ATA ENGINEERING, INC.

Dynamic Analysis with Femap and Vibrata

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Dynamic Response Analysis in Femap

With Vibrata

- Femap is a powerful tool for pre/post-processing
- Vibrata extends Femap with dynamic response capabilities
  - Steady-state frequency response analysis
  - Random analysis
  - Response spectrum analysis
  - Transient analysis
- Vibrata GUI streamlines dynamic response analysis
  - Batch mode also available from command prompt

Modal Dynamic Analysis

Brief Background

- Vibrata uses normal modes to solve the equation of motion

$$M\ddot{u} + C\dot{u} + Ku = f$$

  - Assume harmonic approximation of displacement
- Nastran provides the normal modes (natural frequencies ω_i and mode shape φ_i) as the solution to the eigenvalue problem

$$|-\omega^2 M + K| = 0$$

  - Assume a subset of normal modes is sufficient to approximate displacement
- Analysis type dictates the specific approach to solving the equation of motion

Vibrata Overview

Software for Advanced Modal Dynamic Analysis

- Vibrata uses modal data to solve for dynamic response
  - Requires Vibrata specific Nastran deck
- Femap integration
  - Modal data from Femap MODFEM file
  - FEM interaction and data display
  - Femap Custom API - Toolbar under Custom Tools
- Vibrata provides control over dynamic response solution
  - Solver implemented using freely available MATLAB Compiler Runtime
    - Custom solver can be implemented as MATLAB script
  - Excitation can be transient, harmonic, or random

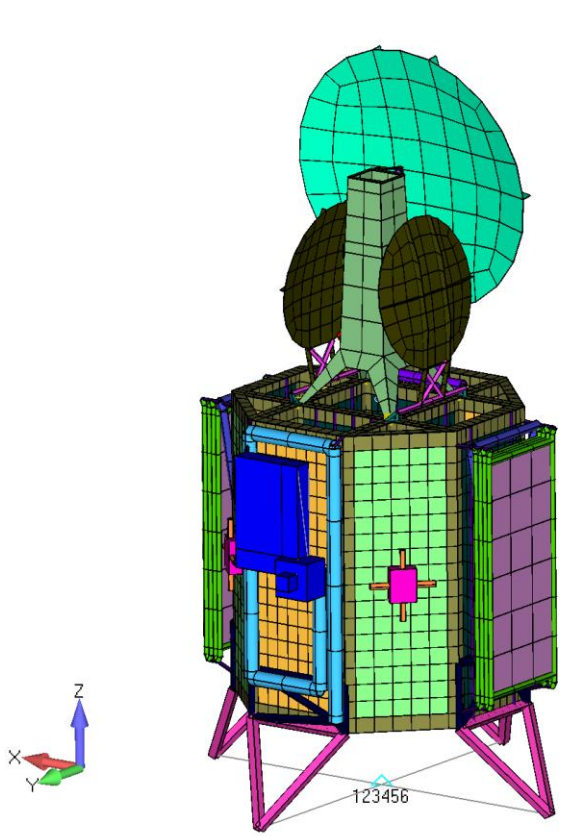
Vibrata Overview

Architecture, Nastran Input File Preparation and GUI

- Requires Femap, MATLAB Runtime (MCR), finite element solver (Nastran)
- Nastran solution sequence for normal modes (SOL 103, SEMODES)
  - Mass normalization
  - OP2 output request for physical response to be solved by Vibrata
  - TITLE card in case control section
  - Analysis type specific input
- Vibrata GUI facilitates the analysis process
  - Interface to Femap model with modal solution

Vibrata Demo

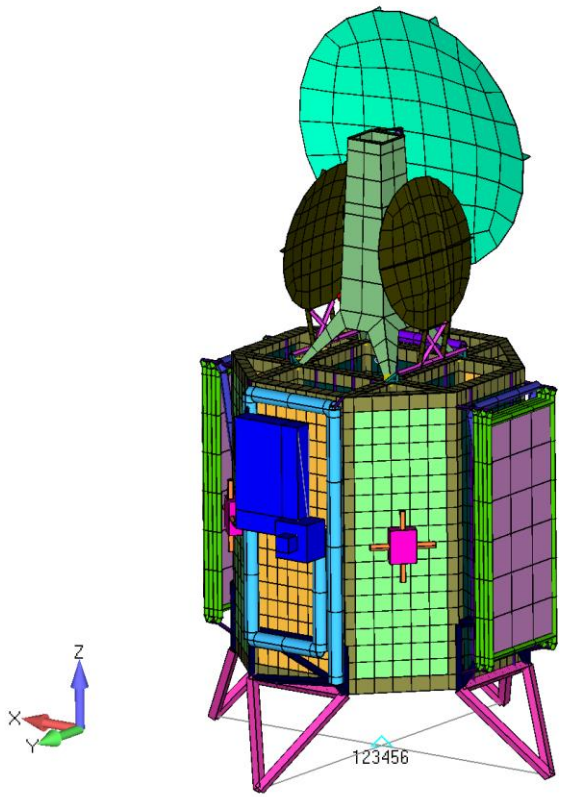
Random Analysis



- Random Analysis Using ISat Launch Configuration Model
  - Base excitation to simulate response during ground test
  - Launch adapter legs connected by RBE2
  - Constraint applied at RBE2 independent node
  - Z-direction base excitation applied at RBE2 independent node using acceleration PSD

Vibrata Demo

Random Analysis



- General Procedure for Random Analysis
  - Create Femap .modfem file with modal results
  - Create a Vibrata event for Random Analysis
    - Set analysis type to Modal Random
  - Define excitation function
  - Set damping values
  - Select output for analysis
  - Solve
  - Post-process
    - Femap contour plots
    - Vibrata XY plots

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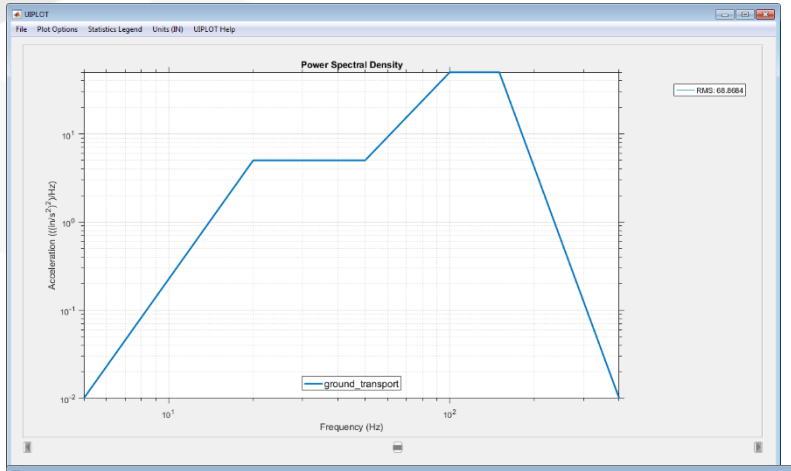
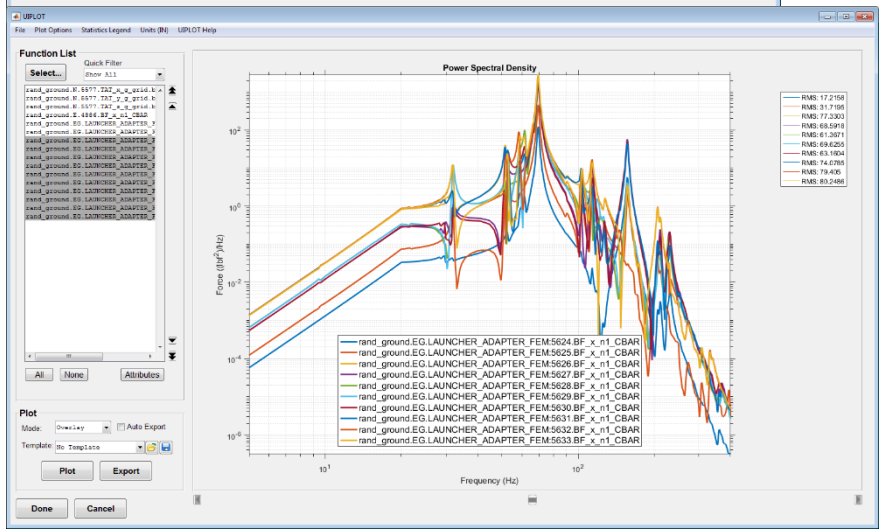
Vibrata Demo

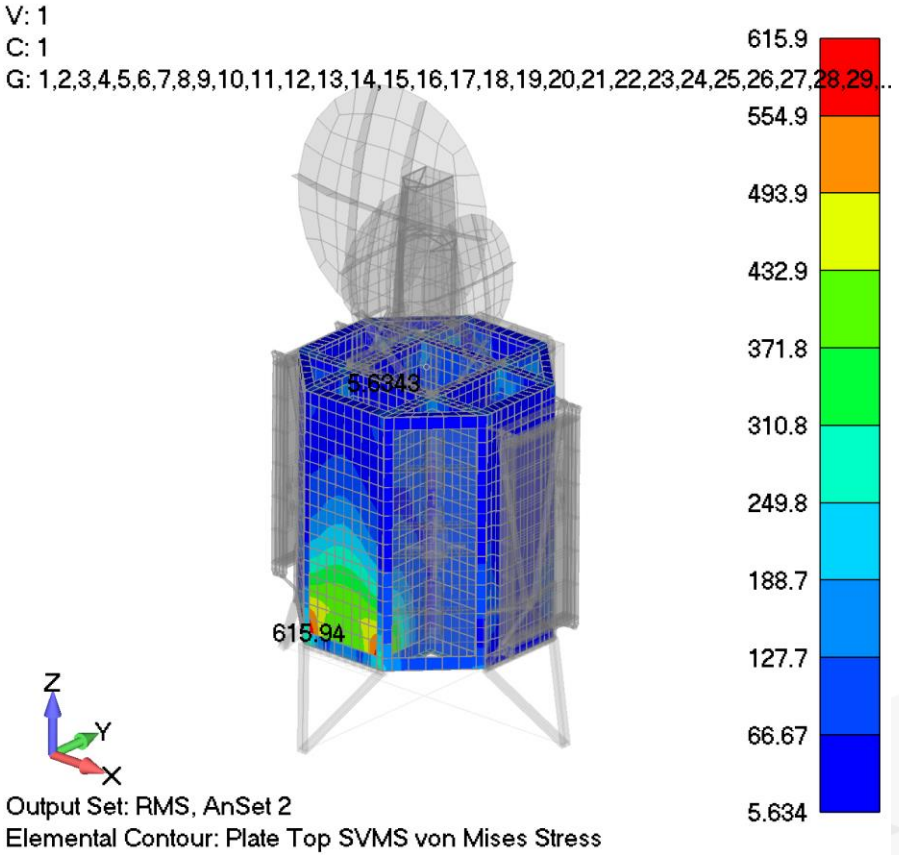
Random Analysis Input Data and Post-processing



Define and view input PSD



Post-processing: PSDs of element internal forces



Post-processing: stress contour in Femap

Vibrata Demo

Transient Analysis

- Transient Analysis Using ISat Deployed Configuration Model
  - Simulate dynamic response due to the firing of thrusters
  - Free-free model without launch adapter legs
  - Solar panels, antenna dishes and instrument package deployed
  - Thrust forces applied at thruster locations

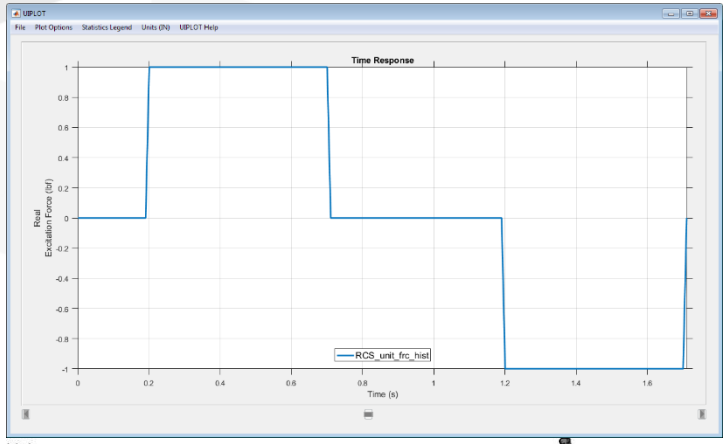
Vibrata Demo

Transient Analysis

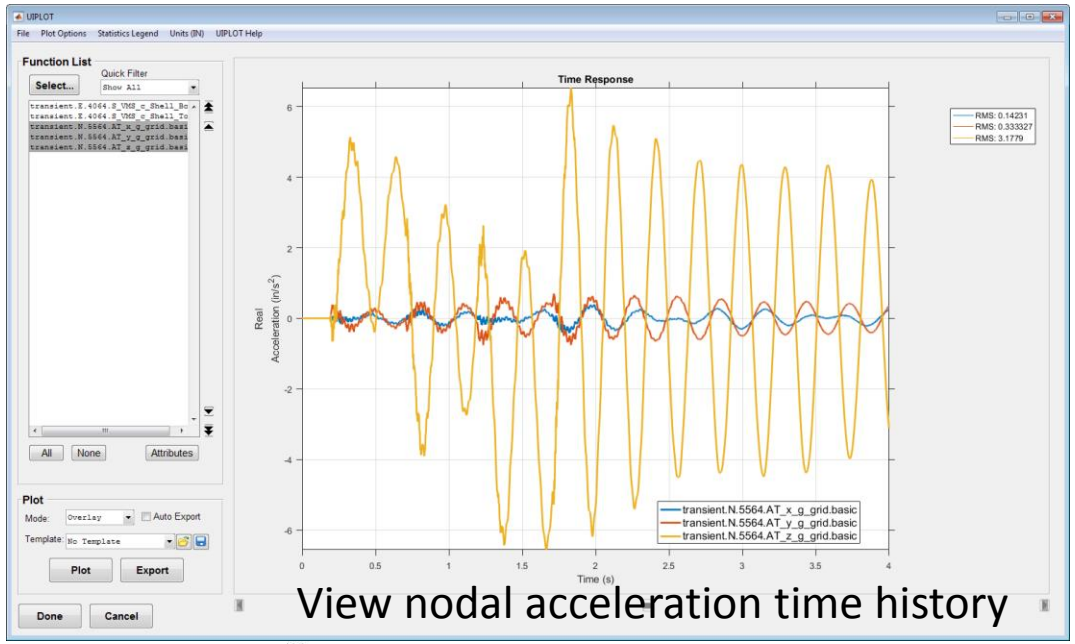
- General Procedure for Transient Analysis Using ISat Deployed Configuration Model
  - Create Femap .modfem file with modal results
  - Create a Vibrata event for Transient Analysis
    - Set analysis type to Modal Transient
    - Set initial condition and duration
  - Define excitation function
  - Set damping values
  - Select output for analysis
  - Solve
  - Post-process
    - Femap contour plots
    - Femap deformed shape plots
    - Vibrata XY plots

Vibrata Demo

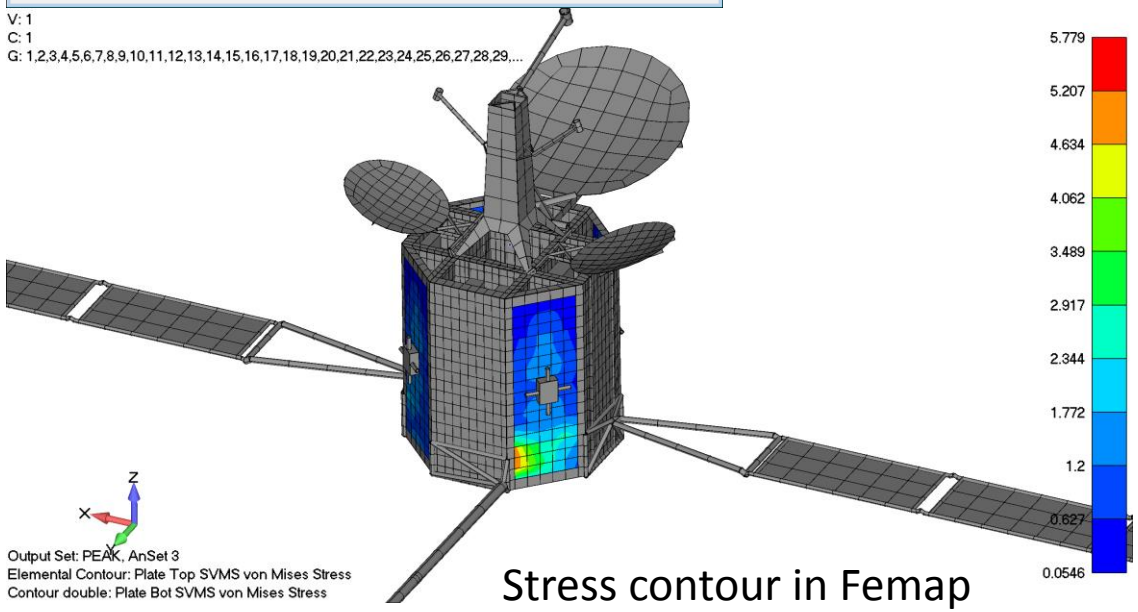
Transient Analysis Input Data and Post-processing



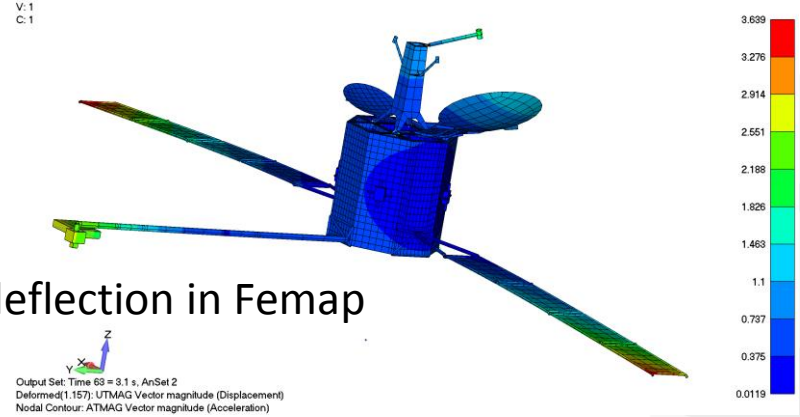
Define and view input



View nodal acceleration time history



Stress contour in Femap



Animated deflection in Femap

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Dynamic Analysis Using Femap and Vibrata

Summary

- Vibrata/Femap enable dynamic analysis
  - Normal modes solution from finite element solver required
- Vibrata dynamic response solvers are fast and robust
  - Built-in solvers: Frequency Response, Response Spectrum, Random, and Transient
  - Custom dynamic response solver can be implemented using MATLAB
- Vibrata GUI provides functionality to facilitate dynamic analysis
  - Solver parameters
  - GUI for creating input functions
  - Output request selection
  - GUI for creating input functions
  - Post-processing

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