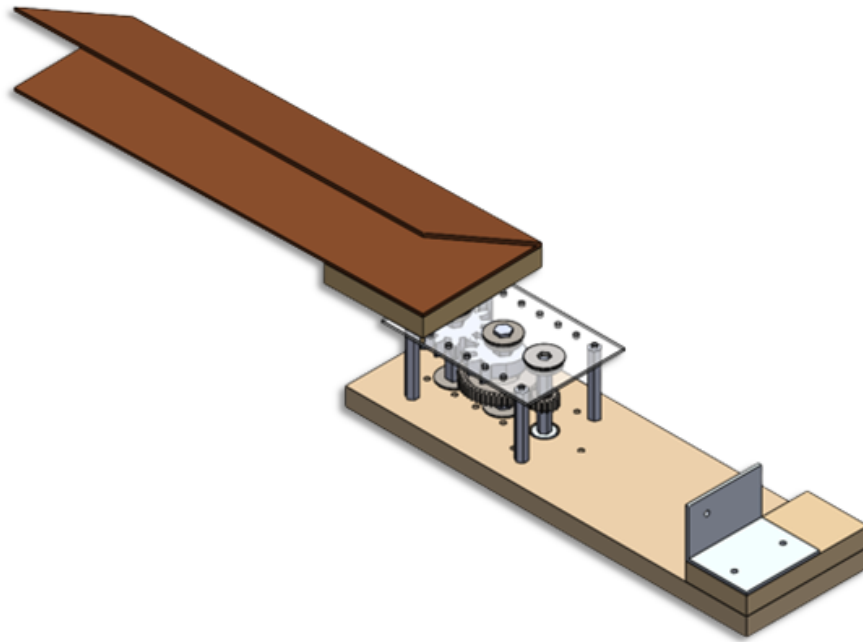


# Designing an Assistive Wheelchair-Mountable Projectile Launcher - **Assembly Instructions**



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## Problem Statement

Those with limited mobility can find it hard to play frisbee with friends, family members, or pets. Wheelchair users can find it difficult to throw frisbees, especially if the movement in their arms are limited

## Project Overview

This project aims to assist wheelchair users by launching frisbees through a device.

## Use of device after assembly

- A frisbee or disc is loaded into the throwing arm
- The launch button is to be held down until the arm is released and launches the frisbee

## Required Parts

### Mechanical System

Name	Purpose	Qty
5" x 16" Plywood ( $\frac{3}{4}$ " thickness)	Base Plate	1
$\frac{1}{2}$ " Hex Bearing	Fastening shafts	4
$\frac{3}{8}$ " Hex Bearing	Fastening Shafts	1
6" x 8" Acrylic ( $\frac{1}{8}$ " thickness)	Top plate	1
8-32 Locking Hex nuts	Fastening bearings	8
$\frac{1}{2}$ " wide washers (innert hole fits 8-32 bolts)	Fastening bearings to base	8
8-32 threaded standoffs ( $\frac{1}{2}$ " length)	Holding top plate	4
10-32 bolts (1" length)	Fasting motor to base plate	3
8-32 bolts ( $\frac{1}{2}$ " length)	Fastening top plate to standoffs	4
8-32 bolts (1.5" length)	Fastening base to standoffs	4
17.6 in/lbs spring (length: 8", strength varying)	Tensioning cover	1
Fishing line (1 ft)	Attaching spring to other components	1
1.5 diameter steel stock	Assembly for motor hat	1
Press Pins ( $\frac{1}{16}$ " diameter, $\frac{3}{4}$ " length)	Assembly for motor hat	5

## Electronic Control System

Name	Purpose	Qty
Arduino	Main microcontroller	1
Buttons (programmable or non-programmable)	Activate other parts of system	2
Relay (max capacity 12V 5A)	Allow for steady power without causing the motor to constantly run	1
DC step-down converter	Allow for one battery source and to not short circuit the arduino	1
12V 5A Battery	Allow for the powering of the entire electronic control system	1
Window Motor	Apply torque to the mechanical system	1
On-Off switch	Turning the system on and off (battery conservation)	1
Reel of 18 Gauge Wire	Connecting parts of the electronic control system together	1

## Assembly Instructions

### Launch System

#### Base Piece

First, holes for the base plate need to be cut out. Please see the Appendices for CAD drawings.

- Hex bearings are to be put into the  $\frac{1}{2}$ " hole and  $\frac{3}{8}$ " hole
  - Use bolts with washers to cover the bearings
    - Ensure that the washers do not cover the hole
- The motor should be put under the base with the motor hole revealing the motor
  - Bolt down the motor, using a drill to create the holes
- Refer to the diagram in appendix 1 for locations for threaded standoffs

#### Motor Hat

To start with the assembly of the motor hat, be sure to check and measure the distance between each tooth on the motor.

The motor hat requires you to put the press pins into the 1.5" diameter steel stock. The arrangement of the pins **must** be able to fit in the motor teeth. Be sure to verify that the pins can fit between the teeth of the motor and that you can accurately put the steel stock on the pins.

The motor hat can then be put onto the motor where the hex shaft can be inserted.

## Hex Shaft

Gears are put into the hex shafts

- There is 1 gear on the hex shaft connected to the motor
- There are 2 gears on the hex shaft between the other two hex shafts
  - Ensure that that one of these gears is the gear without half of its teeth
  - Ensure that the gears are lined up properly with each other
- There is 1 gear on the shaft connected to the arm

The arm is not attached to the hex shaft with the motor and is instead connected to the hex shaft furthest away from the motor hex shaft

## Acrylic Top Plate

We recommend that the acrylic top plate is laser cut, as acrylic can shatter when drilled into. Please see Appendix 2 for CAD drawings.

The Acrylic Top Plate is used to help keep the shafts and gears straight

- Attach Acrylic Top Plate to threaded standoffs for stability
- Ensure that the Top Plate is straight when attached

## Launching Mechanism

The Launching Mechanism is used to launch the frisbee.

- Ensure that the hex shaft connected to the arm is **not** connected through a hex bearing
  - The hex bearing should only be placed on the base plate
  - Allows for movement of the arm to be directly correlated with the hex shaft movement
- Ensure that the launching arm is straight
  - Helps with launching the frisbee at a reasonable angle
  - It is ok if it bends up or down a little

## Spring and other attachments

The Spring is used to store the energy gained from rotating the gears and releasing it for launching

- The spring should be attached to the arm and to the base plate
  - Ensure that string attachment is located in a reasonable spot that would cause it to stretch when the arm is winding back
    - If you are winding it clockwise then the left side of the arm at rest would work

- A string can be used on both ends of the spring
  - Helps for adjustment of power
  - Helps with not damaging the spring
  - Helps provide more linear tension on the gears
- A plate can be attached to the base plate for string attachment
  - Helps for attaching the string through tying
  - Allows for more linear tension when spring is stretched horizontally
- Bolts
  - Used to help reinforce the base plate
    - Refer to base plate diagram in appendix 1 for locations of attachment

## Wheelchair Mount

This section provides details on how to secure the **Launch System** to the wheelchair.

The launcher is secured to a tray-table-like attachment. This tray table is a piece of plywood that spans the width of the wheelchair. Two linear slides are bolted to the plywood and fastened to the wheelchair armrest via removable clamps.

Please refer to the device pin assignment charts

<table><tr><th colspan="2">Mushroom Push Button</th></tr><tr><td>+</td><td>DIG 13</td></tr><tr><td>-</td><td>GND</td></tr></table>	Mushroom Push Button		+	DIG 13	-	GND	<table><tr><th colspan="2">Robotics First Relay</th></tr><tr><td>GND</td><td>GND</td></tr><tr><td>FWD</td><td>DIG 2</td></tr><tr><td>REV</td><td>DIG 7</td></tr></table>	Robotics First Relay		GND	GND	FWD	DIG 2	REV	DIG 7
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## Wiring of Electronic Control System

The device operates on one battery and therefore needs to power both the arduino with all its attached parts and the motor. Figure 1 displays

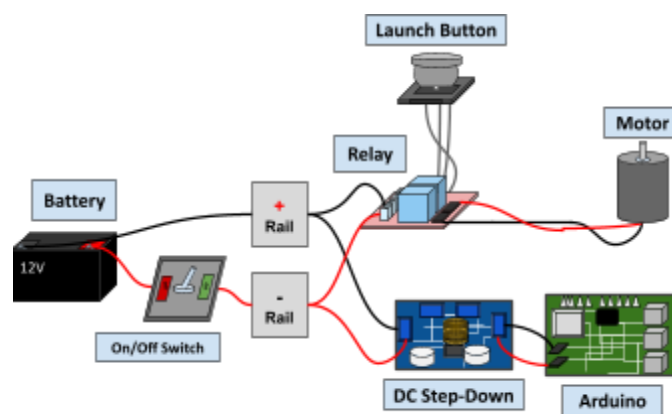


Figure 1: example electronic control system

## ECS parts description and tips

- Battery
  - The capacity of the battery should be at least 12 volts and 5 amps, however any battery close to that range or greater should suffice.
  - If you are using a battery with capabilities that exceed the one listed, ensure that the parts that you have can handle the correct number of volts and amps
  - The wiring for the battery should be run in parallel to the relay and the DC Step-Down (both ground and power)
- Relay
  - The relay listed is a relay H-bridge. This function allows the current of the relay to be reversed through programming or other means.
  - An H-bridge relay is not necessary for functionality of the build, however it can be used to help avoid jamming of the gears
  - The listed relay has 3 pins that can be used by an arduino to control the relay, with the rightmost pin being a ground pin, middle pin being the “Counter-Clockwise” pin, and the leftmost being the “Clockwise” pin.
- DC Step-Down
  - Make sure that the step-down has a capacity that can handle the output of the battery.
  - Adjust the step-down output to 5V as this is the amount of power that is going to be acquired by the arduino
  - Use glue or some other method to ensure that the step-down does not readjust itself
- Launch button
  - Implementation of the button can depend on the kind of button you use and small adjustments have to be made for different buttons
  - The button listed is a button that simply opens and closes a current (similar to a switch)
  - The button is attached to the arduino and **only** to the arduino, the arduino has an internal method that allows it to check for a current going through a specified pin
- Motor
  - The motor is to be attached to the output ends of the relay
- Switch
  - The wiring for the switch should be attached between the battery and one of its parallels in order to completely open the circuit when flipping the switch
- Secondary button
  - This button is optional and is not needed in order for the device to function, however it can be used to help avoid jamming of the gears.
    - An h-bridge relay is required for use of the button
  - Button should be connected to the arduino
    - Refer to pin assignment chart for specifications

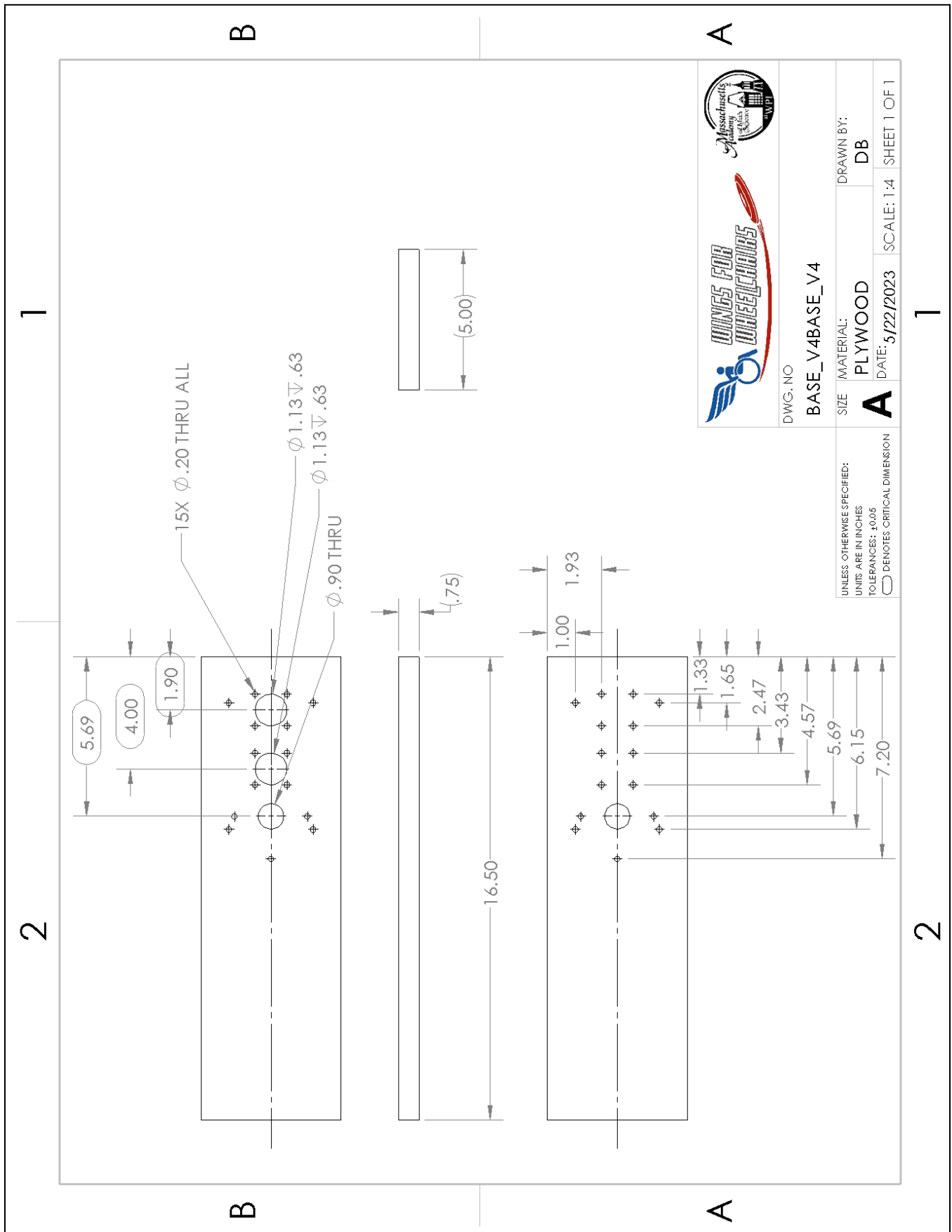


## Care and Maintenance

- Long-term storage
  - Do not store the device with the spring in tension
    - This can put prolonged stress on the gear which can cause it to break when used
    - The spring can stretch out losing some of its capabilities
  - Do not store in humid environment
    - A humid environment may cause the wood on the device to lose some of its strength
- Battery
  - Battery health may deteriorate over time
    - The battery may have to be replaced over prolonged use due to shortened life span of battery
    - View the battery's specific instructions for long term storage
- Wires
  - Wires may become damaged due to tension over time
    - If the electronic control system no longer works, be sure to check the devices system
    - Do not leave the wires in tension if tension occurs

## Safety Precautions and Warnings

- The devices moving parts may break and fly off as a result
  - Ensure that the gears are straight and aligned with each other
    - Gears undergo a lot of tension and may break if improperly aligned
  - Do not move into the arms range of motion
    - The arm is a fast moving part and can cause damage to any individual if you were to be caught in its motion
    - A shield can be used to prevent any extra movement caused by the launching of the device
  - Do not look at the device at eye level when testing
    - Small parts may break if improperly put together and can sometimes move at high speeds
- Ensure that the electronic control system is connected to each other correctly
  - A short circuit may occur with the devices if improperly attached to each other
  - If there is any sign of a short circuit turn the device off immediately and test with a multimeter to find current through the devices
    - Keep the device away from water
  - Turn off the device when not in use



Appendix 2: Acrylic Top Plate Drawing

