CAE driven Vehicle Structure Layout Process

For Vehicle Design – To Improve the Early Vehicle Attribute Assessments

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Parametric Model Knowledgebase

Agenda

• Current Concerns in Concept Model Work
• Definition of Concept Modelling
• Major Components of the Parametric Geometry and the Modular CAE Knowledgebase
  - Morphing Technologies
  - Concept Body Structure Library
  - The Modular CAE Model
• Method Development for Future Improvements of the Knowledge Database
• Conclusions
• Q & A
Current Concerns in Concept Model Work

• Typically, a large number of vehicle alternatives need to be investigated in the early vehicle design phase
• The most critical vehicle concept decisions have to be fixed
• 3D CAD data – required for CAE attribute assessments – have to be created based on this limited input
• Conventional CAD/CAE takes a long time and does not allow to run optimizations up front
Definition of Concept Modelling

The major blocks of Concept Models and Input Streams to Create the Models
Definition of Concept Modelling

Analytical Models:
Mathematical models, i.e. in Matlab

Finite Element or MBS Models:
Classic CAE models: Nastran, Adams ...

Overview of Simplified CAE Simulation Models - Safety
The Morphing Technologies – First Part of the Knowledgebase

- Local morphing via domains and handles

Parametric Morphing Models – Example: Altering the distance dimension of a silencer box
The Morphing Technologies – First Part of the Knowledgebase

- Local morphing via domains and handles

Parametric Morphing Models – Example: Morphing the exhaust manifold via translate
The Morphing Technologies – First Part of the Knowledgebase

- Morph volumes

Parametric Morphing Models – Example: Undeformed and deformed rear suspension (left view)
Parametric Model Knowledgebase

The Morphing Technologies – First Part of the Knowledgebase

- Map to Geometry

Parametric Morphing Models – Example: Mapping with line difference for getting a lower roof
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The Concept Body Structure Library – Second Part of the Knowledgebase

Parametric Geometry Model – Example Shrinking of Rocker Section
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The Concept Body Structure Library – Second Part of the Knowledgebase

Modules of the Concept Body Structure Library, Sub Assembly and Assembly level
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The Concept Body Structure Library – Second Part of the Knowledgebase

Component Assembly – Front End, Floor, Rear End
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The Concept Body Structure Library – Second Part of the Knowledgebase

Platform Components & Top Hat Structure

Mapping Areas (lines)

Platform Components Rear Structure

Component Assembly – Platform and Top Hat Structure
The Modular CAE Component Models – Third Part of the Knowledgebase

• General Method for CAE (Safety, NVH, ...)

• Model Separation to Components and Structure Parts

• No Specific Technique for Model Simplification

• Method Suitable to Support Car Line Development Work in all Development Phases

• Solver or Pre Processor with Pre Compile capability necessary (i.e. Radioss or Nastran with include file technique or interactive Pre Processor, Hyperworks)
The Modular CAE Component Models – Third Part of the Knowledgebase

(Model Build after Selecting the required Model Content)

SAV_BIW
LMV_BIW
Dashboard_RHD/LHD
Energy
Body In Prime
FE_Solver Radioss
LoadCases
Barriers
Dummies
PreProcess
PostProcess
Safety
Front Doors
Rear Doors
DoorTrims
Loudspeaker
Window Regulator
Hood
Liftgate
Hinges
Body Closures
Body Exterior
Front BumperBeam
Rear BumperBeam
Front BumperFacia
Rear BumperFacia
GOR
Headlamps / FogLamp
Batterie Brackets
Cockpit Structure
HVAC
Interiour Trim
IP-Assembly
Front Seats
Rear Seats
Body Interiour
Front Subframe
Rear Subframe
Front Strut & Knuckle
Steering Column
Steering Gear
PedalBox & Booster
Tire & Wheels
ABS Modul
Fuel System
Chassis
Lynx / MTX75
DW10 / MMT6
DW10 / AWF21
DW12 / MMT6
I4 / MTX75
I4 / CFT23
I5 /
Powertrain
Powertrain Mounts
Cooling Pack
Exhaust System
Batterie
Electric Boxes
Electrical
Overview of Safety CAE Data Base
Parametric Model Knowledgebase

The Modular CAE Component Models – Third Part of the Knowledgebase

GOR and Cooling Pack
Instrument Panel & HVAC
Steering System
Chassis Sub frame
Tires / Wheels

Examples of Safety Relevant CAE Components

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## Parametric Model Knowledgebase

### The Modular CAE Component Models – Third Part of the Knowledgebase

<table>
<thead>
<tr>
<th>Test Mode</th>
<th>Diagram</th>
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<tbody>
<tr>
<td>Full Front</td>
<td><img src="full_front.png" alt="Diagram" /></td>
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<tr>
<td>Front Offset</td>
<td><img src="front_offset.png" alt="Diagram" /></td>
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<tr>
<td>Side</td>
<td><img src="side.png" alt="Diagram" /></td>
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<tr>
<td>Side per ECE R5</td>
<td><img src="side_ece.png" alt="Diagram" /></td>
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<tr>
<td>Side per FMVSS 214</td>
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<tr>
<td>Barrier to Car 70% overlap</td>
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<tr>
<td>Barrier to Car Side</td>
<td><img src="barrier_side.png" alt="Diagram" /></td>
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<tr>
<td>Barrier to Car Inline</td>
<td><img src="barrier_inline.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Barrier to Car 00% Offset</td>
<td><img src="barrier_00.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

**Module Example:** **Loadcases**

*EuroNCAP frontal offset impact, def. barrier*

**Examples of Safety Relevant CAE Components**
Method Development for Future Improvements of the Knowledge Database

SFE CONCEPT binary libraries:

- stored in common area on CAE file server
- Data handling direct program function
- example: C1 MCA platform components and assembled platform

Body Structure Sub Assembly and Platform Components stored in the SFE CONCEPT system Library

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Method Development for Future Improvements of the Knowledge Database

Vehicle Layout Parameters to drive the Body Structure and to Help Creating Upfront CAE Models

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Conclusions

• The upfront CAE process is very well supported by the parametric knowledge base

• The major components are implemented
  ➢ The morphing technologies
  ➢ The parametric Body Structure Library
  ➢ The Modular CAE Component Models

• The library technique has been applied at various vehicle programs

• It has been demonstrated that the new process in combination with the modular CAE components enables engineers to drive the design upfront

• Further method development projects – implementation of the parametric knowledge base in the data management system will improve the daily development work

• Further common research and development projects are established in the German Automotive Research Association (FAT)
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Questions & Answers
Backup Material - Links

• Concept Body Structure Library – Details

• Modular Safety (CAE) Models

• Future Research Project (FAT)