‘RED CHAIR’ Seat mover for FS2020/2024 flight - Nov 2024

The project was to build a small, movable and low cost motion sim for use with FS2020/2024 Flight Simulator and a Pico4 VR headset. It had to fit in my small study and push up to my desk so I could use my keyboard and joystick where they normally stayed. The ‘look’ wasn’t critical as I was playing using a VR headset.

Started off with a plain office chair with legs and armrests, attached a square wooden base to the underside of the chair with four screws, this gave a flat smooth surface under the chair seat to work with. The main ‘PIVOT’ is a ‘ball jointed levelling foot’ meant for levelling furniture.

The quoted load capacity (M8x40mm foot) was stated as 350kg/foot.

The base of the rig was made from 18mm plywood (18x700x600mm), with a centre support post of 100x100x350mm wood attached to the plywood (290mm from the front to center of the post) from underneath with four 90mm long wood screws. The height of the post was made to suit the chair, keeping the legs sufficiently off the base to allow movement but if overextended the legs contacted the base preventing any damage. This also meant I could sit on the chair when it was powered down.

A 6.5mm hole was drilled in the centre of the post and the levelling foot screwed down into it letting it cut its own 8mm thread with the ball jointed ‘foot’ facing up. A 50mm square washer and 8mm nut were used to ‘lock’ the foot into place on the post. This allowed some fine tuning of the final chair height (and therefore maximum movement before the chair legs contacted the plywood base).

A piece of 18mmx250mmx135mm pine with a centre hole 42mm in diameter was attached by rails to the underside of the chair on its wooden base, this was to locate the ‘foot’ under the chair, the exact position could be adjusted ± 50mm by means of an 8mm threaded rod pinned via a bracket at the rear end of the underside of the chair base.

The chair could now be placed onto the ball joint and an approximate balance point found.

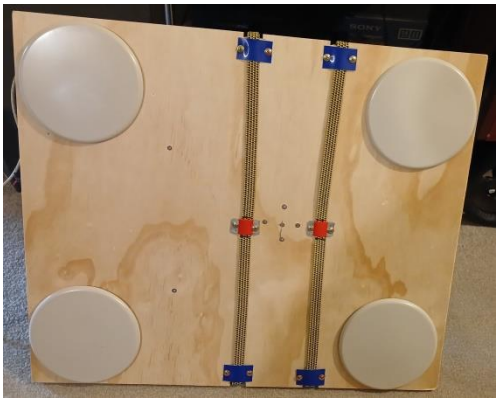
To stop the chair from rotating a piece of lino (250x250mm) was cut and two 10mm holes punched in the lino about 100mm out from the post centre on each side, the lino was then fastened to the top of the post (a slit cut to fit over the ‘foot’) with four screws. Two short pieces of 8mm threaded rod (70mm long) were fixed into the underside base of the chair so they protruded down about 50mm going through the holes in the lino and thus stopping the chair from rotating. The lino was still flexible enough not to interfere with the up/down and side to side movement. This enabled the chair to still be easily removed if required.

The two motors were fitted to the 20x100mm ‘L’ plates which were fastened to the plywood base using three 8g x 13mm wood screws. A similar ‘L’ bracket was used to mount the Hall Effect potentiometers so that the motor and potentiometer shafts were aligned. The Hall Effect bracket was attached to the base using stick on ‘Velcro’ to allow alignment flexibility.

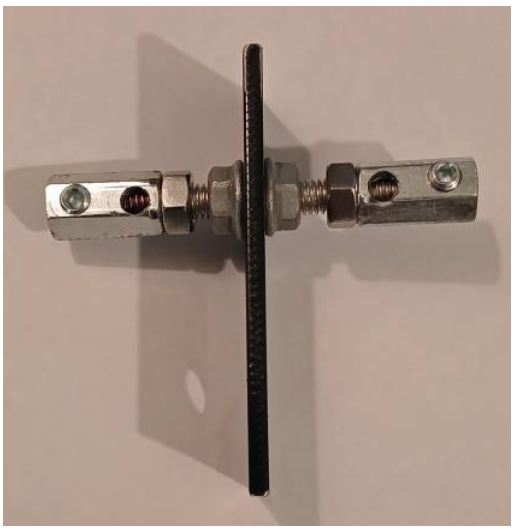
The distance from the pivot centre on the chair to the end of the Black 3mm horizontal bar was 300mm.

The short black bar attached to the motor was 70mm long with the 8mm hole 10mm from one end and the 6mm hole for the motor connecting stainless 6mm screw 20mm from the other end. The 8mm tie rods connected the short bar from the motor to the end of the long horizontal bar attached to the chair.

Two 1 meter bungee cords where also fitted to help balance the chair, these were fixed at the centre underneath so they could not just pull through. Four large furniture sliders were used to allow the whole rig to be easily dragged across the carpet.



One of the hardest jobs was to prevent the short leg of the operating bar 'slipping' under load and this was fixed by 'locking' the bar on the 6mm screw thread via two serrated flange 6mm nuts. The nuts were tightened very tight so that the serrations dug into the sides of the aluminium bar. 6mm hex couplings were used to attach the 6mm stainless screw to the motor and potentiometer shafts. The couplings were drilled and tapped on one side to take M5 x 5mm grub screws. The hex coupling was locknutted on the 6mm screw thread and then a 2mm hole drilled through the coupling and stainless steel thread (using a 2mm cobolt drill bit) so that a 2mm panel pin nail could be pushed through to ensure the coupling could not rotate on the thread. High strength 'Loctite' was also applied to the nuts to help prevent them from moving. The end of the hex couplings going to the motor shaft and potentiometer were also drilled out to suit the motor and potentiometer shaft size of ¼".



Testing was initially carried out by downloading the Arduino SMC3 code and running the SMC3 software to test settings and determine motor direction etc. Then moving on to the 'free' version of SIMTOOLS and testing using the 'LFS' settings to ensure everything worked.

The motors are rated for a maximum current of about 18A – in use the typical current drawn seems to only be about 2-4A, the motors and drivers stay cold in operation however I wired a small 80mm 12v fan to blow a bit of air over everything. A flat black cover was placed over the electronic area for protection.
The Meanwell 12v 150W power supply was mounted on the vertical rear side of the center post and a 15A toggle switch was wired in series with the 12v supply to cut the 12Vpower off if needed when sitting in the chair.

PARTS LIST

1x	Arduino 'UNO' or equivalent	Jaycar	$50
2x	BTS7960 43A H-bridge motor driver	Internet	$32
2x	YG2738 reversible geared Motor (50kg/cm)	Jaycar	$134
2x	Sensor Rotary 180^{o} 6127V1A180L5FS (hall effect)	Digi-Key	$96
1x	Meanwell AC/DC Converter 12v 150W LRS-150-12	Digikey	$40
1x	Toggle Switch 15A S1A 360-2893-ND	Digikey	$16
1x	Mains cable 10A 230V AC 3meters	Jaycar	$10
1x	15A DC twin cable (for toggle switch) 3 meters	Jaycar	$10
1x	12v DC fan 80 x 80 mm	Jaycar	$15
2x	Black 3mm x 1metre Black aluminium bar	Bunnings	$20
1x	8mm x 1metre threaded rod	Bunnings	$15
1x	Pack (4) hex coupler M6	Bunnings	$8
1x	Pack (4) hex coupler M8	Bunnings	$10
10x	Flat Mudflap washers M8 (to attach lino to 8mm studs)	Bunnings	$10
2x	8mm Mini ATV tie rods (go-kart)	Internet	$33
20x	Hex half Nuts M6	Bunnings	$8
20x	Hex half Nuts M8	Bunnings	$10
10x	Serrated Flange Nuts M6	Bunnings	$10
5x	Grub Screws M5 x 5mm socket head	Bunnings	$8
4x	Stainless Steel M6 bolts	Bunnings	$12
2x	Yellow wide flat 1 meter bungee cords	Bunnings	$10
5x	20x100mm 'L' plates (for motor mounting)	Bunnings	$20
1x	Office chair with arms and legs (non swivel)	Donated	FREE

All up cost approx. $600 NZD + cost of SIMTOOLS V3 software

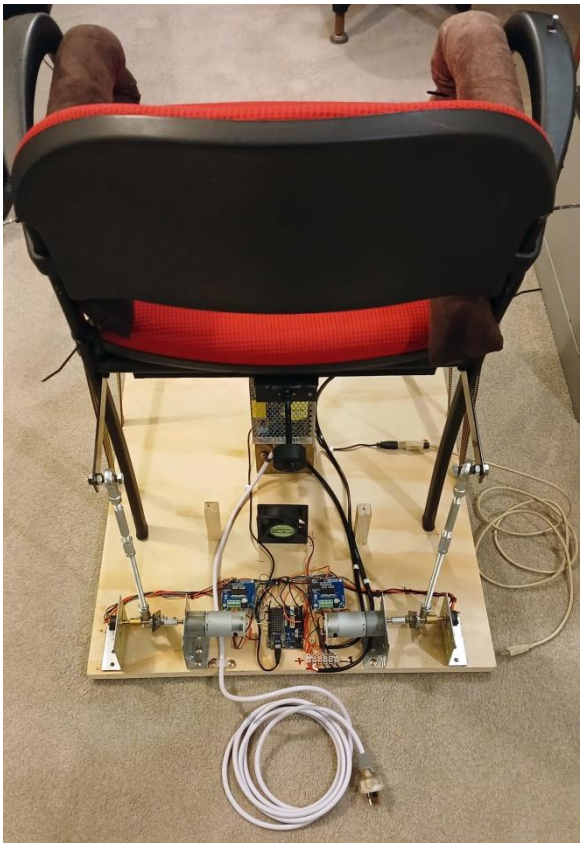
Tools required: Electric Drill, Hacksaw, Wood saw, 6mm & 8mm spanners, Drill bits 12mm, 8mm, 6mm. 10mm hole punch for lino. Loctite thread fastener.

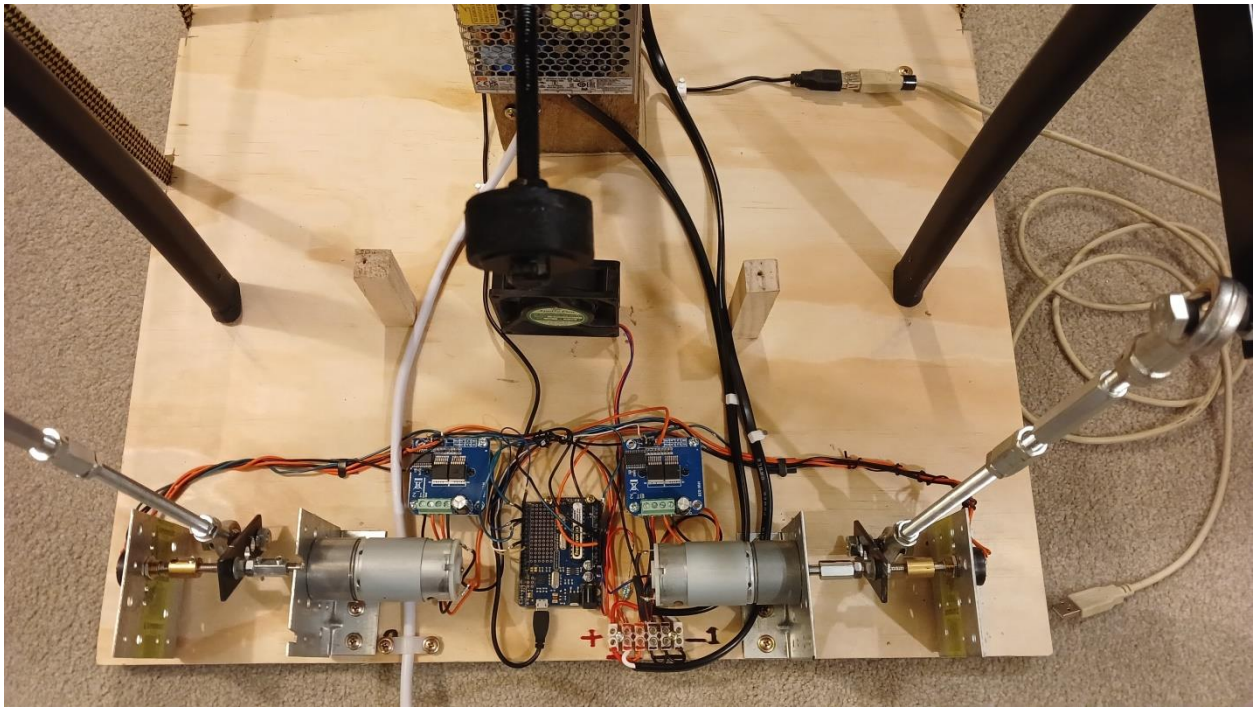
SOFTWARE

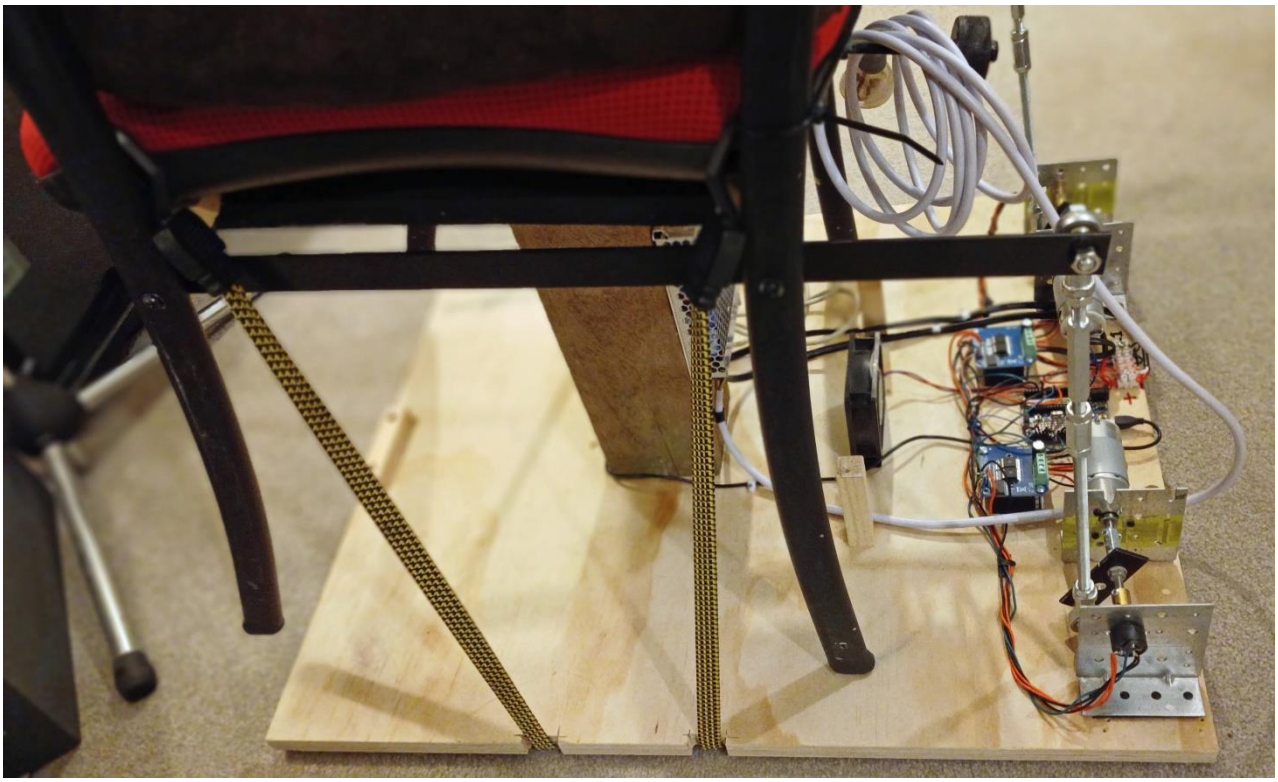
1x	SIMTOOLS V3	Simtools	$135
1x	SMC3 for Arduino	Internet	FREE
1x	Flight Simulator 2020 Std Edition	Steam	

Also required is a suitable power supply (Meanwell 150W) and USB connecting cables, miscellaneous connecting wire for the wiring of the Arduino to motor drivers, motor and positioning sensors etc. I initially used a 12v battery for testing with an inline 10A fuse fitted.

Some photos of Completed Chair

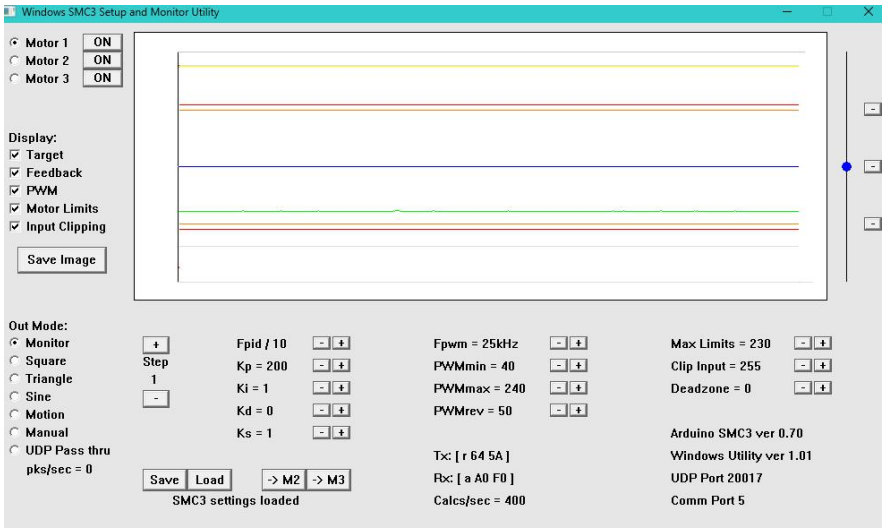






In operation the chair adds a very nice ‘feel’ of floating in the air when flying the plane. The movement is not very large but I also added a small amount of ‘heave’ using the pitch settings in SIMTOOLS V3 which gives a great ‘ground’ feel when taking off or landing.

SMC3 Settings



SIMTOOLS V3 Flight Simulator Settings

Axis1a: PITCH= 60%, Smoothing=50%, DZ=0.4, Bound=OFF, Washout: Rtn= -49%, Gain=1
ROLL= 40%, Smoothing=60%, DZ=OFF, Bound=OFF, Washout: Rtn= -49%, Gain=1
HEAVE=60%, Smoothing=OFF, DZ=OFF, Bound=7, Washout=OFF, Gain=OFF

Axis2a: Set to same as 1a above.
I set **Axis Limiting** to 40 on each axis.

The forces required to move the chair seem a great deal less than if it were a full body simulator.

I'm not sure how well the motors will last as I have only been using them for a few weeks, someone with better welding and drilling skills would be able to make a much better job than me. I had a lot of trouble trying to drill holes that were aligned correctly in both directions. A drill Press would help!

To mount the Jaycar motors to the 'L' plates I printed the Jaycar motor documentation to the correct scaling, drilled a 12mm hole where the motor shaft was to be and then aligned the printed layout over this hole to find the positions of the 3mm motor fastening screws. Because I was so poor at drilling the shafts of the motor and potentiometer were not exactly aligned – I mounted the potentiometer 'L' bracket on Velcro to hold it in place but give it a little flexibility to avoid straining the motor shaft.

Picture of finished Red Chair motion simulator