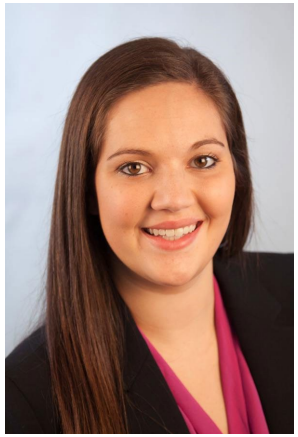
Virtual Design Review #2

Air Force Research Lab (AFRL)
Polymer Infiltration Device

Haimowitz, Stern

The Team

Catherine Kent
Lead ME/Research Coordinator



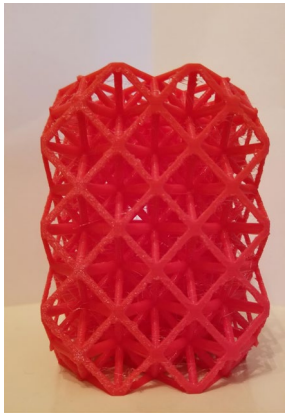
Emily Stern
Lead Technologist

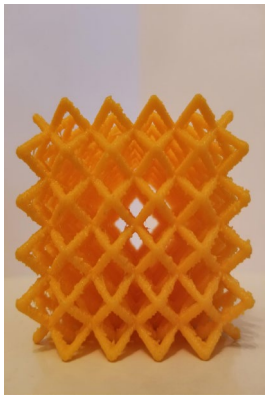
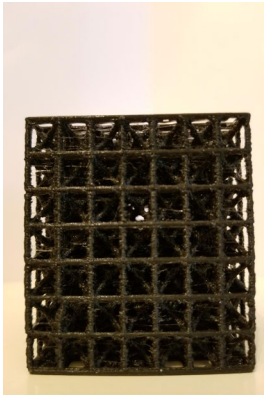
Michael Haimowitz
Team Leader

James Jenkins
Geometric Integrator

Project Scope

- Design and build a prototype to infiltrate open-cell lattice structures with silicone
- Evenly fill the lattices
- Eliminate air voids
- Achieve porosity of less than 1%




Detailed Scope - Project Goals

- Design a device that will completely fill a lattice structure with silicone
- Create a functional prototype
- Analyze filled lattice to verify removal of cavities
- If possible, test the device using silicone mixed with interstitial solids

Project Targets

Emily Stern

Targets

Customer Need	Metric	Target
Fills lattice without porosity	Porosity	< 1%
	Void Volume %	< 1%
	Serial Sectioning	< 1% void area

Targets

Customer Need	Metric	Target
Fills small cube, large cube, and cylindrical lattices	Tolerance	< 0.01 inch of lattice surface
Specimen unconstrained in height		Yes
Specimen constrained by length and width	Volume per unit height (in^3)	Small cube: $4h$
		Large cube: $16h$
		Cylinder: $2.25\pi h$

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Customer Need	Metric	Target
Ensure a working prototype		Yes
Uses standardized equipment and methodology	Working time	< 90 minutes
	Time to degas	Degas+fill lattice < 90 min
	Time to fill lattice	
Used standardized parts		Yes
Provide guidelines to operate prototype and avoid hazards		Yes

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Functional Decomposition and Concept Generation

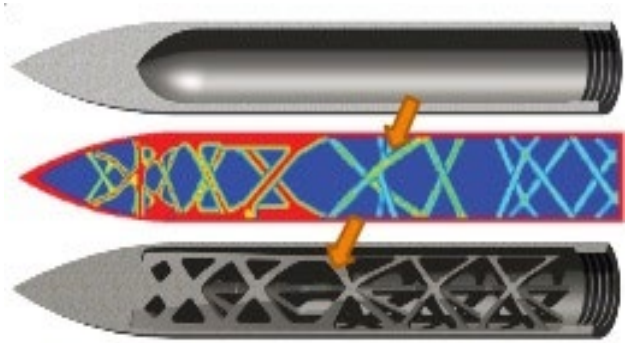
Functional Decomposition

Isolate lattice

Purge air out of fluid/lattice

Transfer fluid

Fill lattice



Concept Generation-Degas Silicone

Concept	Pros	Cons
Vacuum	Simple, sufficient for large amounts of silicone	Large degass volume required, loud
Centrifuge	Quick, no volume expansion	Only small amounts at a time (~10mL)
Vibration table	No volume expansion	Large time required for bubbles to rise, loud

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Concept Generation-Fill lattice

Concept	Pros	Cons
Vacuum	No trapped air	Requires pressurized fill chamber
Fill from top	Simple	Trap air within lattice, introduce air to degassed silicone
Fill from bottom	More difficult to trap air	Must be done slowly to limit uneven fill
Vibration table	Increases mobility of silicone	Trapped air might remain stuck, loud

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Concept Generation-Isolate lattice

Concept	Pros	Cons
Vacuum bag	Glossy finishes, universal, reduce amount of volatiles	Could produce concavities, cannot control evenness of silicone
Plunger	Quick height adjustments	Not universal for all shapes
Jig	Controls tolerance, easy mobility of lattice	Not universal for all shapes

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Summarization and Going Forward

Mike Haimowitz

Summary

- Elimination of porosity is the highest priority
- Functions divided into Subsystems for Concept Generation:
  - Degas silicone
  - Fill lattice
  - Isolate lattice
- To mitigate cons and expand pros, the combination of various concepts will need to be analyzed

Going Forward

- Concept Selection
  - Decision matrix
  - Pugh Matrix
- Create preliminary designs
  - Bill of materials
  - Prototype ideas
  - Solidworks simulations
- Get supplies for prototype
- Build prototype

Works Cited

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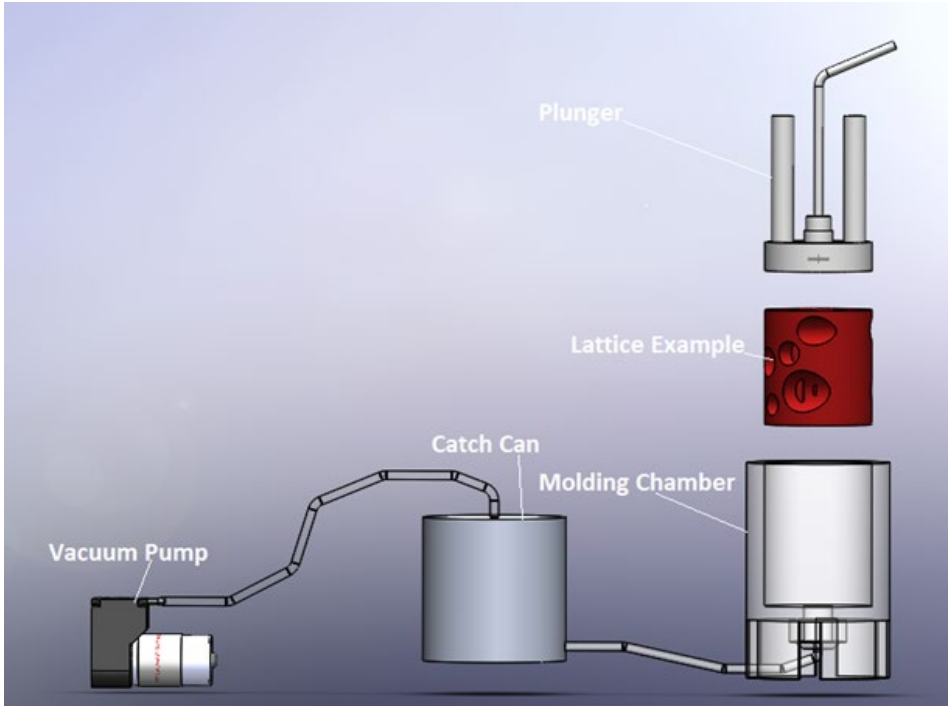
Questions?

Possible Future Concepts

- Lattice is placed in molding chamber and plunger is pressed down
- Pump is used to withdraw air from the chamber and to draw silicone through the lattice
- Plunger is lifted and lattice removed



Possible Future Concepts

- Place lattice in respective jig on scale inside of the vacuum chamber
- Add silicone to vacuum chamber
- Purge air from chamber
- Release vacuum once silicone has been degassed
- Add silicone to jig until desired weight is reached
- Place lattice on vibration table and pull vacuum
- Leave lattice to cure