Development of a new Braking System

Safety-relevant component:
Only 1 prototype was required!

TOSCA Structure
Customer Success Stories
TRW Automotive (Lucas Varity GmbH)
Company Profile: TRW Automotive

- Global player in automotive supplier industry
- 163 production facilities in the automotive centers in Europe, North and South America, South Africa and Asia
- Sales in 2002: more than US$10 billion.
- Leading market position
- Specialist in
  - active and passive automotive safety systems, vehicle braking systems (e.g. in Germany TRW Automotive, Lucas Varity GmbH in Koblenz),
  - steering and suspension systems (e.g. in Germany TRW Automotive, FWS GmbH&Co KG in Düsseldorf)
  - etc.
Customer Problem Definition

Development of a new front axle-wheel brake concept regarding:

- Smaller built-in space
- Higher performance
- A “noise-free“ brake (NVH)
- Cost and weight reduction
- Shorter development times
- Consideration of development of axle parts (supplier’s responsibility for the whole module)
Customer Target and Implementation

- Development of a systematic method for the usage of structural optimization in conjunction with different CAE tools already in use
- Implementation of the method in the company
- Verification of the method at the example of a brake and suspension module through consistent application
- Focus of the optimization: costs, lightweight construction, noise, Vibration & Harshness (NVH) and shorter development times.
- Validation through stiffness, functional and yield strength tests

→ Maximum flexibility through open system design of TOSCA Structure

→ Work in the standard CAE-environment (differs throughout the company) due to interfaces of TOSCA Structure to several FEM solvers (ANSYS, Nastran, Abaqus, durability codes, tools for multi-body simulations (MSC.Adams))
Customer Value

- Development of a completely new front axle-wheel brake concept within two years
- First prototype fulfilled all demands → Immense savings in number of loops and in physical tests
- Important steps in innovation
- Development times drastically reduced
- Notable cost-savings were made
- Three months after development was completed: first order covering approx. 400,000 parts annually from a first-class German automobile manufacturer

→ Software and the new methods involved not only met all expectations to the full extent but actually far exceeded them
Customer’s Statement

“The innovative and technological relationship we have with FE-DESIGN has enabled us to integrate structural optimization as a reliable tool used as part of the CAE development process. It is something we could not imagine being without. Leaps in innovation, much shorter development times and cost-savings for physical tests have shown that the costs invested in a completely new front axle-wheel brake concept that was developed in a short space of time and resulted in a large order, is an investment that pays for itself.”

Joachim Noack
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CAE Methods and Structural Optimization in the Development Cycle of Braking Systems

Joachim Noack, TRW Automotive

07. November 2003

“Simulation in der Produktentwicklung”, Abschlusskonferenz ELAnO

Atlantic Hotel Universum, Bremen, Germany
TRW Modular System Disc Brake

16" wheel swept outline

opposed caliper

HP2

FB1

Slide courtesy TRW Automotive

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Development Cycle FB1 Brake with CAE Methods

Idea → Concept → 1st FEA → Optimization → Defined Design

Production?

- Standard Tests
- First Prototype Sample
- Noise Test and Stability Analysis
- STL Sample

Vehicle Installation

Slide courtesy TRW Automotive
FB1, Results of Topology Optimization

Density distribution

Material reduction 20%

Material reduction 40%

Material reduction 60%

Material reduction 80%

Red color \(\rho \approx 1\)

Blue color \(\rho \approx 0\)

Proposed areas for reducing material

Proposed bolt location

Slide courtesy TRW Automotive
FB1, Result of Topology Optimization (Aluminium Body)

material reduction 25 %
material reduction 50 %
material reduction 75 %

Slide courtesy TRW Automotive
Topology Optimization of a Composite Caliper with Casting Restrictions

- Contact elements
- Pretension elements
- 2 load cases
- 2 split lines for 2 parts
Topology Optimization Brake Carrier FB1
FEA Proof: FB1, Final FE Model

Slide courtesy TRW Automotive
FB1, Final FEA Results

Slide courtesy TRW Automotive

first principal stress

\[ \sigma_{\text{lin-elast.}} \text{ [MPa]} \]
Stereolithography Sample and 1st Prototype

STL Sample

First Prototype

Slide courtesy TRW Automotive
Standard Tests and Vehicle Installation
Summary

- The development of a new braking system FB1 inside the research project ELAnO was successful
  - Development time: 2 years (→ 1st prototype)
  - Only 1 prototype generation (instead 3-5)!
  - 1st vehicle application 7 month later
- Several offers to German and European vehicle manufacturers
  - 2 offers are close to a decision
- Short time developments are only possible with numerical optimization tools and simulation

Slide courtesy TRW Automotive