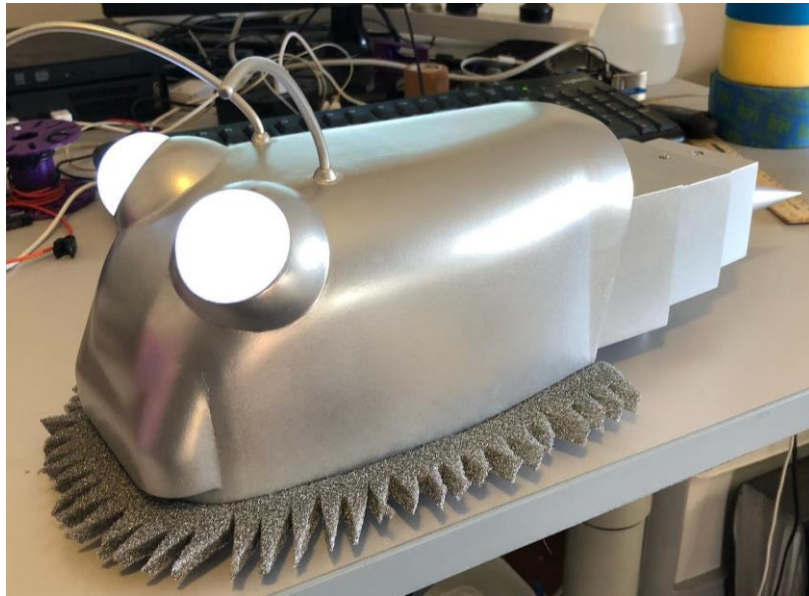


# Cybermat

## Build Log.

**James Baverstock June 2019.**



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## 1. Printing the head and body

The Cybermat (head and body) was printed by Mat (I didn't own a printer at the time) in PETG. It was printed in two parts and for a week I thought there was a problem because the head didn't line up, you need to rotate it 90 degrees first.

### i. 3D files from Thingiverse.

Cybermat Head and Body <https://www.thingiverse.com/thing:2938647>

Tail <https://www.thingiverse.com/thing:3356532>

Nubbins <https://www.thingiverse.com/thing:3350662>

Battery holder (I scaled it up to suit) <https://www.thingiverse.com/thing:145966/files>

Motor mount <https://www.thingiverse.com/thing:3228395>

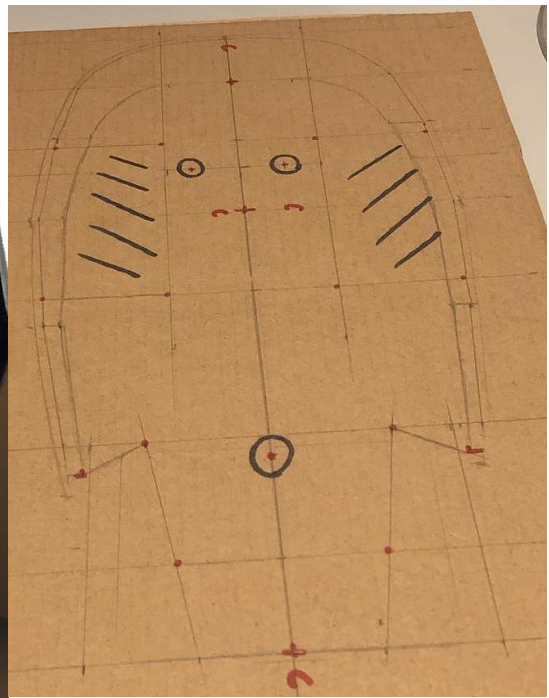
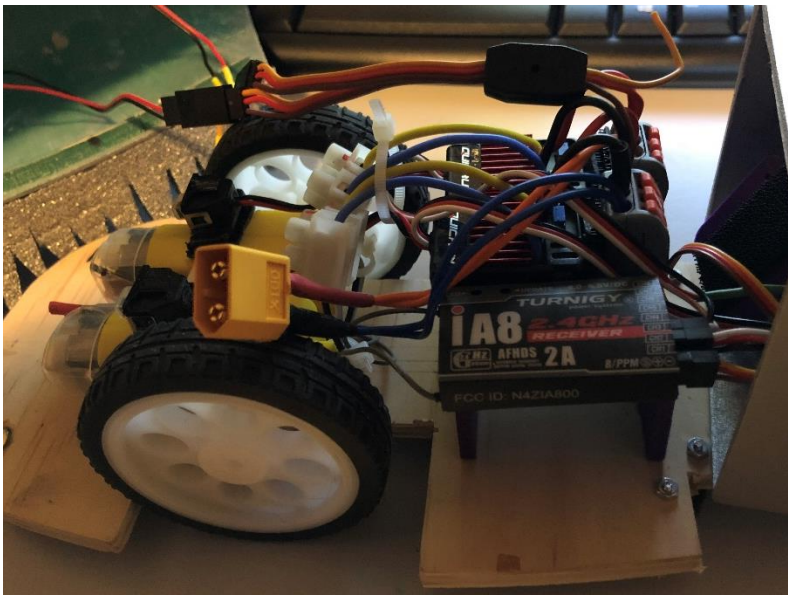
### ii. The Chassis

Mk1 of the cybermat was to have its chassis made from 3mm acrylic or HIPS (because I had some) but bending and shaping plastic is not a beginner level thing and after experiments in MDF and aluminium I settled on 6mm ply (because I had some). Easy to work, easy to drill and screw into. Less nasty dust than MDF and lighter too. A plan was sketched in CAD based on a centreline down the length of the body and then using calipers to measure certain datum points along the body a measured sketch was made. I used a protractor to ensure that measurements would be an accurate 90 degrees from the centreline and then transferred those to my plywood master which is used as a template to make subsequent copies.

After consultation with AZdavros from Thingiverse I discovered a huge difference to the ways that we had been building. I had made my first base by tracing the head and body and then cutting off square at the end. This left for minimal places to mount the tail section due to the relatively large amount of electronics inside and led to awkward methods of mounting batteries. Chassis2.0 has a "beaver tail" on the end which allows for the mounting of the tail with some wiggle room for electronics cabling etc.

Motor mounts were printed and screwed directly into the base. Protruding screw heads were filed flat for safety. There were a lot of different mounts that I tried, these are just what I settled on.

A battery holder was upscaled and printed. It has been held into place with "Weldbond" which is my goto glue when I have no idea what else to use and am too lazy to mix epoxy. Nubbins were CA glued onto the head after initial finishing work had been done.



## 2. Making the tail

### i. Styrene

The most frustrating and time-consuming part of the build. Step one was to make the tail sections in styrene like AZdavros did. Neither the accuracy, skills nor patience to do this well. Bending styrene with a heat gun is probably not the best way either. If you are experienced with styrene, then go right ahead.

### ii. Aluminium

I made a version from .5mm aluminium and glued the boxes together with weldbond. They were certainly light enough and looked genuinely metallic, but I had plans to mount a servo and wheel which was deforming the material. Was unable to find anything slightly thicker like .75mm or 1mm but these could be viable options for others.

### iii. Acrylic and 3D Prints

I tried in acrylic with some better luck, but this made the tail heavier than the rest of the body. I was about to build it out of MDF when I thought I'd use Tinkercad to make some hollow boxes. In hindsight I'd add some countersunk holes next time but the tail section can be printed in a few hours and I think I oriented it so it can be printed in one go. I marked my centres and stepped in 7mm from the end and used a small drill bit at low speed to make pilot holes for pivoting bolts.

### iv. The Tail Dimensions

Segment 1: 90mm x 65mm x 75mm

Segment 2: 70mm x 65mm x 60mm

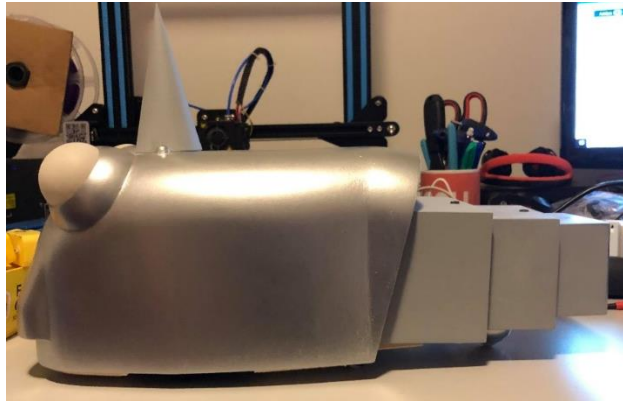
Segment 3: 65mm x 50mm x 55mm

Tail cone H: 90mm Base diameter: 40mm

I used offcuts of styrene to act as shims and hold down any layer separation which allowed a nice fit between the sections. At this point it's worth noting that I only had a generic idea that cybermats were "around 14 inches long"

to go on for my measurements. I guess you could go down the whole draw a grid over a picture and calculate the scale relative to its surroundings; or do as I did and if it looks right, it is right. Beware of “Rivet Counters”.

3mm bolts hold the tail sections together. The largest section will drop into a 5mm nylon bolt poking through the bottom “tongue” of the base and be secured with a nylon nut. Which means it can be easily assembled/disassembled for events and transport.



### 3. Electronics

#### i. Motors

The Cybermat is driven from 2 brushed and geared “TT style” motors. I went through many variations on these and found the ones from ‘makeblock’ part no: 81320 “TT geared motor DC 6V/200RPM” were ideal. There are cheaper alternatives on eBay but all the ones I bought had an axle on both sides and limited space meant having to cut through one axle. The makeblock motors only had one and an added bonus was the lead already soldered to them.

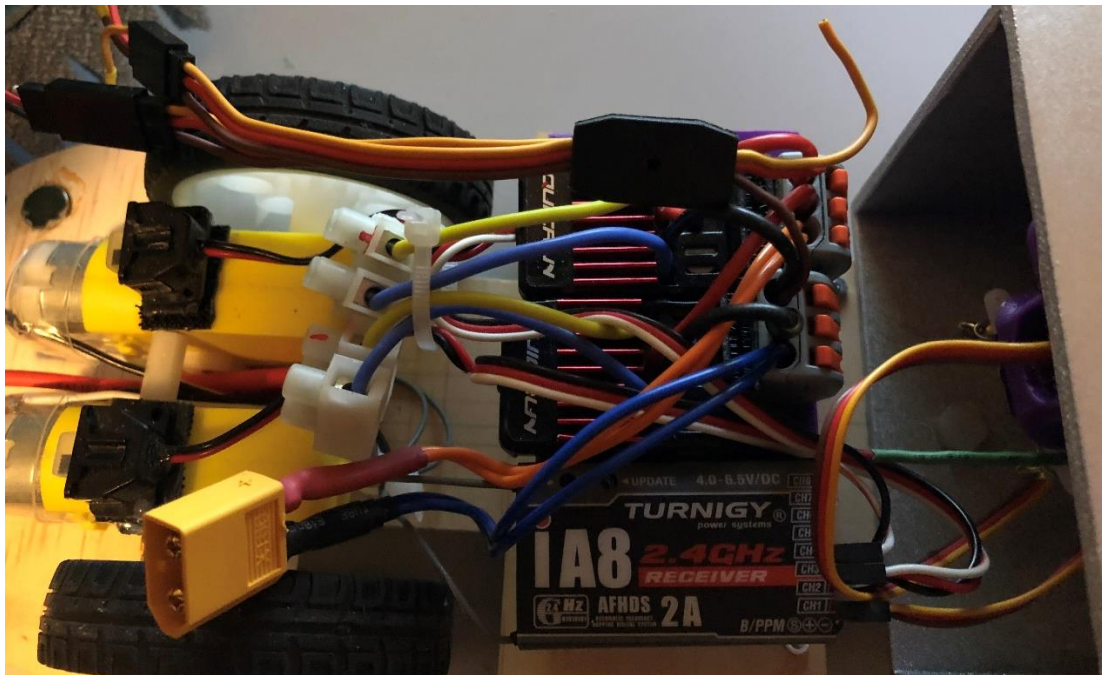
Motors are connected to the speed controllers via some screw terminals. This was in case the connections needed to be reverse for one motor. The splicing terminals wouldn’t work as one controller needed to be connected to one motor, so I’d need 4 block of those rather than just 4 screw terminals, could easily use bullet or spade connectors but these are easy to change and on the whole smaller when space in the cybermat is at a premium.

#### ii. Electronic Speed Controllers

Motors are driven via a pair of Quicrun-WP 1625 Brushed Speed controllers. As they’re advertised as ideal for beginners and a good friend who knows things said they’d work, I bought them. Hate the plugs on them though, try and find the corresponding sockets if you dare. The ESC switches are mounted with 3M hook and look to the top of the gearboxes in order to save space. The speed controllers themselves are mounted with the same hook and loop to the top of the battery “garage”.

[https://hobbyking.com/en\\_us/quicrun-wp-1625-brushed.html](https://hobbyking.com/en_us/quicrun-wp-1625-brushed.html)





### iii. Transmitter and Receiver

The little beastie is controlled with a Turnigy (can't pronounce it, see the video) 9X 9channel transmitter and receiver. Was immensely cheap at the time so keep an eye out for sales. From memory I could use this to control multiple projects and there is at least one other in planning. My good Buddy Mat upgraded it to the OpenTX firmware which allows for a lot more control (most of which I don't know about, but I think there's a document I can attach). The receiver is mounted next to the ESCs on top of the battery "garage" with 3M hook and loop. An added bonus of this method is the ability to access the socket for the tail servo easily.

[https://hobbyking.com/en\\_us/turnigy-9x-9ch-transmitter-w-module-ia8-receiver-mode-1-afhdhs-2a-system.html](https://hobbyking.com/en_us/turnigy-9x-9ch-transmitter-w-module-ia8-receiver-mode-1-afhdhs-2a-system.html)



### iv. Lights and Servo.

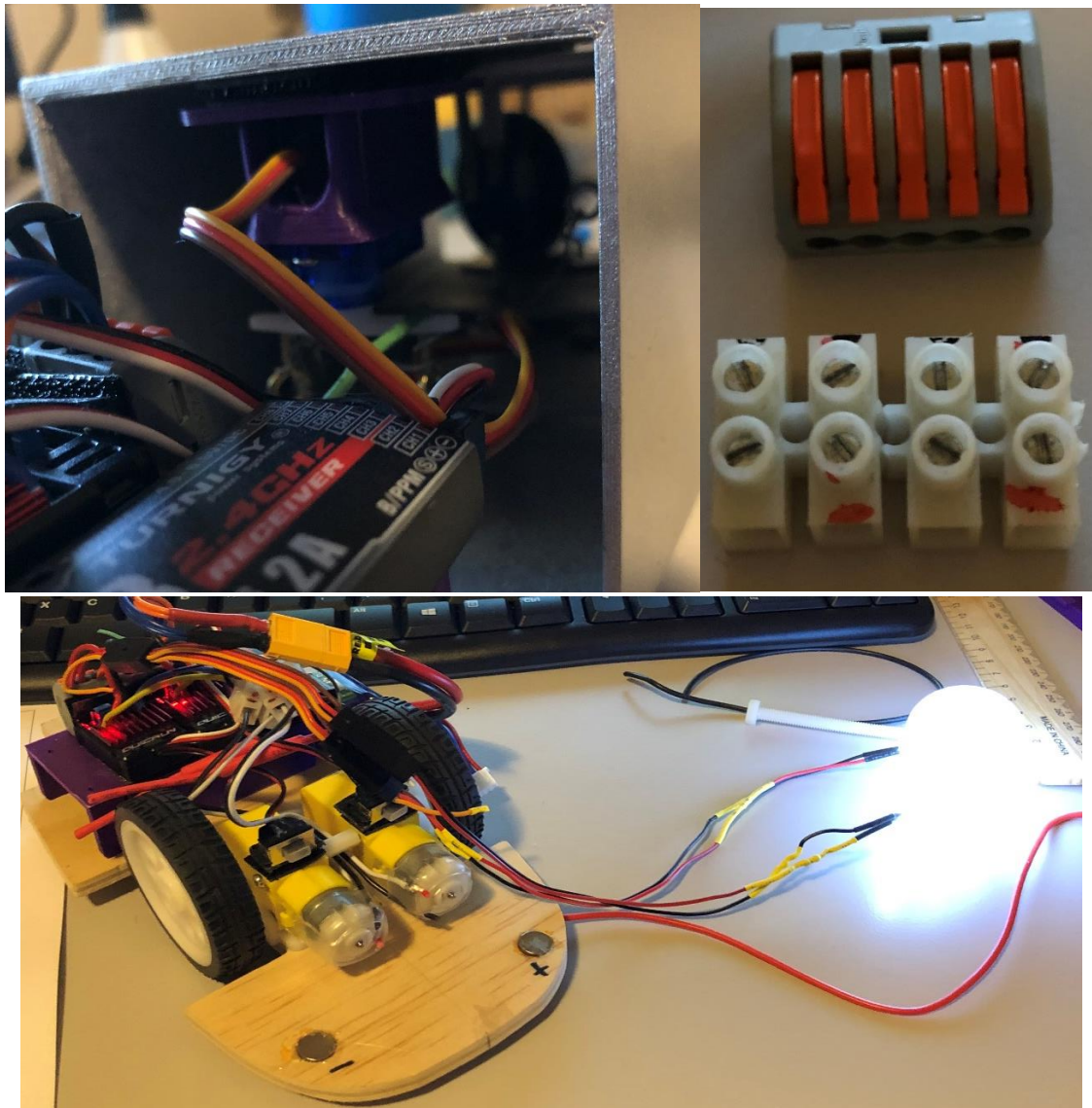
The "eyes" are a pair of ping pong balls (genuine BBC chic) with some small LEDs hot glued into a hole. There is a small resistor (150-200 ohm) soldered to the positive leg of the LED. I cut up a servo Y lead that I got in error and attached the female end to some wires on the eye. I then cut off the male end from a second servo lead and attached that to the wires on the other eye.

The main power and light distribution is done with PCT213 Splicing connectors as my soldering isn't that good. These take up minimal room and are serviceable with no tools so ideal for on the go repairs and changes at events. I am using the genuine Chinese knock offs but they work. All positives to one and all negatives to another.

<https://www.wago.com/au/installation-terminal-blocks-and-connectors/classic-splicing-connector/p/222-413>

A small servo (Hobbyking TG9e) is mounted to the upper section of the largest tail segment. The servo horn is connected to 2 small strips of plywood with small eyelets screwed into them with picture hanging wire. Its quite difficult to get right and this is the first time I have done anything with servos and I'm sure there is a better way. I have trouble telling the difference in size and regularly Googling the answer. This servo makes the "tail" wag with the left stick on the transmitter, this can be changed in OpenTX so that the servo works all the time.

[https://hobbyking.com/en\\_us/turnigytm-tg9e-eco-micro-servo-1-5kg-0-10sec-9g.html](https://hobbyking.com/en_us/turnigytm-tg9e-eco-micro-servo-1-5kg-0-10sec-9g.html)



#### v. Wheels

The first version of the cybermat I saw used the regular yellow TT wheels and tyres. Space was at a premium in my original design, so I sourced some narrow wheels from Core Electronics. Known as a "Thin White Wheel for TT DC Gearbox Motors – 65mm" they were cheap enough to use.

<https://core-electronics.com.au/thin-white-wheel-for-tt-dc-gearbox-motors-65mm-diameter.html>

Balancing the cybermat are three ball castors. I have used nylon ones but in hindsight I'd get some stainless balls instead. On the rear of the main body are 2x 3/8" ball castors. Under tail segment #2 is 1x 3/4" ball castor. All sourced from Core Electronics.

<https://core-electronics.com.au/pololu-ball-caster-with-3-4-plastic-ball.html>

<https://core-electronics.com.au/pololu-ball-caster-with-3-8-plastic-ball.html>

#### vi. Batteries

Space is at a premium in the cybermat (likely due to use of the ESCs but they are a necessary evil for me as I am inexperienced with Arduino. The battery I chose to run the internals of the cybermat is a Turnigy nano-tech 1500mAh 25-50c 2S 7.4V LiPo.

87mm x 34mm x 14mm are the critical dimensions to get the battery to fit but you may choose to do something different. One option was to use a strap to the 'roof' of the body and mount a battery there.

Although overkill and not necessary I have also included the link to the LiFe battery I used for the transmitter. LiFe is a bit more robust than LiPo and this pack even survived a short while re-pinning the connector. Not recommended but worthy of mention. The transmitter comes with a caddy for 8xAA cells, but it is damn near impossible to get the thing into the compartment and get the cover on. Have in fact found some extra covers that are printable to allow some more room for the battery wires to fit in the compartment, but I won't link them here.

[https://hobbyking.com/en\\_us/turnigy-nano-tech-1500mah-2s-25-50c-lipo-pack.html](https://hobbyking.com/en_us/turnigy-nano-tech-1500mah-2s-25-50c-lipo-pack.html)

[https://hobbyking.com/en\\_us/turnigy-nano-tech-1500mah-life-3s-9-9v-transmitter-pack-taranis-compatible-1.html](https://hobbyking.com/en_us/turnigy-nano-tech-1500mah-life-3s-9-9v-transmitter-pack-taranis-compatible-1.html)

### 4. Finishing

#### i. Joining

The body was glued with CA glue at first and then 2 part epoxy was mixed and generously applied to the inside of the joint between the head and body. I use the stuff from The Reject Shop (Aussie version of the pound shop or dollar tree for those in the Northern worlds).

#### ii. Smoothing

The body smoothing began with a medium flat file to take off any lumps and stringing from the printing process. This was the first 3D print I'd worked on, so it came as a learning curve for me. Once the main body had a uniform series of high spots I set to filling and building up the low spots.

Most filling was done with 2-part lightweight car body filler from Supercheap Auto. I have lots of this from dalek building and am getting better at working with it (I now only throw half away). The head and eyes are a pain in the ass to get right as the compound curves were very challenging for me.

I sanded with 120 grit dry and then 320 wet to get a consistent finish and used 5-6 coats of spray putty to try and conceal any crimes left behind with sanding between coats.





### iii. Paint

The body was primed with the final coat of spray putty and the body sprayed with Rust-oleum 2x Ultra Cover Paint and Primer Metallic Aluminium. (was left over and paints well over most things). I did try Supercheap Acrylic Silver but no matter what it always appeared dusty.

<https://www.rustoleum.com.au/product-catalog/consumer-brands/ultra-cover-2x/metallic>

### iv. Teeth

The “teeth” are an offcut of foam I got from the person who made my Tin Man costume a few years back (long story for another time). I cut a zigzag profile into it and sprayed it silver. I masked off the bottom 8mm of the head and body then used some 400 grit sandpaper to rough it up and remove the paint. I’d bought some wiz-bang servo tape from hobbyking which brags to be silicone based and won’t damage surfaces. I cut 12 small strips around 6mm wide and applied them around the base. Starting at the front of the “nose and mouth” I removed the protectant film and pressed the painted foam onto the mounting tape. Should be an easy fix.



### v. Antennae

The antennae are coat hangers that I bought for my dalek gun and I had offcuts left. They are around 130mm long and I bent them both by hand in a small vice to get a rounded profile. Both had to be filed down to be able to drop into the holes in the head. I left a small straight section there so they can be lifted straight out as I think they will cop a beating. They were rubbed down with the 400 grit and sprayed in acrylic silver and then clear coated in Rustoleum 2x clear. They are straight drop in fit and won’t be glued.





## Other Bits and Bobs:

### i. Suppliers:

Hobbyking- ESCs, Transmitter, Servo, Batteries, servo leads, servo tape

Core Electronics- TT geared motors, wheels, castors.

Jaycar (not for parts, waaaaay too dear, but plugs and screws etc)

Mitre10- plywood, Rustoleum paints

Supercheap Auto- body filler, sandpaper, spray putty, silver acrylic paint.

### ii. Reference Pics

Tomb of the Cybermen ©BBC



Cybermat-9x-mixer-  
info-2018.pdf