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# **Cloudmesh Raspberry PI Cluster Case**

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## 1 Raspberry PI 5 Node Cluster Case

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TODO: move designs from

[https://drive.google.com/drive/folders/1D8YjtOAh8FemuruPYPWuV4zYNxszW\\_wN](https://drive.google.com/drive/folders/1D8YjtOAh8FemuruPYPWuV4zYNxszW_wN)

to this github, only keep final design here.

### 1.1 Abstract

Why do we need PI clusters ....

- iu course

Why do we need a case ...

- protect, students take cluster home, students bring cluster to class

How do we anticipate the case is used ...

- want to have access to the components for reuse

Based on these requirements we are designing a Raspberry PI Case for five PI's out of laser cut sheets with the goals of keeping the design as simple as possible, using few parts as to minimize production costs, allowing for easy assembly without screws or glue, while making it structurally sound. Furthermore we allow reproducability through open sourcing the design.

To accommodate larger clusters in the classroom setting a Shelf is proposed in which we place the miniclusters while attaching it through a power distribution bar and a large network switch to integrate the individual clusters into the larger cluster. Furthermore we want to create a product in a box called *Cloudmesh Pi Cluster* that we can give to students so they can assemble such a cluster themselves, or order the parts directly from us and we ship the parts and the cluster case to them.

## **1.2 Introduction :o: this is an experience report or a result, but not an introduction**

On the first day of the internship, the students talked to Gregor and were presented with a challenge to create their own design for a case for Raspberry PI computers. Their first big hurdle in the design process was deciding on an initial design and learning the chosen modeling program well enough to build it. They brainstormed a fairly simple first design, then decided to just start modeling. OpenSCAD took a little time to get used to, because of the programming only orientation, but the students learned enough to build the first prototype. It was very simple compared to the most current versions now, but all things considered was very impressive, and it had many of the elements still central to the current design. The students had two major innovations present in their first prototypes, in one of them, the peg and slot system still used today, and the other, the smaller interlocking pieces used to distribute strain in the case. The first models had none of the refinements of the newer prototypes, but were a very important and large step in the process. These prototypes started what has been the most used and most important process in the design of the case: design, build, test, analyze, repeat. This process allowed the students to rapidly design and test, moving the case closer and closer to completion, removing problems and addressing the requirements along the way.

## **1.3 Requirements**

There were a few requirements presented to us at the beginning of the design process: The cluster had to hold at least 5 Raspberry PI 3 computers as well as a network hub and a power brick, it could not use any glue to stay together, it had to fully encase all parts while having holes for any ports and ventilation, it had to keep all components secure and safe, and the code had to use only variables to

define the parts so any change could be easy to adjust to. While there were other components that would be nice to have, these were the main pieces that had to be incorporated.

## 1.4 Design

Laser cut parts utilize 3mm cut-to-size acrylic supplied to IU from [https://www.tapplastics.com/product/plastics/cut\\_to\\_size\\_acrylic](https://www.tapplastics.com/product/plastics/cut_to_size_acrylic). Acrylic may come cast or extruded. Choosing cast acrylic will give a higher quality in color and engraving but it is also more expensive. Here is a list of acrylic options based on the size of the case arranged as it would be for cutting; this is about 21 3/16inx 15in.

- Extruded Acrylic (Clear): \$11.16
- Cast Acrylic (Clear): \$16.41
- Cast Acrylic (Transparent Colors): \$18.81

The list of parts not including the custom made laser cut parts is provided in Table 1.

Table 1: Parts list as copied from <https://github.com/cloudmesh-community/book/blob/master/chapters/pi/case.md>

Price	Description	URL
\$29.99	Anker 60W 6-Port USB Wall Charger, PowerPort 6 for iPhone 7 / 6s / Plus, iPad Pro / Air 2 / mini, Galaxy S7 / S6 / Edge / Plus, Note 5 / 4, LG, Nexus, HTC and More	<a href="#">link</a>
\$8.90	Cat 6 Ethernet Cable 1 ft White (6 Pack) - Flat Internet Network Cable - Jadaol Cat 6 Computer Cable short - Cat6 Ethernet Patch Lan Cable With	<a href="#">link</a>
\$29.99	Netgear SOHO Switch, 8 port	<a href="#">link</a>
(\$19.99)	Alternative to Netgear switch but not tested for the case: D-link 8-Port Unmanaged Gigabit Switch (GO-SW-8G)	<a href="#">link</a>
\$10.49	SanDisk Ultra 32GB microSDHC UHS-I Card with Adapter, Grey/Red, Standard Packaging (SDSQUNC-032G-GN6MA)	<a href="#">link</a>
\$8.59	Short USB Cable, OKRAY 10 Pack Colorful Micro USB 2.0 Charging Data Sync Cable Cord for Samsung, Android Phone and Tablet, Nexus, HTC, Nokia, LG, Sony, Many Digital Cameras-0.66ft (7.87 Inch)	<a href="#">link</a>
\$7.69	50 Pcs M2 x 20mm + 5mm Hex Hexagonal Threaded Spacer Support	<a href="#">link</a>

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Price	Description	URL
\$7.99	Easycargo 15 pcs Raspberry Pi Heatsink Aluminum + Copper + 3M 8810 thermal conductive adhesive tape for cooling cooler Raspberry Pi 3, Pi 2, Pi Model B+	<a href="#">link</a>
\$34.95	5 * Raspberry Pi 3 Model B+ Motherboard	<a href="#">link</a>
\$6.99	HDMI Cable, Rankie 2-Pack 6FT Latest Standard HDMI 2.0 HDTV Cable - Supports Ethernet, 3D, 4K and Audio Return (Black) - R1108	<a href="#">link</a>

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- (1) items were replaced with similar :o: note the network switch is a different one, find the one we have so it can be recreated with our part for whcih we designed the case

## 1.5 Alternatives

There were a few alternatives we looked into for creating the case before settling on the current solution.

- This program creates basic boxes based on any dimension provided by the user.
  - <https://www.festi.info/boxes.py/>

## 1.6 Manufacturing Facilities

Most of our testing and production of cases were conducted at the maker space at Luddy Hall of IU's School of Informatics and Computing Engineering. Luddy Hall has two laser cutters, both from Trotech; the Speedy 360 and the Speedy 400. The 360 has a 813x508mm bed while the 400 has a 1000x610mm bed. For our chosen material, acrylic, the machines can cut for material thicknesses less than 6mm. To ensure that the material will fit into the laser cutter, ordered acrylic sheets are limited to the dimensions of the bed minus a quarter inch.

## 1.7 Converting the Design for Laser Cutting

To produce a physical copy of our prototypes, we could not simply use the file in its SCAD format. To ready the design for laser cutting, we first had to export the file as a SVG. Once this is done, the file can be edited in a graphic design program, such as Adobe Illustrator. Edits required to prepare the design include the removal of the interior fill color of the case components and adjustment of the edges for cutting. The laser cutter is preset to cut along red lines with a low thickness. For the prototypes, we used a 0.03 point thickness.

The design must also be correctly scaled to the right size. So far, we have achieved the correct scaling by finding a feature within the design and finding the correct scale factor by measuring it. We are currently considering the possibility of using the size of the rectangle the case fits into; this should speed up the process, since the dimensions can be viewed in Illustrator by clicking on the artboard tab on the right vertical tool bar and selecting the artboard settings button. Once the design is appropriately scaled, the artboard must be scaled up as well.

Once all editing is done, the design can be cut. This can be done by selecting the print option in the graphic design program and clicking on settings, in Illustrator, this can be found in the lower left corner of the main print window. If the laser cutter is not selected as the printer, it will need to be selected. The dimensions in the print settings will also need to be adjusted if they are smaller than the size of the design; in Illustrator, the size can be changed under preferences, which is located directly beneath the printer selection. The settings window can now be closed and the “print” button on the main print window can be selected. This will send the file to the laser cutter as a job.

## 1.8 Images

Images of the case, place them where needed

The case is shown in Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17.

test fig. 17.

create proper sentences with refs for images

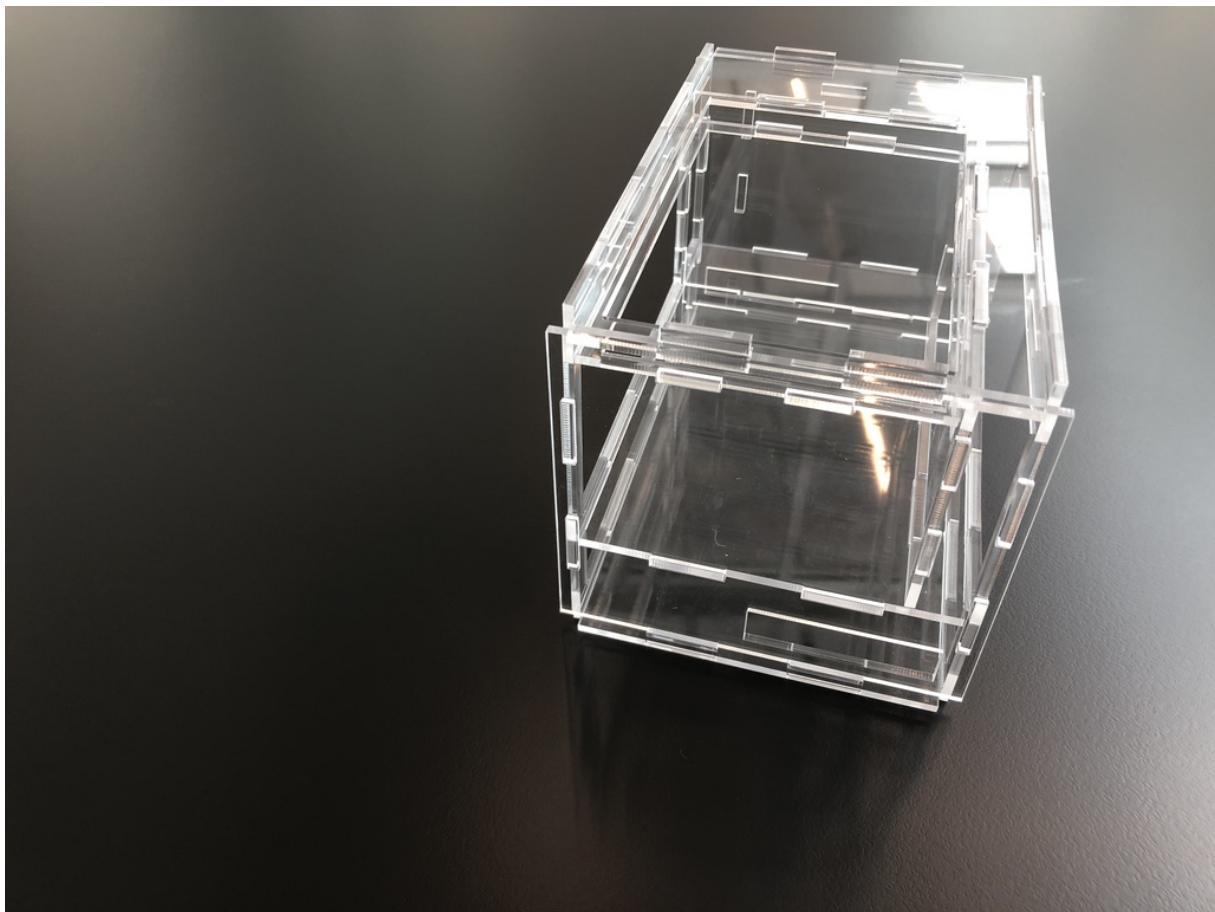
### 1.8.1 Transparent Case



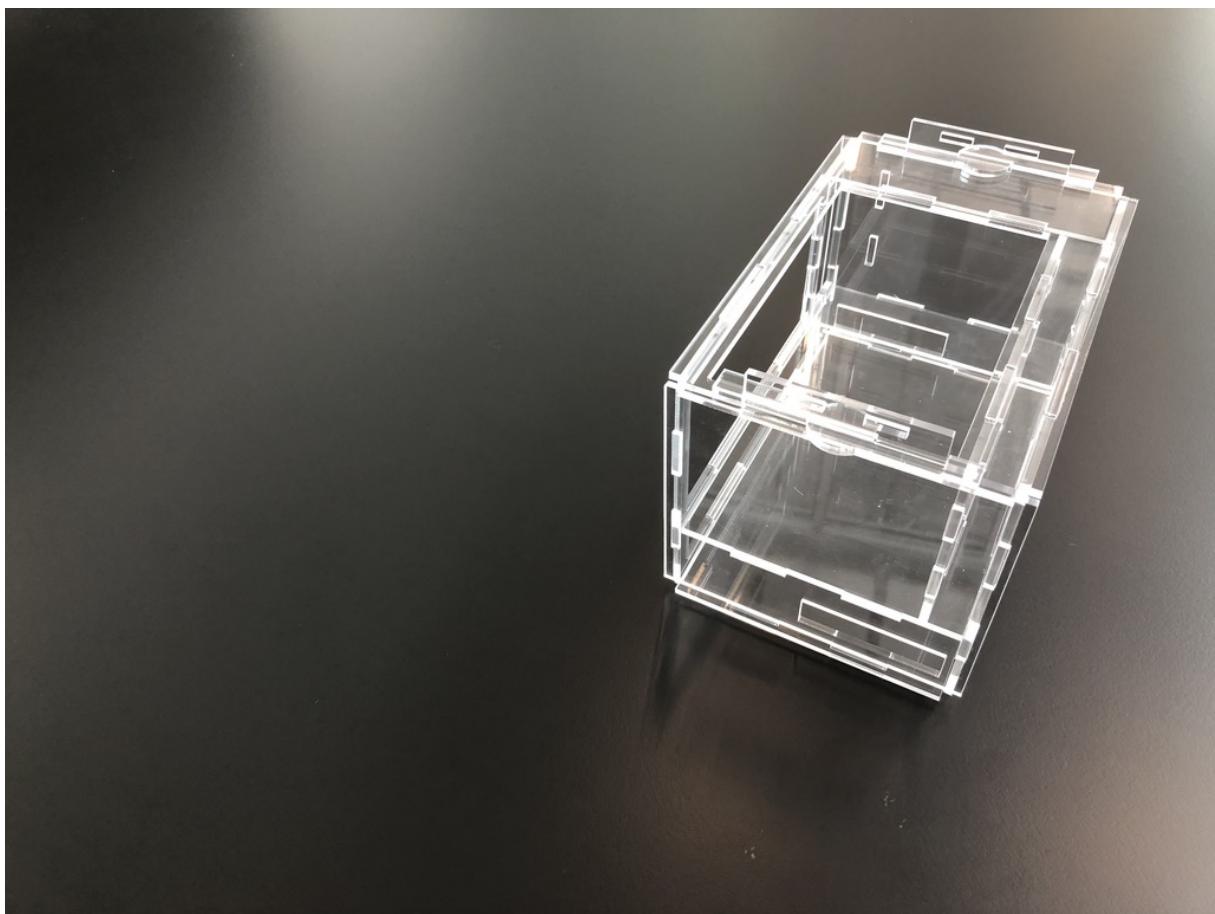
**Figure 1:** Case



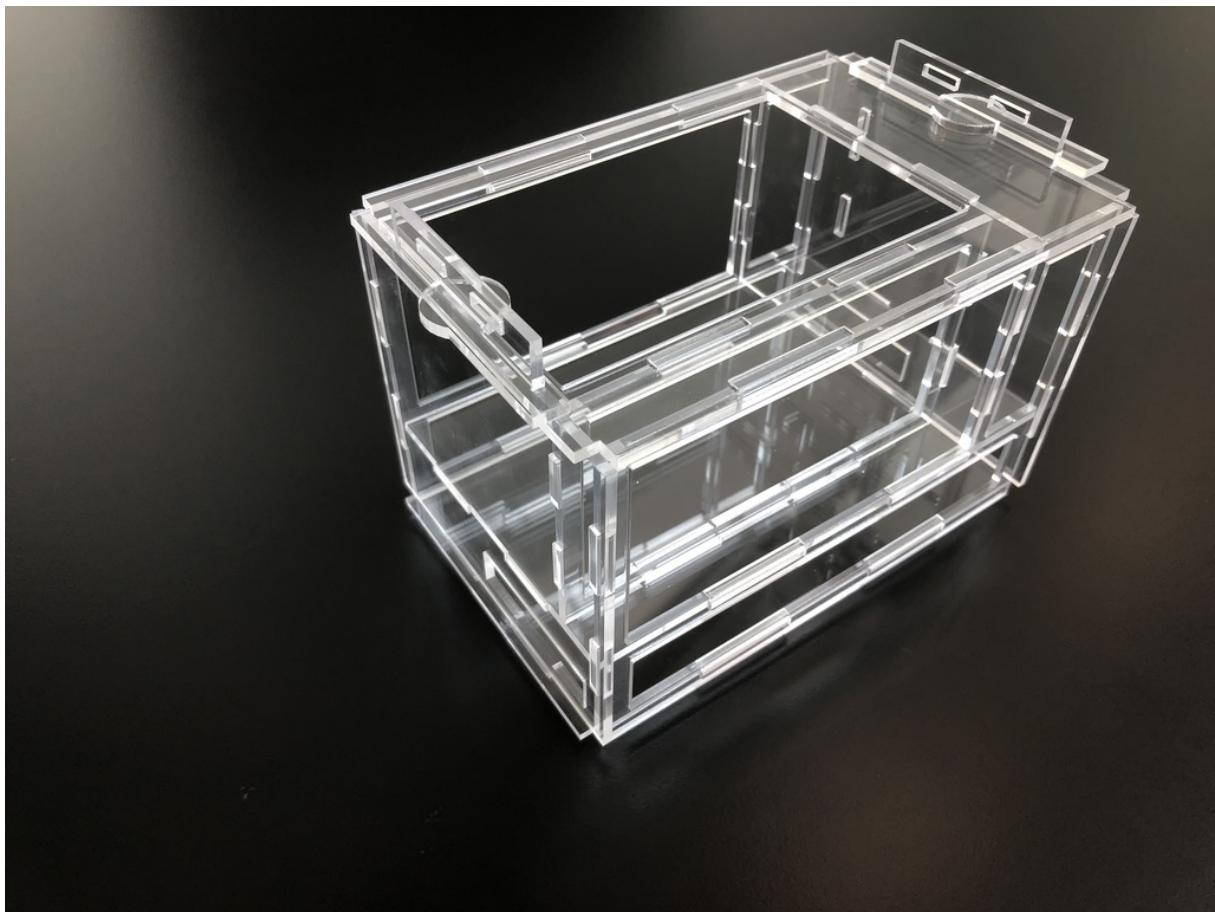
**Figure 2:** Case



**Figure 3:** Case



**Figure 4:** Case



**Figure 5:** Case



**Figure 6:** Case

### 1.8.2 Red Case



**Figure 7:** Case



**Figure 8:** Case



**Figure 9:** Case

### 1.8.3 Balck Case



**Figure 10:** Case



**Figure 11:** Case



**Figure 12:** Case



**Figure 13:** Case

### 1.9 Exhibit

Exhibit at make vention, urls, and so forth, describe what it is



**Figure 14:** Case



**Figure 15:** Case



**Figure 16:** Case



**Figure 17:** Case

## 1.10 Product

Here is the progression of our design, from the first prototype to our most recent model, as well as a link to the .scad and .svg files for the most recent case designs:

- <https://github.com/cloudmesh-community/case/tree/master/design/openscadfiles>

COMMENT: Not sure if I should put anything else in this section

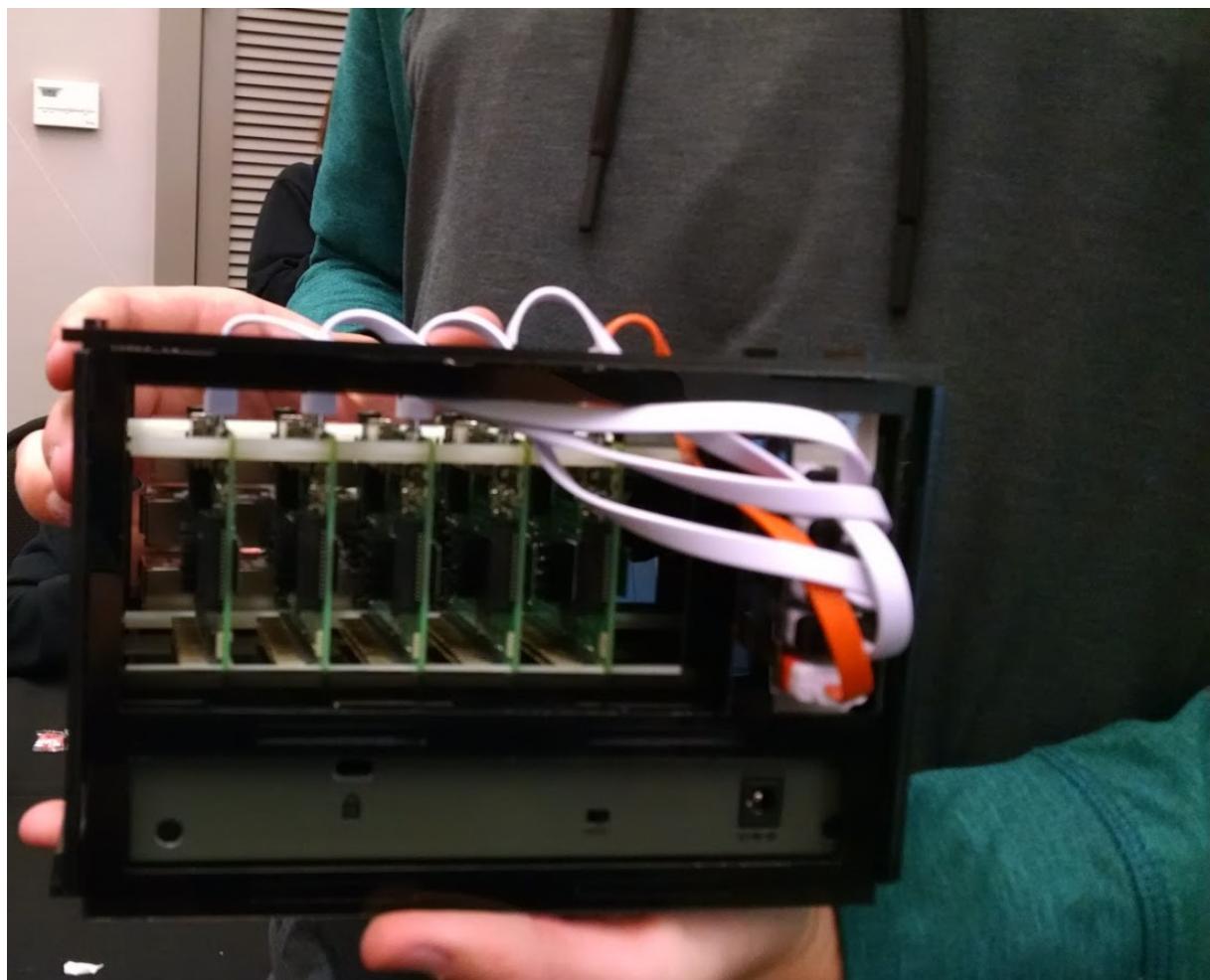
The case si shown in Figures 18, 19, 20, 21, 22.



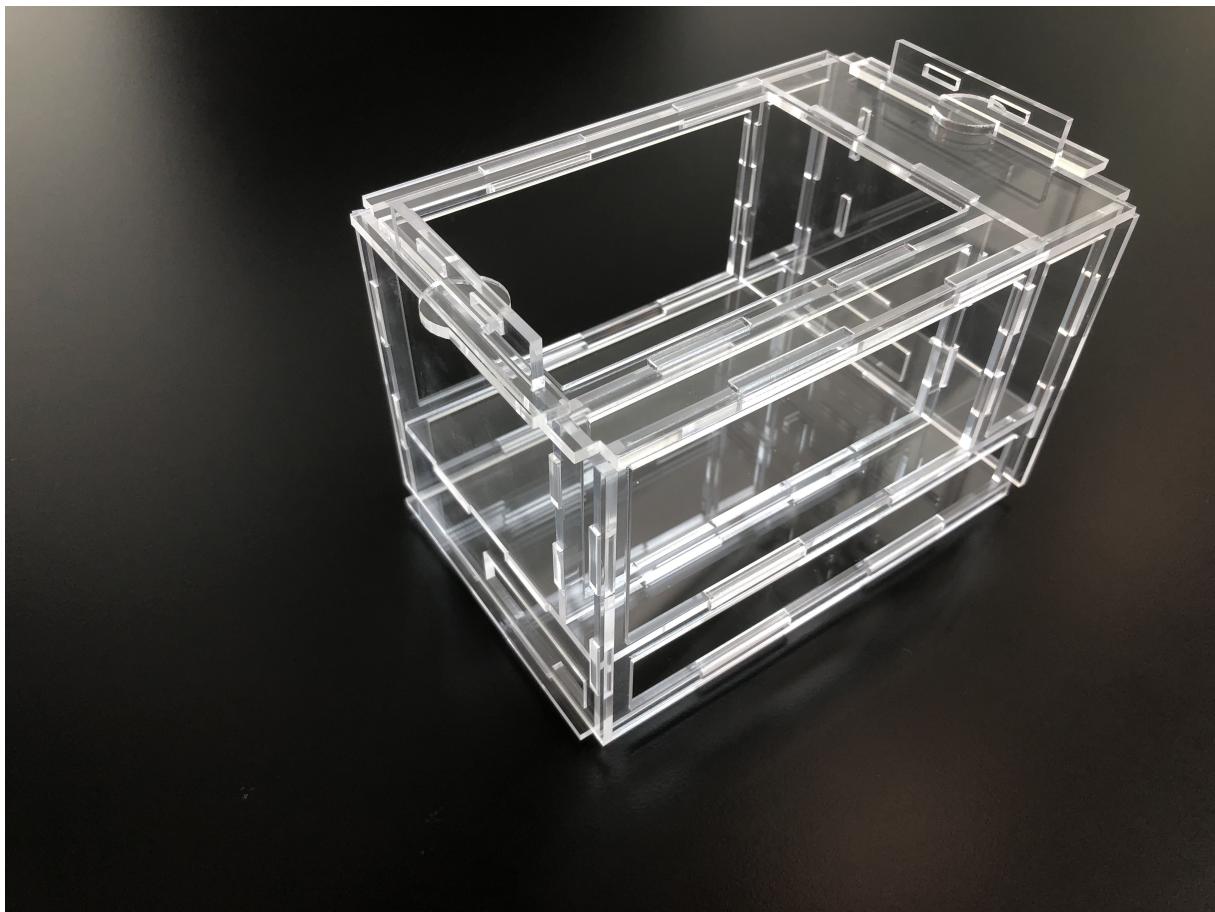
**Figure 18:** Prototype 1



**Figure 19:** Prototype 2



**Figure 20:** Prototype 3



**Figure 21:** Prototype 4



**Figure 22:** Prototype 4

### 1.10.1 Cloudmesh Pi Cluster in a Box

This section describes the design of the box in which we package the cluster ready for shipping or distribution to students.

## 1.11 Future work

We will continue to work on the current design, but it is nearing completion, and we have a few more related projects for the future:

- 19 inch rack for 40 nodes via bitscope, <https://www.festi.info/boxes.py/Rack19Box>
- Shelf for 5 Pi cases.

COMMENT: Should I add more here?

This section lacks details that you need to add. See the links for example in the references which already have some information. You also need to create the shelf in some fashion while placing the clusters in it to demonstrate how the shelf would look like.

Here we test a reference [@www-test]. They need to be placed in references.bib in bibtex format.

## 1.12 References

- Other cases are at <https://github.com/cloudmesh-community/book/blob/master/chapters/pi/case.md>
- Website for OpenSCAD <http://www.openscad.org/index.html>