RepRap 3D-Printer

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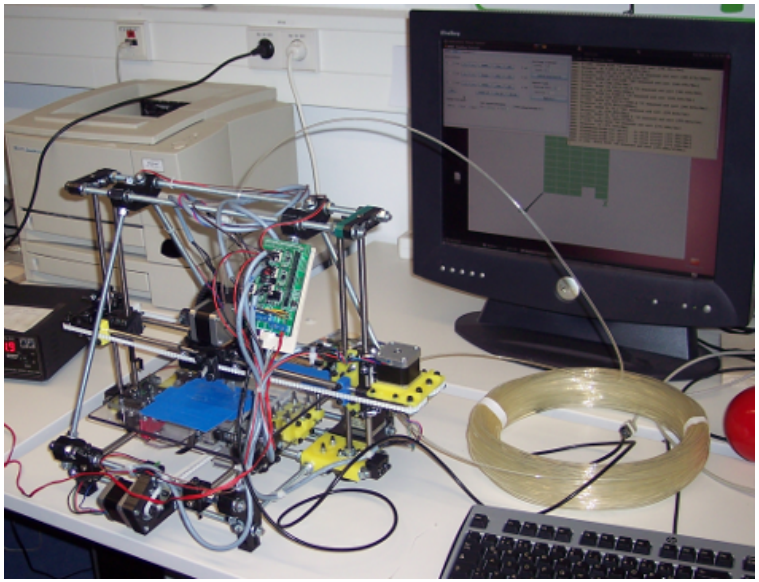
Specifications of RepRap Mendel

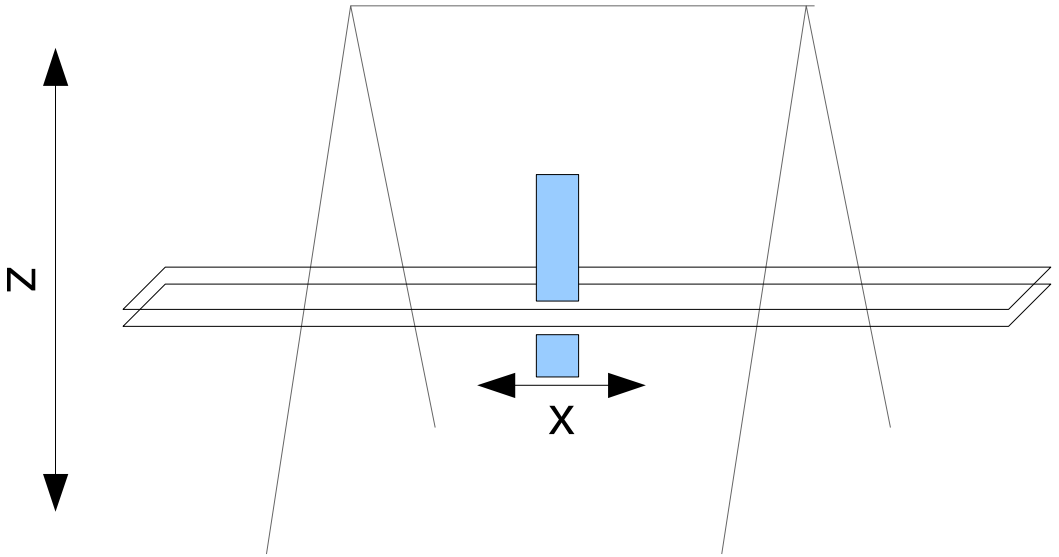
Idea: Assisted self- replicating and self-manufacturing machine



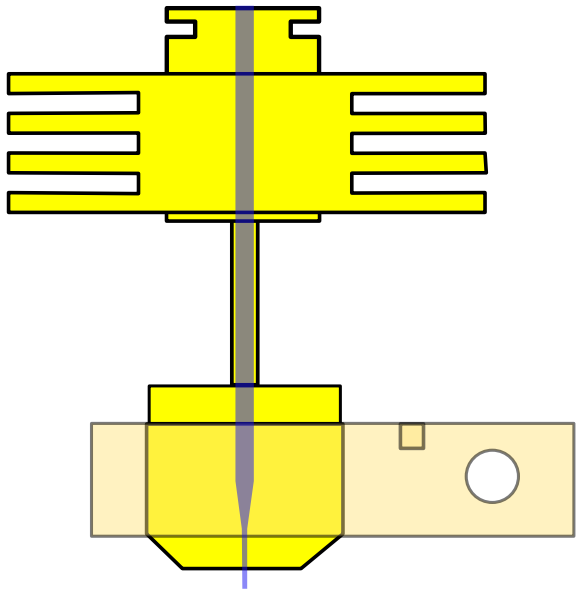
- Technology: FFF
  (Fused Filament Fabrication)
- Print Volume: 200 x 130 x 50mm
- Positioning Accuracy: 0.1 mm
- Min. Feature size: 0.6 mm
- Layer Height: 0,25 – 0.5 mm
- Power Supply: 12 V, 7 A
- Weight: ca. 7 kg
- Price: ca. 700 Euro
  (incl. printed plastics parts)

published in:
R. Jones, A. Bowyer et al: Reprap – the replicating rapid prototyper. *Robotica*. 2011

Mechanics: Frame and Hotend



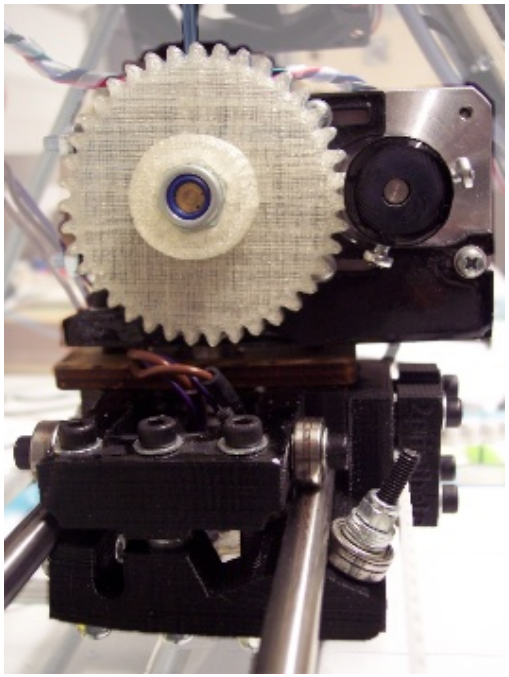
y-axis: Print bed moves perpendicular to the drawing plane



Hotend:

- 0.5 mm Nozzle
- 4 Ω heating resistor
- 100 kΩ thermistor

Stepper Motors and Wades Extruder



Hobbed Bolt pushes filament into Hotend

Calibration (Steps $\rightarrow$ Millimeter):

stepper motors:	$1.8\,^\circ$/step $\Leftrightarrow$ 200 steps/rotation
microstepping:	16 x
bolt diameter:	6 ± 0.5 mm
gear transmission:	39/11

Estimation:

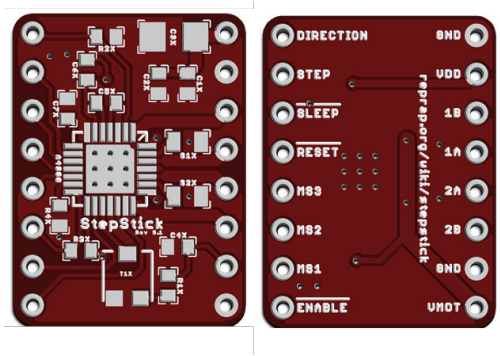
$$\frac{16 \cdot 200 \cdot 39/11 \text{ steps}}{\pi \cdot 6 \text{ mm}} \approx (600 \pm 50) \text{ steps/mm}$$

Measured factor: 558 steps/mm.

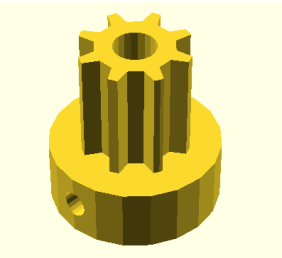
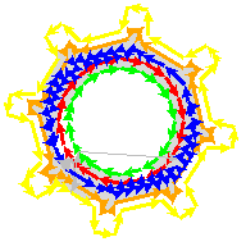
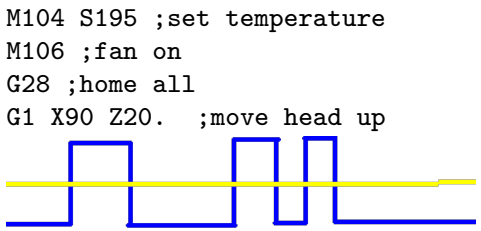
Electronics

Electronics:

- Arduino Board with ATmega1280 microcontroller
- Serial PC-Interface via USB (115kbs)
- A4988 based StepStick drivers
- optical endstops



Software Toolchain

stage	3D-model	STL-Export	Slicing	GCODE	Print
software	Blender, OpenSCAD		skeinforge, slic3r		Printrun, Sprinter
example					

```
M104 S195 ;set temperature
M106 ;fan on
G28 ;home all
G1 X90 Z20.  ;move head up
```

Firmware

Listing 1: GCode Example

```
M104 S195 ;set temperature
M106 ;fan on
G28 ;home all
G1 X90 Z20. ;move head up
```

- C++-Firmware interprets GCode

Firmware

Listing 3: GCode Example

```
M104 S195 ;set temperature
M106 ;fan on
G28 ;home all
G1 X90 Z20. ;move head up
```

- C++-Firmware interprets GCode

Listing 4: Snippet from Sprinter.cpp

```
case 106: //M106 Fan On
if (code_seen('S')){
  WRITE(FAN_PIN, HIGH);
  analogWrite(FAN_PIN, code_value() );
}
else {
  WRITE(FAN_PIN, HIGH);
  analogWrite(FAN_PIN, 255 );
}
break;
```

Easy Usage of the Serial Interface

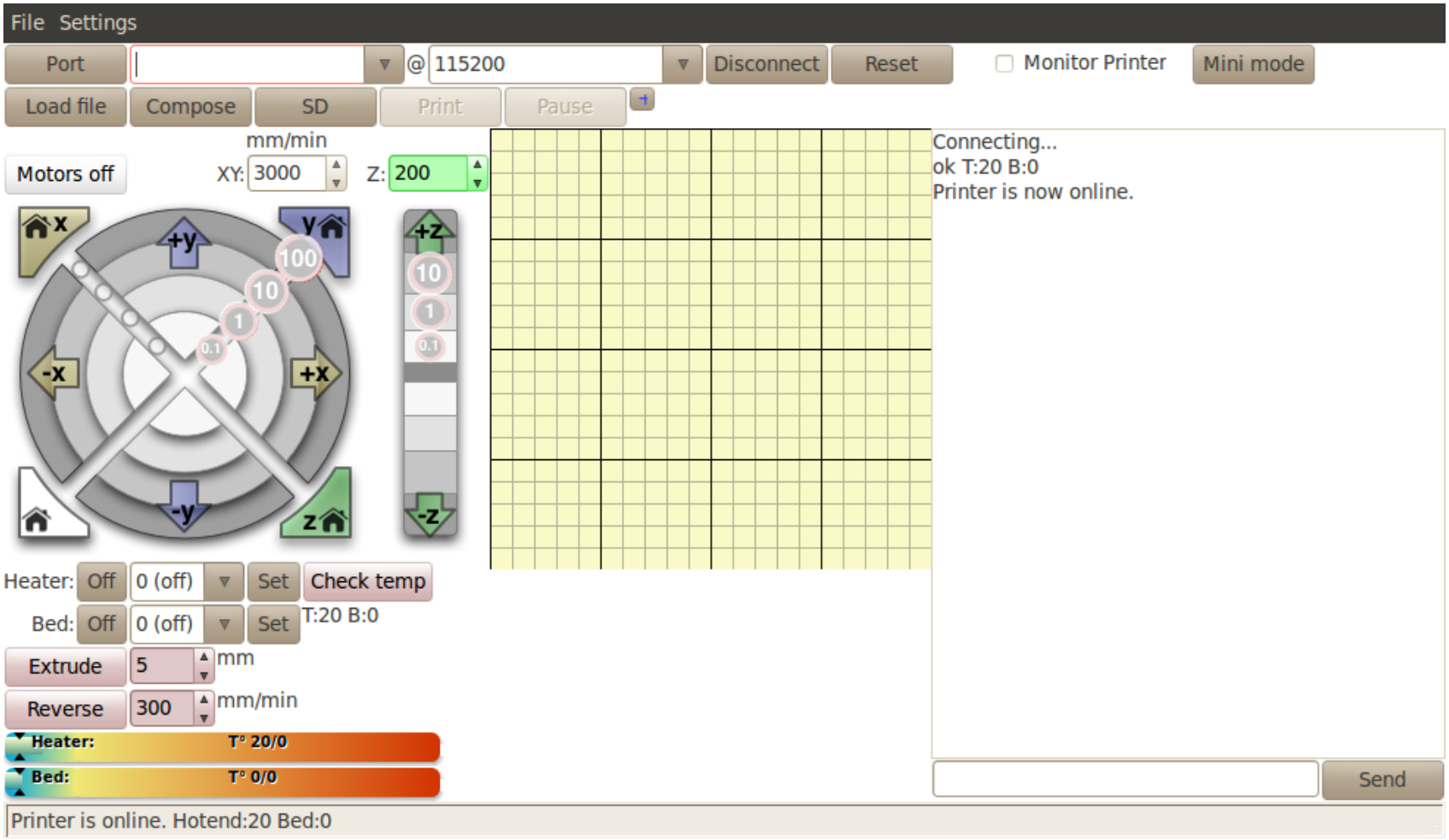
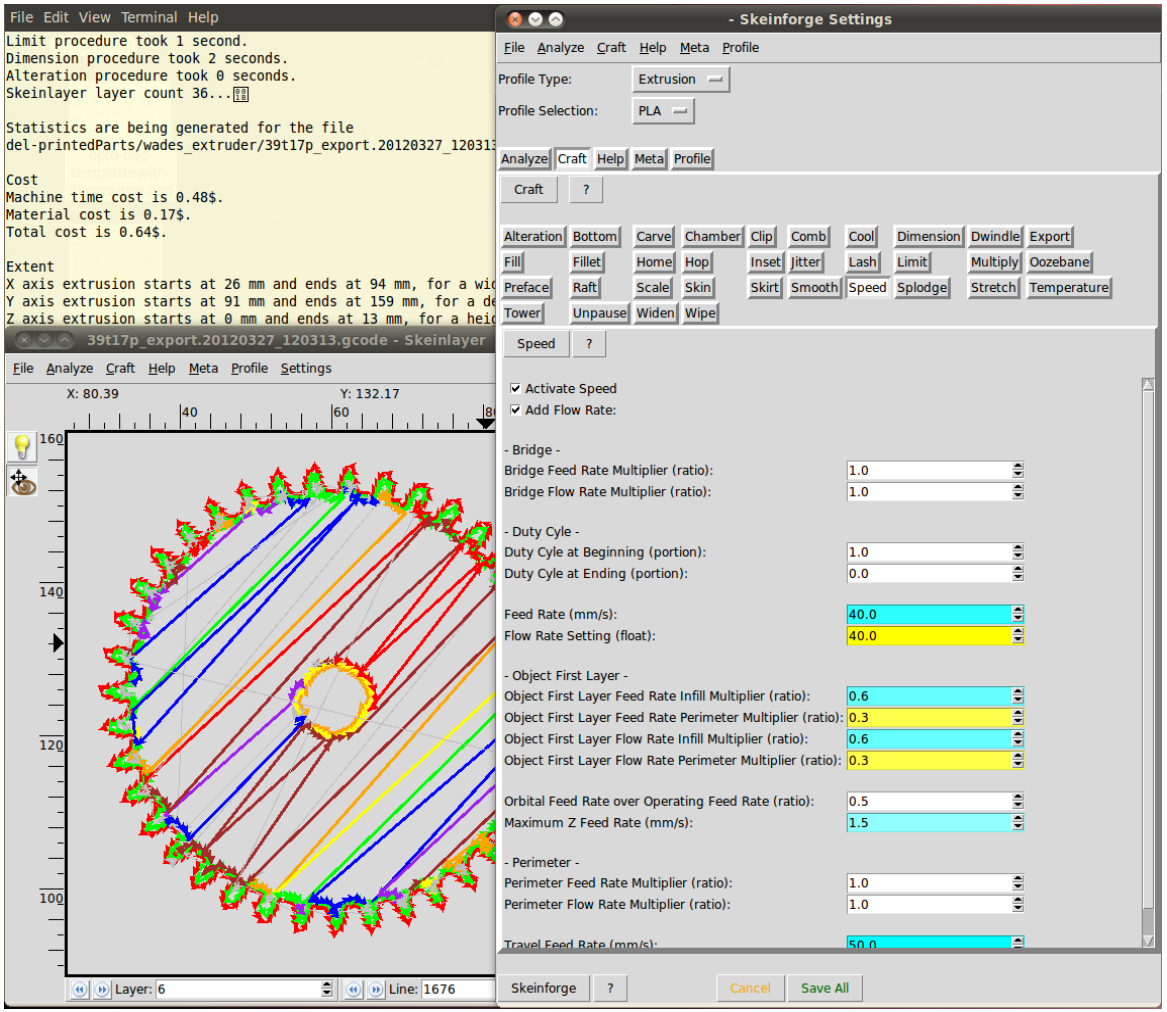


Figure: Pronterface User-Interface

Skeinforge Slicing



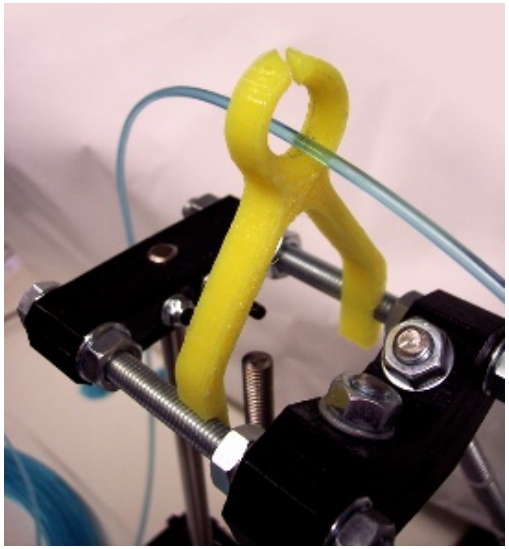
Skeinforge:

- python toolchain
- STL $\rightarrow$ GCode
- many tunable parameters

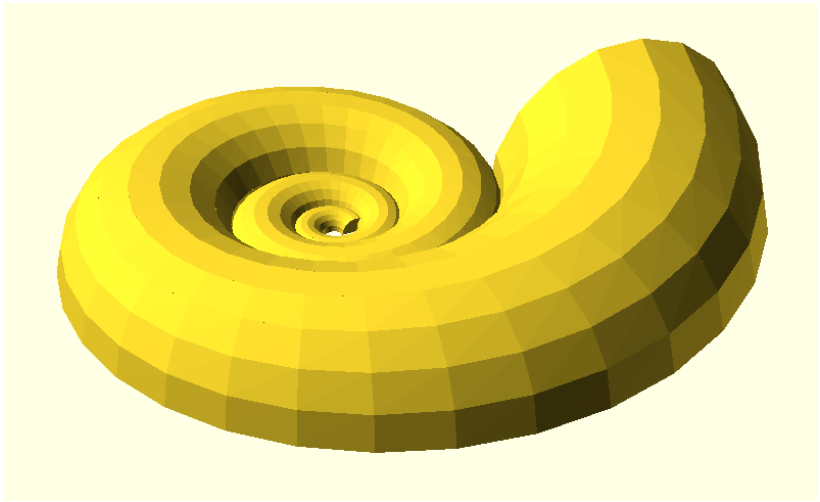
Results: First Prints and Problems

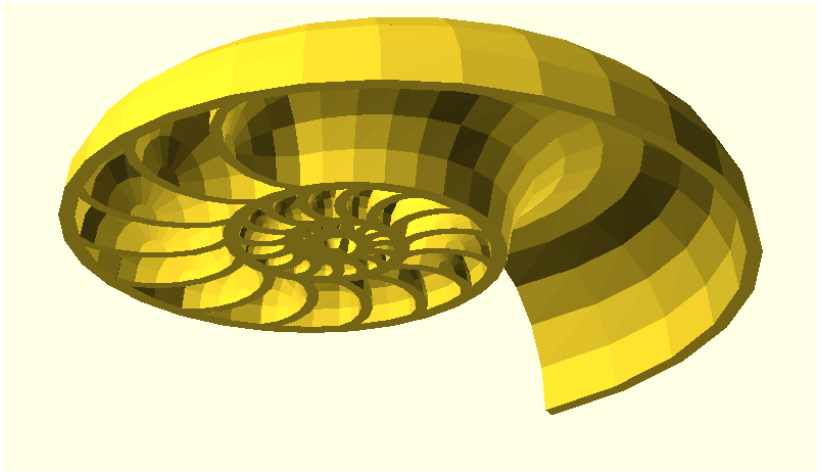
Modifications after first prints:

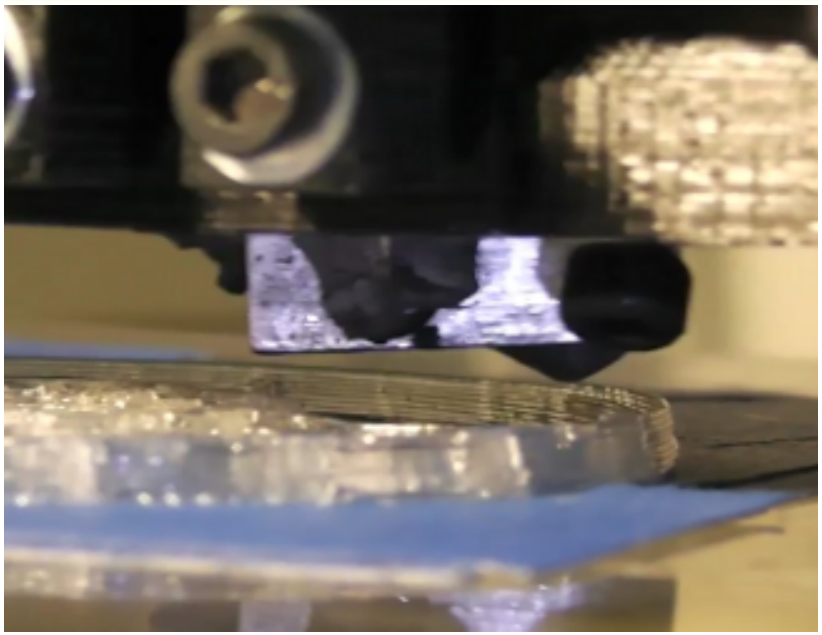
- calibrate and tune temperature and dimension settings
- add oil to the filament to reduce friction
- Filament bends and sometimes breaks above the extruder, Filamentguide solves this issue

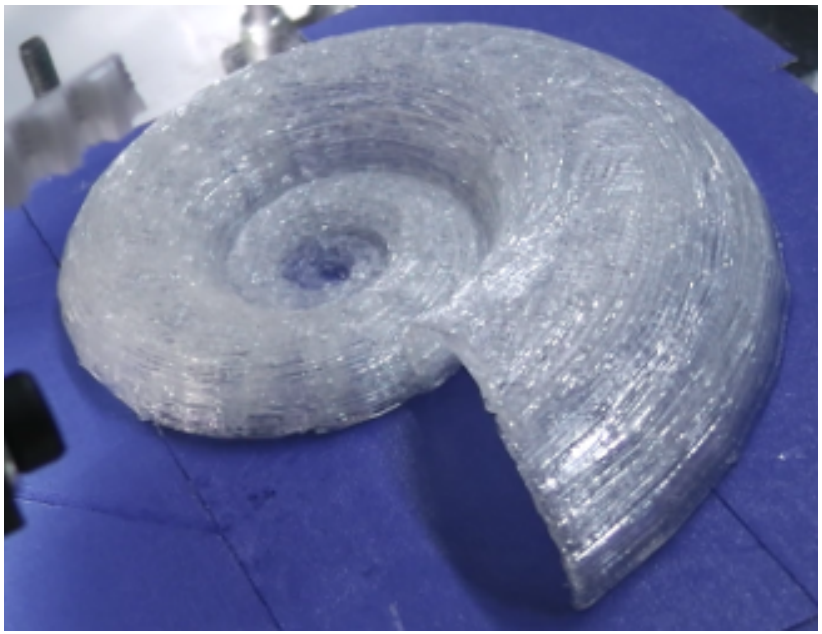


Thingiverse: Nautilus Shell

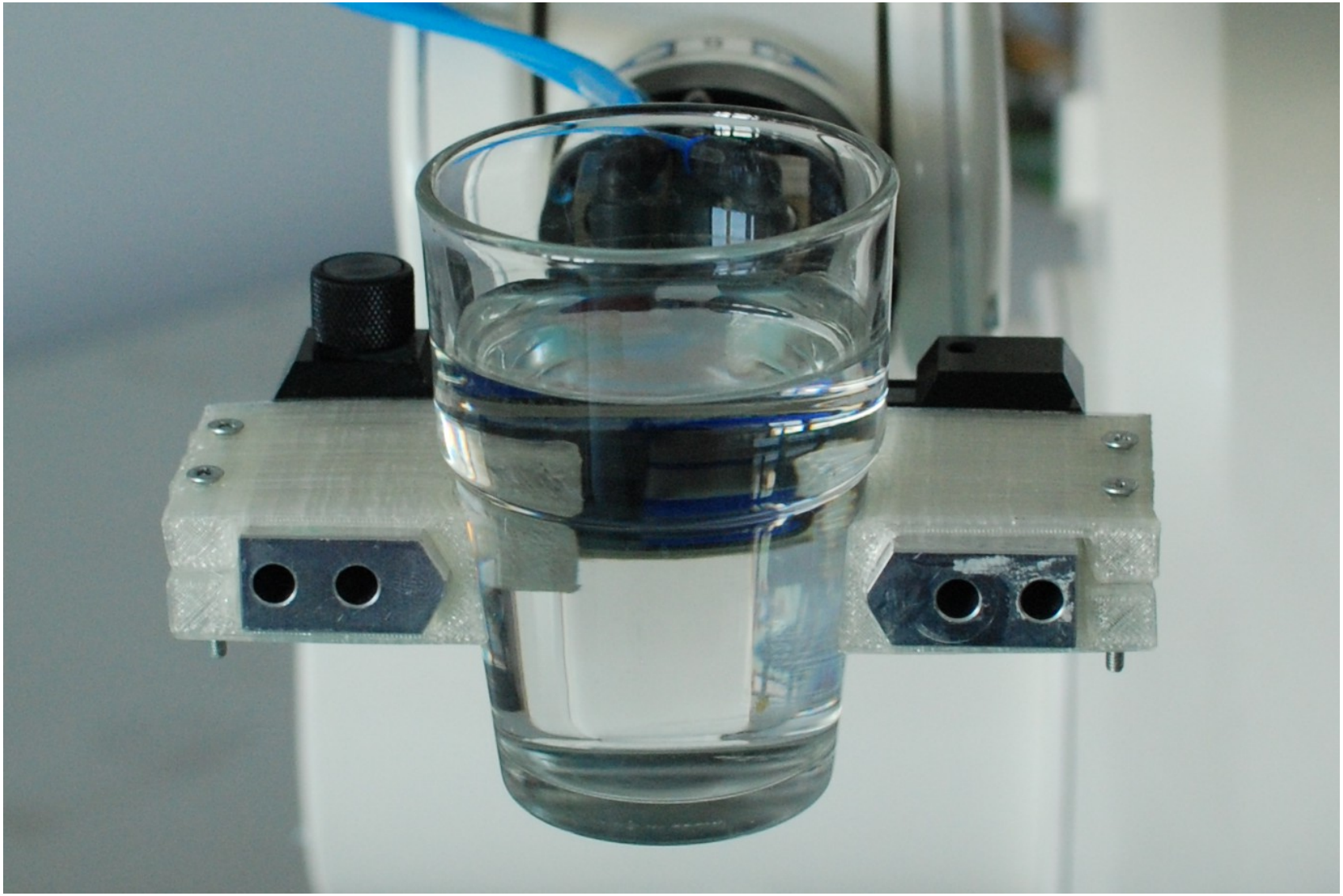








OpenSCAD Design: Gripper



Summary

Summary:

- RepRap allows low-cost 3D-printing
- Build, calibration and parameter tuning done in 5 weeks
- Software available for modelling, slicing and printing
- OpenSource allows rapid improvements in software and hardware

Links

More information and references:

- RepRap Wiki
- Sprinter Firmware, Printrun Host-Software
- Skeinforge

BSc Thesis and material:
`http://orb.uni-hd.de/publications/bsc-jschleic/`