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# Robotic Inspection of Geometrically Complex Tank Systems

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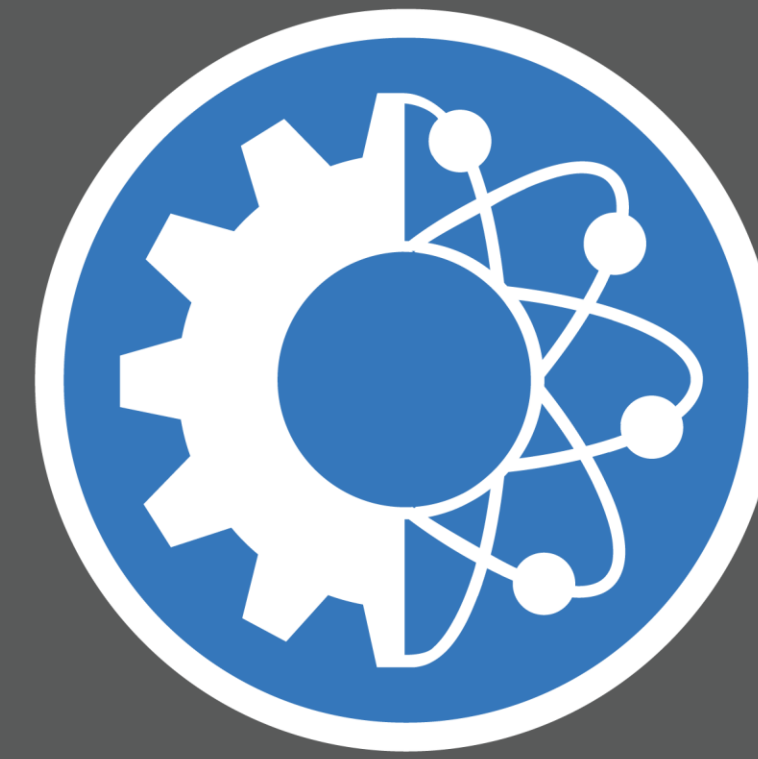
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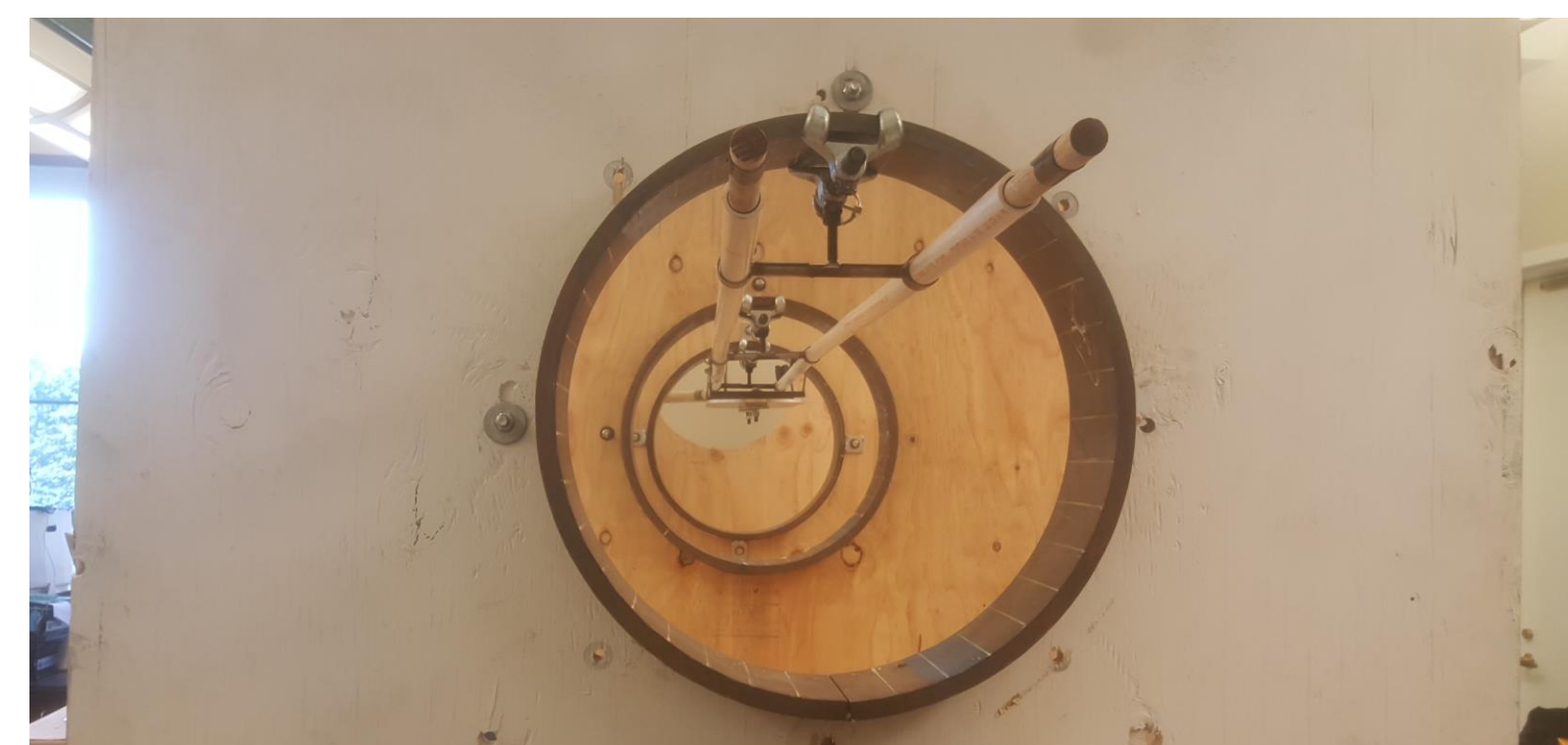
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# Robotic Inspection of Geometrically Complex Tank Systems

## Introduction

- A rail system to support robotic inspection of complex tank systems was designed with input and guidance from Newport News Shipbuilding.
- This is a continuation of a 2014-2015 Senior Design Project.
- Robotic tank inspection reduces hazardous working conditions for laborers.
- Tanks are roughly 3' by 4' and include corner tanks at the ends of a run of up to a dozen straight tanks.
- The only access between the tank bays are 20" flanged holes that vary in size and shape.



Viewpoint from within a Tank Bay

## Design Constraints

- Main design objectives include safety, speed of installation and removal, and accessibility between the bays with the rail installed.
- The system may only utilize the top 6" of the hole.
- Holes may be offset 8" horizontally and/or 6" vertically over a span of only 32".
- The rail system must support 50 lbs. over the largest span in the tanks.

## The Flange-Clamp Design

- The design utilizes a coil spring compressor, modified to securely clamp onto the flange of the access hole.
- A threaded rod is welded to a nut that allows a pivoting hanger to hold the PVC rail.
- The bracket assembly is attached to the tank flange by use of a lightweight electric driver.
- The end of the spring compressor shaft has been modified by adding a tool-free quick-disconnect that can disassemble the flange clamp if an emergency occurs in the tank.
- After the flange clamps are disassembled, the PVC rail can be cut with bolt cutters to get the rail out of the way quickly.



Flange Clamp Installed on Flange



Flange Clamp Assembly Removed

- A new cart was designed to be externally supported, whereas the previous year's design was internally supported.

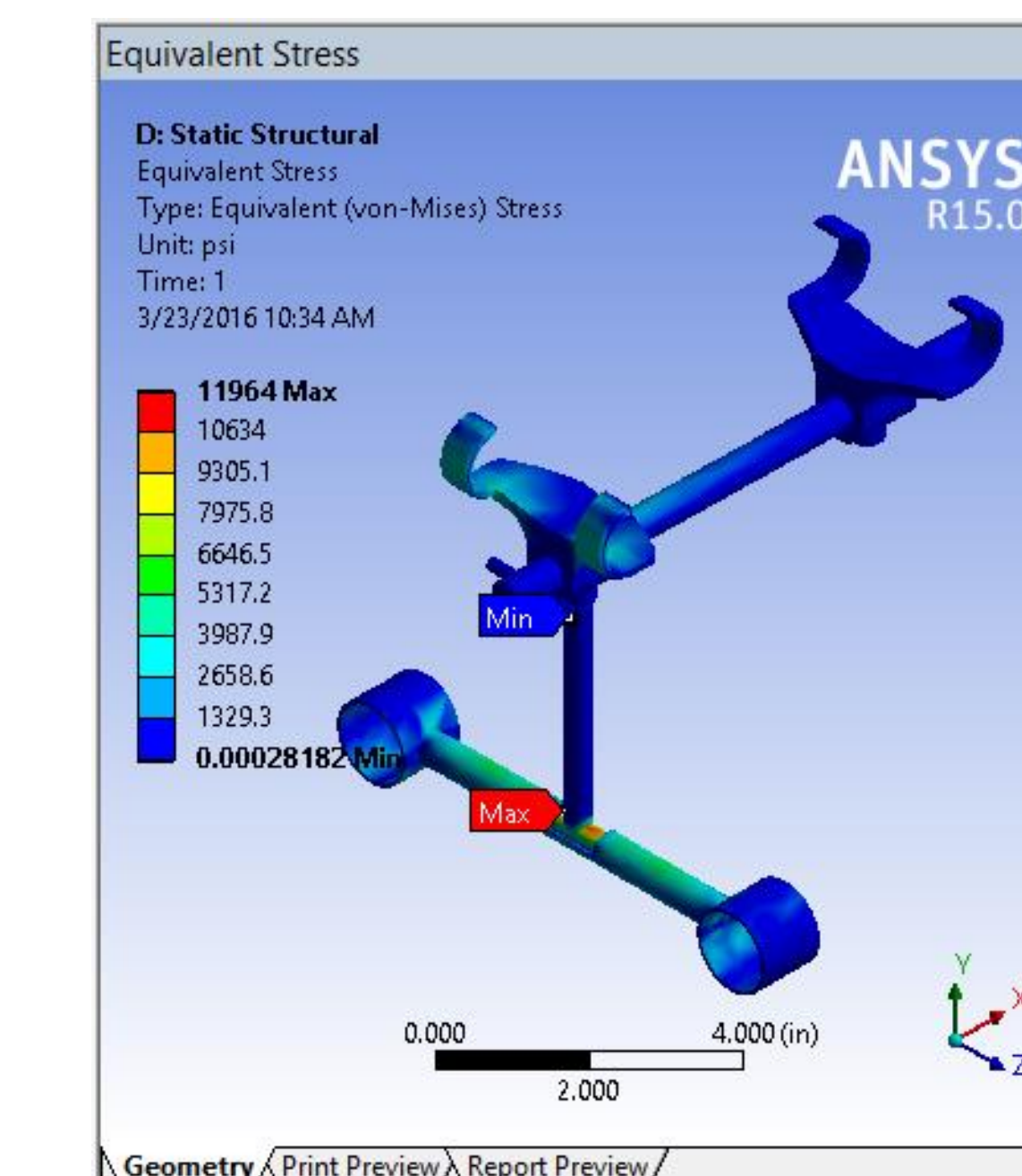


Cart Installed on Rail System

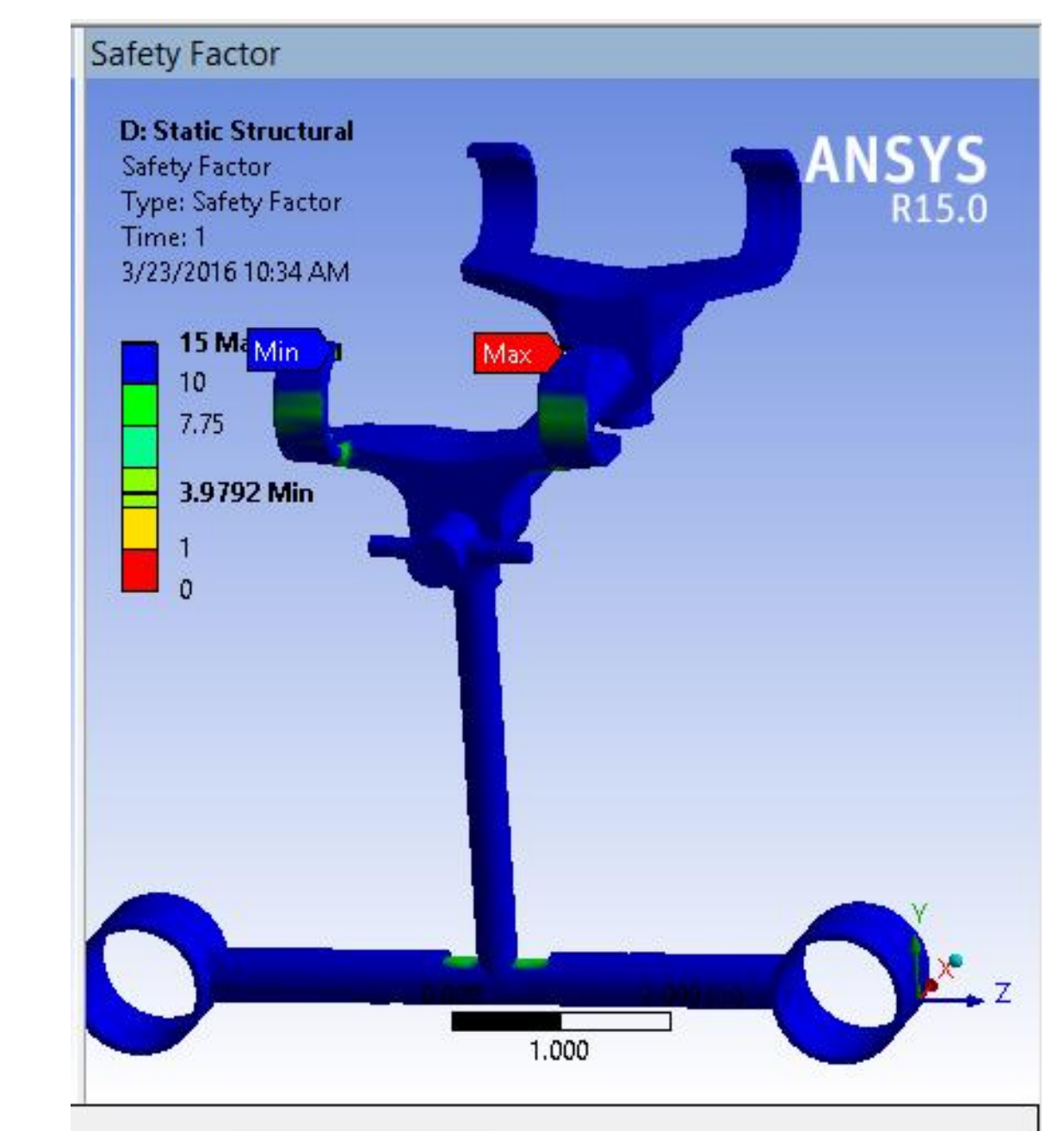
- Rubberized wheels with grooves easily track over the bumps of the hangers and stay straight.

## ANSYS

- A computer model of the flange clamp was created, each part having material properties accurate for their respective alloy.
- Using finite element analysis (FEA), a minimum safety factor of 4 was found while loaded with the full weight of inspection robot (50 lbs).



FEA Results: Equivalent Stress



FEA Results: Safety Factor

## Future Improvements

- The flange clamps could be reinforced in order to mitigate fatigue caused by the high moments created as a result of sand blasting.
- The distance between the rail and the top of the flange could be reduced in order to create the largest crawl space possible below the rails.
- The very top section of the circular rail holder could be removed to provide a completely flat rail surface for the cart wheels to run on.
- The size of the cart's wheels could be optimized to allow greater clearance of the flange.