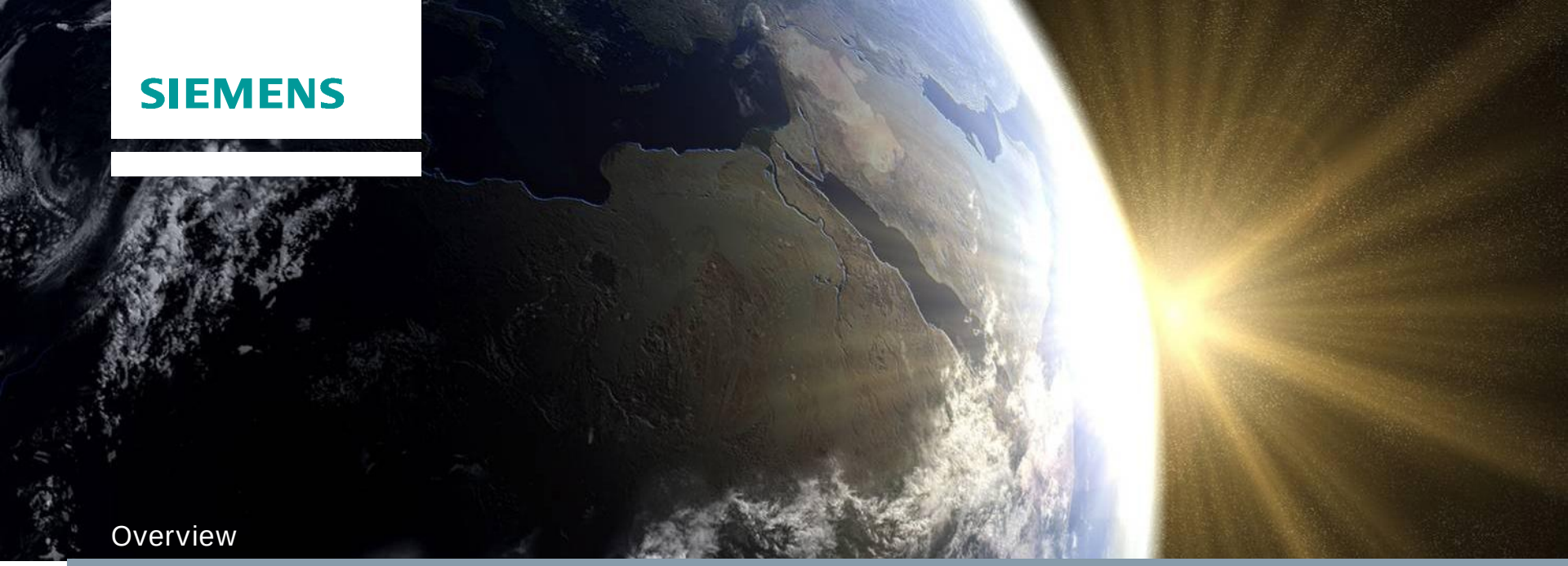


SIEMENS

Overview

Corporate Technology

Munich, 18. September 2012

Siemens is organized in 4 Sectors: "Industry", "Energy", "Healthcare" and "Infrastructure & Cities"

SIEMENS

Siemens: Facts and Figures

Siemens Sectors

Industry

Divisions:

- Industry Automation
- Drive Technologies
- Customer Services

~€ 20 bn [1)]

Energy

Divisions:

- Fossil Power Generation
- Wind Power
- Solar & Hydro
- Oil & Gas
- Energy Service
- Power Transmission

~€ 25 bn [1)]

Healthcare

Divisions:

- Imaging & Therapy Systems
- Clinical Products
- Diagnostics
- Customer Solutions

~€ 12 bn [1)]

Infrastructure & Cities

Divisions:

- Rail Systems
- Mobility & Logistics
- Low and Medium Voltage
- Smart Grid
- Building Technologies
- Osram [2)]

~€ 17 bn [1)]

Corporate functions

- Corp. Finance
- **Corp. Technology**
- Corp. Development
- ...

Corporate Technology

Key figures FY 2011

- **Sales:** ~€ 74 bn
- **Locations:** in 190 countries
- **Employees:** ~402,000
- **R&D expenses:** ~€ 4 bn
- **R&D engineers:** ~28,600
- **Inventions:** ~8,600
- **Active patents:** ~53,300

1) Sales in FY 2011 estimated for the new organizational setup with 4 Sectors
2) Not included in sales figure; Siemens announced its intention to publicly list Osram

Corporate Technology has 3 missions

Corporate Technology: Mission, roles and basic principles

The source of our excellence are our **people.** We attract and develop **creative talents** for Siemens. We foster **talent exchange** with the Business Units.

We develop Siemens' **technology and innovation strategy** on **corporate level.** We ensure **seamless technology and innovation processes** between Corporate and Business Unit levels.

We foster a **culture of innovativeness and high performance** and our **visibility** to all internal and external stakeholders

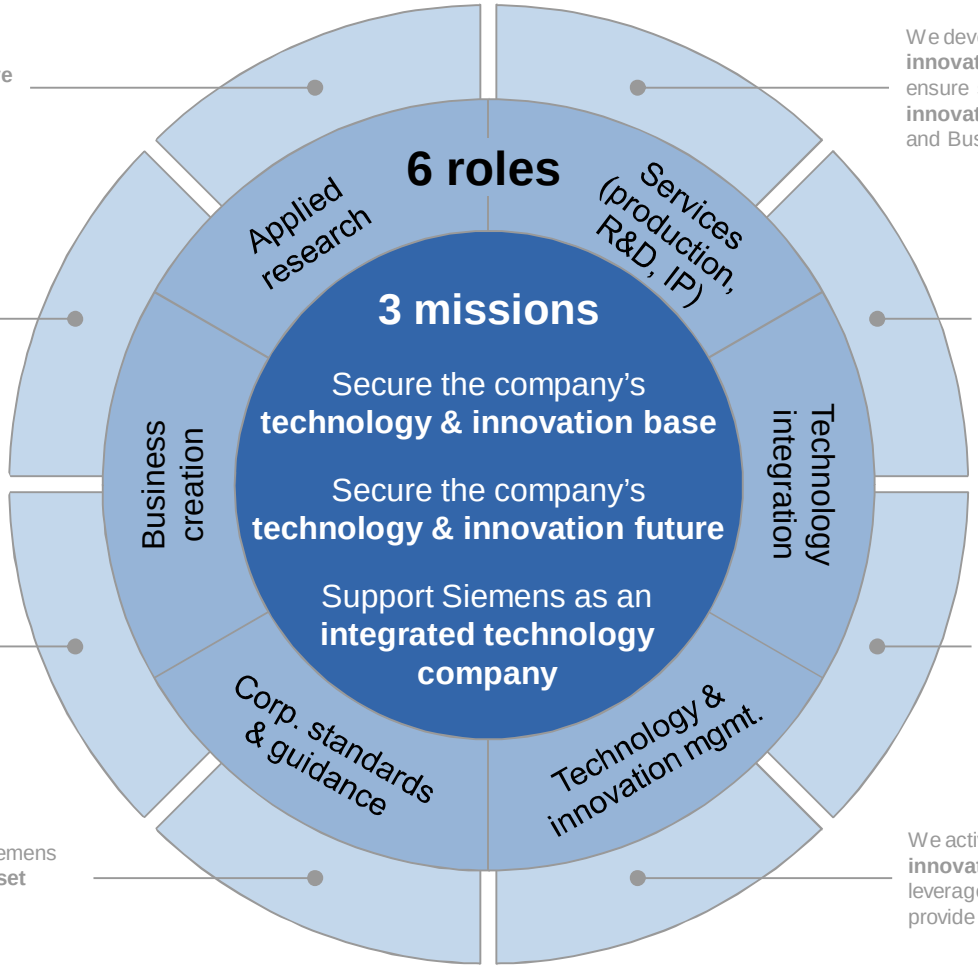
We deliver services for the businesses as a **strategic partner** and integral part of their **value chain**

We take a **focused approach** (e.g., in regional setup, technology focus) to achieve high performance

We regularly develop **high-impact technologies and innovations** for Siemens with a **clear focus on results.** The business responsibility for implementing innovations lies with the Business Units.

We primarily serve **internal** Siemens customers with a **global mindset and setup**

We actively manage our **technology and innovation portfolio.** We systematically leverage **external competence networks** to provide the best know-how for Siemens.



CT contributes to making Siemens more competitive

CT departments: Overview

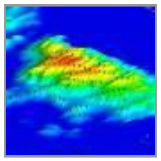
Corporate Technology (CT)
CTO: K. Helmrich

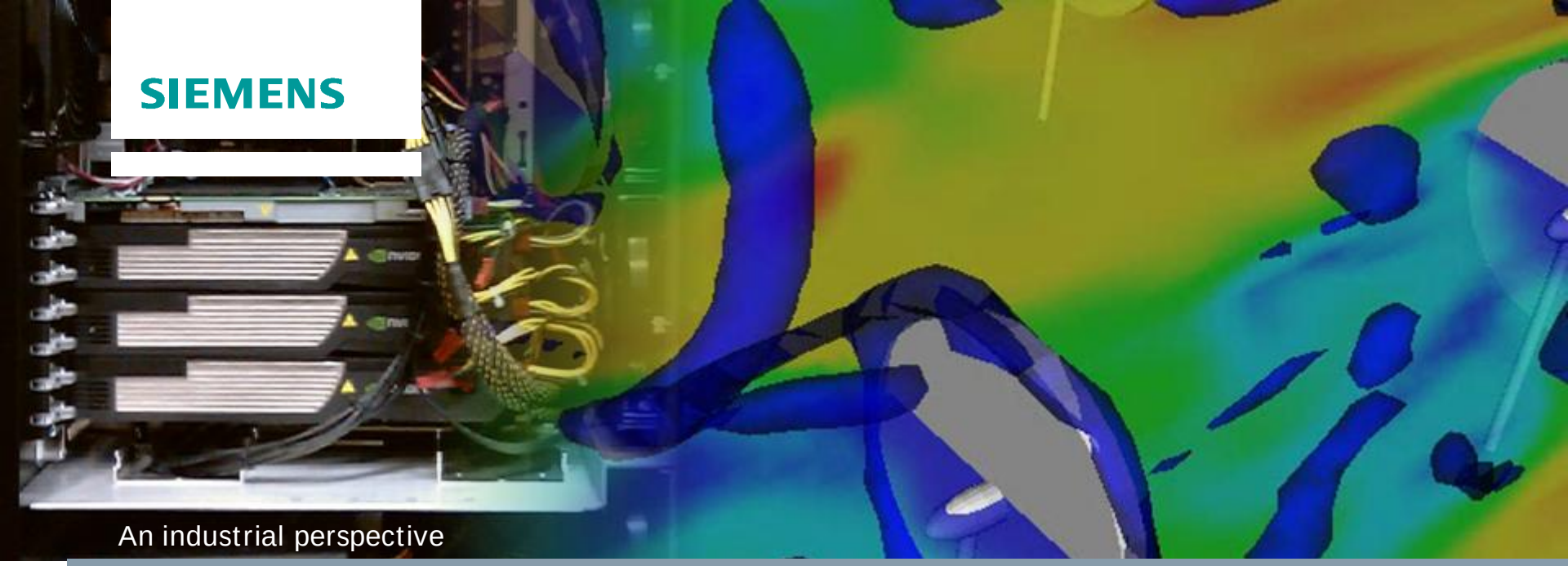
Technology and Innovation Management (TIM)	Corporate Standards and Guidance (CSG)	Research and Technology Center (RTC)	Technology and Innovation Projects (TIP)
▪ Develops the technology and innovation strategy and portfolio ▪ Develops cooperations with external partners	▪ Develops and ensures critical Siemens R&D-related standards – from PLM to Lean and IT Security	▪ Delivers cutting edge research services to the Sectors and innovations for Siemens	▪ Drives major innovation projects forward for Siemens
Production and Process Consulting (PPC)	**Innovative Ventures (IV)**	**Development Center (DC)**	**Intellectual Property (IP)**
▪ Offers consulting services to optimize R&D, engineering and production processes	▪ Builds the bridge from technology to business (e.g., via technology commercialization)	▪ Provides high quality product development services from a near-shore and offshore base	▪ Delivers excellent IP services and drives the Siemens IP strategy

CT develops high-impact technologies with a focus on customer value

SIEMENS

Examples for CT development projects

	Recent examples	CT's contribution
	**Biograph mMR** The world's 1st combined PET / NMR system	▪ Co-development of PET detectors ▪ Frequency filters for gamma radiation ▪ Image stitching
	**Wind park optimization** More power output without HW investment	▪ Simulation of complete wind farm for minimizing turbulence ▪ Prognosis model for weather and output
	**Allgäuer Überlandwerke** National smart grid pilot project	▪ SO EASY software balancing power demand and production ▪ Integration of electric cars
	**Electrolyzer** Bringing energy storage technology to market	▪ Working H_2 hydrolysis prototype ▪ PEM technology in reverse mode
	**Electrical desalination** Pilot plant in Singapore with consuming 50% less power	▪ Membrane-based salt removal using electric fields ▪ Simulation model at molecular level



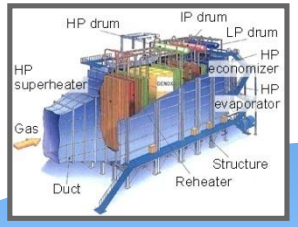
Challenges of Computational Engineering Science

Dr. Dirk Hartmann
Siemens AG
Corporate Technology
CT RTC AUC SIM-DE

Challenges of Computational Engineering Science

Complex System-Simulation

Efficient Derivative-free Optimizers



Vertical Models / Model Reduction

Seamless CAD-Model Integration

Engineering

Development

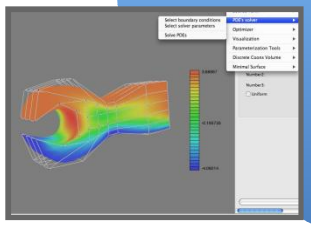
Commissioning

Interactive / Fast Simulations

Design

Simulation-driven Solutions

Operation



Modernization

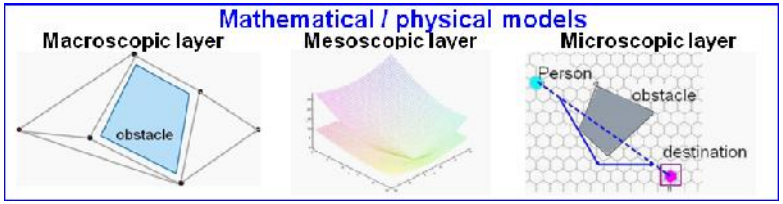
New Modeling Approaches

Uncertainty Quantification

New Modelling Approaches

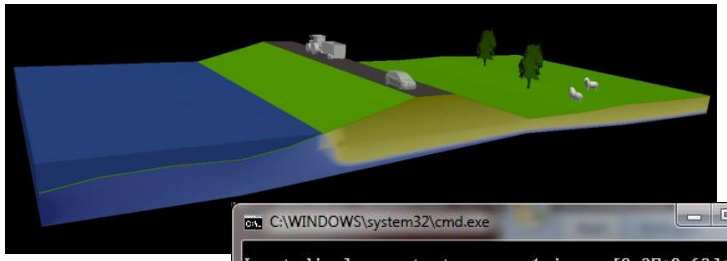
Challenge: New modeling approaches for phenomena which could not be sufficiently modeled before generate new business.

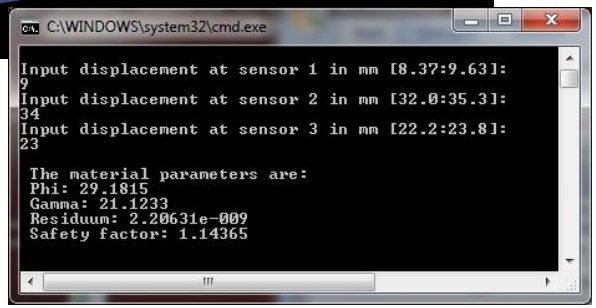
Microscopic Pedestrian Flows



A new era for command and control centers

Models for Piping in Levees



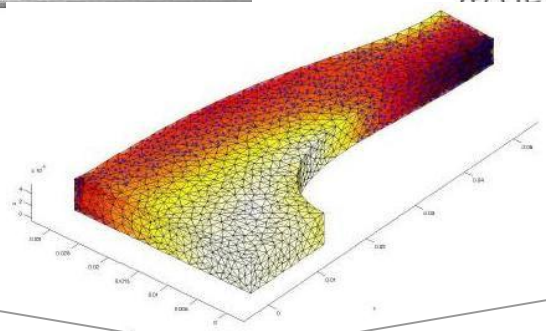


Dike condition / stability monitoring based on simulations

Seamless CAD-Model Integration

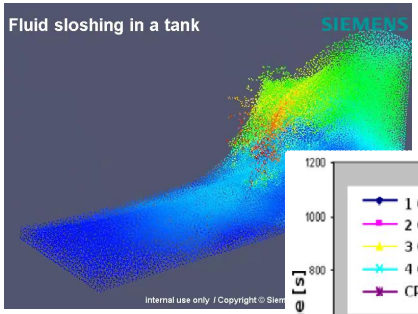
Challenge: The generation of appropriate grids for discretization is a bottle neck in most CAE processes.

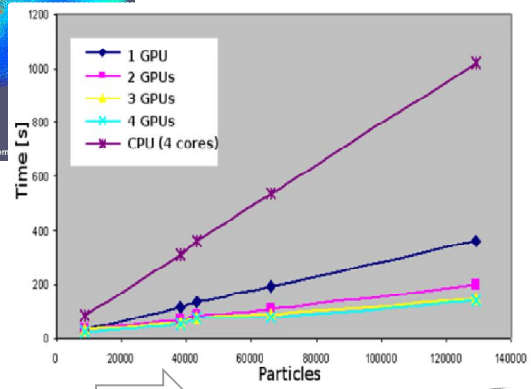
Isogeometric FEM



Simulation tools directly based on CAD-models optimize CAE processes

Meshless Methods





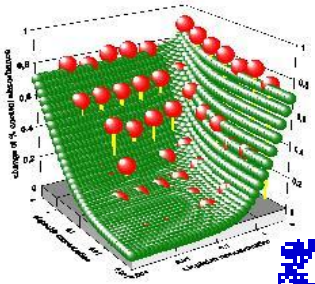
Efficient simulation of complex free surface flows and fluid structure interaction

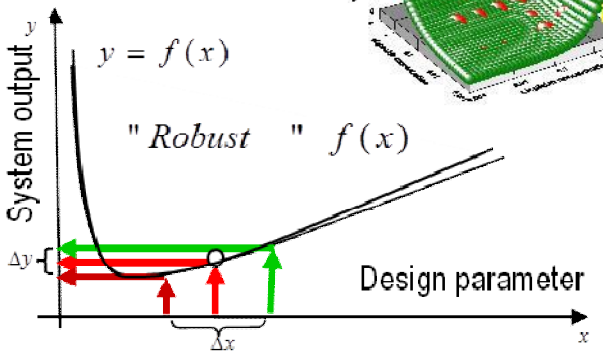
SIEMENS

Efficient Derivative-free Optimizers

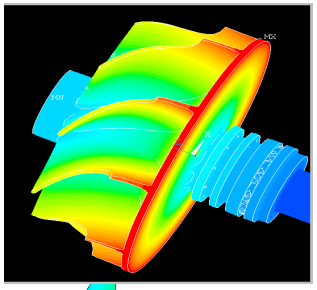
Challenge: Most simulation tools in industrial environments are black box solvers. Developing corresponding derivative-free optimizers is a rewarding challenge.

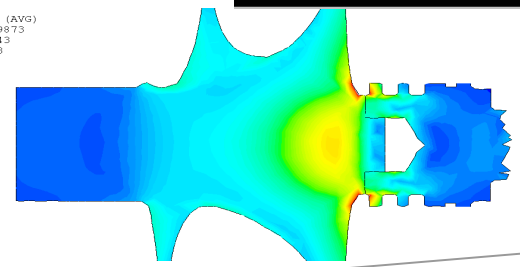
Optimization tools for black box solver





ModeFrontier Toolbox



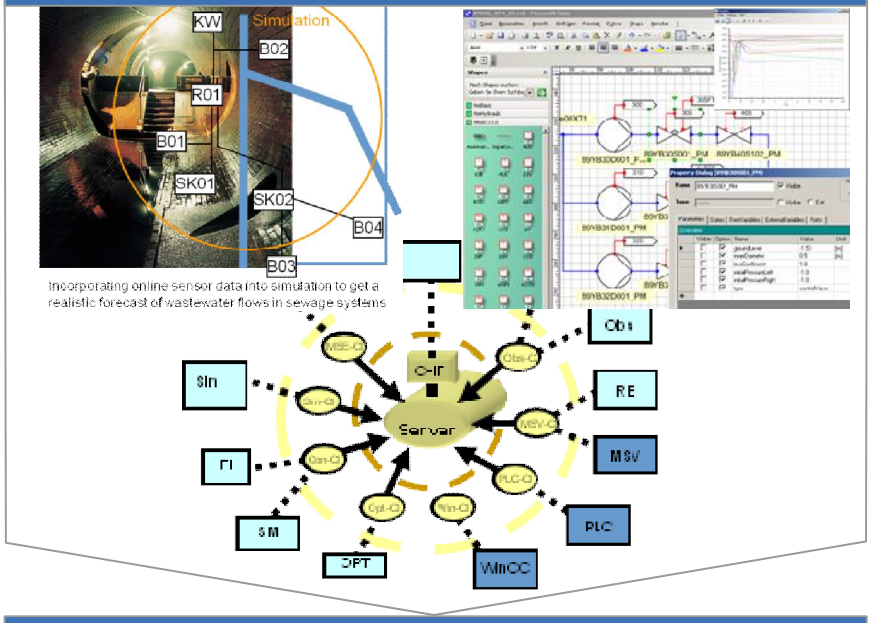


Levering of development with add-on tools in established engineering tool chains

Complex System Simulation

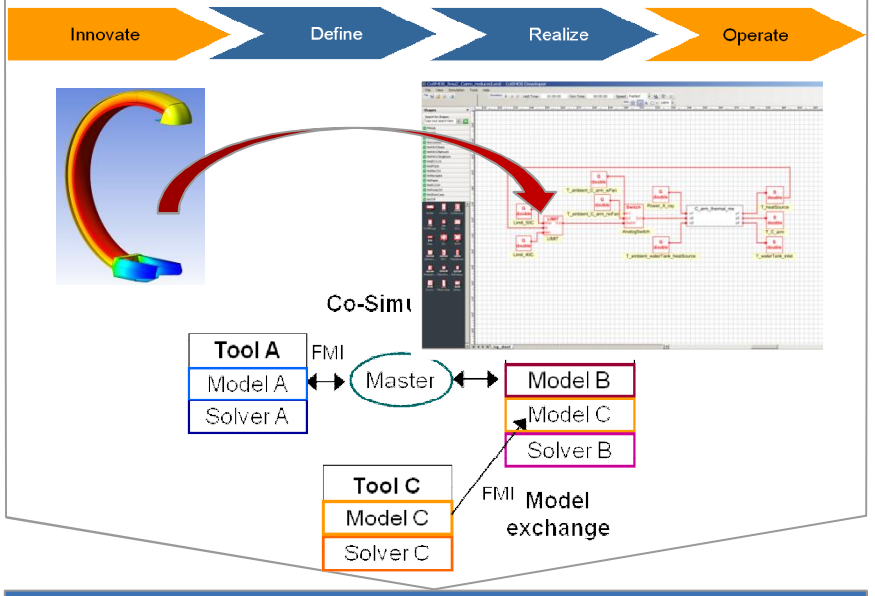
Challenge: Simulating systems as a whole instead of sub-parts typically reduces developing cycles. However, sub-systems are solved with different tools, which need to be coupled efficiently.

CoSMOS



User friendly reusable platform for different phases and solutions

Functional Mockup Interface (FMI)

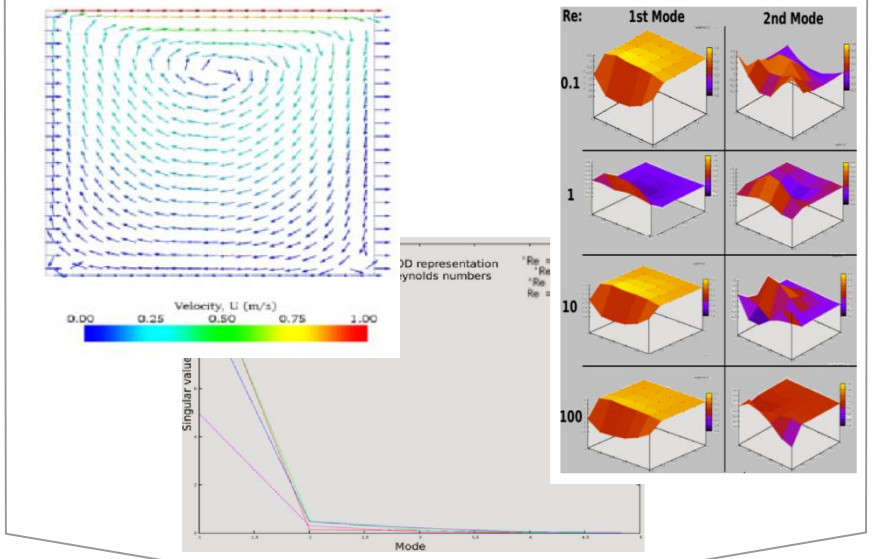


Save time and costs with Integrated system development processes

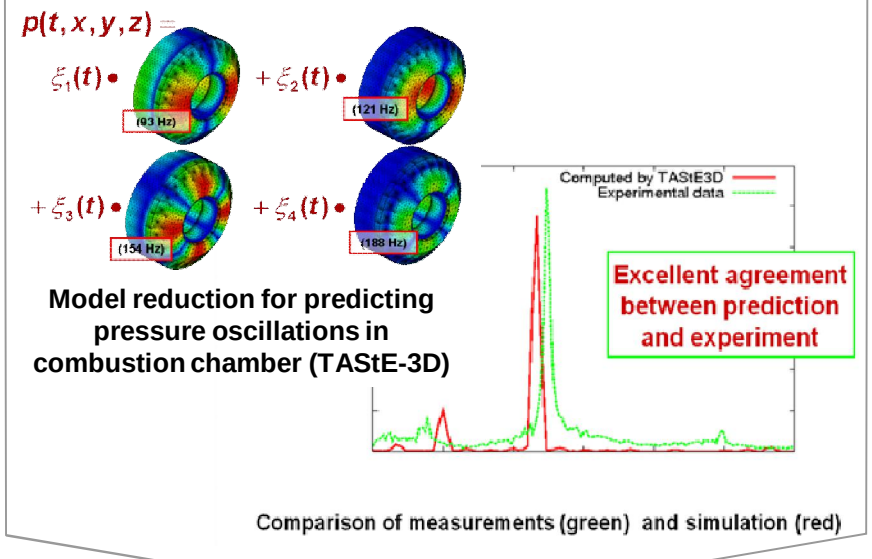
Vertical Models / Model Reduction

Challenge: During the PLM cycle the same models are needed in different complexities. Automatically derived integrated models via model reduction could substantially improve consistency during the PLM cycle.

Gappy POD



Reduced Basis Methods



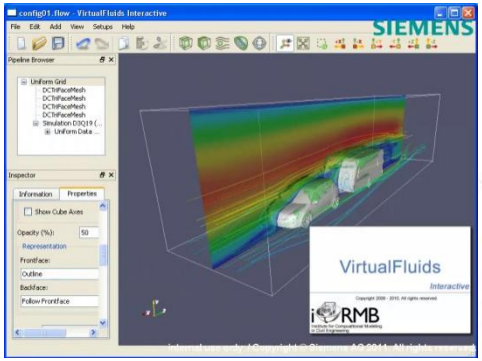
Efficient use of sensors within simulation-based controls

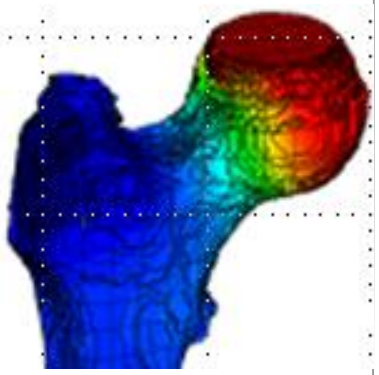
Reduction of noise due to correct prediction of complex acoustic phenomena

Interactive / Fast Simulations

Challenge: Developing fast simulation models / tools allows new control concepts or monitoring systems based on simulations.

Online CFD

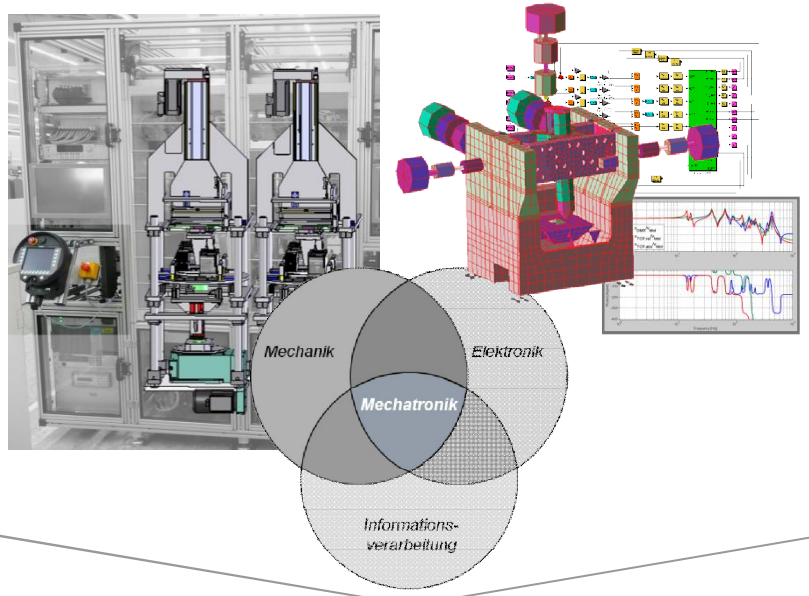




NVIDIA

Interactive simulations can decrease significantly development cycles

Virtual Commissioning

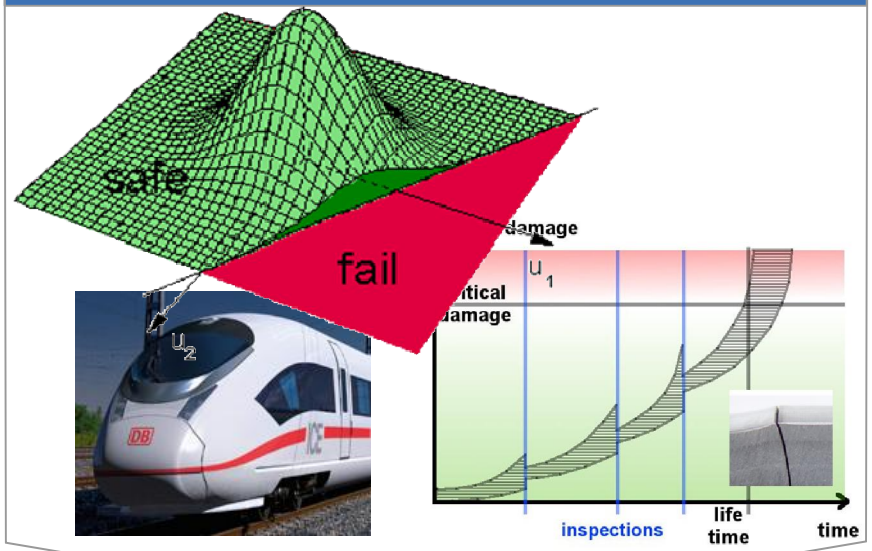


Detailed testing of components of complex machines decreases development cycles

Uncertainty Quantification

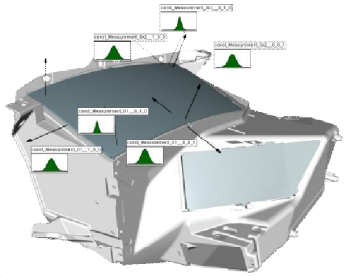
Challenge: Integrated simulation tools in control concepts or monitoring systems have to cope with uncertainties. A rigorous treatment ensures reliability and robustness.

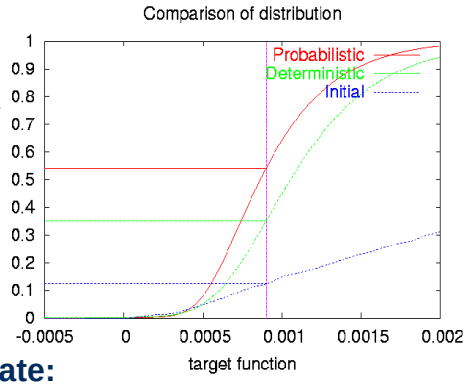
Optimization of Service Concepts



Optimized service concepts for a prescribed reliability

Robust Design of Products





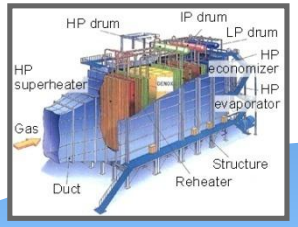
Reject rate:
- **Without optimization: 87%**
- **With det. optimization: 65%**
- **With prob. optimization: 46%**

More robust products due to explicit modeling of uncertainties

Challenges of Computational Engineering Science

Complex System-Simulation

Efficient Derivative-free Optimizers



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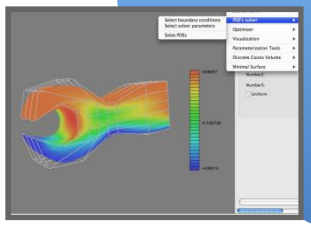

Modernization

New Modeling Approaches

Uncertainty Quantification

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Thank you for your attention!

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