1.6 Concept Selection

In order to select our final concept, a Decision Matrix and Pugh Chart were constructed in order to compare our designs for each system. The Pugh Chart was used to compare each concept directly to the other concepts, using an arbitrarily chosen datum. The Decision Matrix helped to establish a hierarchy of our evaluation criteria to account for the most important targets and customer needs. Both techniques were used to evaluate which design should be selected.

1.6.1 Pugh Matrix

For degassing the silicone, the use of a centrifuge and a vibration table is compared to the current industry standard of vacuum degassing. Each technology was compared on the basis of porosity, allowable fluid volume, degassing time, and cost. Porosity is the measure of how effective the concept is at removing gas pores from the Silicone. The allowable fluid volume is the volumetric amount of silicone that can be degassed in one cycle. Lastly, the degassing time is the amount of time the concept takes to remove the gas. When completed, the Pugh matrix determined that neither the centrifuge nor the vibration table provided a benefit over the vacuum, as seen in Table 2.

Table 1 *Pugh Matrix - Degas Silicone*

Degas Silicone		Concepts		
Criteria		Vacuum	Centrifuge	Vibration
Porosity		Datum	0	-1
Allowable Fluid Volume			-1	0
Degas Time			-1	-1
	Pluses	0	0	0
	Minuses	0	2	2

The second element of the functional decomposition to be investigated is filling the lattice with the judging criteria set as the porosity, geometric compatibility and total working time. The porosity in this test will reflect the concepts ability to abstain from creating or maintaining voids while filling the lattice with silicone. Geometric compatibility refers to the concepts ability to be utilized with different shapes without modification. Finally, the total working time is the metric of how long it takes the concept to fully fill the lattice with silicone. A vibration table under vacuum was used as our datum to be evaluated against filling from the bottom under vacuum, filling from the top under vacuum and injection from the top. The Pugh matrix ranked filling from the bottom with vacuum as the most effective concept at satisfying customer needs.

Table 2 *Pugh Matrix – Fill Lattice*

Fill Lattice		Concepts			
Criteria		Vibration with Vacuum	Fill from Bottom with vacuum	Inject from Top	Pour from Top with Vacuum
Porosity		Datum	1	-1	-1
Geometric Compatibility			0	0	0
Total Working Time			1	0	-1
	Pluses	0	2	0	0
	Minuses	0	0	1	2

For the final matrix, the concepts for isolating the lattice are compared with the vacuum bag being used as the baseline. In this test, geometric compatibility measures the concepts ability to isolate lattices of different shapes without modification. The total working time is the time the concept takes to accept the lattice and be ready to rock. The surface tolerance refers to the surface texture as well as how far from the surface of the lattice the silicone is allowed to set. When compared to the jig and the plunger, the vacuum bag has the greatest ratio of benefits to detriments.

Table 3 *Pugh Matrix – Isolate Lattice*

Isolate Lattice		Concepts		
Criteria		Vacuum Bag	Jig	Plunger
Geometric Compatibility		Datum	-1	-1
Total Working Time			-1	-1
Surface Tolerance			1	1
	Pluses	0	1	1
	Minuses	0	2	2

1.6.2 Decision Matrix

The first system that concepts were generated for was to degas the Silicone. The criteria that was established for the decision matrix was how well the design eliminates porosity, the allowable fluid volume, the time it takes to degas the Silicone, and cost. Each of these criteria were ranked based on their importance on a scale of 1 to 5, five being most favorable. Porosity was weighted the highest since our main objective is to eliminate all air voids. Allowable fluid volume was ranked the lowest because the pot life is long enough to accommodate for most methods and it does not matter if there needs to be multiple batches to degas. After evaluating each concept based on the specified criteria, the vacuum was found to be the best option which was followed by vibration and then centrifuge. The main reasons the vacuum was found to be the best option was its ability to create low porosity which is high priority for our design. The vacuum also ranked highest for degas time and had moderately good ranking values for cost and allowable fluid volume. The centrifuge is also ranked high for porosity and degas time but was ranked lower for the other criteria which is why the vacuum concept outranked it. Even though vibration was ranked high for allowable fluid volume since a vibration table can account for large volumes, and also cost efficient, vibration is not good for creating low porosity and has a slow degas time which was weighted more heavily.

Table 4 *Decision Matrix – Degas Silicone*

Degas Silicone							
		Concepts					
		Vacuum		Centrifuge		Vibration	
Criteria	Weight	Rank	Score	Rank	Score	Rank	Score
Low Porosity	5	9	45	9	45	7	35
Allowable Fluid Volume	2	7	14	3	6	8	16
Degas Time	4	8	32	7	28	6	24
Low Cost	3	6	18	5	15	8	24
	Total	109		94		99	

The second system of our design deals with replacing the air inside the lattice with silicone, which can be seen in Table 6. Three different concepts were compared based on their ability to fill the lattice quickly, have low porosity, be cost effective, and be geometrically compatible. The criteria were also ranked on a scale of 1 to 5. Porosity was given a five due to it being the main target of our design. The remaining criteria of fill time, low cost, and geometric compatibility were ranked 4, 3, and 2 respectively. After completing the Decision Matrix the highest ranked concept for System 2 was “Fill from Top with Vacuum”. Fill from Top with Vacuum received the highest ranking, because the use of a vacuum is expected to remove all the air that could potentially be retained as voids. The fill time for this concept is not known but is expected to only span a few minutes. This concept however could require additional fabrication of components to accommodate varying lattice shapes, which could increase the initial cost of the design. The lowest weight criteria was Geometric Compatibility. This criteria was weighted lowest, but the fill from bottom concept still is effective because it is not dependent on the geometry of the lattice.

Table 5 *Decision Matrix – Fill Lattice*

Fill Lattice									
		Concepts							
		Vibration/ Vacuum		Bottom Fill/Vacuum		Top Fill/Vacuum		Top Fill	
Criteria	Weight	Rank	Weight	Rank	Weight	Rank	Weight	Rank	Weight
Low Porosity	5	8	40	9	45	8	40	8	40
Geometric Compatibility	2	8	16	9	18	9	18	9	18
Fill Time	4	5	20	9	36	8	32	4	16
Low Cost	3	8	24	6	18	6	18	7	21
	Total	100		117		108		95	

The third system of our design is focused on the isolation of the lattice itself, and the concepts ability facilitate a proper fill, which can be seen in Table 7. The criteria used to compare these concepts were geometrically compatible, surface tolerance, unconstrained in height, constrained in length and width, and low cost. Three of these criteria (surface tolerance, unconstrained in height, and constrained in length and width) are extremely important and they must be met by the design concept. These criteria all received 5's which ultimately weighed heavily on each concepts ranking. The highest ranking concept was the "Jig with a Weight Scale", this was largely due to the concepts open jig design that adequately constrains the lattice in length and width while allowing it to vary in height. These constraints will allow for more precision in controlling the tolerances of the silicone protruding from the lattices surface. To allow for a variety of lattice geometries, jigs would need to be fabricated to accommodate the respective lattice shape. This makes the concept initially less adaptable, and would increase the initial costs. However once fabricated the jigs would be reusable and save money, and allow for quick preparation for future uses. The weighted scale portion of the concept would control the amount of silicone being prepared and reduce excess, which will further reduces costs.

Table 6 *Decision Matrix – Isolate Lattice*

Isolate Lattice							
		Concepts					
		Vacuum Bag		Jig/Weight Scale		Jig/Plunger	
Criteria	Weight	Rank	Score	Rank	Score	Rank	Score
Geometric Compatibility	3	8	24	4	12	4	12
Surface Tolerance	5	6	30	9	45	9	45
Height unconstrained	5	9	45	10	50	9	45
Length/Width constrained	5	9	45	10	50	9	45
Low Cost	2	5	10	7	14	6	12
	Total	154		171		159	

1.6.3 Final Selection

Utilizing the Decision matrix and the Pugh matrix as well as our own collective reasoning, the concepts for each aspect of the function decomposition were chosen. The Decision matrix was found to be more effective than the Pugh due to the lack of a weighting system, as porosity is of greater importance to the project than the other constraints.

The best concept to degas the silicone before filling the lattice is the vacuum. It was found that the vacuum would be the most effective method for dealing with the amount of silicone needed and while staying within our budget. To best fill the lattice with minimal porosity, filling from the bottom with vacuum will be used. This concept is simple, cost effective and has a lesser chance of porosity than filling from the top. The jig was chosen as the concept for isolating the lattice. It is the best option for balancing cost and surface tolerance.

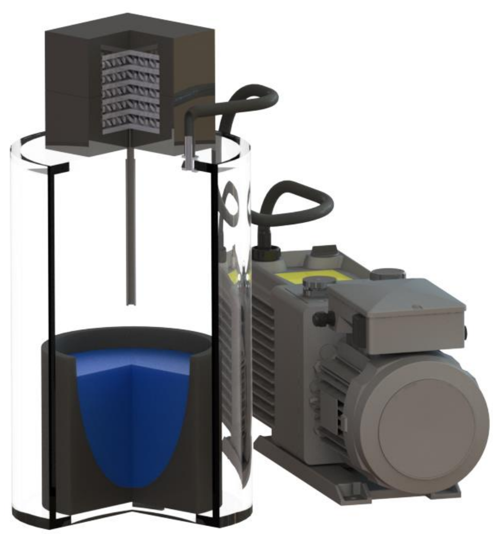

Figure 1 Selected Design