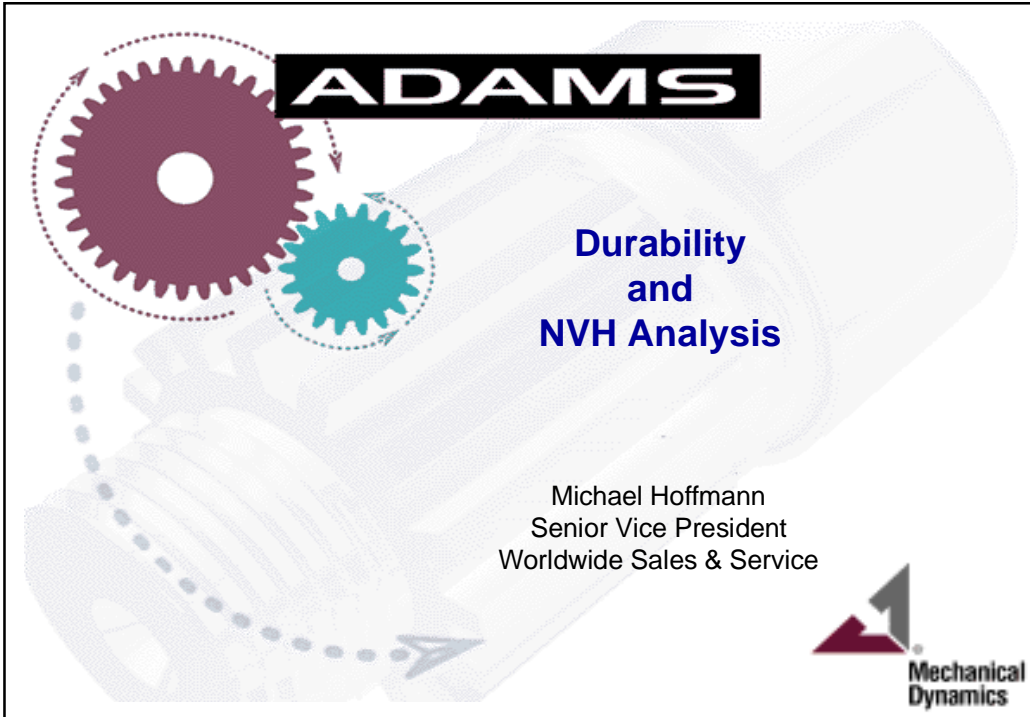



# Durability and NVH Analysis



**ADAMS**

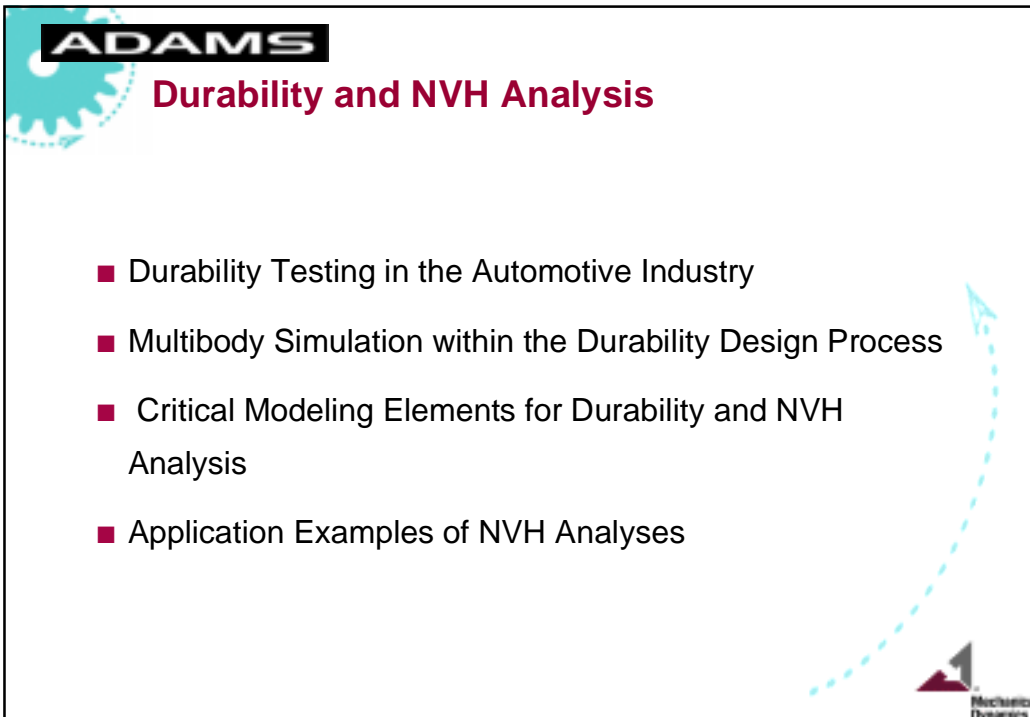
**Durability  
and  
NVH Analysis**

Michael Hoffmann  
Senior Vice President  
Worldwide Sales & Service



Mechanical  
Dynamics


The slide features a background image of a car wheel and suspension components. In the top left, there are two interlocking gears, one purple and one teal, with dashed arrows indicating their rotation. The ADAMS logo is prominently displayed in a black box at the top left.



**ADAMS**

**Durability and NVH Analysis**

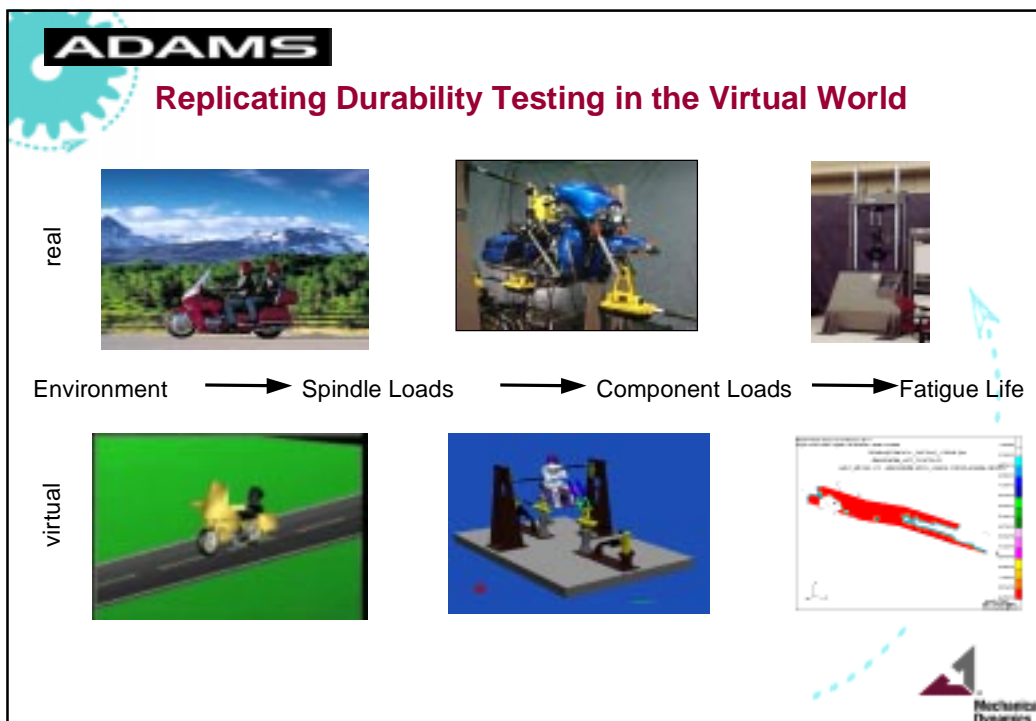
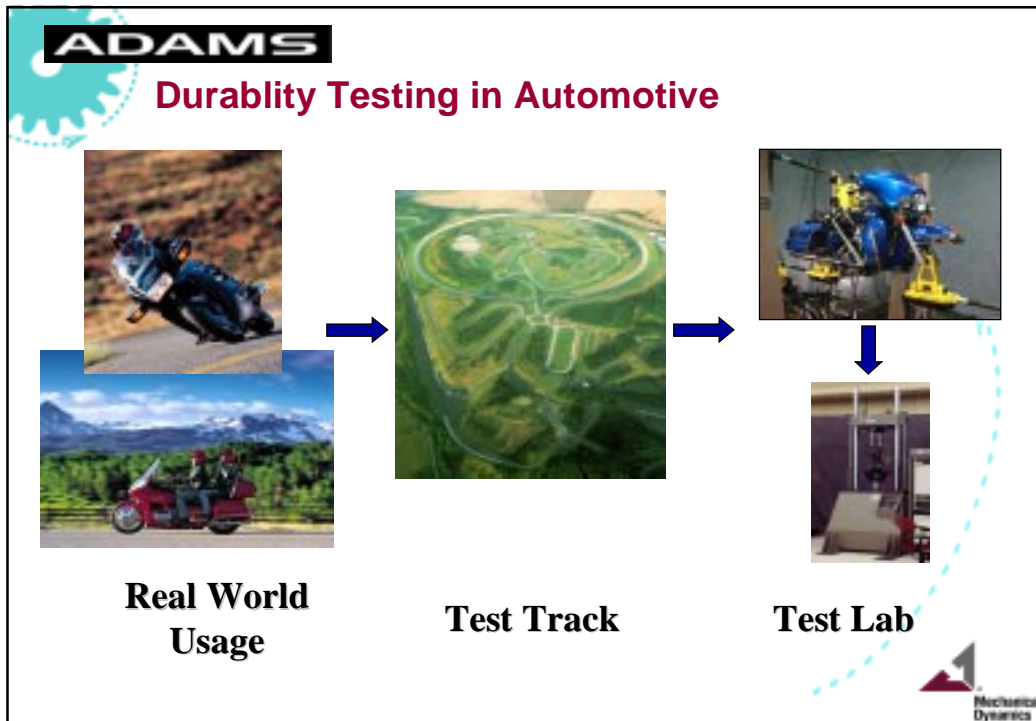
- Durability Testing in the Automotive Industry
- Multibody Simulation within the Durability Design Process
- Critical Modeling Elements for Durability and NVH Analysis
- Application Examples of NVH Analyses



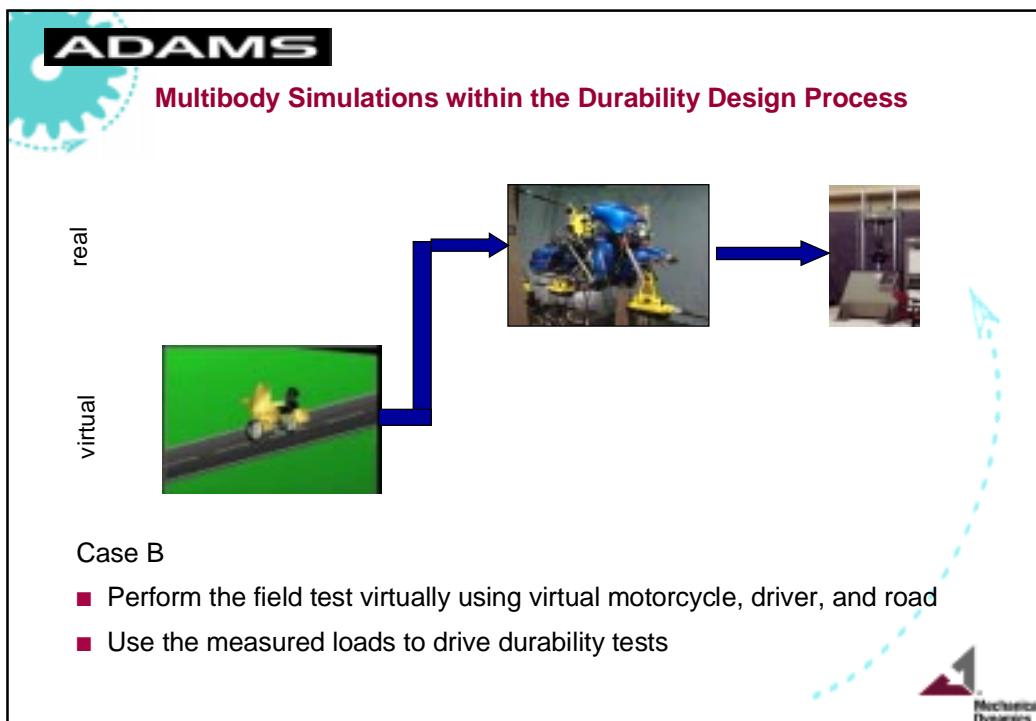
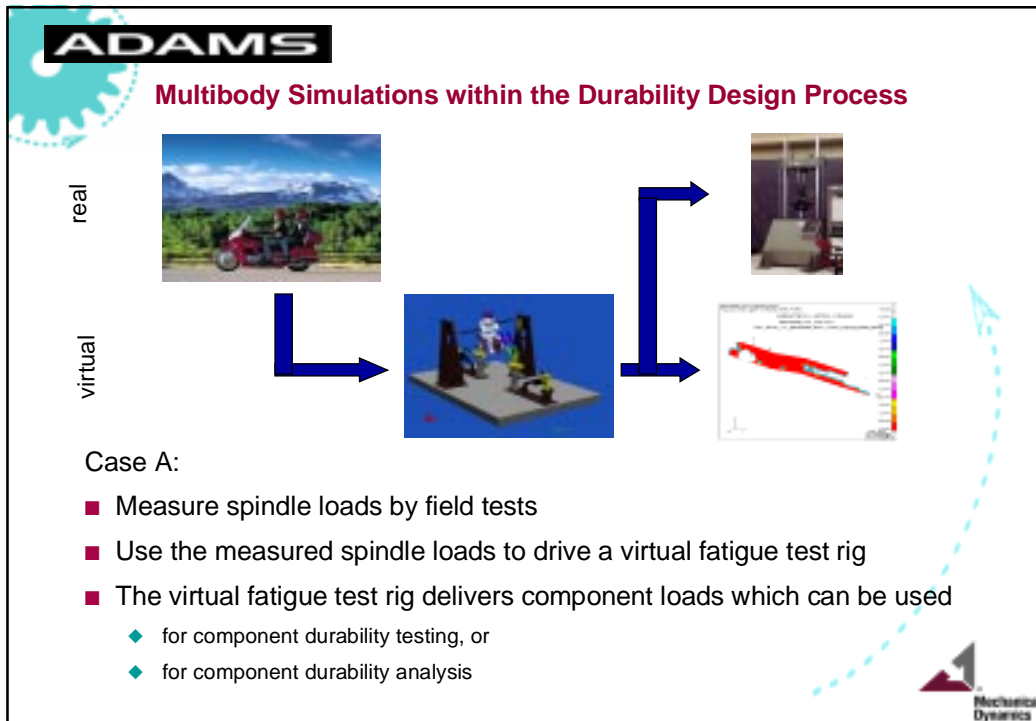
Mechanical  
Dynamics

The slide features a background image of a car wheel and suspension components. In the top left, there is a teal gear with a dashed arrow indicating its rotation. The ADAMS logo is prominently displayed in a black box at the top left. A dashed teal arrow curves from the bottom right towards the top right.

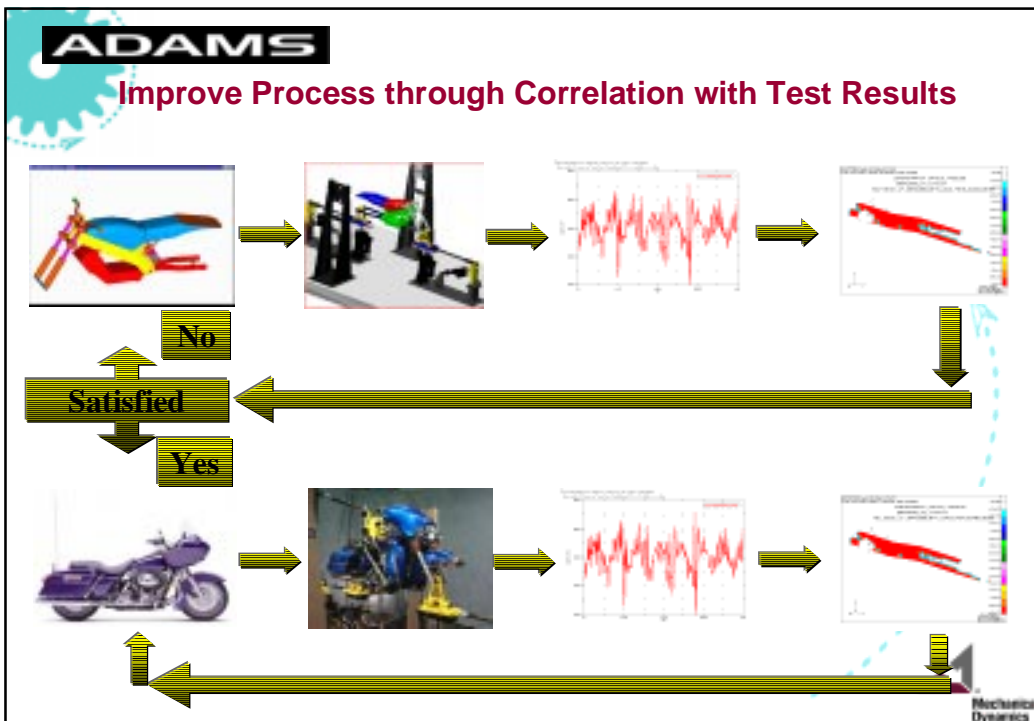
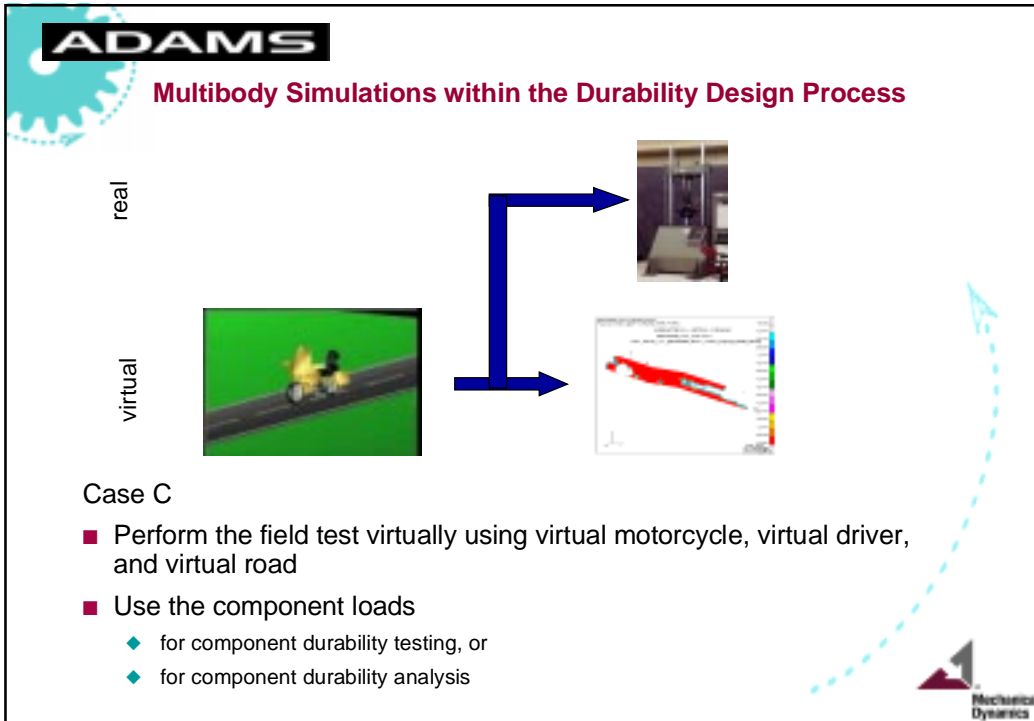
# Durability and NVH Analysis



# Durability and NVH Analysis



# Durability and NVH Analysis

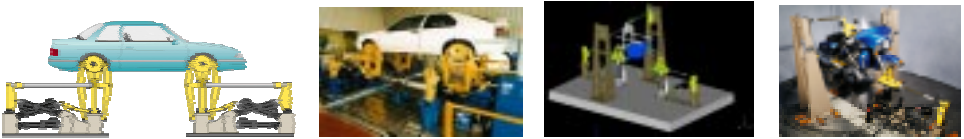


# Durability and NVH Analysis

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## Virtual Test Lab

- Dynamic Models of MTS Systems
  - ◆ Mechanical, Hydraulic, and Control Systems



- Test Engineers & Analysts can evaluate a large number of conceptual design permutations
- Designed to help analysts validate models
  - ◆ Request “better” tests & minimize incorrect tests
  - ◆ Virtual validation *must* emulate physical validation
- Eliminate Repeat Testing for additional Info

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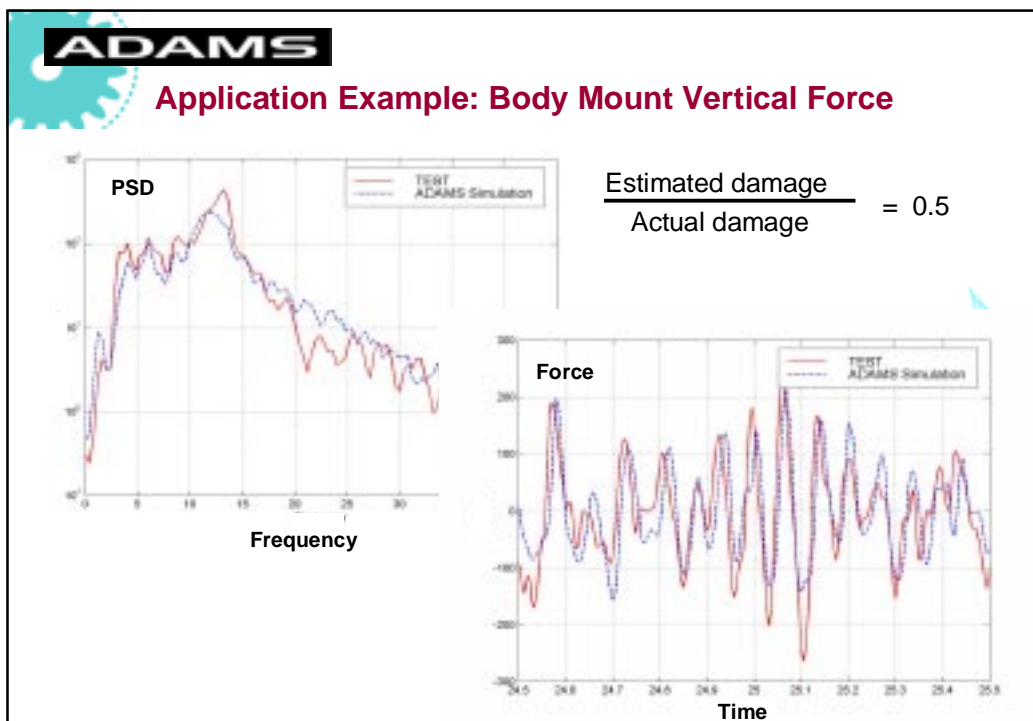
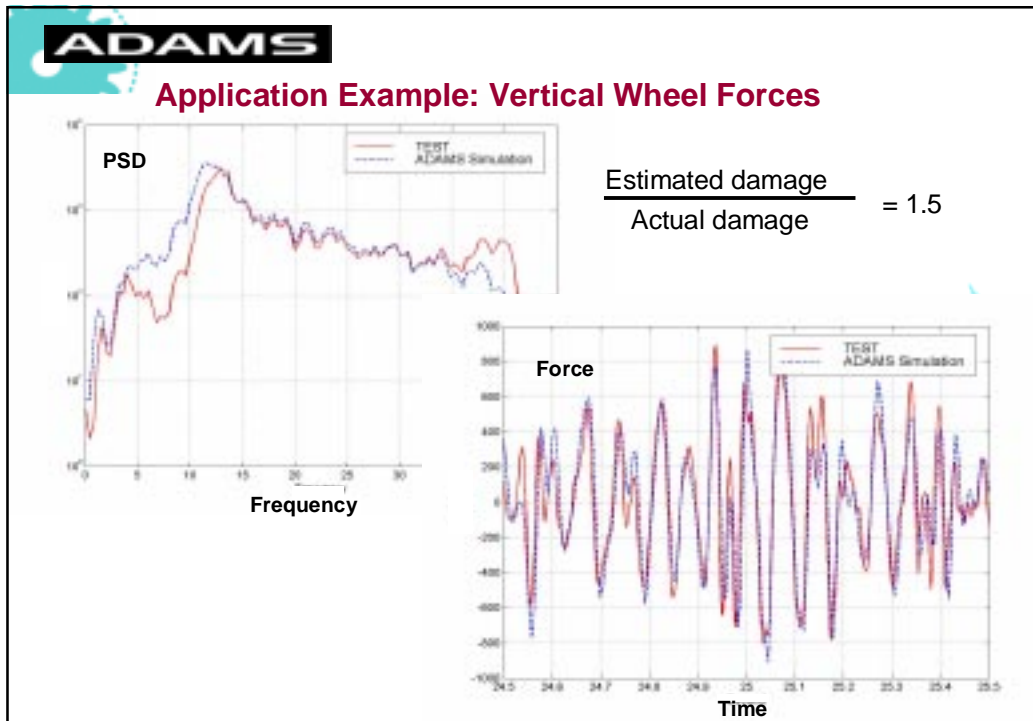
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## Application Example

- Rough road simulated on a virtual 4-post test rig
  - ◆ actuator displacement as test input
- Characteristics of the vehicle model
  - ◆ flexible frame
  - ◆ standard bushing and damper formulation

Mechanical Dynamics

# Durability and NVH Analysis





# Durability and NVH Analysis

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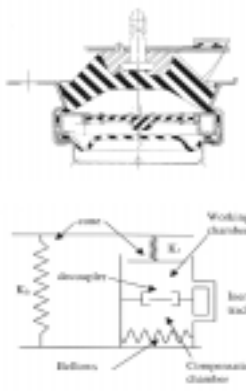
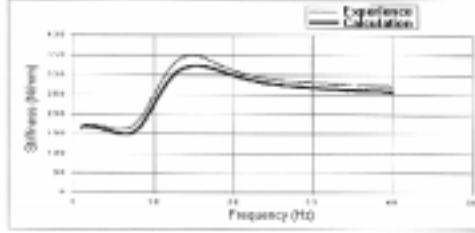
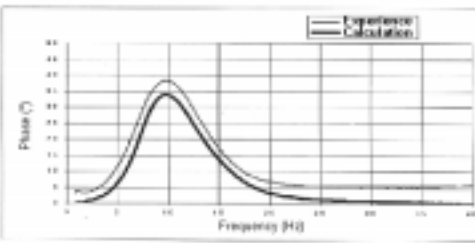
## Refining the virtual prototype

- Critical elements for improving the correlation for durability and NVH analysis
  - ◆ Flexibility
  - ◆ Bushings
  - ◆ Dampers
  - ◆ Tires

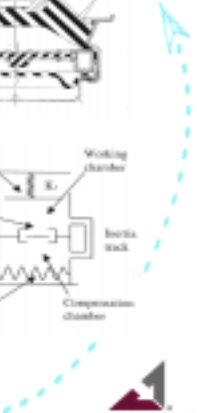



**ADAMS**

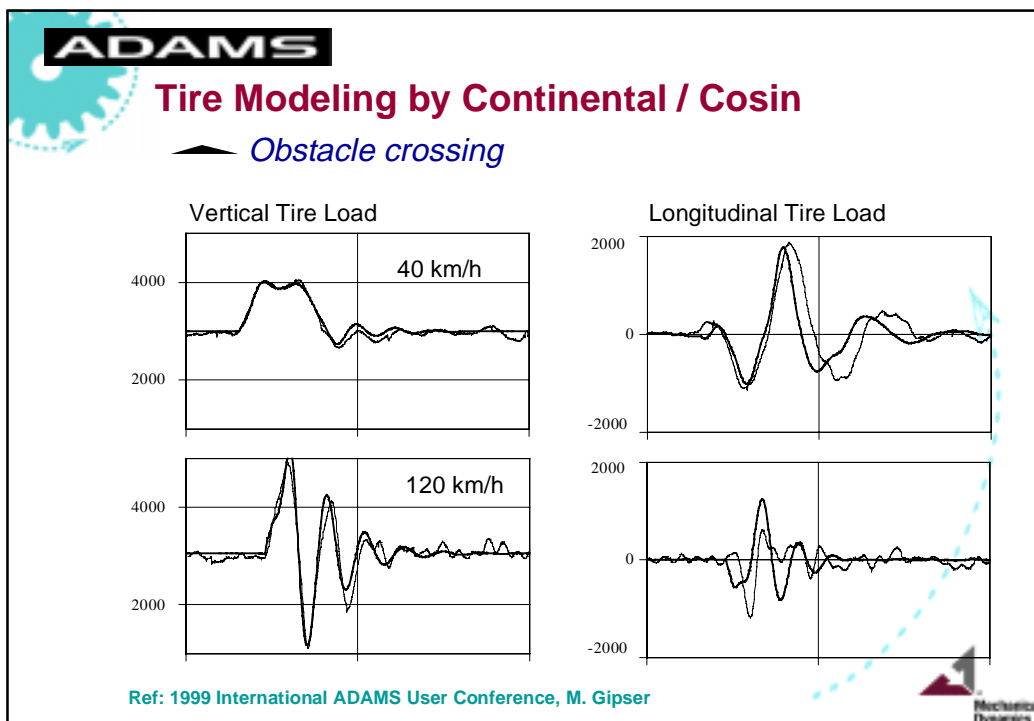
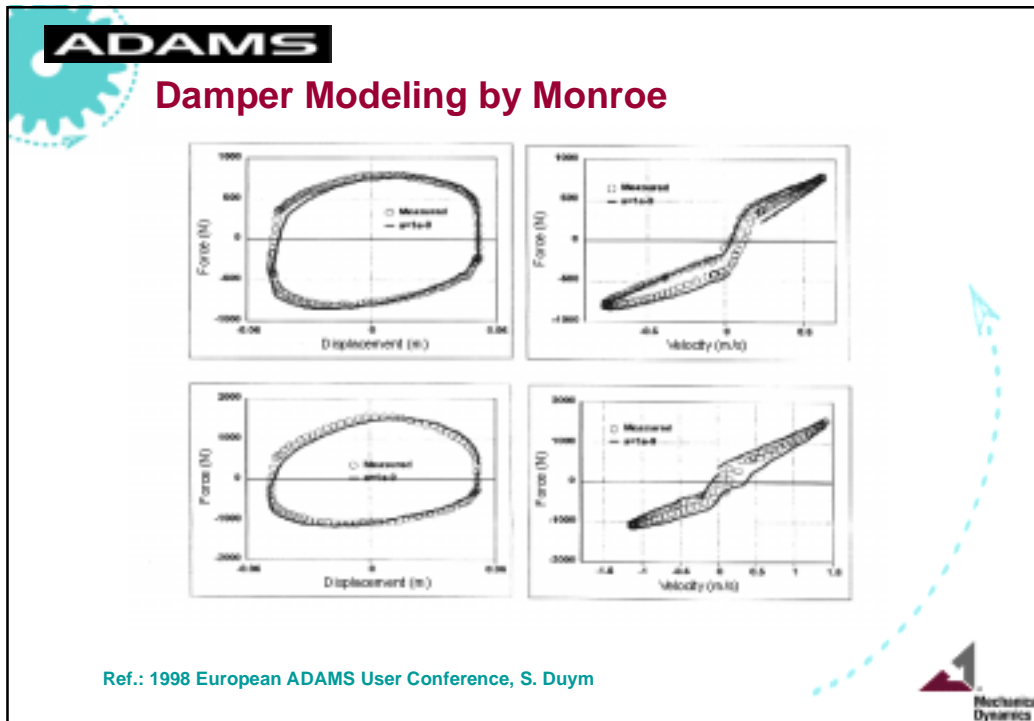
## Hydromount modeling by Paulstra



Ref.: 1998 European ADAMS User Conference, E. Vandervorst



# Durability and NVH Analysis



# Durability and NVH Analysis

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## Empirical Dynamic Model from MTS

- Physical Testing Generates Data for Model Creation
  - ◆ Black Box, Characteristic, and Concept Model

Ref.: 1999 Japanese ADAMS User Conference, A. Barber

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## EDM: How Does it Work?

- Neural Networks
- Frequency Response Functions
- Polynomial Curve Fits

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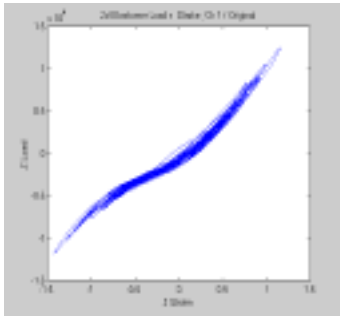
# Durability and NVH Analysis

**ADAMS**

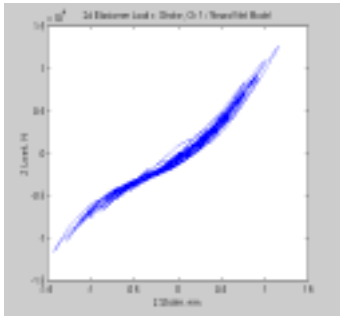
## EDM: How Well Does It Work?


- Bi-axial Elastomer Load versus Stroke
  - ◆ BlackBox Generated Model Prediction
  - ◆ Predicts Amplitude Dependence and Hysteresis
    - Hysteresis is a Frequency Dependent Effect

Physical Test



Model Prediction




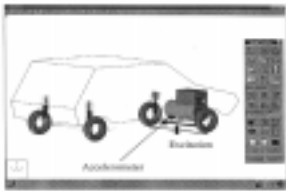



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## Examples of Vibration Analyses

- Engine Mount Design
- Rear Suspension
- Full Vehicle Obstacle Passing
- Brake Noise

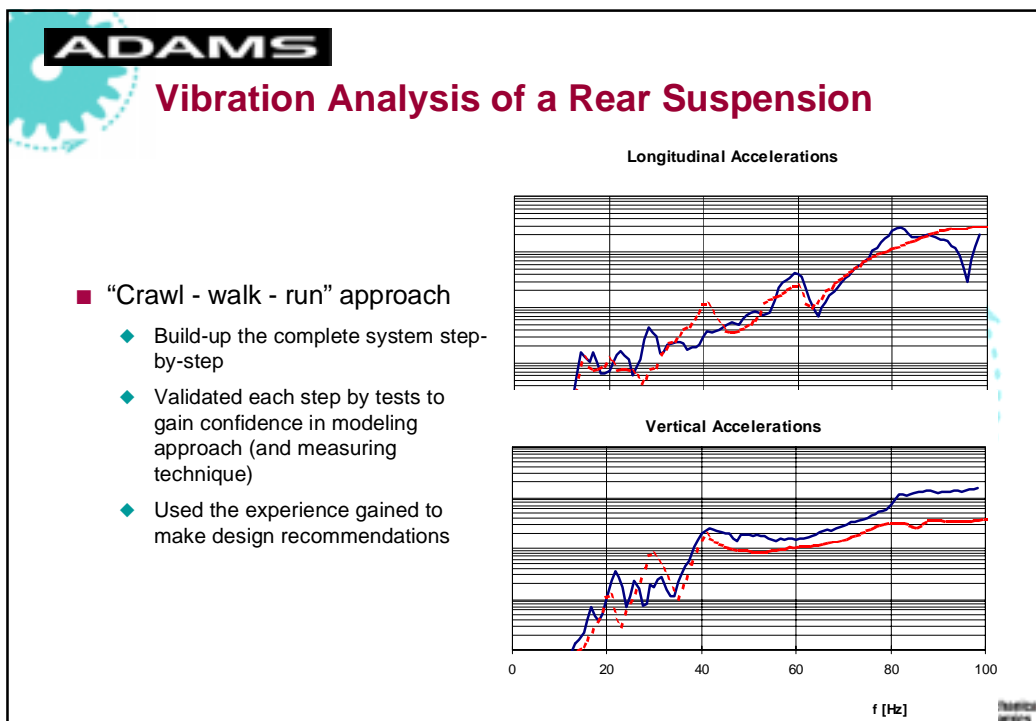
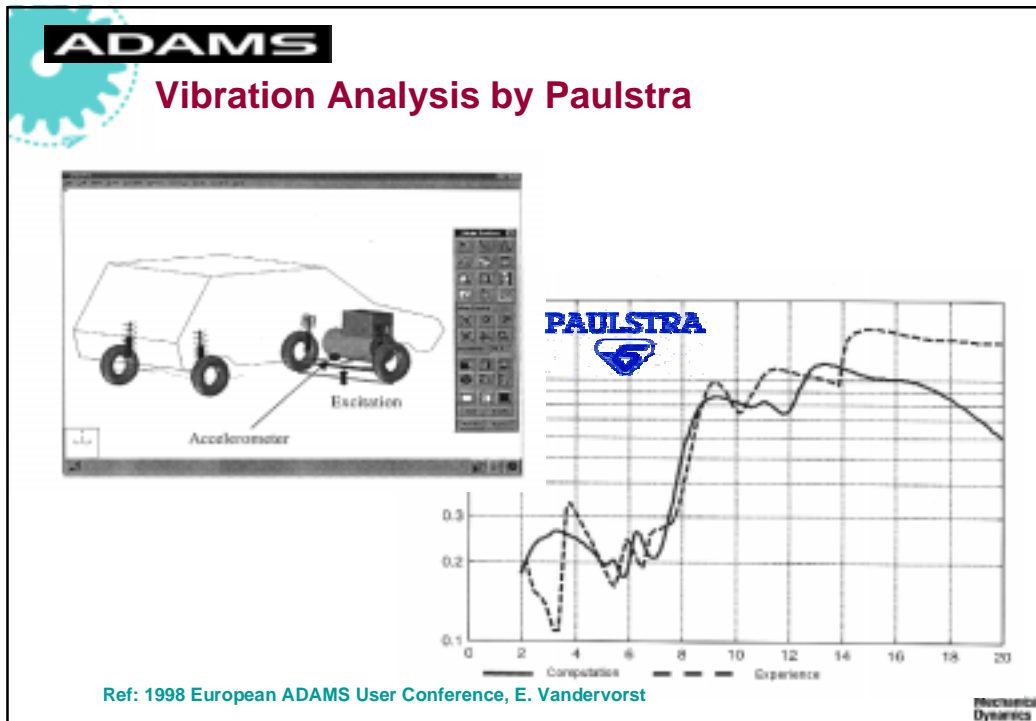








# Durability and NVH Analysis

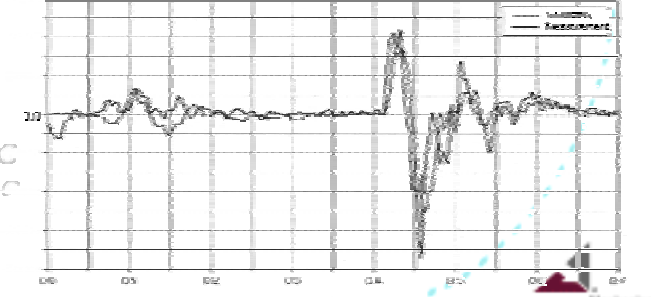
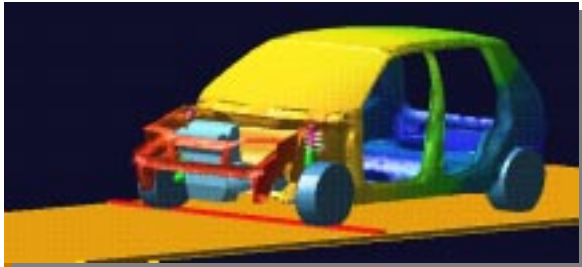


# Durability and NVH Analysis

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## Obstacle Passing Maneuver

- Full vehicle model with
  - ◆ Flexible bodies
  - ◆ Frequency dependent bushings and engine mounts
  - ◆ Comfort tire



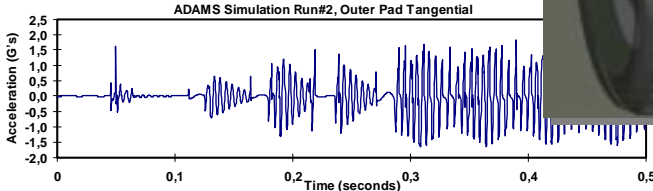
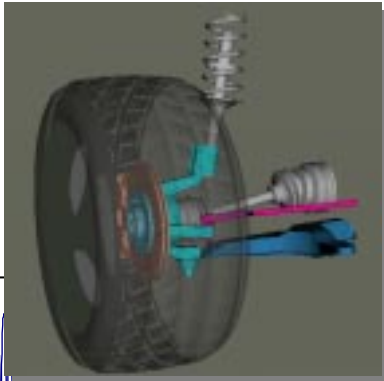

The graph displays acceleration response over time. The x-axis is labeled 'Time (seconds)' with markers at 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, and 4.5. The y-axis is labeled 'Acceleration (G's)' with markers from -2.0 to 2.5. The plot shows a relatively flat line around 0.5 G until approximately 2.5 seconds, where it exhibits a sharp, high-frequency spike reaching about 1.5 G, followed by a smaller secondary spike and then settling back to the baseline level.

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## CASE FILE: Bosch Automotive

### *Eliminating disc brake moan through simulation*



The graph is titled "ADAMS Simulation Run#2, Outer Pad Tangential". The x-axis is labeled "Time (seconds)" with markers at 0, 0.1, 0.2, 0.3, 0.4, and 0.5. The y-axis is labeled "Acceleration (G's)" with markers from -2.0 to 2.5. The plot shows a highly oscillatory signal that starts around 0.1 seconds and continues until 0.5 seconds, with peaks and troughs reaching approximately 1.5 G and -1.5 G respectively.

Ref: 1997 International ADAMS User Conference, W. Stringham

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# Durability and NVH Analysis

