NORTHERN ARIZONA UNIVERSITY

Quick Change Electrical Connection

Raytheon

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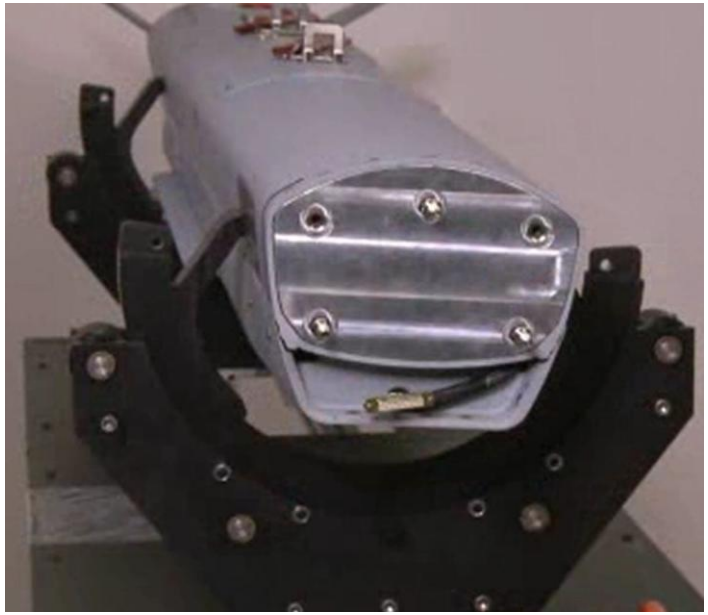
Overview

- Introduction
- Problem Statement
- Constraints
- Original Design
- Revisions
- Final Design
- Testing
- Conclusion
- Questions

Introduction

- Client: Raytheon Missile Systems
  - Started 90 years ago
  - Defense, aerospace and government applications
- Quick Change Electrical Connection



Problem Statement

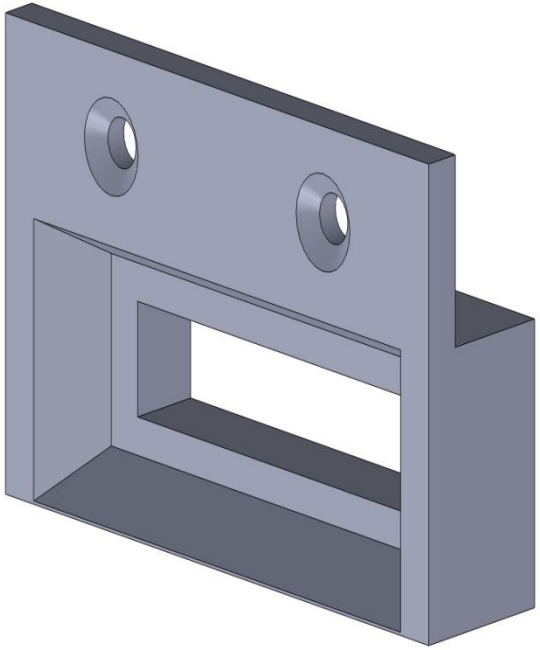
- The current nose assembly is unable to provide the ability to quickly install the nose without compromising the electrical connection.

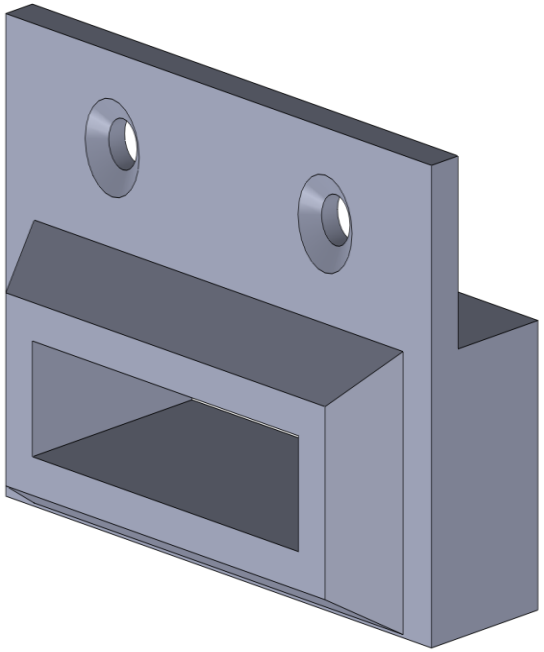
- Goal
  - Design an improved electrical connection alignment

Constraints

- Focus on evaluating materials under the specified operating conditions:
  - Power Loads
    - Transportation Loads
    - Bomb Rack Ejection
  - Environmental Factors
    - Temperature
    - Sand/Dust
    - Water/Ice
    - Salt
  - Operational Factors
    - Vibration
    - Jet Fuel

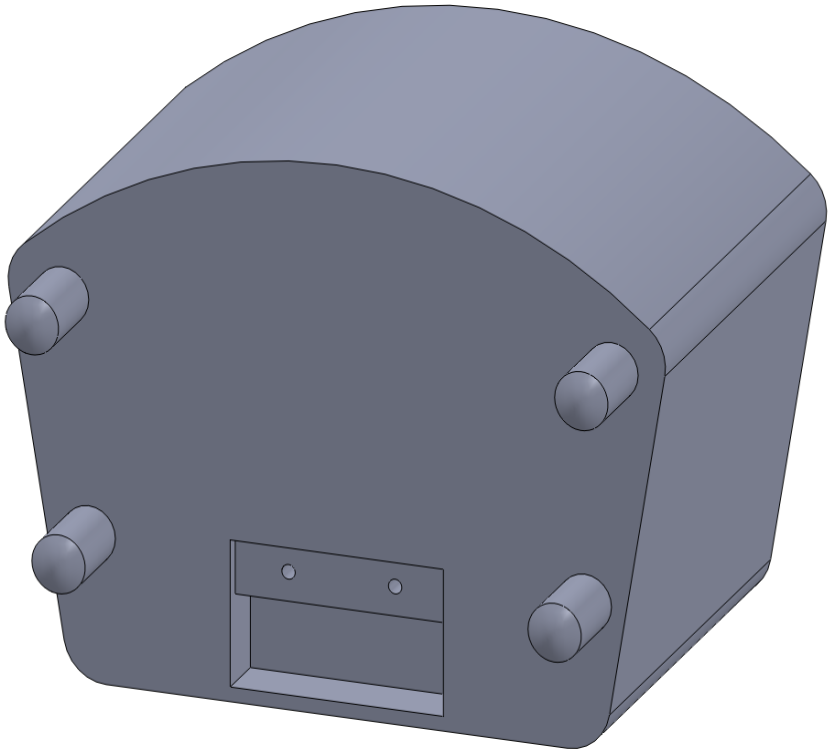
Original Design

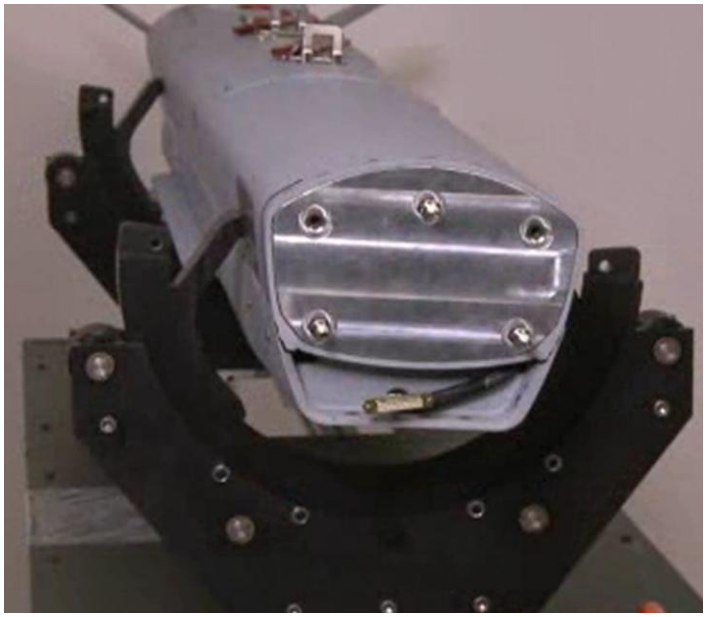




Electrical connector used:

Original Design





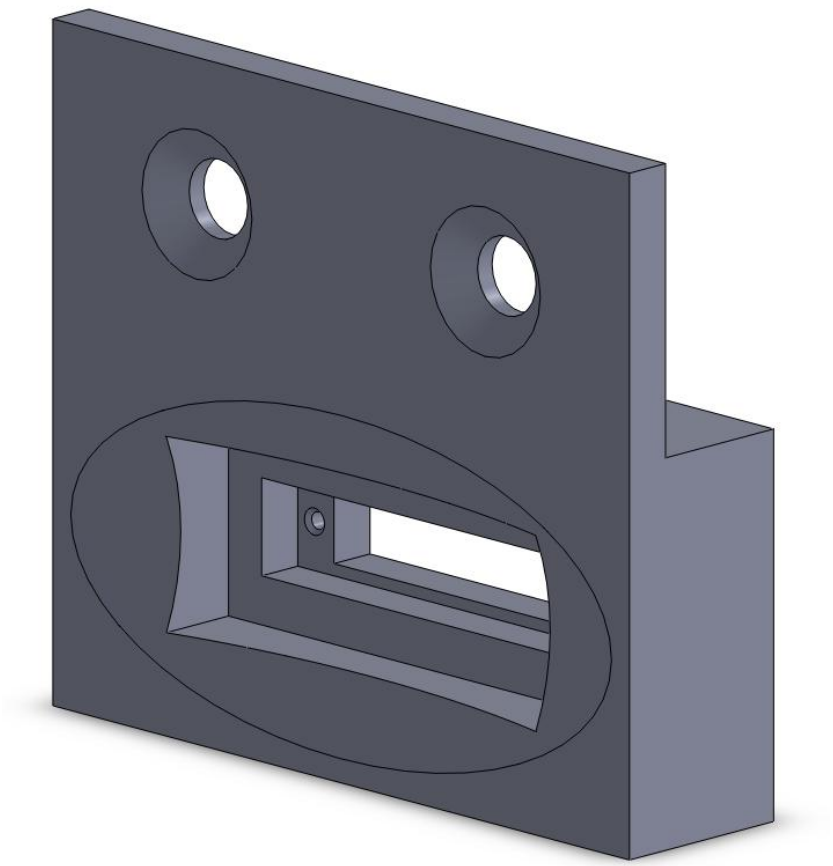
Material Selection

- Assumed outside shell of missile will take most of the forces produced from bomb rack ejection
  - Corrosion is more important
- Material Choice: AISI 303 Stainless Steel
  - Annealed
    - Stronger and less brittle
  - Resistance to corrosion

Revisions

- Design Issues
  - Slants difficult to machine
  - Connectors caused alignment issues
- Material Issues
  - Machining
  - Heavy
  - Expensive
- Increase Field Replaceability
  - Orifice added to the back
  - Screw holes added to the design

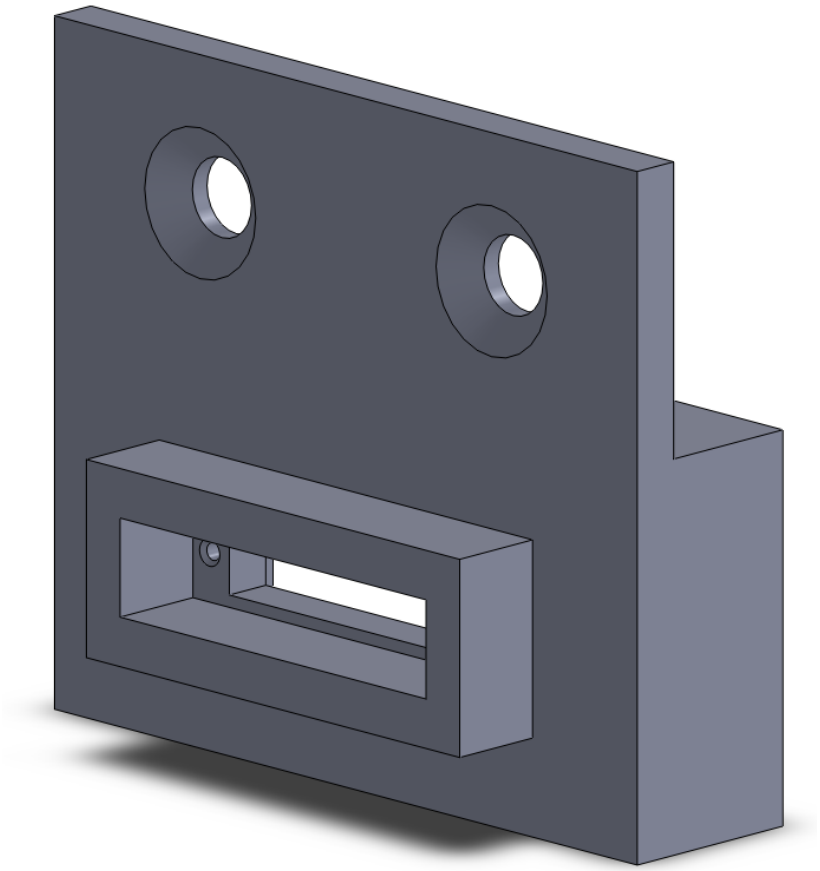
Final Design



Body Side

- Elliptical indent guides self alignment
- Guiding channel added
- Two modes of replaceability
  - 3/8’’ clearance holes for 90° flat head screws
  - 4-40 machined screws

Final Design



Nose Side

- Extruded section leads into channel
  - Self aligning
- Screw holes added for field replaceability

Material

Property	6061 Aluminum
Hardness	95
Ultimate Tensile Strength	310 MPa
Modulus of Elasticity	68.9 Gpa
Thermal Expansion at 250˚C	25.2 µm/m-C˚

- Improved Manufacturability
- Cuts cost of final design

Cost Analysis

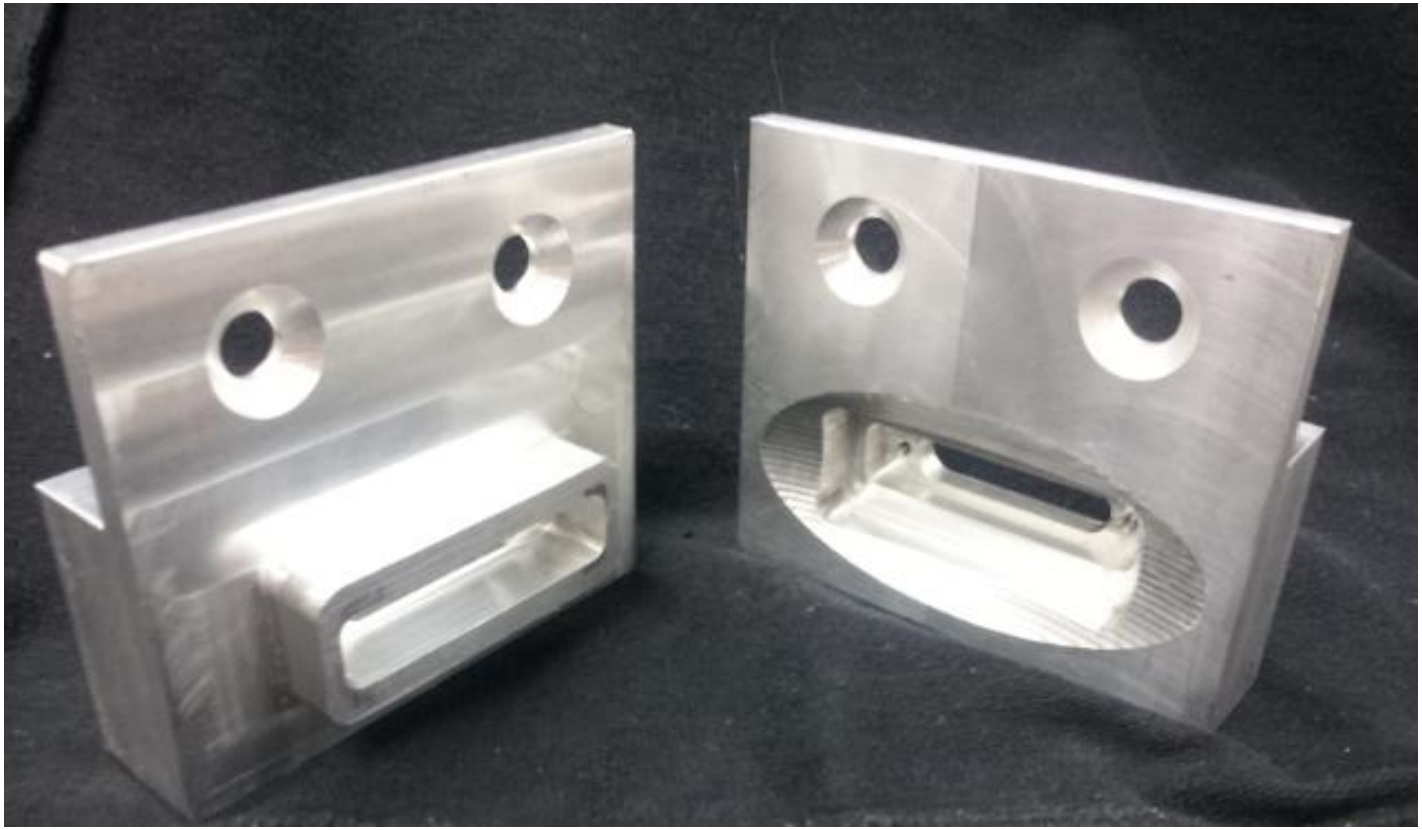
Category	Units	Cost
Material	$	$50
Manufacturing	Man Hours	2 hours ~$100
Electrical Connector	Glenair Unit Price	$20
Total	$	$170

- Meets requirements for cost
  - Overestimation

Machining

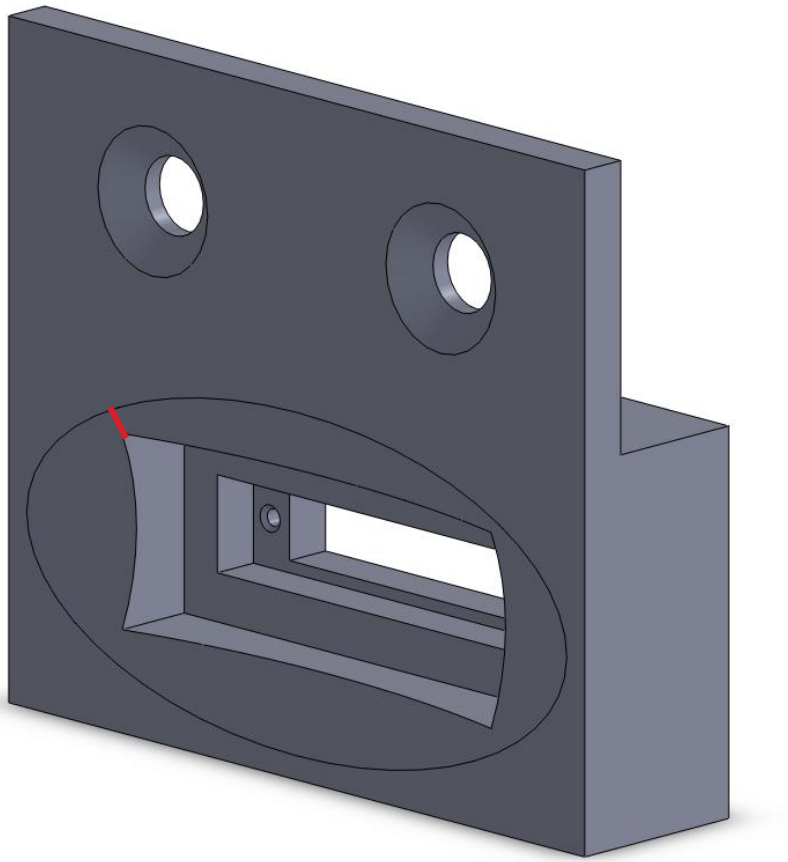
- To machine our design the following processes were used:
  - End Mill
    - To create pockets
    - Smooth surfaces
  - Drill
    - Holes for fasteners
  - CNC Coding
    - To create elliptical indent

New Design

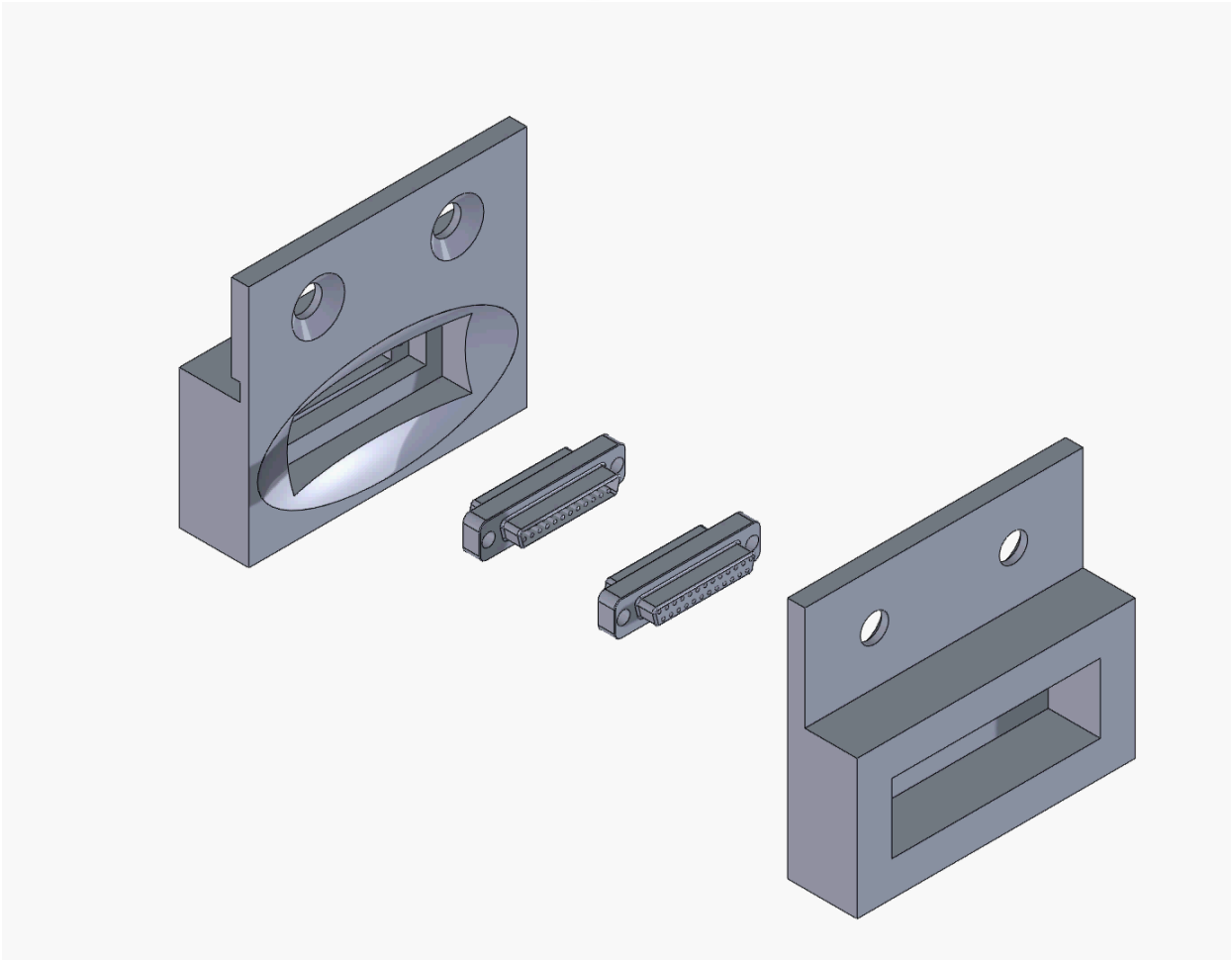


Testing

- Mating contingent on oval on body side of missile
- Requirement:
  - .080’’ for 1’’ away
  - .020’’ for ¼’’ away
- Radially:
  - Red line
  - Our design will mate with a .114’’ misalignment

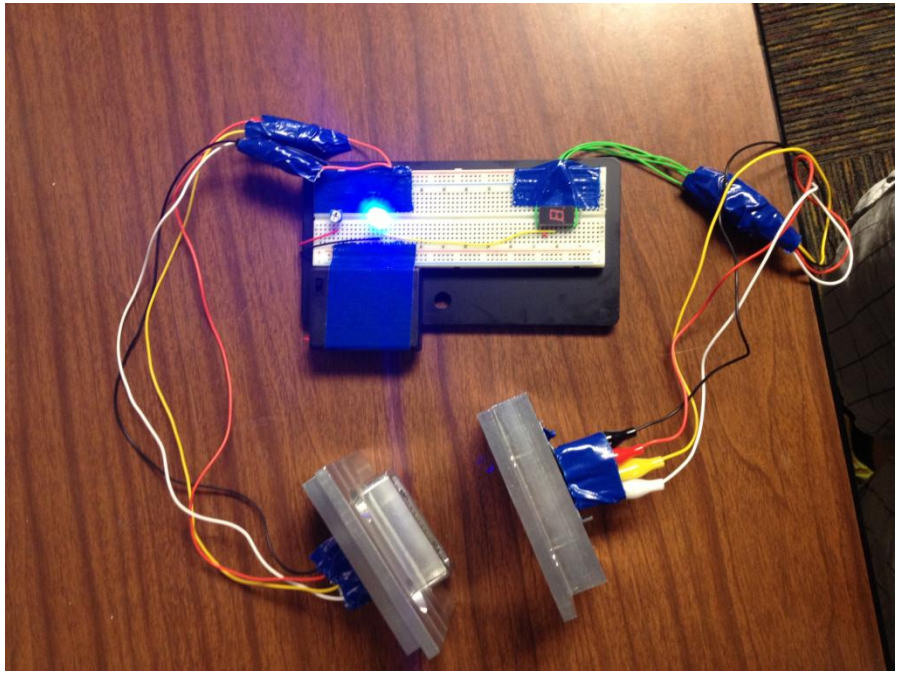


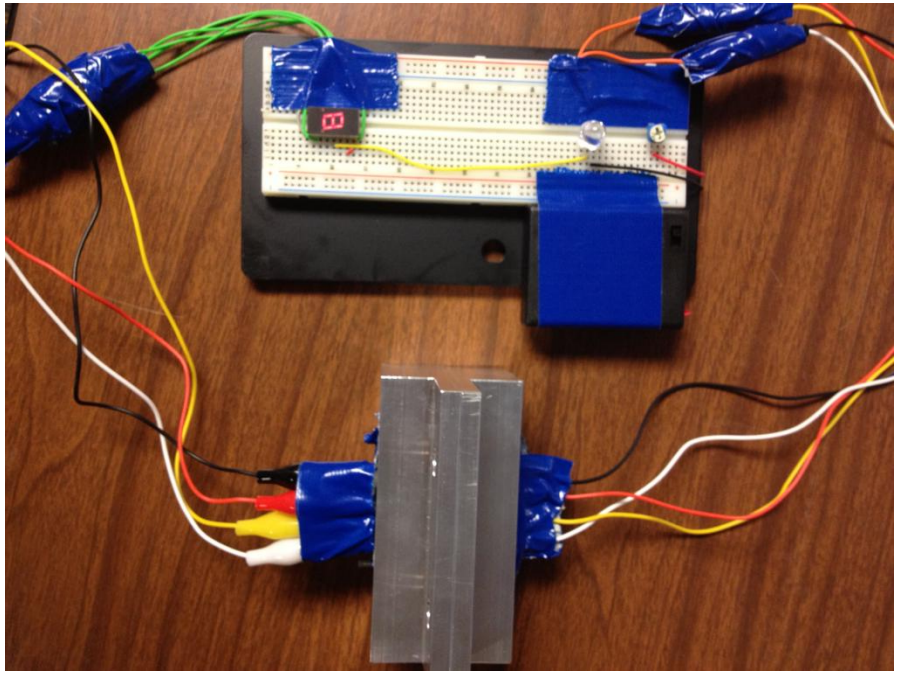
Visual of Mating



Testing

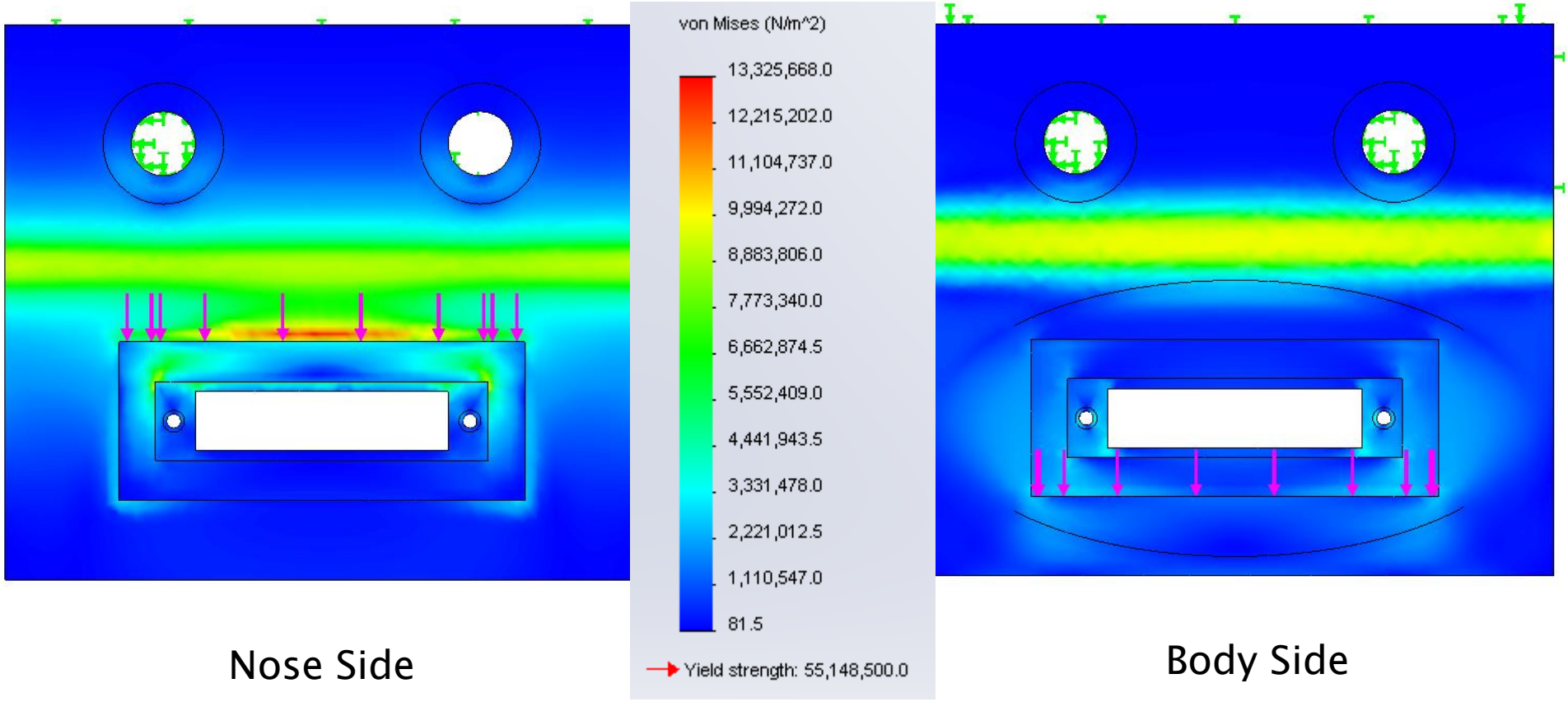
- Verifying the Electrical Connection





Testing

- Finite Element Analysis

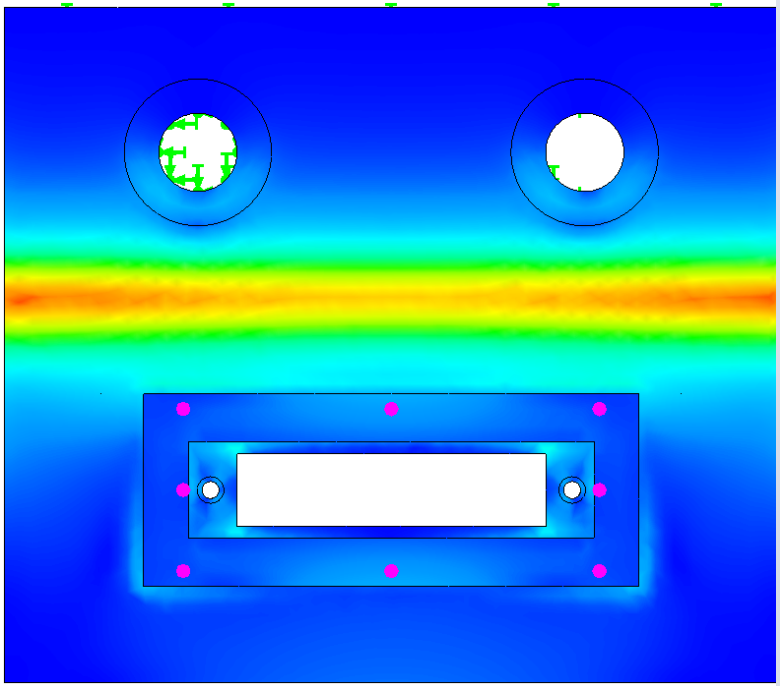


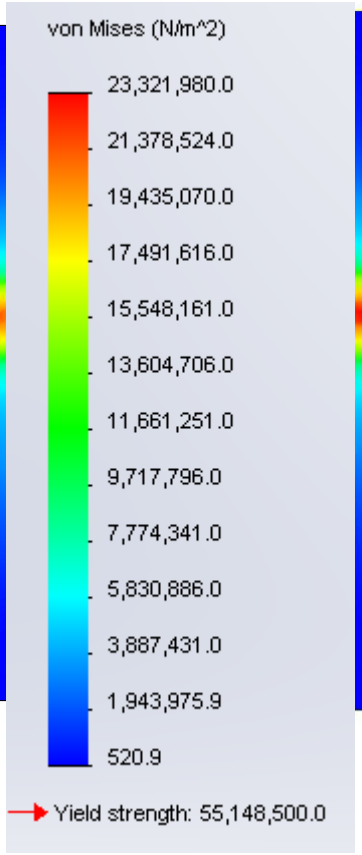
Nose Side

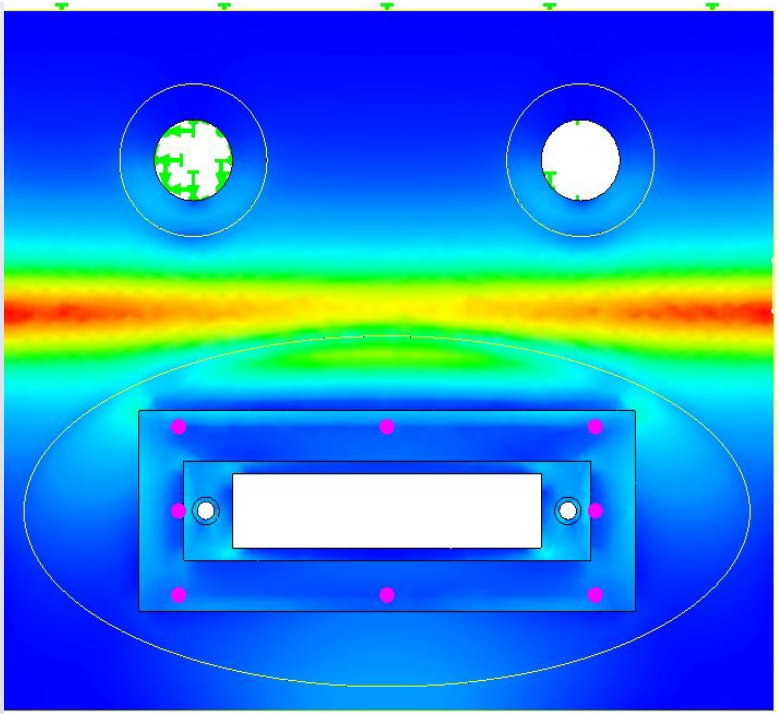
Body Side

Testing

- Finite Element Analysis





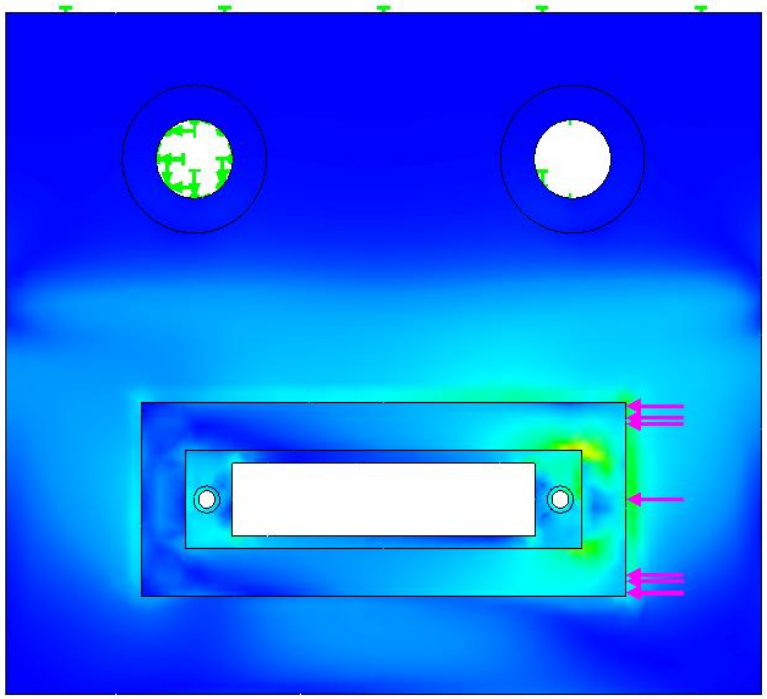


Nose Side

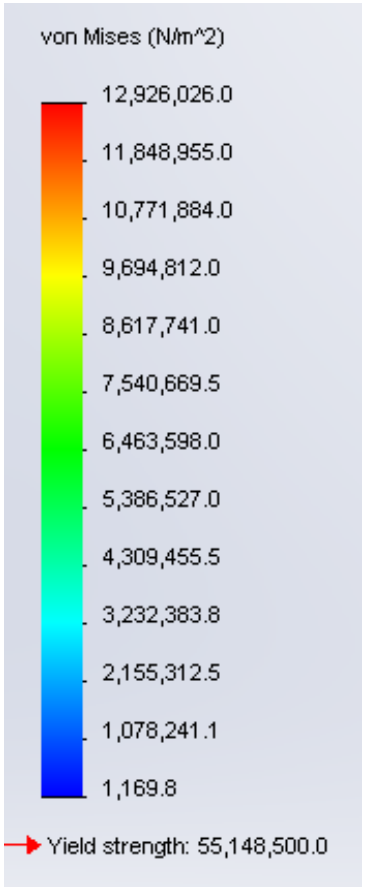
Body Side

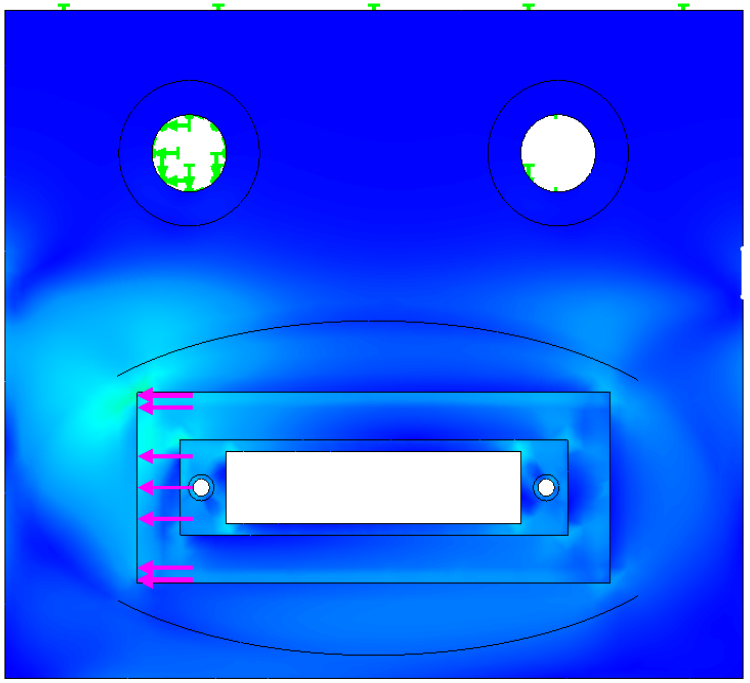
Testing

- Finite Element Analysis



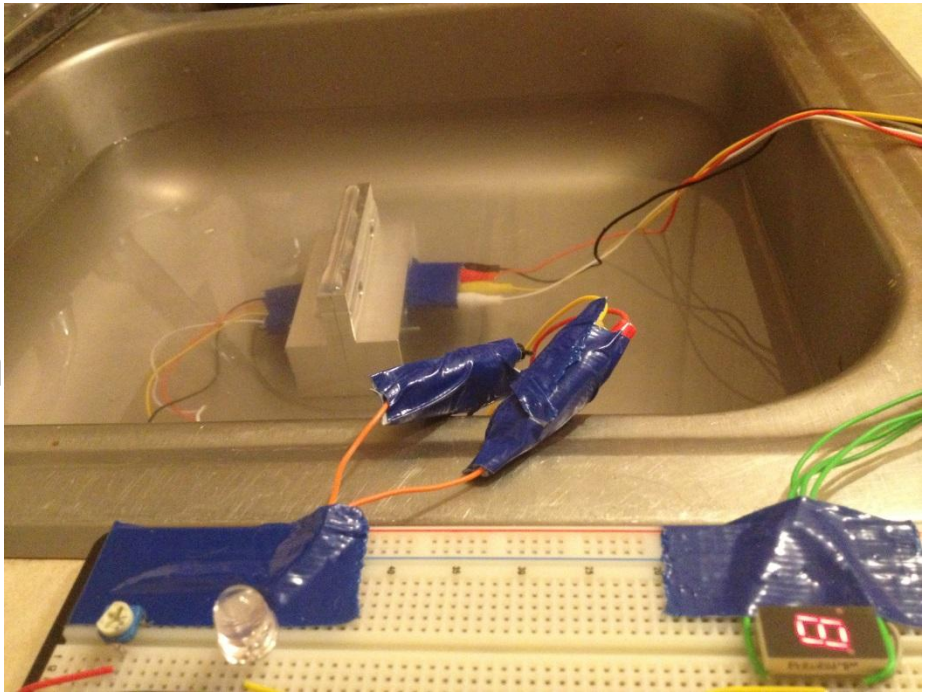
Nose Side





Body Side

Testing



- Water/Ice
  - Did not hinder operation of electrical connection
- Sand/Dust
- Salt
- Temperature
- Further testing required for:
  - Vibration
  - Jet Fuel

Conclusion

- Our Design
  - Effectively corrects any misalignment
  - Field replaceable
  - Will last within the expected lifetime
  - Meets our clients requirements with room for error

Acknowledgements & References

- Acknowledgements
  - Andrew Concillio (Raytheon)
  - Dr. Kosaraju (NAU)
- References

  - Shackelford JF, 2009, *Introduction to Material Science 7th Edition*, Pearson Prentice Hall.\
  - Budynas RG, Nisbett JK, 2011, *Shigley's Mechanical Engineering Design 9th Edition*, McGraw Hill.
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Questions?