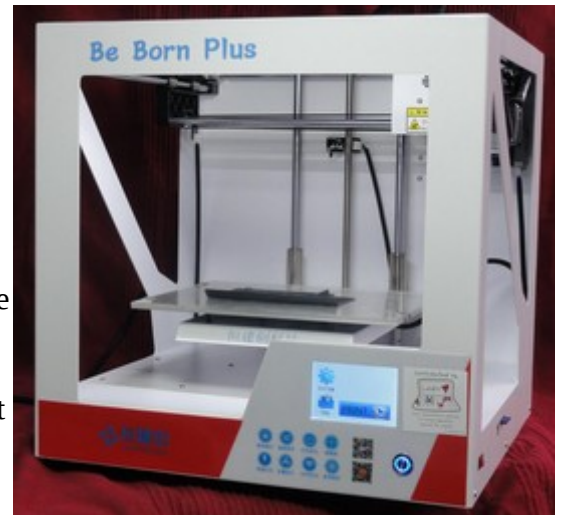


## Experience report 3D printer in the Labdoo project

### Current situation

Labdoo often receives IT donations with important parts such as hard drive covers, parts of the chassis, keys etc. broken. If spare-parts are even to buy, the spare parts cost a lot of money and often come from Asia (transport, CO2). Since Labdoo is funded solely by donations, these fundings should be used responsibly.

A long-cherished wish was the acquisition of a 3D printer, in order to be able to produce missing parts and thus to reduce the costs for spare parts. But in the past 3D printers were too expensive, too big, too slow, too sensitive. However, the rapid development in this area enabled us to purchase a 3D printer at reasonable conditions (less than € 400). Taking into account the consumables, these initial costs should have paid for themselves after about 40 spare parts.



So in December 2017 the charitable association Labdoo.org e.V. (Germany) bought a 3D printer BeBornPlus Prusa I3 <http://www.ebay.de/itm/263296461509> and gave it to the Labdoo Hub Rhein-Ruhr.

### The 3D printer

We chose the model BeBornPlus Prusa I3. It is compact (about 40 x 40 cm, about 10 kg). Some parts have to be mounted after delivery, but this is done quickly.

The illuminated work space does not calibrate automatically and must be readjusted manually after each print. The production of work pieces up to 24 \* 20 \* 20 cm are possible. A fan is built in, but sounds pretty loud.

Various materials can be processed. Labdoo uses PLA and ABS plastic (heat resistance up to 70 ° C, recommended, only the working surface for ABS must be preheated for approx. 25 minutes and cooled down for approx. 15 minutes).

The die (extruder) of this model processes filaments of 1.75 mm diameter and applies the material with 0.4 mm layer width and 0.1 to 0.4 mm layer height. Thus, the smallest possible structure of 0.4 mm in width is given. With filigree elements such as ventilation grids, one encounters limits here and you may have to construct parts coarser (bigger) than in the original template. There are small dies (extruder) with e.g. 0.2 mm diameter available, but this will double the printing time.

The working environment must be dust-free, without drafts and, if possible, in a constant temperature range (room temperature). At the same time, particularly when processing ABS, harmful vapors are produced. Solving this is a challenge.

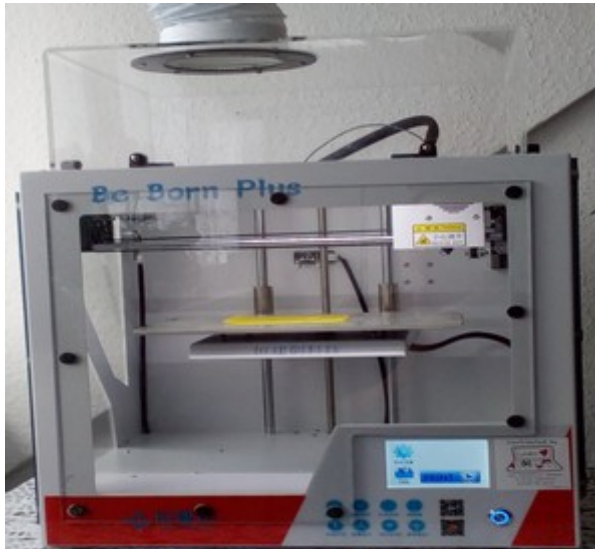
And you have to be patient - the 3D printing of one of the below shown spare part takes ca. 2 - 3 hours or more.

## Experience report 3D printer in the Labdoo project

### Exhaust air device and covers with magnetic holder

As the production of 3D parts causes fumes that may also be harmful to health, the 3D printing was improved by Labdoo helpers:

- The printer was sealed using adapted plastic covers on all sides. The covers are fixed by magnets and can be easily detached.
- A hood with a fan and exhaust pipe is placed as a suction on the printer. The exhaust air device vacuums the resulting fumes directly to the outside through the exhaust pipe.



### The work steps

#### CAD (recommended FreeCAD)

First, the 3D model has to be developed in a CAD program. **FreeCAD** is a free, open source software, available under Windows and Linux (already included in the Labdoo image for cloning). <https://www.freecadweb.org/> (release 16).

Either you design the workpiece with the CAD program or you might be sometimes be able to download prepared CAD models of workpieces from the internet. With luck, someone has already developed the required construction and put it on the web as a free model.

It is important to carefully measure the template or the workpiece and transfer data into the model.

#### Slicer (recommended Slic3r)

Having finished the 3D CAD model next step is to work out the layer model. The layers and their data is needed to send their data to the 3D printer to print the workpiece. The "Slic3r" program (<http://slic3r.org/>) has proven to work well with FreeCAD and our 3D printer.

## **Experience report 3D printer in the Labdoo project**

The transfer of slicer data to the 3D printer can be done via USB, SD card and WiFi. Under Linux, it is recommended to save the layer data directly from Slic3r onto an SD card and read it out in the printer, as some utilities of the 3D printer were only made available running Windows.

### **Filament** (plastic strands)

Filaments are available in different colors, materials and qualities. Pay attention to a good quality, because otherwise the printed part is bit brittle and is difficult to rework (finishing, edges etc.). Filaments should be stored dry because they attract moisture ("hydrophilic").

The filament manufacturer will specify the pressure temperature and temperature of the heated work space.

### **The 3D print**


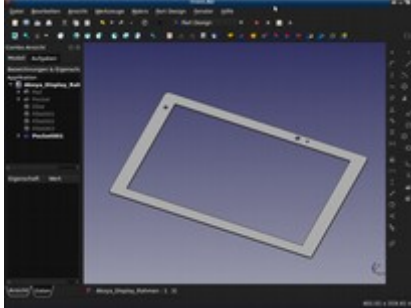
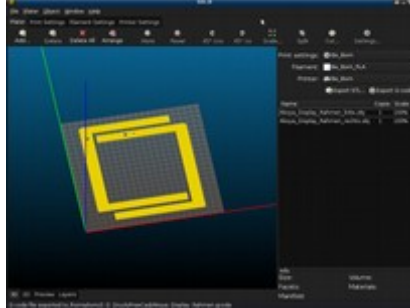
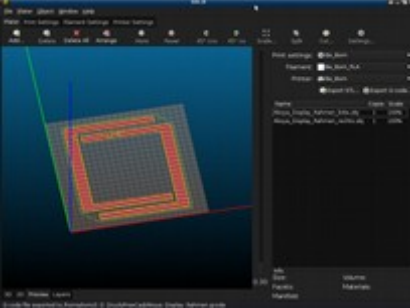
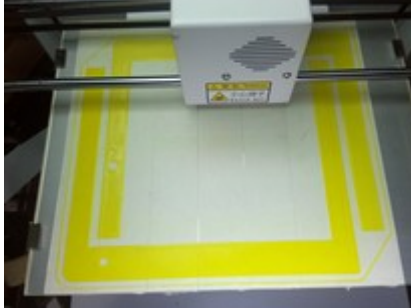

Then the 3D print takes place. In practice, we have found that the printed workpieces are minimally smaller than they should be after CAD design. Presumably, the material shrinks on cooling. For complex and filigree structures, gravity is a factor ;) If e.g. a thin, sloping surface cantilevered "in the air" and it is printed, the warm, soft material bends "through" a bit. Then you get a slight curvature, where actually should be a straight surface.

Also, post-processing is almost always required, e.g. for smoothing the edges. Also filigree structures such as tabs, ventilation grille etc. can only be reproduce conditionally ("as close as possible to the original, but not so small details").

## Experience report 3D printer in the Labdoo project

### Examples of 3D prints in the Labdoo project

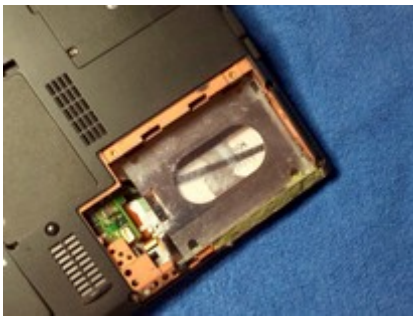
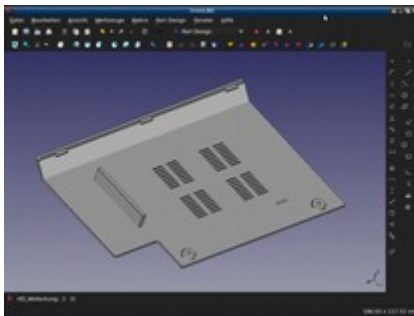
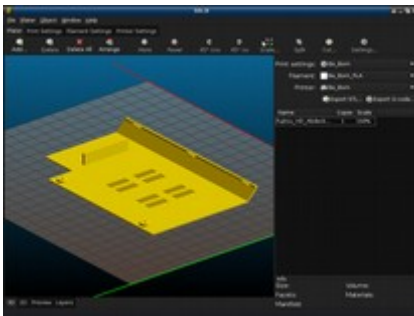
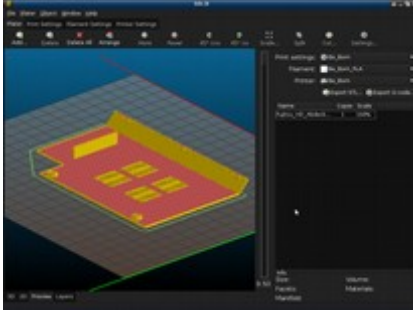


#### Akoya netbook (missing frame to cover the monitor)

We got donated...	The FreeCAD construction	The Slic3r construction
		
The Slic3r layer model	The 3D printing	The result
		

Please do not mind the yellow color of the workpieces. This material was delivered with the 3D printer as a basic equipment. There are of course other colors :) And so you can see the produced work pieces better in the photos taken ;)


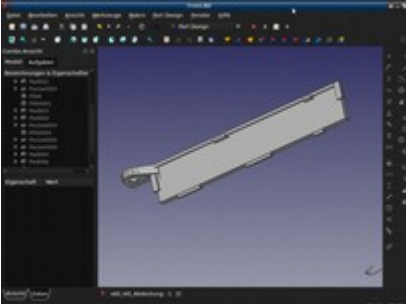
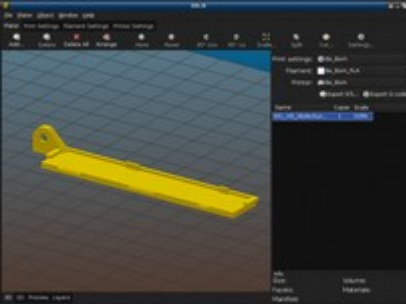
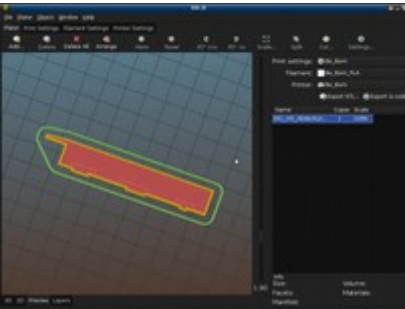


# Experience report 3D printer in the Labdoo project

## Fujitsu Laptop (missing cover hard drive)

<b>We got donated...</b> 	<b>The FreeCAD construction</b> 	<b>The Slic3r construction</b> 
<b>The Slic3r layer model</b> 	<b>The 3D printing</b> 	<b>The result</b> 

## Experience report 3D printer in the Labdoo project

### Lenovo X60 (Missing cover disc drive / HDD)

We got donated...	The FreeCAD construction	The Slic3r construction
		
The Slic3r layer model	The 3D printing	The result
		

### Conclusion

All described components (3D printers, FreeCAD and Slic3r) work well together and have proven their usability.

The technological progress is fast in 3D printer market. Therefore, this review can only be a snapshot taken during winter 2017/18. What is valid today, can be outdated tomorrow :)

Mülheim an der Ruhr, December 2017

The team of the Labdoo Hub Rhein-Ruhr