Hazard or near miss requiring reporting and follow up action</i>	LOW	LOW	LOW	LOW	LOW

Preventative Measures:

- 1. Use Caution: Keep the flame away from skin and flammable materials.

2. **Flame Safety:** Only use the lighter in well-ventilated areas and away from combustibles.
3. **Store Properly:** Store in a cool, dry place to prevent accidental ignition or explosion.
4. **Avoid Fume Inhalation:** Do not inhale fumes from the lighter.
5. **Eye Protection:** Use caution to prevent flame from reaching your face.

Criteria 8

Evaluation Rubric

	0 (not shown)	1 (low)	2 (medium)	3 (high)	4 (very high)
The feeder must be able to dispense food from a hopper into a dog bowl. (S denotes success percentage)	Doesn't dispense at all.	Dispenses sometimes. (0%<S<80%)	Dispenses successfully most of the time. (80%<S<100%)	Dispenses successfully every time, but not between tolerance zone of 190-210 grams.	Dispenses successfully every time within 190-210 gram tolerance range.
The feeder must be equipped to run without human input.	Can store enough food and have enough power for <1 days of feeding.	Can store enough food and have enough power for 1-2 days of feeding.	Can store enough food and have enough power for 3-4 days of feeding.	Can store enough food and have enough power for 5-7 days of feeding.	Can store enough food and have enough power for >7 days of feeding.
The feeder must be able to fit in a 500x500mm square area in my laundry.	Fits in a severely larger than 500mmx500mm area. (>500mm over limit.)	Fits in a moderately larger area than 500mmx500mm area. (<250mm over limit.)	Fits in a slightly larger than 500mmx500mm area. (<50mm over limit)	Fits slightly in a 500mmx500mm area. (<100mm under limit)	Fits in much less than a 500mmx500mm area. (>100mm under limit).
The product must have a fully sealed electronics box and feed hopper, as well as no exposed wires.	All wires and electronics are exposed.	Some wires and electronics are protected by electrical tape.	Most wires and electronics are protected by hard material or electrical tape.	All wires and electronics are protected by hard material or electrical tape.	All wires and electronics are protected by hard material.
The product budget is set at \$100	Project cost was >\$200	Project cost was >\$150	Project cost was <\$150	Project cost was <\$100	Project cost was <\$50
Total					15/20

Evaluating the Constraints and Considerations

Constraints Evaluation

Constraint	Evaluation
The feeder must be able to dispense food from a hopper into a dog bowl.	Being the core function of my product, this consideration was important to meet. While I developed a dispensing design that was reliable and easily controlled, the electronics side of my project meant that the servo motor was underpowered and thus not able to consistently output food as it would stall or get jammed easily. Ignoring the autonomy side of things, the design met the consideration fully. The hopper could hold food, the auger screw could move food along and out the bottom of the frame, and the chute held all the food in and ensured it made it to the bowl.
The feeder must be able to dispense food without regular human input (less than daily attention).	The dog feeder could not 'dispense' without regular human input due to the servo issue discussed above. However, the hopper could hold 5 days of feed and the 9V AC-DC wall power supply meant my project could run indefinitely so long as my house doesn't suffer a power outage. The inclusion of the ultrasonic sensor meant a much more accurate and reliable way to alert my client when the feeder was empty. So, in terms of that part of the consideration, it was met if not exceeded. My client theoretically should only have to attend to the dog to fill the hopper once every 5 days, which is definitely an improvement from twice per day.
The feeder must be able to fit in a 500x500mm square area in my laundry.	My design needed to be relatively compact in footprint to avoid creating a nuisance in the laundry where it resides. The final design ended up measuring 350x250x560mm (length x width x height, not counting the protrusion of the chute as this hangs over my dog's food bowl), which was significantly lower than the constrained footprint I aimed to meet. This aspect of the project was a resounding success.
The product must have a fully sealed electronics box and feed hopper, as well as no exposed wires.	I set this constraint to protect the safety of both my dog and my client. Exposed wires could be chewed or touched and cause serious harm. My final project included a latching electronic box to protect the Arduino and wiring inside while still maintaining ease of access for me should I need to fix things in the future. The wires running from the ultrasonic to the box were wrapped in electrical tape, as well as the wires from the servo to the electronics box. Ideally, these would be integrated and protected under some solid material, but this was not something I was intensely focused on adding as the electrical tape was satisfactory for me.
The product budget is set at \$100	The final project cost was estimated to be \$50. It was hard to put a precise number on it due to the fact I didn't pay for the filament, timber and most of the electronics as they were supplied by the school and Bendigo Tech School. I used scrap timber from the woodwork room for the wooden frame. I used wires, an Arduino, servo motor, buzzer, LED's and power supply from the Systems room, so they were essentially free. The 3D filament was either recycled or already purchased so that was essentially free. The only significant cost was the paint, which was \$45. Due to the very low cost of my project compared to the budget, I can say this consideration was met and exceeded.

Considerations Evaluation

Consideration	Evaluation
The product could have a dial or similar that can adjust the feeding portion and time of feeding,	This consideration was not met, as it would have added a lot of electronic and code complexity I was prepared to sacrifice due to the significant time commitment it would have required.
I could implement aesthetically pleasing features like a cover for the whole machine or painted timber.	This consideration was met to the best of my abilities and judgement. I painted the timber frame and used the same colour filament for all 3D printed parts to ensure a sleek, consistent and appealing aesthetic for my product. Arguably, I could have made a integrated cover for the electronics box, servo mount and bottom half of the hopper but I chose not to do this because it was a lot of filament and I wanted my engineering to be on display.
I could utilise a speaker/whistle to alert the human when the hopper is empty, and to play a sound when it's feeding time for dog.	This consideration was met as I integrated a buzzer and two LED's to alert my client of the status (empty or not empty) of the feed hopper. The buzzer also meant my dog could be alerted when the feed was ready, so he didn't miss it. Overall, these were simple but effective additions that added to my project.
I could implement an app that allows me to control the feeder remotely. This would mean I would have to host a server or something like that to achieve this.	This consideration was not met, mainly due to scope and ability. This was a whole other project in a way and would require more expensive hardware and programming skills I do not possess. It was certainly a stretch and was not necessary, so I am not concerned this consideration wasn't met.
Backup battery– if the primary power source goes out, there can be a backup battery for when our family is away for long periods of time and the power source runs/cuts out.	This was not justifiable to include in the end, as the AC wall outlet is so reliable it was not worth the added complexity and time to add a backup power source. However, in a way this was needed, as my servo likely needs its own power source since it is underpowered when sharing power with the ultrasonic and RTC module.
The machine could be built out of more durable materials like metal and glass.	This would have been expensive and made it much more difficult to rapidly prototype designs, so I am glad I didn't try and meet this consideration.

Final Comments

I deem the overall product to be a success. I fully completed my production plan and have a polished product to show for it. The changes from the original design option meant my product was more effective, reliable and more aesthetically pleasing. The issues with the motor meant the dispensing of the food was difficult and inconsistent, which was disappointing and meant the product won't be able to be used in real life. Although the electronics posed to be an issue, I may be able to revisit them and fix them after the submission. Nevertheless, I am proud of my engineering and product management skills I utilised and improved throughout this project to create something that genuinely looks like a commercial product.

Acknowledgements

This project would not have been possible without the help and support of many fantastic people both inside and outside of school. Thank you to the following people:

- **Steve Tyzzer** for being my teacher, always reminding us to 'get to building' and making sure we had a laugh when things got stressful. Your woodworking and handyman skills proved invaluable in a few difficult situations and thank you for always unlocking the door and putting up with me bothering you outside of class time.
- **Bethany Amsing** for helping with the folio side of things. Most of this project was about the paper and not the product, so your guidance and advice on the folio work proved invaluable and kept me on track and ticking off the criteria.
- **Matthew Everton** for fixing the 3D printer and offering some great advice throughout the project.
- **Travis Tooley** for printing countless parts at the BTS for me, you were always quick to get them on the printer and have them ready to be picked up. Without this I wouldn't have a project.
- **Caleb Tobin** for being my mate and competitor over the course of the year, without you egging me on I wouldn't have put in so much effort into this thing. Thank you for always helping me when I needed something held down or photographed when my hands were full and battling through this journey together.
- **Claire Everton** for supervising our class when Steve was away and always checking in to see how we were going and giving us Mentos.
- **Matthew Angove** for always letting me duck out of Physics class to check on my 3D prints.
- **Linda Kolevas** for always letting me leave study in the library to go work on my project in the systems room. Quote "I don't understand what's in the Systems room that is better than being here, but yes you can go Flynn."
- **Cal Daff** for letting me use his repair screwdrivers and tools to take apart multiple servo motors and fixing my computer whenever Fusion made it implode.
- **Lincoln Munday, Finn Cunningham and Oliver Sexton** for being my 3D printer consultants, always helping me change filament or fix some sort of issue with the Flashforge.
- **Vin Virk** for helping me in the woodwork room to ensure I didn't cut off my finger or break something.
- **Alex Aurisch-McGrath** for always trying to distract me from my work and being a great mate in class.
- **Mum and Dad** for offering invaluable reviews of my designs and taking me to Jaycar, Supercheap and Mitre 10 to make sure I had the parts I needed.

Thanks,

Flynn Saunder

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