

Finite Element Analysis at Sandia National Laboratories

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.



Introduction

- My background
 - Technical Staff,
Sandia National Labs
 - Ph.D. candidate,
Mechanical Engineering
- My department's role
 - Design & testing of
telemetry systems
(ruggedized electronics)
 - Interdisciplinary (EE, ME)
- My roles
 - Mechanical engineering
 - Design & solid modeling
 - Analysis (FEA)
- My interests
 - Modeling circuit boards
in vibration & shock
 - Bringing FEA into
conceptual design

Presentation outline

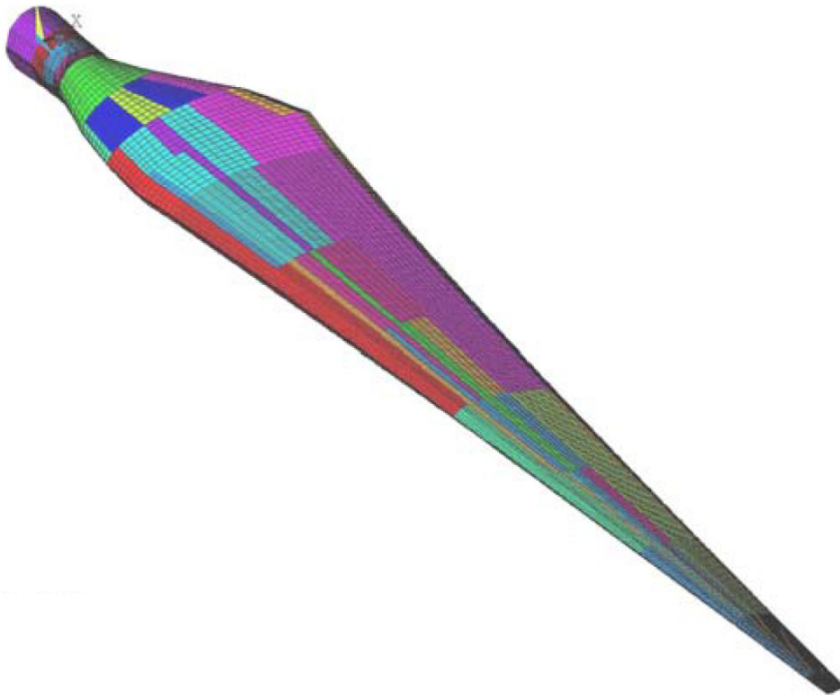
- Use of FEA at Sandia
 - Codes used
 - Examples FEA analyses from Sandia
- My research
 - FEA during conceptual design of electronics packaging
- Roles & responsibilities at Sandia
- Model flow from CAD to FEA
- Overview of structural dynamics

FEA software used at Sandia

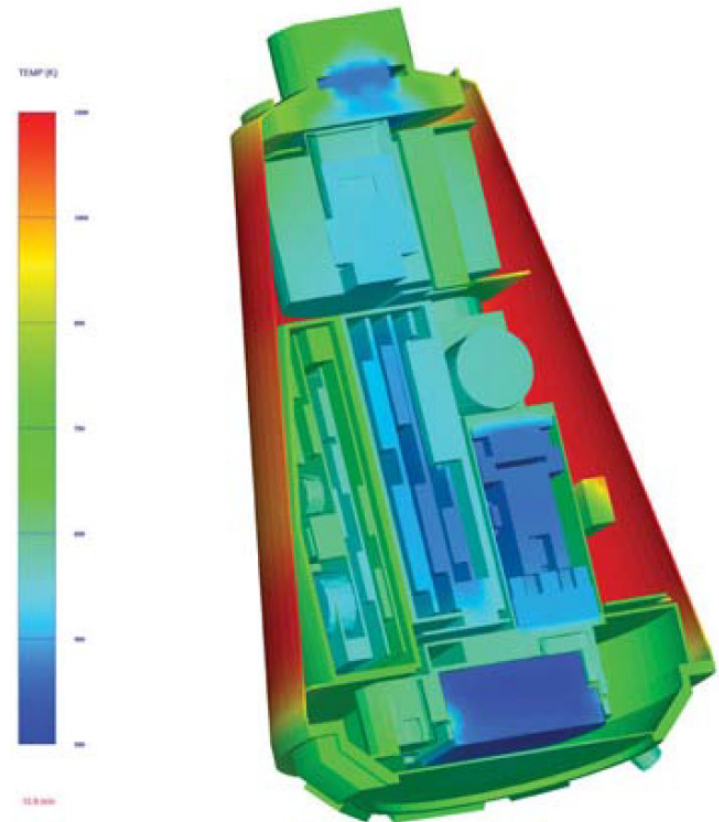
- Commercial FEA codes
 - Abaqus
 - Nastran
 - Ansys
- Commercial FEA codes integrated with solid modeling software
 - Pro/Mechanica
 - Solidworks Simulations (Cosmos)
- Sandia proprietary FEA codes
 - Cubit
 - Presto
 - Adagio
 - Salinas
 - Tahoe
 - Alegra
 - Autodyne

FEA at Sandia: Highly detailed designs

Structural analysis of a wind turbine blade ^[1]

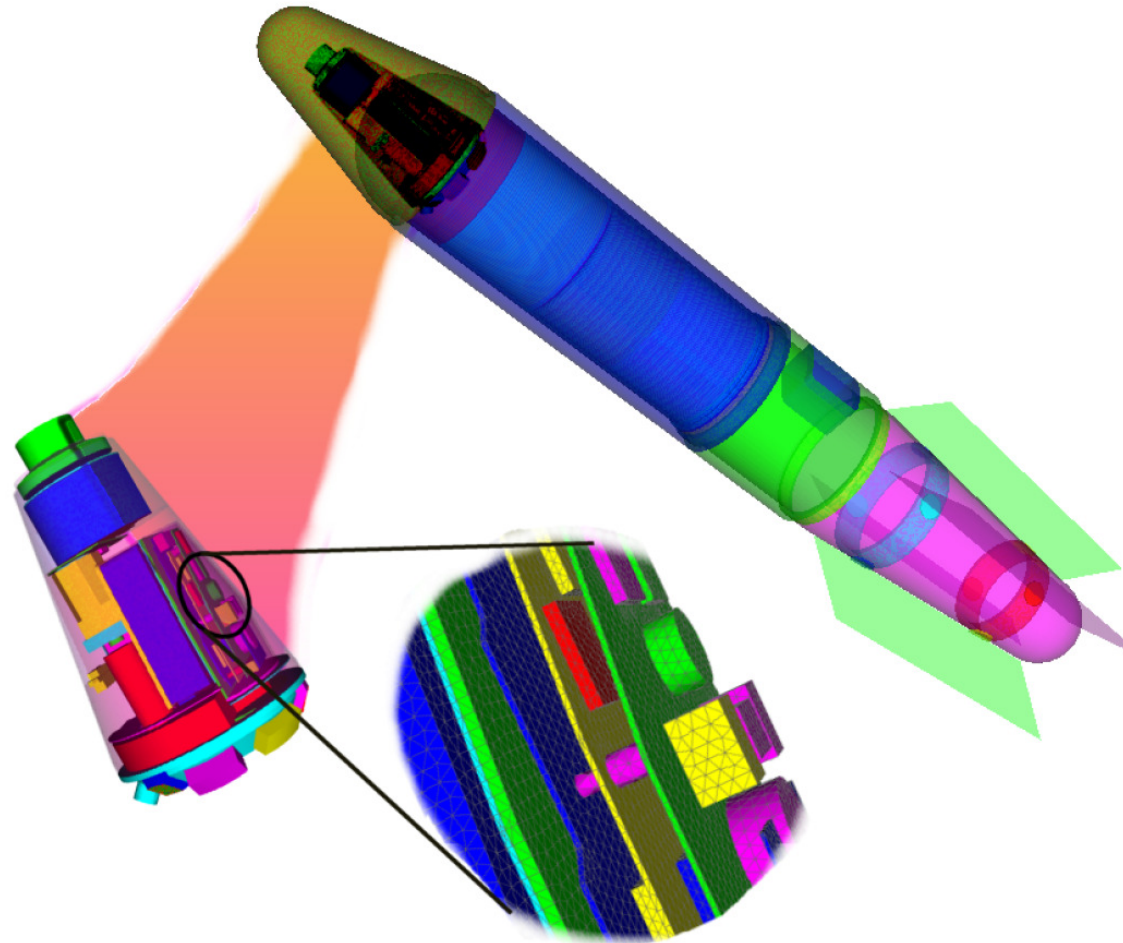


Thermal analysis of an electro-mechanical component ^[2]



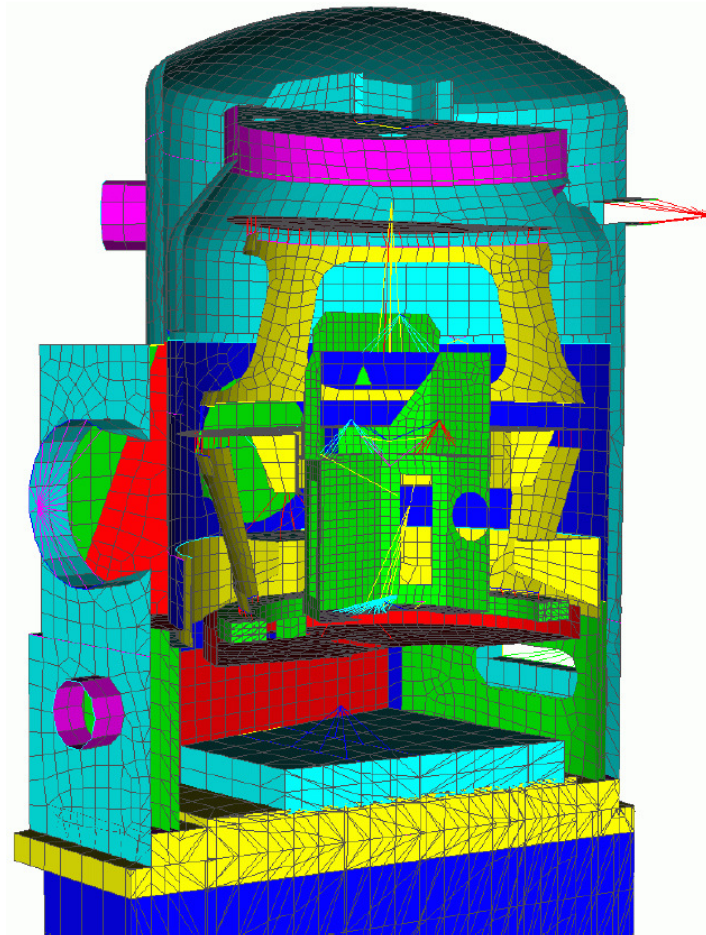
FEA at Sandia: Highly detailed designs

Vibration analysis of an entire weapon system ^[3]



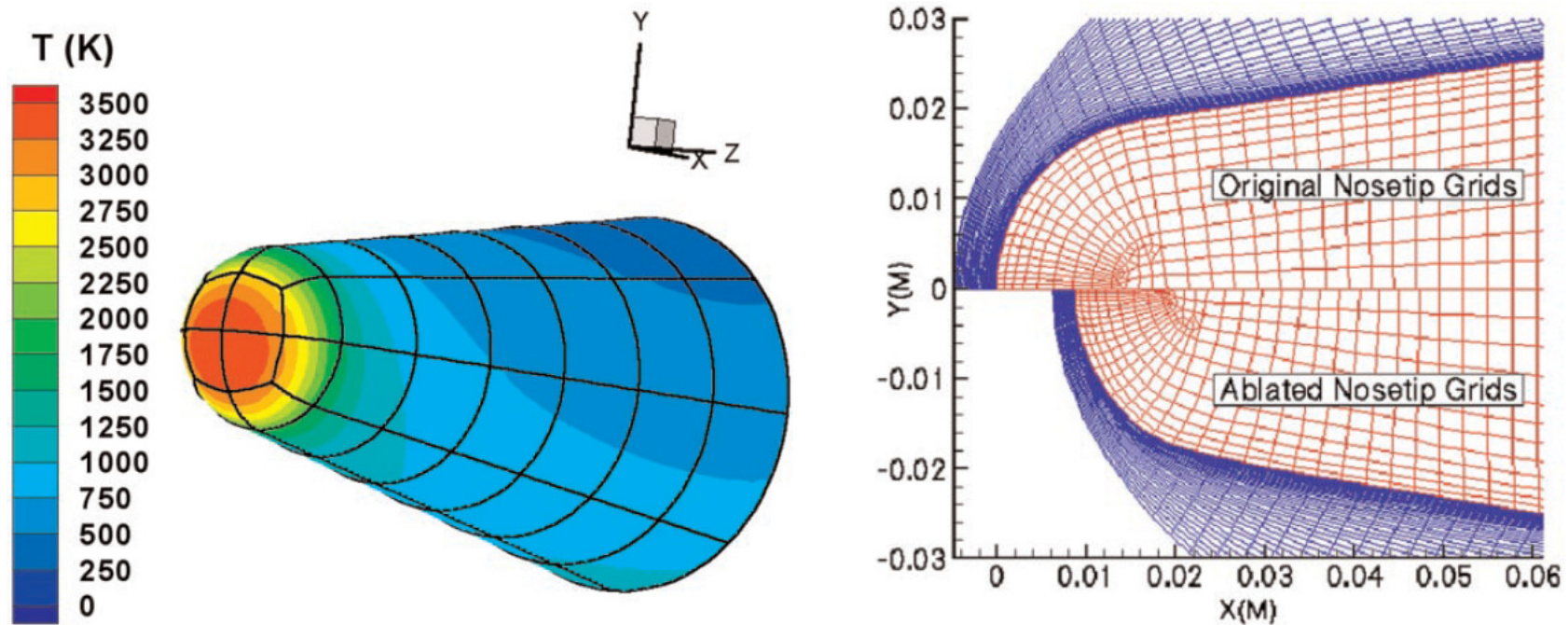
FEA at Sandia: Highly detailed designs

Modal analysis of a next-generation lithographic system ^[3]



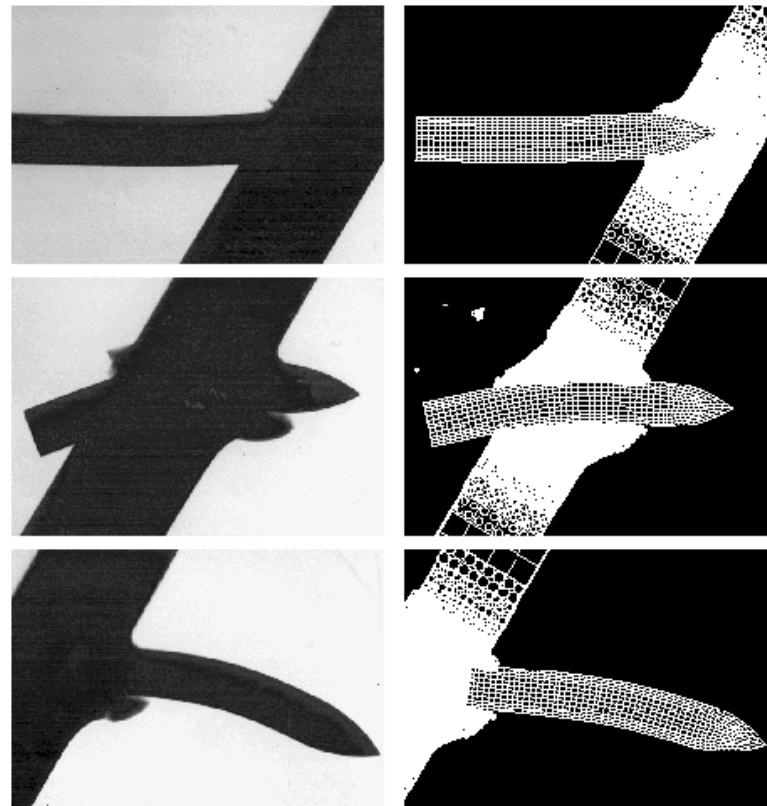
FEA at Sandia: Multi-physics models

Ablation characteristics at nose of weapon [4]



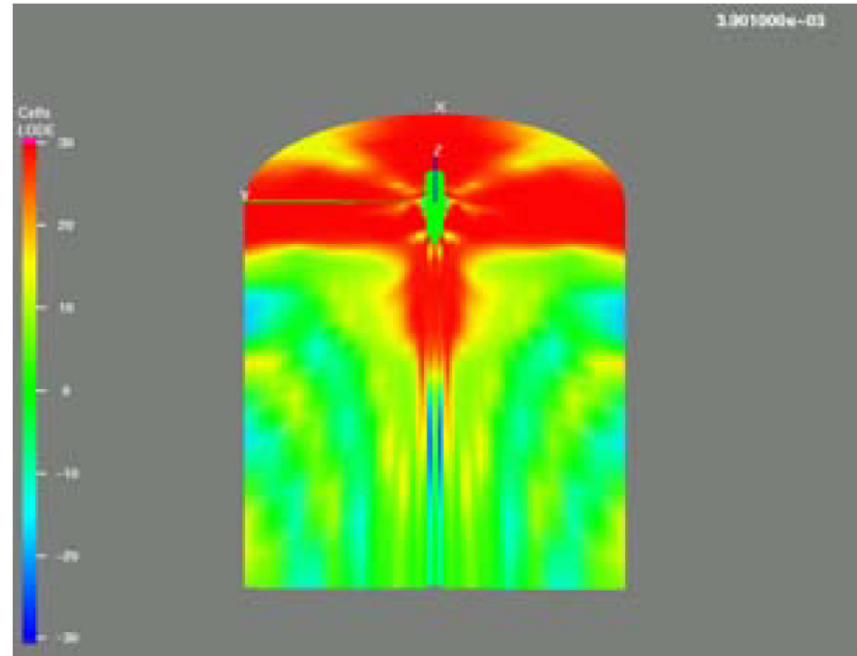
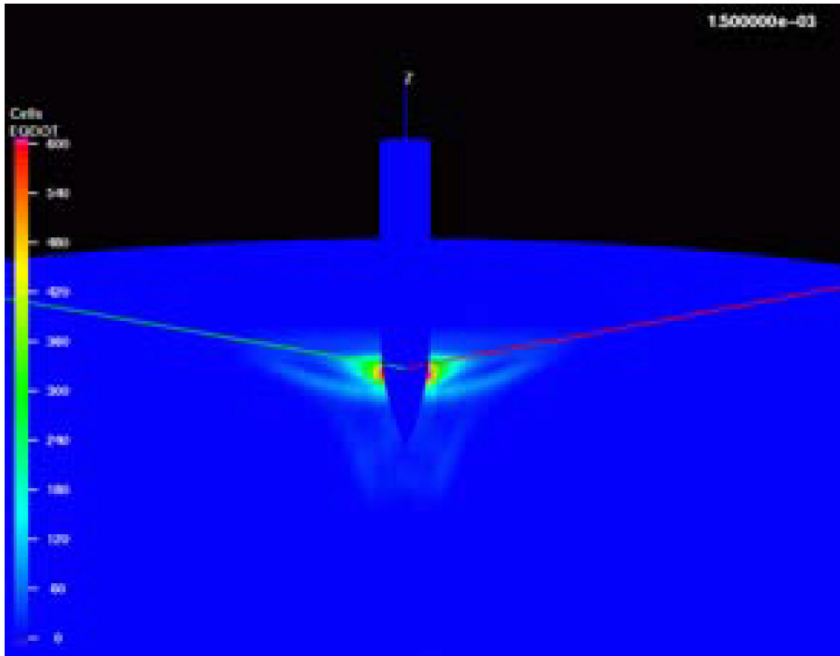
FEA at Sandia: Multi-physics models

Bullet piercing through a plate [5]



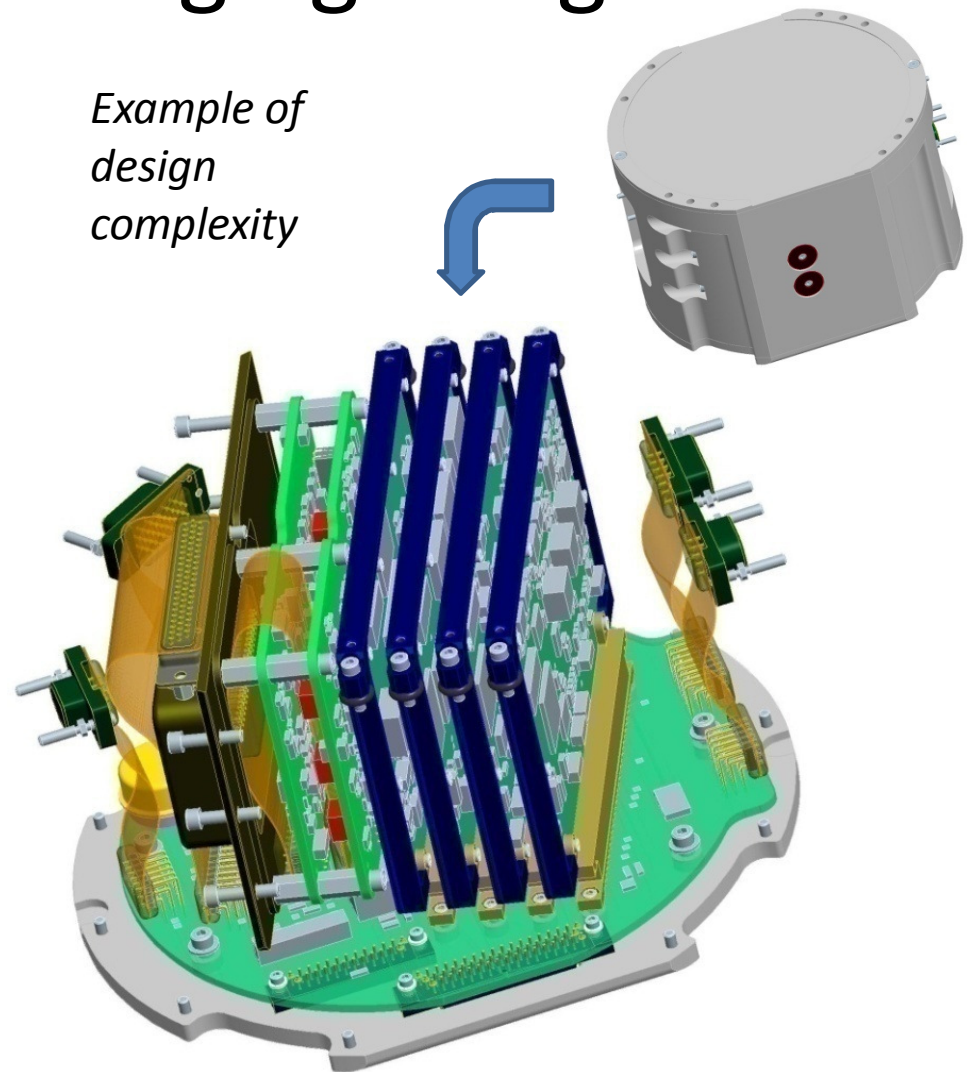
FEA at Sandia: Multi-physics models

Weapon impacting rock or concrete [6]

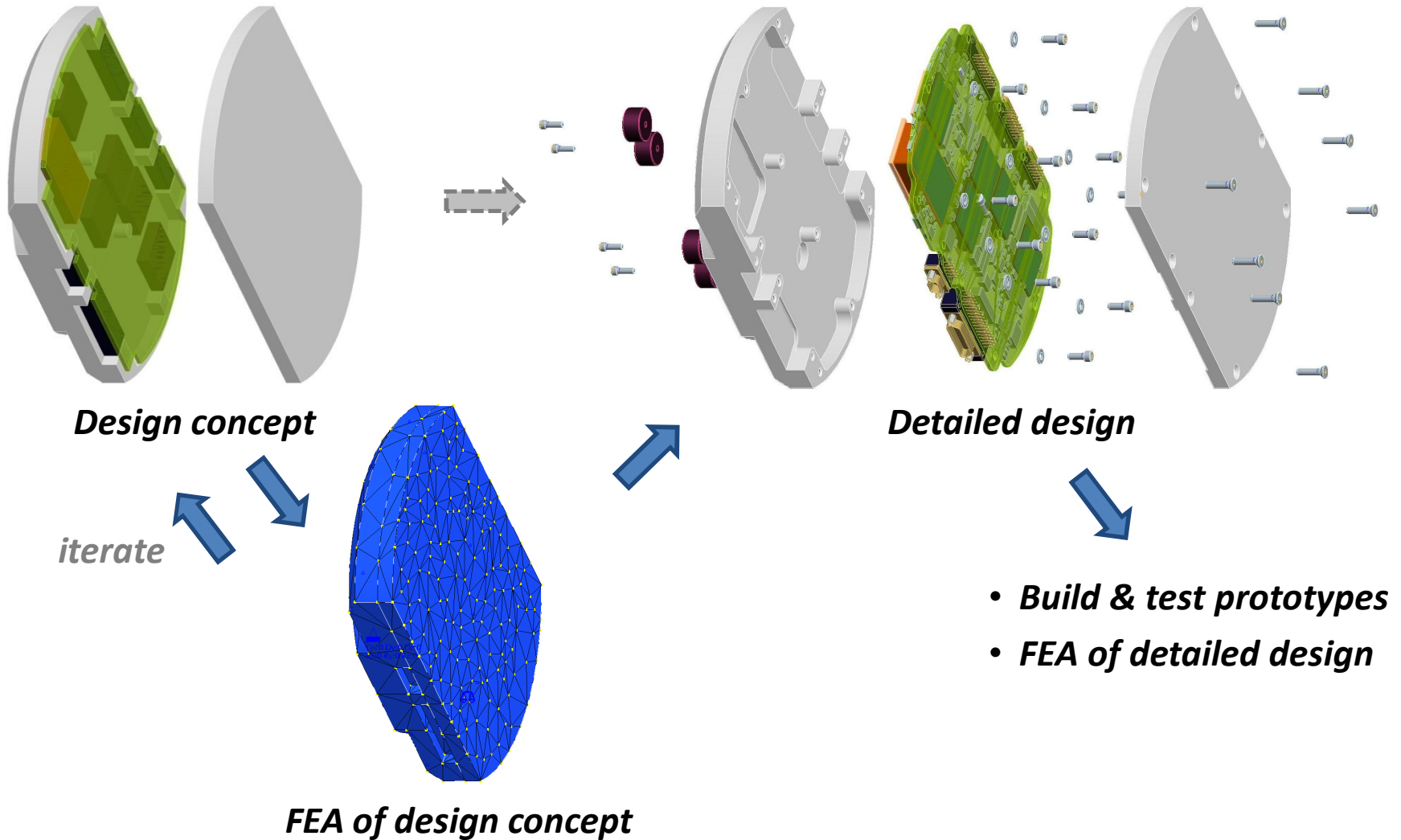


My work at Sandia: Electronics packaging designs

- Typical requirements
 - Volume constraint
 - Interface
 - Mounting features
 - Electrical connectors
 - Circuit board area
 - Mass properties
 - Weight, center of gravity
 - Inertia tensor
 - Design-for
 - Manufacture
 - (Dis-)Assembly
 - Environment
 - Ruggedness
 - Vibration, shock
 - Thermal

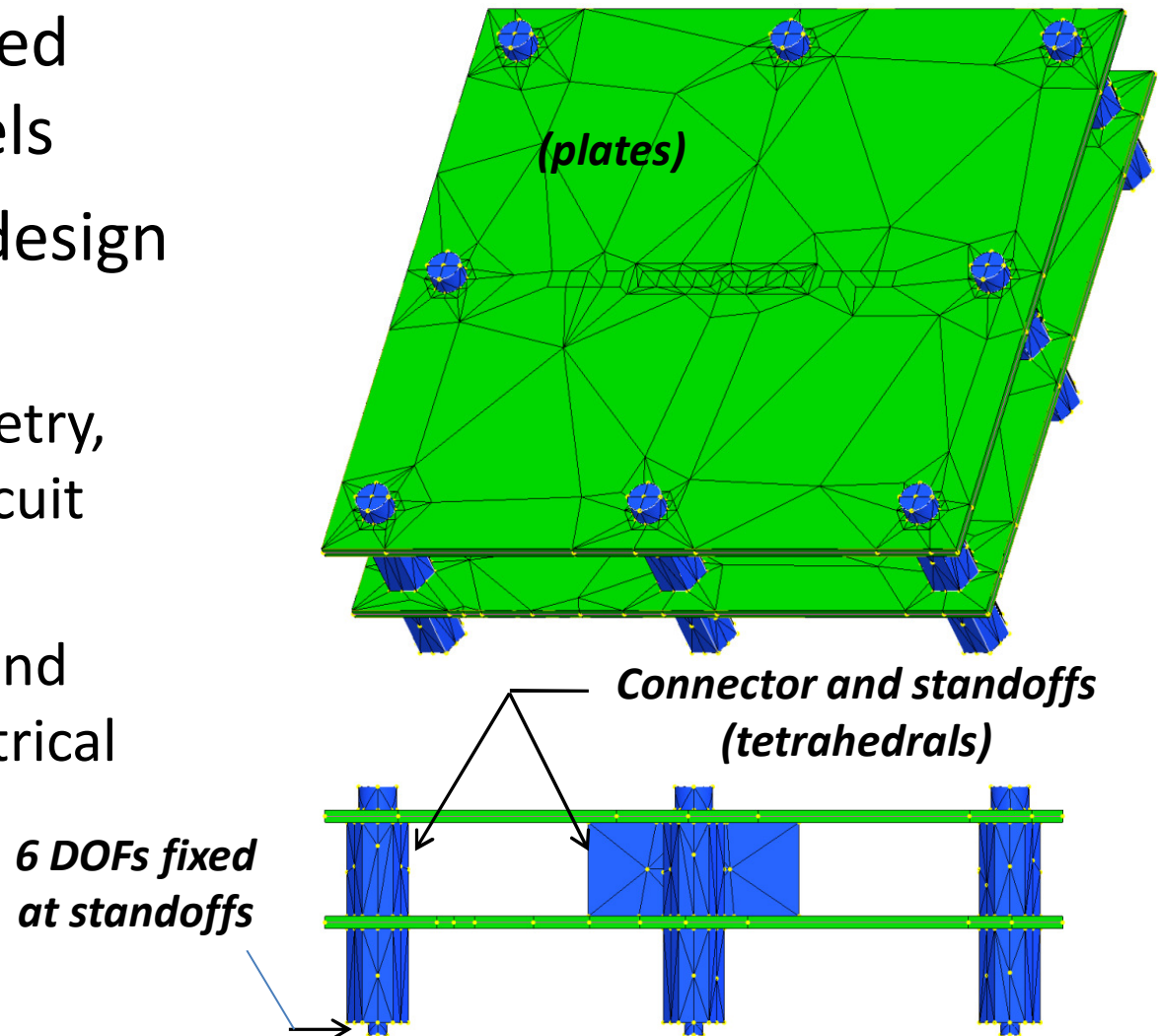


My research: FEA during conceptual design



My research: FEA during conceptual design

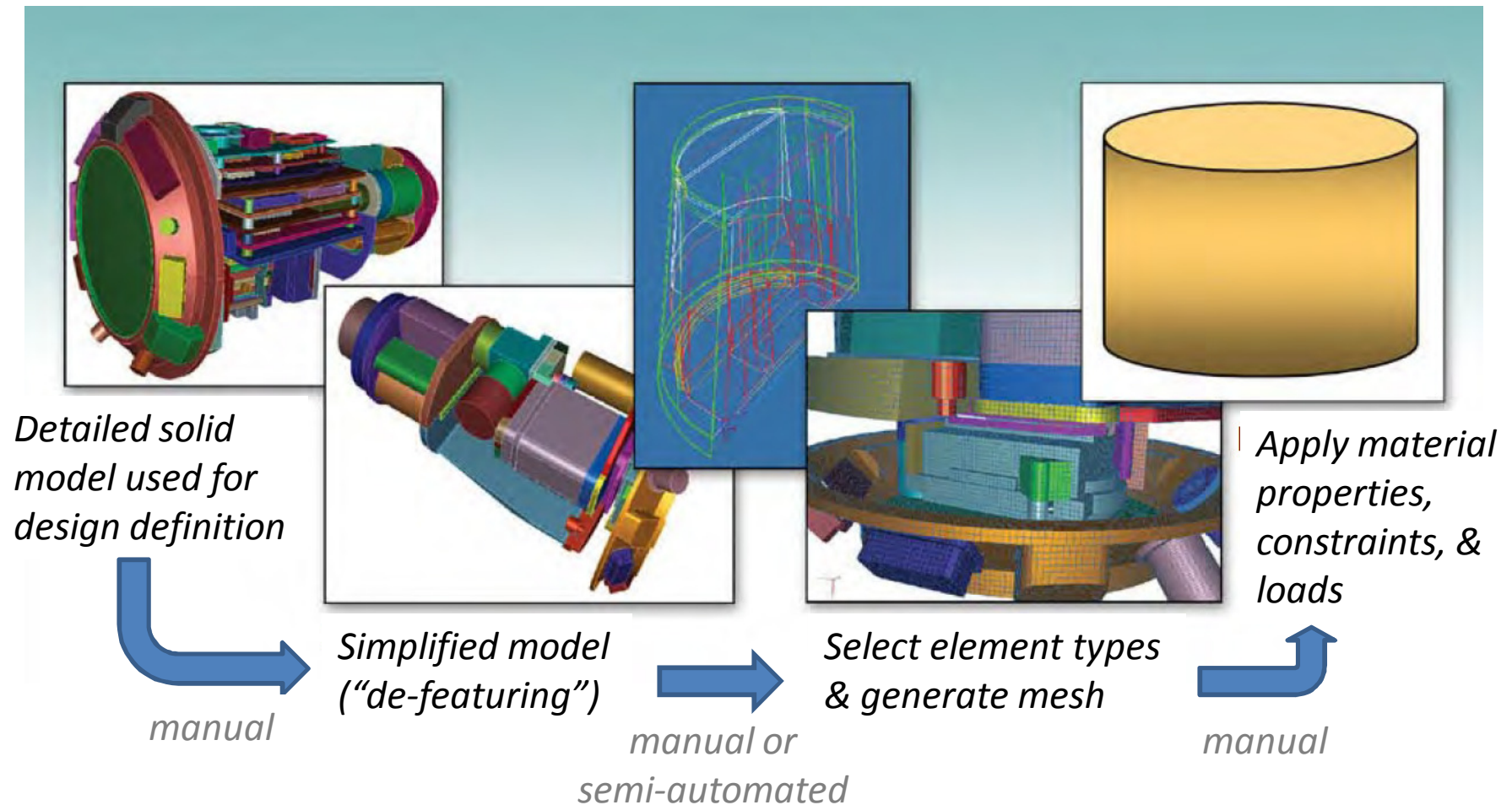
- Develop simplified connector models
- FEA to support design decisions:
 - Quantity, geometry, mounting of circuit boards
 - Quantity, size, and location of electrical connectors



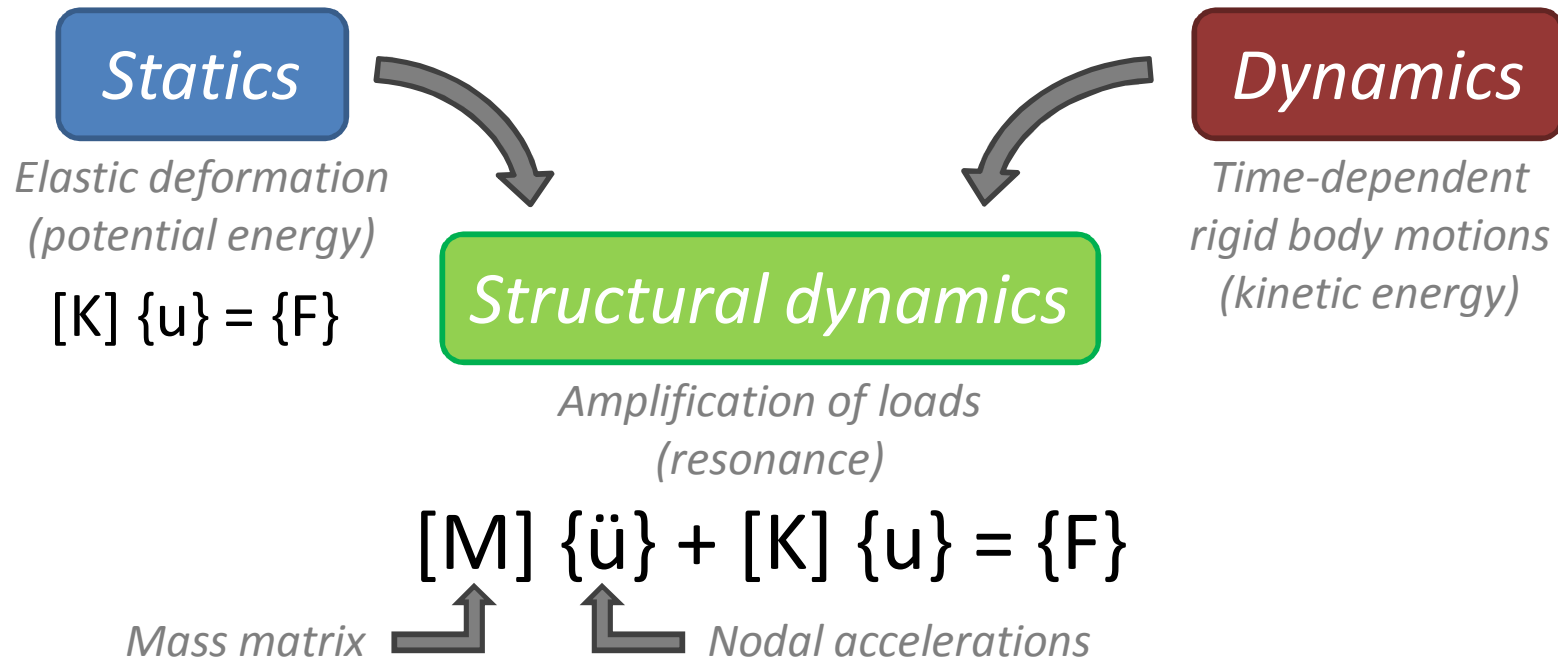
Roles & responsibilities

- Engineer
 - Responsible for product (system, component)
 - Oversees work by other team members
 - Interfaces with customer
- Designer (CAD)
 - Builds solid models and generates 2-D drawings
- Analyst (FEA)
 - Full-time analysis work

Model flow from CAD to FEA [7]



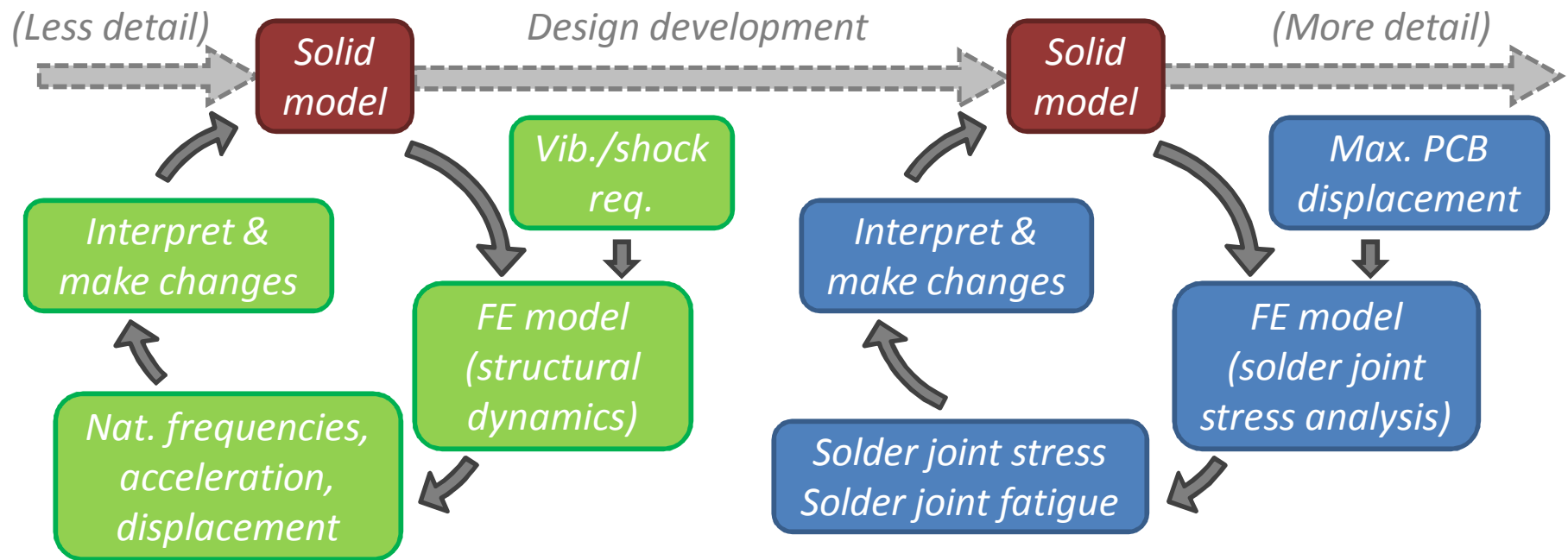
Overview of structural dynamics



1st step: modal analysis

- Find resonant frequencies of structure
- Find displacement shape associated with each resonant frequency

Analysis of packaging designs



STRUCTURAL DYNAMICS

- Does not 'predict' failure
- Relies heavily on engineering judgment
- Does not require detailed PCB design

SOLDER JOINT STRESS ANALYSIS

- Goal is failure prediction
- Requires detailed PCB design

References

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