ADAMS/Car Modelle mit Hilfe von VI-CarRealTime
nutzbar machen für Fahrsimulatoren sowie
HIL- und SIL-Anwendungen

Christoph Ortmann
VI-grade GmbH

ADAMS User Meeting
Mai 2011, München
We have 20+ years experience in software

All members of our development team have great experience in multibody system-level simulation and software development
We have experience in different fields
All members of our development team have great experience in several different disciplines that make the VI-grade offering complete
State-of-the-art solutions

Our solutions are designed for complex investigations of the modern transportation industry

Compatible to ADAMS/Car

Accessory Tools
Agenda

- Trends in Multi Body Simulation
- Requirements on Tool Chain
  - Sharing of Model Data
  - Sharing Event Definition
  - Tool Overview
- Leverage ADAMS/Car Models in other domains
  - SIL, HIL, Simulator
- Summary
Trends in Multibody Simulations
ADAMS and real-time Solvers

- Analyse effects of design parameters on dynamic performance
- Maintain two models for simulation:
  - **Complex** for design purposes and detailed investigation
  - **Simple** conceptual design, DOE, optimization, SIL, HIL, DIL

**Complex: ADAMS**
- Most used MBS SW worldwide for more than 20 years
- Very detailed system design, high frequency dynamics, FE integration, durability...
- Generic solver for any model

**Simple: RealTime solvers**
- Exportable to on-line simulation for SIL, HIL and DIL simulations
- Easy to be used by non-mechanical engineers
- Specific solver for each model
Agenda

- Trends in Multi Body Simulation
- Requirements on Tool Chain
  - Sharing of Model Data
  - Sharing Event Definition
  - Tool Overview
- Leverage ADAMS/Car Models in other domains
  - SIL, HIL, Simulator
- Summary
Simulation Technologies
Vehicle Dynamics

10 years ago....
VI-grade
Automotive Solutions

“One model from concept to sign-off”

Vehicle Dynamics, Ride

Software-in-the-loop

DOE & Optimization

Hardware-in-the-loop

Benchmarking

Driving Simulator

ADAMS/Car

VI-CarRealTime
ADAMS/Car and VI-CarRealTime

- Rigid or flexible body
- Any type of suspension
  - kinematic
  - elastic
  - dependent or independent
- Any type of Tires
- Any type of Driveline
- Any type of Steering system
- Any type of control system
- Any type of user customization

Complex

- 6 DOF rigid vehicle body (flex body compliance)
- Dependent or independent suspensions
  - suspension curves
  - system identification
- Each Wheel
  - 2 DOF (Z, \( \Omega_z \))
  - Each Tire: 2 auxiliary states
- Driveline and Differentials
- Simplified Steering System
- I/O Channels
  - over100/over600
  - customizable

Simple

ADAMS plugin
Share Data and Events

- **Chassis**
  - **Same** Geometry, Mass and Inertia
    - Suspension
    - Characteristic curves from Subsystems
    - System Identification
  - Powertrain
  - Differential
  - Steering
  - Brakes

- **Tires**
  - **Same** Pacejika Tires

- **Road**
  - **Same** 3D smooth road
    - High freq uneveness

- **Database**
  - **Same** structure
  - **Same** subsystem org
  - **Same** property file format

- **Simulation Control**
  - **Same** Event Builder
    - **Same** Driver Control
    - Speed Profile Generator

- **Post-Processing**
  - **Same** postprocessor
    - results directly comparable with full ADAMS/CAR™ model
VI-CarRealTime
Validation vs. Adams/Car
VI-CarRealTime
Validation vs. Experimental Results
Agenda

- Trends in Multi Body Simulation
- Requirements on Tool Chain
  - Sharing of Model Data
  - Sharing Event Definition
  - Tool Overview
- Leverage ADAMS/Car Models in other domains
  - SIL, HIL, Simulator
- Summary
VI-DriveSimDynamic
Driving simulator architecture
Motion Platform Design

- Performance and Layout
  - Better performances compared to an hexapod with same active workspace
  - Simulation of commercial vehicles and racing cars

<table>
<thead>
<tr>
<th></th>
<th>VI-DriveSim</th>
<th>Equivalent Hexapod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base area</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Volume</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Performance(stroke)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Performance(rate)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Weight</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>VI-DriveSim</th>
<th>Equivalent Hexapod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Acceleration Surge **</td>
<td>[m/sec²]</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Maximum Acceleration Sway **</td>
<td>[m/sec²]</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Maximum Acceleration Heave **</td>
<td>[m/sec²]</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed Surge **</td>
<td>[m/sec]</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed Sway **</td>
<td>[m/sec]</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed Heave **</td>
<td>[m/sec]</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Maximum Acceleration Roll **</td>
<td>[°/sec]</td>
<td>1458</td>
<td></td>
</tr>
<tr>
<td>Maximum Acceleration Pitch **</td>
<td>[°/sec]</td>
<td>1563</td>
<td></td>
</tr>
<tr>
<td>Maximum Acceleration Yaw **</td>
<td>[°/sec]</td>
<td>521</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed Roll</td>
<td>[°/sec]</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed Pitch</td>
<td>[°/sec]</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed Yaw</td>
<td>[°/sec]</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Maximum Displacement Surge</td>
<td>[m]</td>
<td>+/- 0.5</td>
<td></td>
</tr>
<tr>
<td>Maximum Displacement Sway</td>
<td>[m]</td>
<td>+/- 0.5</td>
<td></td>
</tr>
<tr>
<td>Maximum Displacement Heave</td>
<td>[m]</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Maximum Displacement Roll [°]</td>
<td>[°]</td>
<td>+/- 20</td>
<td></td>
</tr>
<tr>
<td>Maximum Displacement Pitch [°]</td>
<td>[°]</td>
<td>+/- 12</td>
<td></td>
</tr>
<tr>
<td>Maximum Displacement Yaw [°]</td>
<td>[°]</td>
<td>+/- 20</td>
<td></td>
</tr>
</tbody>
</table>
VI-DriveSim

Advantages

- Off-line and on-line simulation are totally integrated
- Physical vehicle components could be included in the simulation (HiL)

Digital Vehicle Development

Off-line Sim

On-line Sim

Physical Vehicle Development

Confirmed vehicle behavior

Validated vehicle data

<< many less >>

much better
VI-SimCenter

Features

- Two fixed platform simulators, **VI-DriveSim Static**:
  - Passenger car cockpit
  - Race car cockpit

- One moving platform simulator **VI-DriveSim Dynamic**:
  - It can be equipped with both passenger car or race car cockpit
VI-SimCenter

Features

- All VI-DriveSim installations are equipped with high resolution graphic environment for realistic vehicle and track rendering
- Several tracks available:
  - Barcelona
  - Silverstone
  - Hungaroring
  - Motorland Aragon
  - Sepang
  - Monza
  - Nordschleife
  - MonteCarlo
  - Custom proving grounds
VI-SimCenter
Features

- All VI-DriveSim installations are available with sophisticated and realistic cockpits:
  - Realistic steering wheel torque feedback
  - Possibility to start and stop driving session in any point of the circuit
  - Immersive view from cockpit
  - Sound feedback
  - Direct communication with track engineers in the control room while driving
VI-SimCenter

Features

- From VI-SimCenter control room is possible to:
  - Monitor data from telemetry
  - Modify vehicle model on-the-fly
  - Visualize car from different views
  - Communicate with driver to get his feedback
  - Have two drivers driving two simulators simultaneously on the same track (with vehicle collisions) and display the cars on the same scene
  - Review driving sessions in the graphical environment
VI-SimCenter

- VI-SimCenter is available for test drive on your specific vehicle
- VI-SimCenter moves the simulation to the next level at affordable prices
- VI-SimCenter benefits from VI-grade expertise in vehicle dynamics, software development and vehicle simulation

- **Come and visit us!**
Summary

- ADAMS/Car is the gold standard in automotive industry
- Simple models like VI-CRT for SIL and HIL development
- Use integrated modeling environment to re-use data, events,…
- Leverage the model to get a feeling for the car in a driving simulator