SIMPACK as a MBS-Tool in the BOSCH-CS Simulation Concept

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Simulation in the development process of Vehicle Stabilising Systems: The BOSCH-CS Simulation Concept

MBS-vehicle model

Realisation and process

Next steps
The BOSCH-CS Simulation Concept
A Mechatronic System requires various Tools

**Sensors:** Yawrate, AY
Wheel speed, Steering angle, Precharge pressure
**Tools:**
EDYSON, ...

**ECUs:**
ESP, ABSR, DME
**Tools:**
SABER, ...

**Mechanics:**
Chassis with suspension, steering system, drivetrain, tyres
**Tools:**
FASIM, SIMPACK, PKW0

**Application Software:**
Control and Safety Algorithm
**Tools:** MS-Developer Studio, C-Compiler, Simulink, ASCET-SD

**Foundation and Actuation:**
MC, Booster, Wheel Brake Cylinder
**Tools:** CoBrake

**Brakehydraulics:**
HU, Brakeline
**Tools:** AMESIM, EDYSON, ...

**Miscellaneous:**
Driver, Environment
The BOSCH-CS Simulation Concept
Local Simulation Activities imbedded into the Concept

System Design

Realtime Models
Functional Models
Structural Models

Vehicle Dynamics Simulation with Control

Hydraulics

Realtime Models
Functional Models
Structural Models

Electronics

Realtime Models
Functional Models
Structural Models

Foundation

Actuation

Structural Models
The BOSCH-CS Simulation Concept
Agreed Simulations Concept at BOSCH-CS

Integration Platform MATLAB/SIMULINK

MATLAB/SIMULINK Models
S-Functions

Co-Simulation: Interface Concept and -Definition

SIMPACK complex/reduced

AMESIM complex/reduced

SABER complex/reduced

Controller

Data

Aspects:

• **One integration platform** to set-up the complete system by agreed interfaces

• **Agreed interfaces** enable direct implementation of the models or coupling by communication modules (CoSimulation)

• **Tool decision** platform is MATLAB/SIMULink
Simulation in the Development Process of Vehicle Stabilising Systems

- Systems Development
- Design of Control Algorithm
- Systems Application
- Component Development
- Fundamental Research
- Knowledge Management
- Co-operation with Customers
MBS-Vehicle Model
Application Area of Vehicle Models

- Functional MBS-Model
- Structural MBS-Model
- Structural MBS-Model with FEM

- Handling
- Comfort
- Oscillations of Bodies
- Structural Oscillations

Amplitude vs. Frequency

SIMPACK:

One Tool

One Basic Dataset

One Modeltyp

Model Development

Model Application

SIMPACK

Stand alone

Vehicle Modelling

Fundamental Investigations w.r.t. MBS

SIMPACK

in CoSimulation (SIMAT)

- ABS-Development
- MBS-Investigations
- New Actuator Concepts
- Wirkketten-Engineering

Code Export - CS_CAR

Plugin to SIMULink

- SW-Development and Quality Assurance
- System Development
- System-Application

- Small number of projects,
  - SIMPACK know how
- Big number of projects,
  - no SIMPACK know how

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Specification of CS-CAR

- Vehicle with rigid bodies and 15 DOFs
- Suspension kinematics described by kinematics maps
- Interfaces for tyre models of different complexity
- Environment described by files and evaluated by SIMPACK-function
- Interfaces for other vehicle components
- Interfaces to BOSCH components (sensors, actuators, controller, brake, ...)
- Implemented in SIMULink as a plug in using the SIMULink solver
- Modelling based on SIMPACK with Code Export
- Parameterisation capability
- Vehicle data base according to BOSCH-CS requests
Realisation and Process Structure of CS_CAR

Model Library
- owned by BOSCH
- by INTEC

Model with SIMPACK Algorithm
- SIMULINK
- IF Routines
- SIMPACK Library

Data Library
- owned by BOSCH

Vehicle Parameters
- Environmental Parameter
- Initial Conditions
Realisation and Process
Process of Model Set-up

Specification

Modelling in SIMPACK

Code Export

S-Function Generation

Parameterisation

Verification, Validation

Archiving

Customer Data

Customer Structural Model

BOSCH Model Library

Only for structural Models

Using CS-CAR for several projects requires automised conversion of data sets to target tool

- Development of tool specific converters
- Adaptation to different data formats and number of input and output files
- Conversion of characteristic maps and curves for suspension kinematics
- Adaptation to transformation matrix parameters and direction of rotation
- Determination of conversion function concerning spring, damper and anti-roll bar
- Transformation of spring and damper data fields into global coord. system
- Conversion of tyre maps
- Estimation formalisms for none available parameters
Aspects:

- Feasibility Study
  - Fundamental questions
- MATLAB/SIMULink
  - used as platform
- Models of all components
  - all CS-Business Units engaged
- ESP Controller implemented to MATLAB/SIMULink
  - using ECU-Code
- CS_CAR_1
  - specified by BOSCH
  - developed by INTEC
Next Steps

Function and Projects

- Application in different pilot projects
- Build up of a model library for several projects
- Using elastokinematics
- Using structural axis

SW-Architecture, Environment

- Set up archiving and data base
- Documentation
- GUI
Thank you for your Attention

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