Simulating an AWD Vehicle using ADAMS/Driveline

2000 International ADAMS User Conference

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Mechanical Dynamics
Orlando, June 21st, 2000

Mechanical Dynamics

Agenda

- Introduction to ADAMS/Driveline
- Building a Virtual model of an AWD transmission
- Simulating the model
- Conclusions

Mechanical Dynamics

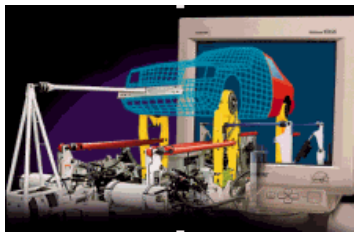
ADAMS/Driveline Consortium

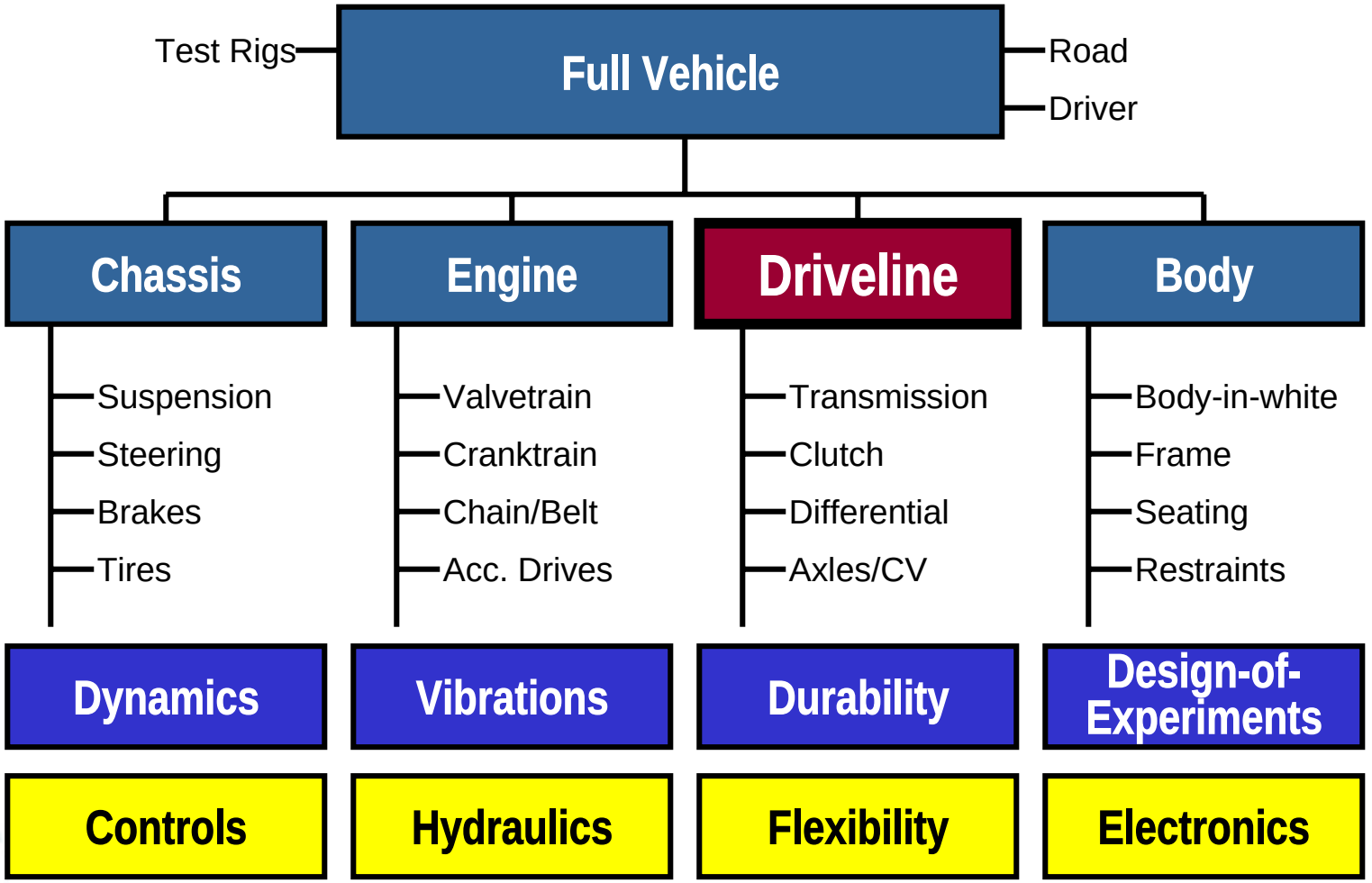
- Founding members in 1999

- Set goals and requirements for ADAMS/Driveline

Mechanical Dynamics

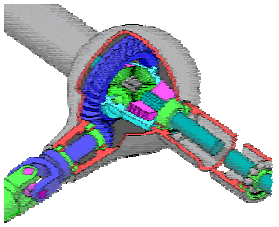
Functional Digital Car®





Mechanical Dynamics

ADAMS/Driveline

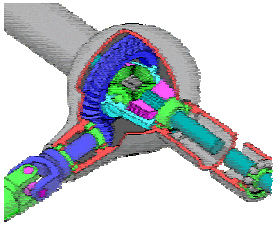


Components	Analysis	Other Features

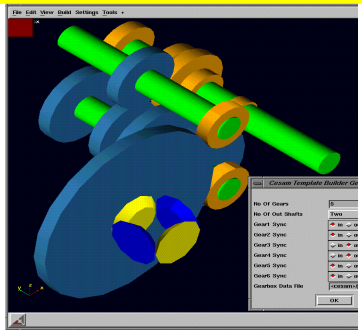
Templates \ Components	Bevel gear	Viscous S. Diff.	Mechanical L. S. Diff.	Viscous coupling	Center differential	Planetary gear (Single pinion)	Planetary gear (Double pinion)	Flex Shafts Backlash
FWD	✓	✓	✓					✓
RWD	✓	✓	✓					✓
Permanent 4WD	✓	✓	✓		✓	✓	✓	✓
Part-Time 4WD	✓	✓	✓	✓				✓

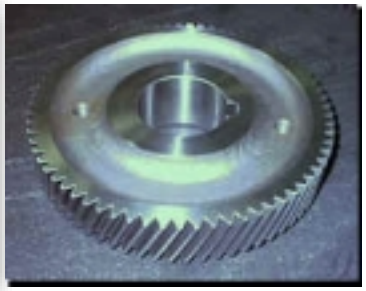
Mechanical Dynamics

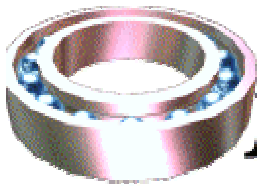
ADAMS/Driveline

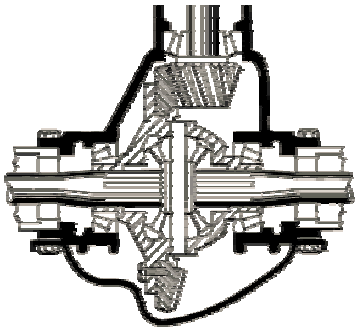


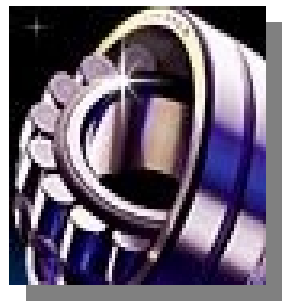
Components | **Analysis** | **Other Features**





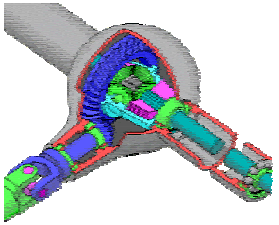






Mechanical Dynamics

ADAMS/Driveline



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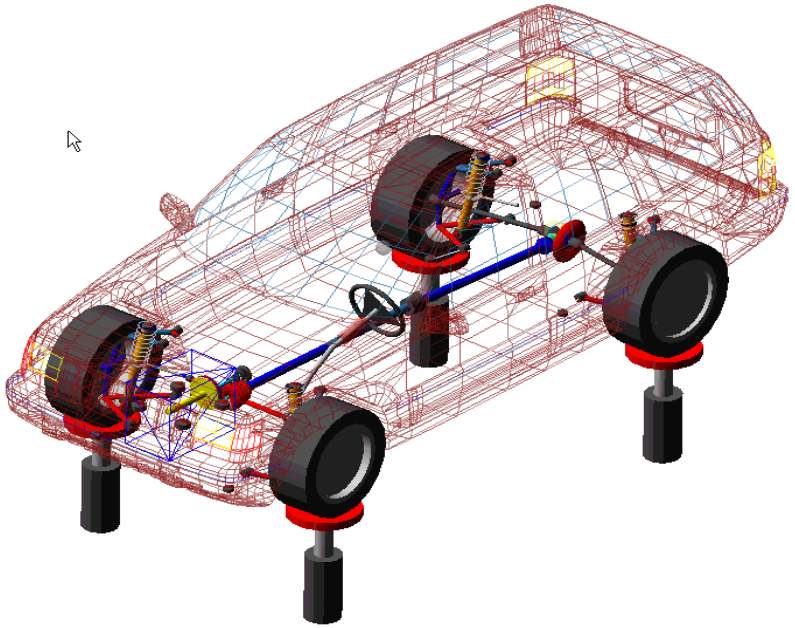
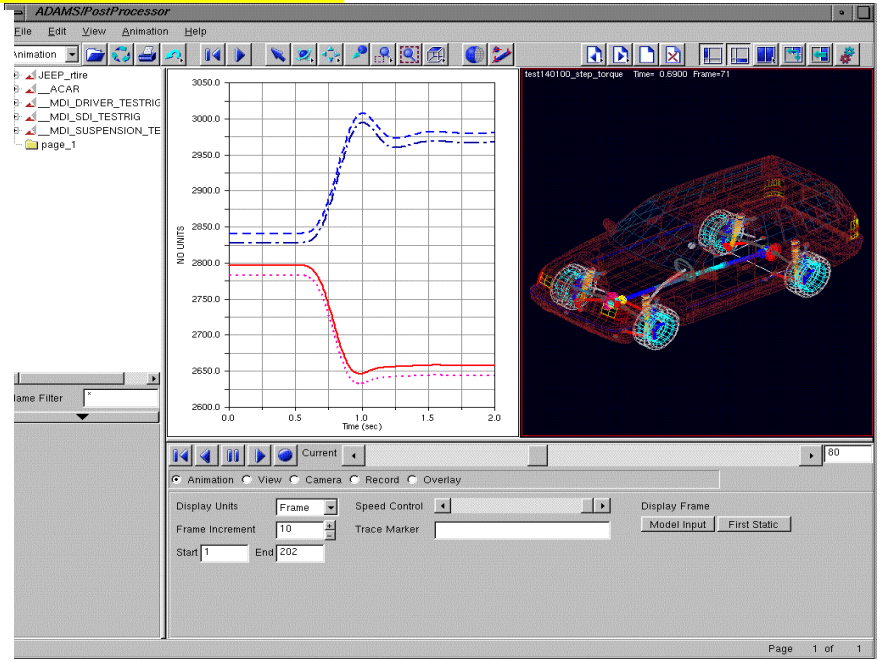
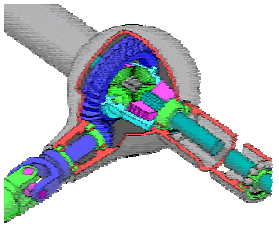




Mechanical Dynamics

ADAMS/Driveline



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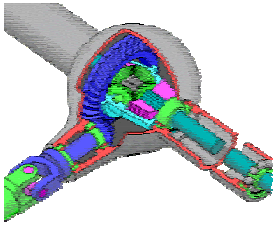
Mechanical Dynamics

ADAMS/Driveline Road Map



Phase 1: General Modeling

Basic Driveline Components
Full-Vehicle events
Bench tests

Phase 2: High-Fidelity Modeling

More detailed Components
More Full Vehicle tests
3D Road
Tire Models

Phase 3: Interfaces

Gear Tool
Flexible Bodies
Torque Control Systems (ADAMS/Controls)

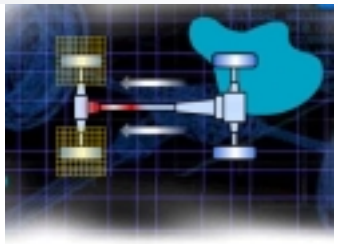
Phase 4: Vibration Analysis

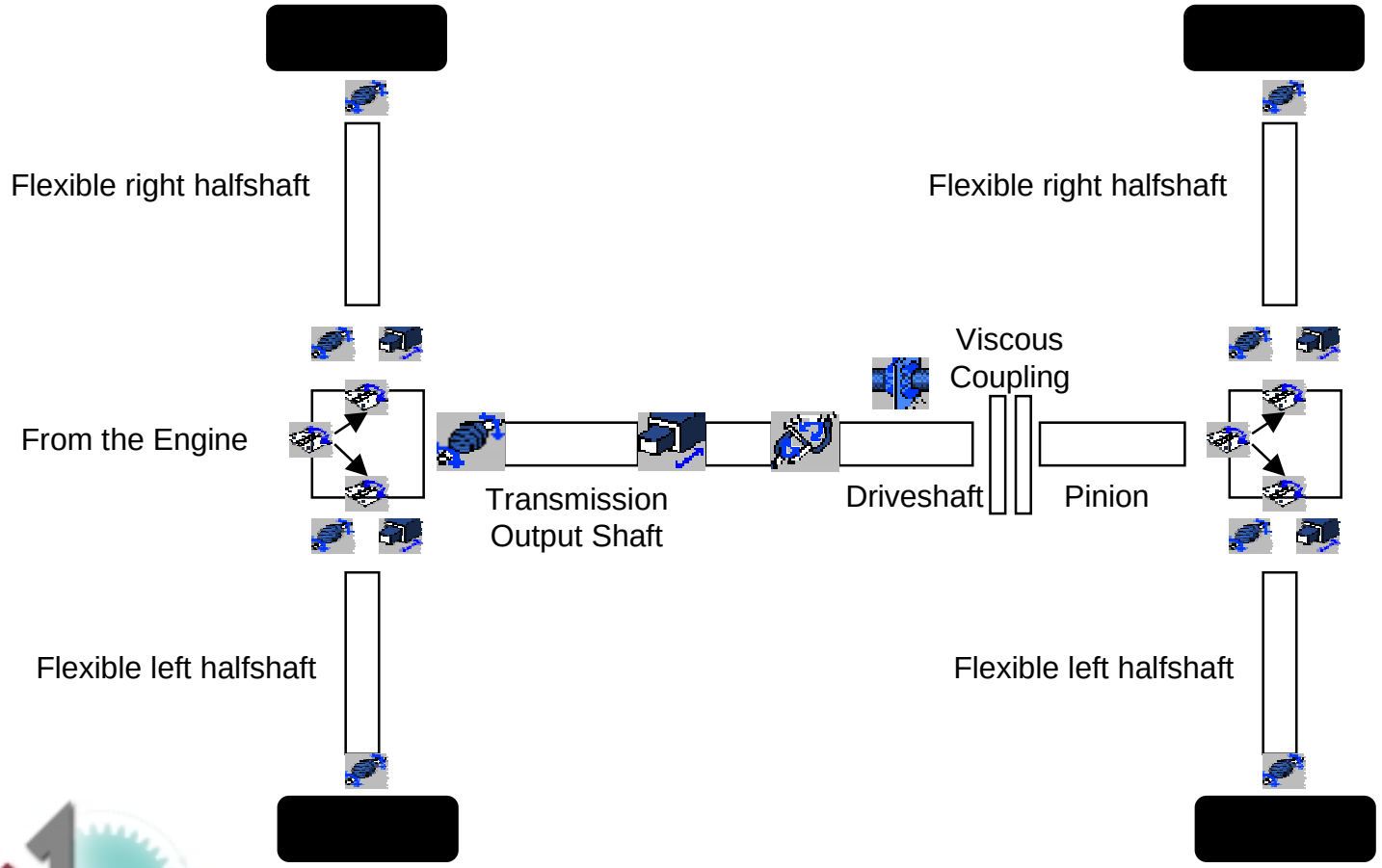
Frequency Dependent Elements
NVH Analyses
CrankTrain Module Interface

Multiple Releases

Mechanical Dynamics

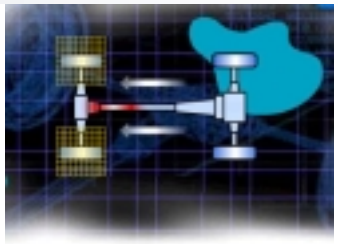
AWD System

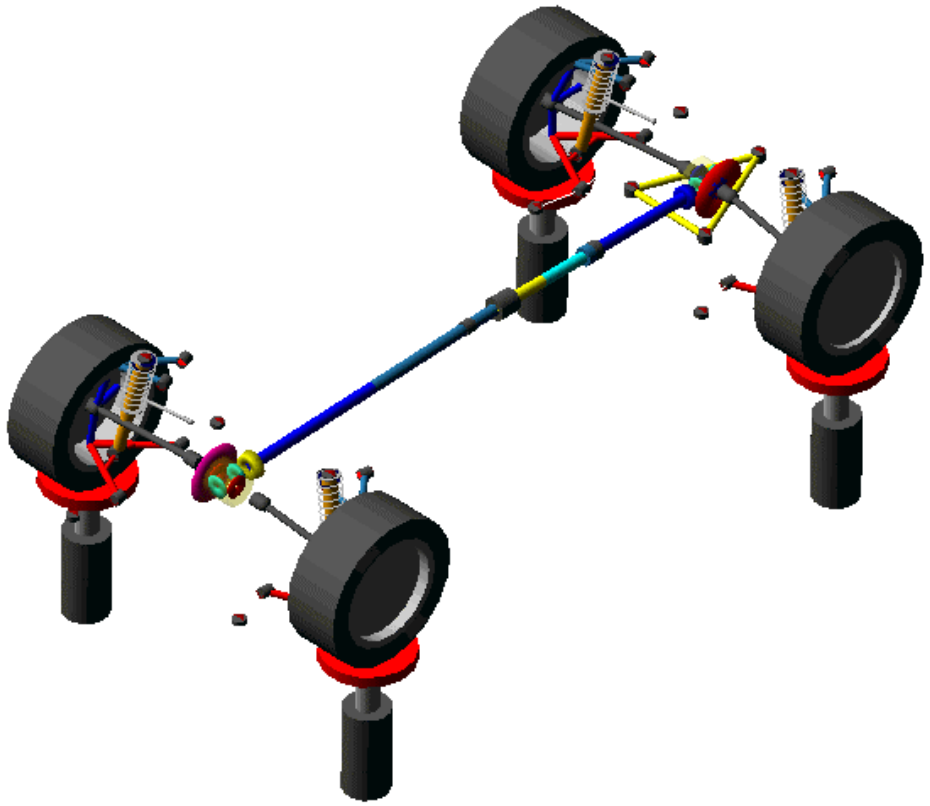




Mechanical Dynamics

The ADAMS/Driveline Model (1)

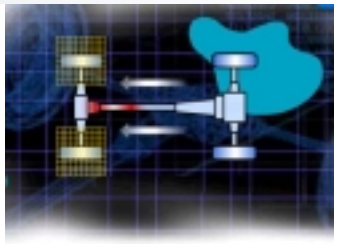


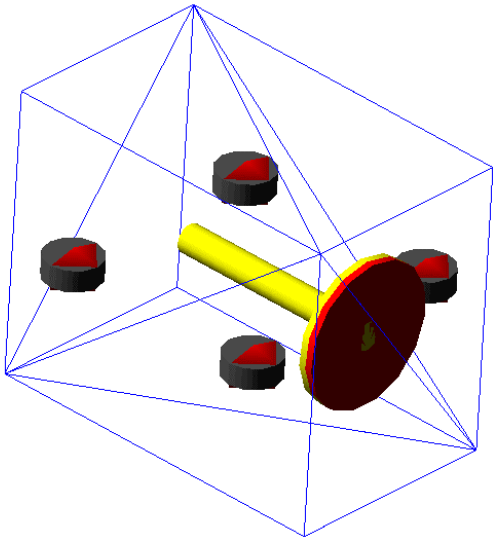


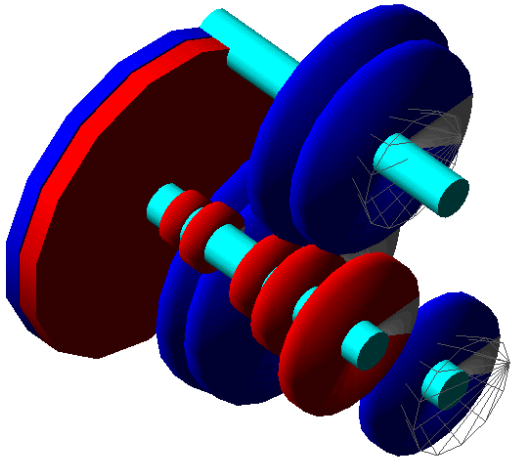
- Front and Rear Differential
- Shaft Elasticity
- Viscous Coupling
- Front and Rear Viscous Limited Slip Differential

Mechanical Dynamics

The ADAMS/Driveline Model (2)



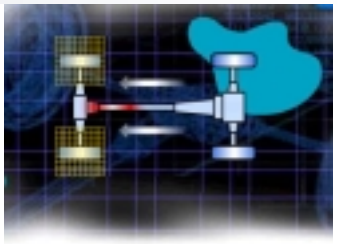




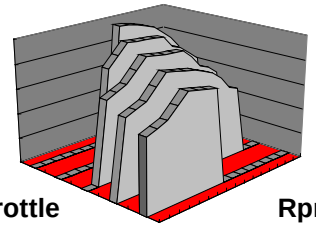
- Simple Engine with Rotational Inertia
- Detailed Clutch Model (detachable)
- Multiple Shafts Gearbox Topology
- Gear Meshes with Rotational Backlash

Mechanical Dynamics

How the Model is driven

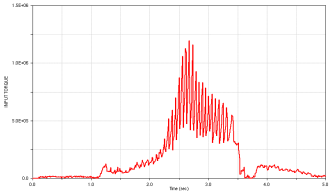


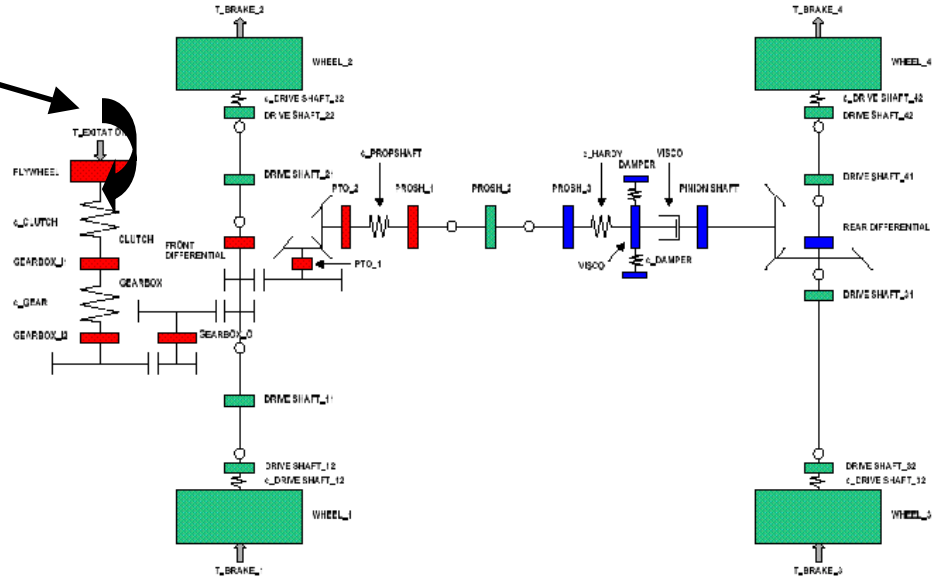
1. Engine Map



2. Predefined Expression (Step, Impulse, Ramp,..)

3. Experimental

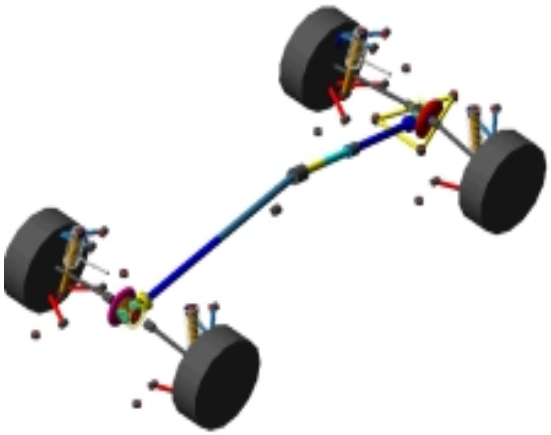




Mechanical Dynamics

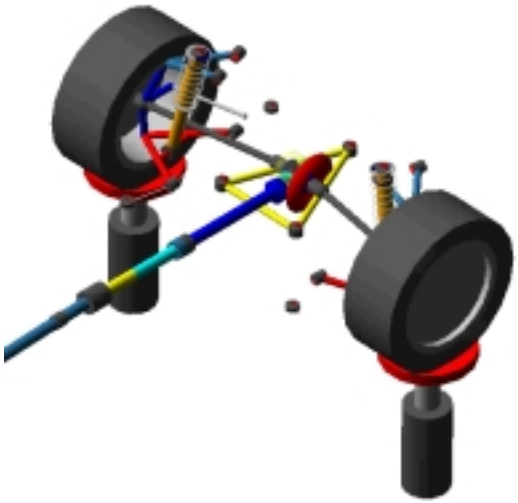
Simulations

Component Level



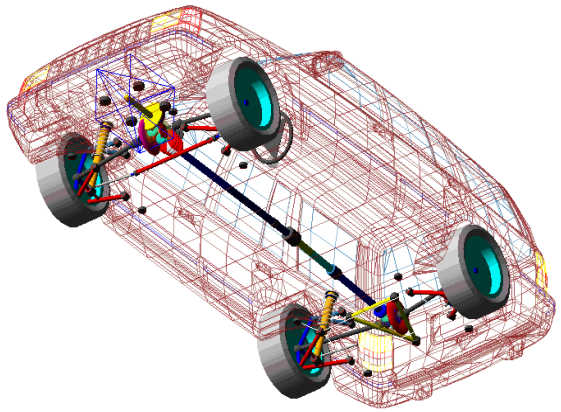
1. Linear Analysis
2. Bench Tests

Four Post Rig



1. Sinusoidal Inputs
2. Experimental Inputs

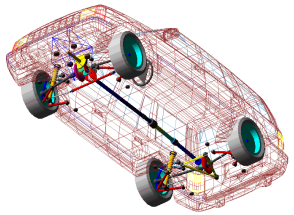
Full Vehicle Events



1. Split μ (Left → Right)
2. Split μ (Front → Rear)
3. Uphill Start
4. 3D Road
5. Snap Start

Mechanical Dynamics

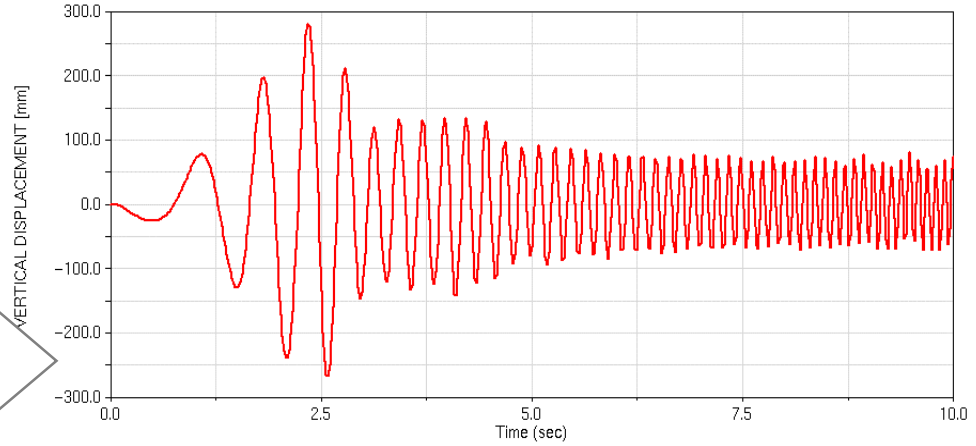
Four Post Testrig Simulation



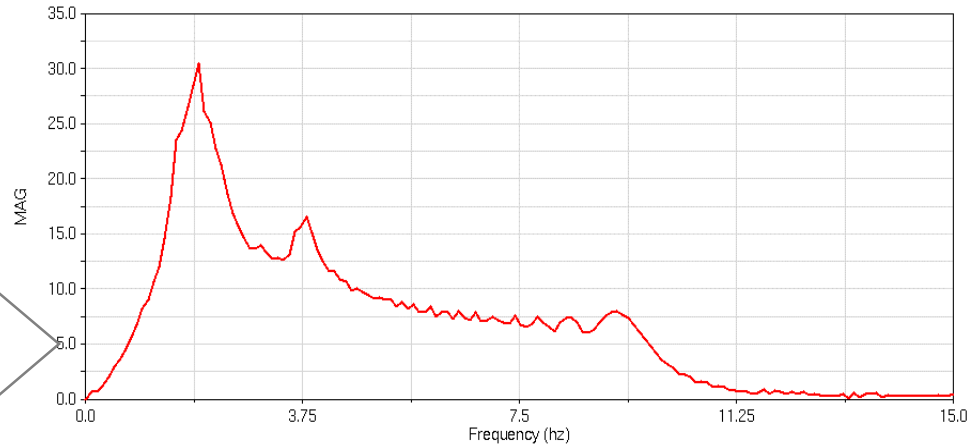
Analysis Conditions

1. **Peak Displacement :**
   10 mm
2. **Frequency Range:**
   0 - 10 Hz

Diff Case Vert Displ

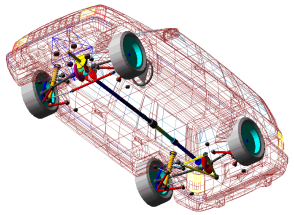


FFT



Mechanical Dynamics

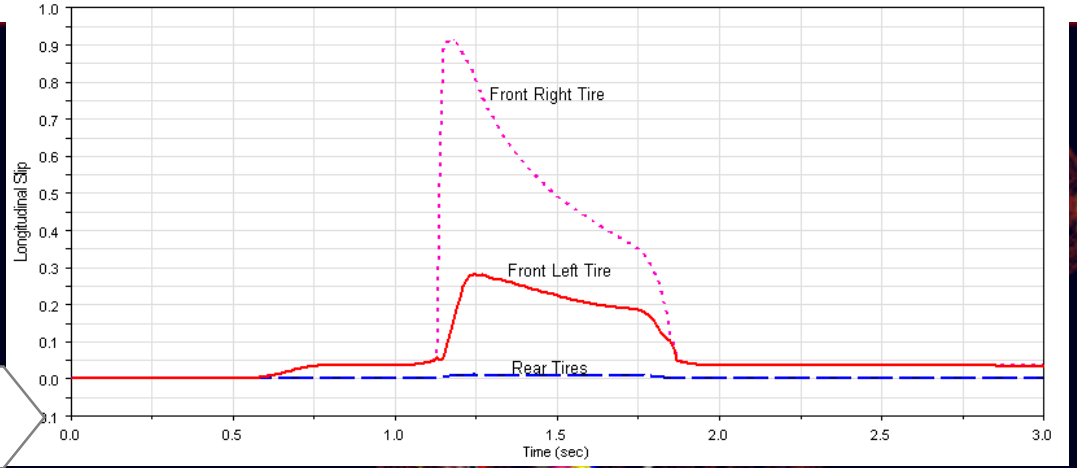
Split μ (Front → Rear)



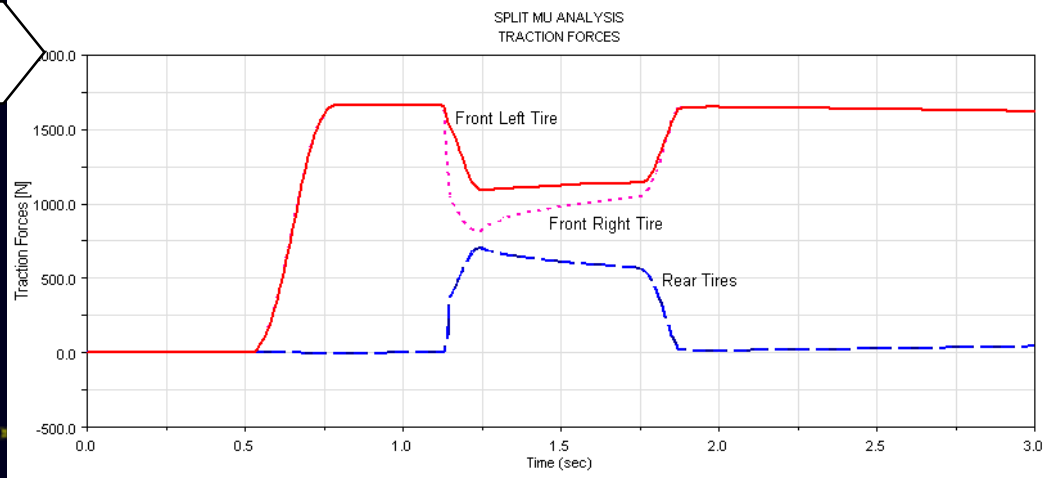
Analysis Conditions

1. **Input Torque: 1000 Nm**
2. **Front Tires Friction:**
   1 → 0.5 → 1
3. **Rear Tires Friction: 1**

Slip

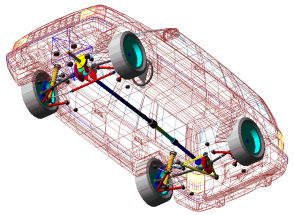


Traction



Mechanical Dynamics

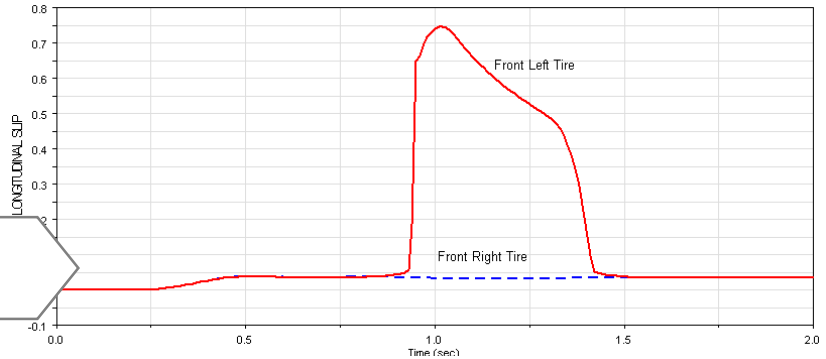
Split μ (Left → Right)



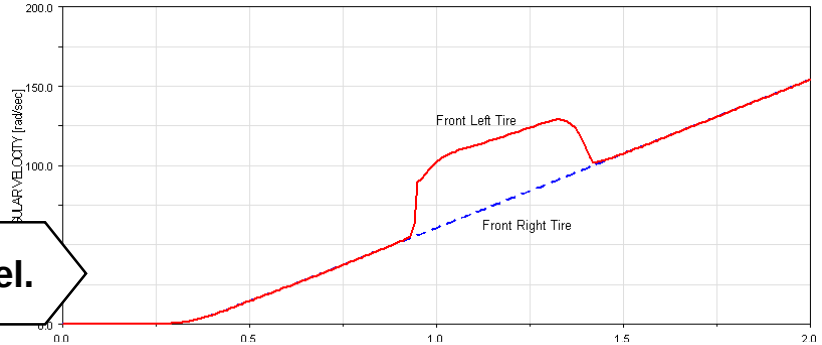
Analysis Conditions

1. **Input Torque: 1000 Nm**
2. **Left Tires Friction:**
   1 → 0.5 → 1
3. **Right Tires Friction: 1**

Slip



Angular Vel.



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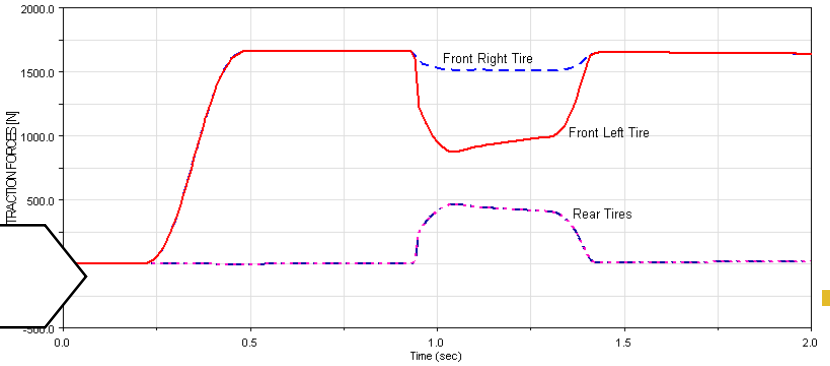
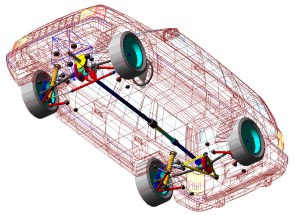


Mechanical Dynamics

Conclusions



- Take advantage of all ADAMS/Car capabilities
- Easy to include driveline components into ADAMS/Car Full-Vehicle models
- Possibility to test driveline components both on bench tests at component level and on full-vehicle events

Mechanical Dynamics