

How to construct your own helicopter (huey-esque) anti-torque pedals

(with halls sensor).

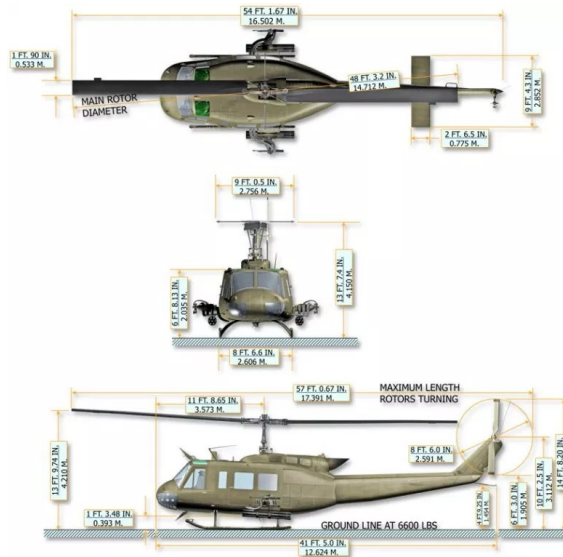
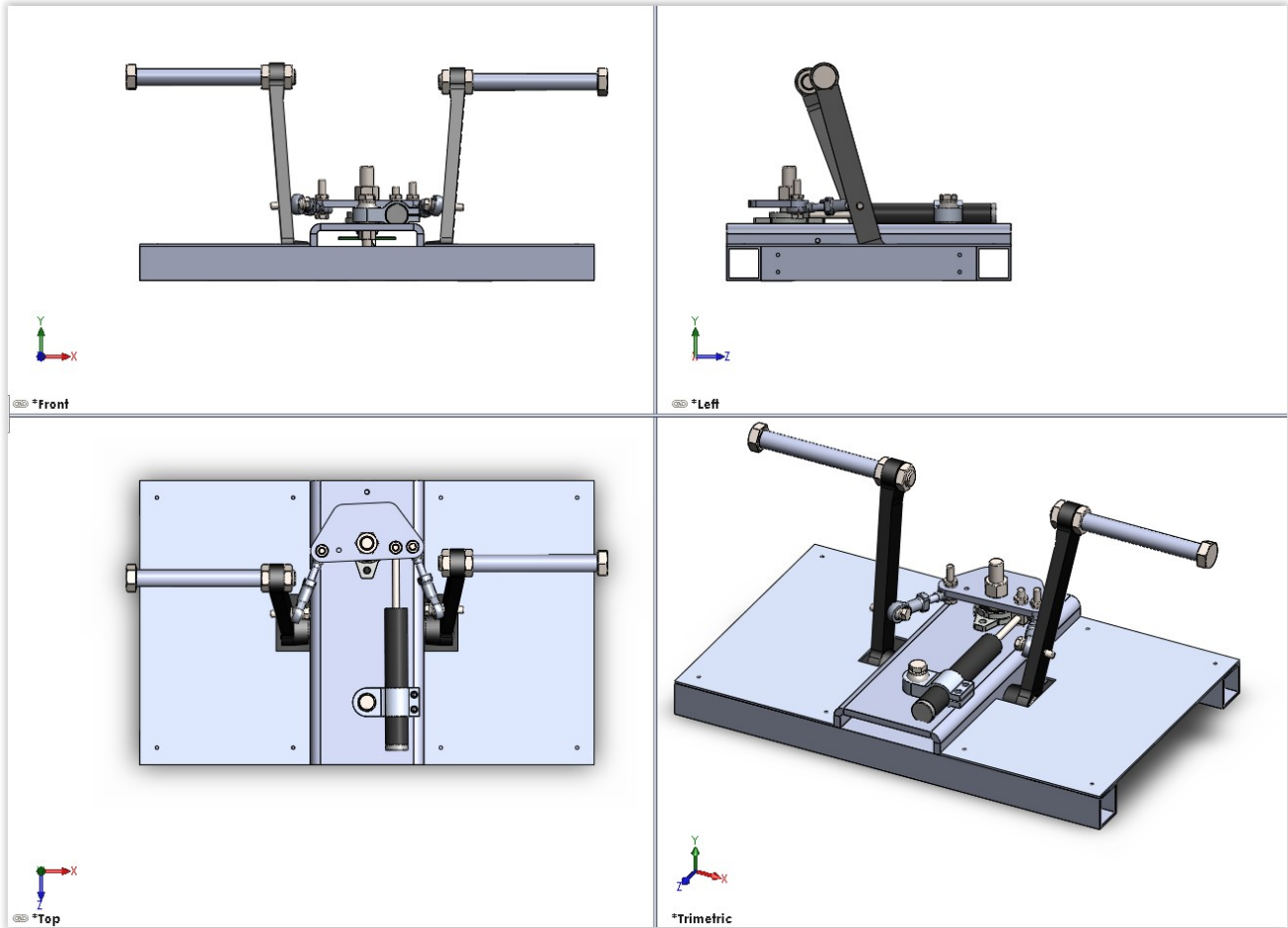


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Aim:

this project was undertaken in order to replace my inadequate retail pedals and their shoddy analogue potentiometer performance with a set of reliable, robust and accurate pedals

But not a chance in hell was I going to fork over US\$500, just not going to happen.

Overview

Design:

Bicycle cranks formed the main aspect of this concept, looking at a set of huey pedals constantly reminded me of bicycle crank arms. I sourced some aluminium stock that was suitable for the framework and started drawing up the design, as I was building the pedals, a few instances occurred where I had to simplify the construction process and I was always mindful of keeping the build as straight forward and simplistic as possible, the most basic of tools only & everything had to be readily available.

Cost:

Aluminium material ~AUS\$50<\$75 if that
Bolts ~AUS\$25<40
Dampener ~AUS\$40<50
Pro Micro ~AUS\$30 for 5 units
TLE5010 ~AUS\$12<15

Estimate between ~AUS\$150 <\$200 max (only if you don't shop around)

Tools:

You are going to need some basic tools, I kept this assembly as simply (&therefore somewhat ugly) as possible, so that even the most challenged at hands-on, might have a chance.

I have listed the base set of tools, the recommended option and an optimal (lucky bastard that owns everything)

Basic requirement	Recommended	Optimal
Drill	Bench Drill	Vertical mill/drill
Clamps	Vice	Transitioning flatbed, w/hold downs
Hacksaw	Angle grinder(with cutting disks)	Vertical mill
Metal files	Angle grinder(with grinding disks)	Vertical mill
Shifter	Spanner/Socket set 22mm, 21, 19, 10mm	Spanners/Ratchet with 22mm, 21, 19, 10mm sockets
Phillips head Screwdriver	Phillips head Screwdriver, Tek gun	Phillips head Screwdriver, Tek gun
Square	Square	Square
ruler	Ruler, callipers	Ruler, callipers
pencil	scribe	scribe
Hot glue gun	Hot glue gun	Hot glue gun
	Metric thread tapping set	Metric thread tapping set
Assorted metric drills	HSS Metric drill set, centre drill	HSS Metric drill set, centre drill
Hammer and large nail	Hole punch and hammer	Vertical Mill with DRO
A friend who can solder	Solder iron	Solder iron workstation

Aptitude:

Along with the tools, you will require some basic skill sets in using them safely (ie: without severing any appendages -

Note: I am not liable for your inability to use a tool (without doing yourself harm).

Same goes for soldering - if you burn a hole in yourself, that's called Darwinism

Stock:

I chose aluminium as the material of choice, unlikely to break like plastic, a little easier, (but far messier) to work with than steel and cheap / light enough to suit the purpose.

You could just as easily use steel if you prefer, but would need to adjust all measurements based on the stock sizes available.

The stock required is as follows (sourced from 'Action Aluminium' in Dandenong Victoria)

- 1 x section of structural aluminium C channel section
(100mm wide x 50mm deep x 6mm wall thickness)
x 250mm length (I made mine at 250mm, you may prefer yours slightly longer ~300mm)
x 250mm length (I made mine at 250mm, you may prefer yours slightly longer ~300mm)
- 1.5m x 30mm box tube
(30mm wide x 30mm deep x 2mm wall thickness)
2 x 400mm lengths
2 x 190mm lengths
4x 30mm lengths (cut in half to make 8x right-angle brackets)
- 100mm x 30mm x 50mm x 6mm flat bar
(6mm thick for rigidity x 100mm long x 50x50mm for shaping - this is the pivot plate.)
Have a look in the offcut bin of your local aluminium supplier, you'll probably find a suitable piece there
- 250mm x 150mm x 2mm thick aluminium checker plate
(2 pieces required - 1 sheet of at least 250mm x 300 required)

Components:

I tried to use as much off the shelf components as possible and as many readily available items as possible

- 2x left hand bicycle cranks (must be LH - as RH cranks have the main cog sprocket attached). ebay
- 2x Push pull rod ends (sourced from ebay)
- 1x adjustable dampener (sourced from Aliexpress)
- 1x 12mm collar bearing (sourced from ebay)
- 15mm curtain rod, 2x lengths of ~110mm
- TLE5010 magnetic angular sensor (kit incl: mounting nuts, screws and magnet) (sourced from Aliexpress)
- Pro Micro ATMEGA32U4 HID USB device. (sourced from Aliexpress)
- USB panel mount to micro-USB cable (sourced from Aliexpress)

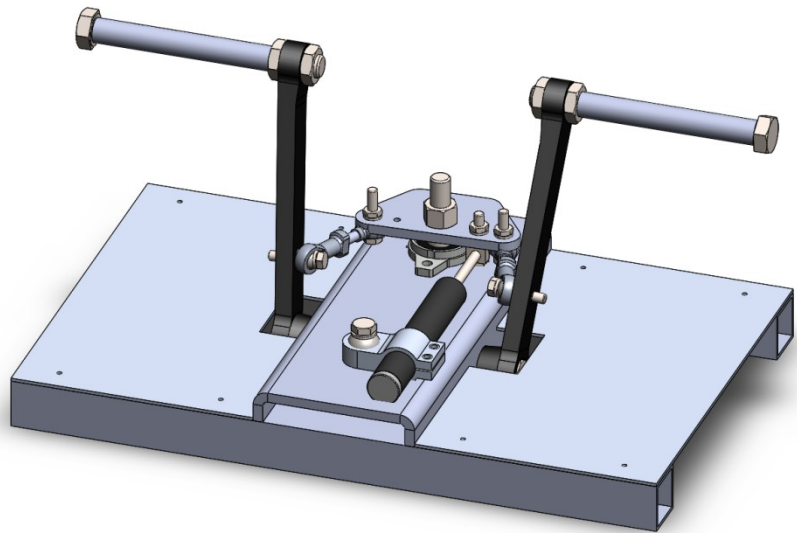
Fasteners:

- 2x M14 x 150mm bolts
- 2x M14 x 50mm bolts
- 2x M14 standard nuts
- 4x M14 Nyloc nuts
- 6-8x M14 washers
- 1x M12 hex head bolt
- 1x M12 nyloc nut (note: NO M12 washers required)
- 5x M6 x 30mm bolts
- 5x M6 nyloc nuts
- 8x M5 x 15mm screws
- 8x M5 nyloc nuts
- Metal Tek screws x ~25+

Walk Through

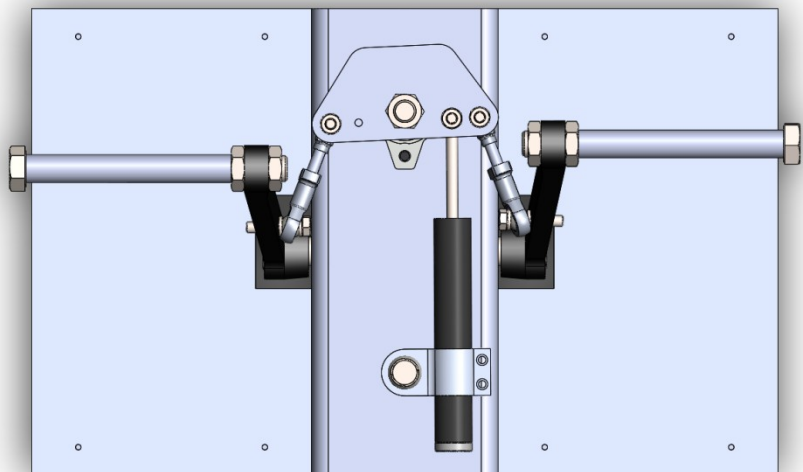
Perspective view:

She's not likely to win any beauty contests, but she's built to last and fully functional



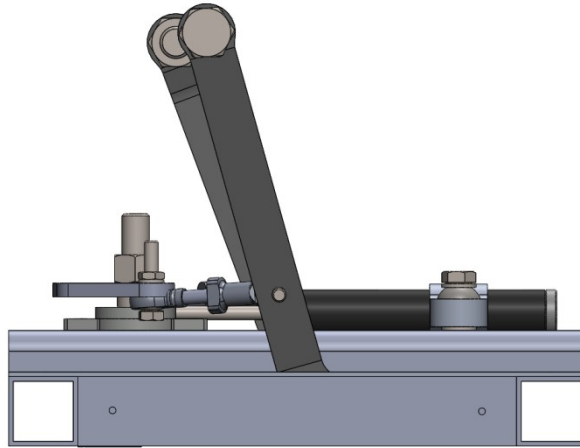
Overhead view

pedals, single dampener and pivoting plate, collar bearing can be seen orientated in a north/south alignment



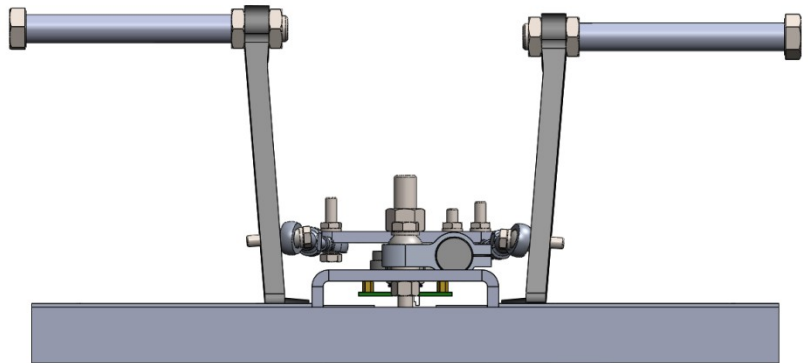
Side view

Showing the collar bearing and clearance under the pivot plate for the control arm rod ends and the adjustable dampener arm



Front View

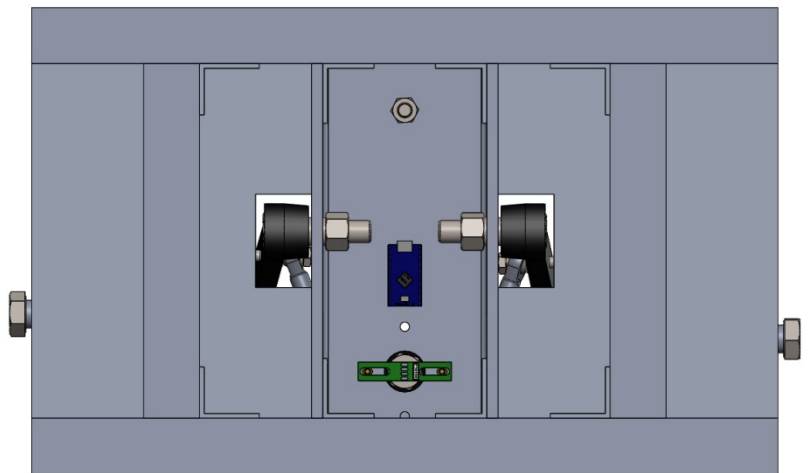
From this view the electronic sensor can be seen, located underneath the main structural centre beam, providing maximum protection from being stomped on.



Underside view

depicting the TLE 5010 sensor, the Pro Micro MMJoy2 flashed HID USB card and the pedal pivots and floor plate cutouts, along with the supporting struts that prevent the floor plate from sinking.

Note the 2 additional north south beams down the centre of the foot locations to provide additional support under the checker plate floor panel and avoid it sagging from excessive weight/foot pressure.

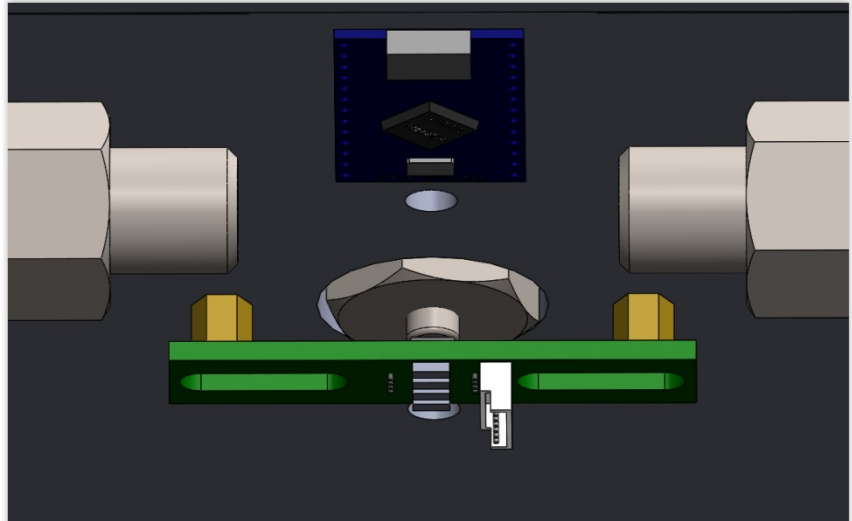


Sensor mounting

The placement of the TLE5010 sensor directly above the magnet centrally located on the pivoting bolthead (attached directly to the collar bearing and pivot plate)

If using a hex head bolt you will need to drill a small recess hole to prevent the magnet from displacing, this will need to be drilled perfectly central, (really only achievable by spinning up on a lathe).

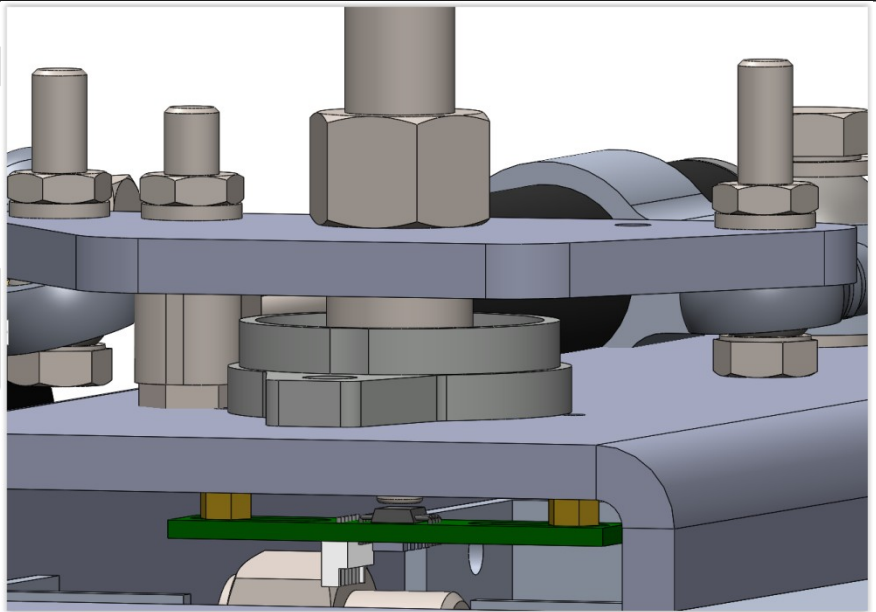
A cap head bolt would allow you to utilise the hex recess to place the battery centrally and readily recessed.



Sensor clearance

Here you can see the clearance (approx 0.5mm) between the magnet & the sensor

Also the collar bearing on top of the main body, holding the pivot plate spacing for the rod end connectors to fit in snugly underneath, Note: no washers on the M12 pivoting bolt.



Fabrication

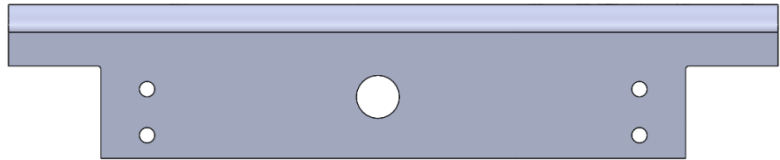
Lets begin with the centre beam

Centre Beam

Ideally when you purchase this stock, ask them to cut it to length for you

Then all you have to do is cut out the step overs and drill all the holes

Optimally this should be done in a drill press, but can be drilled by hand.

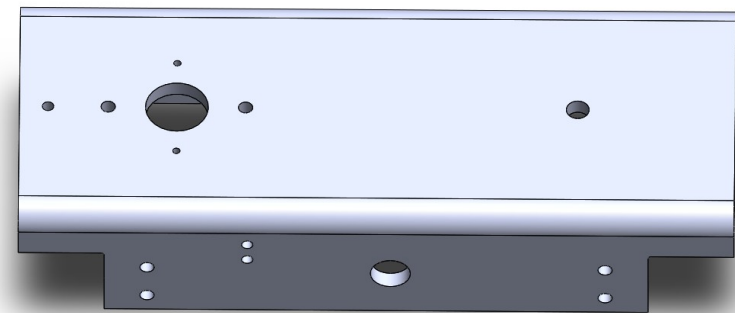


Measure carefully and double check all your workings, take special note of drill sizes for each hole

Take note of holes that only occur one one surface, not both side walls

Measure twice - cut/drill once

Ensure all holes are bored at right angles to the surface



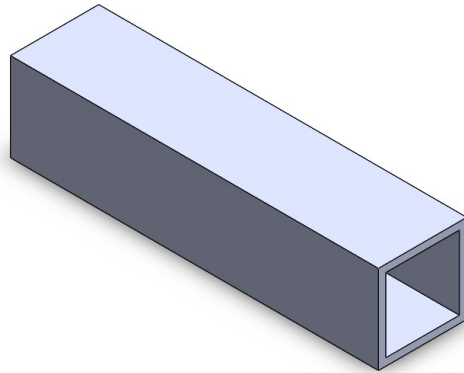
Now for the brackets

Brackets

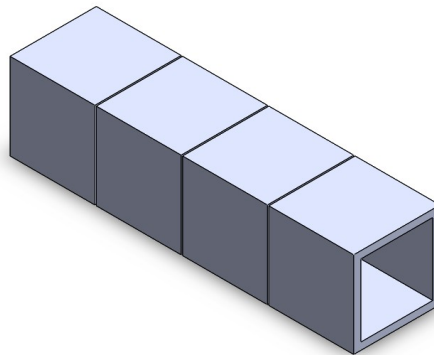
Take a section of around 120mm box tube

This will depend on the width of the square section, my production was with 30x30mm

So I need 4 x 30mm sections plus a few mm extra for the blade cuts. (~125mm total)



Cutting 4 sections so that I have 4 x cubes effectively (less 2 sides)
Equal dimensions



DO NOT CUT THE CORNERS ON A 45 deg ANGLE!!!

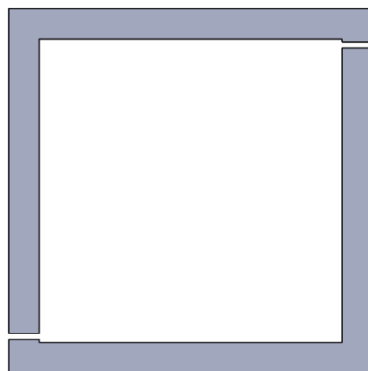
This will give you super sharp edges and your bound to cut something important

Instead, cut along the internal wall on opposite sides as indicated here

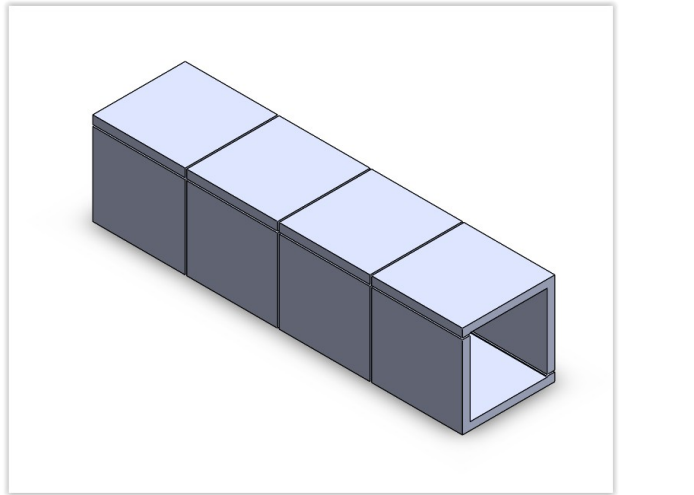
This will result in brackets that are 30mm at the base and ~27.5mm on the wall

Cut as close to the internal wall as possible without cutting into it

This will reduce the amount of effort required with the file to deburr and cleanup



We need 8 brackets in total, so 4 cubes cut in half, we're all done

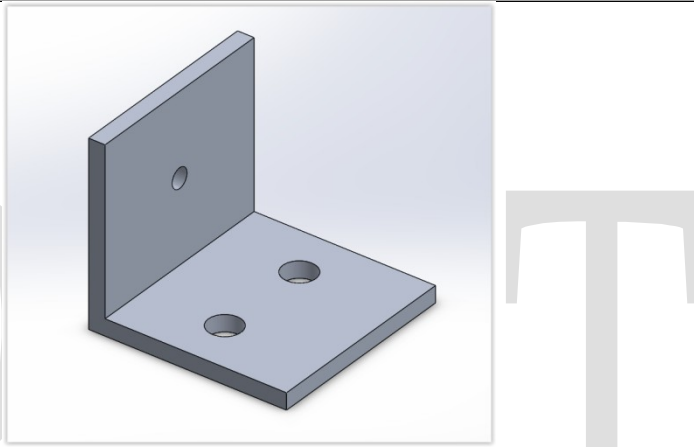


On each bracket multiple holes are required (DON'T DRILL THESE YET)

2x holes in the base to prevent the bracket from twisting

1x hole in the wall to secure the attaching part

Drill this only whilst clamped to the piece they will be attached to to ensure alignment



Now lets move onto the cross beams and support beams

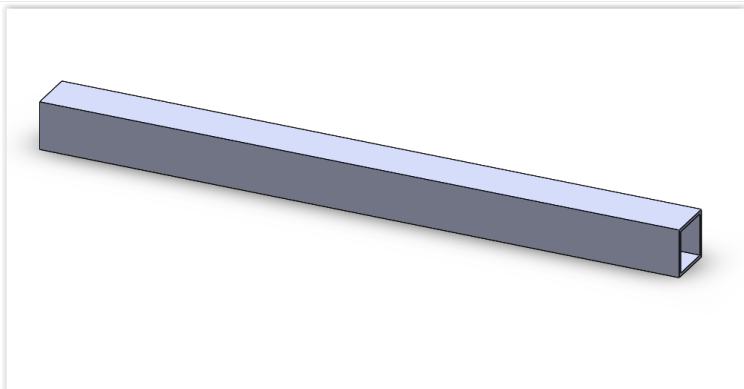
Cross Beams

We need to cut 2x 400mm lengths of 30x30mm square tube

Always clamp the piece in a vice to cut

Ensure your measurements are accurate

Always mark the cut line around the box tube with a set square so you always have a reference cut line as you rotate the piece in the vice or clamp



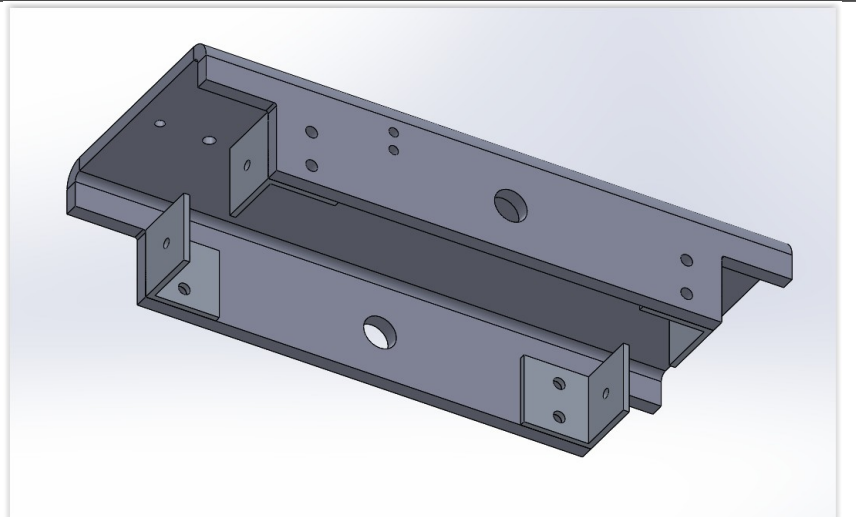
Clamp and drill the brackets to the centre beam

Drill the holes through both parts whilst clamped together flush

Ensure brackets are square to the centre beam ends.

Mark each bracket # 1 - 4 and notarise in the corner of the centre beam so that each corner is numbered to the corresponding matching bracket so that the holes will match perfectly.

Secure brackets to central beam with M5 x15 scerws and nyloc nuts



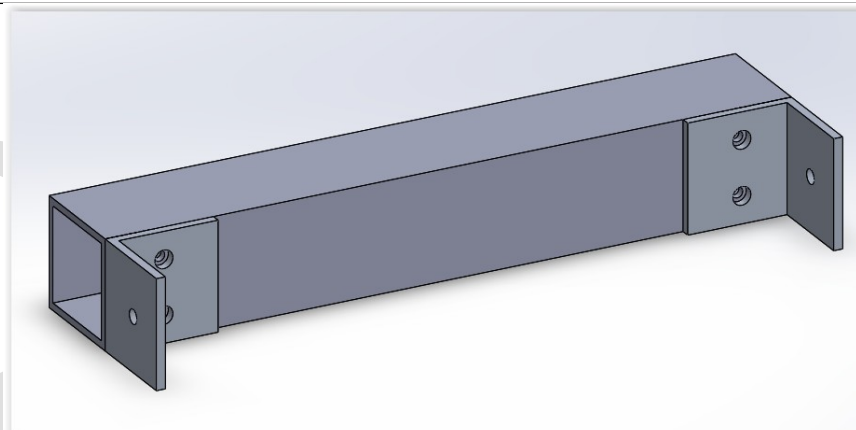
Clamp and drill the brackets to the supporting beams

Drill the holes through both parts whilst clamped together flush

Ensure brackets are square to the centre beam ends.

Mark each bracket # 5 - 8 and notarise on the end of each support beam so that each end is numbered to the corresponding matching bracket so that the holes will match perfectly.

Secure brackets to support beam with 2x Tek screws to prevent pivoting



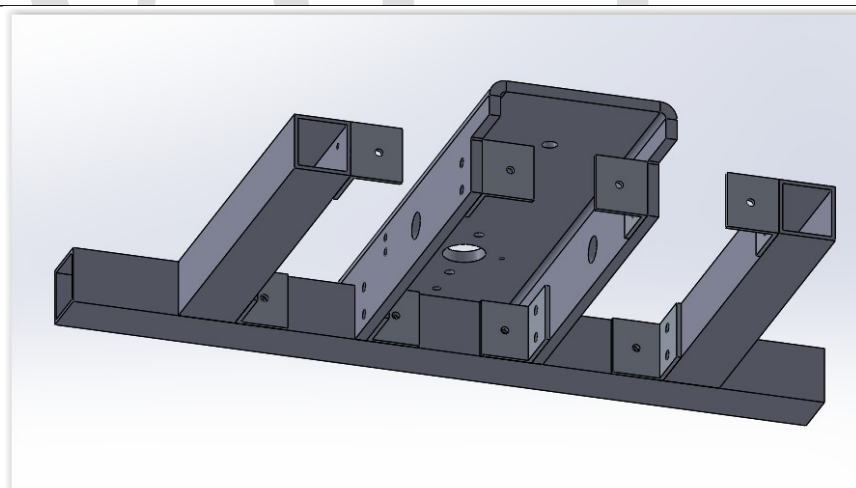
Clamp & drill four holes in the one side of the cross beam to attached to the main beam section and support beams to the cross beam

Drill the holes through both parts whilst clamped together flush

Ensure brackets are square to the cross beam and support beams.

Mark each hole and notarise on the end of each support beam so that each hole is numbered to the corresponding matching bracket so that the holes will match perfectly.

Secure each bracket to the cross beam with a single Tek screw

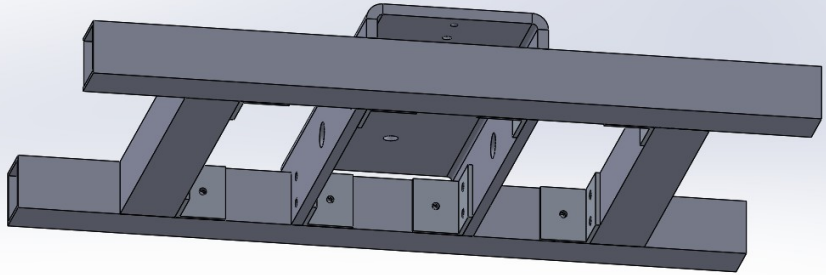


Repeat the process with the second cross beam

Clamp & drill four holes in one side of the second cross beam to attached to the main beam section and support beams

Clamp, Drill, number, secure

Secure each bracket to the cross beam with a single Tek screw

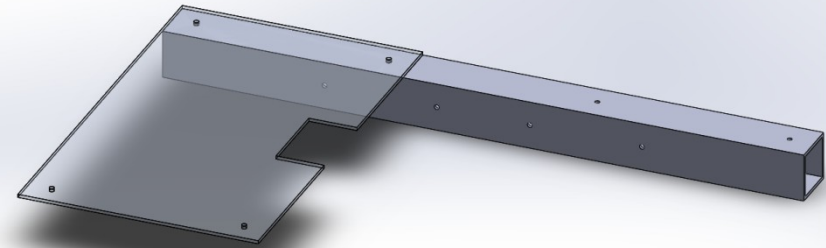


*** DO THIS LAST**

4 holes drilled on top are for securing the floor plate to the crossbeams

This will help keep hold everything square

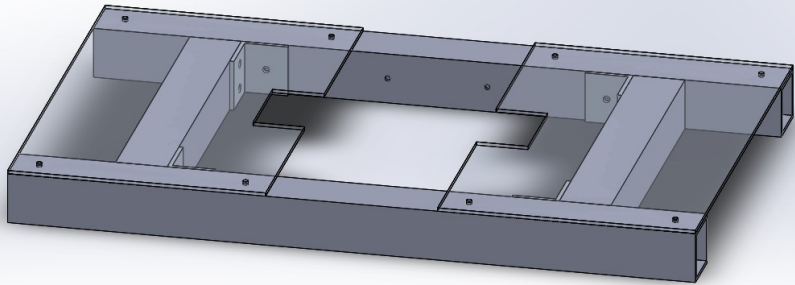
Recommend clamping the floor plate to the cross beam, Measure & mark the holes on the floor plate and drill both at the same time whilst clamped together flush.



Once assembled, we will now remove the central beam from the base frame

You can attach the floor panels now if you wish or leave them till the end (recommended), so you have more room to work with.

Secure with tek screws



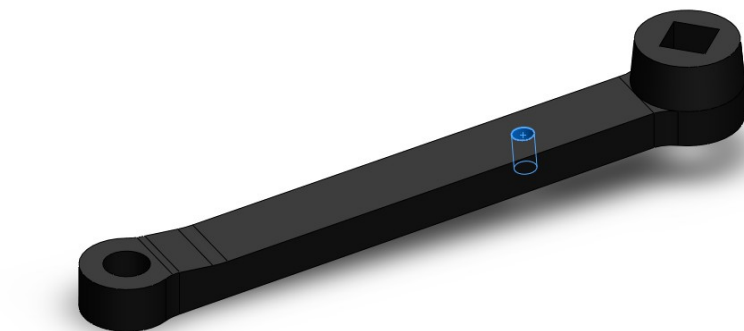
Pedals

The Pedal Cranks require a single hole to be drilled to facilitate the rod ends connectivity to the pivot plate

Clamp and Drill or place in vice and use bench drill if available

Drill at right angles to the pedal shaft as the rod end bearings will allow for the angle

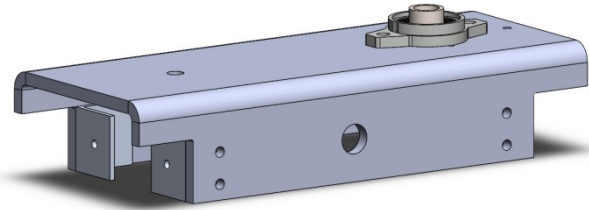
secure with M6 x 30mm button head or countersink head screws with nyloc nuts



Assembly - central beam

Collar Bearing

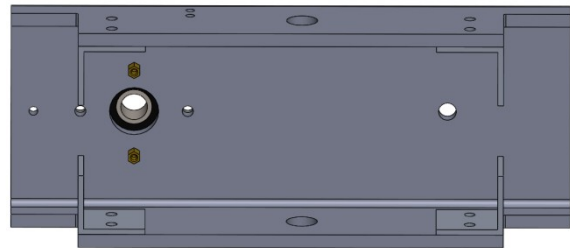
Secure the collar bearing in place on the central beam use countersink head M6 x 30mm screws and nyloc nuts



Insert the hex spacer nuts for the sensor on the underside of the central beam

*this are a 2.5mm drilled hole
then tapped with a 3mm metric thread tap*

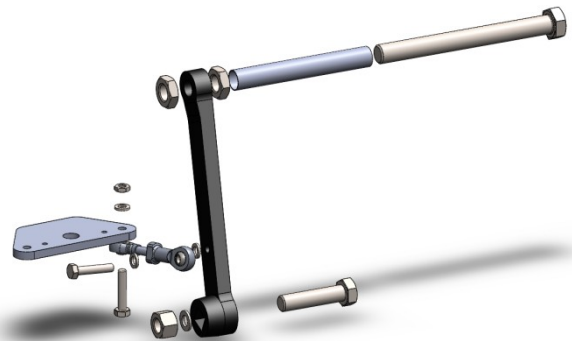
*you could always drill these out with a 3mm drill and use
M3 screws with nuts on both sides to secure and act as
spacers*



Pedal Assembly

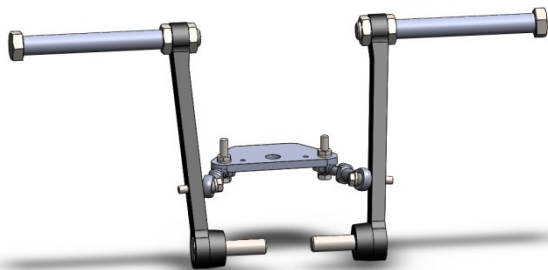
Assemble a pedal and attach to the pivot plate

secure rod ends to pivot palte with M6 x 30 bolts and nyloc nuts



Assemble the second pedal and attache to the pivot plate

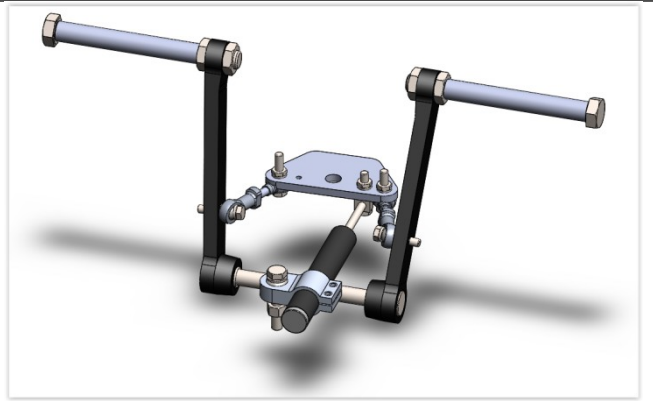
Note: once the pivot plate is secured to the collared bearing, you wont be able to get the bolts to secure the rod ends into place



Assemble the adjustable dampener

Attach the dampener to the pivot plate.

Note: as per the pedal rod ends, once the pivot plate is secured to the collared bearing, you wont be able to get the bolts to secure the dampener rod end into place

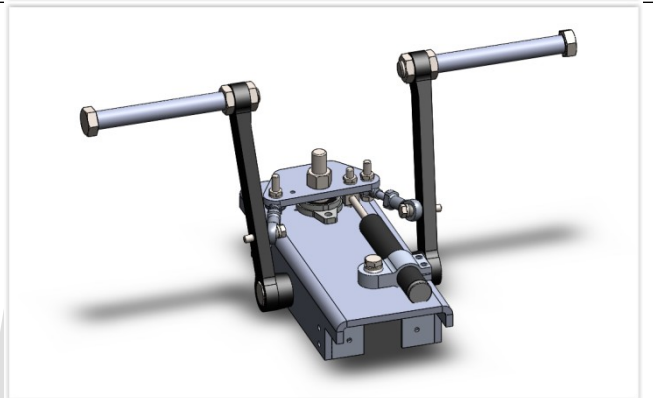


Secure the pivot plate to the collared bearing

Note: NO washers, the pivot bolt and pivot plate are hard up against the collar bearing shaft

Secure the pedals to the central beam
(use washers)

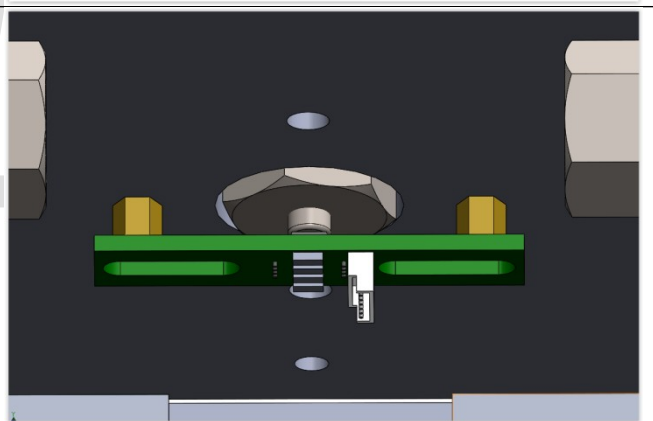
Secure the adjustable dampener to the central beam
(use washers)



Magnet placement

Attach the magnet to the recess located in the centre of the pivot bolt

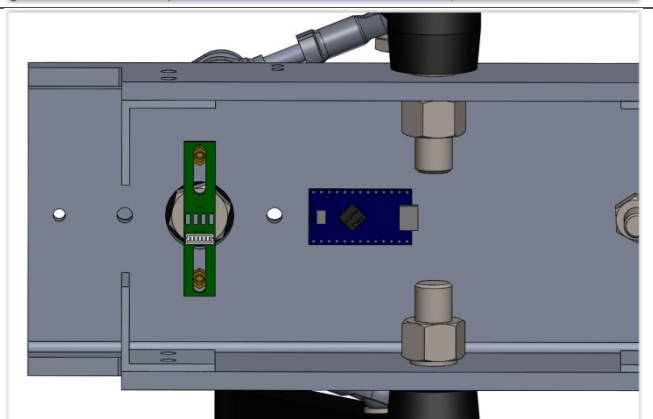
Attach the hall sensor to the central beam underside, via the hex spacer nuts



Install the Pro Micro

Secure the Pro Micro (MMJoy) HID USB board to the underside of the central beam

Use the Hot Glue Gun a small blob in each corner is suffice



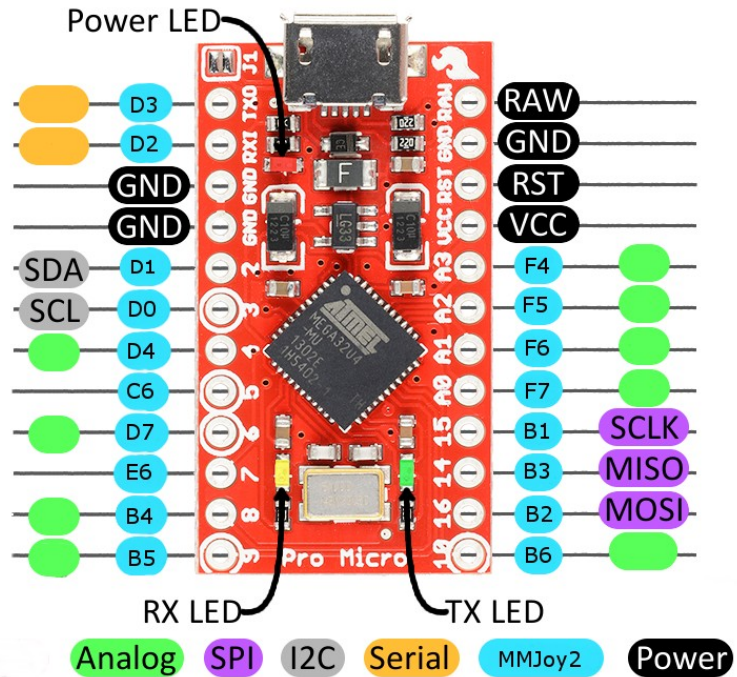
Electronics

Soldering the TLE5010 sensor cable to the Pro Micro

For simplicity the following diagram provides the pins and their assignments

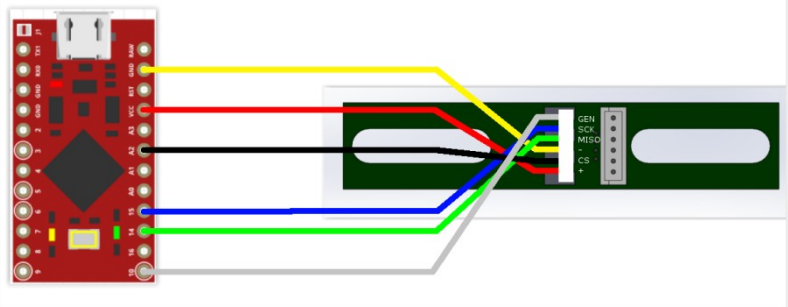
We will utilise the following pins (all down the right hand side)

- GND
- VCC
- A2/F5 (any pin can be used except GND/RST/RAW)
- 15/B1(SCLK)
- 14/B3(MISO)
- 10/B6



Solder the wiring connector supplied with the TLE5010 sensor to the Pro Micro (MMJoy2) HID USB board as illustrated:

Func	Wire Colour	Pro Micro Pin
GEN	White	10 (MMjoy B6)
SCK	Blue	15 (MMjoy B1)
MISO	Green	14 (MMjoy B3)
-	Yellow	GND
CS	Black	A2 (MMjoy F5)
+	Red	VCC

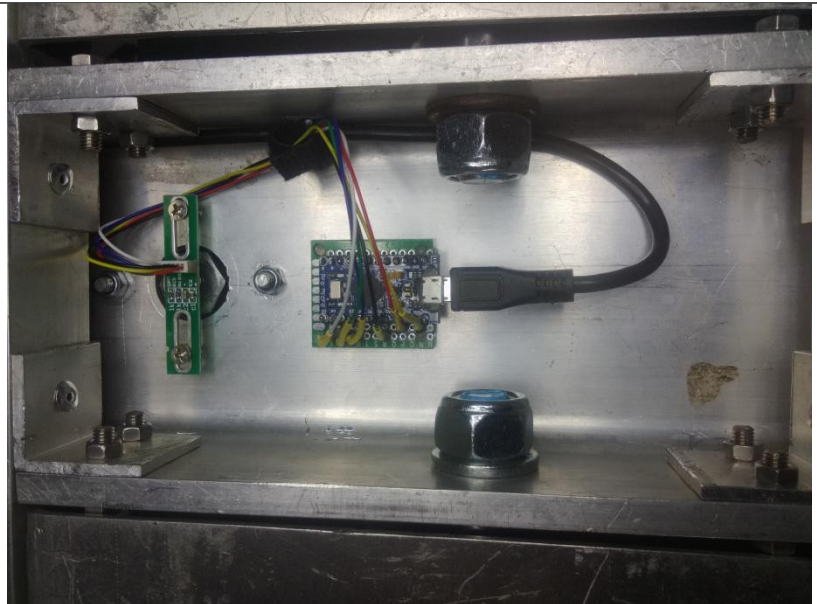


Run the wiring to the connector

Run the USB panel mount to micro USB cable to the Pro Micro (MMJoy2) HID USB board

Use cable ties via the small holes to secure the cabling in place

Use double sided velcro for ease of removal or otherwise a small cable tie (inexpensive)



Run the wiring to the connector

Run the panel mount USB to micro USB cable through the gap between the crossbeam and the central beam

Use cable ties to secure the panel mount end flush with the end of the central beam with using the small hole

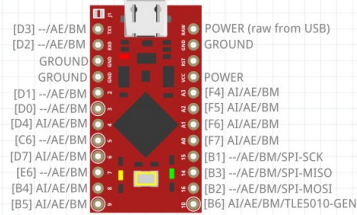
This will hold the connect USB cable flush against the end of the pedals and reduce the likelihood of damage (nothing sticking out)



Configure Pro Micro

The original diagram provided by MMJoy2

Sparkfun Pro-Micro pinout for MMJoy2:



Where "[XX] AI/AE/BM":
 [XX] - MCU ATmega32u4 pin name
 AI - available for Axis Internal ADC
 AE - available for Axis External ADC (SPI)
 BM - available for Button Matrix

MMJoy2 (c) mega_mozg.

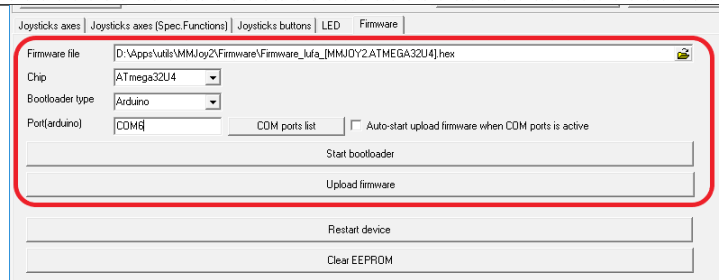
FREE. PERSONAL DIY ONLY. NOT FOR COMMERCIAL.

fritzing

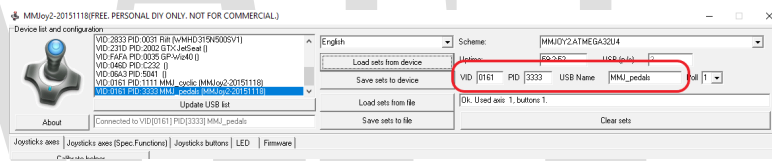
Flash MMJOY to board

Flash the firmware on the Pro Micro card in order to run MMJoy2 software

ensure you identify the correct COM port of the device and select the correct firmware file for ATmega32u4



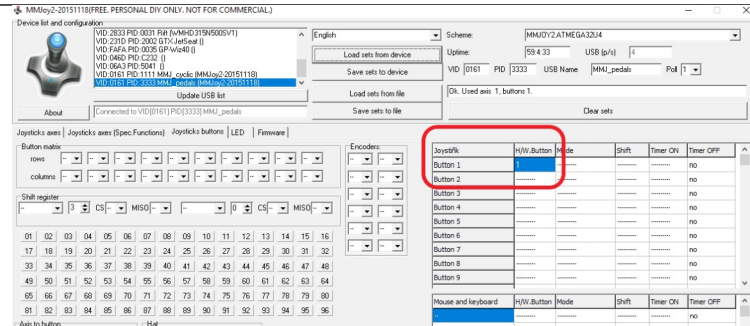
Configure the MMJoy HID boards custom VID, PID and USB name



Map Hardware button

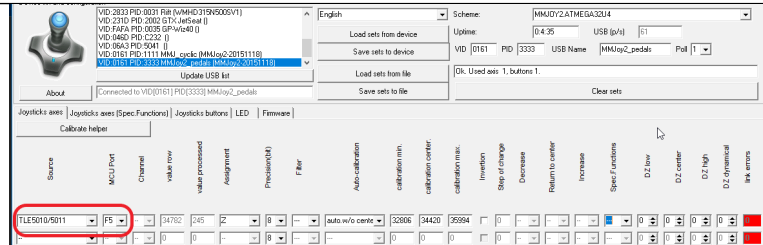
Configure a joystick button
Map HW button#1 to button#1

Note: essential so that the board will be recognised by windows as a game controller



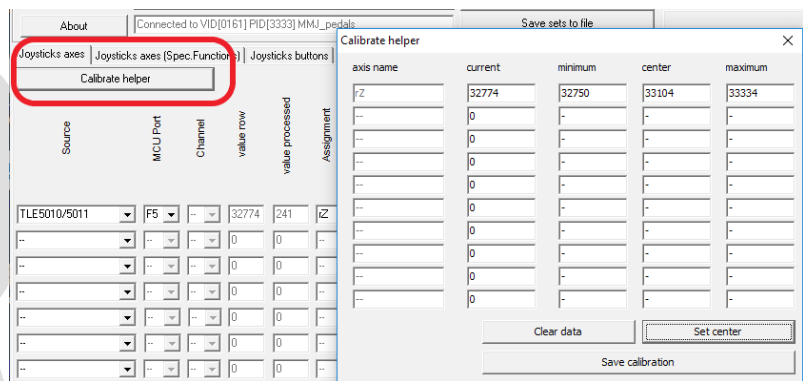
Configure Axis

Configure MMJoy2 to utilise the TLE5010 sensor

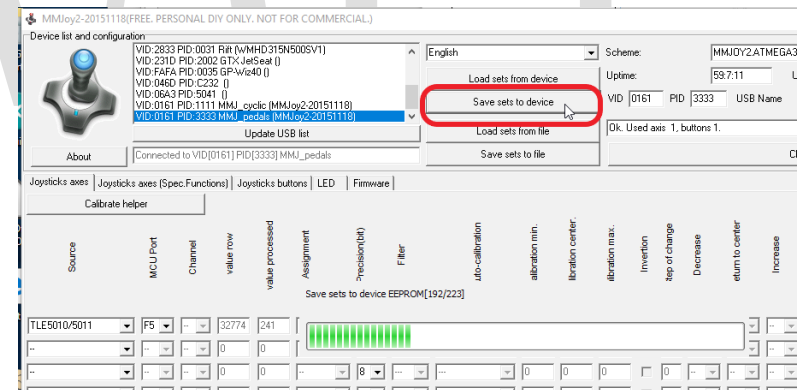


Calibrate Axis in MMJoy2

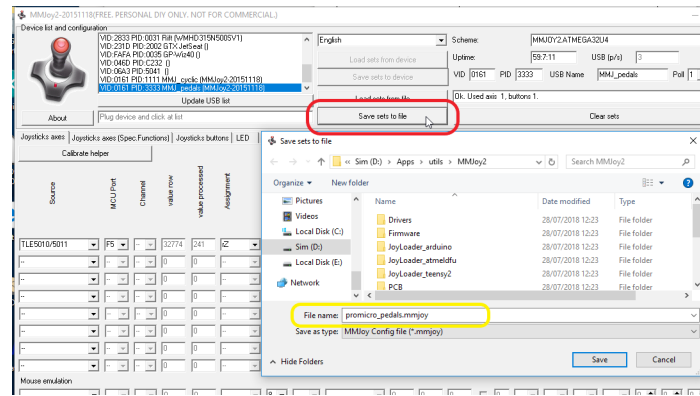
perform full left and full right pedal travel
set the pedals to the central position and
click on the center axis button



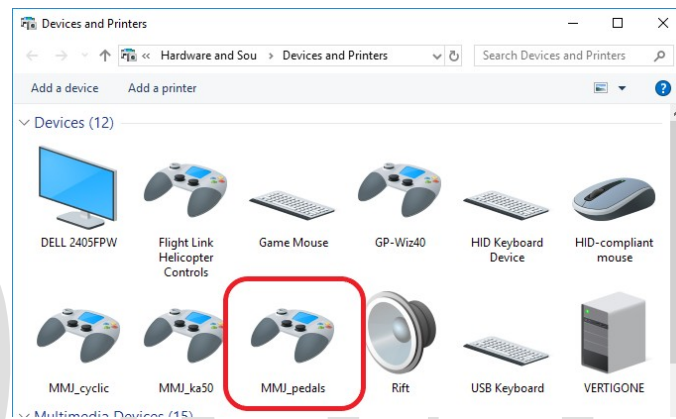
Save sets to the controller



Save sets to a file for backup

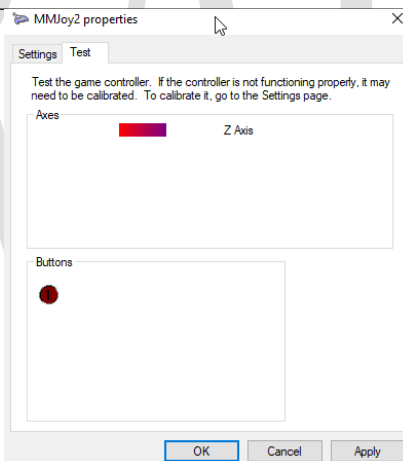


Confirm windows detects the device correctly



Windows Controller Calibration

Perform windows game controller calibration and test

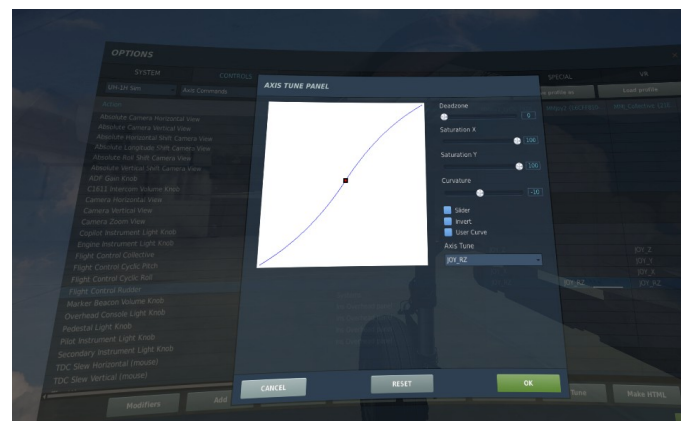


DCS: Axis Tune

Configure and tune the axis in DCS

note the halls sensor is quite sensitive and you may require to set curvature to suit your personal preferences.

(I have flown so long with crap pedals that I enjoy the ability to merely apply foot pressure and get a response, with barely any movement required).



Completion

Attach the central beam to the base frame

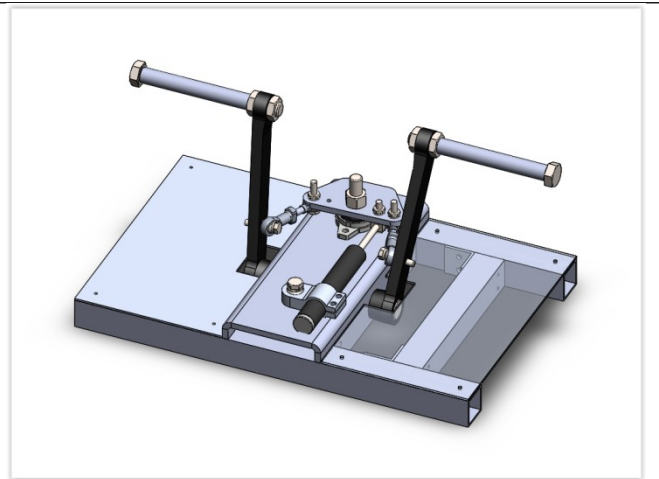
Once all configuration calibration & testing has been completed

Attach the floor plates to the base frame

Connect all cabling and test

Secure the pedals to the floor of your simpit or other location

enjoy



Sorry Lads – no toe brakes

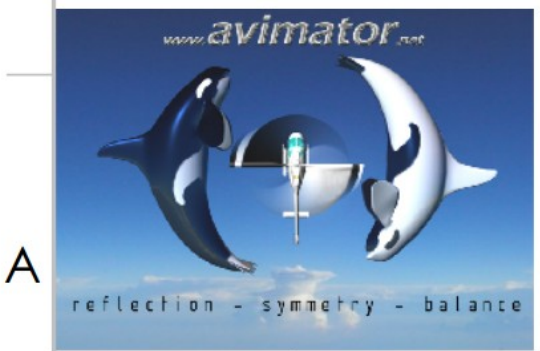
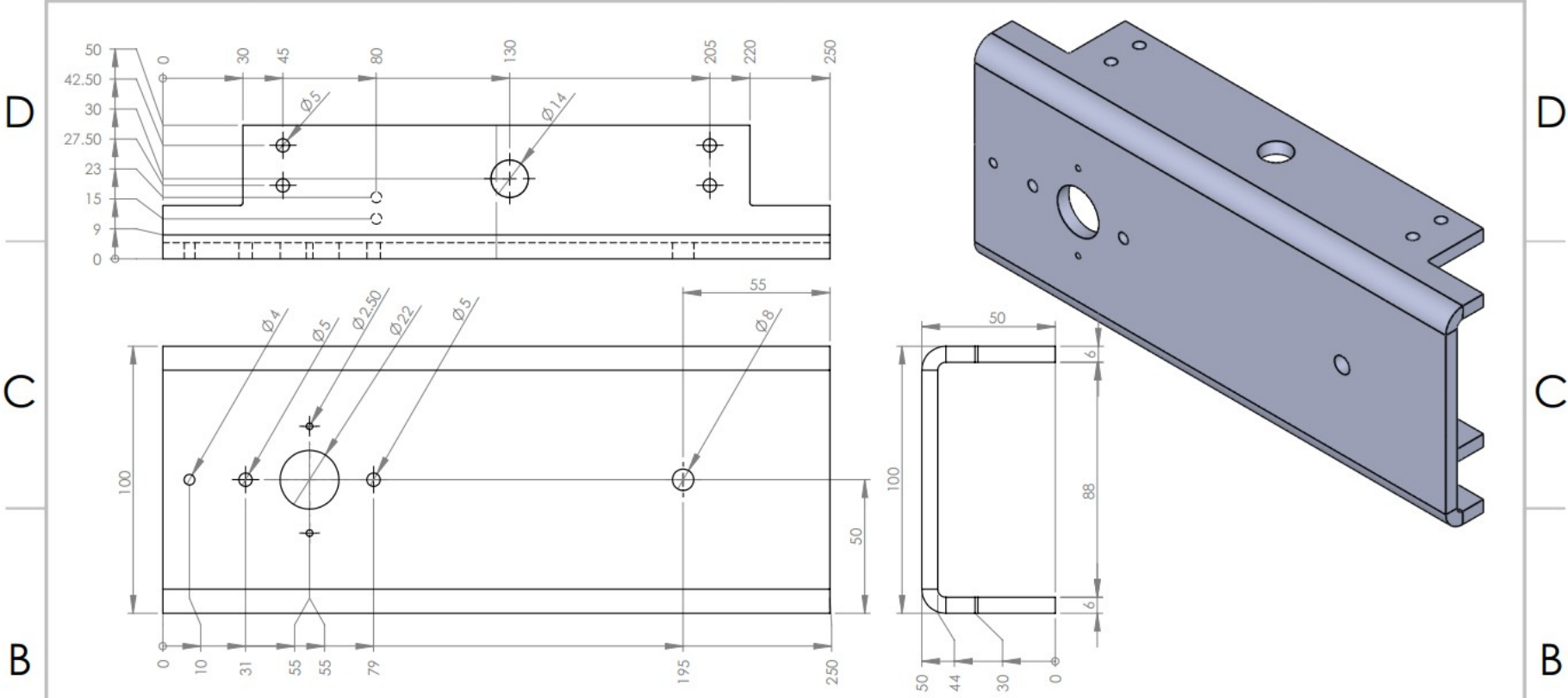
DRAFT

Appendices

Appendix A - Schematics

1. Dwg - Pedal Base Centre (Central Beam)
2. Dwg - improvised Bracket
3. Dwg - Pedal Base Leg (Cross Beams)
4. Dwg - Pedal Base Leg Spt (Supporting Beams)
5. Dwg - Pedal Crank (Pedal Crank)
6. Dwg - Pedal Pivot plate (Pivot Plate)
7. Dwg - Pedal Base plate (Floor Plate)

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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:				FINISH:	DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
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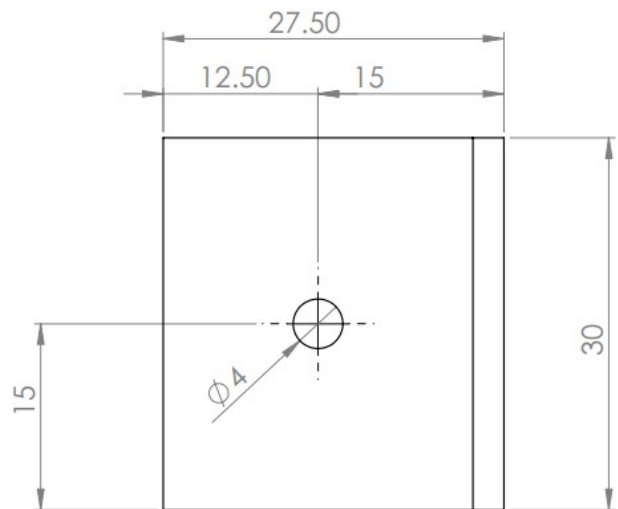
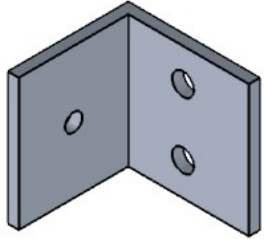
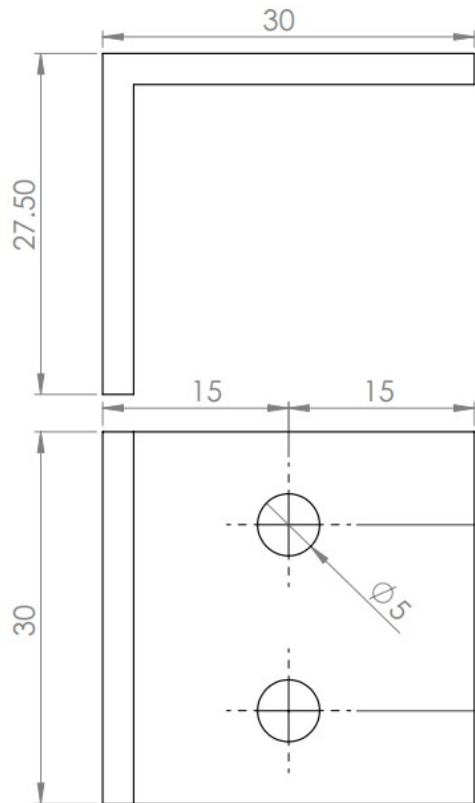
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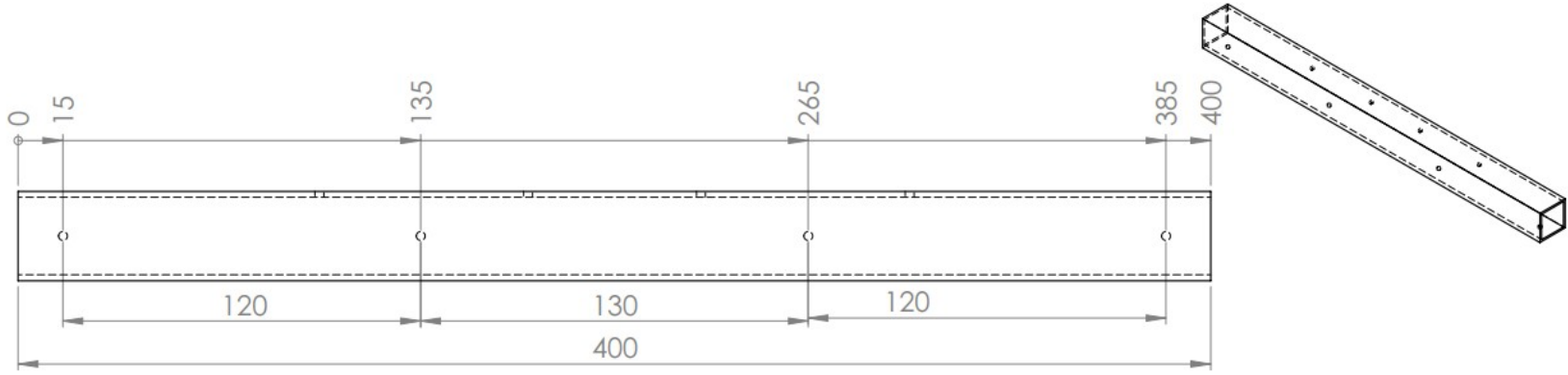
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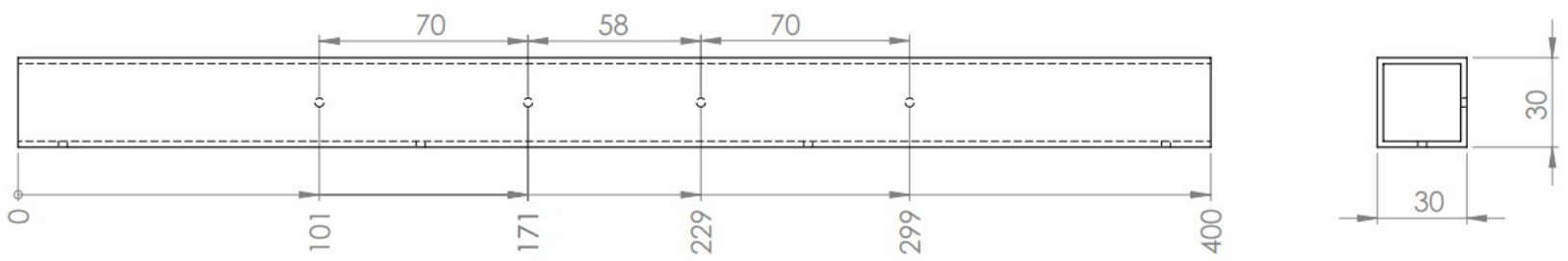
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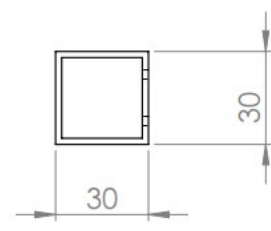
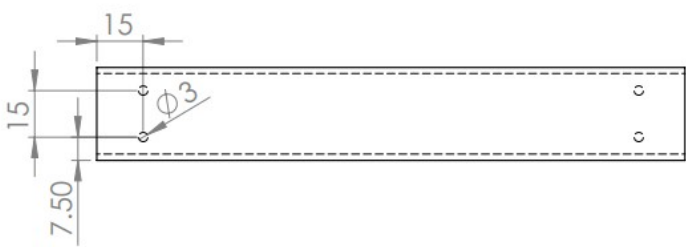
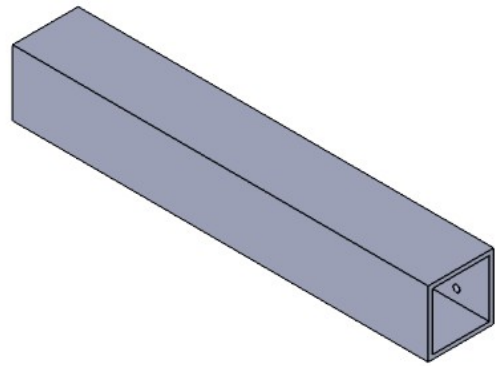
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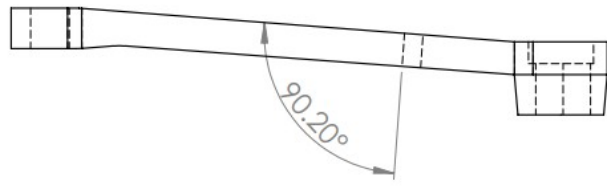
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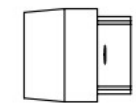
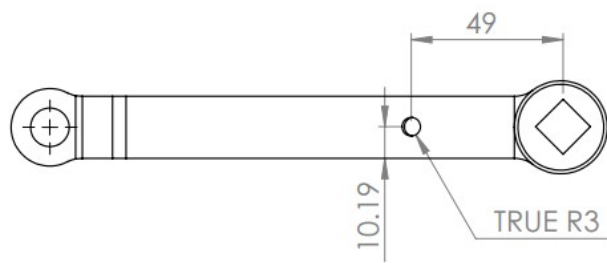
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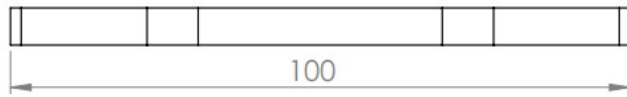
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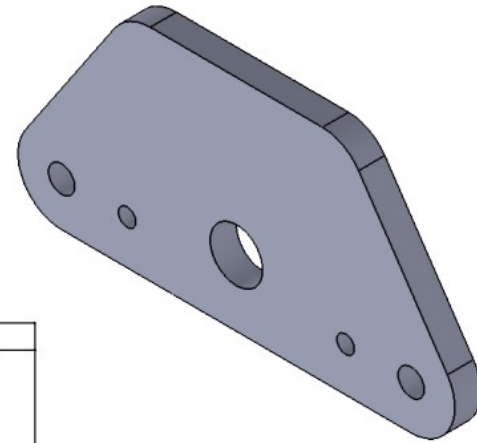
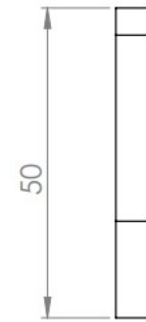
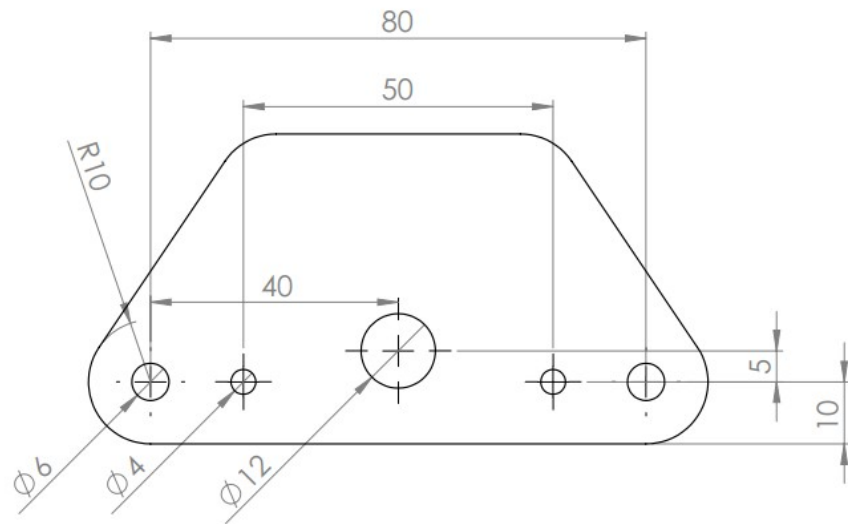
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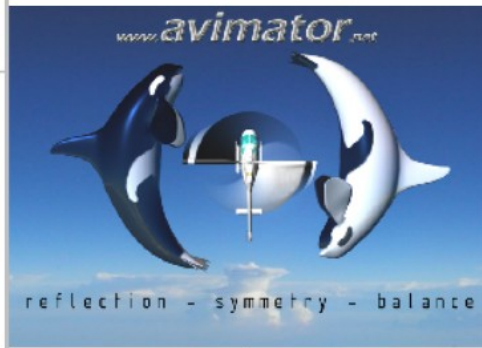


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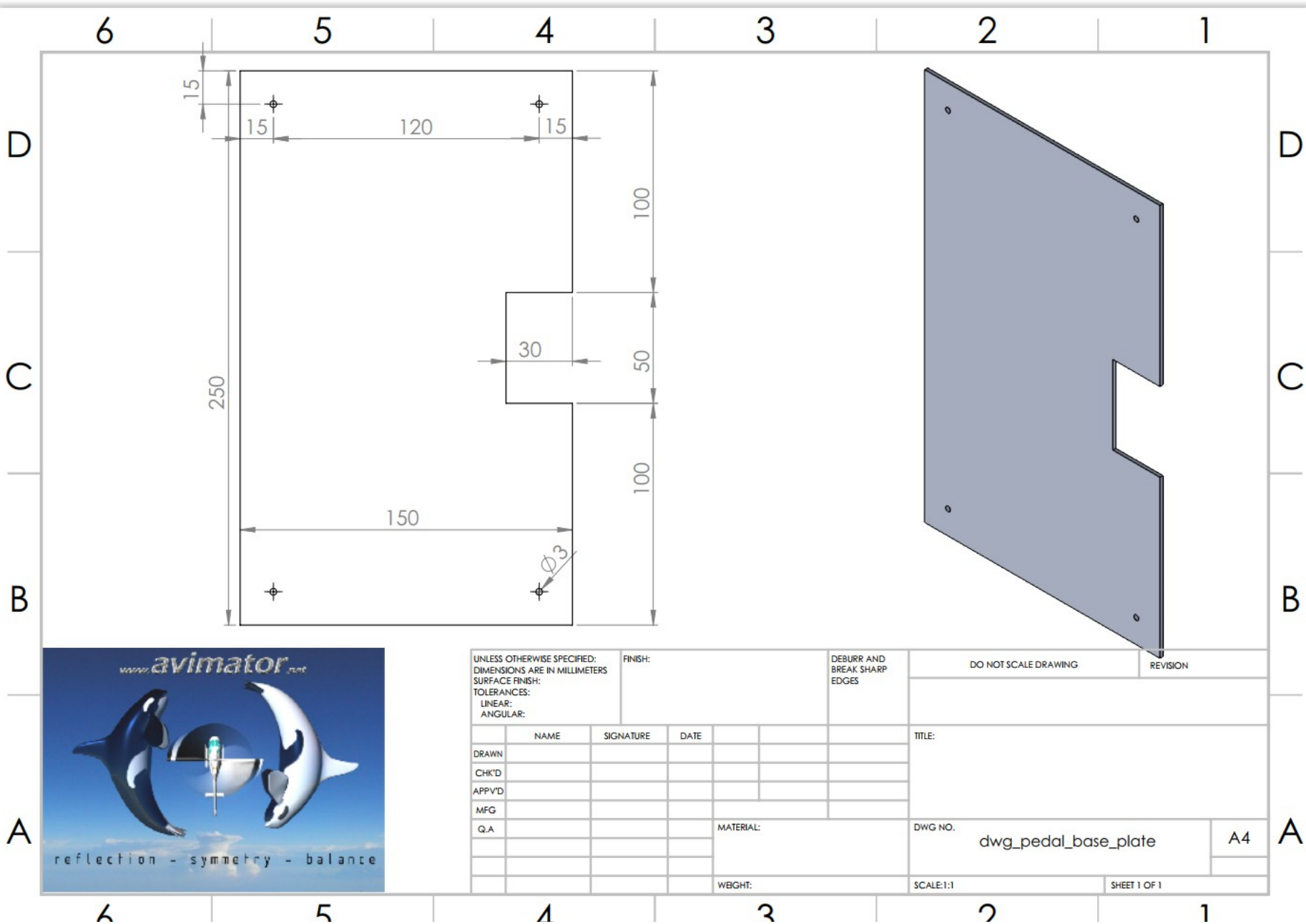
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