Multidisciplinary Design Optimization by modeFRONTIER

An overview on industrial applications

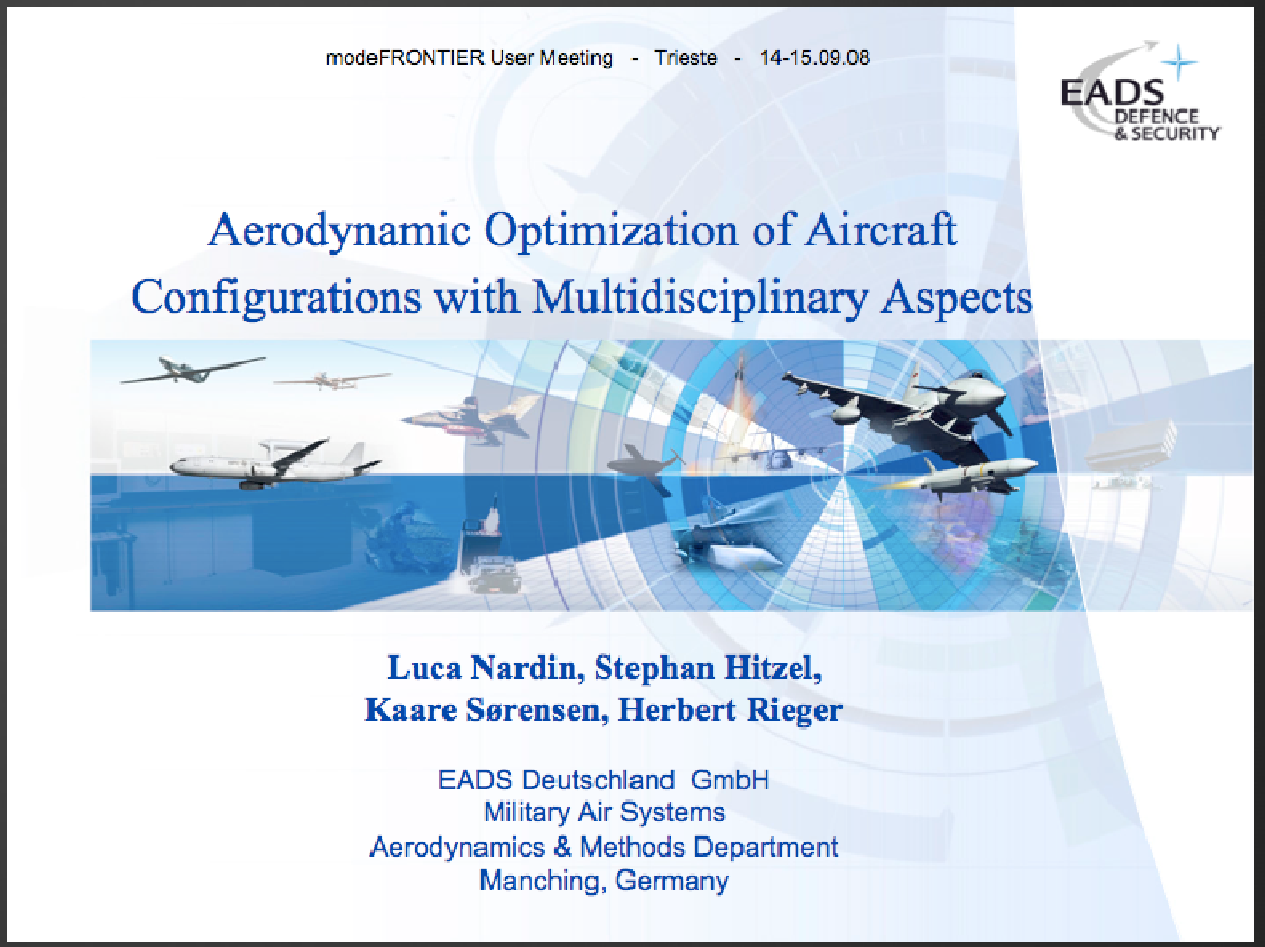
Luka Onesti

modeFRONTIER Users' Meeting 2008

- 45 contributions from modeFRONTIER users
- 3 Plenary sessions
- 3x3 Parallel sessions by application area (Automotive, Aerospace, Electromagnetic, Methodology)
- Closing session by ESTECO staff
- 200 participants

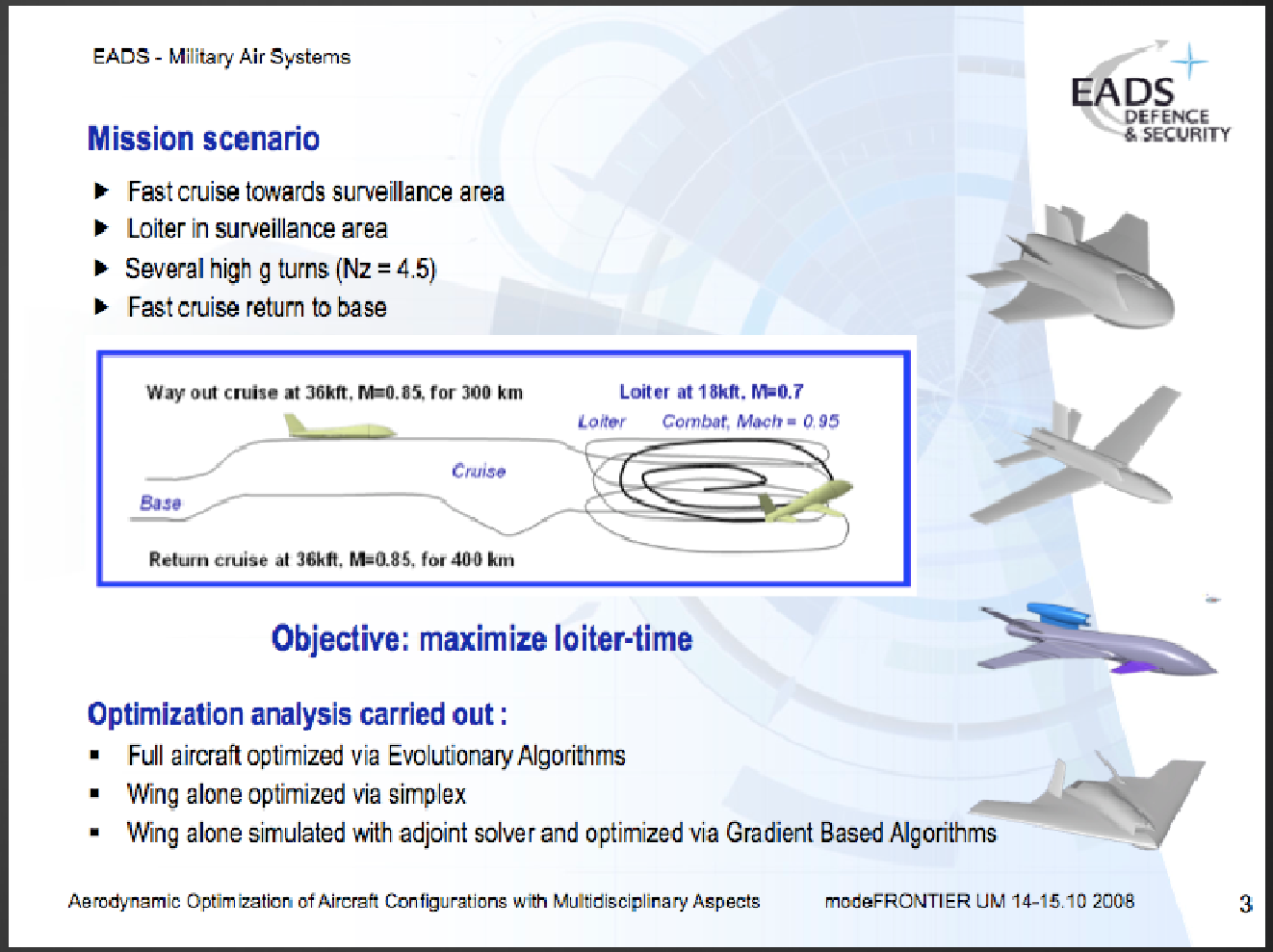
EADS Military Air Systems

- Mission Scenario
- The Parameterized Geometrical Model
- Simulation Model (Wing-Weight, Autopilot, Chimera-Mesh, Loiter-time)
- Optimization Process



Optimize for The Mission

- Gradient and Simplex methods for the wing
- Full aircraft via EA



Parameters for Wing, Fuselage, Tail, Engine

EADS - Military Air Systems

Design Parameters for the full aircraft configuration

EADS DEFENCE & SECURITY

Profilparameters

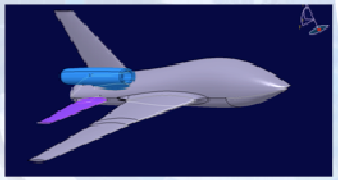
Profileshapes

front rear

camberline

front Yrear slope front Xrear

Thickness



Parameter

7 Para	15 Para	4 Para
Horizontal Tail	**Fuselage**	**Engine**
Aspect Ratio	Length	Position
Tail Span	Cross Sections	Length
Taper		Intake Profile
Position	**Fairing**	
Sweep	Length	
Incidence	Shape parameter (3)	
Profil		

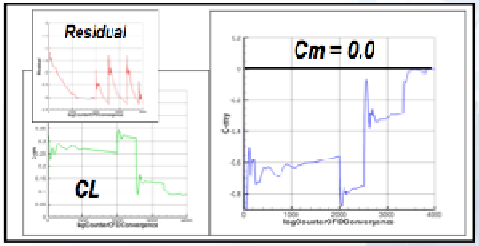
Σ 50 Para

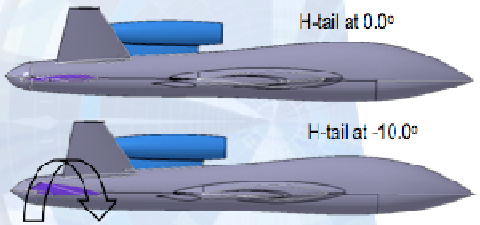
Aircraft Configurations with Multidisciplinary Aspects modeFRONTIER UM 14-15.10 2008 6

EADS - Military Air Systems

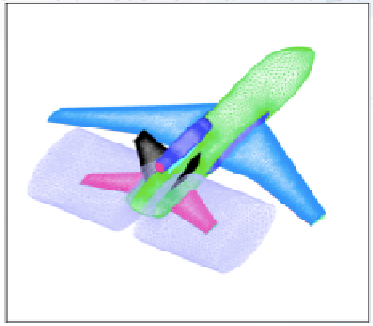
Trimm via Chimera Approach

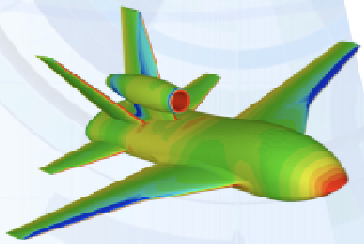
Trimm-History of a complete configuration





Chimera model for H-tail and aircraft

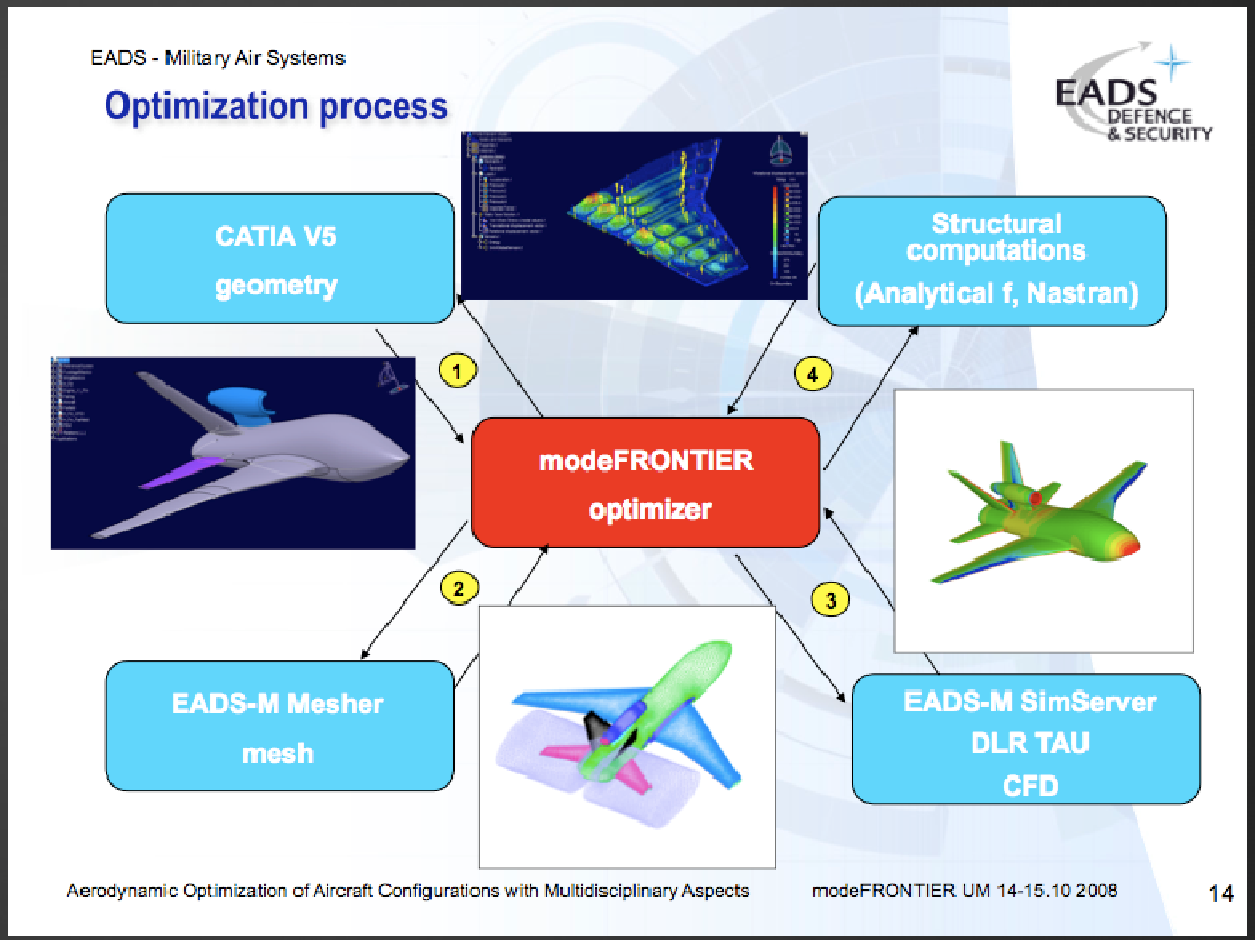




Aerodynamic Optimization of Aircraft Configurations with Multidisciplinary Aspects modeFRONTIER UM 14-15.10 2008 9

Simulation Chain & Interaction With The Optimizer

- Several codes are connected:
  - Cad, stucture, cfd
  - Pre-Post processing
  - Autopilot

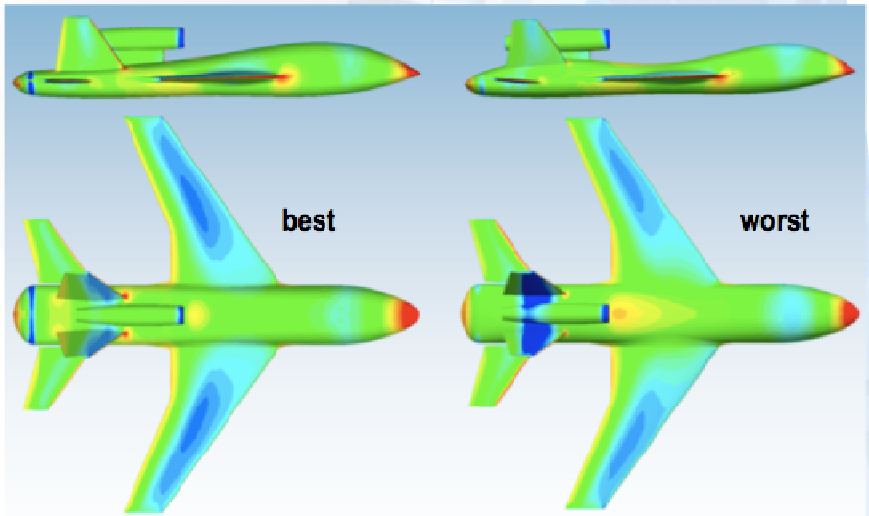


Results

EADS - Military Air Systems

Aircraft Optimization with Wing Configuration Fixed

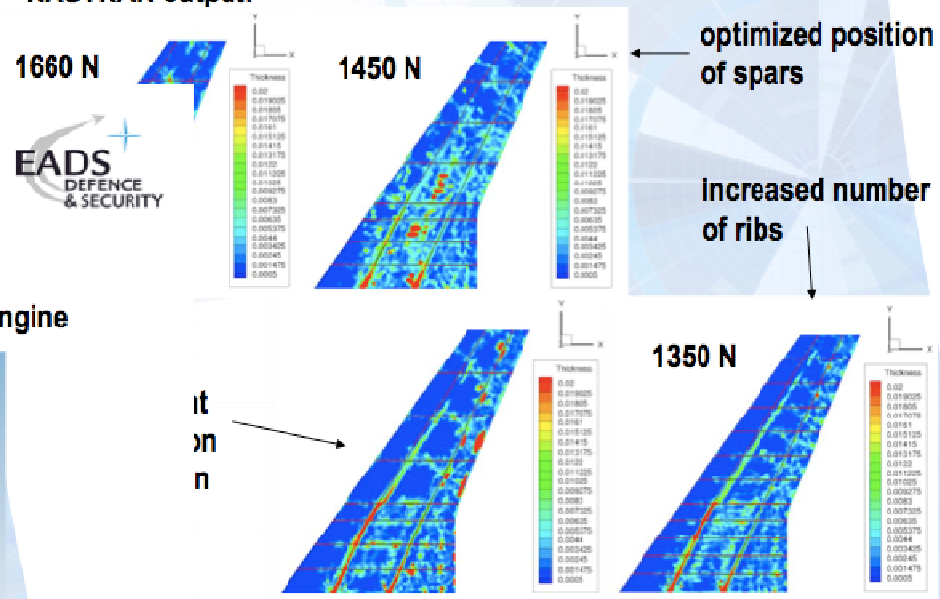
- Engine moves forward to alleviate shock and move forward the cg
- Streamlined fuselage reduces recompressione effects ahead of the engine



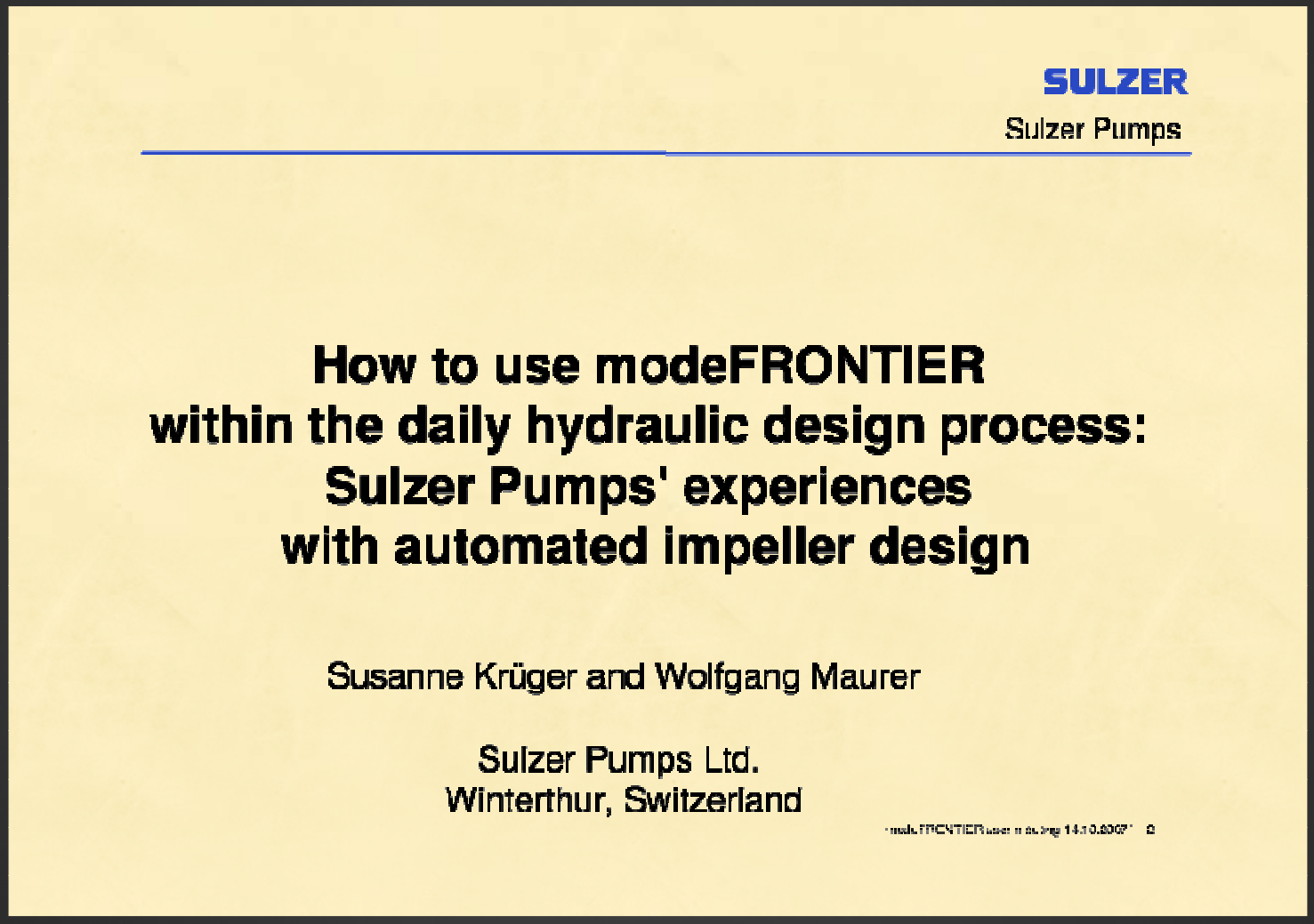
EADS - Military Air Systems

Structural Optimization of the wing alone

- NASTRAN output:



Hydraulic Pump Design

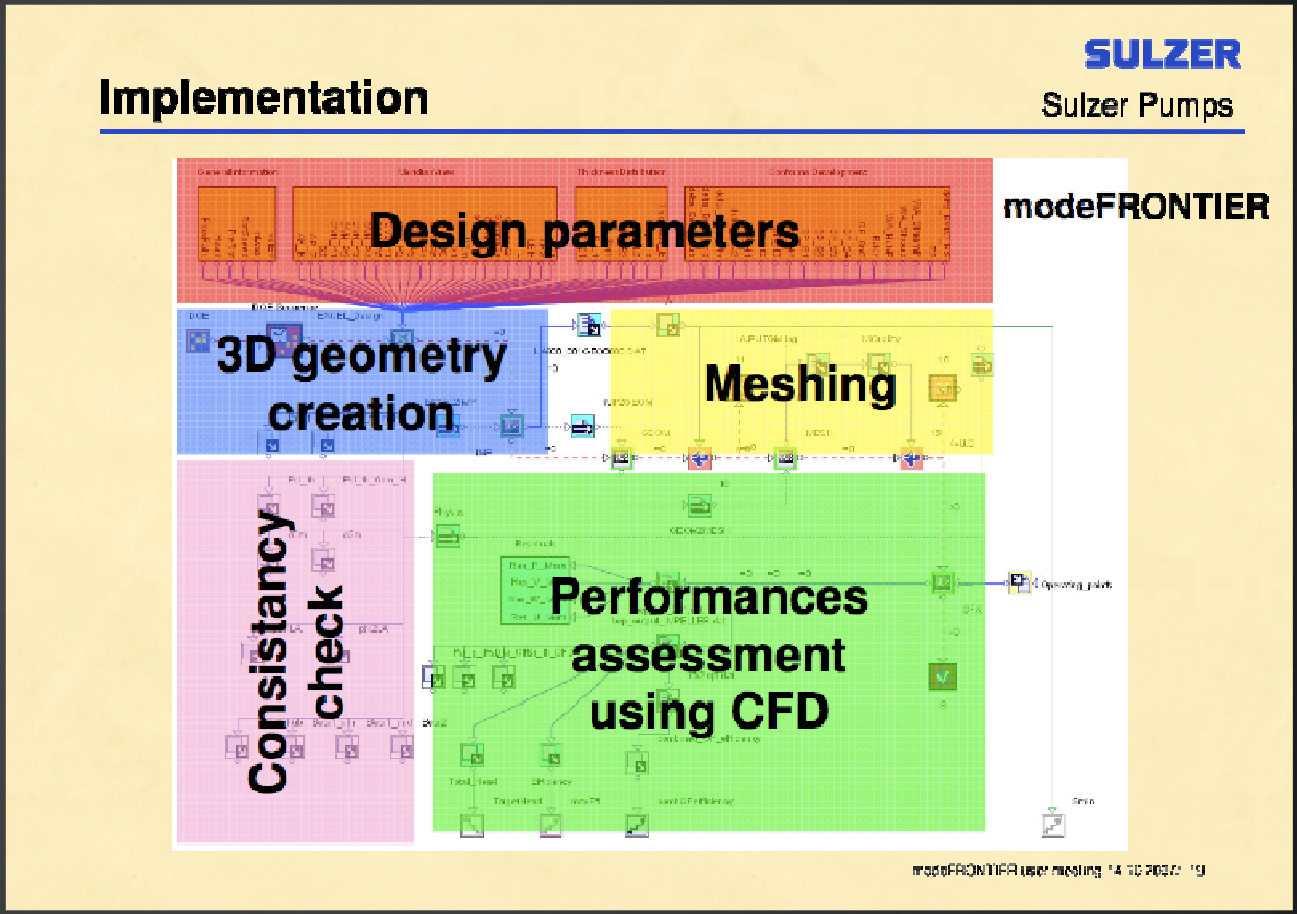


Hydraulic Pump Design

Optimization procedure works very well for serial impellers and suction impellers

Designs obtained with automatic optimization procedure are in excellent agreement with our experience

Design process is significantly reduced in time but quality is obtained

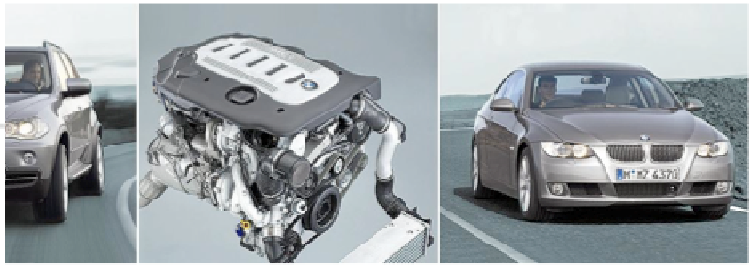


Automotive

BMW Motoren
Giovannini
14.10.2008

BMW Diesel Engine Development
modeFRONTIER user's meeting 2008

ADVACED NUMERICAL OPTIMIZATION METHODS IN THE RAPID PRODUCT DEVELOPMENT PROCESS OF DIESEL ENGINES

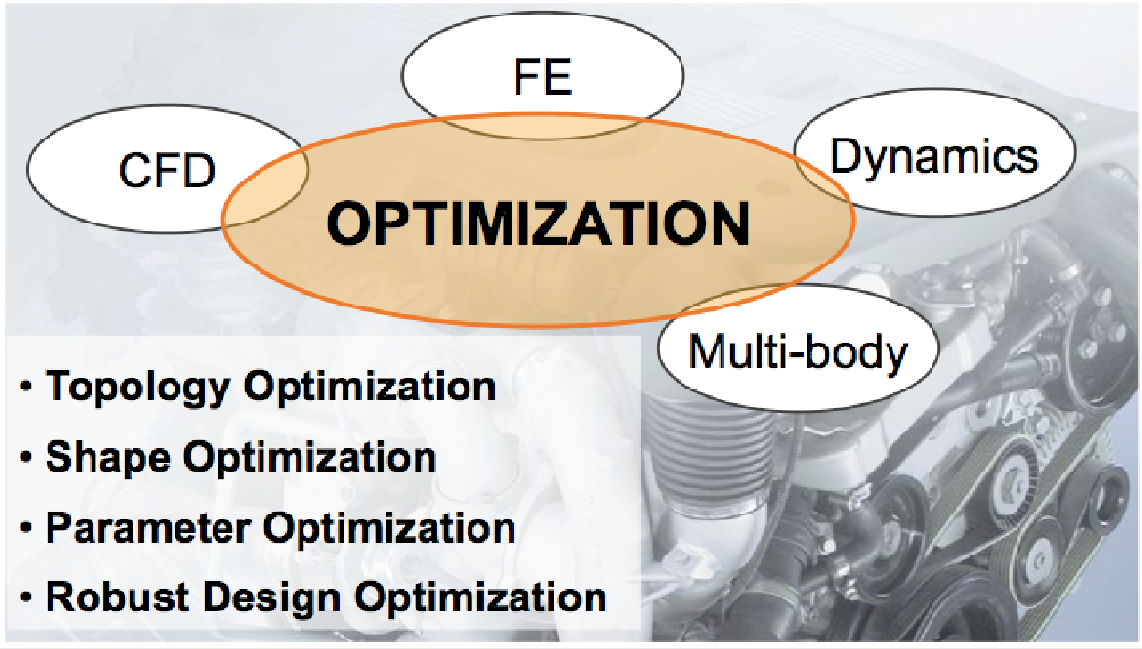


ΓIER user's meeting 2008
este - Italy

ovannini, Dipl.-HTL-Ing. Günther Pessl
bH Steyr, Austria

BMW Motoren
Giovannini
14.10.2008

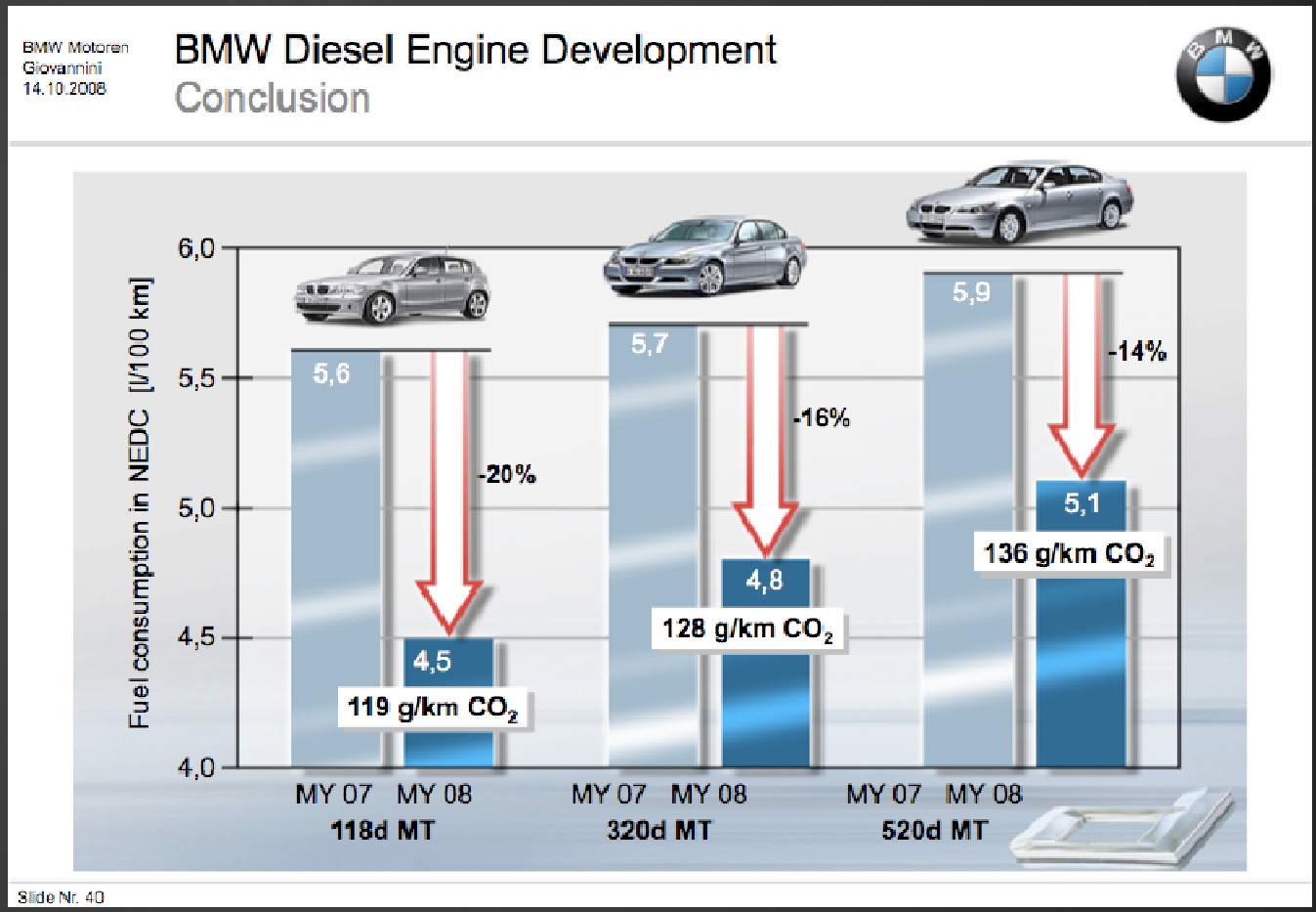
BMW Diesel Engine Development
Optimization Methods



Slide Nr. 7

Automotive

- Numerical methods are an essential part of the product development
- Consistent use of optimization methods help to solve target conflicts



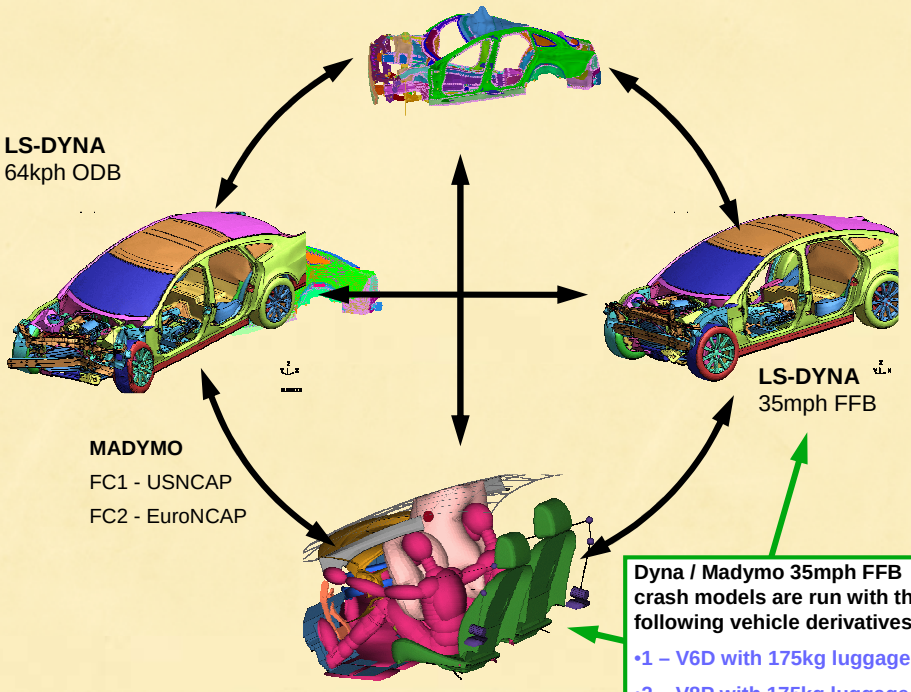
Automotive

From 6 weeks to 2 hours Auto correlation on airbags

CAE Models

Following models are created for each design iteration

Extracted results are constrained or optimised



Dyna / Madymo 35mph FFB crash models are run with the following vehicle derivatives

- **1 – V6D with 175kg luggage**
- **2 – V8P with 175kg luggage**
- **3 – V6D with 0kg luggage**

JAGUAR | LAND ROVER

Design Objectives

- Minimise Mass
- Maximise US/ EuroNCAP star rating

Design Constraints

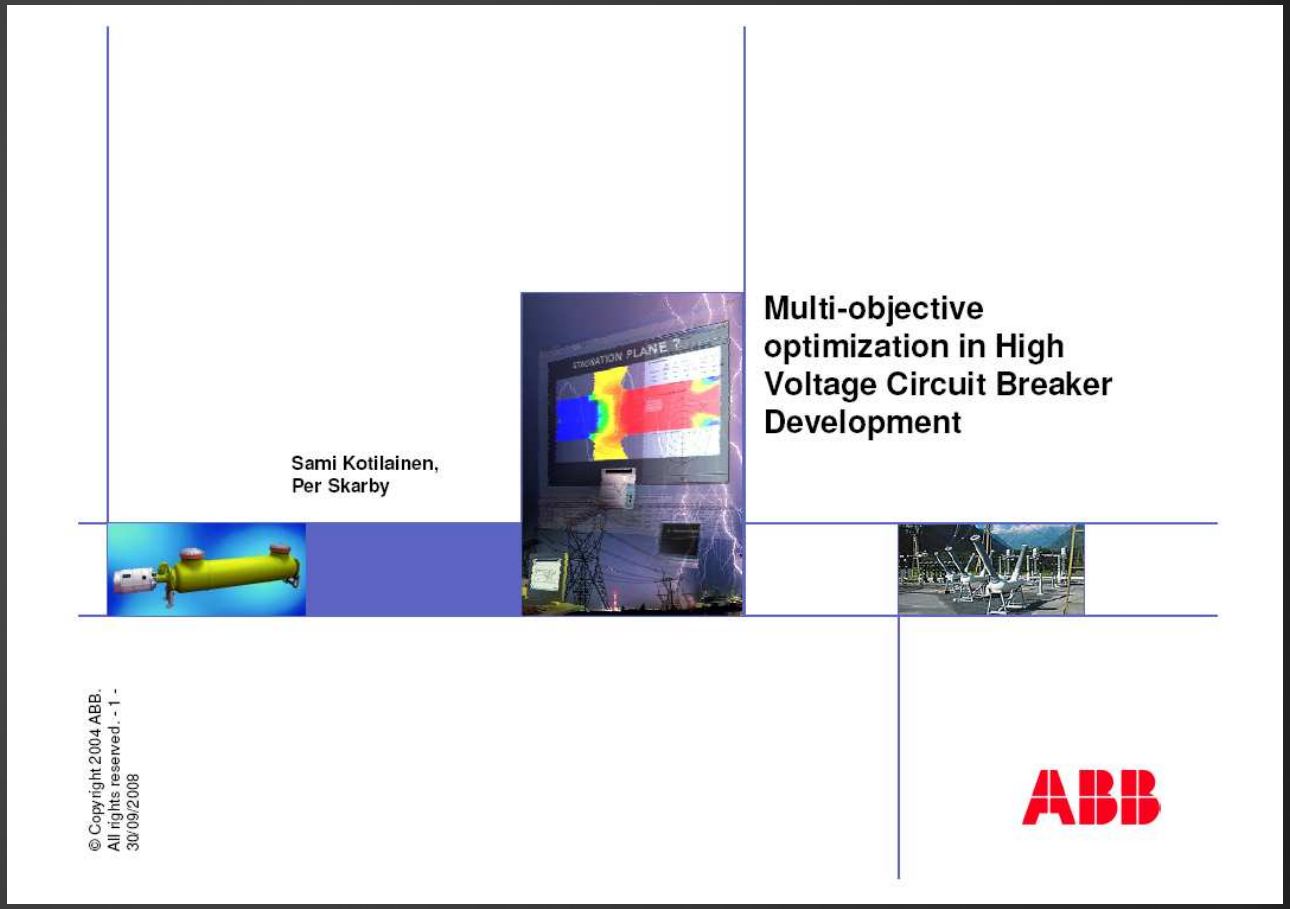
Meet all attribute targets and FAC constraints, eg:-

- Vehicle pulse and intrusion
- Occupant injuries
- Bending/ torsional stiffness
- Point dynamic stiffness
- Body natural frequencies

A Multidisciplinary “High Voltage” Application

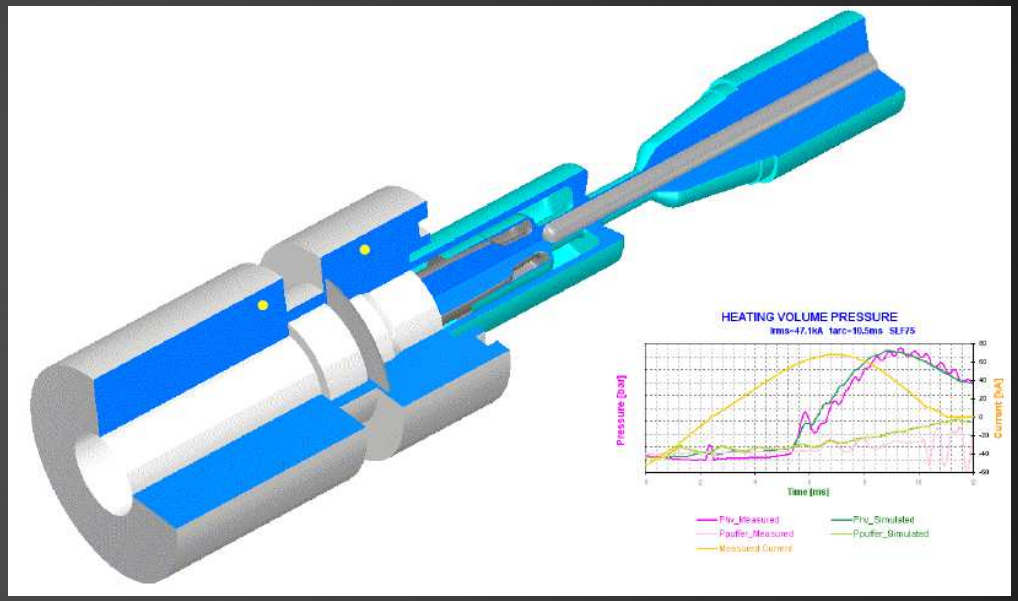
A circuit-breaker is:
- Device used to open/close electric circuits
- Complex electro-mechanical thermodynamic device
- Ideal conductor in close position
- Ideal insulator in open position

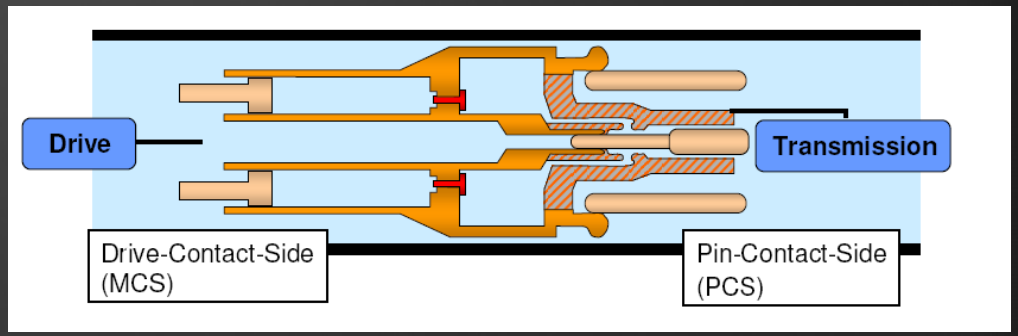
Why to use a circuit breaker?
- Fault current switching
- Unplanned events initiated by the network’s protection system
- Load current switching
- Planned events initiated by the system operator



A Multidisciplinary “High Voltage” Application

- Ratings 72-1100kV, 25-80kA
- Secure operation over large current range (e.g. 1-63kA)
- Contact movement 100-200 mm
- Relative contact velocity 5-15 m/s
- Operating time 30-50 ms (accelerations 100-200G)
- Maximum temperatures ~30000K
- Maximum Pressures ~100bar
- Lifetime ~30 years, 10000 Operations

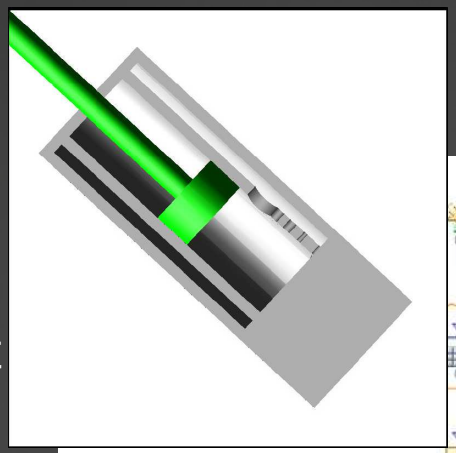




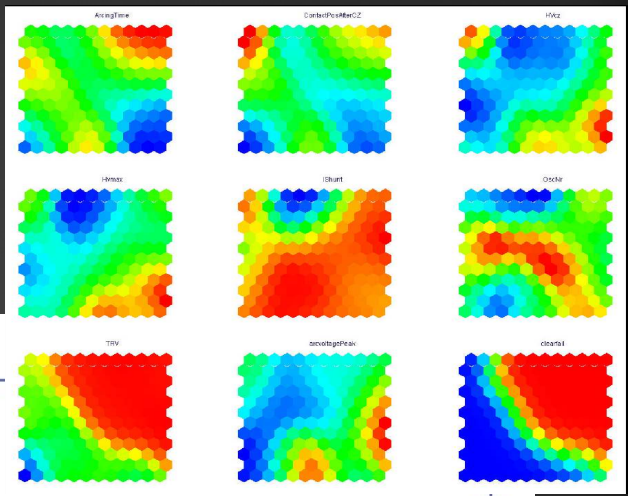
A Multidisciplinary “High Voltage” Application

Model Analysis:

- Preliminary mechanical layout with Mathcad model
- Damper model with ADAMS+ Pressure build up Simulator
- Coupling with Electric Field Simulator



A Multidisciplinary “High Voltage” Application



The Goals:

- Objectives on relative position of contacts:
  - Coordination
  - Capacitive switching 1
  - Capacitive switching 2
  - Reaction time
  - Open gap
- Minimize Force
- Minimize Energy

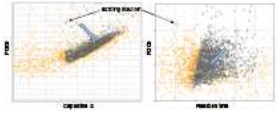
Optimization Strategy:

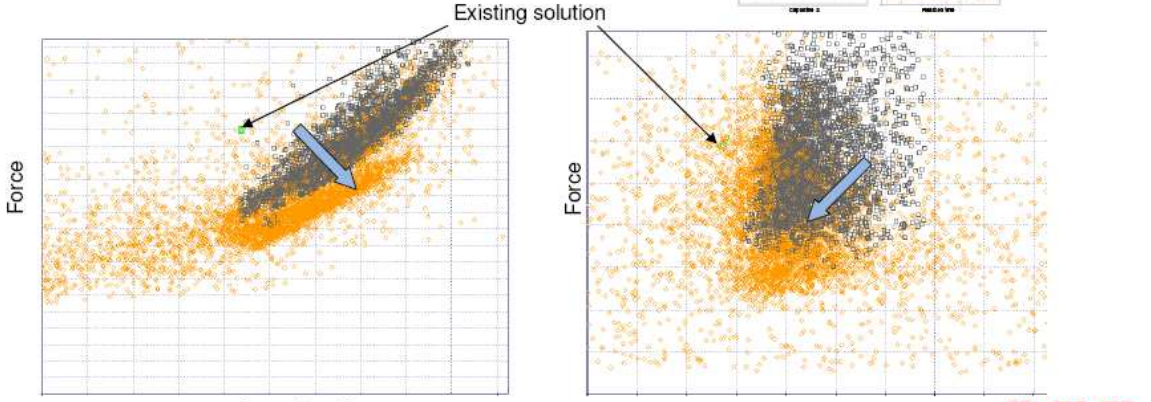
- MOGT (~30min run) initial population
- MOGA (~12h run) improved BEST solutions by 4-30%

Optimizing Existing Design

- With size constraints

	Coordination	Reaction time	Capacitive1	Capasitive2	Force	Size
Original design	0%	0%	0%	0%	0%	0%
opt10164	-44%	4%	15%	5%	-53%	27%
opt17113	-8%	2%	39%	33%	-1%	27%





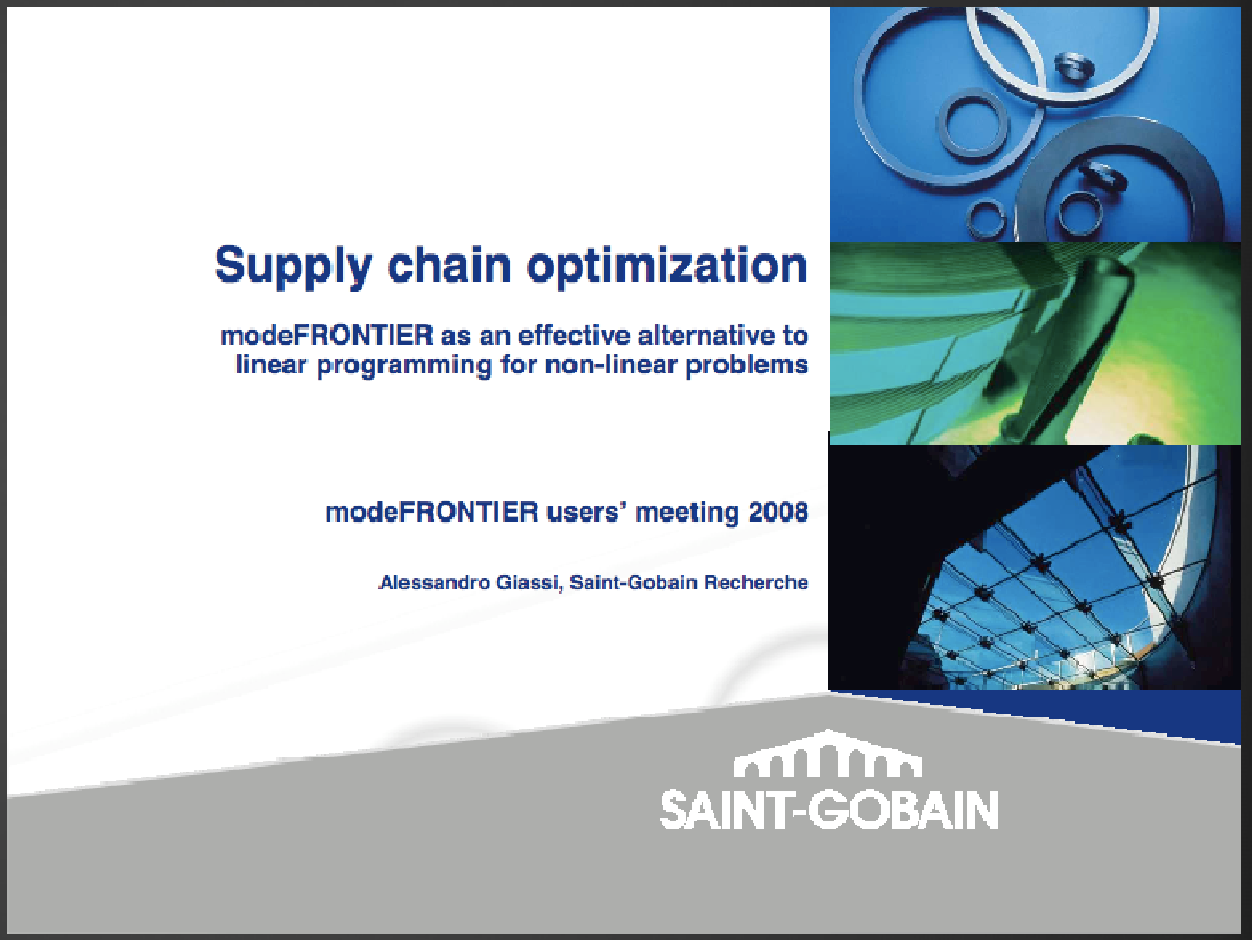
ABB

Supply Chain Optimization

Given an item, **find**:
- the plant(s) where it has to be produced
- the satellite stock(s) where it has to be stocked
- the customer catching area of each site

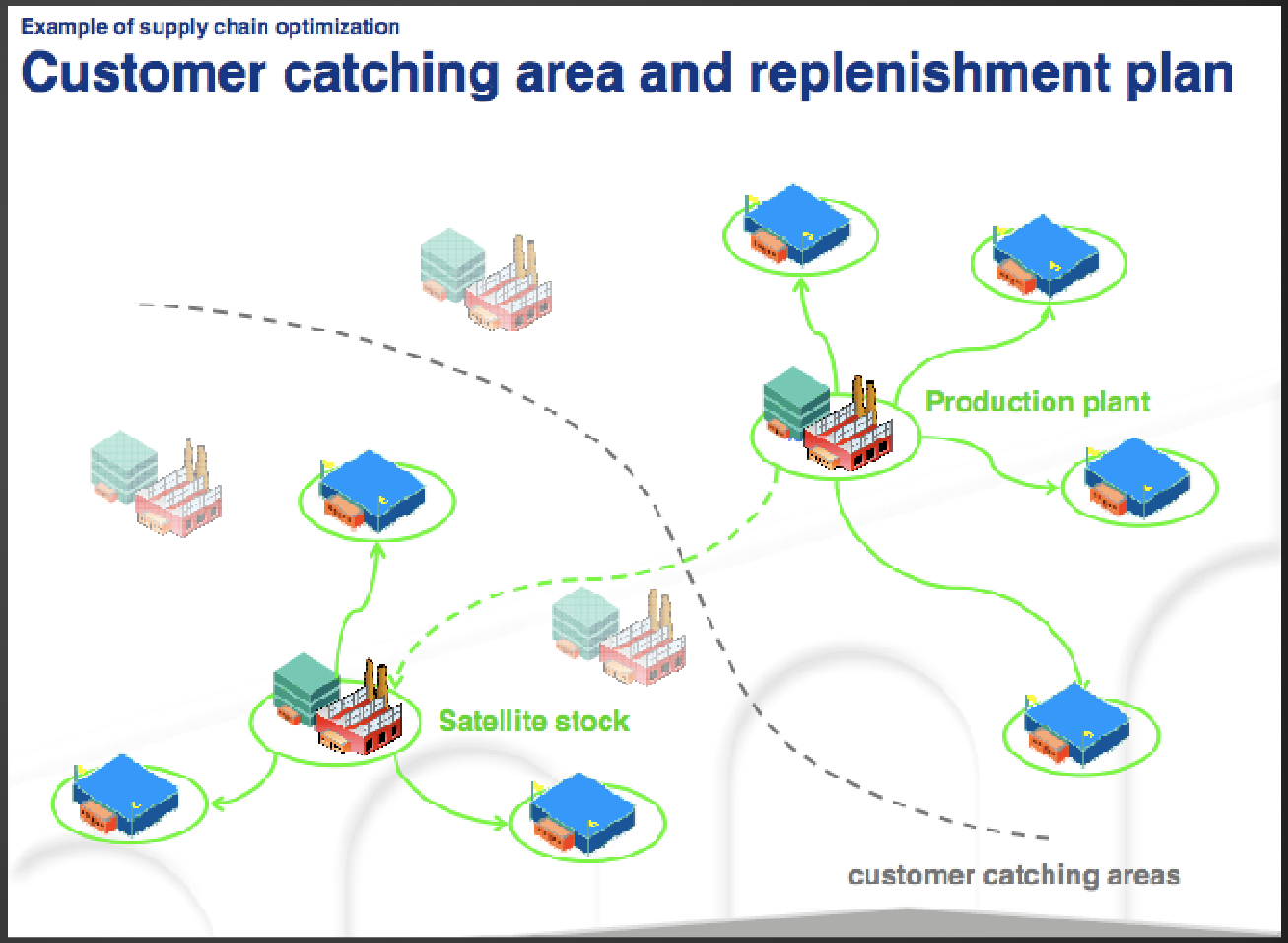
that **minimize** the total logistic cost:
- transport costs (transfer and delivery)
- handling costs
- stock costs

and **respect** the constraints on:
- maximum delivery delay
- stock capacity
- production capacity



Supply Chain Optimization

Reference solution
Real customer catching areas of a high added value item (2007)



Supply Chain Optimization

Results

The gain of 0.3 M€(10%) on the delivery cost is not negligible:

At the item scale ...

transport cost savings

0.3 M€~ 0.3 M Km

- distance: **7.5** earth's circumferences
- fuel volume: **100.000** liters / year
- CO_2 emission: **600** tons / year

At Saint-Gobain scale ...

transport cost savings

150 M€~ 150 M Km

- distance: **1** A.U.
- fuel volume: **50** M liters / year
- CO_2 emission: **300000** tons / year

Real World Accidents Reconstruction

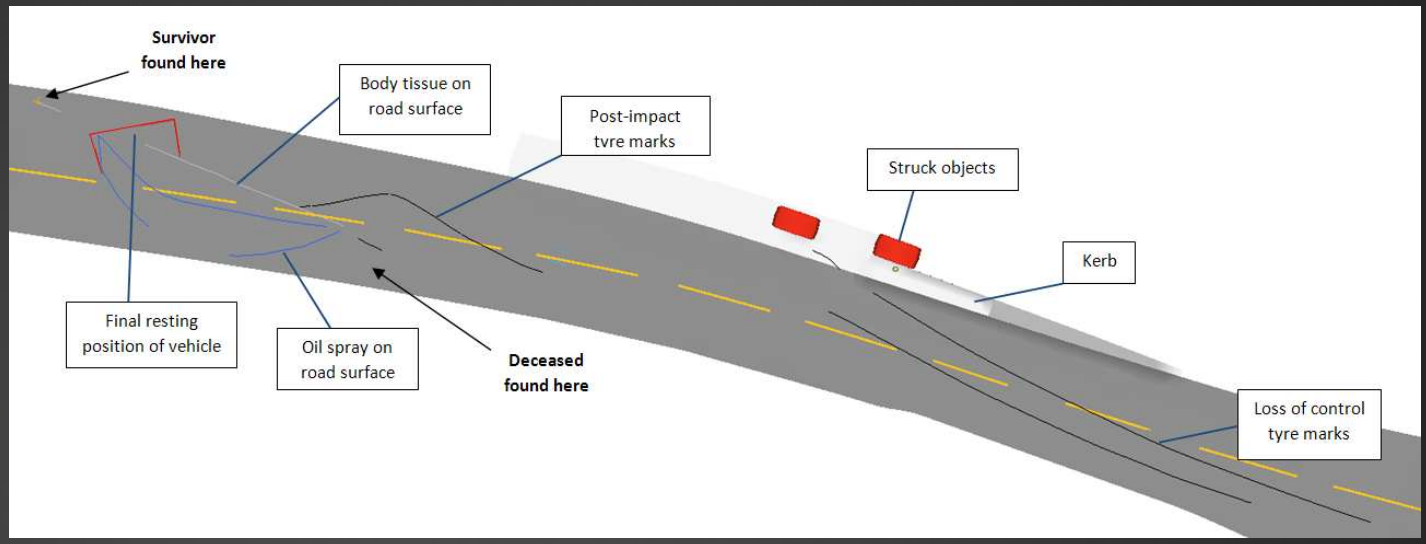
modeFRONTIER has been used to assess the sensitivity of all input factors which would contribute to the accident's unique set of circumstances

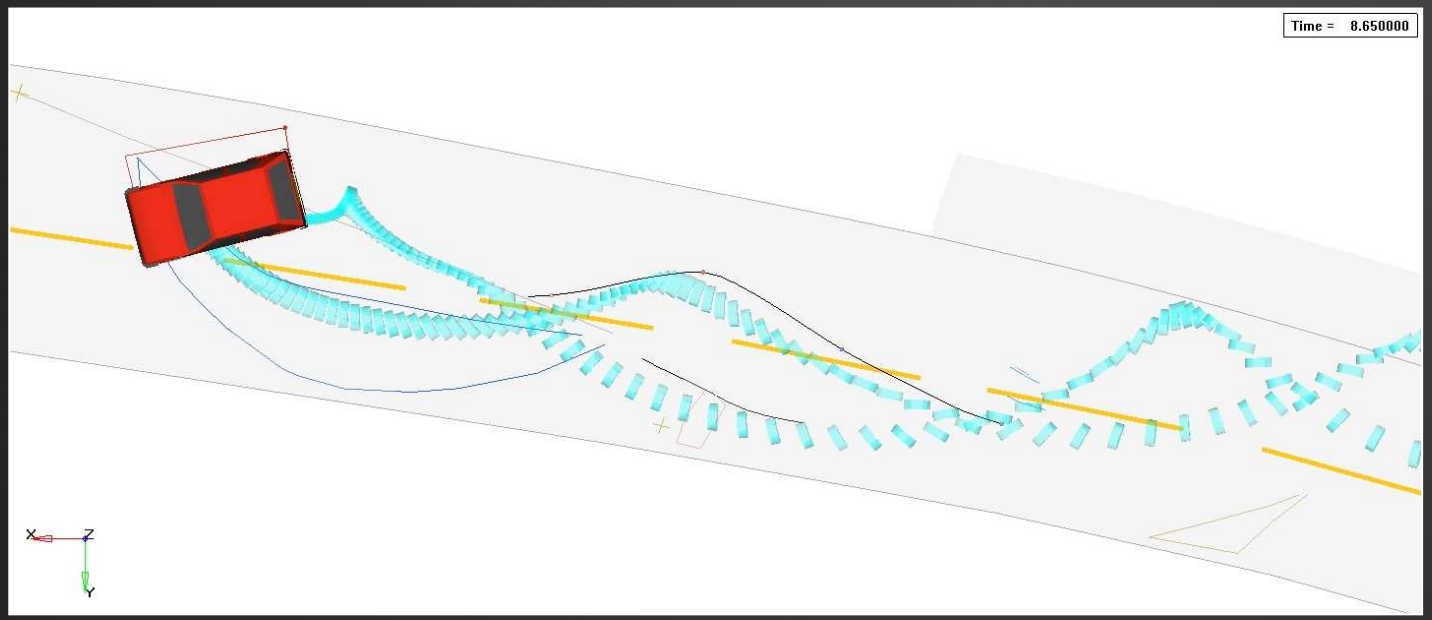
Typically when simulation are used to reconstruct accidents, only single iterations are usually developed based on a series of known data and assumptions.

Real World Collision Reconstruction

Very little data is known in this case:

- No initial Speed can be calculated from markings
- Initial position of vehicle is not known
- How did the driver react – i.e. steering & braking

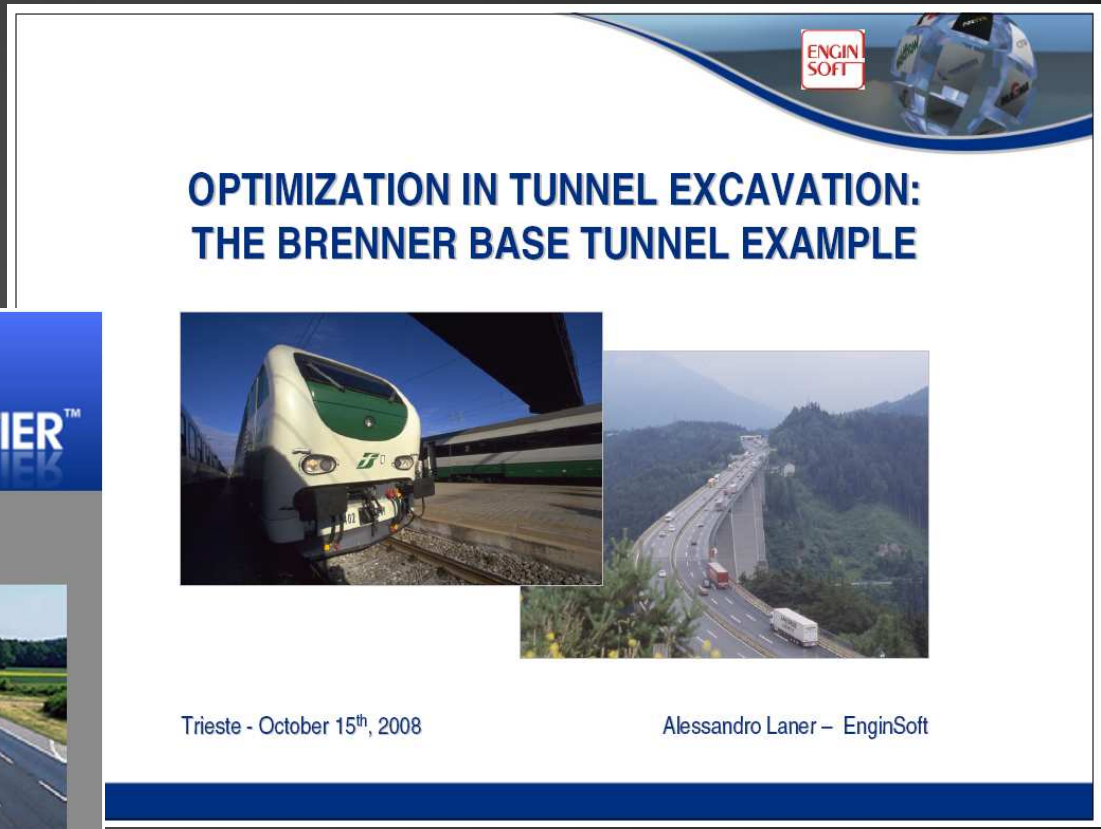




- Approximately 4,000 iterations were carried out
- Loss of Control marks correlated to within one tyre width
- Final positioning matched to within 0.5m

Civil Engineering Applications

Optimal Road Path



Cost, Time & Risk Management

modeFRONTIER: a way of thinking

- Look at the global problem
- Analyze the detail to understand its importance
- Improve always whenever possible