FAMU-FSU College of Engineering

Powder Removal in Microgravity Environments (PRIME)

Team 518

Virtual Design Review 2

Team Introductions

Cole Daly
Mechatronics Engineer

Chelsea Kiselewski
Quality and Design Engineer

Lauren McNealy
Systems Engineer

Team Introductions

Kyle Evans
Thermal Fluids Engineer

Tripp Lappalainen
Manufacturing and Design Engineer

Alexander Fryer
Project and Test Engineer

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Sponsor and Advisor

Project Sponsor
Justin McElderry
Materials Engineer -
NASA Marshall Space Flight Center

Academic Advisor
McConomy, Shane Ph.D.

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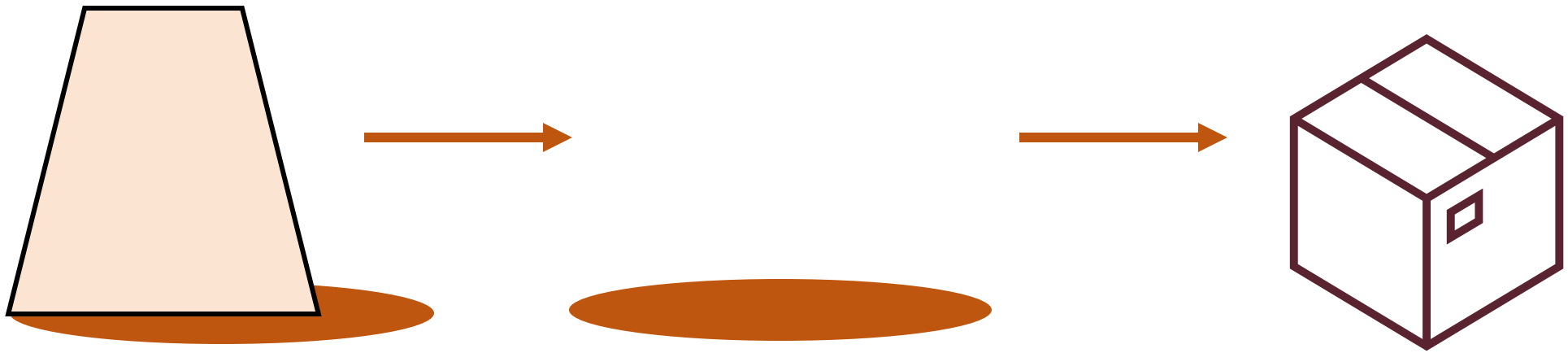
Objective

The objective of this project is to develop a proof of concept for removing powder residue from additive manufactured parts in microgravity environments.

Clean

Remove

Contain



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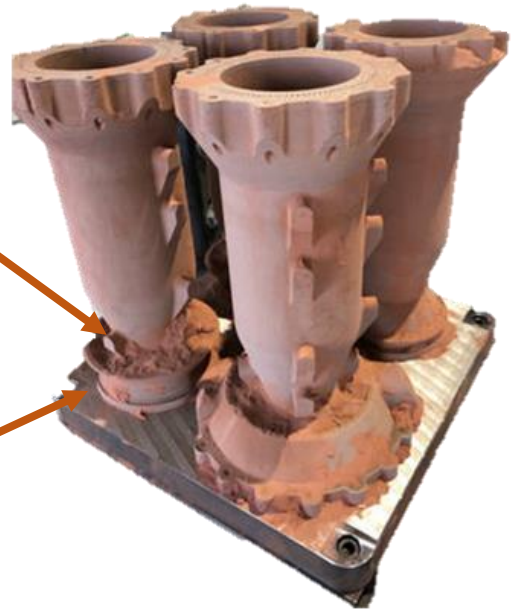
Project Background

Additive Manufacturing offers:
Rapid Prototyping
Reduced Production Time

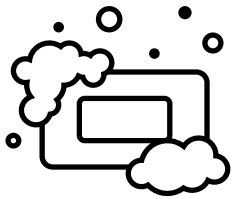
Trapped powder inside parts

Hazardous particles in microgravity

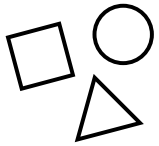


Goal: Portable cleaning device to bring to ISS

Key Goals

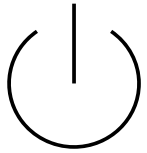


Clean Internal Features

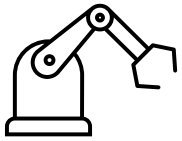


Clean Multiple Parts

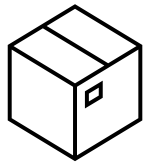
Functions in Microgravity



Automatic Operation



Physical Prototype



Contain Dirty Solvent

Assumptions

No supports

120V, 15A outlet

P = 1 atm

Functional Decomposition

Cleaning

Containment/Safety

Targets and Metrics

Cleaning

Containment/Safety

Targets and Metrics

Design will be able to clean 85-90% of debris

Cleaning

Containment/Safety

Targets and Metrics

Design will be able to clean 85-90% of debris

Cleaning

Particle are contained with no leaks in the device

Containment/Safety

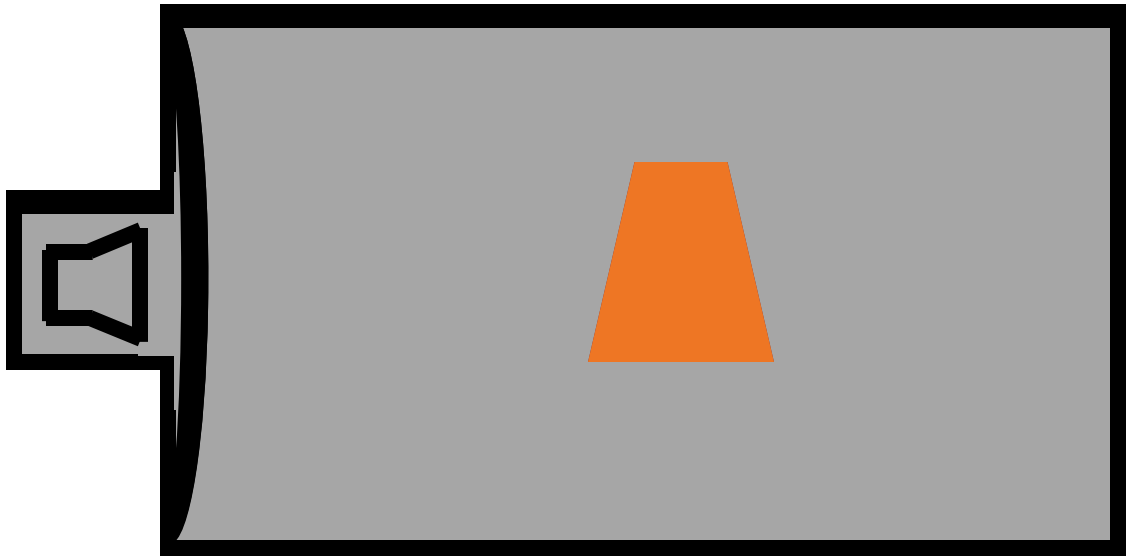
Targets and Metrics

Measuring Safety of Device

Contain Debris
Prevent Leaks
Structurally Sound

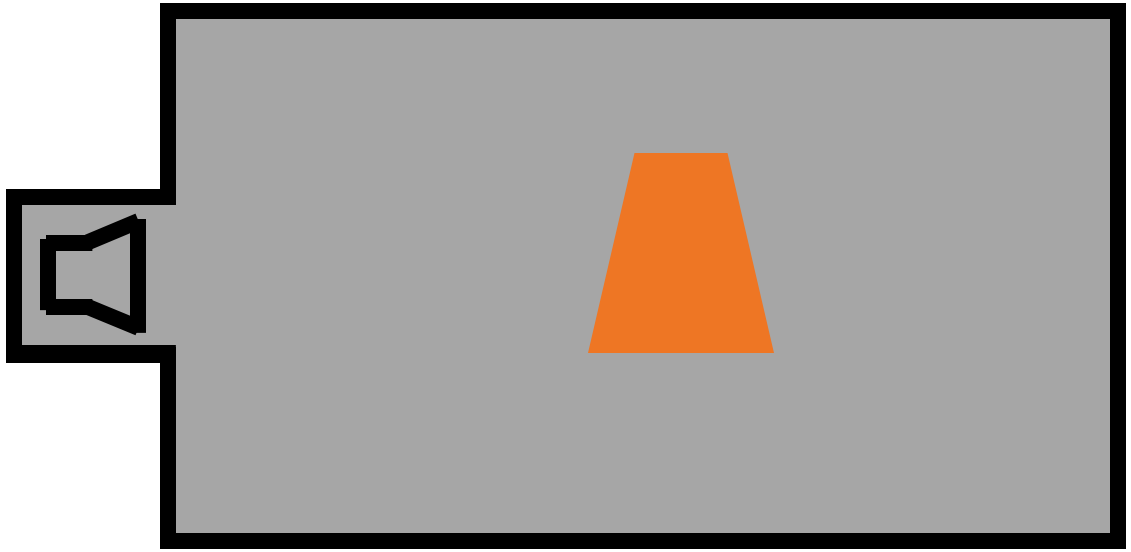
Targets and Metrics

Measuring Debris Collected



Targets and Metrics

Measuring Debris Collected



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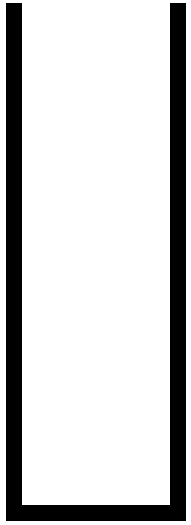
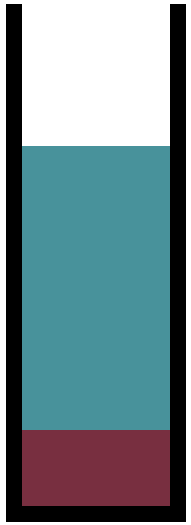
Measuring Debris Collected

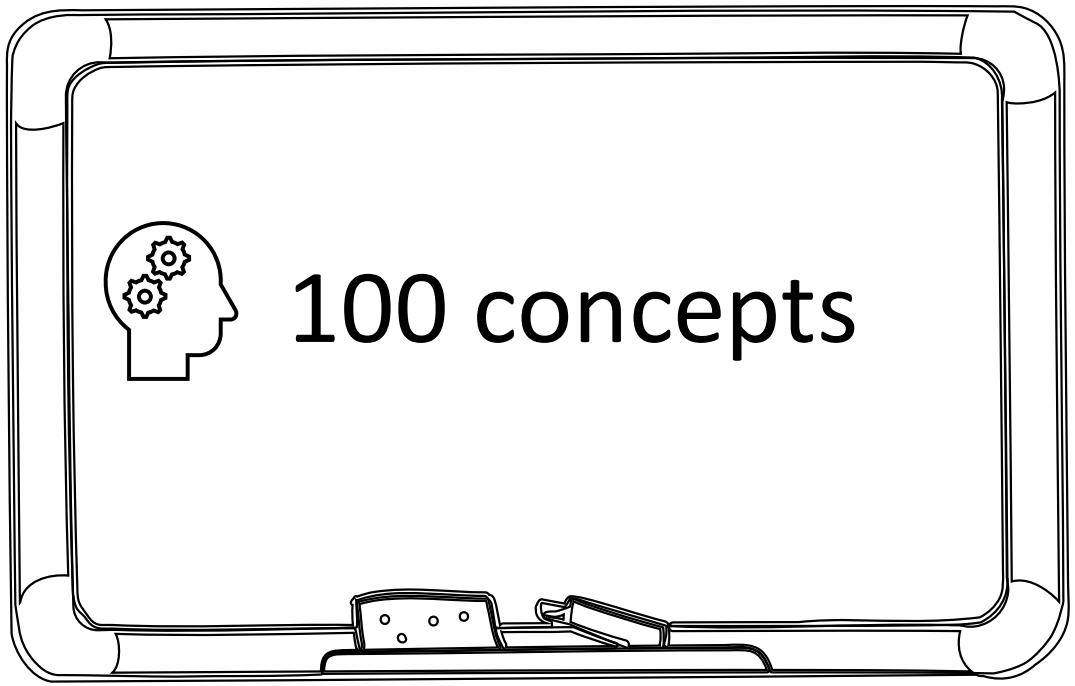


Targets and Metrics

Measuring Debris Collected



Concept Generation



5 Medium Fidelities

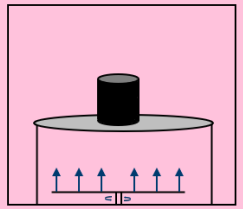
3 High Fidelities

Generation Methods

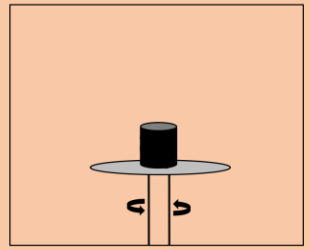
Biomimicry	Forced Analogy	Anti- problem	Battle of Perspectives
• Snake Like Device • Elephant Trunk Jetting	• Car Wash • Dishwasher	• Powder Coat • Sonic Wave	• Momentum Shaker • Spinning Disk

Medium Fidelity Concepts

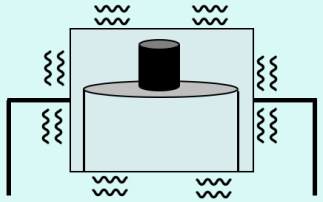
Dishwasher



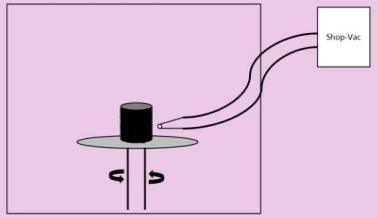
Spinning Plate



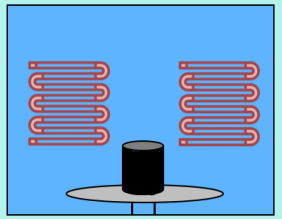
Momentum Shaker



Shop-Vac



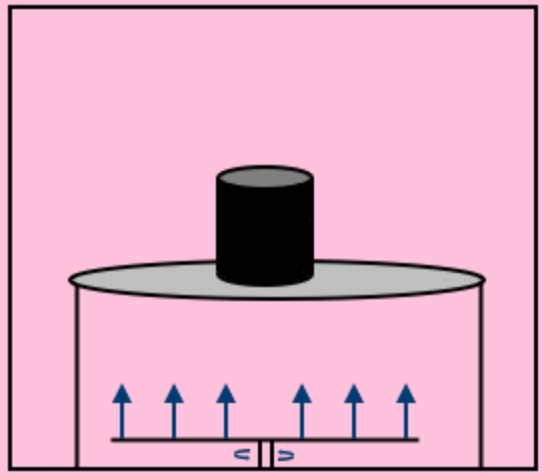
Boiling Water



1 2 3 4 5

- Spray water through grooves under the plate
- Cycle the water around

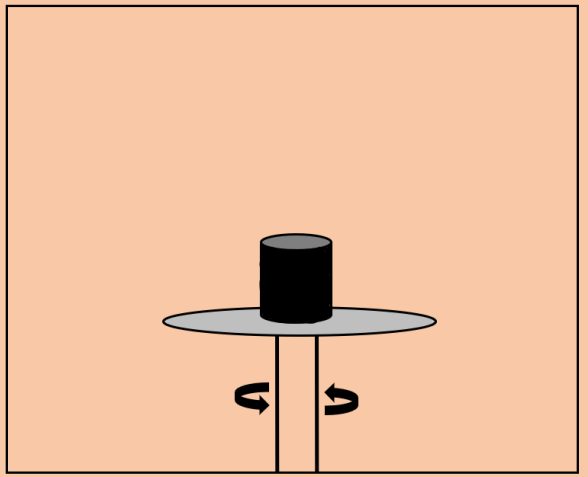
Dishwasher



1 2 3 4 5

- Spin the plate through a fast-rotating pole
- Particles are thrown outward away from the part

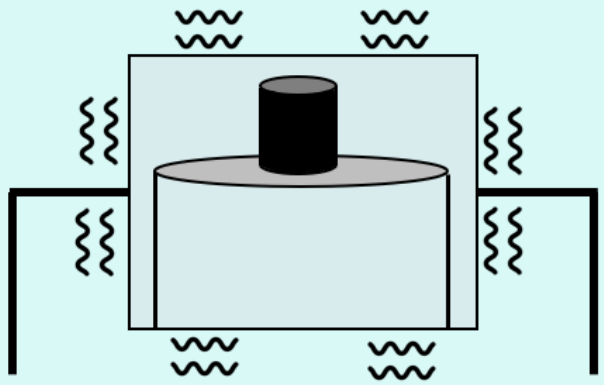
Spinning Plate



Cole Daly

- Shake the part in a confined space
- Particles are detached and moved away from the part

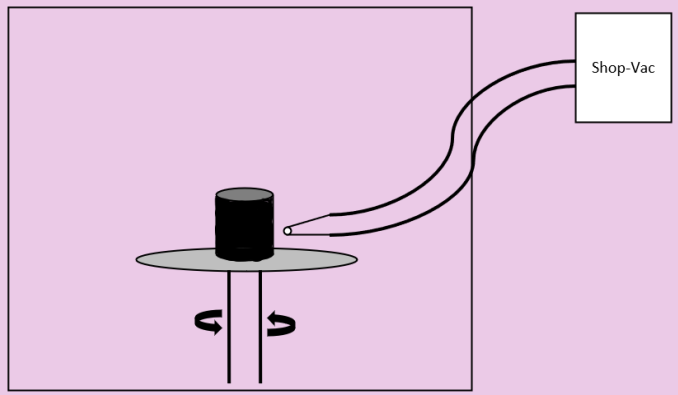
Momentum Shaker



Cole Daly

- Use a vacuum attachment to collect dust through small grooves in the part
- Gathers powder on the outside wall and inside cavities of the part

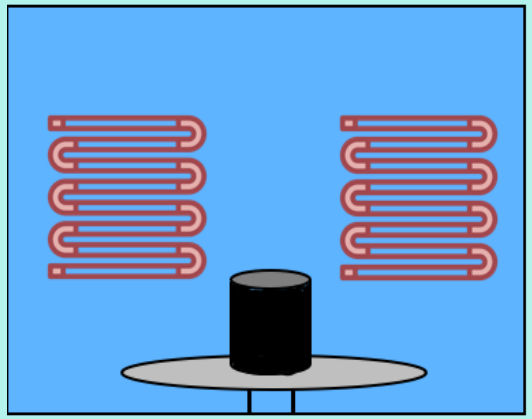
Shop-Vac



1 2 3 4 5

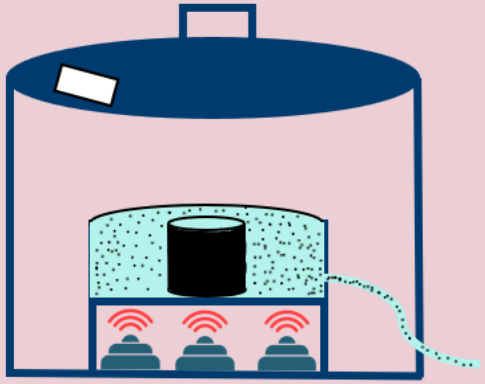
- Use boiling water to excite powder residue out of the part
- Causing the part to expand flushing the particles out

Boiling Water

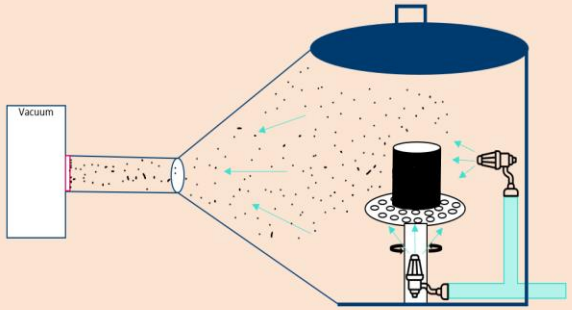


High Fidelity Concepts

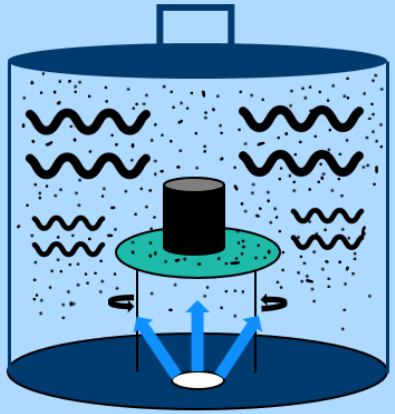
Sonic Wave Cleaner



Liquid Nitrogen Spray

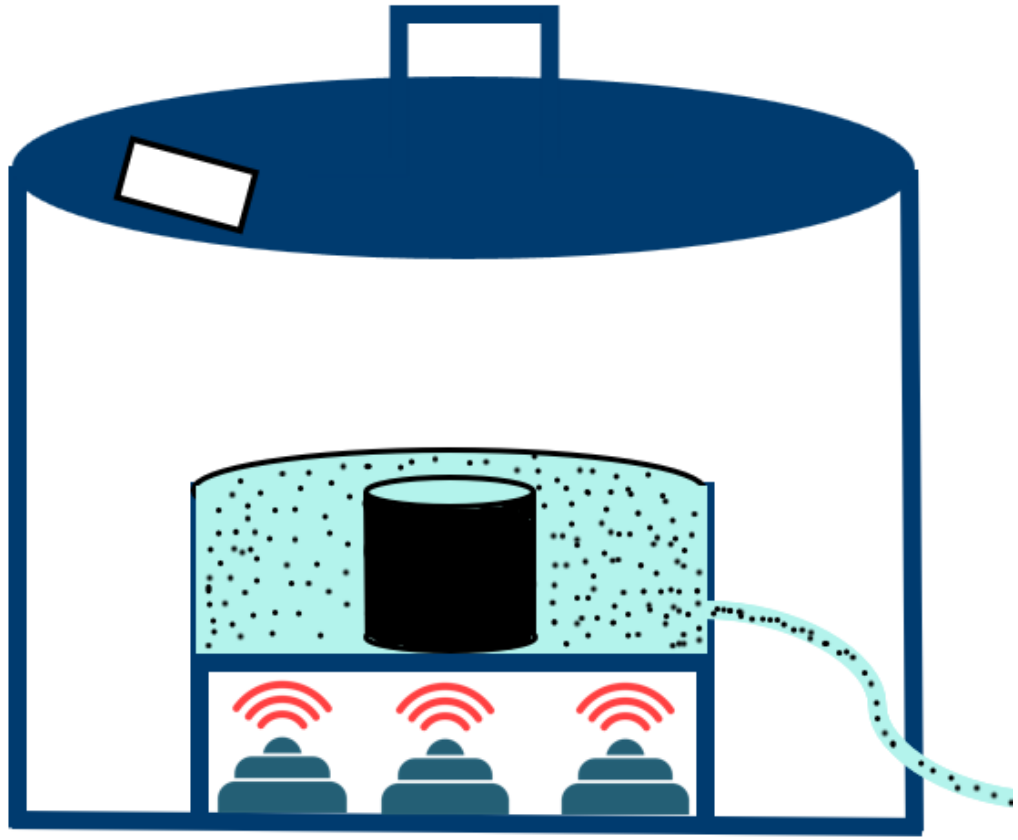


Vacuum Nucleation



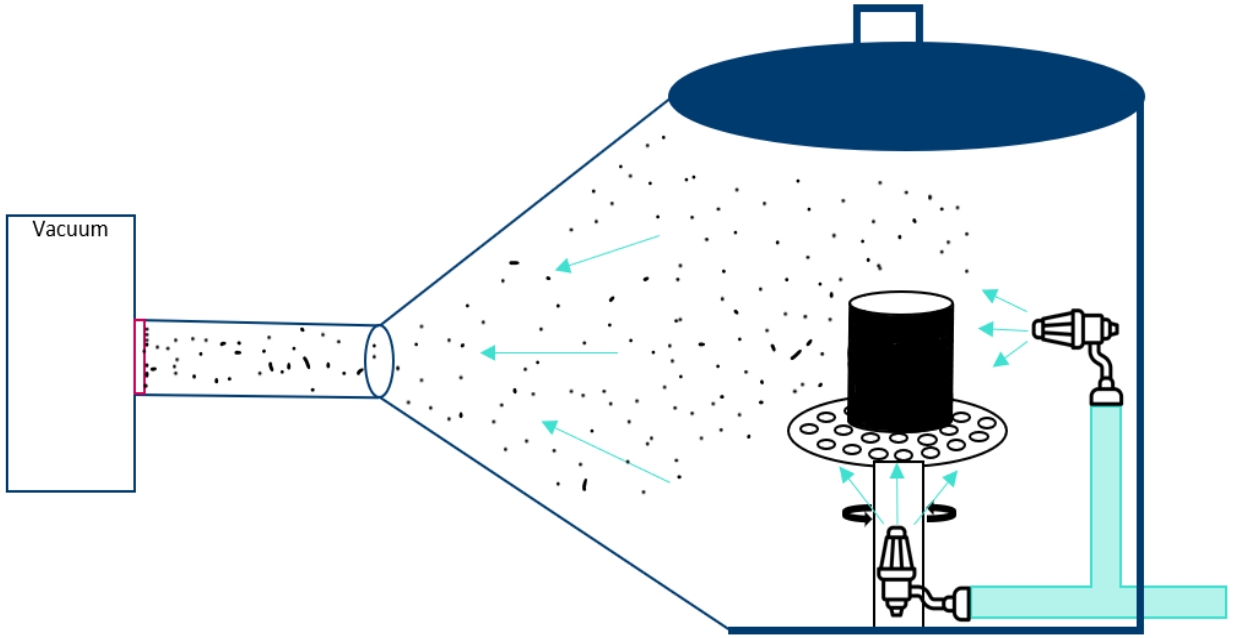
Sonic Wave Cleaner

- Sonic waves pulsed underneath fluid
- Fluid is spun creating vortices
- Fluid is drained while being spun to keep the particles away



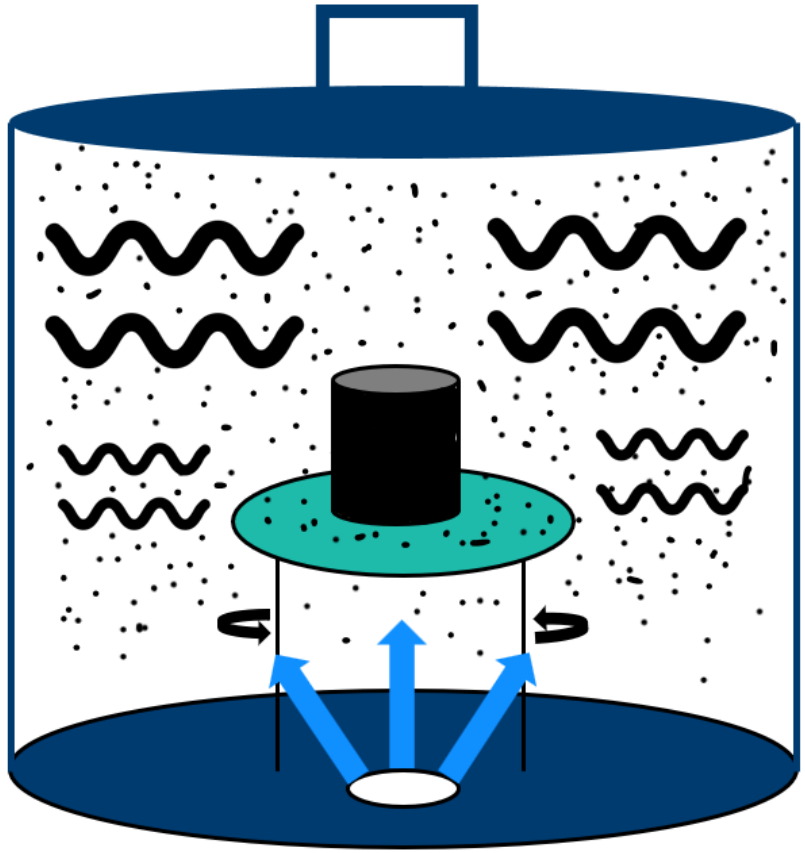
Liquid Nitrogen Spray

- Rotating Plate spins the part
- Sprayed from underneath and side
- Vacuum used to create a pressure differential



Pulsing Vacuum Nucleation

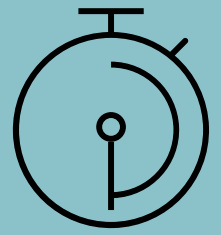
- Vacuum pulse every second
- Soapy water had been used as medium
- Fluid is drained once pulses have been completed



House of Quality

Total Mass

Time to Clean



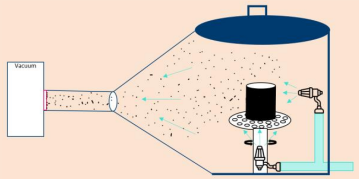
Volume Collected

m^3

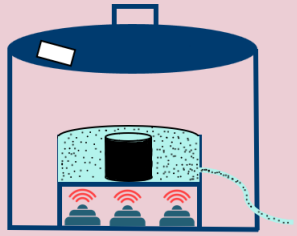
Total Area

Pugh Chart: First Iteration

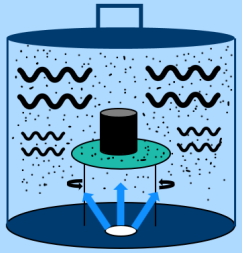
Liquid Nitrogen Spray



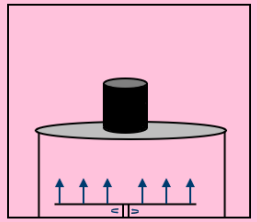
Sonic Wave Cleaner



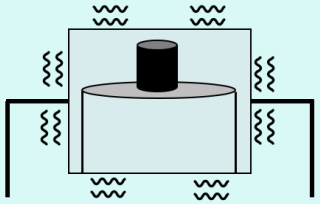
Vacuum Nucleation



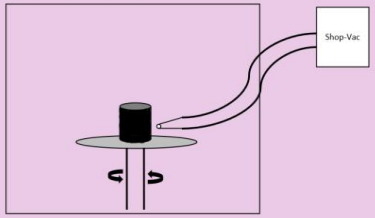
Dishwasher



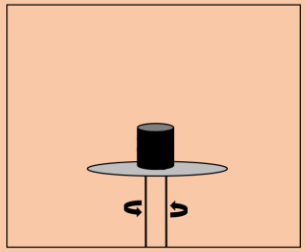
Momentum Shaker



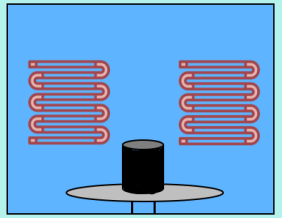
Shop-Vac Hose



Spinning Plate

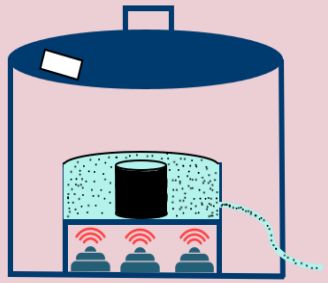


Boiling Water

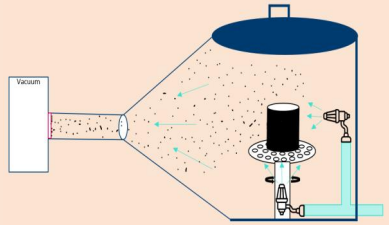


Pugh Chart: Second Iteration

Sonic Wave Cleaner



Liquid Nitrogen Spray



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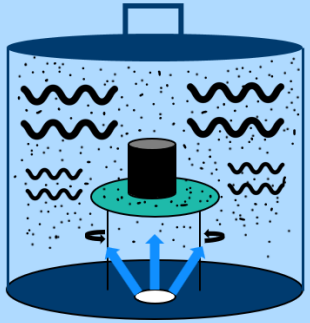
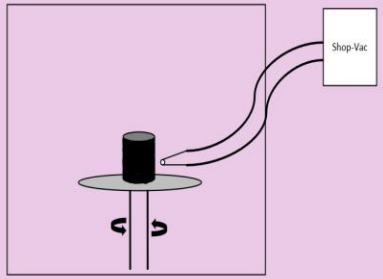


Shop-Vac Hose



Analytical Hierarchy Process

Final Selection	
Concept	Alternative Value
Sonic Wave Vibrational Cleaning	0.533
Liquid Nitrogen Sprayer	0.333
Pulsing Vacuume Nucleation	0.134

Winner

Future Work

Create first prototype

Research and list materials needed

Talk about next semester plans

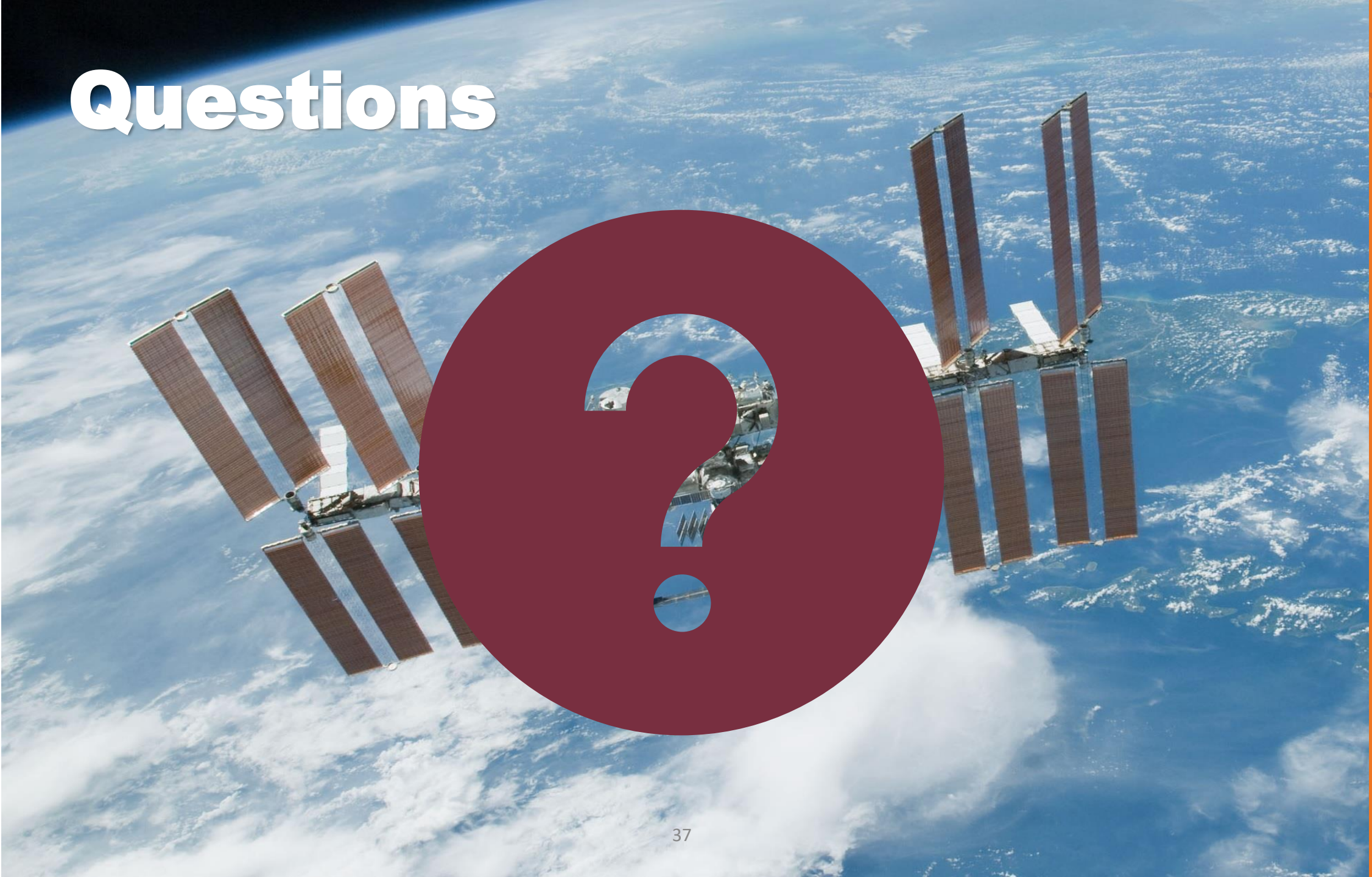
Iterate on prototype

Research skills needed to build device

Reference

Justin McElderry, J.E. (2023, September 22). Intro to PRIME. NASA Marshall Space Flight Center

Questions



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