

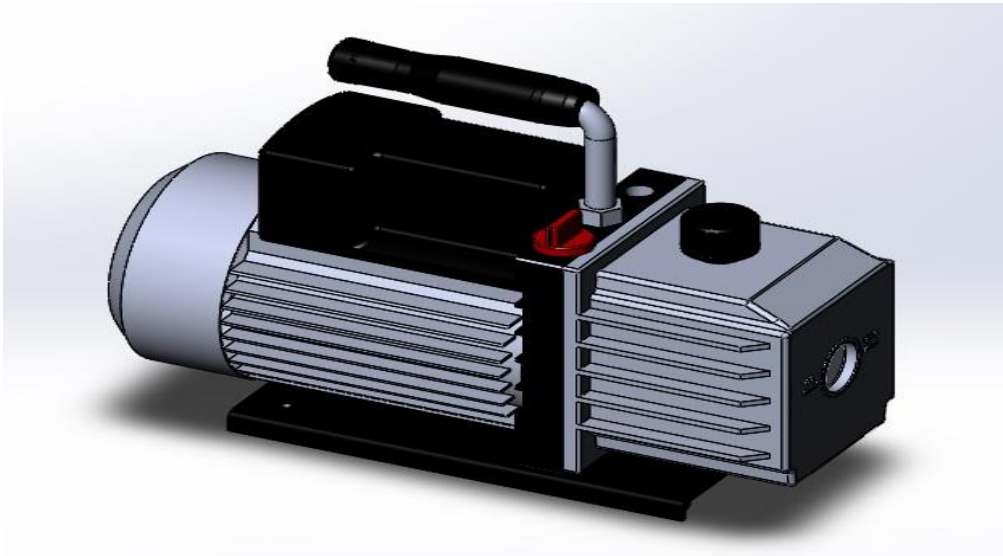
## 1.5 Concept Generation

### System 1 (Degas Silicone)

The client's most important stated need is a lack of porosity. Because of the relatively high viscosity of silicone it is very common for air to be trapped within it. This will be one of the greatest sources of air throughout the process, so it is necessary that it be removed in order to avoid porosity.

#### *Concept 1 (Vacuum)*

Concept 1 removes air from the medium by placing it in a vacuum chamber. This is a very common method in industry, and very simple. By removing the ambient air, the silicone will expand up to 400% as the bubbles are pulled up to the top. At a critical point, the silicone will contract after enough air is removed from the mixture.



*Figure 1 Vacuum Pump used to evacuate air from a chamber or bag.*

*Pros:* This method can accommodate a large amount of silicone. In addition the vacuum pump can be utilized elsewhere in the design, requiring less hardware overall.

*Cons:* A large vacuum volume is required in order to accommodate up to 400% expansion of the silicone.

### ***Concept 2 (Centrifuge)***

Concept 2 utilized the centrifugal force to isolate the silicone from the entrapped air. This is done by increasing the effective force of gravity within the silicone.

*Pros:* Can be done very quickly (~2 minutes) and does not cause volume expansion.

*Cons:* Can only accommodate small amounts of silicone at a time (~10mL).

### ***Concept 3 (Vibration)***

Concept 2 utilizes vibration to motivate the bubbles to the top.

*Pros:* Does not cause volume expansion.

*Cons:* Requires time to allow the bubbles to rise to the surface.

### **System 2 (Fill Lattice)**

System 2 is a method to fill the lattice without any air. It is vital that air be removed from the lattice in order to decrease porosity.

### ***Concept 1 (Vacuum)***

Concept 1 utilized a vacuum to remove all of the air within a chamber that houses the lattice.

*Pros:* This completely removes the possibility of air being trapped within the lattice, because there is no air inside the lattice to trap.

*Cons:* This requires a pressurized chamber.

### ***Concept 2 (Fill from top)***

Concept 2 removes the air from the lattice by displacement with silicone. The silicone flows through the lattice from the top to the bottom.

*Pros:* Can be achieved very simply, in open air, by pouring the silicone directly onto the lattice. Can direct the silicone to where it is needed.

*Cons:* Can easily trap bubbles and air within the lattice. Can easily introduce air into previously degassed silicone due to turbulent flow.

### ***Concept 3 (Fill from bottom)***

Concept 3 removes the air from the lattice by displacement with the silicone. The silicone flows through the lattice from the bottom to the top.

*Pros:* More difficult to accidentally trap air, because the silicone is displacing the air from the bottom.

*Cons:* Must be done slowly. If done too fast, the flow through the lattice could be uneven and trap air within the lattice.

### ***Concept 4 (Weight Scale)***

Concept 4 uses a weight scale to directly measure and control the exact amount of silicone that is introduced to the lattice. Scale would also be used to predict the final weight of the lattice, so we know when we have poured enough silicone to replace all the air that was originally in the lattice.

*Pros:* Using a scale will help to measure how much silicone is needed for the lattice being filled, reducing the amount of silicone left over and wasted.

*Cons:* Measuring out the amount of silicone needed to fill the lattice will require pulling vacuum on the chamber multiple times in between steps.

### ***Concept 5 (Vibration)***

Concept 4 uses a vibrating table to remove air from the lattice once the silicone has been introduced to the lattice.

*Pros:* Using vibration causes the coefficient of friction in the silicone to be reduced, allowing air bubbles to rise with less resistance.

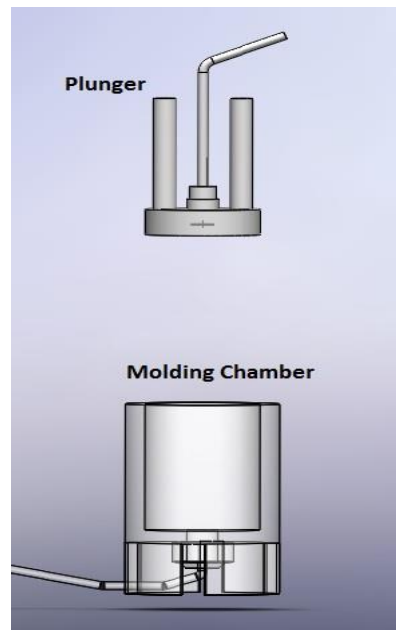
*Cons:* Air bubbles that are trapped on the lattice structure may remain stuck while under vibration.

### **System 3 (Isolate Lattice)**

These methods will insure that the lattice is isolated, so that the silicone being introduced is only able to flow to the lattice and can't overflow or be wasted.

#### ***Concept 1 (Plunger and Molding Chamber)***

The vacuum purges the molding chamber of air before the silicone is introduced to the system and continues to pull vacuum drawing the silicone into the chamber and beyond to the catch can.



*Figure 2 Plunger and Molding Chamber for isolating a lattice.*

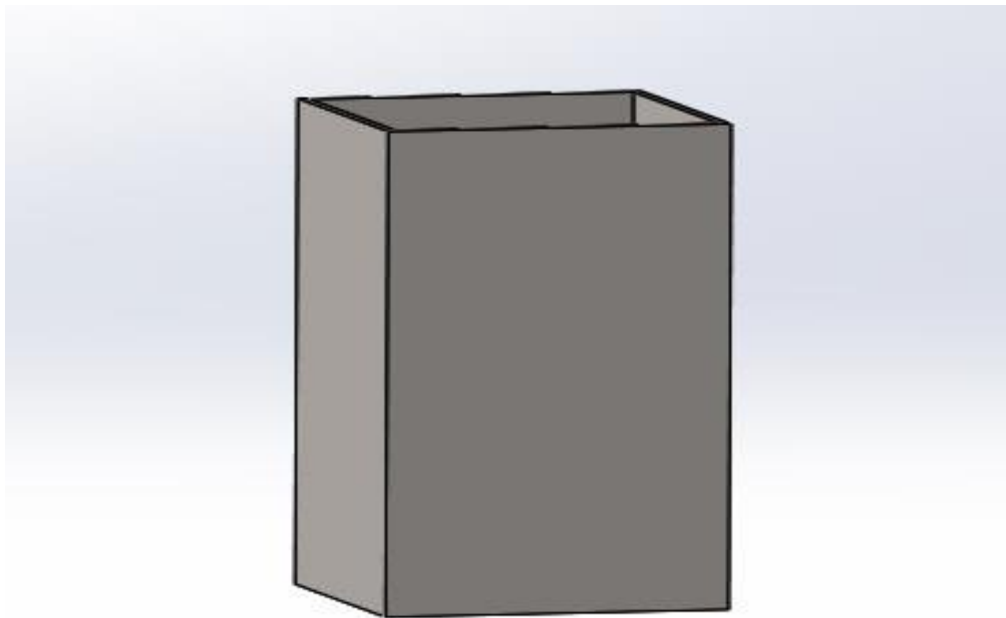
*Pros:* Plunger allows for quick adjustments for lattices of different heights and enforces a seal using an O-ring forced against the molding chamber wall using a chuck mechanism. The

molding chamber provides a rigid casting chamber for the lattice for vacuum to be maintained and the lattice restrained in the X and Y axes.

*Cons:* Molding chamber does not allow for varying geometries in the X and Y plane. The plunger O-ring could create an imperfect seal disrupting the vacuum environment.

### ***Concept 2 (Jig)***

Concept 2 is a container used to hold the lattice in place that is designed for a particular lattice shape and size.



*Figure 3 Jig used to contain lattice with matching geometry.*

*Pros:* A jig can be tailored to control the tolerances of the final lattice, and allows for easy mobility of the lattice during the infiltration process.

*Cons:* Requires a specific jig to be manufactured for each variation of lattices

### ***Concept 3 (Vacuum Bag)***

Concept 3 utilizes a bag as the vacuum chamber instead of having to pull vacuum on a larger volume, this allows for a quicker vacuum to be pulled.

*Pros:* This method can produce glossy finishes, and can reduce the amount of volatiles (ex. water, ethyl acetate) during the curing process, which would lead to voids.

*Cons:* May cause indentations where the bagging is pulled into the lattice, which would cause the lattice to not be filled completely. Compacts the area in which the silicone will be traveling, which could cause difficulty in controlling where the silicone flows.

