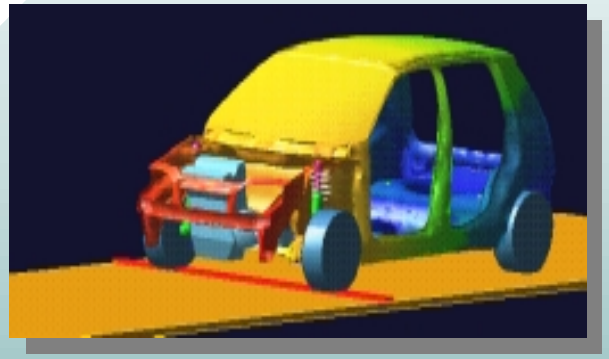
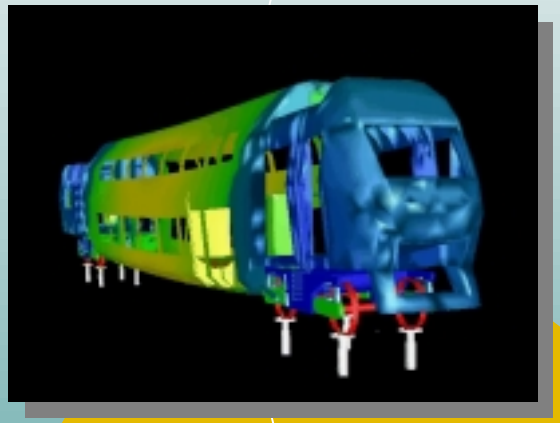
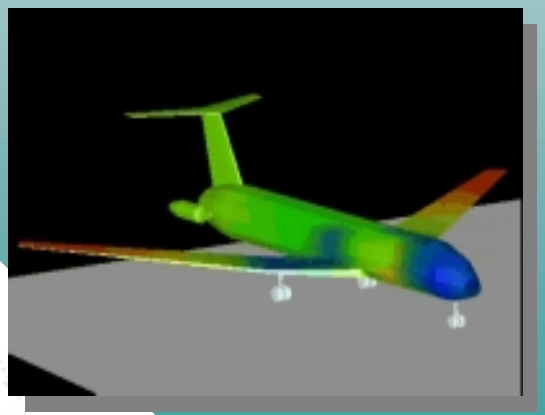
ADAMS/Vibration Capabilities for Release 11 and Beyond







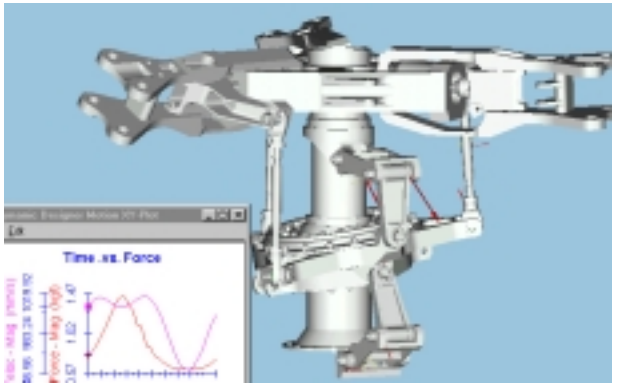
Gabriele Ferrarotti

June 21st, 2000

Mechanical Dynamics

Key Vibration Issues Facing Engineers and Designers

- How comfortable is the ride, whether in an automobile, airplane, railcar, or off road machinery?
- Will excitations in one part of the system drive another part of the system?
- When problems occur, how can they be isolated?



Mechanical Dynamics

Industry efforts and metrics

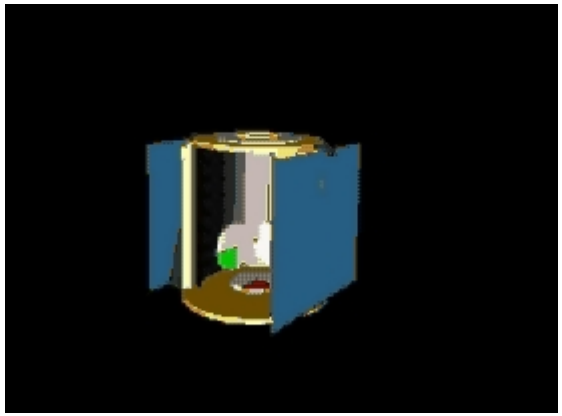
- Good vibration characteristics are a purchase motivator and improve customer satisfaction
  - Need a good way to measure a design
- Optimum NVH often conflicts with other attributes such as durability or vehicle dynamic performance
  - Need a way to balanced competing requirements
- Significant efforts are spent to understand and quantify customer NVH requirements into objective terms and to define specific tests that relate to customer events
  - Current methods are expensive

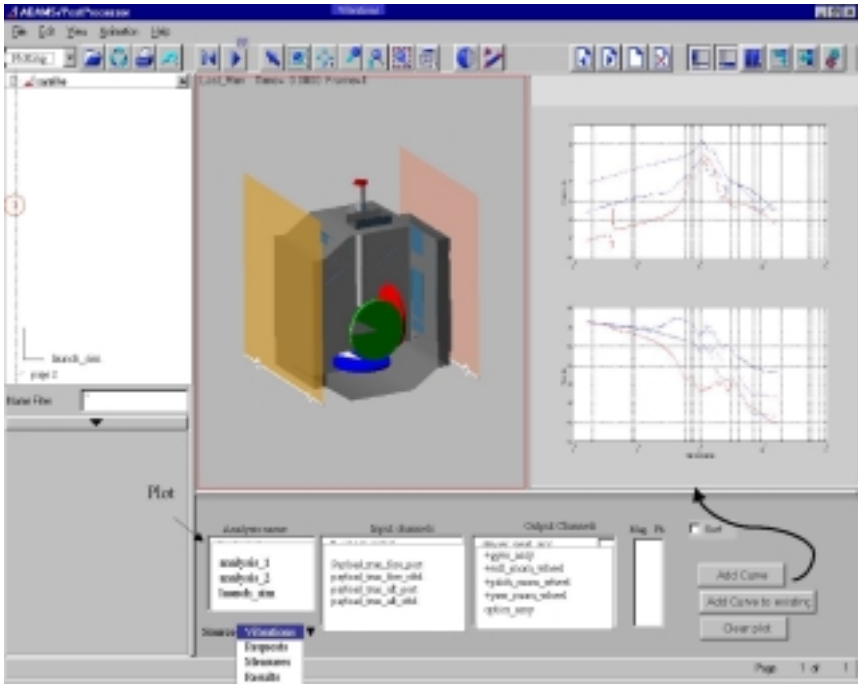
Industry efforts and metrics

- NVH involves both objective and subjective development
  - Part of the process can be quantified with analytical tools
- Suppliers must “tune” their systems/components (right the first time) to the prototype vehicle or else they are responsible for NVH resolution
  - Need a way to study system
- Issues are often discovered late in the prototype development process resulting in money and time loss
  - Value in designing the right way

The Need

- A way to study system level vibrations the same way you can now study system level motion problems





Mechanical Dynamics

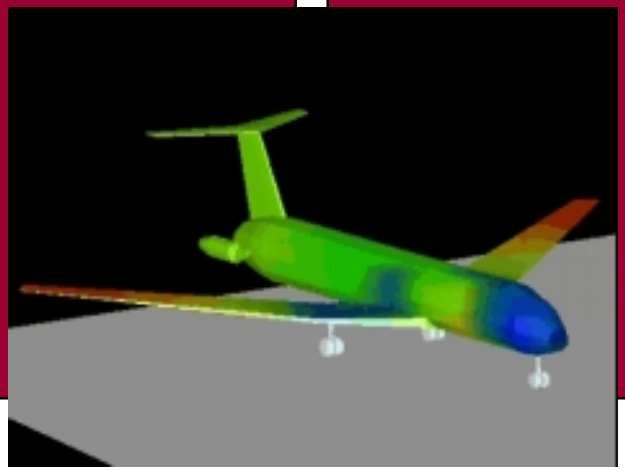
Solution: MDI Extends the Scope of Virtual Prototyping

Motion/ Performance

Safety

Durability/ Fatigue

Noise/ Vibration



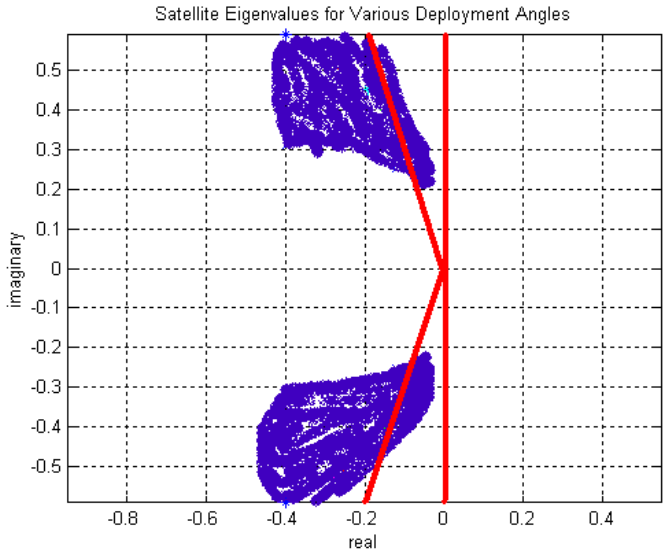
Mechanical Dynamics

Three reasons to use ADAMS/Vibration

- Take your system to different operating points to analyze the vibratory behavior (without having to create new models!)
- Include effects of hydraulics, controls, and other subsystems on the vibration characteristics
- Analyze system modes including attachment characteristics and other nonlinear characteristics

Analyze the Vibratory Behavior in Different Configurations with One Model

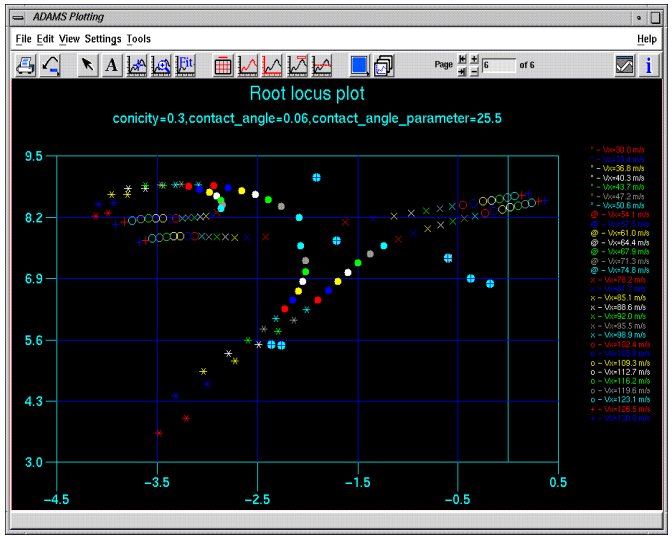
- Satellite Example:
  - System eigenvalues shift according to
    - Panel deployment angle
    - Locking condition
    - Contact condition
    - Actual spring rates
  - *This shift effects attitude control margin, pointing jitter magnitude, and structural loading conditions*

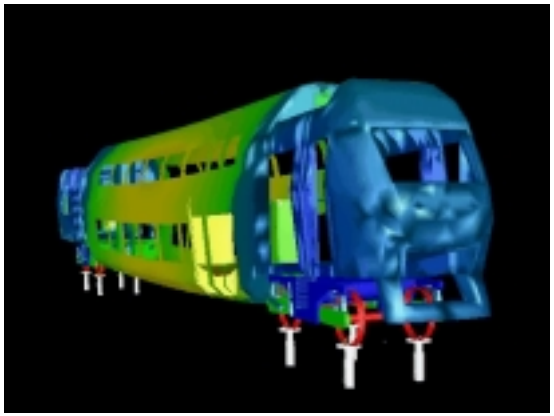


Mechanical Dynamics

Analyze the Vibratory Behavior in Different Configurations with One Model

- Railcar Example:
  - System eigenvalues shift according to
    - Equivalent conicity
    - Suspension stiffnesses
    - Damper characteristics
  - *This shift effects railcar stability and running comfort*

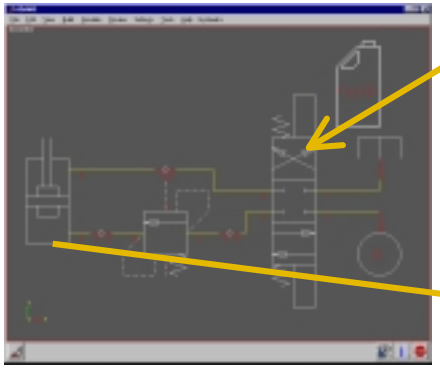


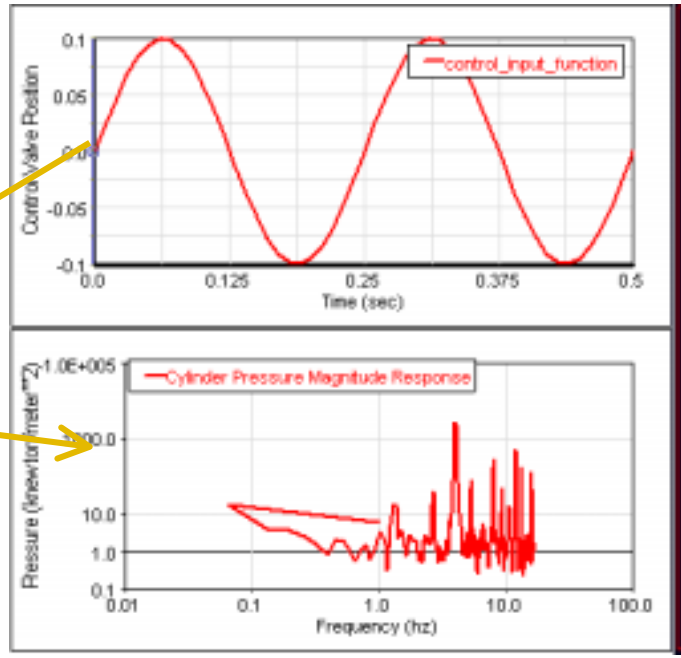


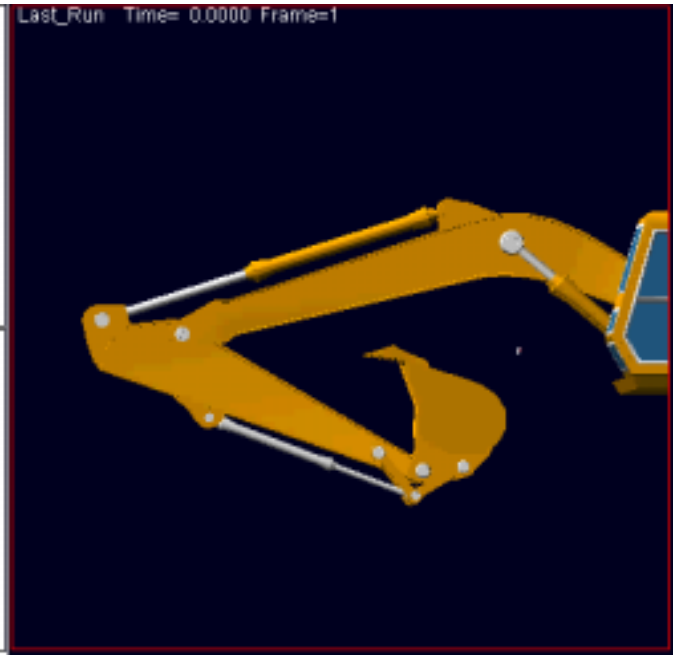
Mechanical Dynamics

Include Effects of Hydraulics and Controls on System Vibration Behavior

- Hydraulics Example:
  - Apply input vibration to control valve and see effect at cylinder pressure and boom movement in frequency response function plots and animations



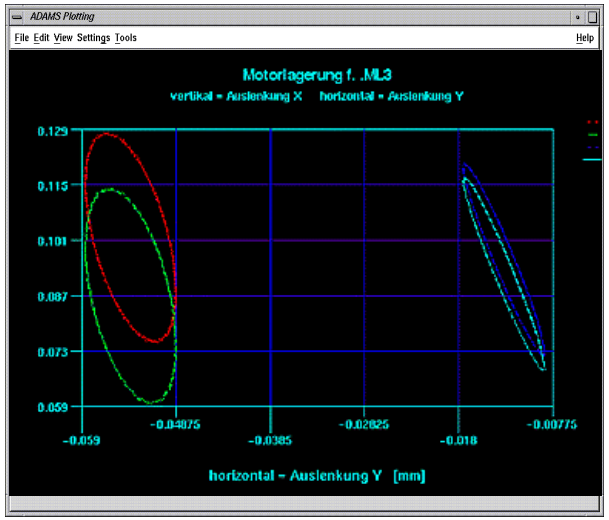


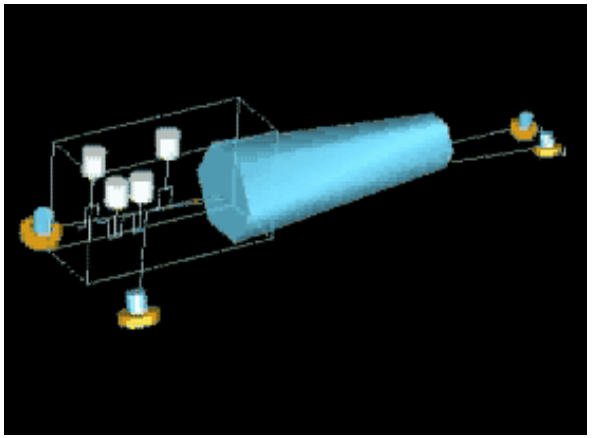


Mechanical Dynamics

System attachment characteristics

- Automotive Example:
  - Engine mount displacements due to combustion forces in dependency of
    - Engine mount characteristics
    - Engine mount position
  - *Frequency domain analysis helps designers to improve engine mount installations*

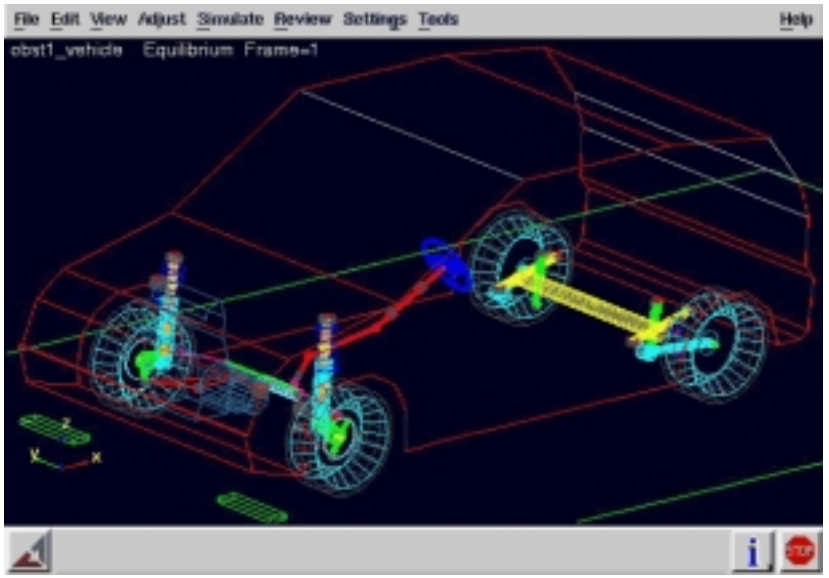




Mechanical Dynamics

11.0 Assumptions

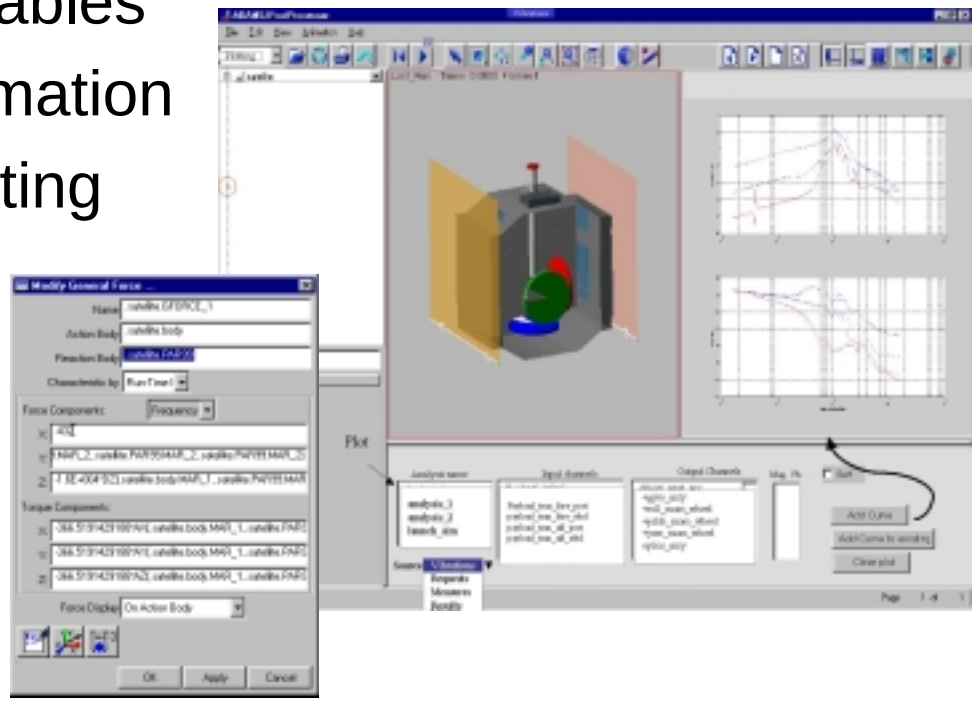
- Add-on product targeted at existing ADAMS user with existing ADAMS model
- Value of solving for system modes, including non-rigid attachments
- Leverage existing system model which includes hydraulics and controls



Mechanical Dynamics

11.0 Requirements

- Frequency domain input forcing functions
- Frequency response function calculations
- Modal participation tables
- Forced vibration animation
- Forced vibration plotting



Mechanical Dynamics

How does it work: Simplified/Unified Approach

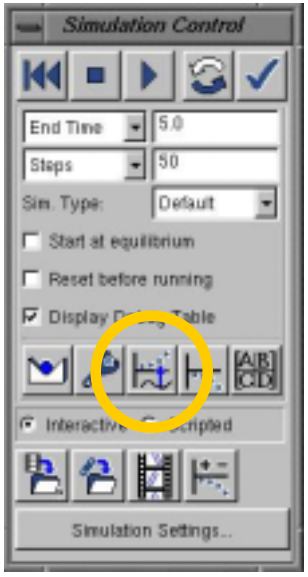
Solution

Input

Motion or Vibration Simulation Process

Post-processing

Time or Frequency Domain Inputs

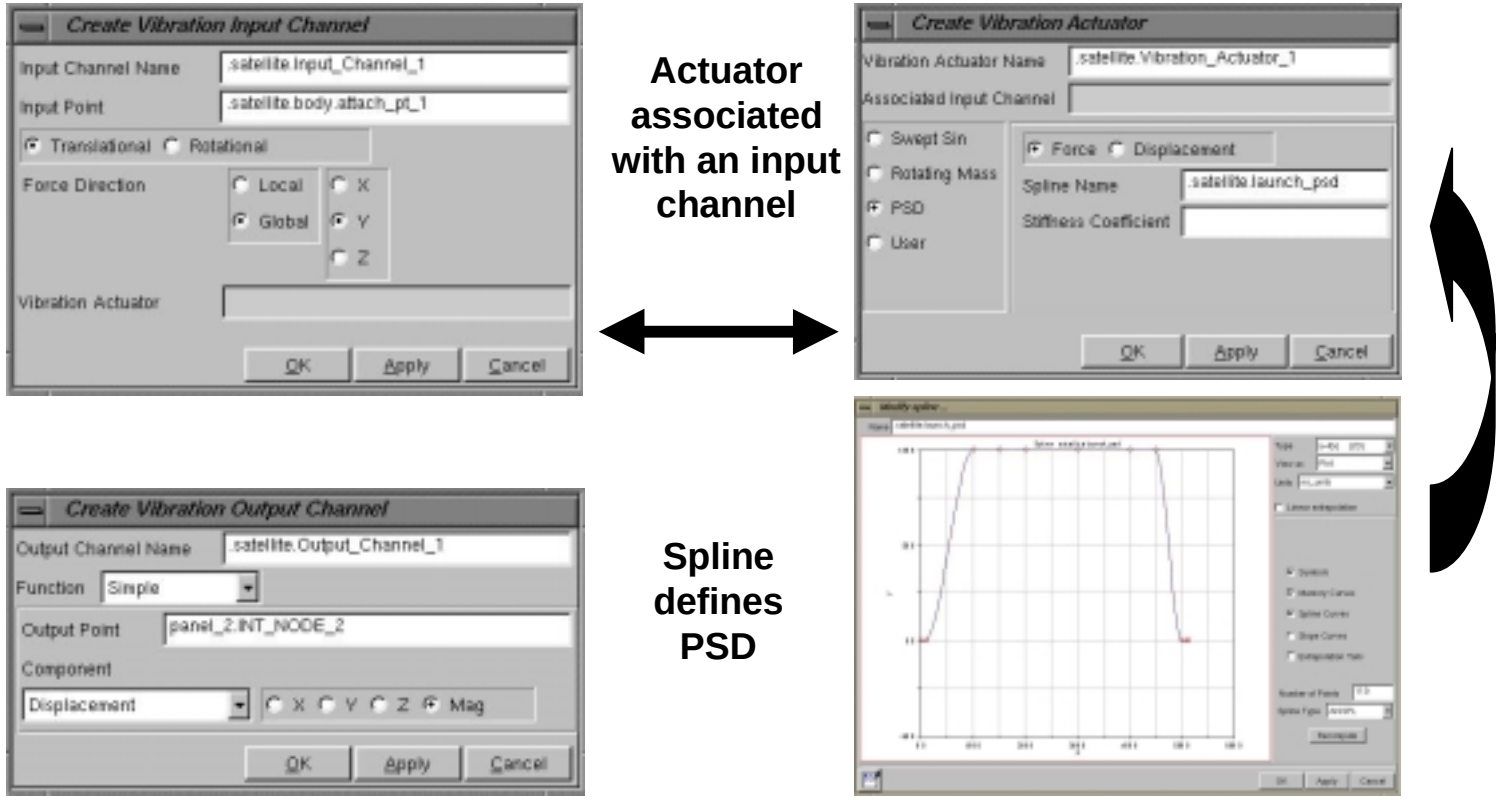


Plots, Animation, Tables, other time and frequency data

Mechanical Dynamics

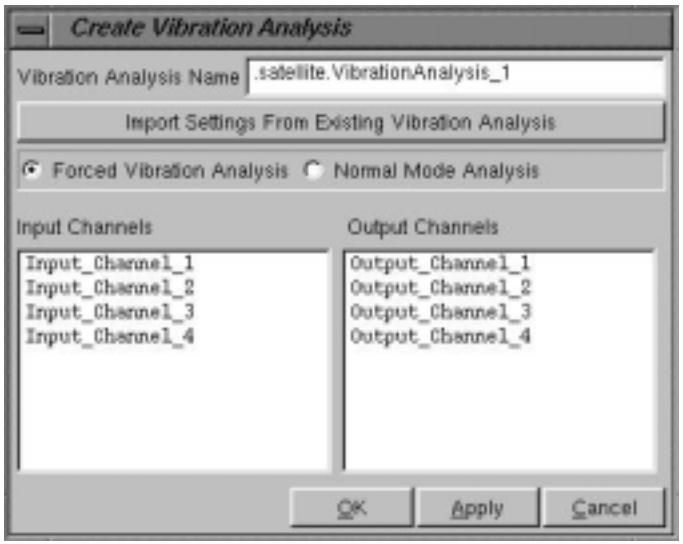
ADAMS/Vibration Walkthru...

- Step 1
  - Create input channels, output channels, and actuators

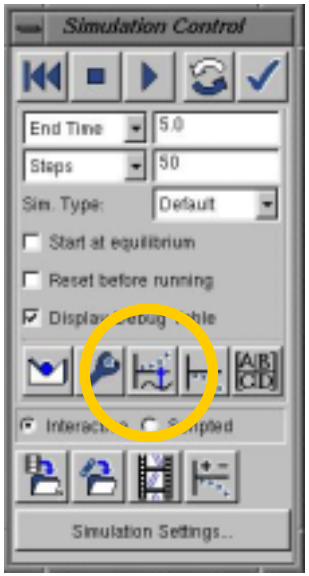


ADAMS/Vibration Walkthru...

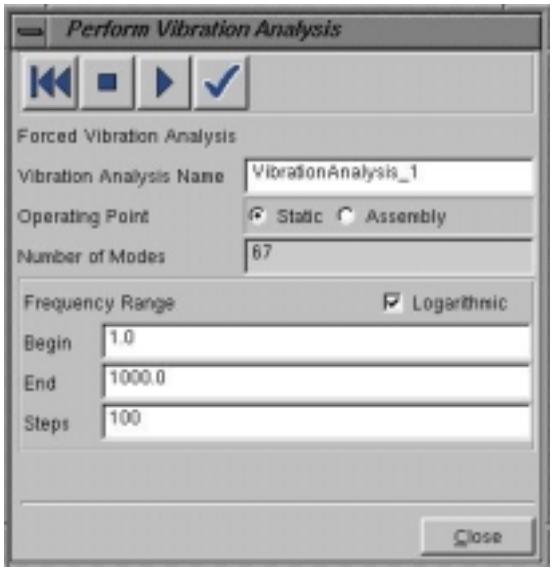
- Step 2
  - Run Analysis



Define inputs/outputs to use



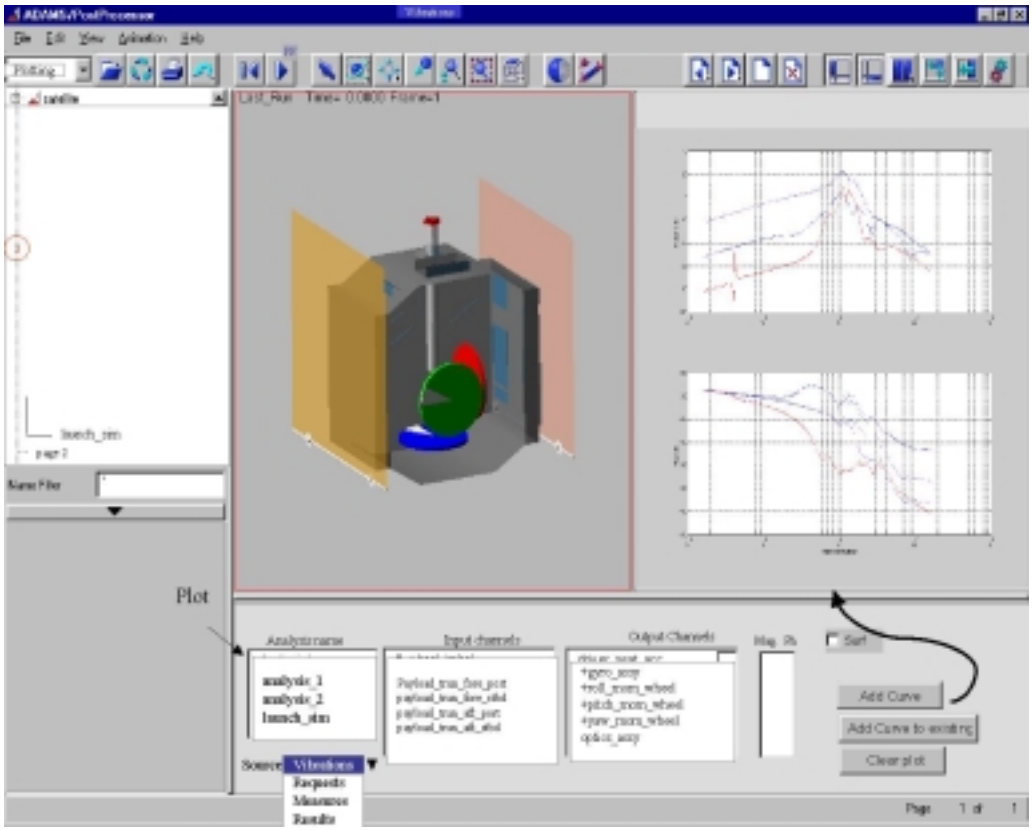
Define operating point, frequency range, and steps



Mechanical Dynamics

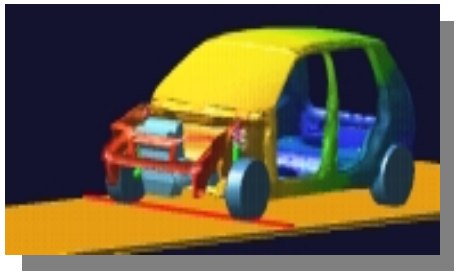
ADAMS/Vibration Walkthru...

- Step 3
  - Post-Processing
    - Forced Vibration Animation and Plotting
    - Frequency Response Functions
    - Modal Participation Tables



Mechanical Dynamics

ADAMS/Vibration Roadmap



Phase 1
Forced Vibration

Extending ADAMS/Linear to support forced vibration analysis including animation, frequency response, and modal participation.

Phase 2
System Modal Energy

Modal kinetic and dissipative energy distribution.
Inclusion of time based vibration analysis.
Greater ease of use.

Phase 3
Frequency Based Model and Test Comparison

Using MTS test utilities to support import of physically tested components and subsystems into ADAMS/Vibrations for full vehicle analysis.
Support of VEMA capabilities.

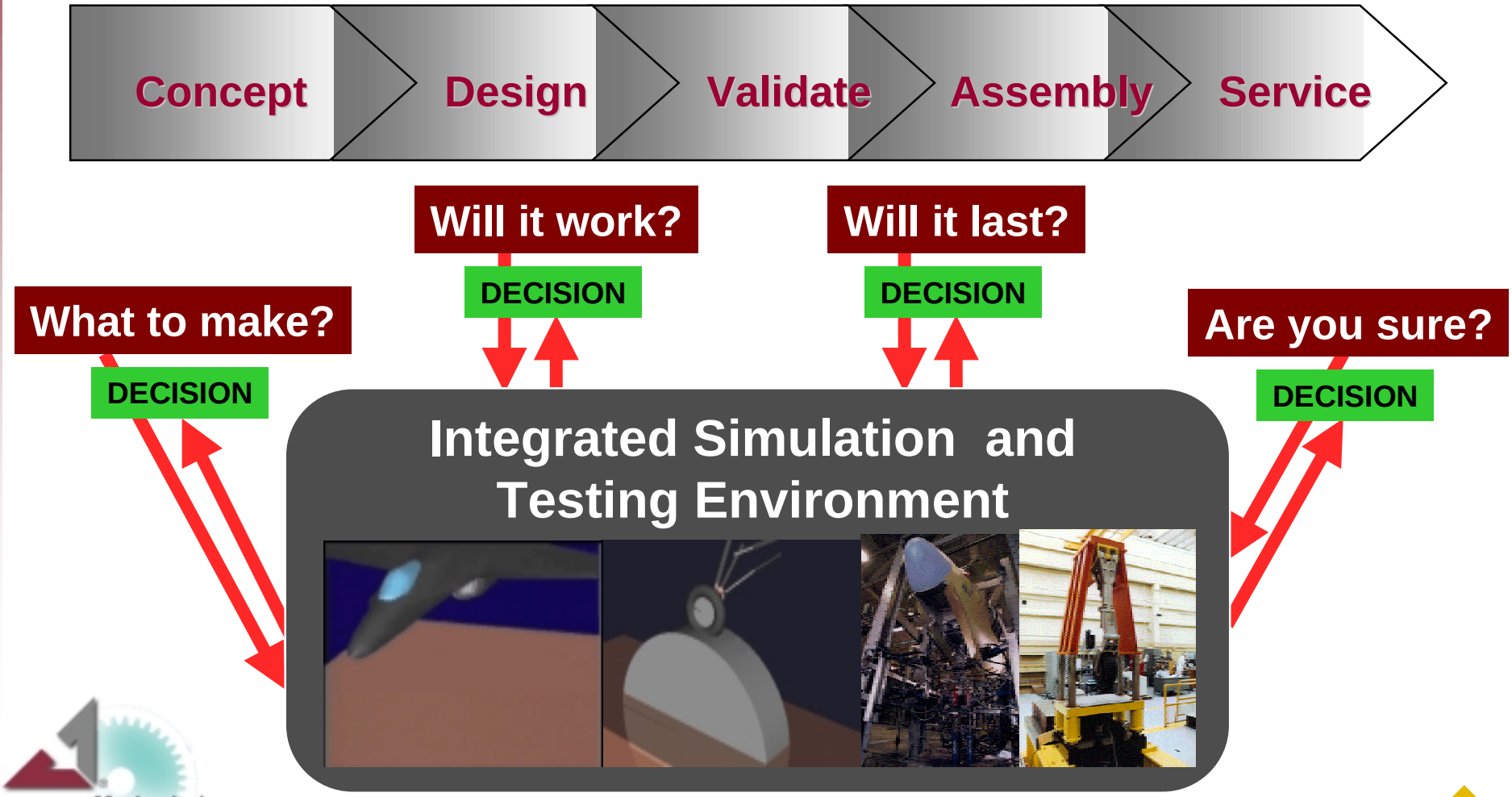
Phase 4
Vibration Analysis of General Nonlinear Systems

Extended capability to handle general rotating systems, quasi-linear systems, and vibro-acoustics.

Upcoming Releases

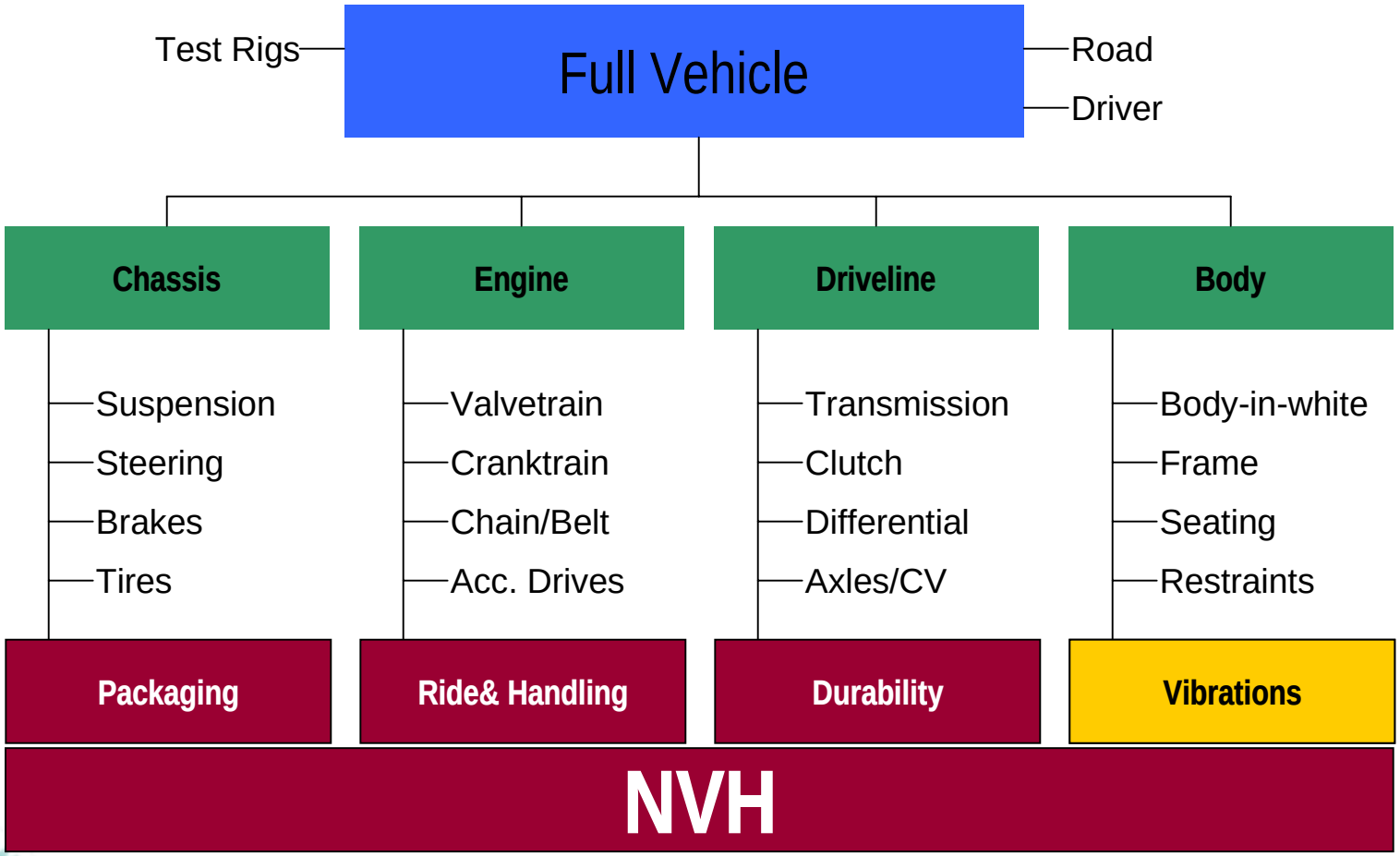
Mechanical Dynamics

Virtual TestLab™ Including Vibration



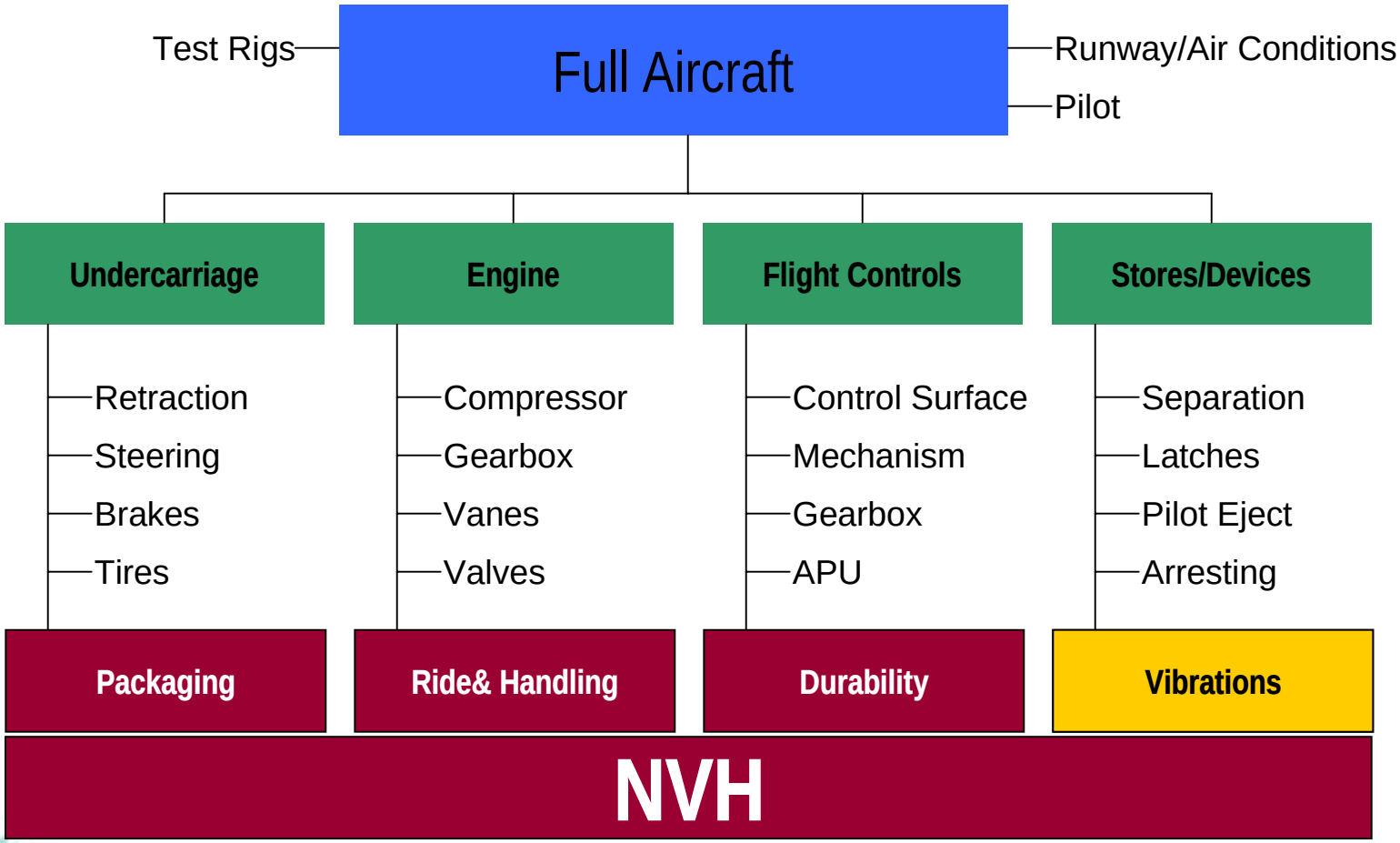
Mechanical Dynamics

Functional Digital Car Including Vibration



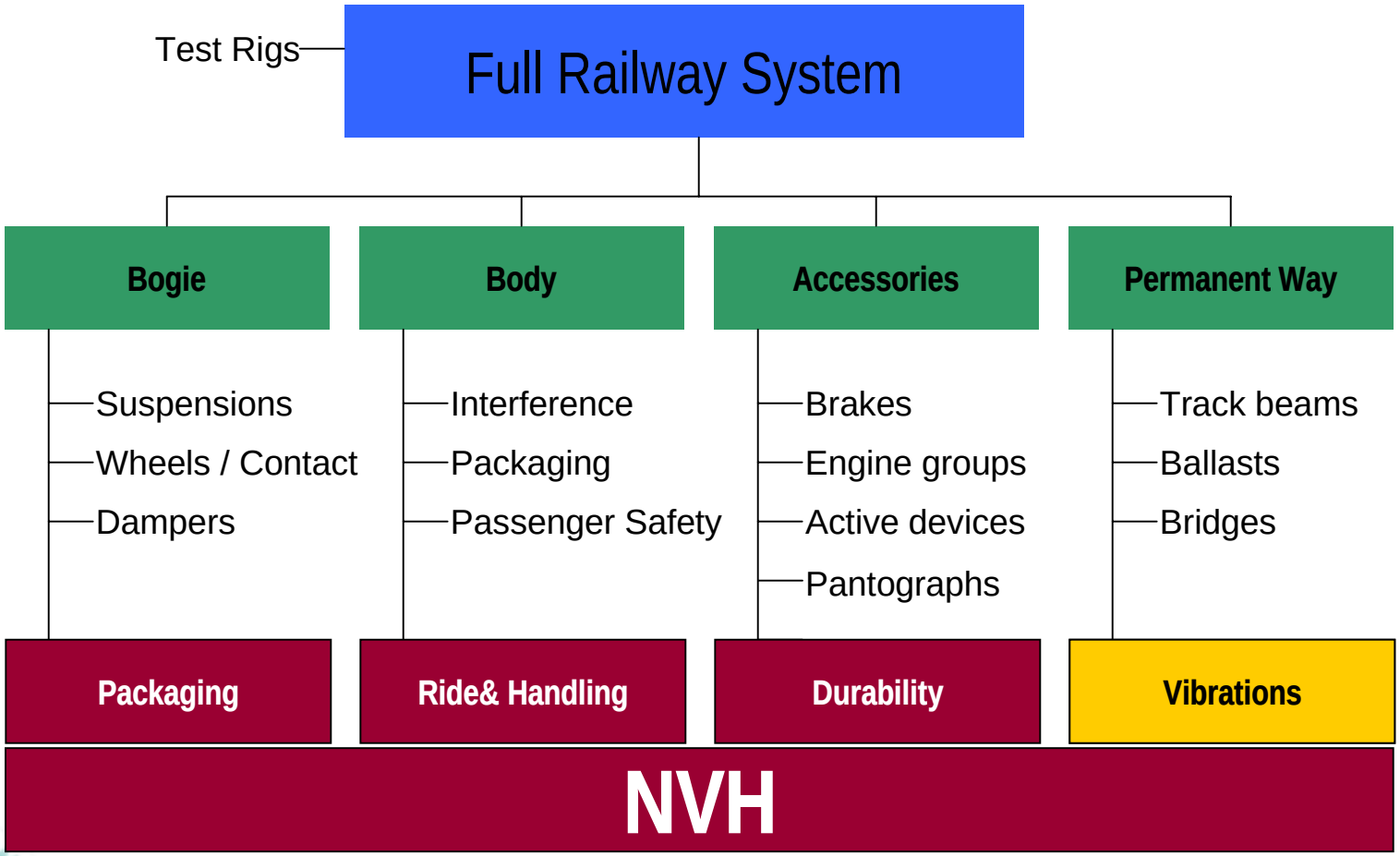
Mechanical Dynamics

Functional Digital Aircraft Including Vibration



Mechanical Dynamics

Functional Digital Train Including Vibration



Mechanical Dynamics