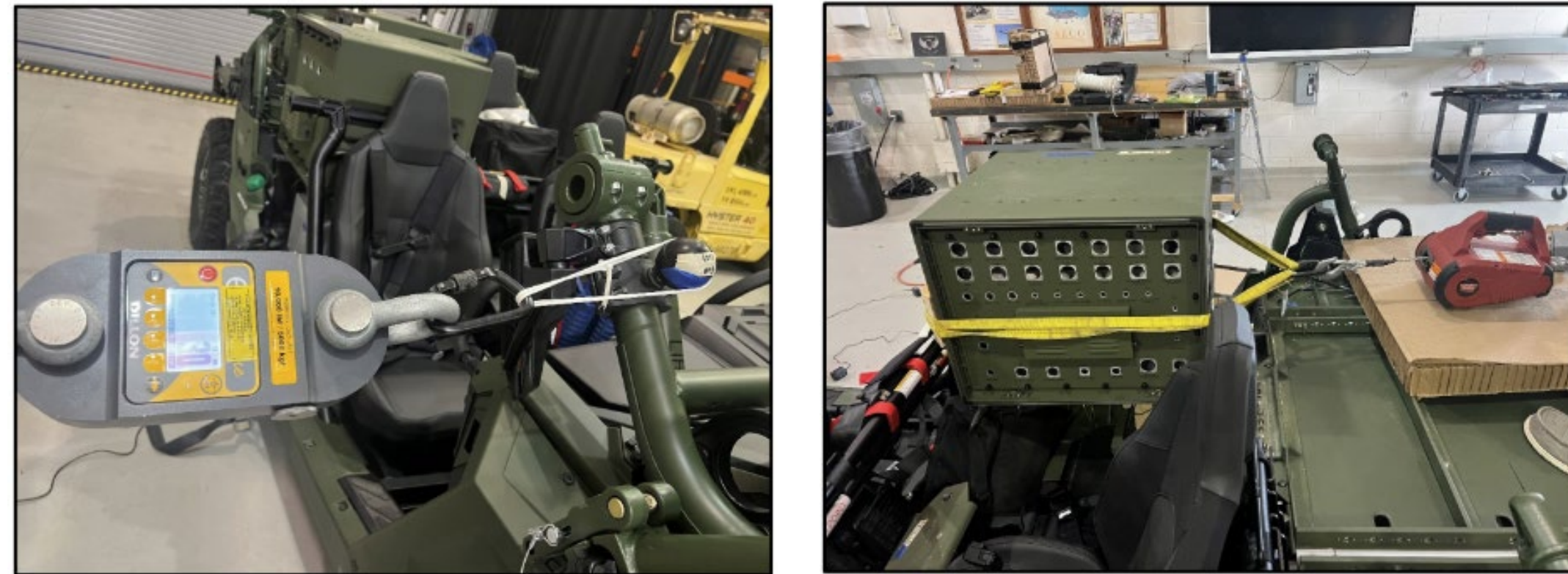


Problem Definition



Existing NAWCAD Solution

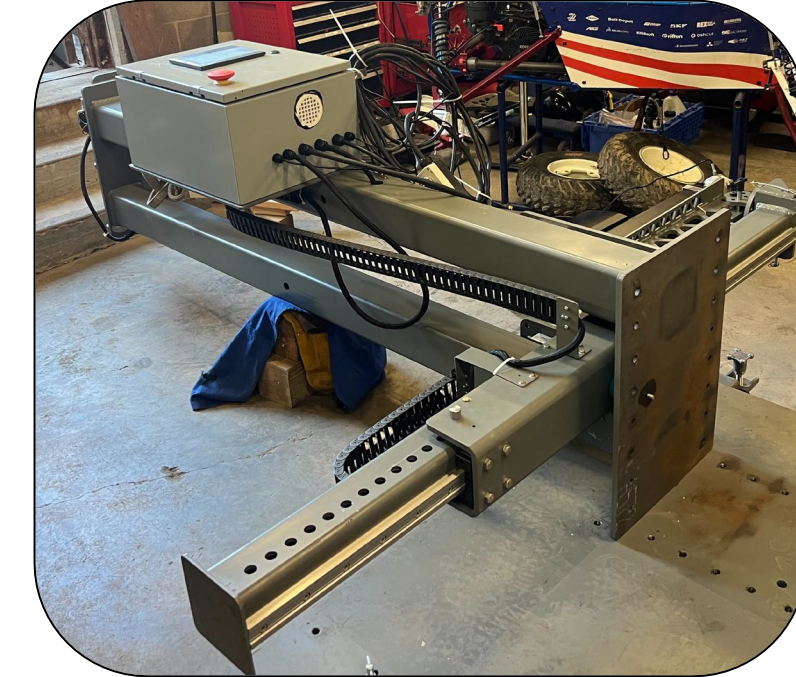
All Navy vehicles & cargo must be proven to withstand 4Gs in the direction of flight and 3Gs in all other directions if they are to be transported by air. Some vendors create hardware but cannot prove their designs meet these loading requirements. The NAWCAD cargo lab must manually apply 3G and 4G loads to these vehicles/attachments and measure deformation to confirm structural integrity. Currently this is done with low precision, low data output, low versatility equipment.

Key Design Requirements

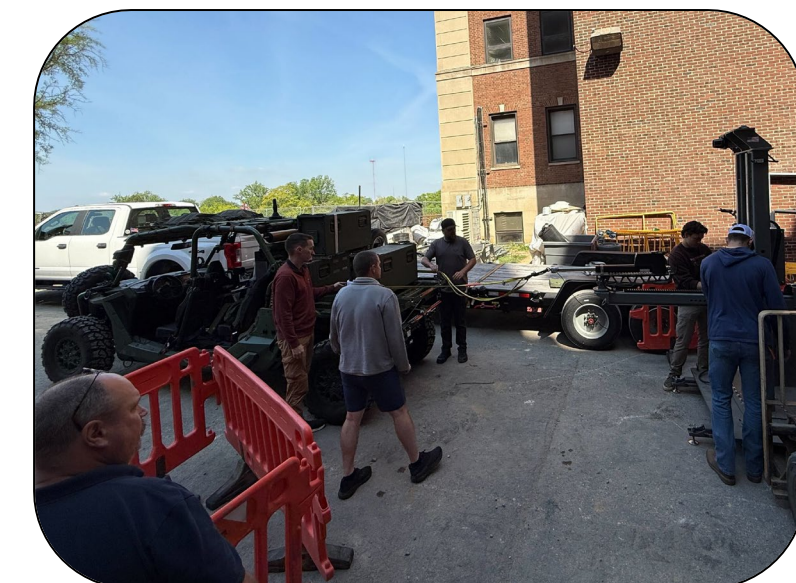
- Reach cargo up to 75" high and 48" into vehicle
- Variable load up to 1000 lbf
- Under 64.5" tall when stored
- FWD, AFT, LAT, VERT Directions
- Record Deflection to 0.001"
- Easy Implementation



Transportable By Forklift



Storage Under 64.5"



Ease of Set-Up



Multiple Orientations

Design

- Hoist**
 - Provides adjustability along Z axis
- Carriage and Rotator**
 - Provides adjustability in X and Y axes around pivot and along linear rails
- Linear Actuator**
 - Bidirectional force application up to 1000lbf
- Outriggers**
 - Reduce tipping risk
- Ballast**
 - Reduces tipping risk
- Control Panel**
 - Houses electronics and operator controls
 - Controls include actuator and hoist jog, cycle start, cycle pause

Structural Strength Tester in Active Testing

Solution

Solution: Fully Custom Steel Rig
High-strength steel weldment rig with an actuator that:

- Can be easily transported by forklift or pallet jacks
- Can be positioned up to 75" vertically
- Extend up to 48" outward
- Adjustable to many different angles
- Digital indicators on versatile mounting arms can be attached to the vehicle reference frame



Analysis & Testing

FEA Done on All Custom Components & Full Rig Tested to 125% Proof Load WLL as per OSHA 1926.251(a)(4)

Custom Steel Component FEA Results

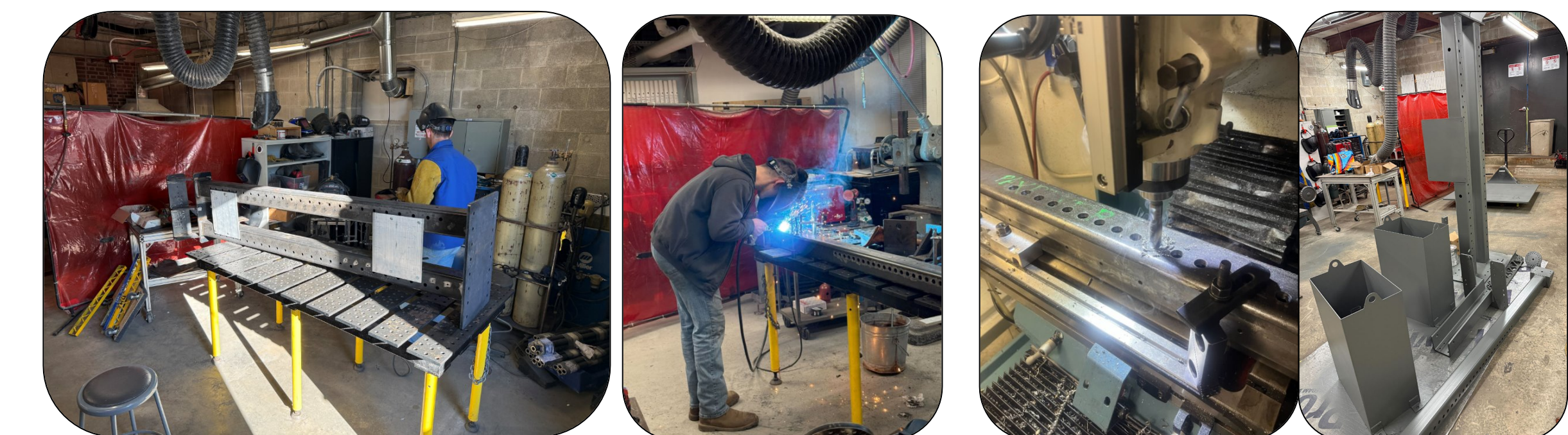
Component	Margin
Mounting Plate	27.1%
Rotator	8.7%
Slider Tube	7.2%
Carriage Weldment	1.0%
Vertical Posts	12.5%
Outriggers	25.0%
Bushings	1.7%
Pallet	51.0%



Proof Load Test for Frame Validation

Manufacturing

All Welding, Painting, & Machining Done In-House, By Team



Acknowledgements

Senior Design: Rich Bauernschub, Nick Watson, Jacob Hammond
JHU Machine Shop: Daren Ayres, Rich Middlestadt,
NAWCAD: Cory J. Kopa, Mike "Thriller" Jackson, Stevie Klock