CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

Title: John Deere Tie-Rod

Agricultural & Biological ENGINEERING

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Introduction

Problem Statement:

- To design a versatile tie-rod that can be adjusted to change the tread width of the machine with ease.

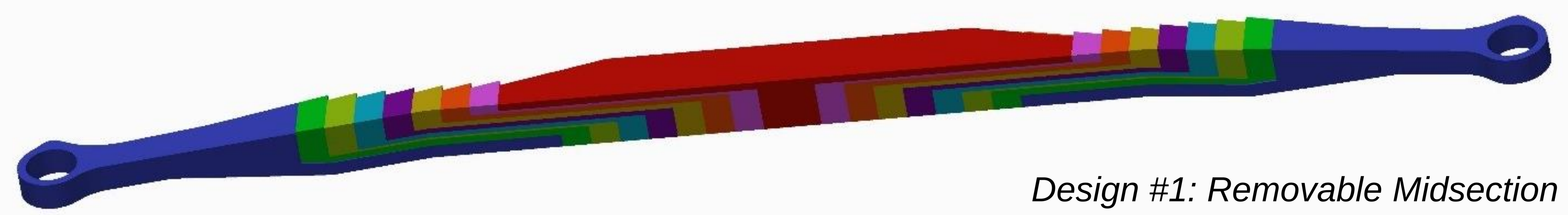
Background:

- Different row crops require various row spacing and in order to prevent customers from having to purchase separate tie-rods for each row spacing they require, an adjustable tie-rod will be implemented.

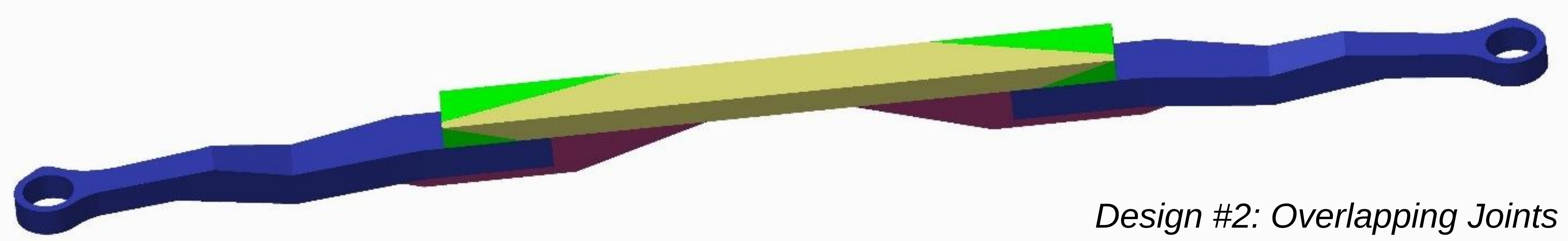
Criteria:

- Must fit within the given space-claim
- Must withstand high-buckling loads from steering dynamics
- Must perform safely under high tension and compression loads
- Must deliver precise adjustments of 4 inch increments

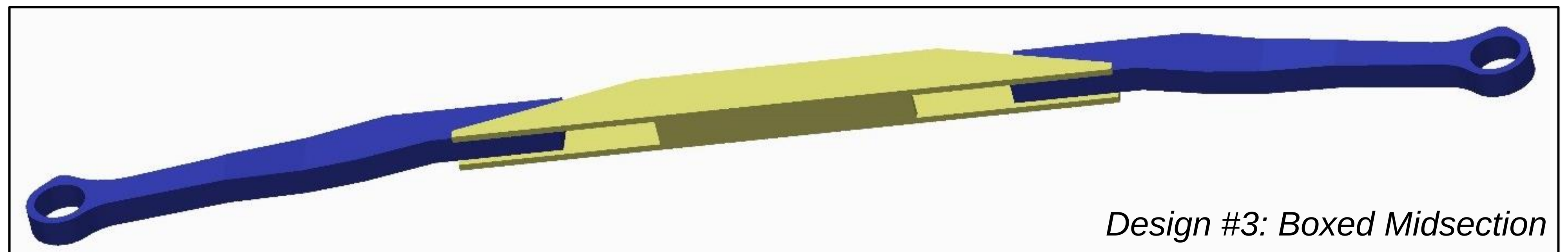
Alternative Solutions



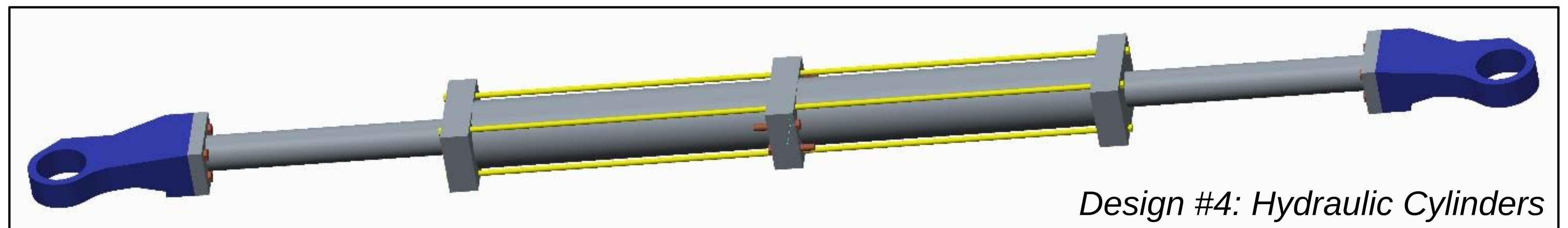
Design #1: Removable Midsection



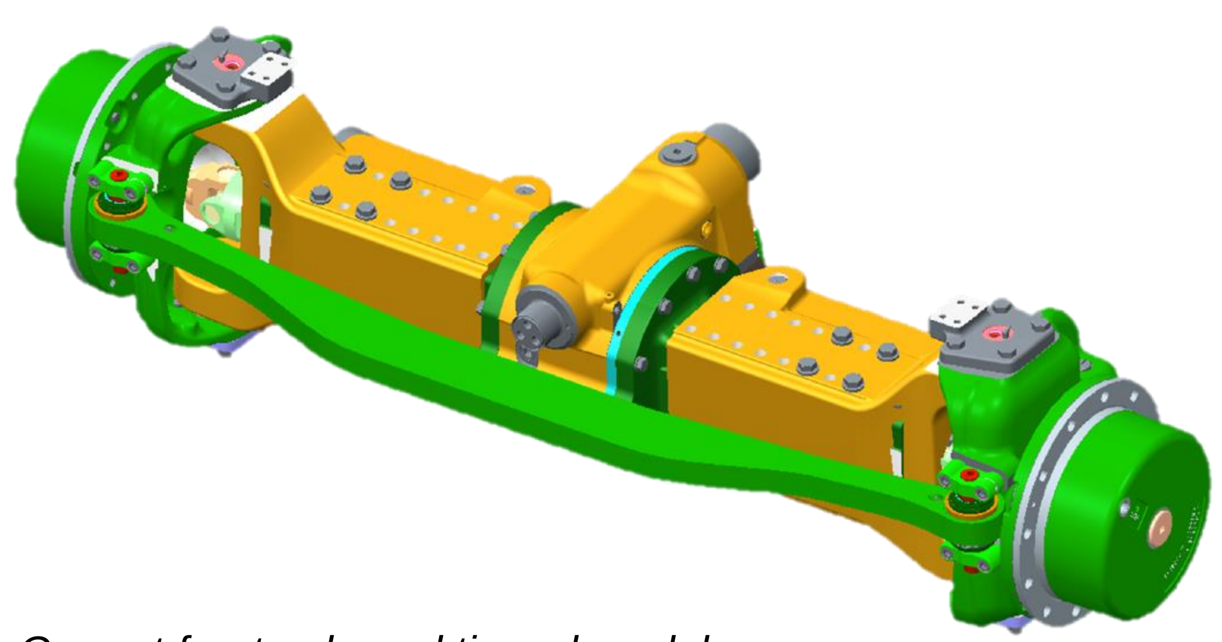
Design #2: Overlapping Joints



Design #3: Boxed Midsection



Design #4: Hydraulic Cylinders



Current front-axle and tie-rod model

Societal Impacts & Sustainability

Benefits:

- Customer can have access to many different tread settings while only purchasing one tie-rod
- Ease of adjustment of tie-rod will create the customer more uptime
- Requires less material than the current option
- Allows the company to invest in the production of 1 tie-rod assembly vs. the production of several

Disadvantages:

- Leakage of hydraulic fluid in hydraulic design may have negative environmental impacts
- Rusting of steel, especially bolt holes in mechanical designs, may decrease the overall lifetime of the tie-rod

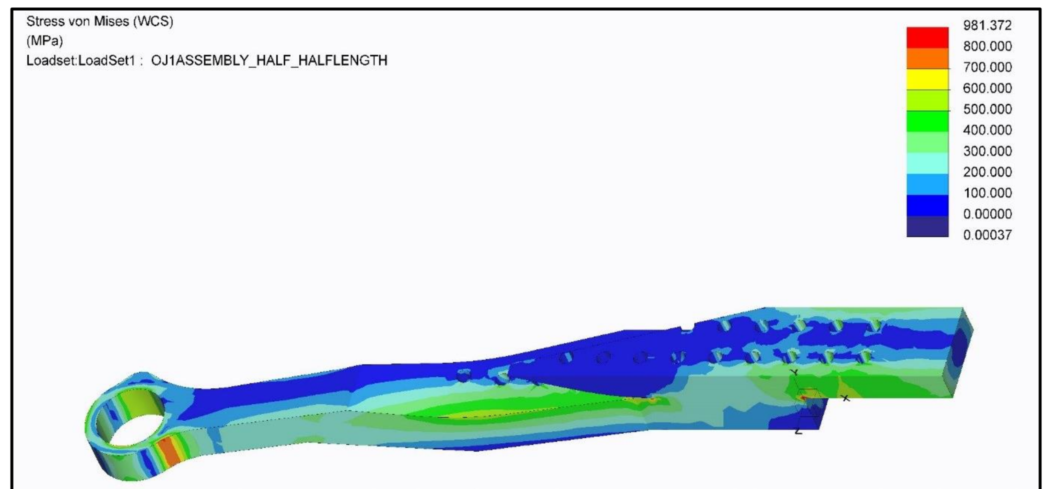
Economical Analysis of Design #2

Cost of material:	$1,160
Cost of custom machining:	$17
Cost of forging:	$53
TOTAL cost per part:	$1,230

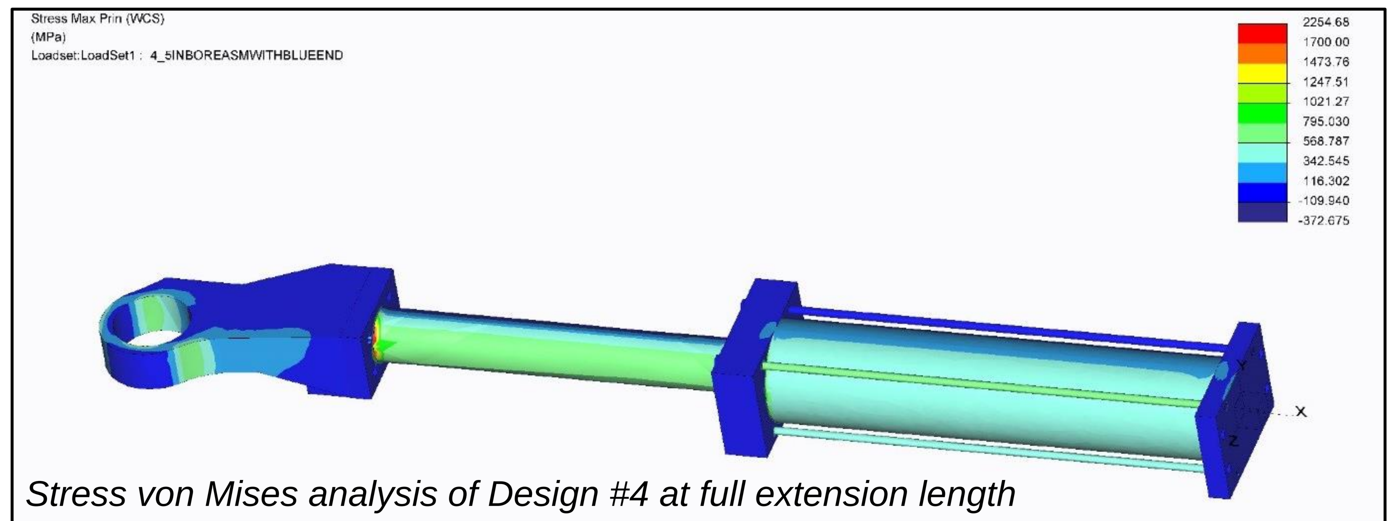
* Assume 1,000 parts produced in total

Calculations & Analysis

- Through a mid-design review, 2 alternative solutions were chosen to move forward with analysis
  - Design #2: Overlapping Joints
  - Design #4: Hydraulic Cylinders
- Hand calculations were performed on both models to get the following results:
  - Buckling loads
  - Deflection
  - Bolt Shear Stress
- Creo FEA was also performed on both models and the results were comparable to the hand calculations
- Through analysis, several iterations were made to both Design #2 and #4



Stress von Mises analysis of Design #2 at mid-extension length



Stress von Mises analysis of Design #4 at full extension length

Final Solution

- The team's final recommended solution to the given problem statement is Design #2: Overlapping Joints
- The material selected for the final solution is Armstrong Ultra 960 steel
  - Provides F.S. = 1.2, given analysis results
- Why this solution was the best:
  - Stresses shown in analysis were allowable
  - Minimum parts required
  - Meets all design criteria
  - Cost effective

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