

Mechanical Engineering Careers

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Outline

- Career Paths
- Work Experience
- OpenMETA Tools

Career Paths

Engineering Skills Taught in College

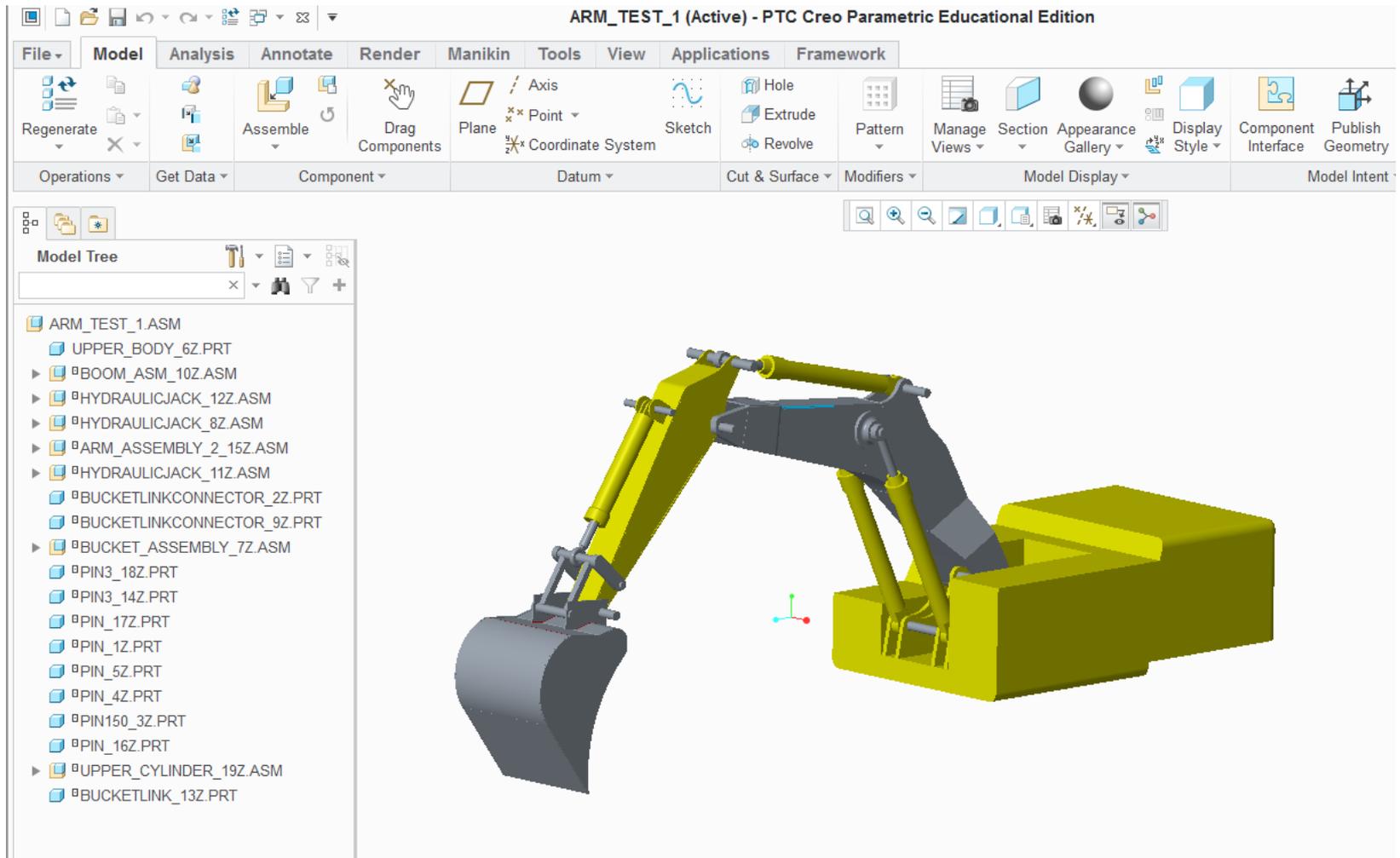
- **Indirectly Applies**
 - System Engineering
 - Project Manager
 - Plant Manager
 - Executive Path (MBA)
 - Application of Problem Solving Skills
 - Medical/Dental School
- **Directly Applies**
 - (next slide)

Career Paths (cont.)

Engineering Skills Taught in College

- **Directly Applies**
 - Computer-Aided Design (CAD) Model Parts/Assemblies
 - Structural Analysis
 - Thermal Analysis
 - Modal Analysis
 - Computational Fluid Dynamics (CFD)

Computer-Aided Design

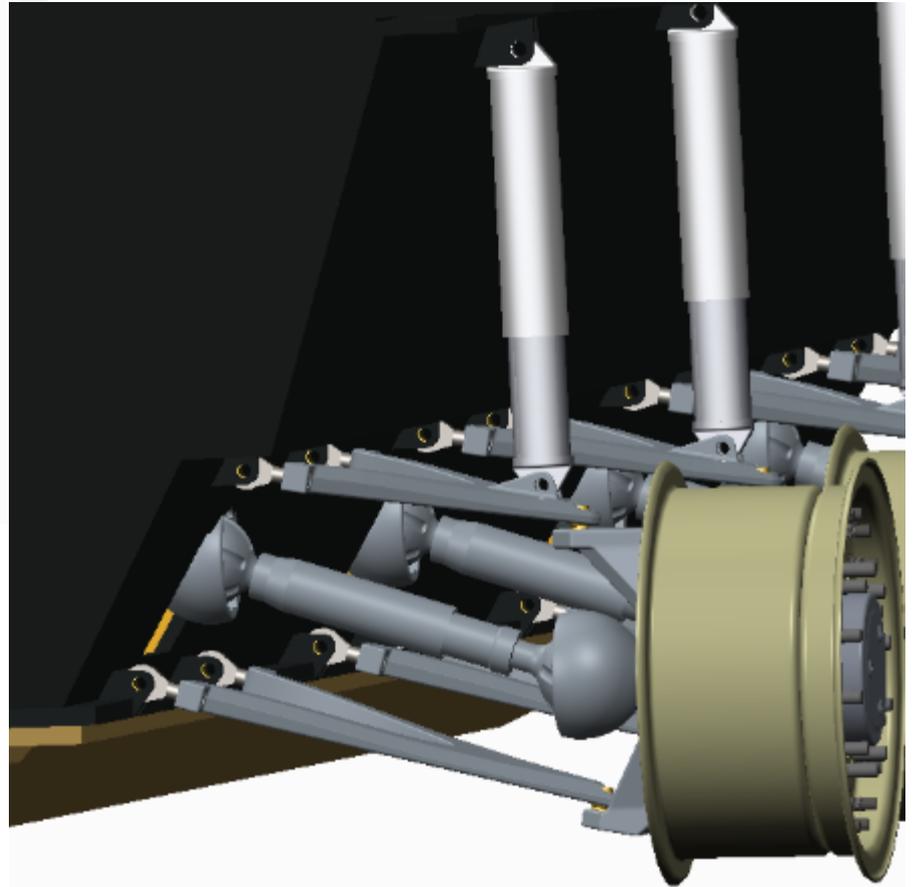
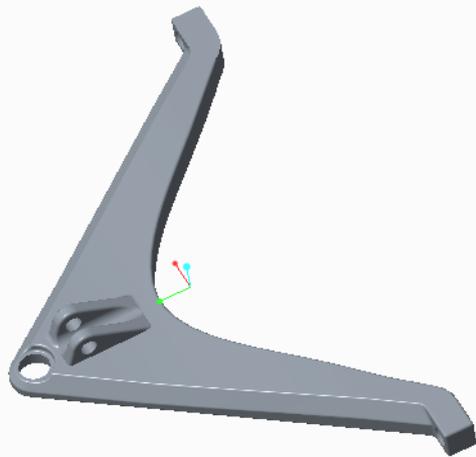


Structural Analysis

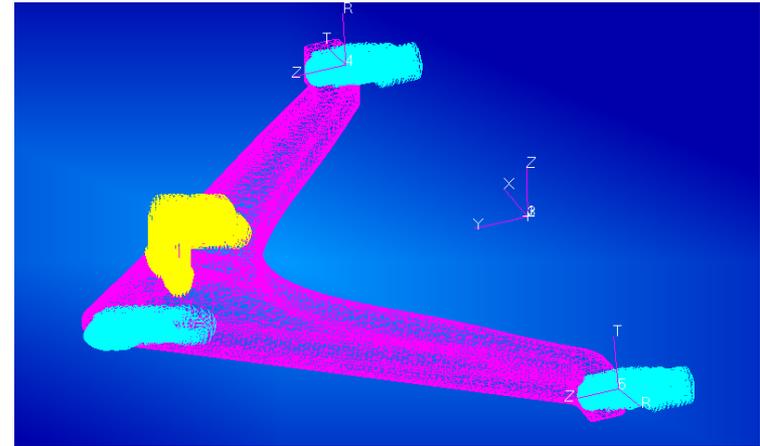
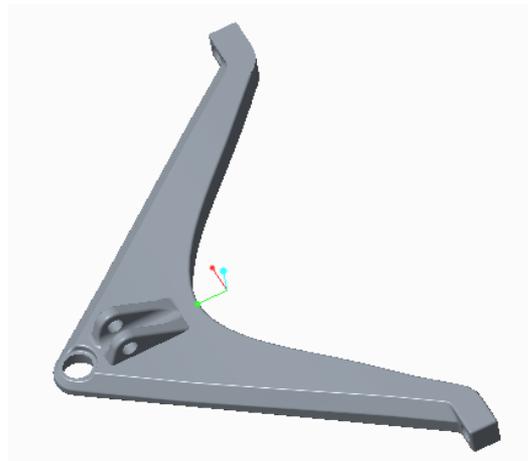
Closed Form Equations

- Stress in a Beam:
<https://skyciv.com/tutorials/calculate-bending-stress-of-a-beam-section/>
- Stress in a Plate:
<http://www.mitcalc.com/doc/plates/help/en/plates.htm>
- Classic Book:
https://www.amazon.com/Roarks-Formulas-Stress-Mechanical-Engineering/dp/0071742476/ref=sr_1_sc_1?s=books&ie=UTF8&qid=1502145329&sr=1-1-spell&keywords=formuals+for+strees+and+strain

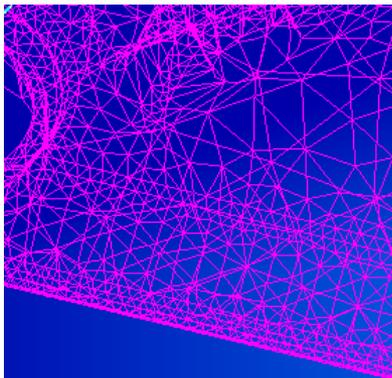
Structural Analysis Example



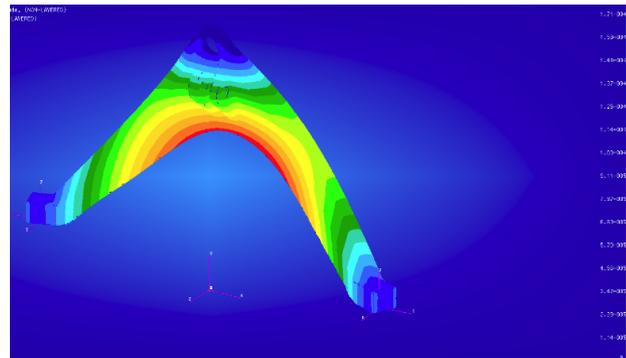
Structural Analysis – Finite Element Analysis



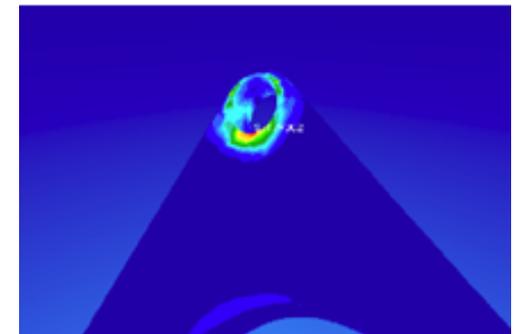
FEA Model – Yellow Load, Aqua Constraints



Mesh

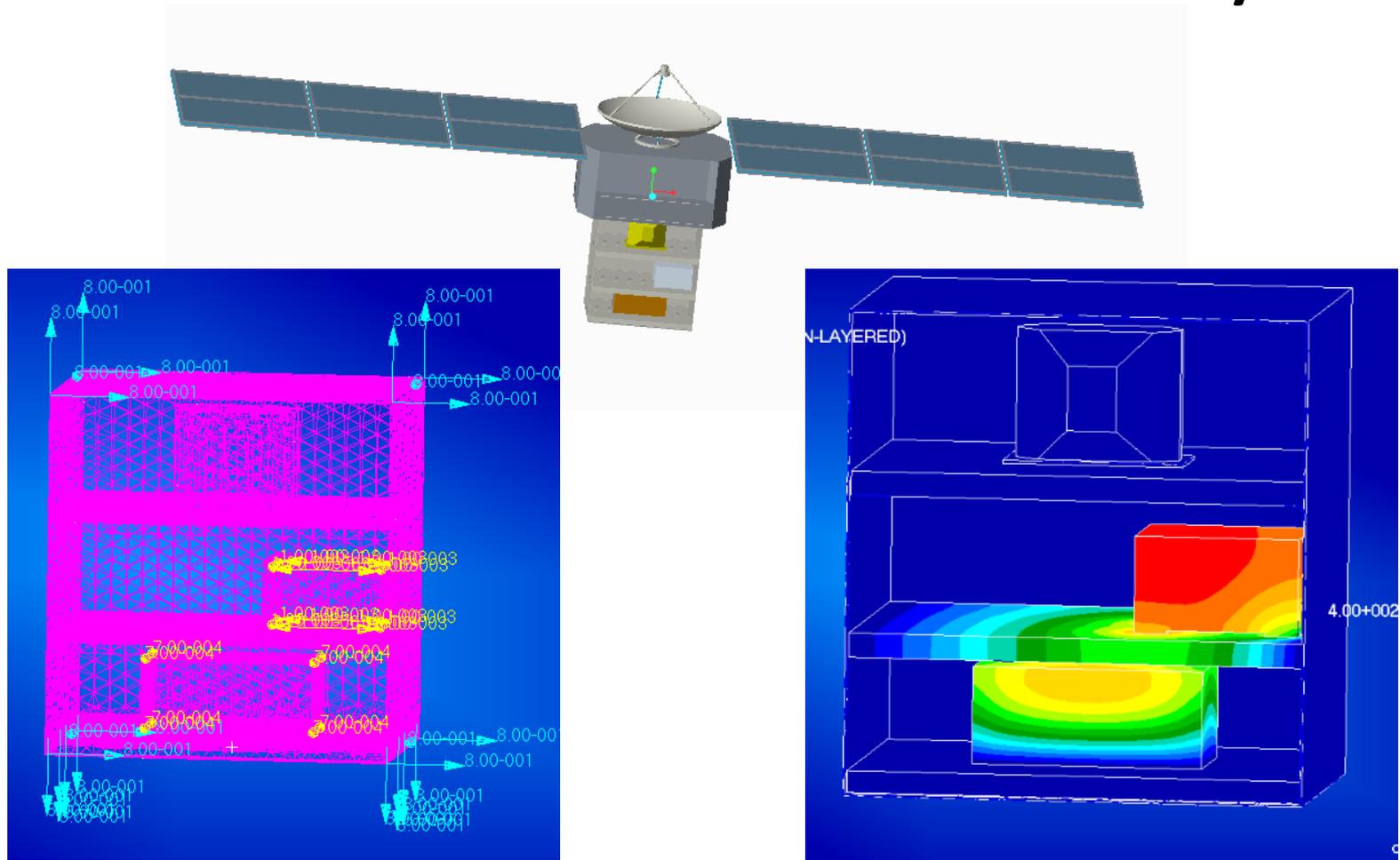


Displacement Plot



Stress Plot

Thermal Finite Element Analysis



Thermal FEA Model
Yellow-Heat Source , Aqua-Radiant Surfaces

Thermal Plot

Modal Analysis

- Compute First Few Modes of Vibration
- Avoid Exciting the Structure at the First Few Modes
- Overview of Modal Analysis:
https://en.wikipedia.org/wiki/Modal_analysis
- Flutter Examples:
 - Tacoma Washing Bridge
<https://www.youtube.com/watch?v=XggxeuFDaDU>
 - Glider
<https://www.youtube.com/watch?v=kQI3AWpTWhM>

Computational Fluid Dynamics (CFD)

- Example Computations:
 - Aircraft wing lift, fuselage drag
 - Car drag
 - Boat Drag
- Overview https://en.wikipedia.org/wiki/Computational_fluid_dynamics

Cooperative (Co-Op) Education Experience

- Alternate between going to school and working
- Work along with and at the direction of engineers
- I worked at Plant Hatch Nuclear Power Plant.
Engineers:
 - managed upgrades to the nuclear power plant
 - oversaw refueling
 - monitored health of the reactor

Aerospace Experience

- Phase of Projects
 - Build Prototype
 - Make Prototype Producing
 - Build Production Units

Make Producing Workflow

- Investigate ways of improving the design
 - Simplify the design
 - Use castings
 - Loosen tolerances
 - Use off-the-shelf components...
- Prepare drawings of new parts/sub-assemblies (70% of the time)
- Design reviews with cross-functional team (e.g. Manufacturing, QA, Stress Analyst...)

Analysis Workflow

- Analyzed parts via equations
 - Closed form equations
 - Roark equations
- Created Finite Element (FEA) Models
 - Create FEA models
 - Validate models via testing (e.g. instrument with strain gauges and load the part/sub-assembly)
 - Approve changes based on validated FEA model

Software Development for Mechanical Applications

- Developed software to improve the Mechanical Engineering process
- Usually a significant return on investment (ROI)
- General Workflow
 - Gather requirements
 - Design the software (architecture, software modules)
 - Write the code
 - Test
 - Deploy

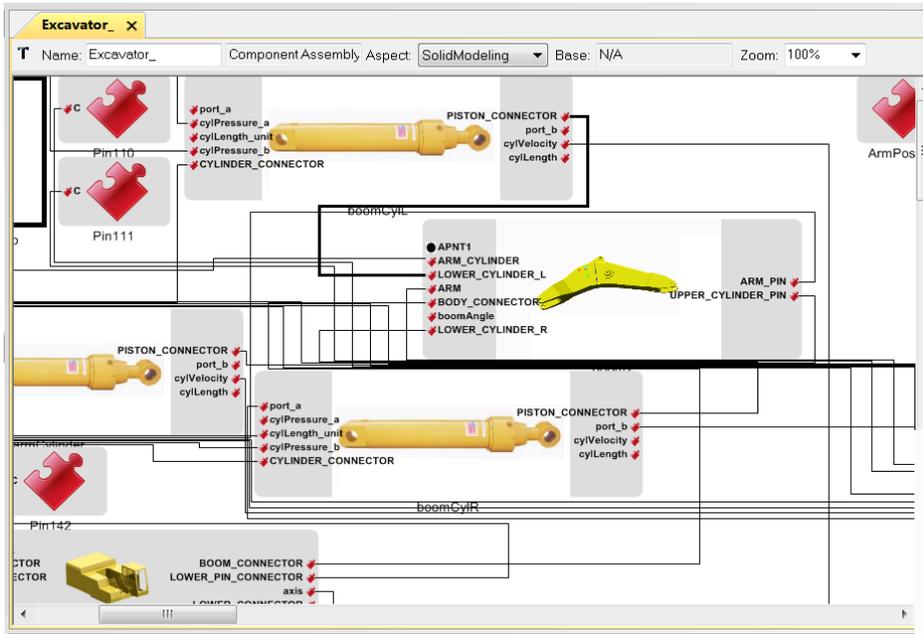
Career Considerations

- Mechanical Engineering Automation
- Electrical Engineering Automation
- What will be Automated in the Future

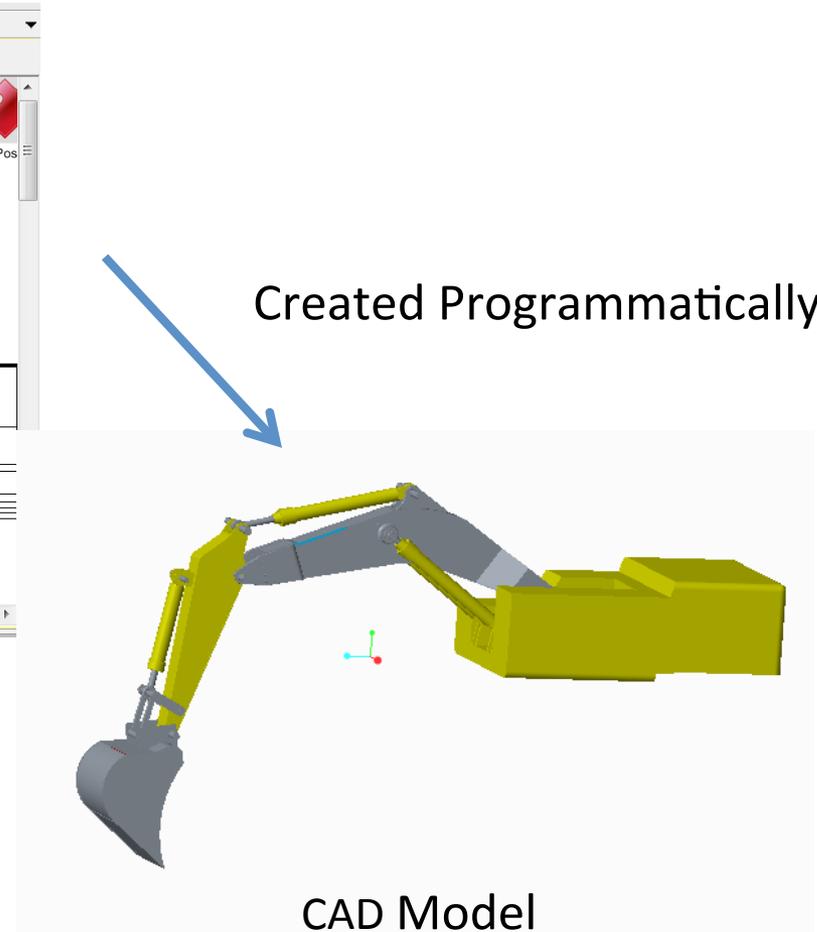
Charlie Rose interview of Andrew Moore

<https://charlieros-e.com/videos/29644>

Vanderbilt Tools - OpenMETA

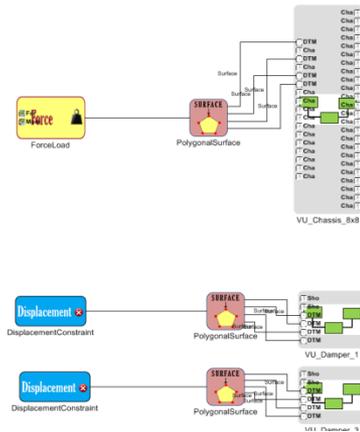


Cyber Physical (CyPhy) Model



CAD Model

FEA Analysis Macroscopic View



1

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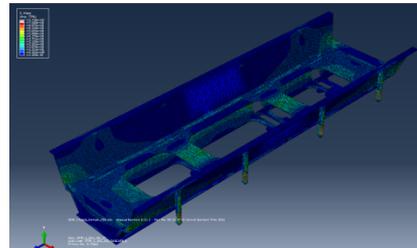
2



FEA Deck

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GRID, 7, 2, 787.1, 474.941, 6485.23, 3
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GRID, 9, 2, 1066.67, 932.891, 6485.23, 3
GRID, 10, 2, 1066.67, 912.618, 6485.23, 3
GRID, 11, 2, 966.674, 912.618, 6485.23, 3
GRID, 12, 2, 757.002, 336.55, 6485.23, 3
GRID, 13, 2, 635.963, 336.55, 6485.23, 3
GRID, 14, 2, 441.656, 0., 6485.23, 3
GRID, 15, 2, -441.656, 0., 6485.23, 3
GRID, 16, 2, -635.963, 336.55, 6485.23, 3
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GRID, 18, 2, -775.78, 388.14, 6485.23, 3
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3



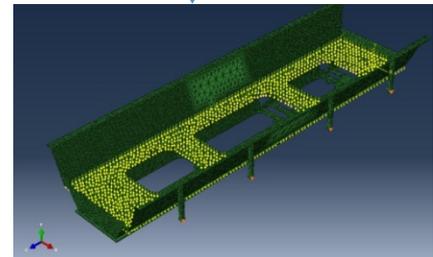
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    </Configuration>
  </Configurations>
</RootObjectType>
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To Dashboard

Optional View Deck



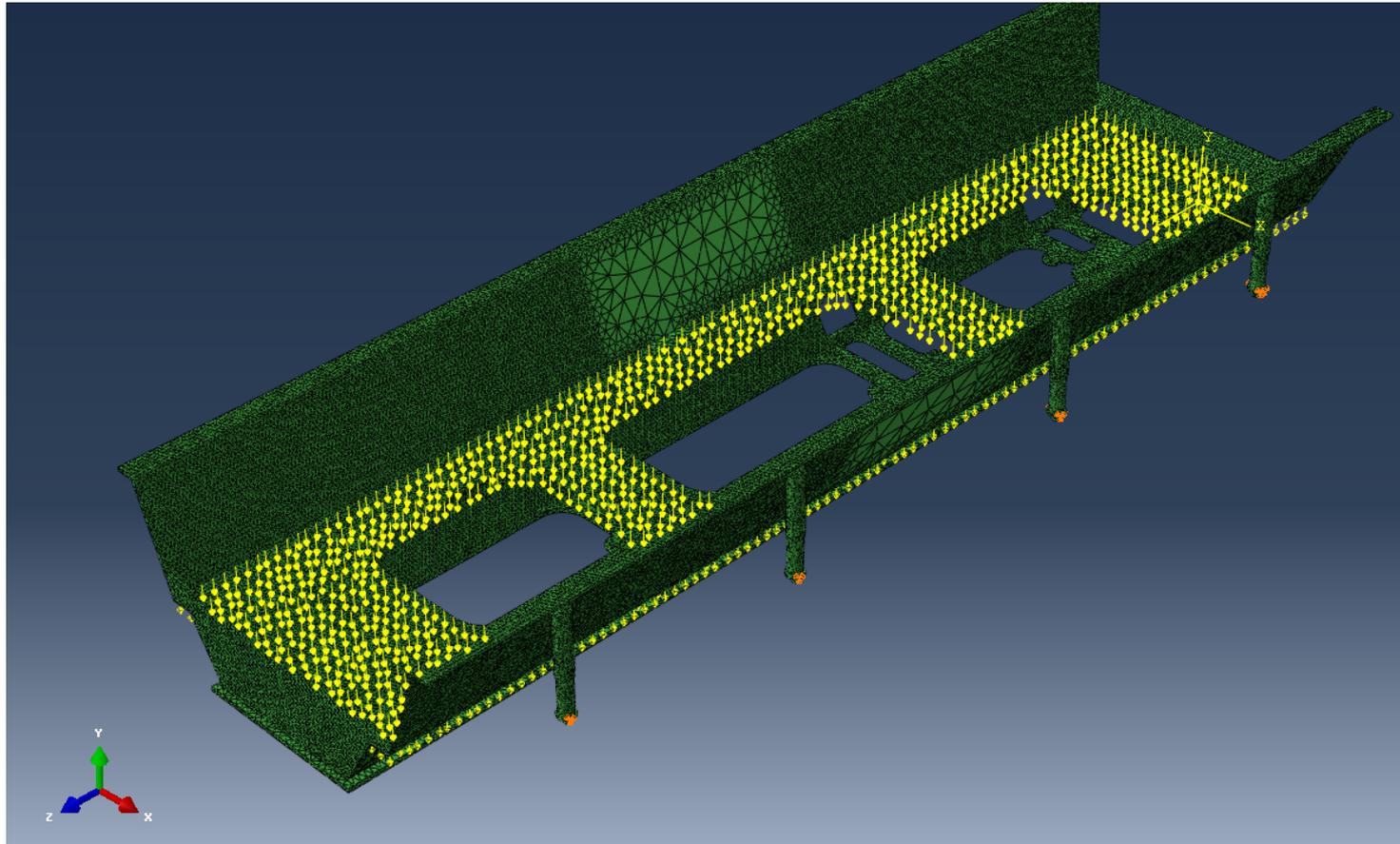
Legend:

- 1) Export Assembly/
FEA XML
- 2) Create Assembly/
FEA Deck
- 3) Invoke Solver (i.e.
Nastran), Post
Process

Programmatically Created Assembly

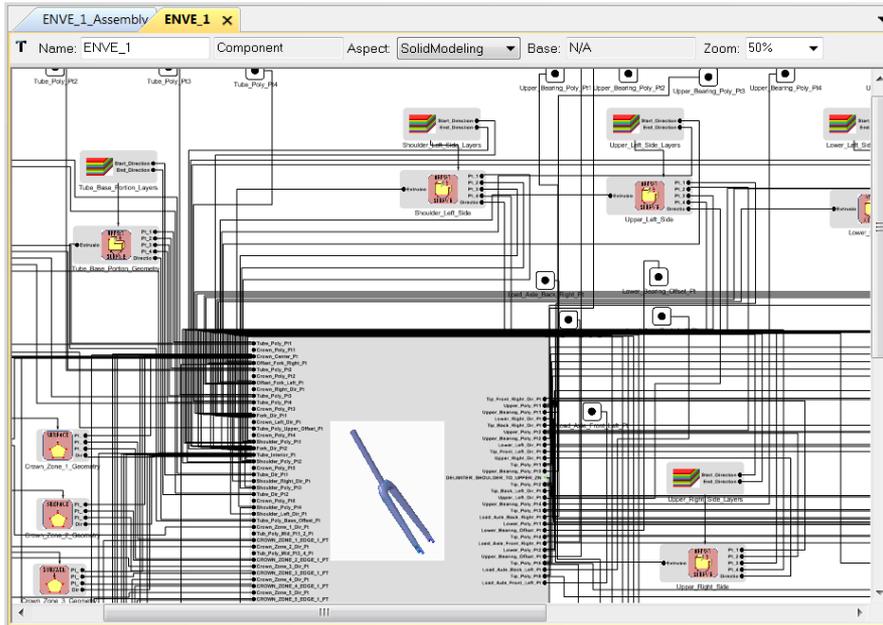


Rendering of Programmatically Created FEA Deck



Yellow – Loads Orange – Constraints (i.e. supports)

Composite Analysis



CyPhy model defines the ply stack-ups for each zone of the bicycle fork.



FEA model created programmatically and Tsai-Wu failure criteria computed.