14. CADFEM FORUM

Konstruktion und Simulation – Teamarbeit oder Einzeldisziplinen?

CAE in der Produktentwicklung - Zusammenspiel von Design, Berechnung, Versuch und Projektmanagement

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Konstruktion und Simulation – Teamarbeit oder Einzeldisziplinen?
Global Project Teams

Application projects requires participation of all engineering disciplines:

- Project management
- Requirement management
- Design
- Simulation
- Prototyping
- Bench testing
- Vehicle testing

Steering Committee

CAE

Design / Prototyping / Testing / ....

Project Management
Global Project Teams

Application projects require participation of all engineering disciplines:

- Project management
- Requirement management
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- Simulation
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- Bench testing
- Vehicle testing
Brake Engineering / Engineering Footprint

- World Headquarters
  - Livonia, Michigan

- Technical Centers
  - Koblenz, Germany
  - Shanghai, China
  - Jablonec, CZ
  - Limeira, Brazil
  - Shirley, U.K.

- Regional Offices
  - Shanghai, China
  - Seoul, South Korea
  - Kuala Lumpur, Malaysia
  - Tokyo, Japan

- ASEAN Headquarters
  - Kuala Lumpur, Malaysia
Simulation Responsibility Assignment

**Design:**
- Simple FEA
  - Linear structural and modal analyses
- Standardized and validated simulations
- “short runners”

**CAE:**
- Complex FEA
  - Non-linear analyses
  - CFD and multiphysics studies
  - Optimization
  - Multibody dynamics
- Preparation of simulation standards
- Support for Design FEA and sign-off
Job Description Design Engineer

**Design work:**
- CAD design
- Tolerance calculation
- Design space investigation / feasibility studies
- Drawing definition
- ...

**Supplier communication:**
- Feasibility discussions
- Design discussions

**Customer communication:**
- Design presentations
- Requirement discussions

**Operation:**
- Manufacturing feasibility
- Costs

**Simulation:**
- CAD model preparation for simulation teams
- CAE “Wizard” studies

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Design Engineer Tasks

- CAD Design; 30%
- Simulation; 5%
- Tolerance calculation; 5%
- Operations discussion; 5%
- Design space investigation / feasibility studies; 5%
- Drawing definition; 10%
- Supplier communication; 10%
- Internal communication; 10%
- Customer communication; 20%
Job Description CAE Engineer

**Design work:**
- Manipulation of existing geometry data for simulation purpose

**Supplier communication:**
- CAE results discussions
- Requirement definition
- Design discussions

**Customer communication:**
- CAE presentations
- Requirement discussions

**Simulation:**
- CAE analyses, result interpretation
- Model generation
- Model validation
- Standardization
  - For design departments
  - For global CAE teams
- Methodology development
- Coordination of global onshore and offshore teams

**Design support**
- Model and result check / CAE sign-off
- “Hotline” support
- Training

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Jack of all trades Device (Eierlegende Wollmilchsau)

All Design Tasks + All CAE Tasks =
Benefits of sharing CAE work with Design

- **Advantage for the product and design**
  - Improved development process (efficiency) and product quality
  - Increased throughput due to faster analysis response and design cycle time
  - Products are more optimized (→ increased “simulation depth”)
  - Higher robustness and product quality
  - Better product understanding and improved engineering skills
  - Global standards

- **Advantage for the CAE specialist teams:**
  - “simple” analyses are not longer at the desk of the experts, therefore resources are freed up to work on complex simulation topics
  - CAE teams are able to develop and implement further standard analyses procedures for the design teams
Changed Roles and Responsibilities (for Simulation)

■ Before
  – Design Department
    – Model preparation for CAE
    – Requesting CAE simulation
  – CAE / Simulation Department
    – Performing simulation (simple components and complex studies)

■ After
  – Design Department
    – Model preparation for CAE
    – Requesting complex CAE simulation
    – Performing standard component FEA
  – CAE / Simulation Department
    – Preparing simulation standards for design
    – Specification, tools, training, validation
    – Internal CAE “hotline”
    – Performing simulation (components and complex studies)
    – CAE sign-off
Enablers

- Validated standard procedures / specifications / processes
- Sufficient software tools have to be chosen, ideally the simulation approaches are as much automated (scripts, templates, programs) as possible
- “easy-to-use” is required, no additional effort, short calculation times
- Design engineers need to be trained in
  - Tool usage
  - Methodology
  - FEA standards
Simulation Integration in the Development Process

Opportunity Development

Kick Off

Concept Design & Verification (CV)

A-Sample Phase

DataSheet

A0-Sample Phase

CAE

Detailed Design & Verification (DV)

B-Sample Phase

Designer FEA Tools

Product & Process Validation (PV)

C-Sample Phase

EBP HiL and System Model

Product Launch

D-Sample Phase

Production

Product Launch

Production

Case Study: Electric Parking Brake Application

CAE

NVH Lab

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Development Process

Opportunity Development

Kick Off

A-Sample Phase

A0-Sample Phase

Concept Design & Verification (CV)

Detailed Design & Verification (DV)

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Case Study: Electric Parking Brake Application

DataSheet

CAE

NVH Lab

Product Launch

Production

Designer FEA Tools

EBP HiL and System Model

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Designer FEA Tools

- FEA tool programmed to support component development with controlled standard FEA in the design department
- Analyses process is represented menu-driven in the simulation tool
- Enables 100% simulation support, quick response in the development process

→ “FEA Pocket Calculator”

History:
- 1999: Simple CATIA V4 FEA
- 2006: Wizard development
- 2008: Global rollout
CAE Tasks to the Design → ZF TRW History

Component analyses → CAE Department

Automation in professional simulation tools, customized for use in design teams

Effort reduction due to improved simulation tools and computer speed
CAE Tasks to the Design → ZF TRW History

FEA performed in CAE team (specialists)

→ Bottleneck: lead time to perform all necessary analyses in time!

→ Data administration more time consuming than analyses itself

Off-shoring / outsourcing of standard CAE

Automation!
Benefit of doing FEA in the Design

**Design / Test:**
- Standard Simulation Request
- (Data collection / creation, CAD, loads, etc…)

2 days

**CAE:**
- Data collection and control of necessary data
- Sending project data to off-shoring resource

2 days to 4 days for standard analyses

**Off-Shoring**
- Standard analysis and documentation

1h to 2h max. for 1 analysis

**Design / Test:**
- Finite Element Analyses Request (Standard)
- Data creation (CAD)
- Finite Element Analysis with process oriented guiding inside the simulation software
- Automated report creation

CAE:
- Providing validated standard procedures
- Providing / compiling standard wizards and template
- User support (“Hotline”)
- Training

Design OK

“New” Process: → started in 2006!

“Old” Process: → Needed Improvement!

Design NOK

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Example: Brake NVH Development

Initial NVH test

Internal and customer requirement

NVH (rig) testing

Correlation to Simulation

CAE

Mode A

Mode B

Root Cause Analyses:

NVH Package II
Disc & caliper (+180g)
⇒ less weight & cost

NVH Package I
Caliper only (+470g & shim)
⇒ high weight & cost

CAE + NVH + Design

CAE + NVH
Thank you for your attention

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driving motion, mobility and safety