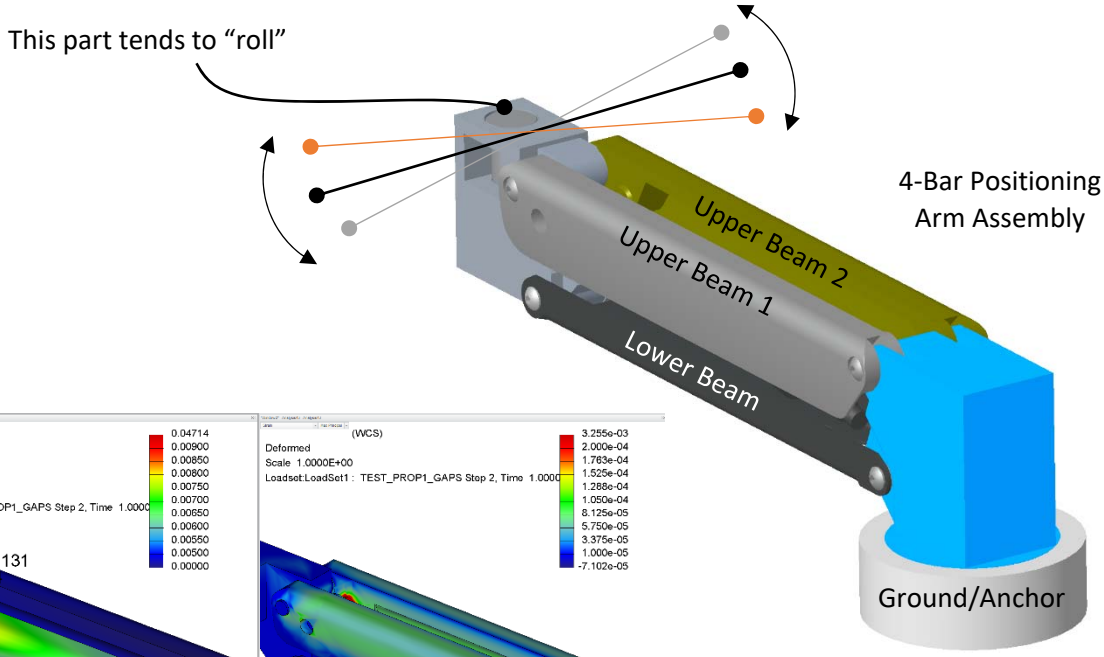
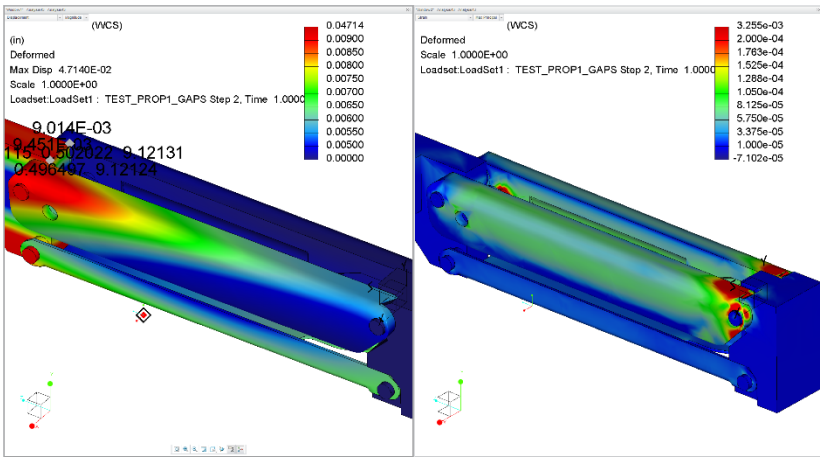
Virtual Engineering, Inc.

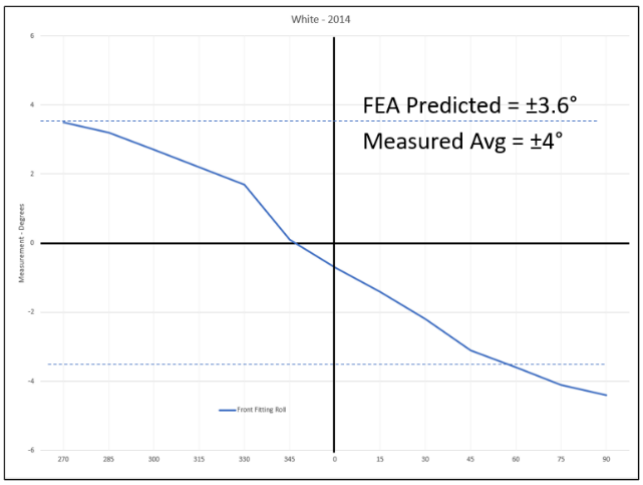
Engineering Your Competitive Edge…

Increase Arm Structure Stiffness Using FEA and Experimentation

- **Objective:**
  - Customer wants to increase the stiffness, reduce “roll” of a 4-bar positioning arm
  - Experimentally determine root cause of “roll” and best areas to target for improvement
  - Offer design options, analyze options in FEA, and confirm results correlate with analysis
- **Constraints:**
  - Maintain exterior shape of all parts as well as materials and manufacturing processes







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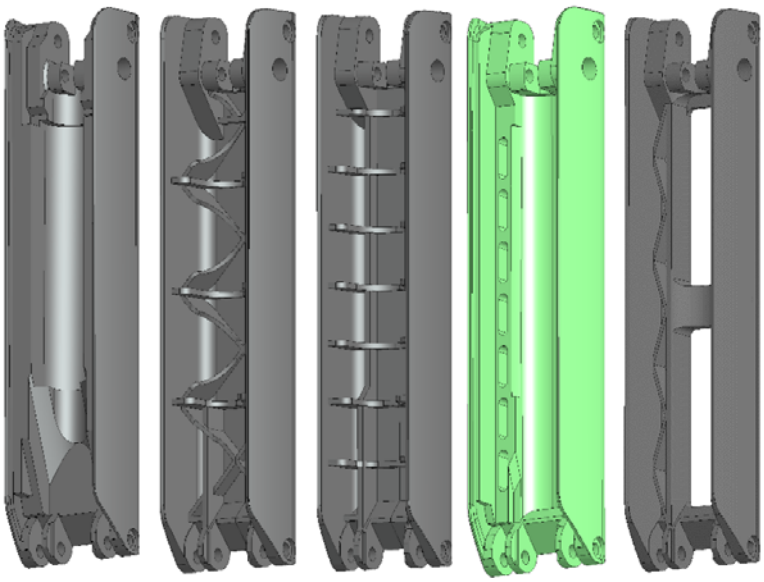
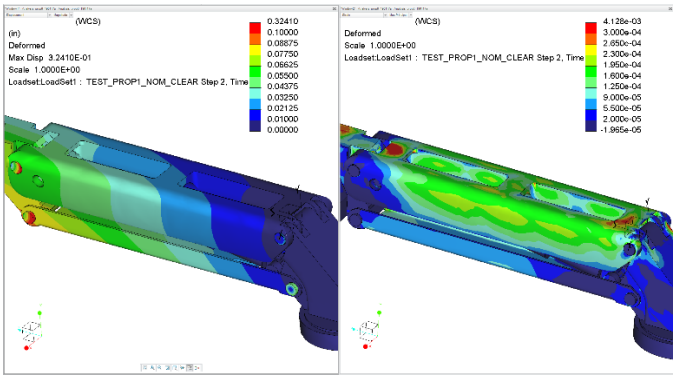
- **Process:**
  - Extensive measurement on the structure confirmed scenarios where displacements were most evident and pointed to the Upper Beams as the prime area of concentration
  - Enventive analysis and FEA (in Creo Simulate) proved that required pivot clearances and the two-piece Upper Beam construction were significant contributors to the amount of roll
  - Designed an initial concept of a one-piece Upper Beam to replace the two-piece
  - Maximized material in the initial concept by matching the exterior profile and clearing the internal components by a minimum amount
  - This defined the maximum possible stiffness, but was not an efficient use of material
  - Analyzed the current design and the initial concept in Creo Simulate to find and compare theoretical displacements and stresses
  - Initial concept was fabricated and both designs were measured to find experimental roll
  - Found a positive correlation between experimental and theoretical (FEA) results
  - A series of one-piece design variations were modeled and analyzed to find the best combination of low displacements, reasonable stresses, manufacturability, and weight
- **Results:**
  - ***Achieved 63% reduction in displacements while increasing mass of the assembly by only 6%***

Multiple Iterations Analyzed





	FEA Results
Proposal 6	1.5°
Proposal 6a	1.8°
Proposal 6z	1.4°
Proposal 7a	0.9°
Proposal 7b	1.1°
Proposal 7c	1.2°
Proposal 7d	1.3°
Proposal 7e	1.1°
Proposal 7f	1.2°
Proposal 7g	1.2°
Proposal 7h	1.6°
Proposal 7i	1.4°

Selected Option

Best for manufacturing

Good mass reduction

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