

Generative Design Avionics Rack

Project Description

Within the Boeing CH-47 Chinook Helicopter, an avionics rack is used to house ancillary electronics units. **Our team has been tasked with reducing the weight of these avionics racks while maintaining or improving structural integrity.** Additionally, we must select fasteners to adequately secure the avionics to the shelves. Weight reduction is a critical constraint in aircraft design and will optimize overall performance including extended range and enhanced maneuverability. Once a new design has been selected, FEA and CFD analysis will be performed to ensure that the new shelves will be able to withstand the loading, thermal, and vibrational constraints provided by Boeing. The results of this analysis will be compared to analysis on the racks currently utilized by Boeing to see how our design holds up.

Vibrational Constraints:

Fixed Sine Tone Vibration		Source Frequency
Fundamental	1P	4 Hz
Blade Passage	3P	12 Hz
1 st Harmonic	6P	24 Hz

Avionics Dimensions and Weights:

Box #	Length	Width	Height	Weight
Shelf #1 (Top)				
Box 1.1	12.5"	4"	5"	8 lbs
Box 1.2	11"	3"	5"	5.5 lbs
Box 1.3	8"	8.5"	4"	7 lbs
Shelf #2				
Box 2.1	10"	6"	7"	10 lbs
Box 2.2	11"	3"	7"	6 lbs
Box 2.3	10"	6"	7"	10 lbs
Shelf #3				
Box 3.1	11"	4.5"	5"	6.5 lbs
Box 3.2	11"	4.5"	5"	6.5 lbs
Box 3.3	11"	4.5"	5"	6.5 lbs
Box 3.4	11"	4.5"	5"	6.5 lbs
Shelf #4 (Bottom)				
Box 4.1	9"	7"	5"	9 lbs
Box 4.2	10"	4"	5"	7 lbs
Box 4.3	5"	5"	5"	3.5 lbs

Material Decision Matrix:

Each material is ranked out of five based off its performance in that category.

Material Type	Specific Stiffness	Specific Strength	Density (kg/m^3)	Youngs Modulus (Pa)	Max Tensile Strength (Pa)	Total
Aluminum(6061)	3	3	2	3	2	13
Titanium(Grade 1)	3	1	1	4	2	11
Glass Fiber	4	5	2	4	5	20
Twill Carbon Fiber	2	2	3	2	1	10
Kevlar Fabric	2	3	4	2	3	14
PETG-GF	1	5	5	1	5	17
Steel	4	2	1	5	3	15

Semester Deliverables:

- Design an Avionics Rack that decreases the overall weight while maintaining the structural integrity of each shelf.
- Create a CAD model of the new design.
- Complete FEA (Finite Element Analysis) on the new shelves.
- Perform coupon testing to analyze the properties of select materials.
- Compare the durability of the new shelves against the original rack from Boeing.



Current Avionics Rack in the Chinook CH-47

Weight Constraints:

- The max weight of each shelf is ~6 lbs

Loading Constraints:

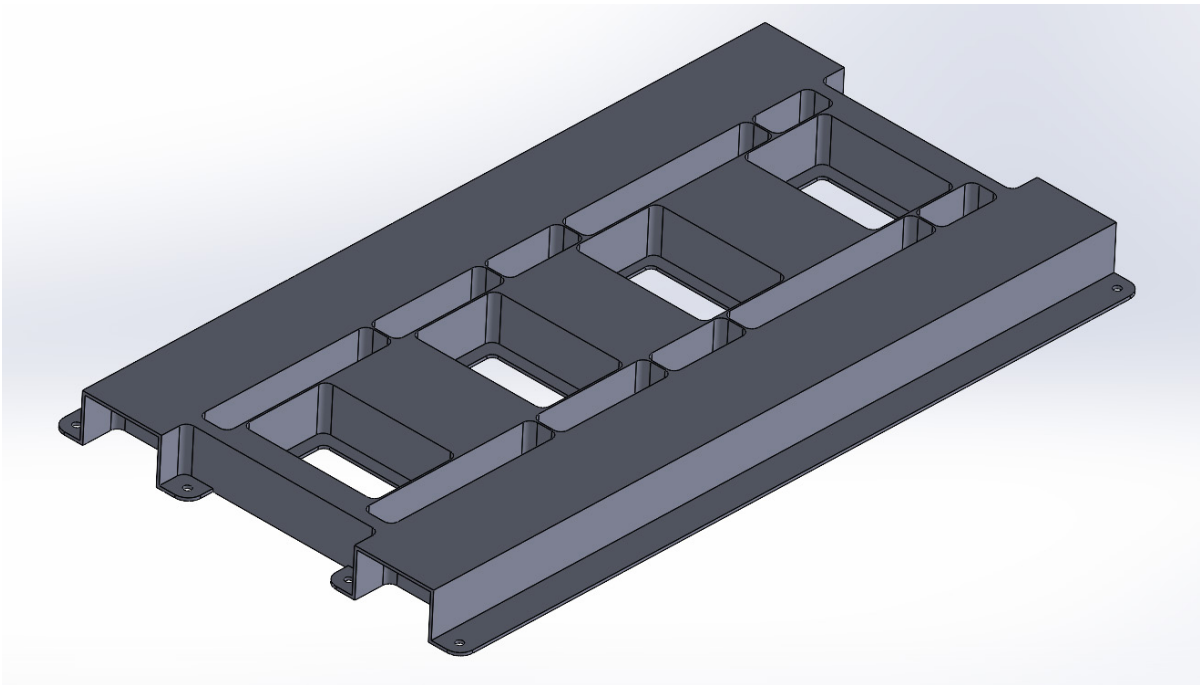
- MIL-STD-1290A Section 5.5.3.2 Batteries and Electrical Components
- Weight of all avionics on each shelf

Mounting Constraints:

- Attached on one end to aircraft fuselage the other to an intermediate structure

Space Constraints:

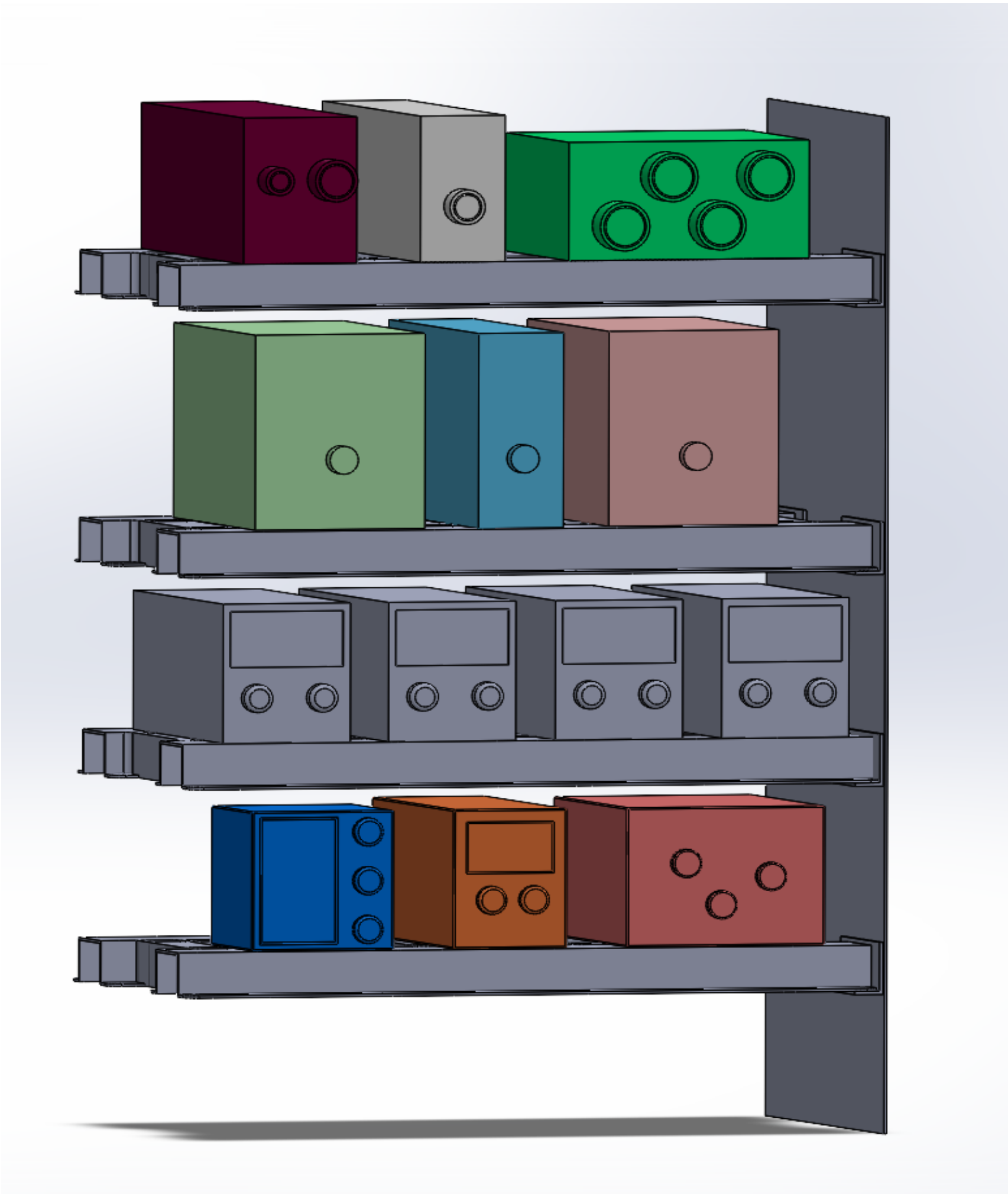
- Equal spacing between all avionics on each shelf
- Avionics to be placed as closely to each other as possible while allowing for ample cable routing space
- Shelf #4 requires a 3" diameter cutout underneath the avionics to allow for cooling



Current Design of Shelf 3

Current Avionics Rack Assembly:

- Made from Aluminum 6061
- Each shelf is specifically designed to include cooling holes based off the avionics placed on the shelf
- Each shelf without loading weighs around 6 lbs



Current Avionics Rack



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