Transit Protection System

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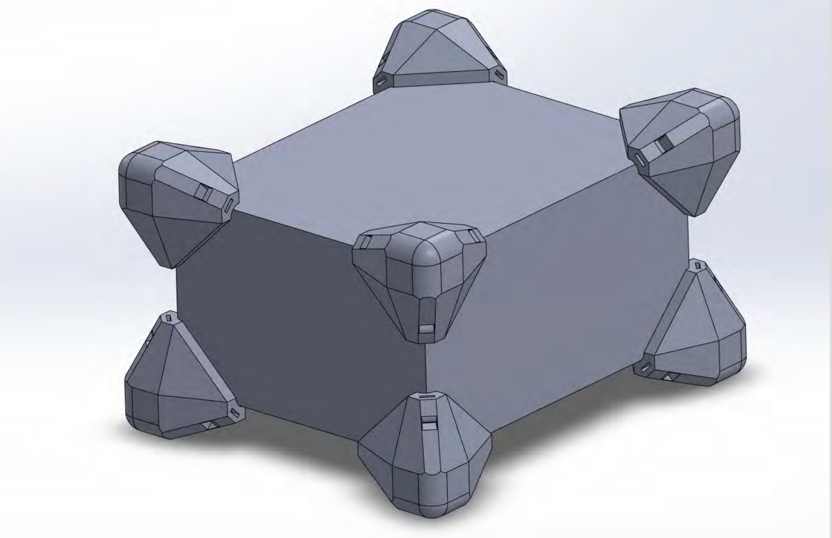
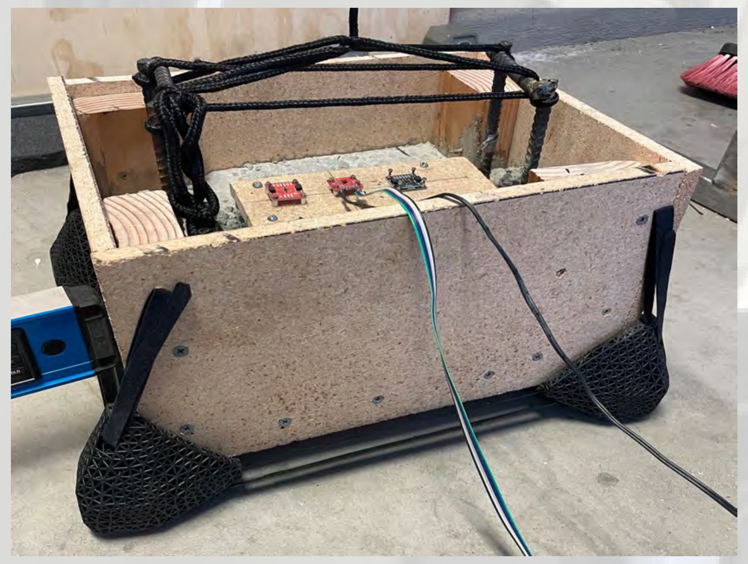
Abstract

L3Harris currently uses Pelican cases to transport their sensitive electronic equipment. These cases tend to be bulky, expensive, and overall an inefficient packaging system. They are looking for a solution to replace their current transit protection system with something that costs less, requires less storage space, and has the same shock and vibration protection as the current system. Our design concept uses a set of 3D printed corner bumpers made from Carbon EPU 40 to provide protection while saving space and offering flexibility on product sizes.



Corner bumper design concept assembly shown in SolidWorks



Corner bumpers attached to stand-in package

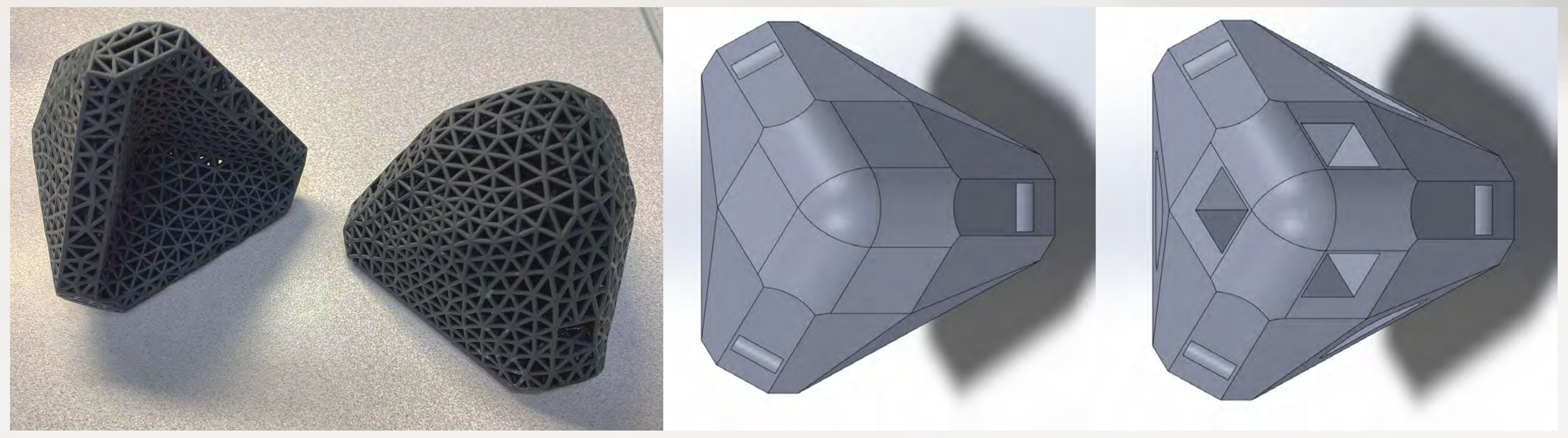
Objectives

The goal of this project was to create a transit protection system that is able to protect against shock and vibration experienced during transit. To meet these goals, we conducted shock and vibration testing on our prototype as well as a sheet of Pelican case polyurethane foam for comparison. The design metrics were never fully defined by our sponsor and were fluid throughout the entirety of the project.

Methods

Design

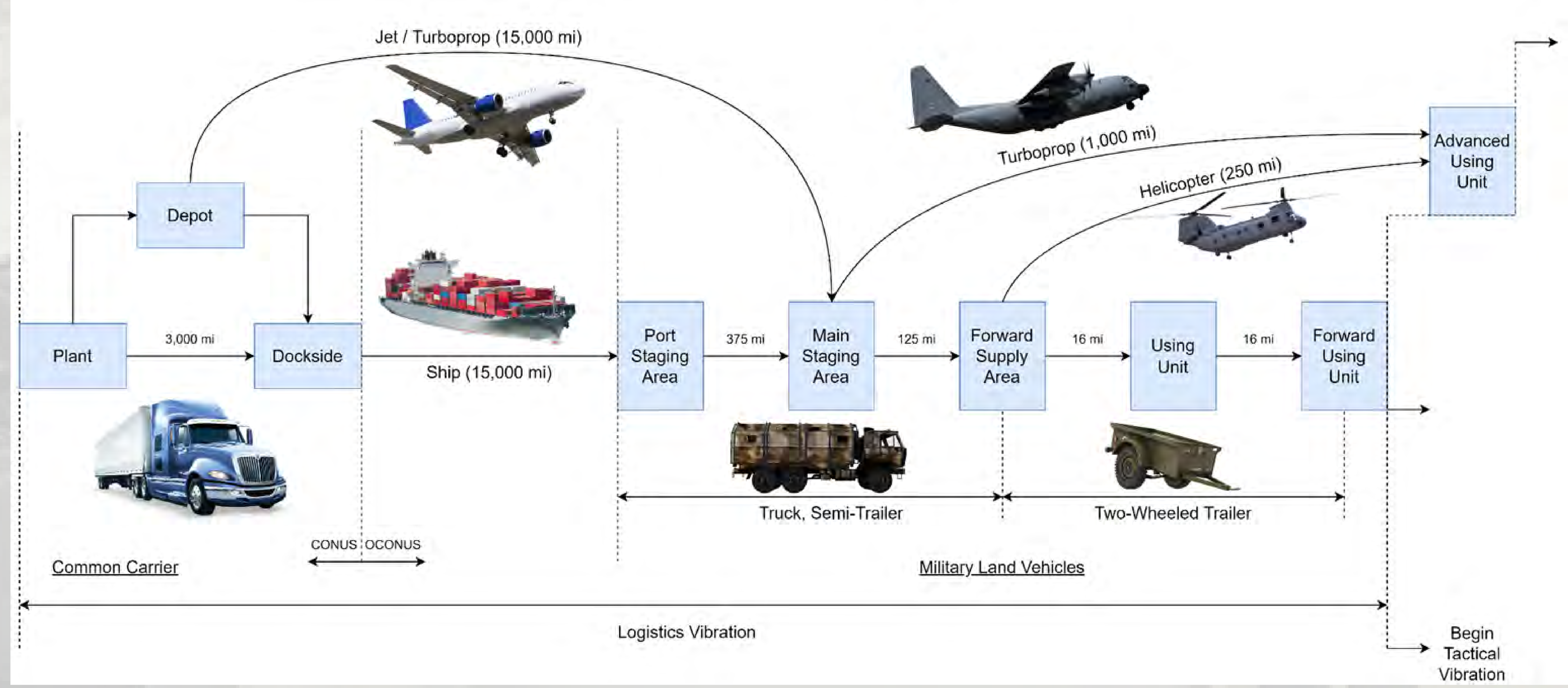
Our prototype design was created primarily using nTopology, which allowed us to convert a solid model of our bumper into a “latticed” version. This latticed bumper design was sent to L3 Harris for printing on their Carbon M2 3D printer. We also created two simplified designs to test the effect of decreasing complexity on the performance of our prototype. Simpler designs reduce file sizes and improve workflow. The simplified bumpers were made of FormLabs Flexible Resin 2.



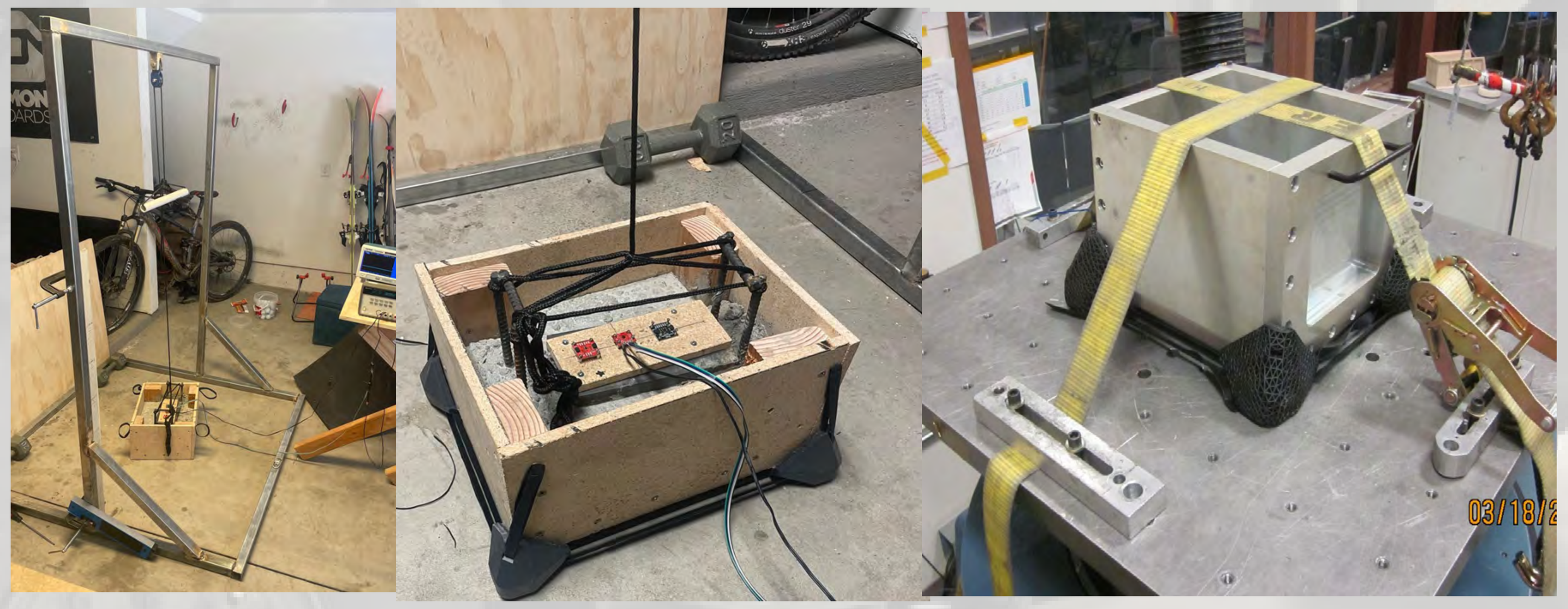
Latticed Bumper (Left), Solid Bumper (Center), Intermediate Bumper (Right)

Testing

We started by drop testing our prototype using a stand in package with mounted accelerometers and a pulley system for repeatable results. This package was constructed from plywood and rebar-reinforced concrete such that it met the nominal outer dimensions and weight provided to us by L3Harris. The results of our drop tests indicated that our simplified bumper designs were inadequate to protect the package from impact, which led us to move forward with testing vibration only on the lattice bumpers. Vibration testing was conducted on site at L3Harris.



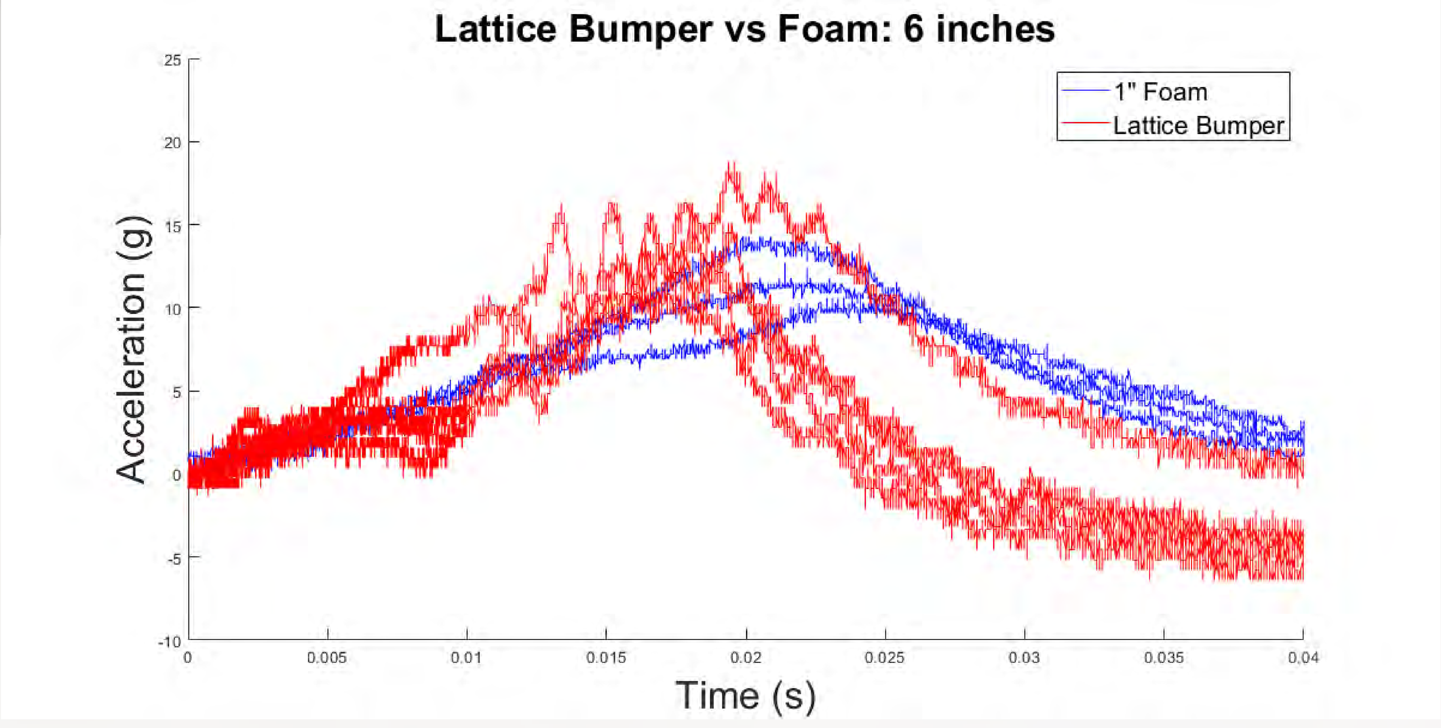
MIL-STD 810 transportation flowchart



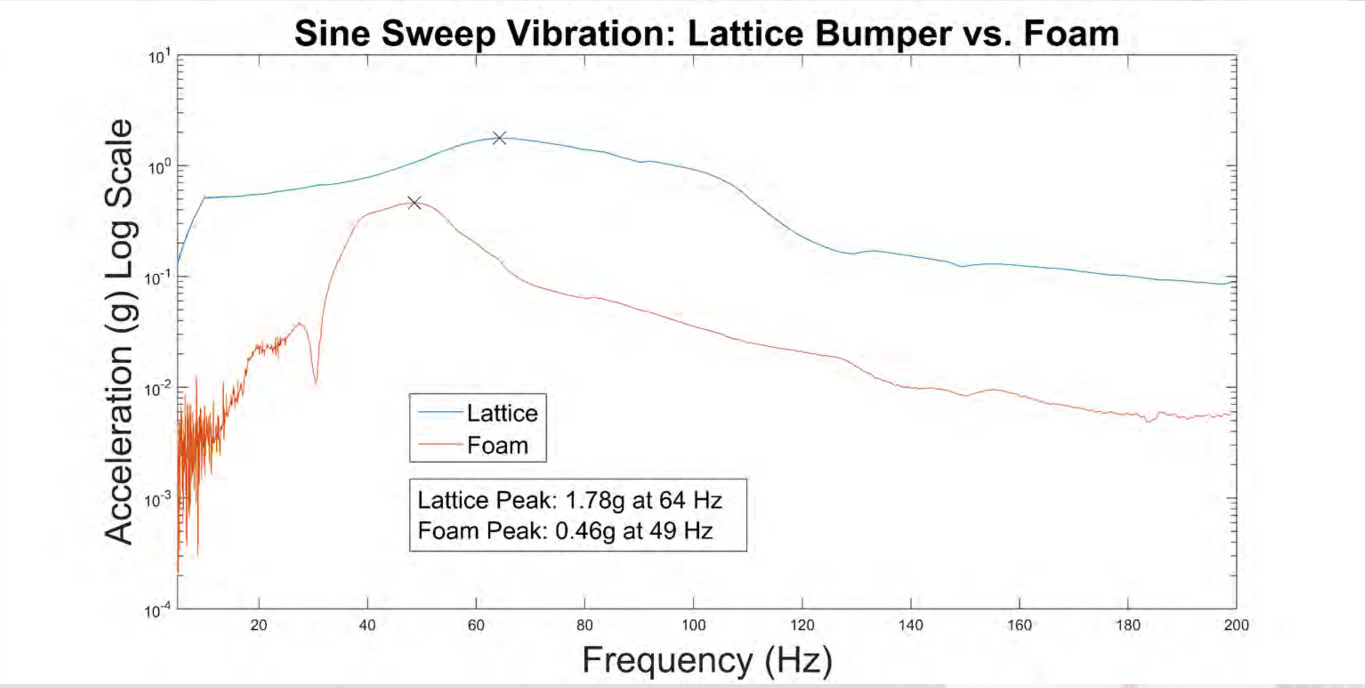
Photos of drop testing and vibration testing setup

Results

The results of our drop tests show that our prototype design reduced the acceleration of our stand-in package during impact similarly to the foam at low drop heights.

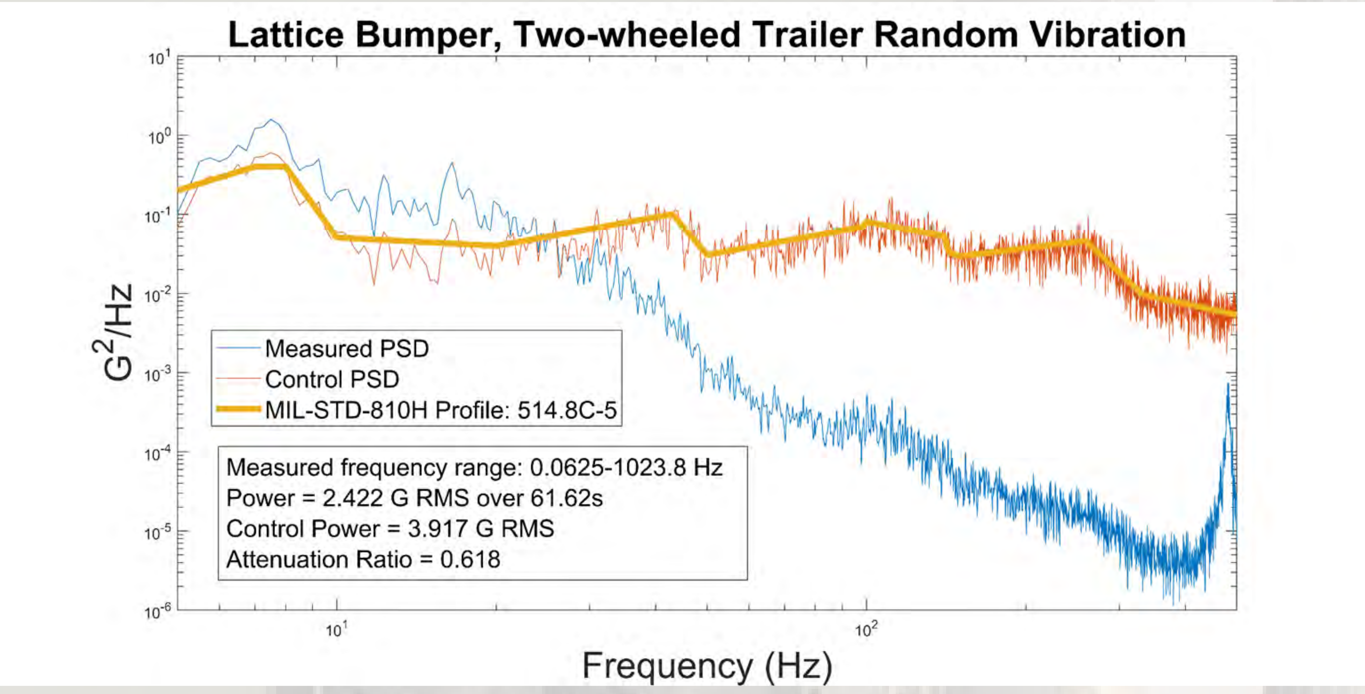


Acceleration during impact on Lattice Bumpers and Polyurethane foam sheet: 6 inch drop on to concrete



Sine Sweep vibration test for lattice bumpers and polyurethane foam

- The lattice responds more to periodic signals
- There are no major resonance frequencies



Power spectral density graph indicating the amount of energy transferred to the system as a function of frequency

- 0-25 Hz: The lattice bumper slightly amplifies vibration
- 25+ Hz: Lattice bumper significantly reduces vibration

Conclusion

The results show that our design concept attenuated vibration and shock similarly to the polyurethane foam at low accelerations and frequencies. During our drop tests, we saw an increase in acceleration of only 11% between the foam and bumpers at 18 inches. A random vibration test was also conducted, which showed that our prototype greatly reduced the vibration of the package at high frequencies. When testing at more extreme acceleration levels, the foam proved to protect better than our design concept. To improve upon these results, the parameters of our lattice design could be modified to achieve more desirable material properties.

Acknowledgments

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Main Sponsor - Provided funding and 3D printing capabilities

nTopology

Provided the software necessary to create lattice structures