1. Tools & Materials Required

Tools
Laser Cutter
3D-Printer
Soldering iron
CNC *
Relevant Screwdrivers and Power tools

Material
Bearings (Or equivalent)
Motor (Or equivalent)
PSU (compatible for motors)
Speed Controllers (Or alternative to control motors)
Bolts (M3 -> M6)
Nuts (M3 -> M6)
Plastic Filament (Recommended materials are: PLA, ABS and PC+)
Wood (6mm MDF)
Wood (16mm x2) *
Wood (6mm) *
Plexiglass (3mm Acrylic) *

***** *For optional components*

2. Safety Precautions

Safety

1. Always wear safety goggles when cutting or assembling.
2. Use gloves when handling sharp metal or acrylic parts.
3. Ventilation required during laser cutting or soldering.
4. Disconnect power before testing mechanical movement

If you follow the same materials and fabrication methods listed below, do NOT try to shred the following:

1. Fully completed 3D prints
2. Thin (and thick) large surface areas
3. Harder material then PLA and PETG
4. Large strings of filament that can wrap around the axle

If you follow the same materials and fabrication methods listed below, you should be able to shred the following:

1. Support in PLA and PETG
    a. NOTE: May vary depending on support variant, organic support has been most successful in testing
2. Brim
3. Small prints dependent on their infill (0-5%) and their infill pattern

Disclaimers for usage:

1. The shredder itself might start to move/rotate if overloaded, since it's not bolted to any surface area. Be aware. Might need to be physically held down while shredding
2. The axle connectors might break if overloaded
3. When gears are run for a long time or at a high speed, a lot of heat can be generated, this may cause melting or very hot screws.
4. Shredding material with higher than 20% speed on the motors has not been tested

3. Overview of Components

See the external build of materials (BOM) for a brief overview of all components used in the system. Each component is assigned a unique ID (in parentheses) which is consistently referred to throughout the manual to ensure clarity during fabrication and assembly.

4. Fabrication Instructions

4.1 Laser Cut parts

These instructions and settings are based on Epilog Fusion 75w, settings should be tuned to your specific machinery.

General settings

- 6mm MDF
    - Raster: Power 100% ; Speed 4% ; Frequency 10
- 3mm Acrylic
    - Raster: Power 70; Speed 80; Frequency 10

4.2 3D printed parts

These instructions and settings are based on Prusa Mk4s, settings should be tuned to your specific machinery.

General settings

- Layer Height: 0.2 mm
- Nozzle Size: 0.4 mm standard

Filament Settings

- PLA
    - Parts in PLA are not under heavy load, therefore 10-20% infill should suffice.
    - Follow your filaments specific temperature settings.
- ABS
    - Should be printed in an enclosed printer, heated 20-30 mins before starting.
    - Use Large brim and glue to keep the print from warping.
    - Consider turning auto-cooling/fan off while printing.
    - Follow your filaments specific temperature settings.

Instructions

- Axle (1)
    - Material: ABS
    - Infill : 25%
    - Infill pattern : Gyroid
    - Printed horizontally to align layer lines perpendicular to torque forces
- Shredder blades (2)
    - Material: ABS
    - Infill : 30%
    - Infill pattern : Gyroid
    - Perimeters : 6
    - Printed horizontally to align layer lines perpendicular to torque forces
- Spacers axle (3)
    - Material: PLA
    - Infill : 10-20%

- Spacers wall (4)
    - Material: PLA
    - Infill : 10-20%
- Spacer mount wall (5)
    - Material: PLA
    - Infill : 10-20%
- Wall snap connector (8)
    - Material: PLA
    - Infill : 10-20%
- Bearing connector (9)
    - Material: PLA
    - Infill : 10-20%
- Roof handle (11)
    - Material: PLA
    - Infill : 10-20%
- Ring Gear (12)
    - Material: PLA
    - Infill : 20%
- Planet Gear (13)
    - Material: PLA
    - Infill : 15-20%
- Input Gear (14)
    - Material: PC+
    - Infill : 20%
- Output Hub (15)
    - Material: PLA
    - Infill : 20%
- Sun Gear Carrier (16)
    - Material: PLA
    - Infill : 20%
- Ring Gear Holder (17)
    - Material: PLA
    - Infill : 15-20%
- Arduino Housing Box (18)
    - Material: PLA
    - Infill: 15%
- Arduino Housing Lid (19)
    - Material: PLA
    - Infill: 15%
- Arduino Mounting Plate (20)
    - Material: PLA
    - Infill: 15%

4.3 Mount for gearbox and Motor

The motor and gearbox assembly requires a stable base to maintain alignment and withstand torque during operation. The mounting procedure described here is based on the motor and gearbox modules used in this project. If you are using a different motor, you may need to adjust the dimensions accordingly. Mounting Instructions:

1. **Prepare the Base:**
   Using a CNC machine, mill a recessed slot approximately 4.3 mm deep into a 16 mm thick wooden base. The length of this slot should match the total length of your assembled gearbox modules. This slot helps stabilize the gearbox by allowing the ring gear holder to rest securely.
2. **Layer and Fasten:**
   Stack and fasten the milled 16 mm wooden base with a 6 mm MDF sheet to create the correct total platform height (~22 mm). Fasten these together using appropriate screws or bolts to ensure rigidity.
3. **Positioning Requirements:**
   The mount must raise the gearbox to a total height of approximately 37 mm, while maintaining the 4.3 mm recessed channel for proper alignment and secure placement of the gearbox

Note: This method ensures the gearbox aligns correctly with the shredder axles (1). While this design is optimized for the motor used in this manual, users may adapt the approach for other motors, provided the height and alignment constraints are respected.

4.4 Electronics Housing (3D Printed)

The electronics are mounted on a 3D-printed backplate measuring 110 × 85 × 5 mm, which fits inside a housing box with internal dimensions of approximately 125 × 100 × 60 mm. The enclosure was printed in PLA with 3 mm wall thickness, providing enough space to accommodate components and vertical clearance for jumper wires, headers, and connectors.

Cutouts in the top lid were designed to match the mounted components, including the LCD screen, momentary push button, buzzer, and LED strip. The lid uses a press-fit design, with a 2 mm outer frame and an inner lip measuring 121.7 × 96.7 × 1 mm, which sits snugly inside the box opening to hold the lid securely in place without screws or fasteners.

5. Post-Processing (Sanding, Tapping, Deburring, etc.)

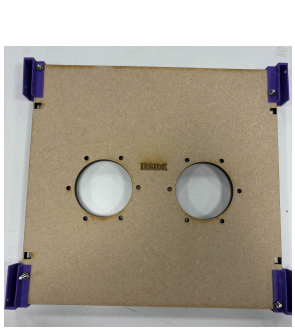
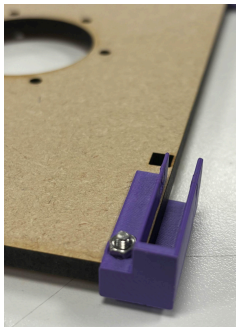
The axle might need sanding if spacers or shredder blades either don’t fit or are too tight.

6. Assembly Instructions

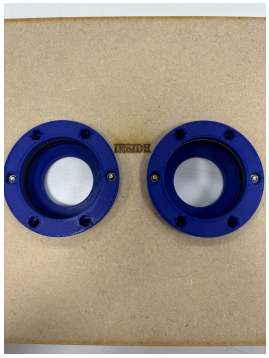
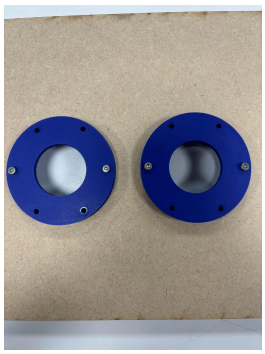
6.1 Sub-Assemblies

6.1.1 Shredder

Step 1 – Attach wall snap connectors (8) to both front and back walls (6). Make sure the text “inside” on the connectors faces upward, as shown in the reference image. Use M3 bolts and nuts to secure them.

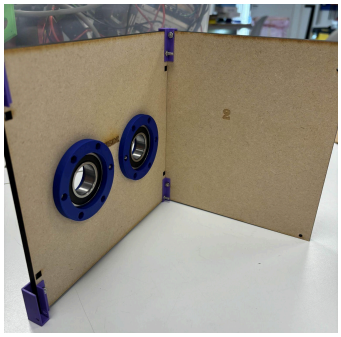



Step 2 – Using M3 bolts and nuts, mount the bearing connectors (9) onto the inner side of both front and back walls (6).

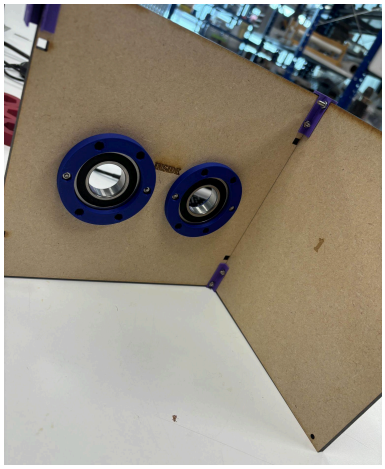



Step 3 – Insert the bearings into the connectors (9) from the inside, pushing them in until they are flush with the wall.

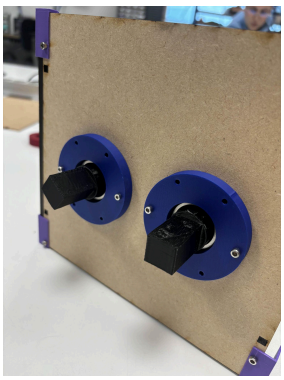
Step 4 – Attach the side wall (7) labeled “2” to the left side of one of the walls with axle holes (6).



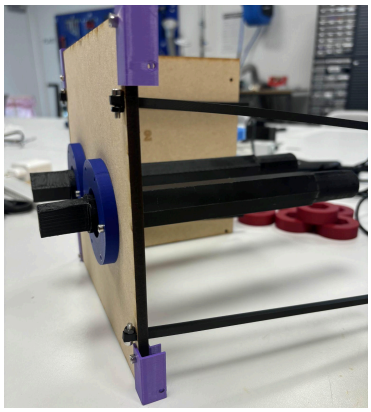
Step 5 – Attach the second side wall (7) labeled “1” to the other wall (6) in the same fashion..



Step 6 – Insert both axles (1) through the bearings on the wall connected to side wall 2. Ensure the square end of the axle faces outward, as illustrated.

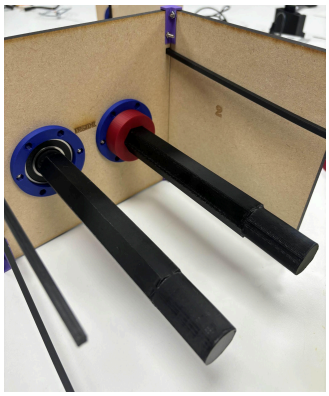



Step 7 – Insert M3 bolts and nuts into the mounting holes for the spacer mount wall (5). Press the assembled mounts into their designated square holes in the wall (6).



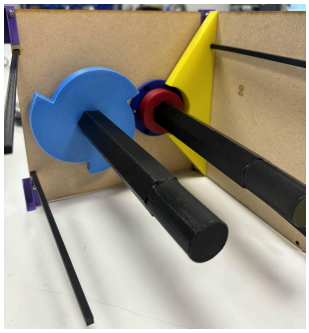
Step 8 – Begin assembling the rotating mechanism on the axle:

8.1 On the right-facing axle (1): Add a spacer axle (3)

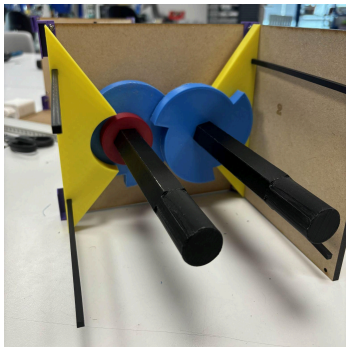


8.2 then a shredder blade(2) on the left facing axle (3).

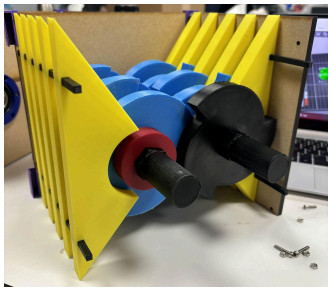
8.3 Add a wall spacer (4) on the same side as the axle spacer (3)



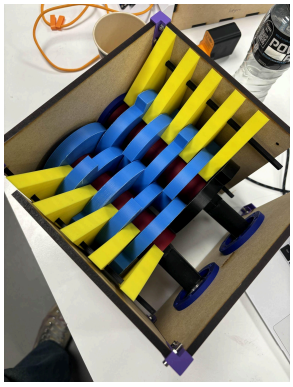
8.4 Now repeat this for the other side



8.5 Repeat the previous step, alternating spacers (3), shredder blades (2), and wall spacers (4), until the axles are fully loaded on both sides.



Step 9 – Once both axles are fully stacked, attach the remaining front or back wall (6) to enclose the assembly, completing the shredder structure.



Step 10 – Lid(Optional). Screw handle in roof

6.1.3 Gearbox

Step 1 – Prepare the Bearings and Planet Gears

1.1. Gather 4 × 608-ZZ ball bearings and 4 planet gears.

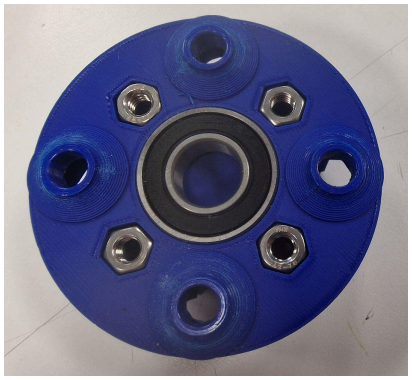
1.2. Using a bearing press (or equivalent tool), press each 608-ZZ bearing all the way into its respective planet gear until it sits flush.

Step 2 – Install the Output Hub Bearing

2.1. Take one 6002-2RS ball bearing.

2.2. Press the 6002-2RS bearing fully into the output hub until it is fully seated.

2.3. If you are assembling more than one gearbox module, repeat Steps 2.1–2.2 for each additional sun-gear carrier.

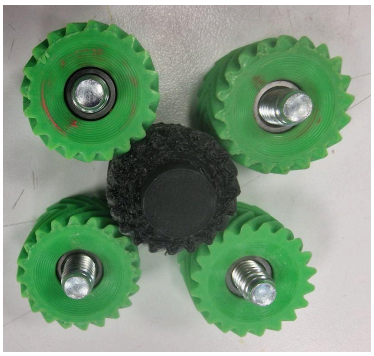



Step 3 – Secure the Housing with Hex Nuts

3.1. For each gearbox housing, insert 5 × M3 hex nuts into the side slots of the housing.
3.2. Make sure each nut is aligned and fully seated in its slot.
3.3. If you have multiple housings (one per module), repeat this step for every housing.

Step 4 – Position the Planet Gears on the Input Gear

4.1. Take the four planet gears you prepared in Step 1.
4.2. Evenly space them around the input gear of the module below.
4.3. You may thread the M8 screws through the planet gears now, or leave them loose until the next step.

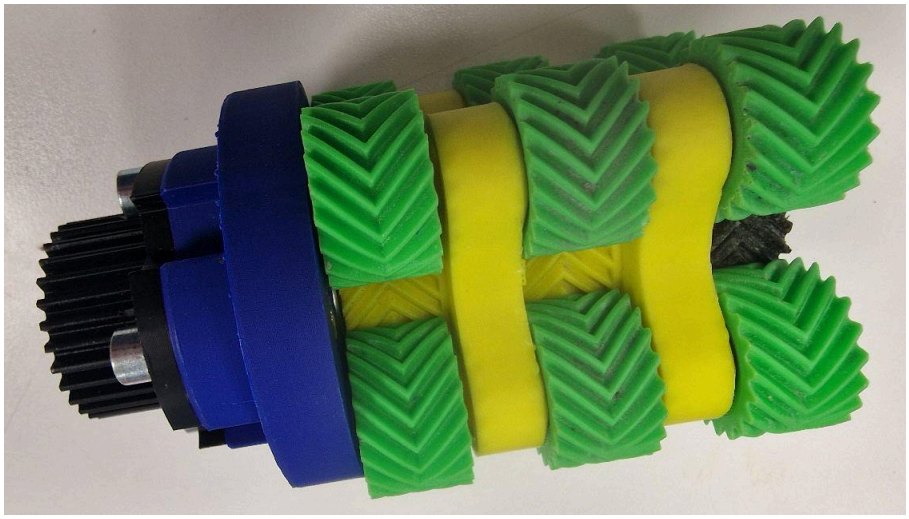


Step 5 – Align the Sun-Gear Carrier (Output Hub)

5.1. Lift the output hub (sun-gear carrier) and lower it straight down over the planet gears.
5.2. Apply gentle pressure until all M8 screw holes in the carrier line up with the screws (if pre-inserted) or with the planet-gear mounting points.

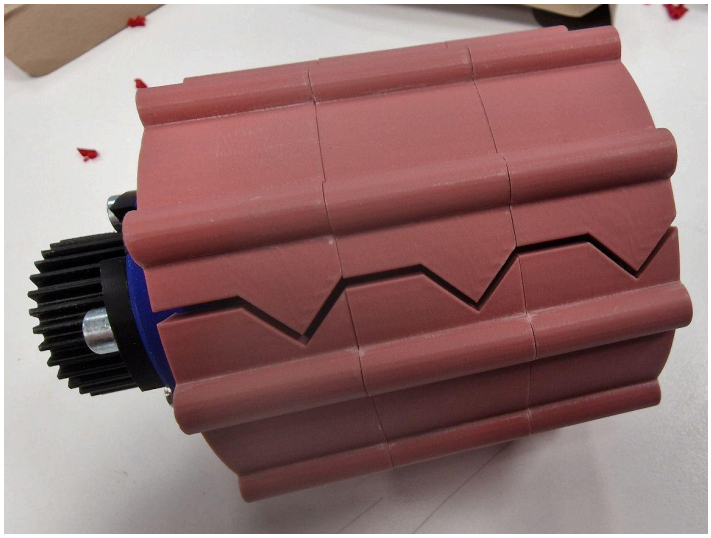
Step 6 – Secure with M8 Hex Nuts

6.1. Insert four M8 hex nuts into the corresponding recesses on the underside of the sun-gear carrier.
6.2. Begin tightening each nut by hand in a criss-cross pattern to ensure even clamping.
6.3. As you torque them down, periodically spin the gears by hand to verify that they still roll freely.
6.4 Repeat step 4 - 6 for etch module



Step 7 – Install the Ring Gears

7.1. Take one ring gear per module and carefully slide it down over the planet gears.
7.2. Ensure that the teeth of the ring gear mesh correctly with the planet gears.
7.3. Note: The ring gears are directional — make sure you orient each one correctly according to its design.

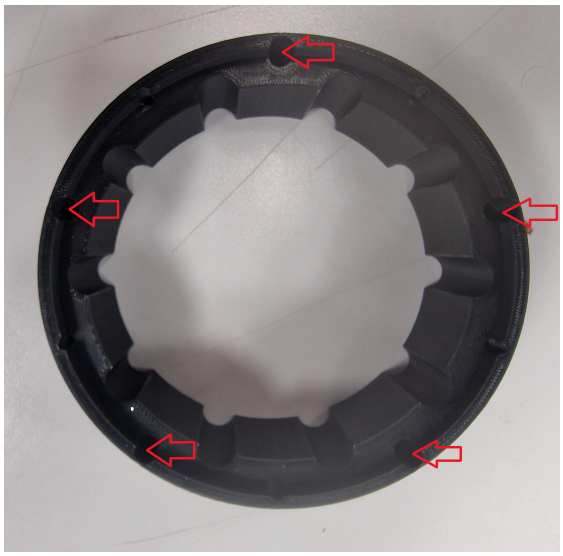


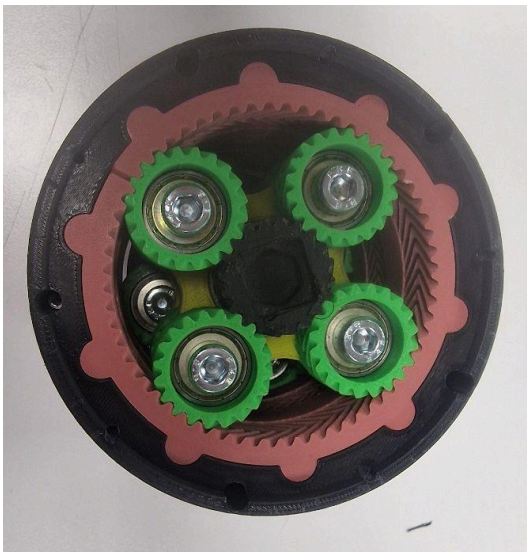
Step 8 – Insert the Assembly into the Housing

8.1. Carefully slide the entire gearbox assembly into the housing, ensuring that all components are properly aligned and seated.

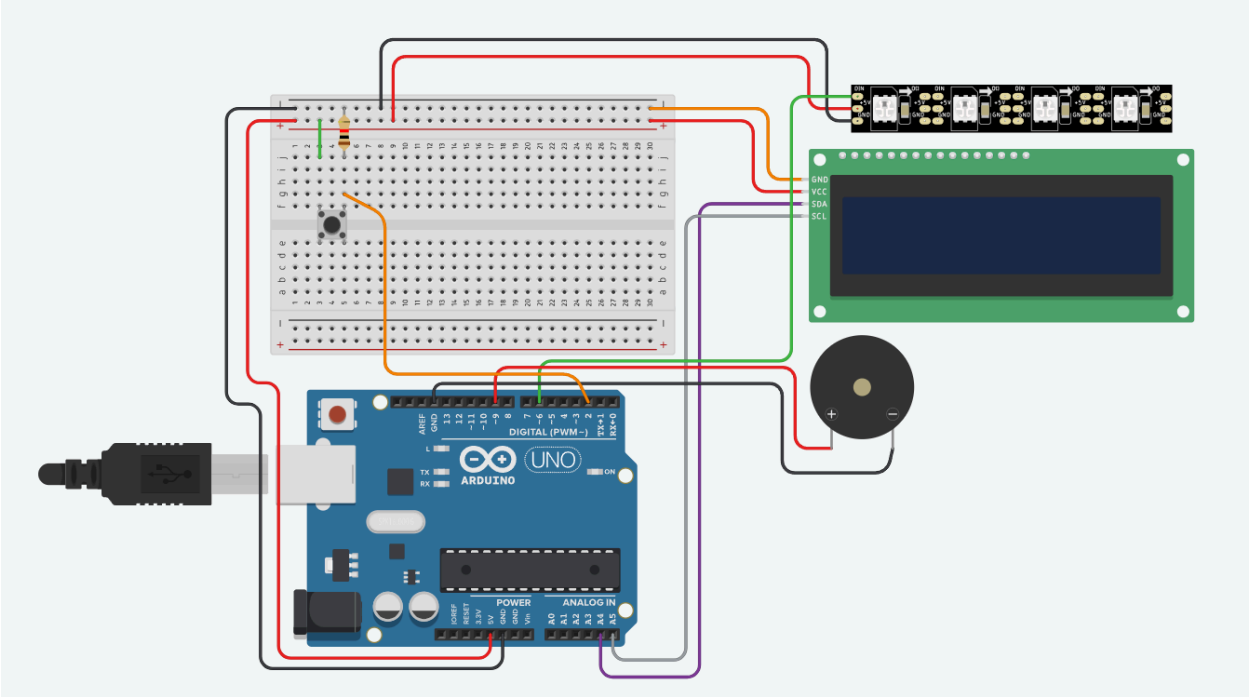
8.2. If you are building a multi-stage gearbox with several modules, align each housing section and fasten them together using 5 × M3 screws.

8.3. Tighten the screws evenly to avoid misalignment between modules.





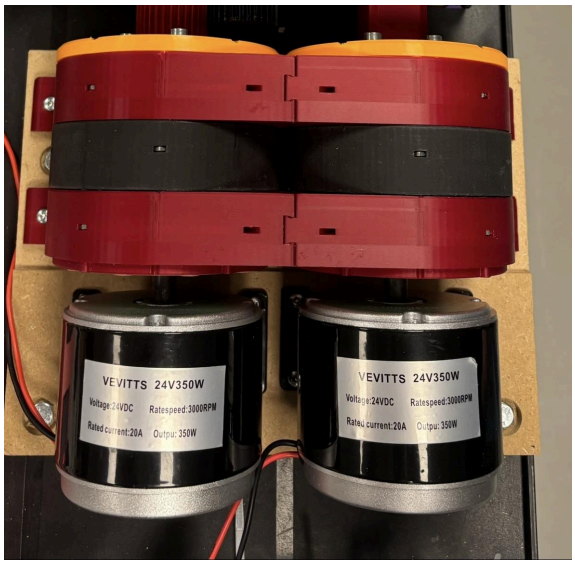
6.1.5 Arduino



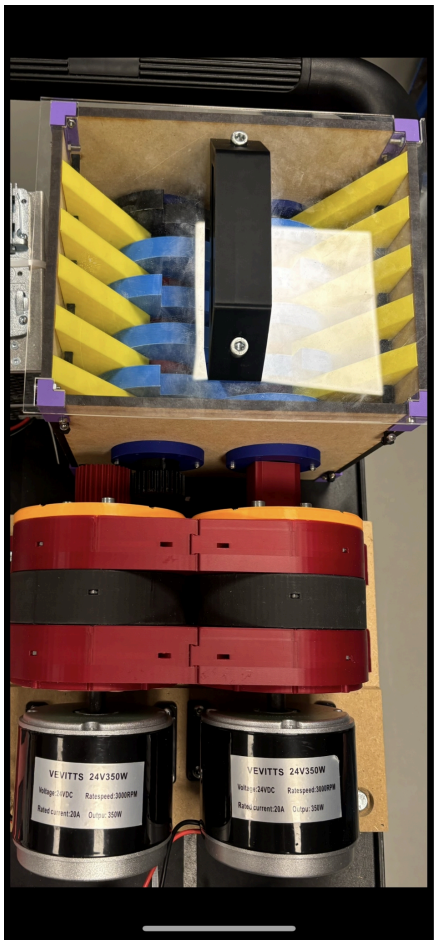
**Resistor is 10KΩ

6.2 Final Assembly

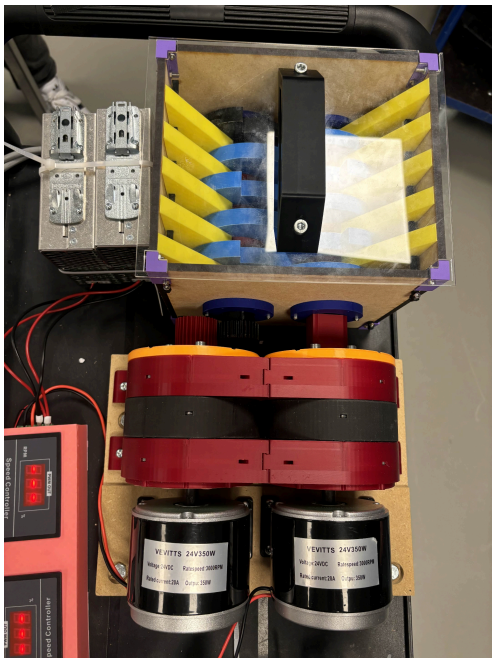
Step 1 – Mount Gearbox and Motor



Step 2 – Connect gearbox with shredders axle



Step 3 – Mount the electronics backplate inside the 3D printed housing. Ensure that the LCD, button, buzzer, and LED strip align with the cutouts in the top panel.



7. How to use

Step 1: Power Setup

1. Connect all the components to power:
    - Plug in all four 24V power supplies (two per moter) to a wall outlet using appropriate power strips or extensions.
    - Power the Arduino Uno via either a USB A to USB B cable, or a dedicated 5V power adapter.
    - Confirm that the LCD display turns on and shows the startup screen.

Step 2: Follow On-Screen Instructions

The LCD will guide you through the process. You advance to the next step, by pressing the connected button.

Before you start following the steps from the Arduino, the shredder should not be active, and the speed should be set to either “000” or “---”.

1. Screen 1 - Startup
    - Display:
        Shredder Ready
        Insert Material
    - Remove the lid from the shredder and insert the plastic material into the shredding area.
2. Press the Arduino button to continue.
3. Screen 2 - Secure Lid
    - Display
        Secure Lid
        Next Page…
    - Ensure that the shredder lid is in place to contain the debris.
4. Press the button to continue.
5. Screen 3 - Ready to Start
    - Display:
        For runtime:
        Press when start
    - This screen indicates the machine is ready to begin timing

Step 3: Activate the Motors

1. On the external speed controller enclosure:
    - Press the green power button on each of the controller to start each motor.
    - Use the rotary knobs to set the motor speed as needed.

    - The speed controller display will show a percentage (0 - 100%), indicating the motor speed.
2. Ensure both motors are running before continuing.

Step 4: Start Runtime

- Press the button on the Arduino interface to begin the timer.
- Display
  Shredding…
  Time: X.Xs
- The buzzer will indicate the start of the timer, by beeping.
- The LED strip will flash yellow during the shredding.
- The runtime will be displayed in seconds on the LCD screen.

Step 5: Stop Shredding

- When the shredding is complete, turn of the motor or set the speed to “000”.
- Press the Arduino button
- Display
  Shredding Done
  Time: X.Xs
- Two short beeps will sound.
- The LED strip will turn solid blue to indicate that the process has ended

Step 6: Reset and Repeat

- Press the button once more to return to the startup screen.
- The shredder is now ready for a new cycle.