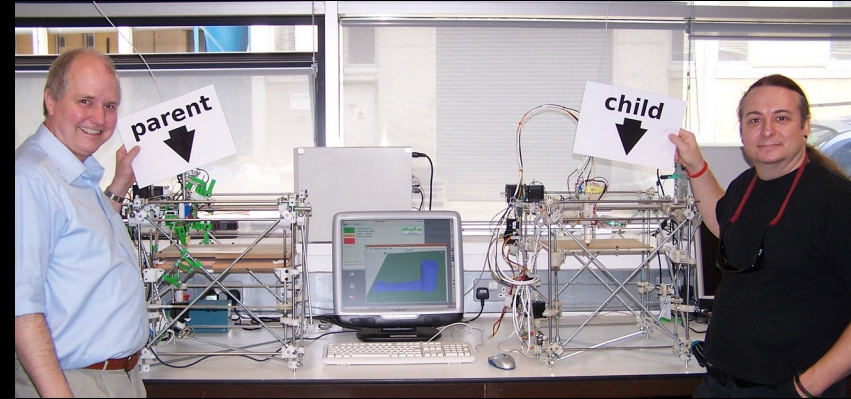
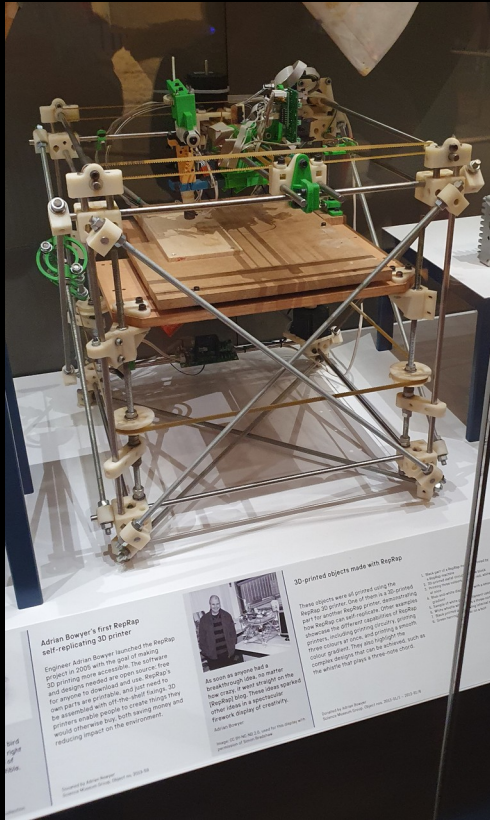


The 3D printer that took a decade to tune

+

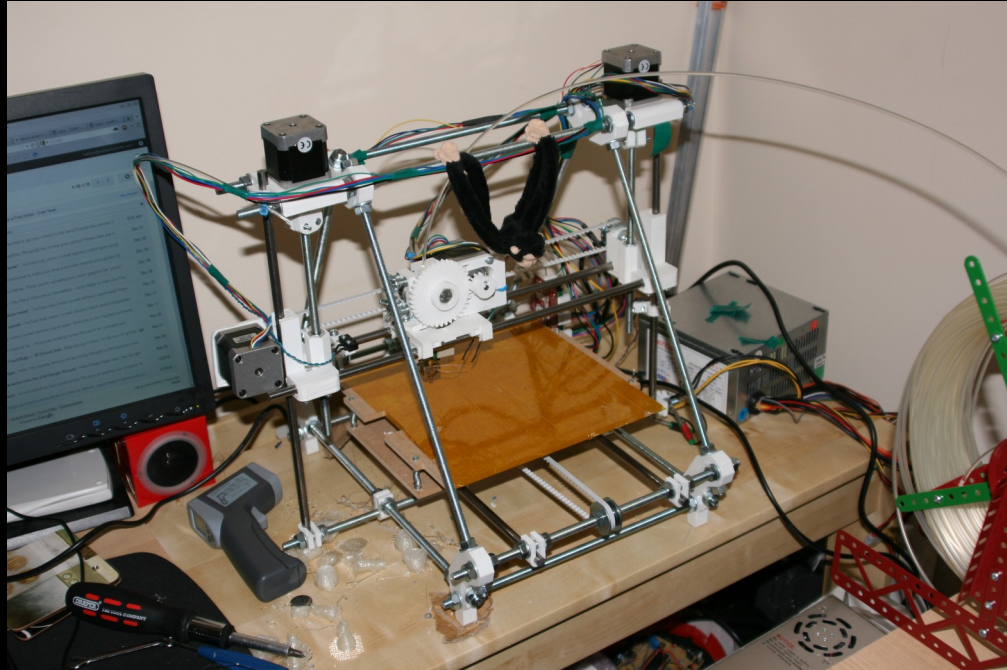
The project begins



- RepRap project started 2005
- First replication was in 2008 at University of Bath
- I was at Bath from 2005-2012...

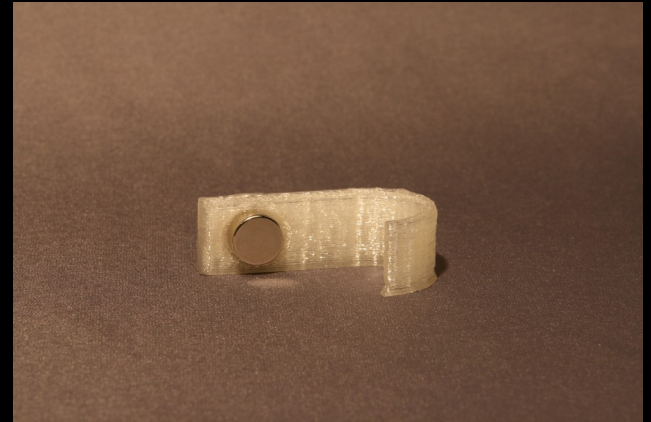
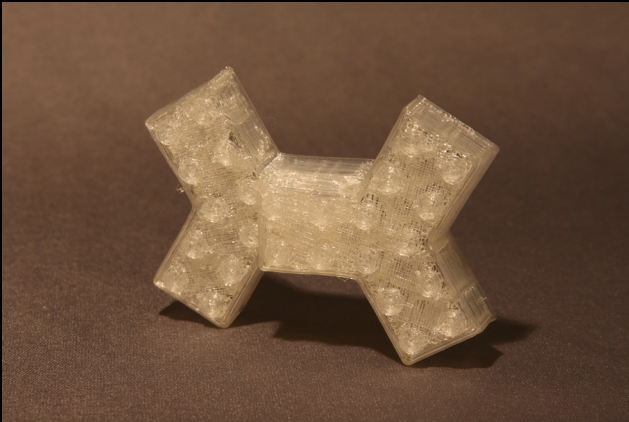
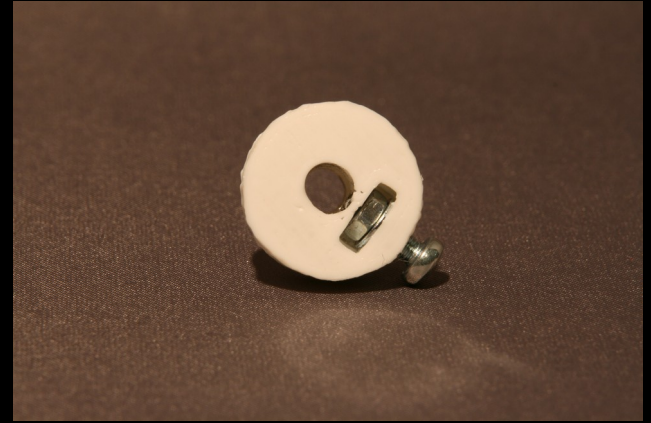
Images from repprap.org Licensed under GNU FDL

I built it wrong

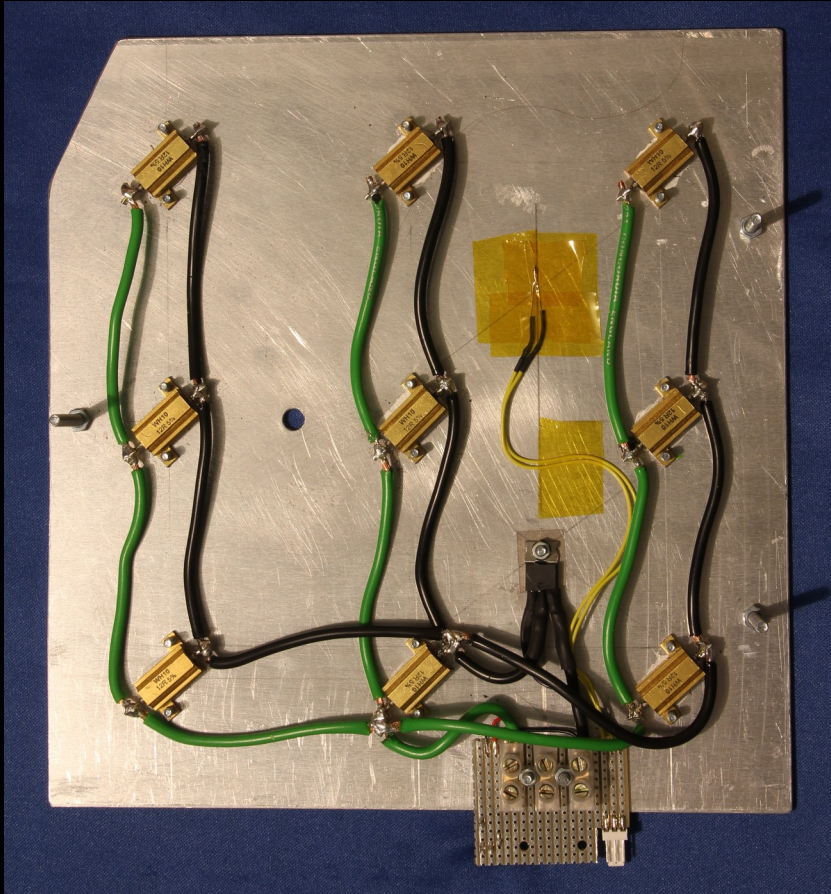


- Ordered some wrong parts (updated the wiki)
- Let my stepper motors get too hot (big problem)
- Very basic build had minimum features (no heated bed, part cooling etc.)

Early prints

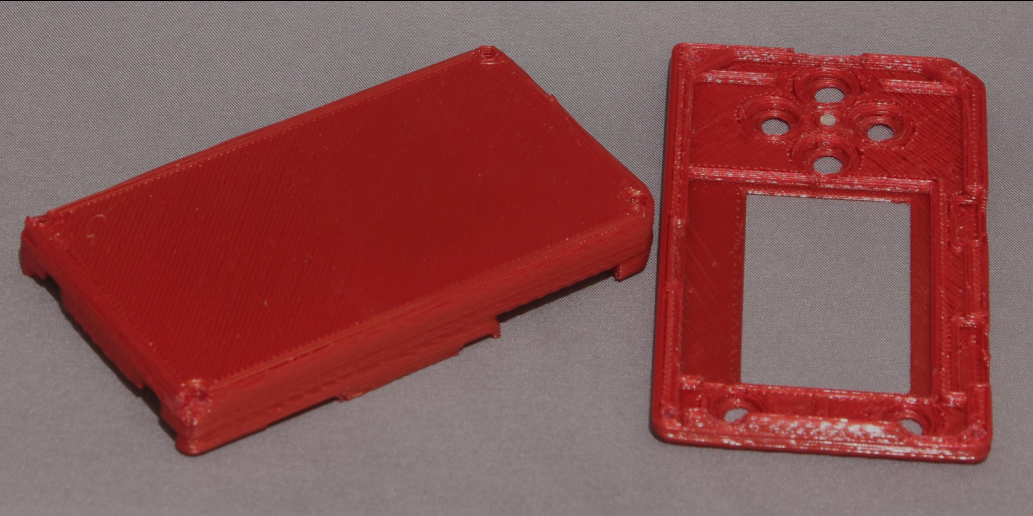


First upgrade, a heated bed



- Based on Adrian's design from RepRap.org
- Built with parts I had on hand
- Made larger prints without warping possible

Larger prints are working



- With the heated bed larger parts were possible without warping
- If you look around the edges though you can see there are still accuracy problems

Into storage



- Kids
- Two house moves
- Not enough time
- Printer lives in a really big box

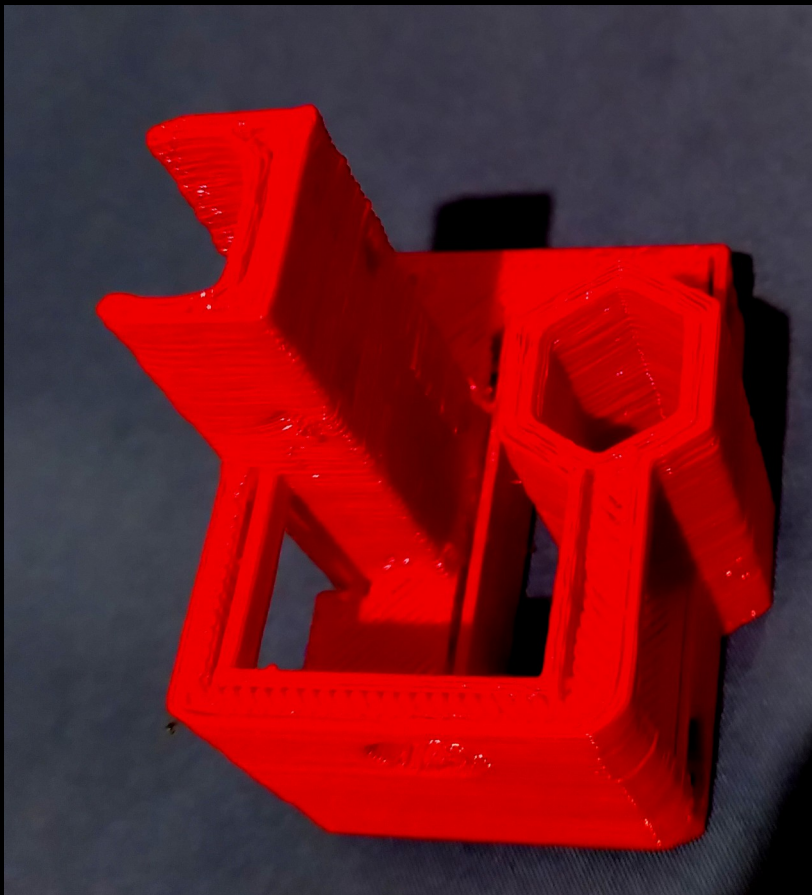
5 Years Later



PrusaResearch from Printables.com Creative Commons 4.0 BY-NC

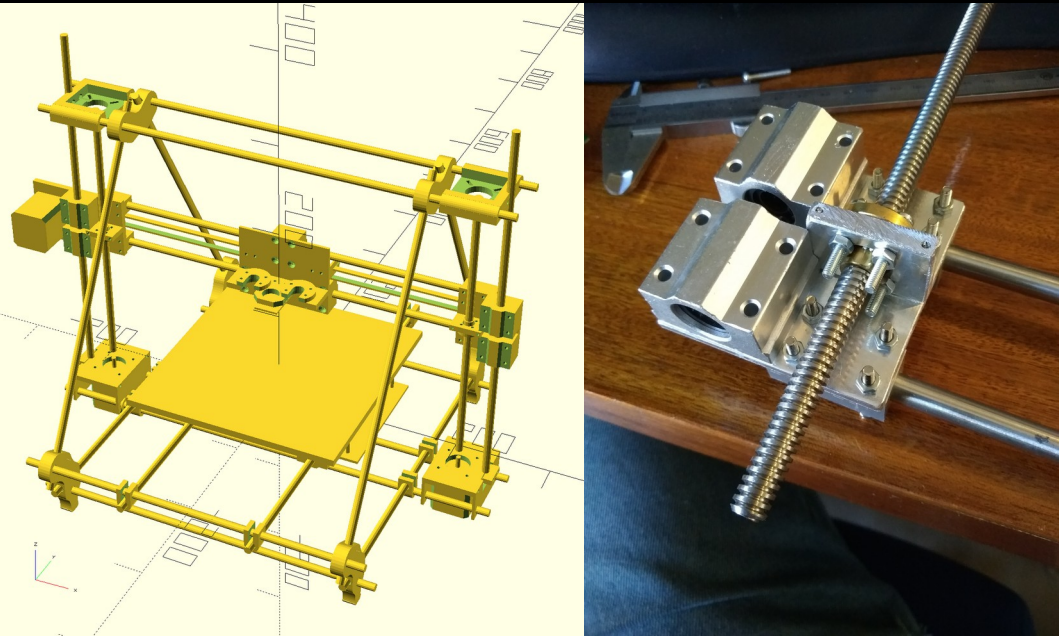
- COVID PPE rush
- GP requested printed face shields
- Printer was unpacked...
- But the printing area was too small

Upgrade Attempt 1: Print New Parts



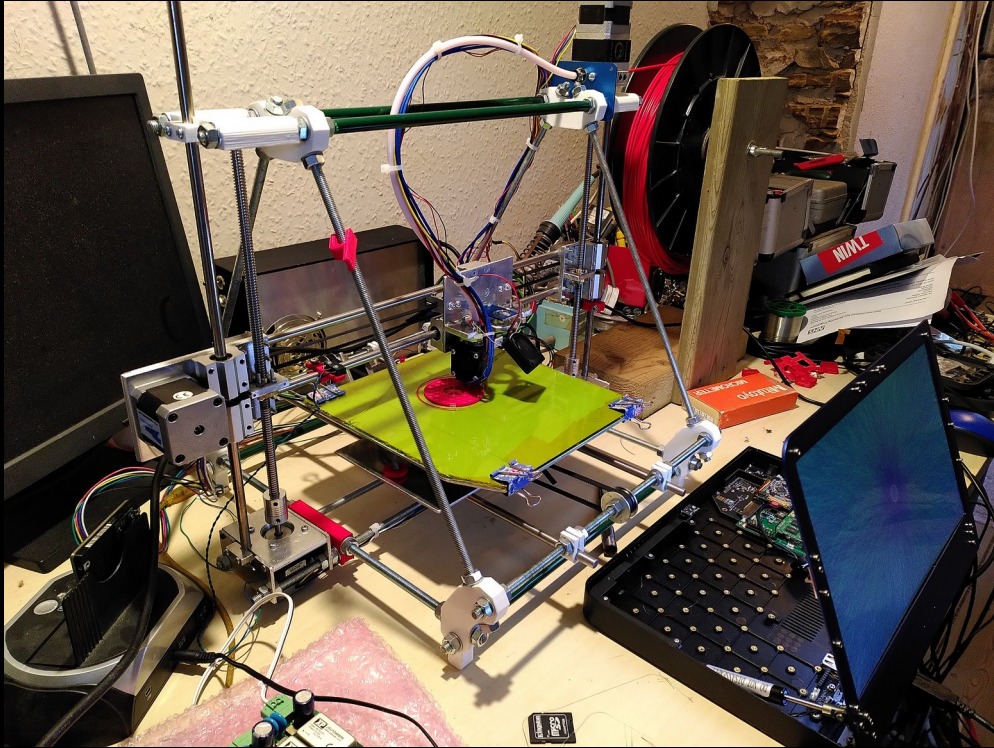
- To upgrade the printer I needed some new parts, which I could print
- The overheating stepper motors problem was never really solved, as the print goes on the backlash gets worse
- Printed parts just weren't accurate enough

Attempt 2: Design a RepStrap



- Design replacements for the broken parts
- Use off-the-shelf mechanical parts or simple aluminium plate can be made with a hand-saw and drill
- Designed in OpenSCAD using some of the original parts where they were still functional

It works!



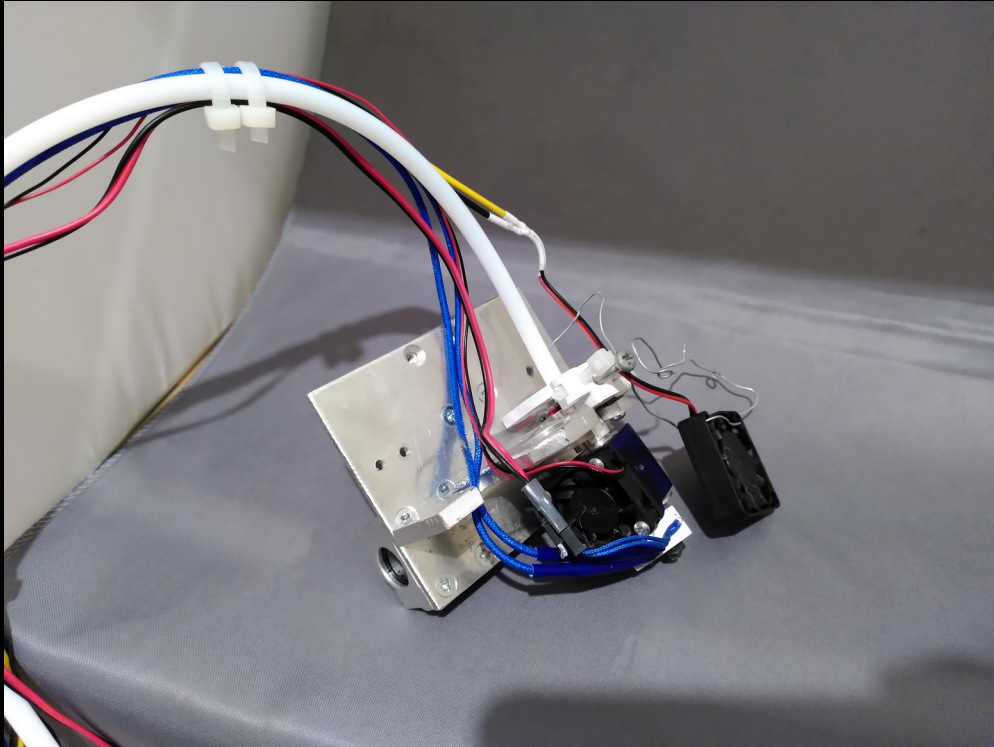
- The fatal flaws were fixed
- Upgrade used an off-the shelf extruder and new hot end which had been in storage with the printer

It broke!



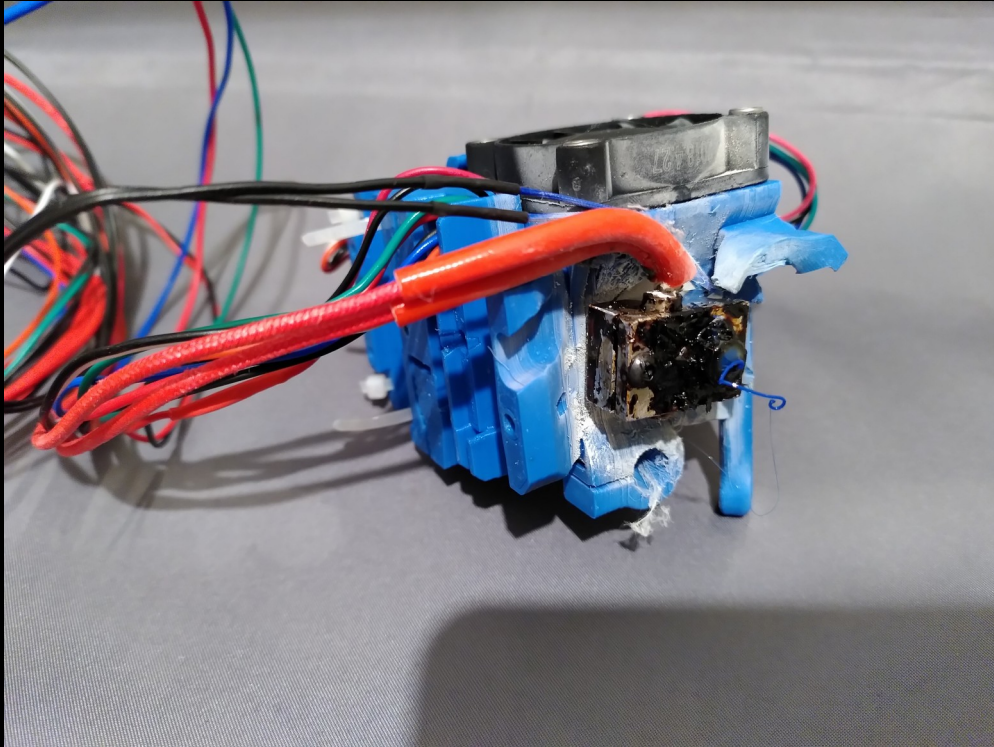
- Airbrush nozzle hot end
- Some over-extrusion/first layer too thin
- Ripped the nozzle clean off

Extruder upgrade



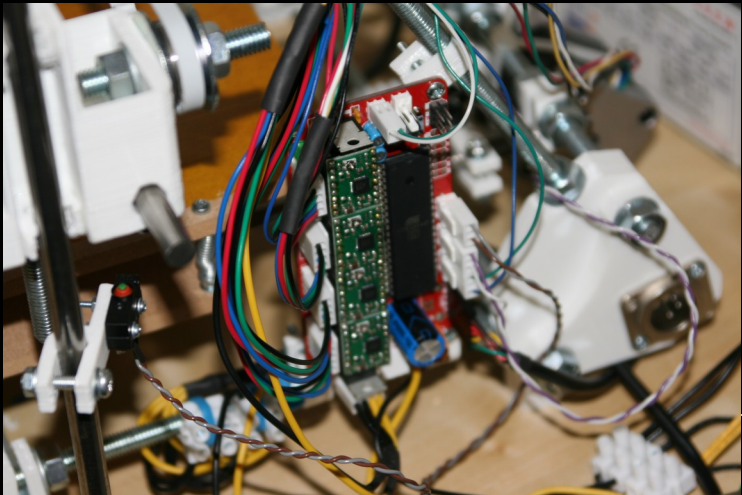
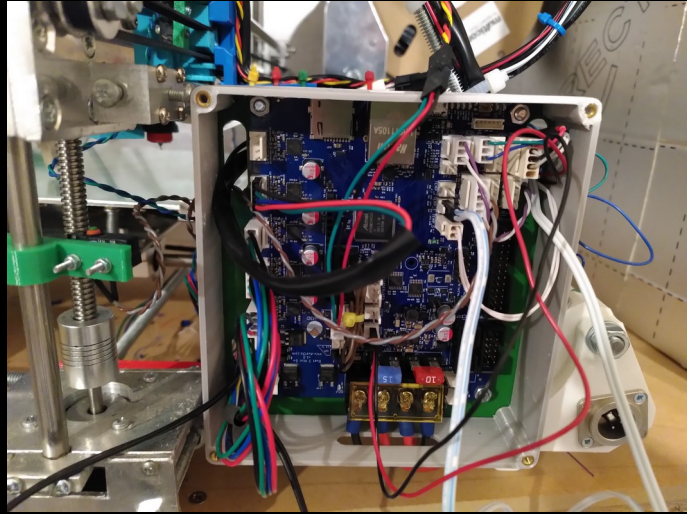
- Genuine E3D V6 hot-end
- Still using the Bulldog extruder via bowden tube
- Clocked hundreds of hours and kilos of filament with this configuration
- Started printing PETG

Update the extruder



- Went to a Prusa MK3S extruder
- Possible because it's open source
- Printed the parts myself
- Used the same stepper motor as the original Wade's extruder
- Prints 1.75mm filament
- But now the controller died

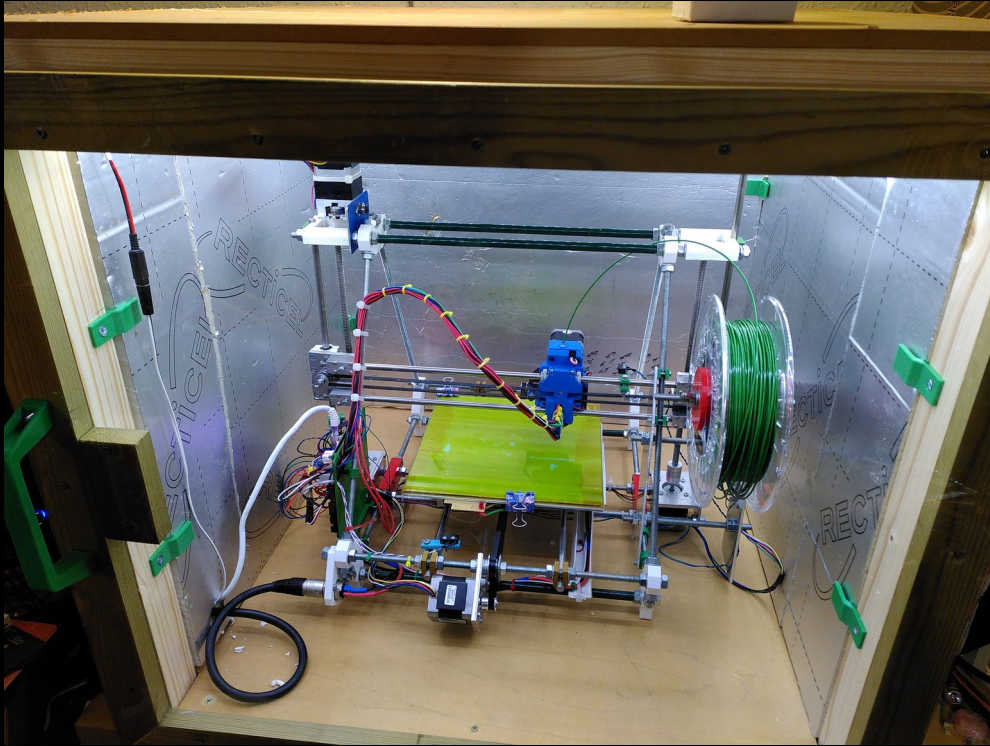
Upgraded controller



- Updated from the Sanguinololu 8bit MCU to Duet3D V3 Mini 5
- No separate control PC required now
- Better controls for part cooling fan etc.

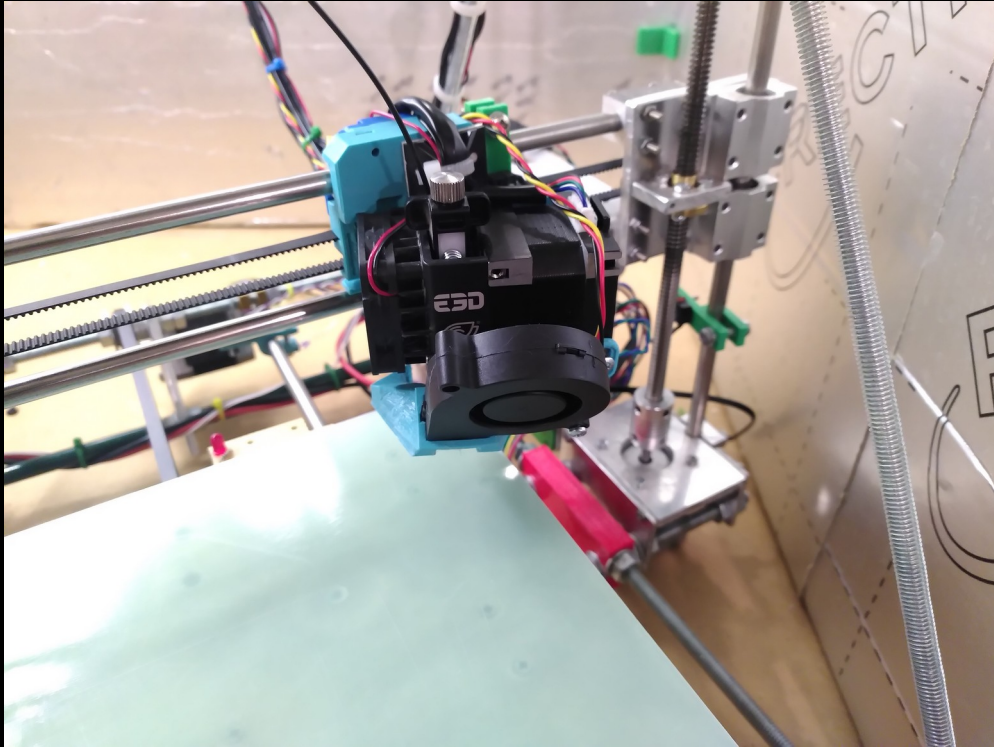
<https://github.com/Duet3D/RepRapFirmware>

Build enclosure



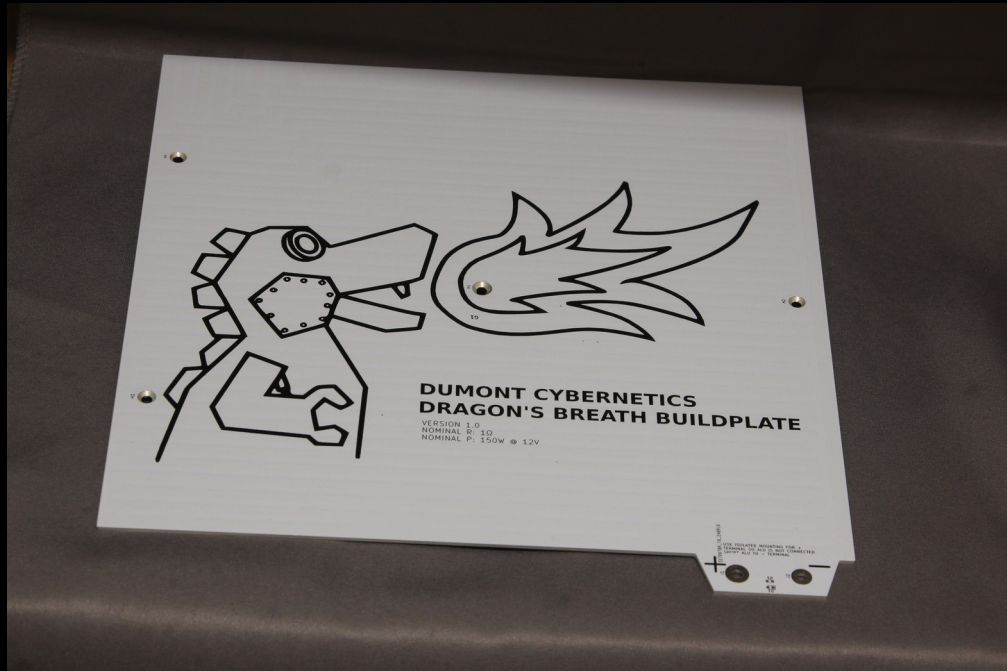
- Can print bigger parts without warping
- Works much better in winter
- Can add filtered extraction for certain filament types
- Actually the insulation was overkill and the build chamber easily gets too hot

Extruder upgrade again



- Installed an E3D Hemera Revo combi extruder and hot end
- Even better filament control for smooth printing
- Achieved first TPU (flexible filament) prints

Heatbed upgrade



- Old heated bed finally warped
- New custom PCB heatbed
- Improved mechanics with drag chain

What have we learned

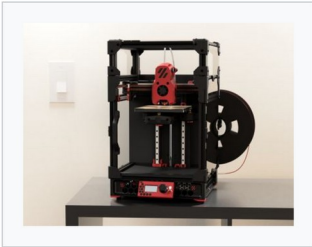
- Building your own 3D printer is possible thanks to Open Source
- Upgrading that printer is possible because people are still sharing their updates
- It's a cycle
 - Break it or need a new feature
 - Implement a fix/upgrade
- There are a lot of trickle down advantages
 - Stepper control boards for plotters, laser cutters, other machines
 - Ways of constructing machines
 - Temperature control and monitoring
 - Availability of industrial grade mechanical parts in small volumes

The future?

Active Projects



Prusa i3 (license: GPL)



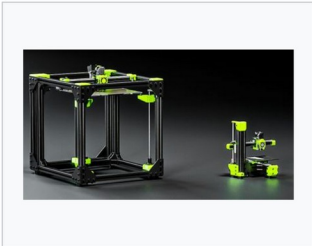
Voron 0, Voron Trident, Voron 2,
Voron Switchwire, Voron Legacy
(license: GPL)



Cairo Mini 3d Printer (license: CC-BY-SA)



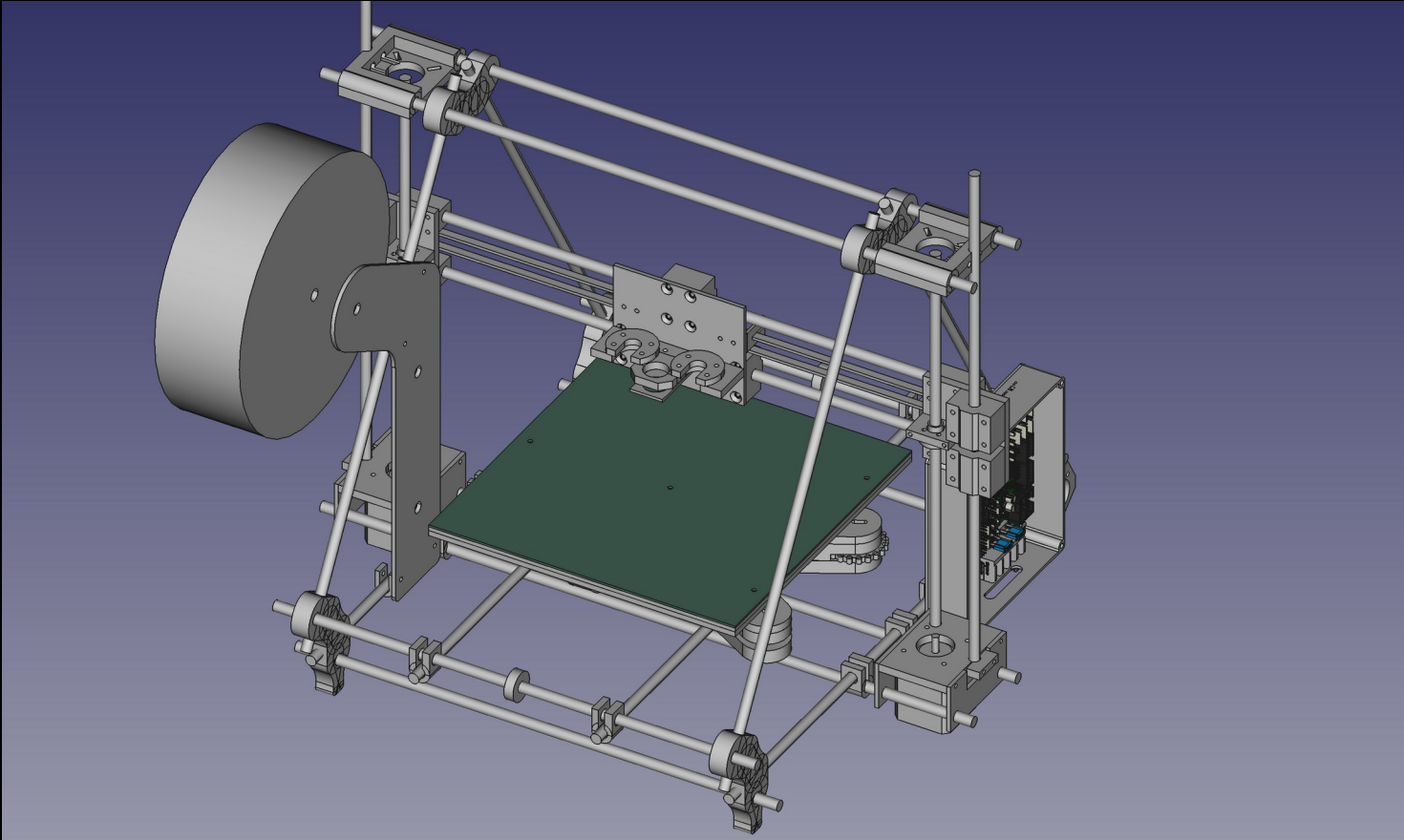
Cairo 30 3d Printer (license: CC-BY-SA)



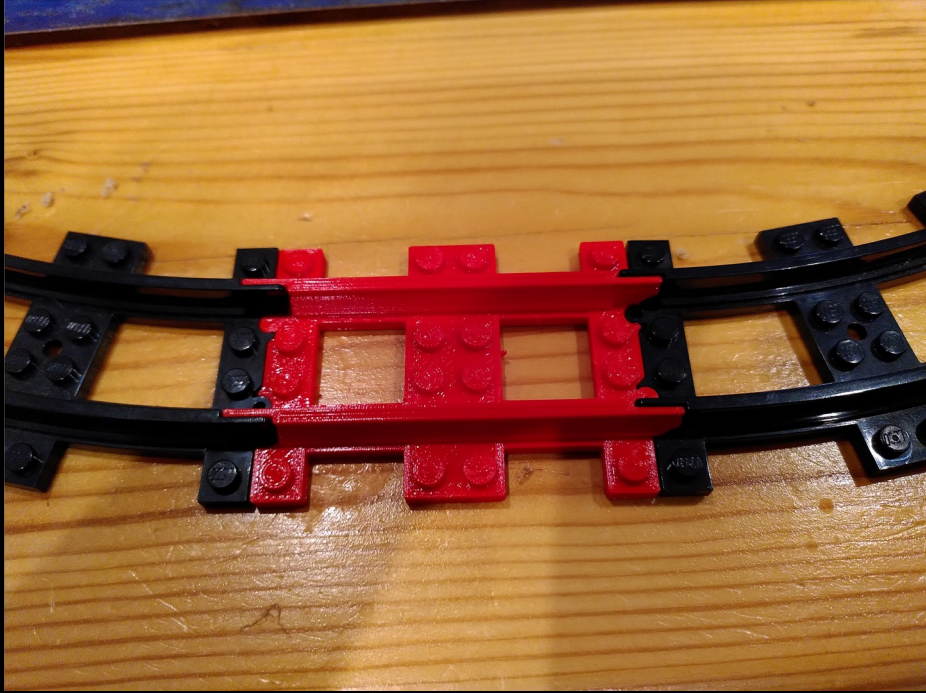
RatRig V-Core, V-Minion (license: CC-BY-NC-SA 4.0)

- There are still open RepRap projects in progress
- Upgrade to a Voron CoreXY printer
- Print the printable parts with the existing printer!

The end...



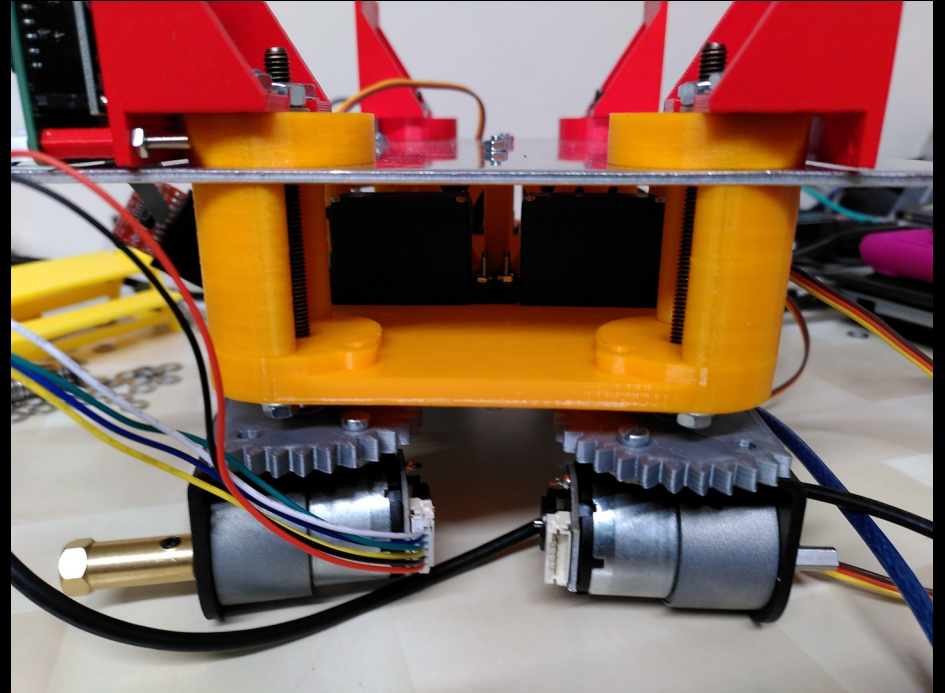
What do you print - Toys



Repair pieces



Robot parts



Enclosures

