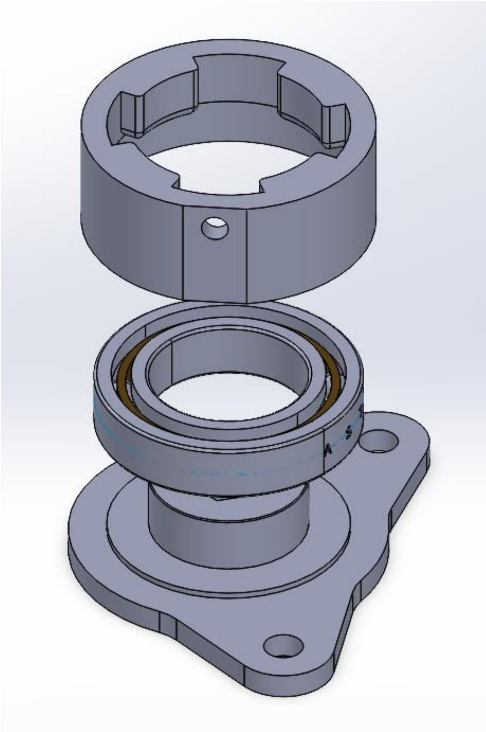
## Contents

# Improvements

## *Press-Fits*

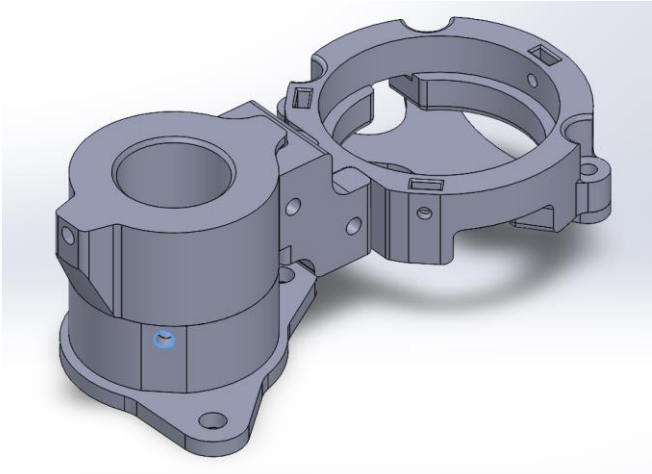
The press-fit between 3D-printed parts and the bearing loosened over time due to vibrations and regular use. The 3D-printed components that are press-fit onto the bearing are "**Bearing_Ring_Final"** and **"Base_Final"**. To increase the tightness of the fit and prevent loosening one could try adding epoxy or superglue between the press-fit components. One could also try to change the tolerances on the parts to allow for a tighter fit. The best interference fit should be achieved when the diameter of the 3D-printed part is approximately equal to the diameter of the bearings +/- 0.1 mm.



*Press-fit components in the assembly*

## *Loose Components*

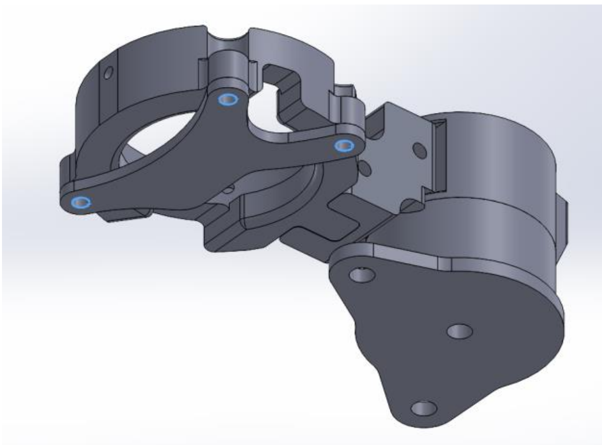
With regular use and vibrations, the connections between **"Bearing_Ring_Final"** and **"Arm_Final"** loosened. Note that this connection is accomplished with a single screw (fed through **"Bearing_Ring_Final"**) and a captive nut in the **"Arm_Final"** part. To reduce play between the parts, two or three more captive nuts can be added to **"Arm_Final"**. To prevent the screws from loosening, one can add a thread locker (e.g., Loctite).



*Single hole which accommodates a screw which threads into a captive nut in* **"Arm_Final"**

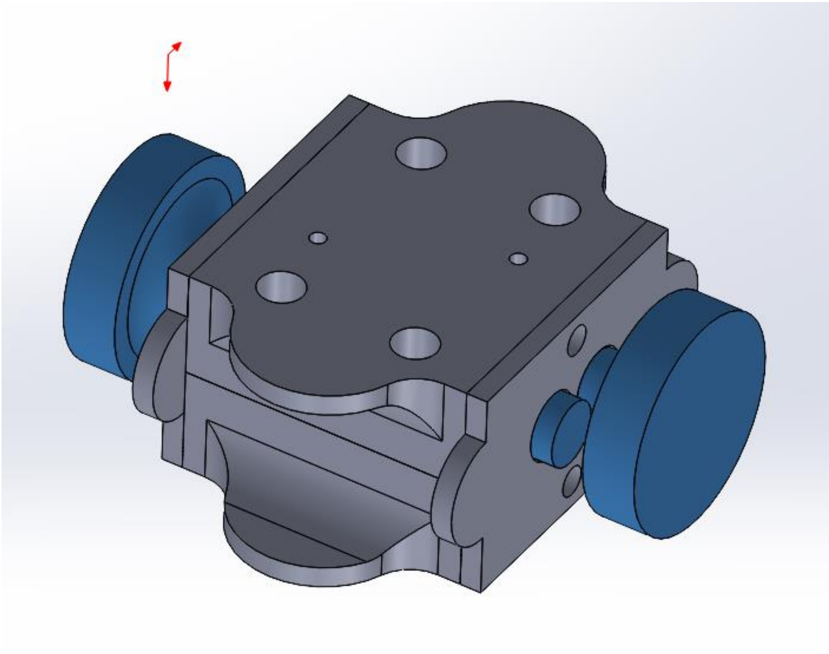
### *Heating Source*

The heating source successfully heated up the melting cup however there were a couple of issues. First, the heating unit is difficult to mount. It requires the part **"Cap_Final_Large"** to support the silicon sock which holds the temperature probe and the cartridge heater. One improvement would be to replace the current mounting method (which using screws and nuts) with a clip-on method leveraging the flexibility of thin 3D-printed components.



*Bracket named* **"Cap_Final_Large"** *mounted to the underside of* **"Cup_Final"**. *The bracket is mounted to* **"Cup_Final"** *using screws which feed through both parts, and nuts.*

Another issue with heating source is that it requires a custom silicone sock to hold the components. The silicone sock is manufactured using RTV silicone (thermal gasket material) and a custom, 3D-printed mould consisting of the parts, **"Silicone_Sock_Side(s)"**, **"Silicone_Sock_Top_Bottom"**, and **"Silicone_Sock_Rod(s)"**. One improvement would be to replace the part **"Silicone_Sock_Rod(s)"** by aluminum rods with an equivalent diameter. Metal rods would be less prone to breaking and could be easier to extract with hand tools.



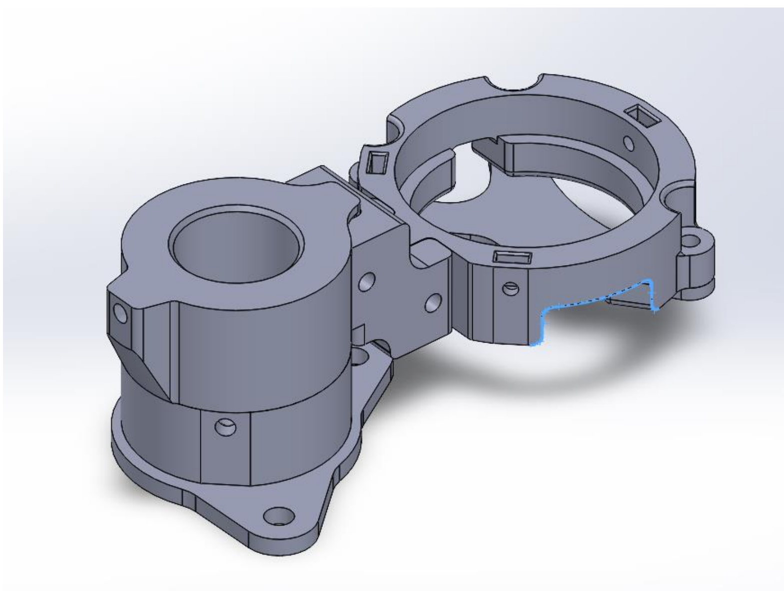
*The silicone mould, the parts* **"Silicone_Sock_Rod(s)"** *can be replaced by aluminum rods*

Since the cartridge heater is cylindrical, there can only be a line of contact between it and a flat surface. To maximize heat transfer, the cartridge heater was mounted in a thermally conductive silicone sock. The silicone sock served to enable a plane of contact with the bottom of the cup. An alternative to the cartridge heater is a nichrome-wire coil (or another similar material) embedded in silicone and adhered to the bottom of the melting cup. It may also be possible to design a PCB which incorporates a resistive, heating coil. An example of this is shown in the following video, https://www.youtube.com/watch?v=2cvDjeSUgwY.

An issue with the temperature probe is that is large relative to the size of the melting cup. It is also cylindrical meaning that it needed to be mounted in a silicone sock to enable a plane of contact with the melting cup. An alternative to the temperature probe used in the first prototype is a thermocouple. The thermocouple can be mounted with silicone directly to the underside of the cup. The thermocouple will require a voltage divider.

### *Melting Cup*

The melting cup mounts directly in the 3D-printed part, **"Cup_Final"**. The aluminum melting cup is ribbed and **"Cup_Final"** has diametrical tolerances such that the two parts snap into each other. To further secure the melting cup in the 3D-printed part, three set-screws with captive nuts were added. To reduce assembly time, the number of set-screws can probably be reduced to one or two. The main issue with **"Cup Final"** is that the exiting tube (which connects to the fluidics module via a peristaltic pump) tends to interfere with the drill when the melting cup assembly is retracted, and the drill is boring. To solve this problem, the tube exit port should be moved to the other side of **"Cup_Final"**. However, since the other side already contains the exit port for the temperature probe and cartridge heater wires, some re-arranging will be necessary to ensure that all the components can fit.



*Exit port for the tube in the 3D-printed part* **"Cup_Final"**

### *Electronics*

The electronics all worked however there were several issues with connections. First, the connections to the stepper motor and the three pumps should be changed to JST or MOLEX. In the current prototype, screw terminals soldered to a perf-board and mounted in a 3D-printed case are used for connections. The connections to the temperature probe and cartridge heater or thermocouple and heating coil should be swapped from JST or MOLEX connectors as well.

The electronics fit within a fairly large case. To make the electronics more compact, a custom PCB should be made for the heater/stepper motor control circuit. The PCB would incorporate headers to mount the Arduino and connections for the stepper driver and transistor. Another PCB could be made for the fluidics module. This PCB would also have headers to mount the Arduino. To save more space, the current H-Bridge modules could be substituted for three compact L9110H chips. These modules can be directly soldered onto the PCB.