Technology in the 21st Century

Customization | Prototyping | Development | Research | Science

Introduction

Who is LCM?

- R & D service provider
- Transfers research results into industrial application
- One-Stop-Shop

LCM Facts

- Founded 2001
- 120 Employees
- > 450 Customer
- 4 Business Areas
- Drives | Mechanics & Control | Sensors & Communication I Emerging Technologies
- Location Linz
- Nominated for the international technology innovation award „Hermes"/Hannover 2017 und 2012
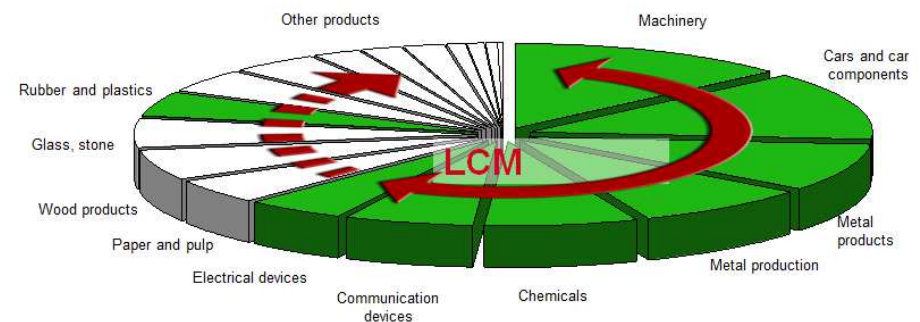
Introduction

What offers LCM?

- R&D services
- Engineering
- Measurement services
- Technical consulting
- Software tools (simulation, optimization, programming, calculation)
- Virtual development and virtual commissioning
- Commissioning support
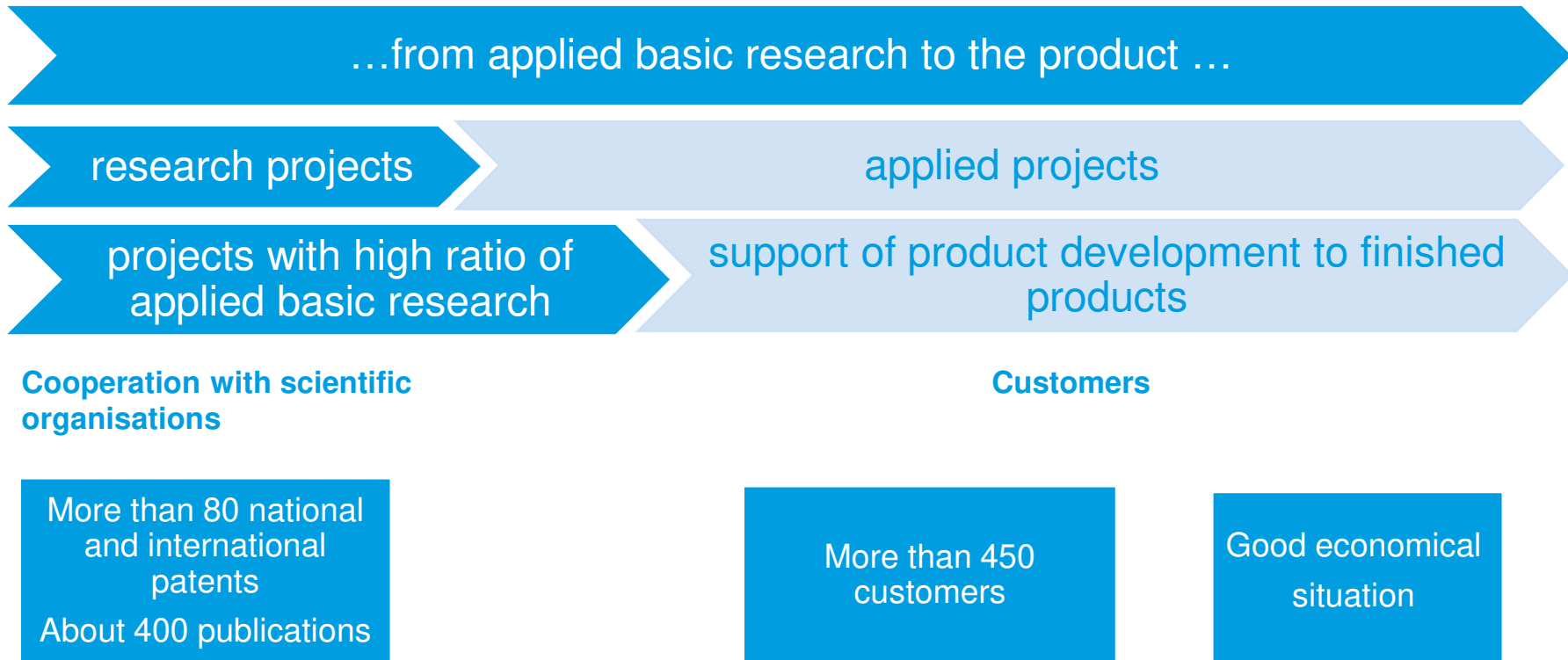- Manufacturing of prototypes and small lot sizes

What are the advantages of LCM?

- One partner from idea up to the product
- Development – optimization - reengineering
- Technology knowledge above the state of the art
- Professional project implementation
- Integration of different technologies to the overall solution
- Cross-industry know-how
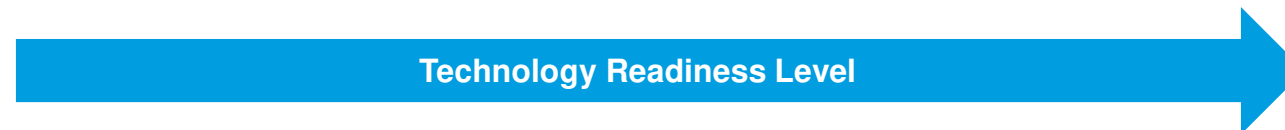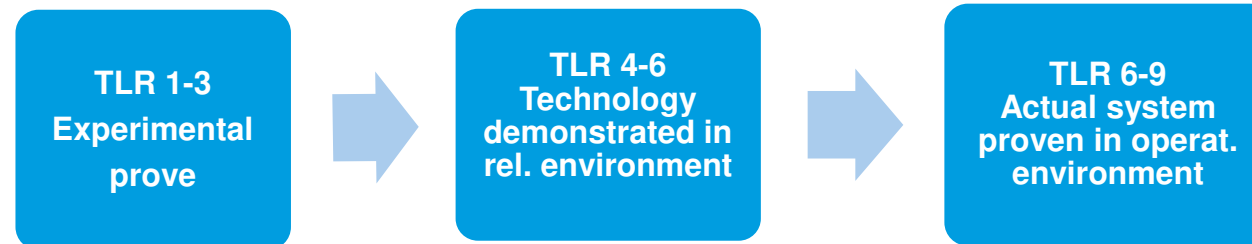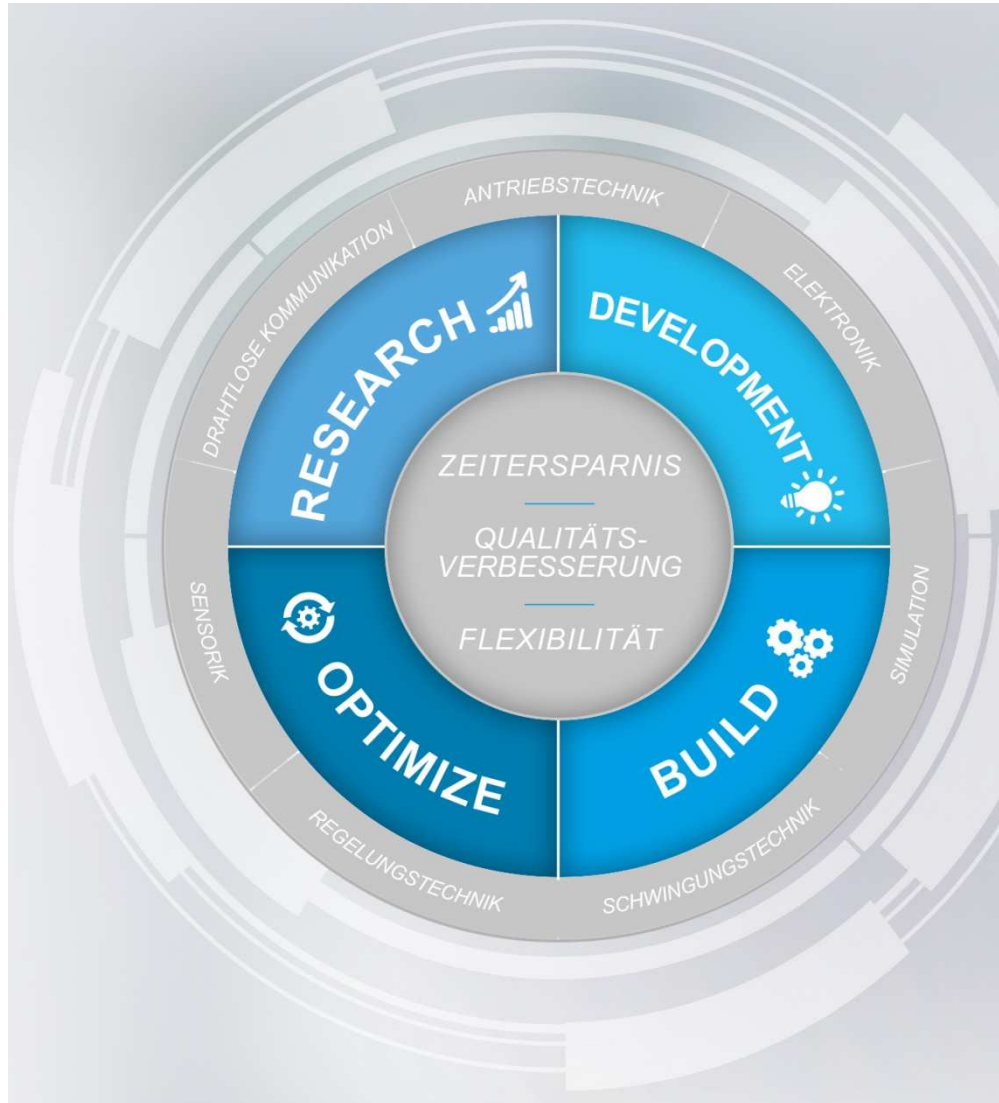- Comprehensive customer and partner network

POSITIONING

LEM LINZ CENTER OF MECHATRONICS GMBH

…from applied basic research to the product …

research projects → applied projects

projects with high ratio of applied basic research → support of product development to finished products

Cooperation with scientific organisations

Customers

More than 80 national and international patents

About 400 publications

More than 450 customers

Good economical situation

POSITIONING

LINZ CENTER OF MECHATRONICS GMBH

| Basic Research | Applied Research | Develop-ment |

Cooperation with scientific organisations

Customers

| TLR 1-3 Experimental prove | TLR 4-6 Technology demonstrated in rel. environment | TLR 6-9 Actual system proven in operat. environment |

Technology Readiness Level

Know-how

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Virtual Development

Emerging |Technologies
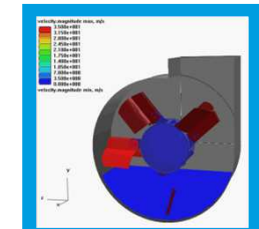

Hydraulic Drives

Power Electronics
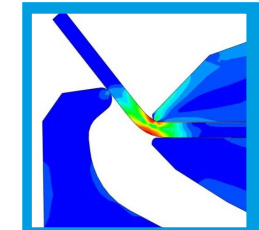
Autonomous Digital Twin

Electrical Drives
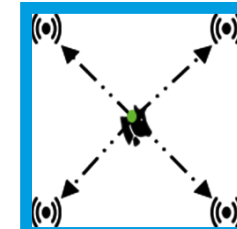
Localization

Simulation

Magnetic Bearing

Electronics, Sensornetworks, Wireless Communication

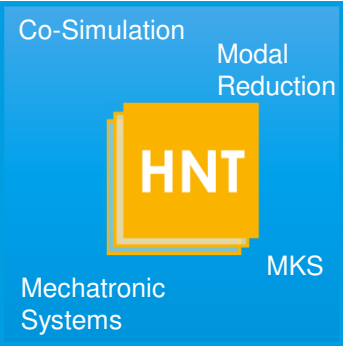
Control - and Vibration Engineering

Virtual Development

Softwareplatform

MAGOPT

Softwareplatform - Magopt

X2C

Softwaretool X2C

Co-Simulation

Modal
Reduction

HNT

MKS

Mechatronic
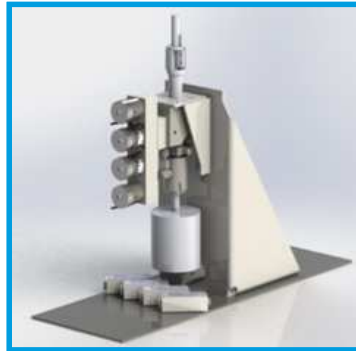Systems

Simulation Tool HotInt

Hydraulic Drives

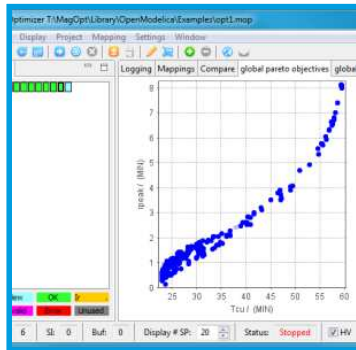
Digital Hydraulics

Integrated Drives

Hybride Drives

Example - Micro-Positioning

Simulation | Optimization

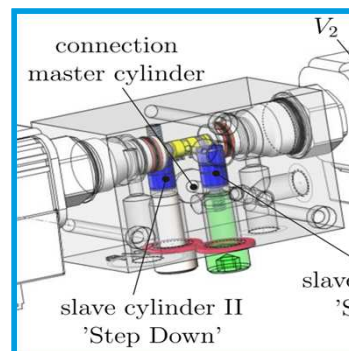**Measuring | Data Mining**

Example – Valve Development

Example – Hydraulic Cabin Damping

Softwaretool Techcalc

Example - Hydraulic Stepper

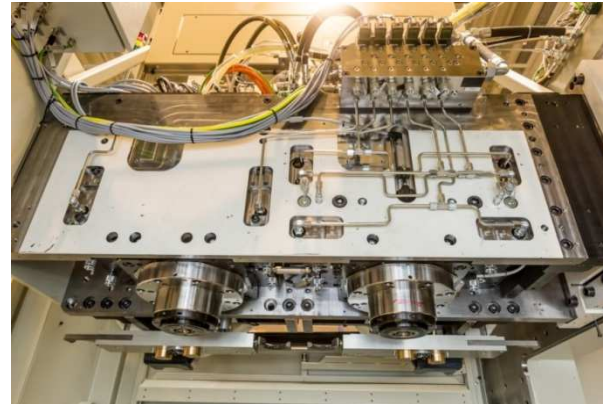**Example - Digitalhydraulic Pressure Control**

Digital Hydraulic

Applications

- Micro positioning
- Digital pressure control
- Dosage
- Hydraulic stepper drive
- Energy-efficient compact axles
- Digital pumps (DDP)
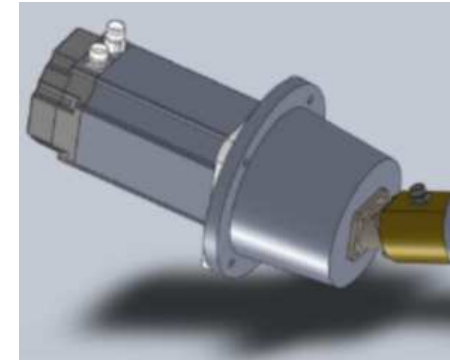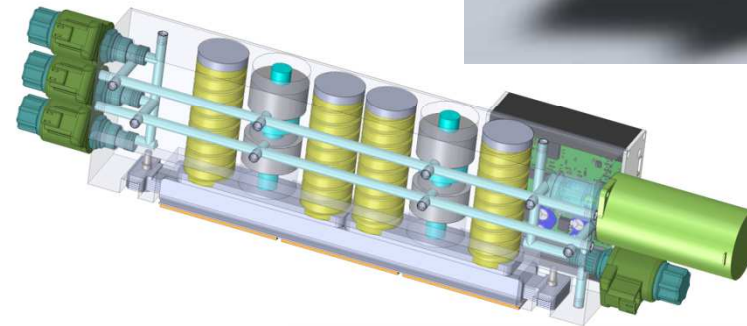
What's the benefit?

- Highest accuracy with simple components
- Compact construction
- Compact hydraulic supply
- Higher flexibility
- Low cost
- Highest energy efficiency

Source: MHI Vestas

Integrated Drives

Applications

- Press drives

- Hydraulic supply (Load Sensing)

- Combination variable speed pump with digital hydraulic attachment for pressure maintenance

- Compact hydraulic axle for
    - Robotics
    - Exoskeletons
    - Machine tools

What's the benefit?

- High energy efficiency

- Compact axles (Plug & Play)

- Good controllability

- More flexible adjustment to the required force

- Reduced oil volume

- No conventional hydraulic supply

Hybride Drives

Applications

- New circuit concepts for industrial and mobile hydraulics

- Use of regenerative and recuperative energy flows

What's the benefit?

- Reduced drive power (downsizing)

- Power smoothing

- Boost operation

- Saving of primary energy

- Optimal design (with components available on the market)

- Fulfillment of new emission standards
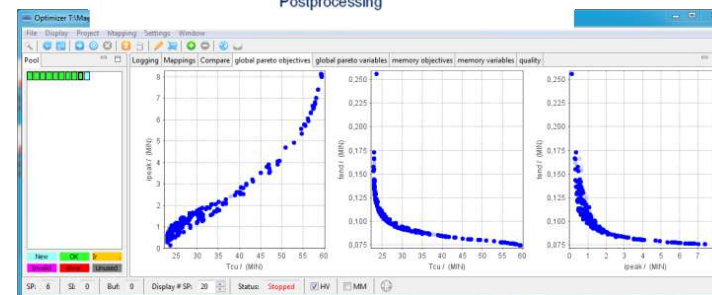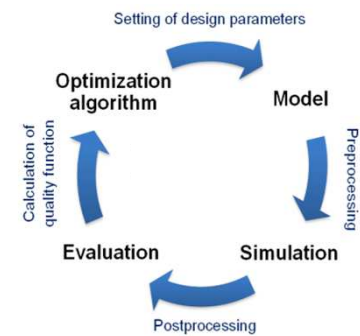
Simulation / Optimization
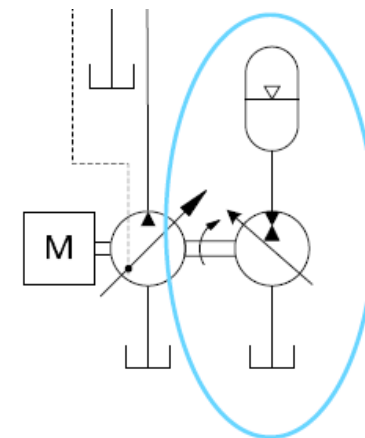
Applications

- Simulation of hydraulic systems

- Co-simulation of hydraulically-mechanically coupled systems

- Optimal system design (Multi-Physics Optimization)
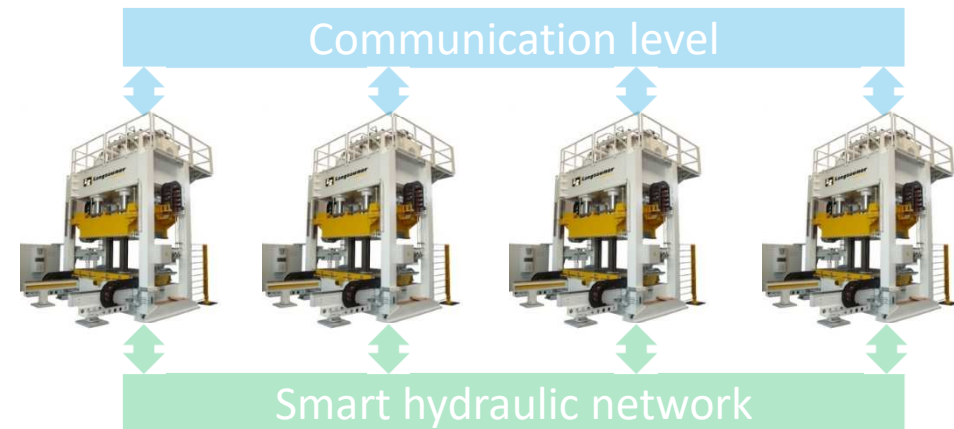
What's the benefit?

- Better understanding of the system

- Simulatory analysis of systems

- Optimal system design

Measurement | Data Mining

Applications

- Problem analysis in plants

- Identification of potential for improvement

- Verification of plant modifications

- Condition monitoring over a longer period of time (Remote Access)

I, III .... Motorischer Betrieb

II, IV .... Generatorischer Betrieb
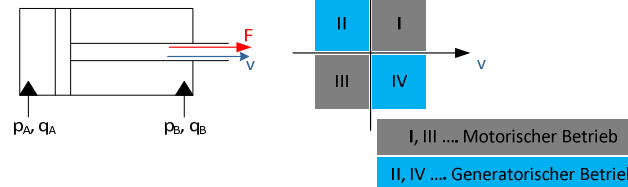
What's the benefit?

- Better plant know-how

- Troubleshooting

- Proof of machine cycles

- Condition monitoring

- No measuring equipment at customer site required

- Predictive System available

Example: Valve Development

Requirement

- Highest valve dynamics

- Minimal electrical energy consumption

- Lifetime | Last Games

- Costs

Solutions

- Total optimization

- Development of own valve electronics

- Hydraulic switching times ~ 1ms, and repetition rates up to 500Hz possible

- Adaptation of the PWM frequency to the environment (for example, adapt to the pump frequency)

- Digital hydraulic control algorithms

Example: Micro-Positioning

Requirements

- Actuator development (X, Y, Z axis)
- Accuracy <1µm
- High positioning speeds
- High robustness
- High rigidity
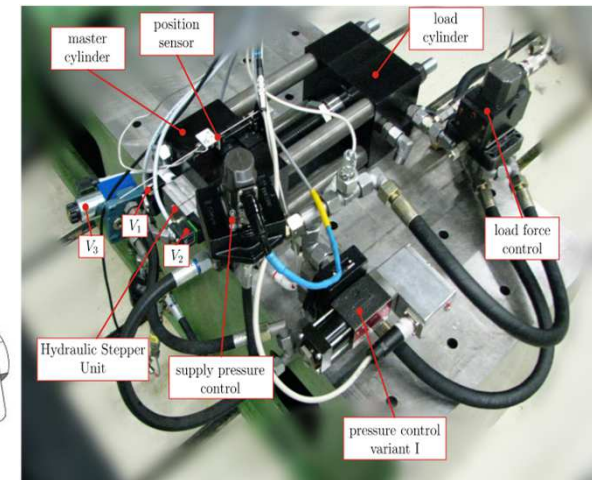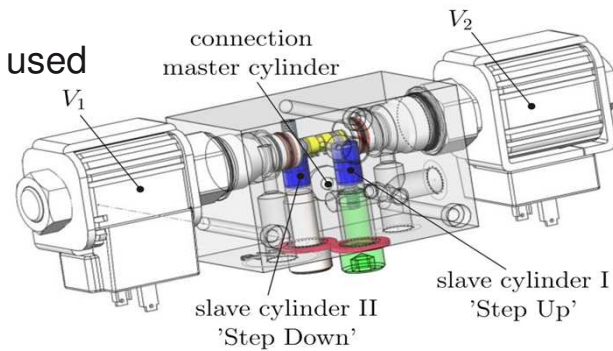- Sensor integration
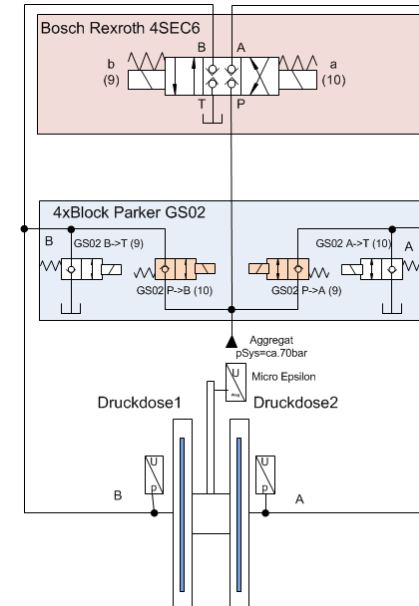
Solutions

- Spindle positioning with TM
- Highly accurate cylinder postioning
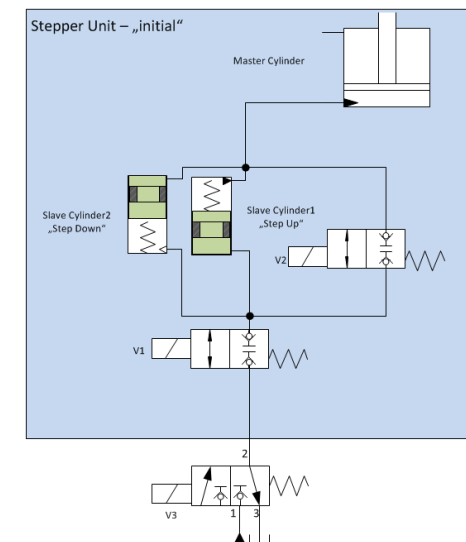- Calibration

Example: Hydraulic Stepper

Requirements

- Sensorless positioning (error <5μm)
- Compact design
- High repetition rates for the valves used
- Tightness of the valves

Solutions

- Sensorless drives
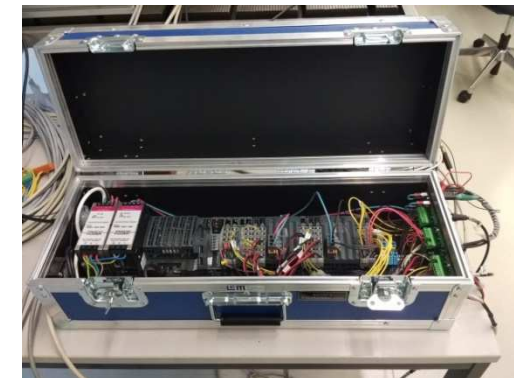- Synchronization controls
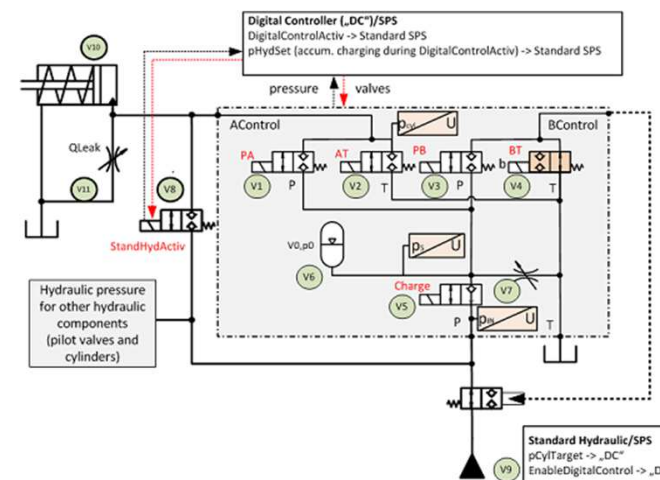- Dosing

Example: Digitalhydraulic Pressure Control

Requirement

- Control accuracy <0.2bar
- As an add-on to existing systems (presses)
- Short commissioning times at the customer
- Use in series machines

Solutions

- Pressure control in hydraulic systems (presses, clamping devices, etc.)
- High precision force control

Example: Passive/Semiactive Hydraulic Cabin Damping for Commercial Vehicles


Requirement

- Compact 4-point cab damping (electric or hydraulic)

- No mechanical stabilizers in the cab suspension

- Simple level control

- Adaptation damping on-road / off-road (semi-active)

Solutions

- Compact hydraulic system that can be operated both passive and semi-active

- Coupling of hydraulic cylinders (positive feedback)

- Sportive tuning of the cabin suspension

- Optimized system in terms of vertical, pitch and roll stiffness

Softwaretool TechCalc

TeC

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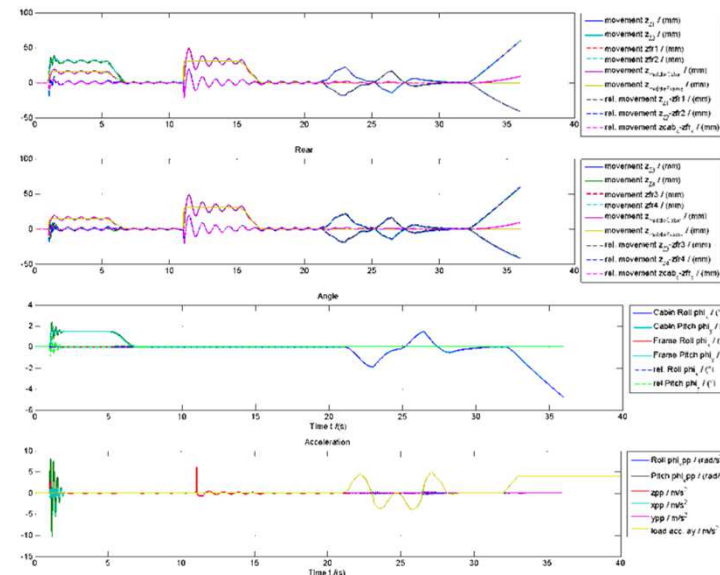
Applications

- Efficient, fast and error-free design and calculation routines in daily engineering

What's the benefit?

- Calculates in all directions (symbolic equation solution in background)

- Units are always considered

- Calculator (units, numerics, number systems)

- Notepad for each workbook

- Calculation documentation

This softwaretool can be part of **SyM**
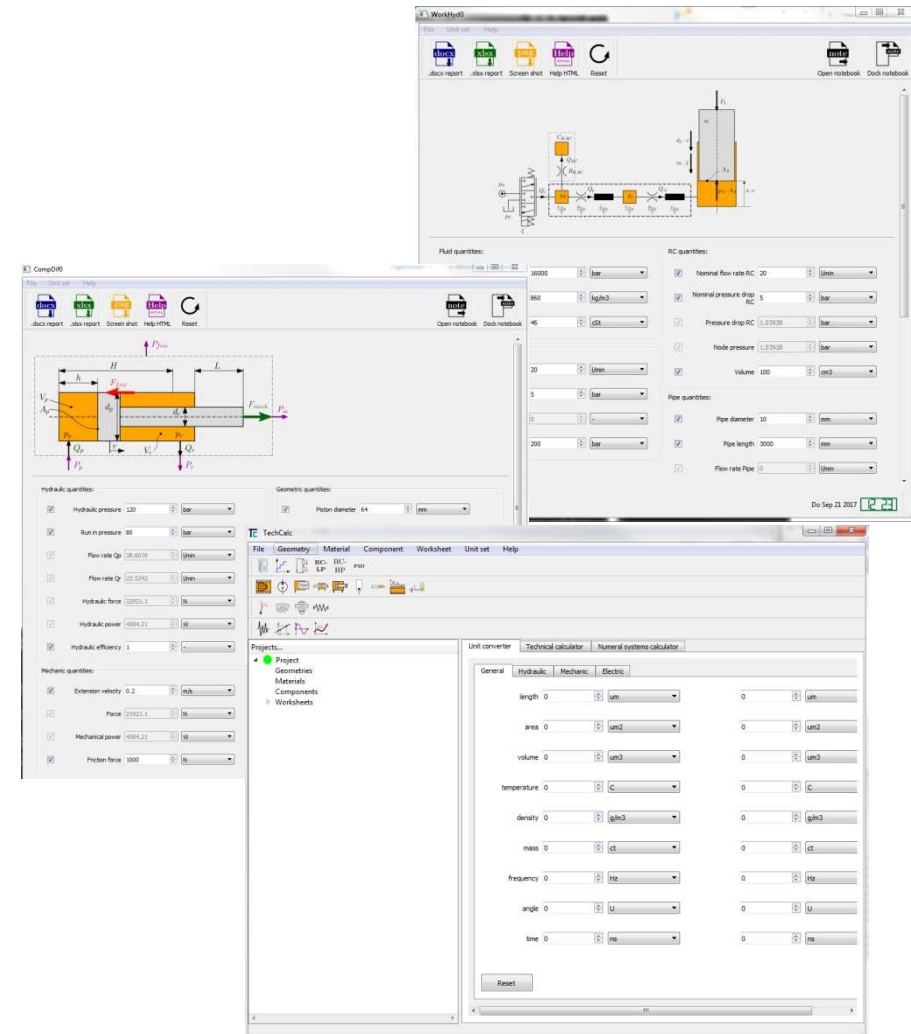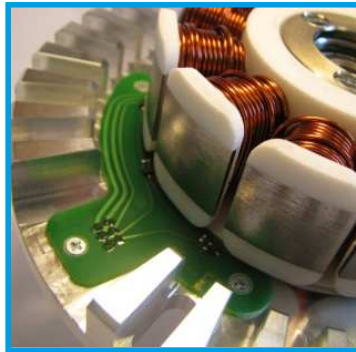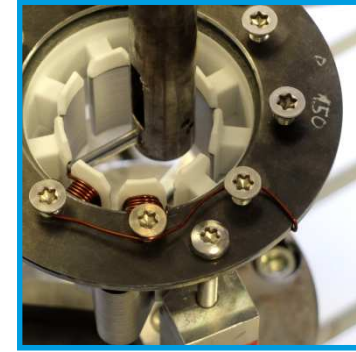
Electric Drives

Optimal Actuator/Motor

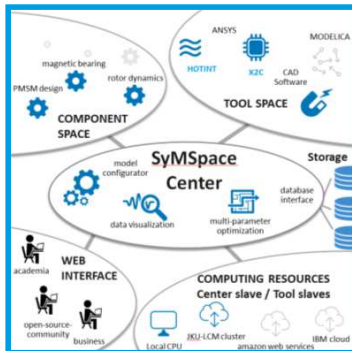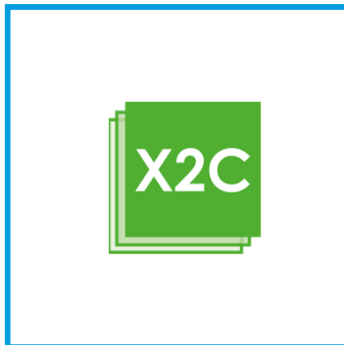**Integrated Drive Solutions**
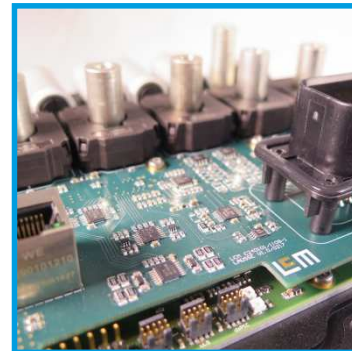

Magnetic Bearings

Prototyping

Multi-physics Optimization

Softwaretool X2C

Power Electronics
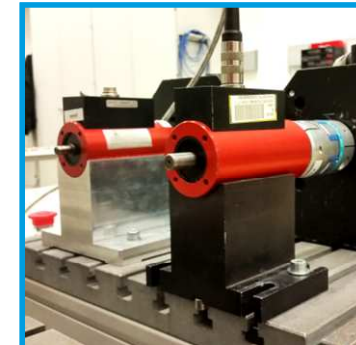
Test-Bench

Softwareplatform

Softwareplatform -Motorbox

Exampel - Hydroelectric Generator

Axial Flux Motor

Integrated Drive Solutions

Applications

Drives with integrated electronics

What's the benefit?

- Compact

- Reduced wiring

- Reduced costs

- Reduced losses

- Optimal adaptation to the conditions

- Lower interferences due to the omission of the sensor cables

Optimal Actuator/Motor

Applications

- Synchronous and induction machines, SR- machines, stepper motors
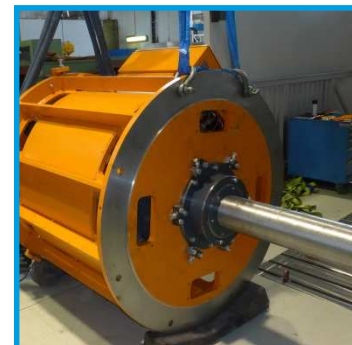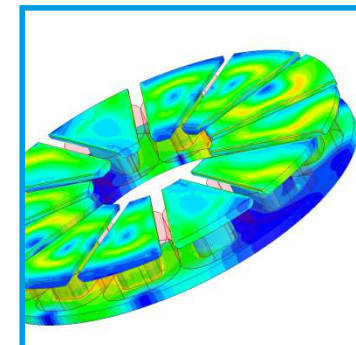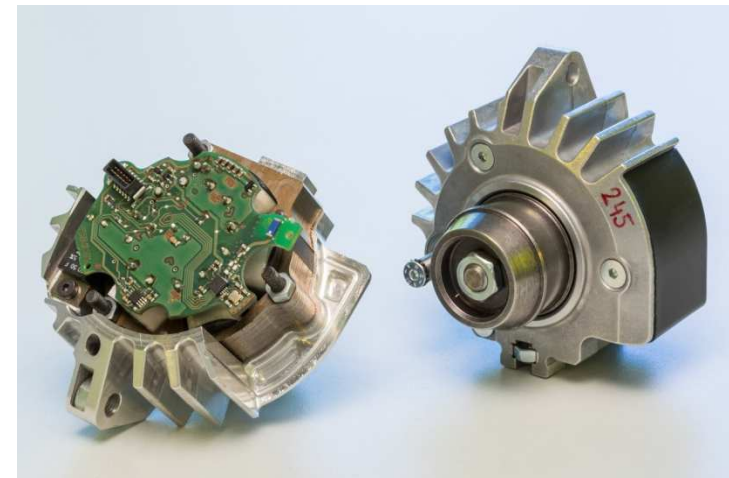
- Linear actuators, servo drives, oscillators

- Magnetic bearings, high-speed drives

- Industrial drives, gear motors

- Pump drives, magnetic valves
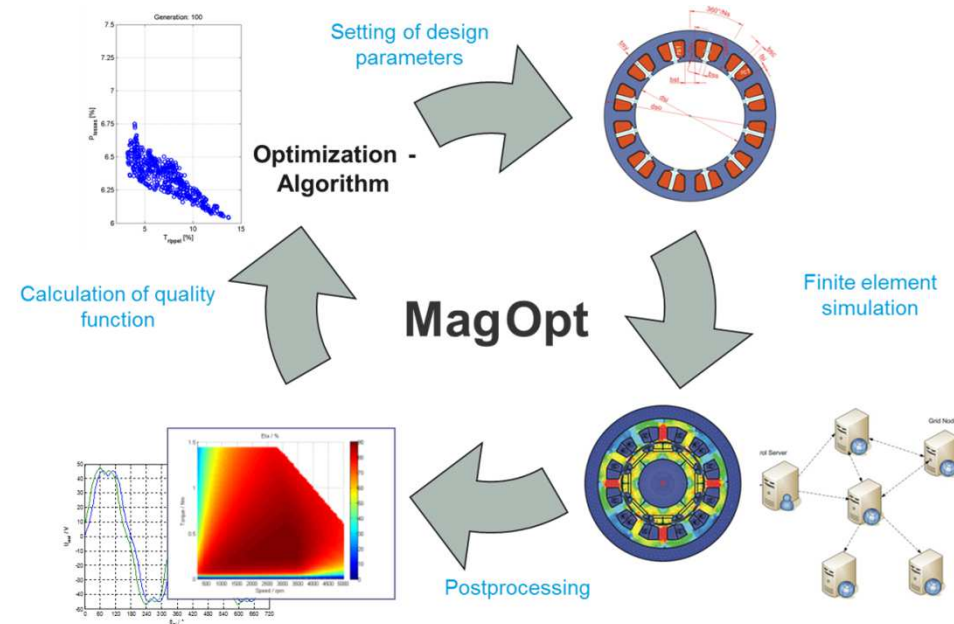
What's the benefit?

- Optimal match of the drive, electronics, and application

- Cost- and production-optimized solutions - „Design for Manufacturing"

- Optimization in terms of controllability - „Design for Control"

- Designs based on complex specifications are possible

- Designs that meet multiple boundary conditions

- Integration of customer-specific scripts (Matlab, Python, Java, ..)

Multi-Physics Optimization

Applications

Optimization of the entire system

- Magnetic

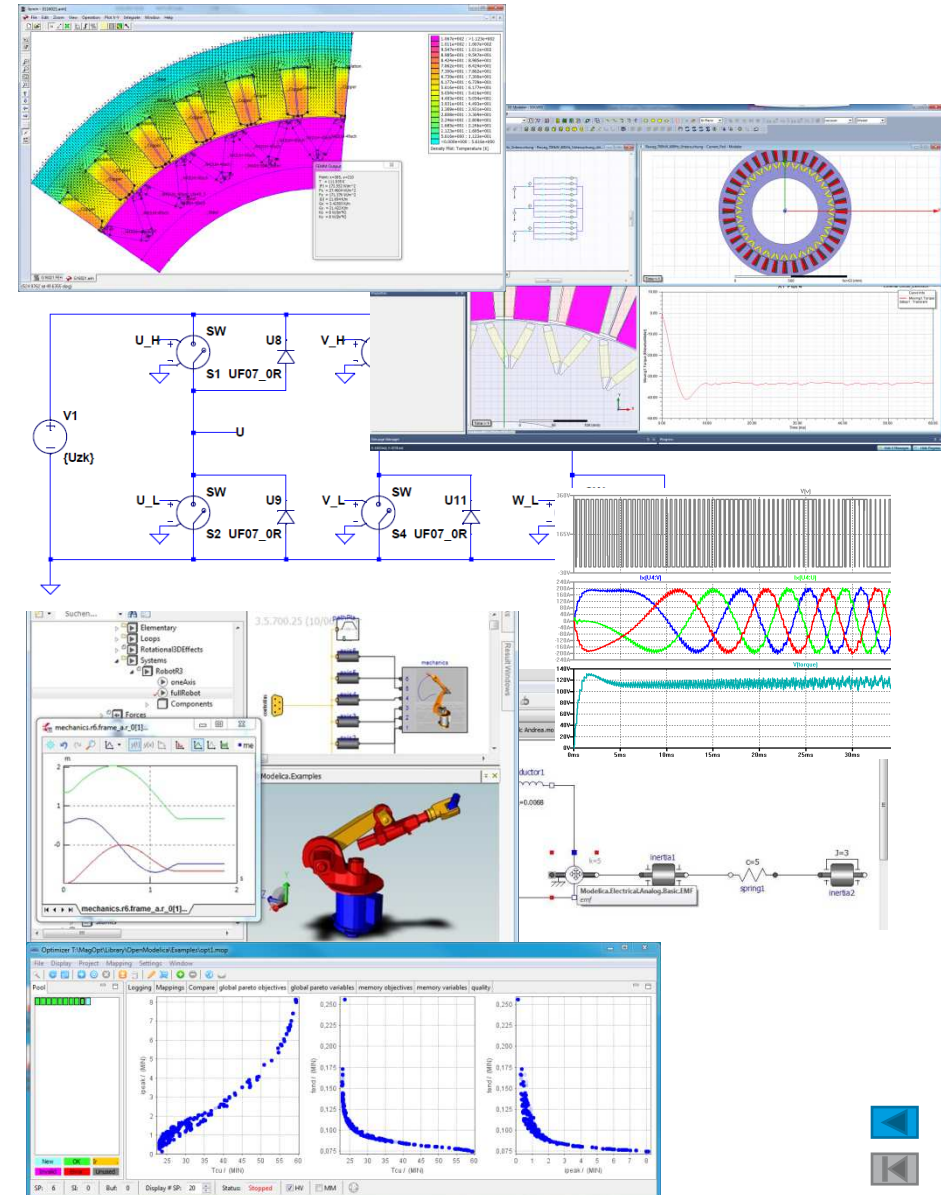- Electrical

- Mechanical

- Thermal

- Cost models

What's the benefit?

- Optimal match of all components considering multiple boundary conditions

- Cost- and production-optimized solutions

- High overall efficiency

- Minimized development risk through overall system consideration

Simulation of Magnetic Circuits

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Applications

- Optimization of electric actuators

- Analysis of existing systems

- Identification of potential improvements

- Problem analysis

- Derivation of dynamic component models

What's the benefit?

- Increased performance

- Reduced material costs

- Reduced noise (cogging, harmonics, …)

- Identification of and solutions to problems of existing systems
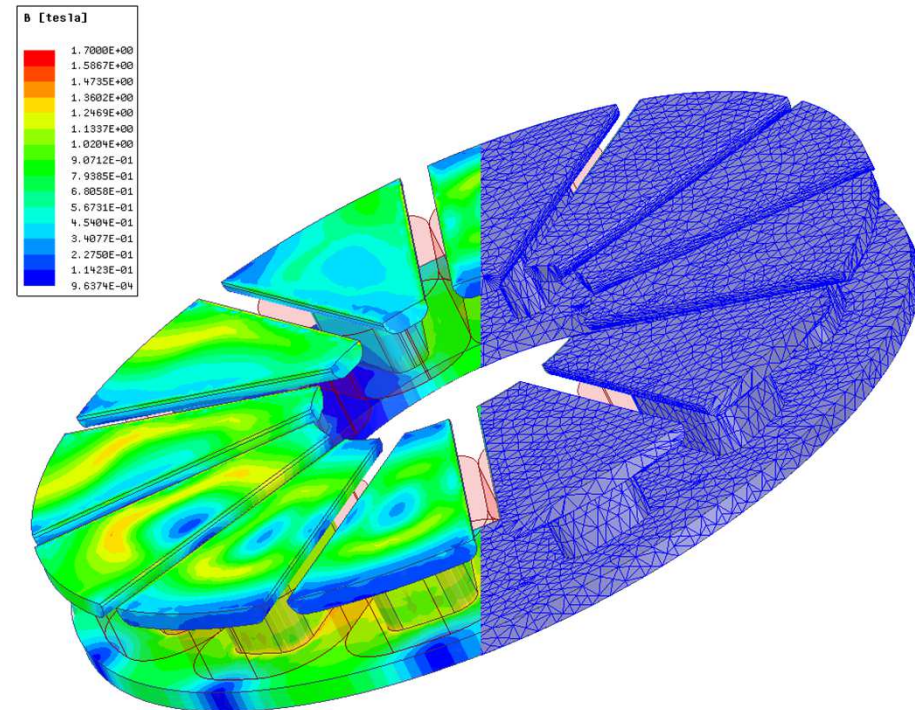
Magnetic Bearings

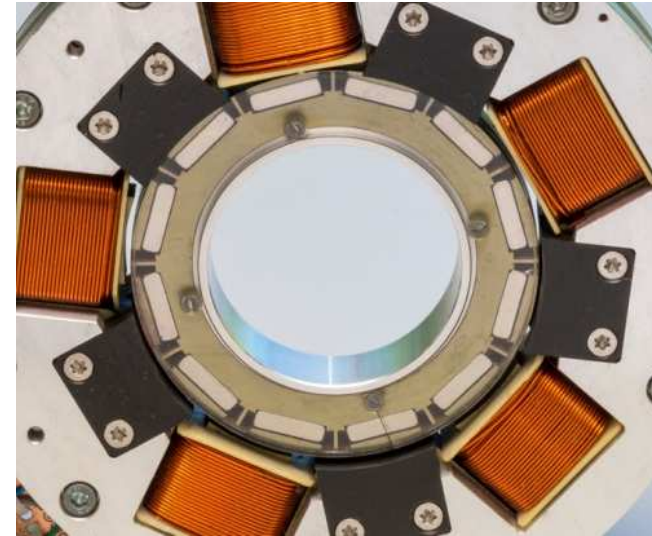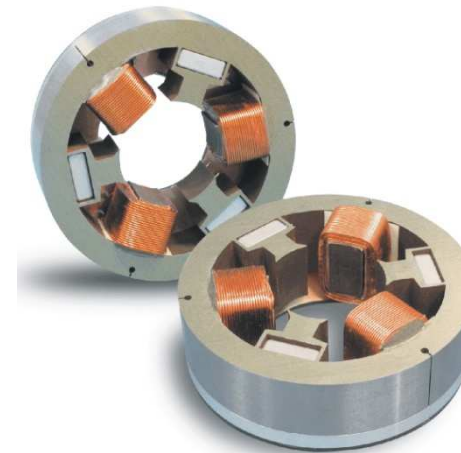## Applications

- High-speed drives

- Harsh environmental conditions

- Operation in vacuum

- Operation in hardly accessible places

- Where classical bearings are not feasible

What's the benefit?

- No maintenance of the bearings

- Low frictional losses (only air friction)

- No wear – long lifespan

- Excellent monitoring of the system

- Hermetic encapsulation of the rotor is possible

Power Electronics

Applications

- Power electronics for novel actuators and highly dynamic drives

- Innovative circuit concepts for power electronics

- Quasi-current source inverter for high-speed drives

- Silicon-carbide inverter

What's the benefit?

- Long-term experience in different industrial branches

- Optimal match of the power electronics and actuator

- Compact design and optimal utilization of the available installation space

- Cost-effective realization from low-cost to high-end products

- Design, setup and commissioning of functional models

SyMSpace – Softwareplattform SyM
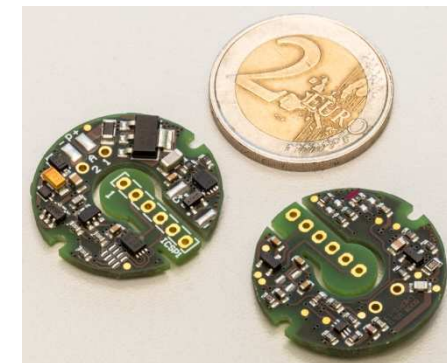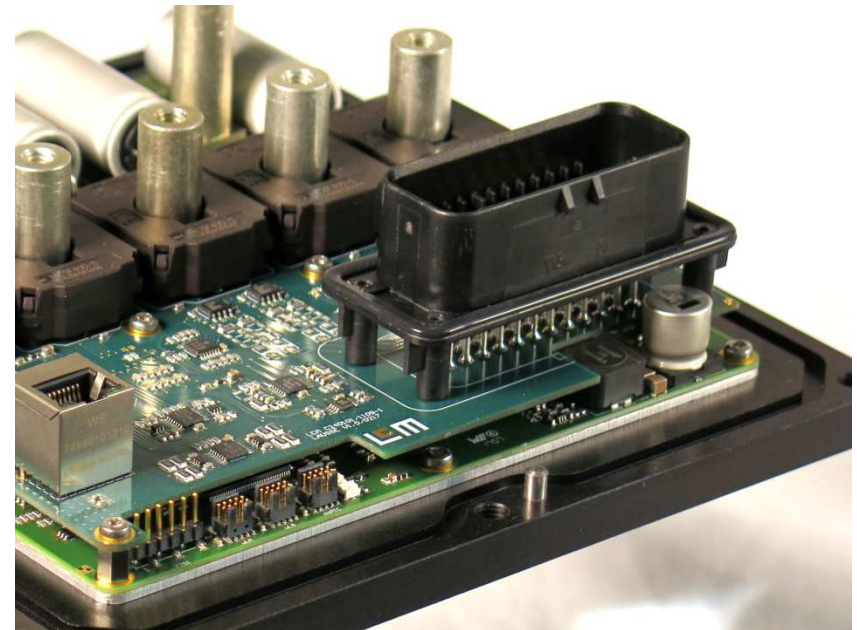
Application

- Development of mechatronic components and systems

- Optimization of mechatronic components and systems

What's the benefit?

- Reduction of expensive development time

- Reduction of costs in the prototype phase

- Reduction "time-to-market"

- Protection of performance data

- Optimized design for production

- Demand-oriented product development

- Attractive pricing models "Pay per Use"

- Modular design - expand individual functions step by step

- Easy integration into the existing SW environment

- Direct result transfer (digital twin) into a finished product

- Cloud or local - no expensive additional hardware

SyMSpace – MotorBox
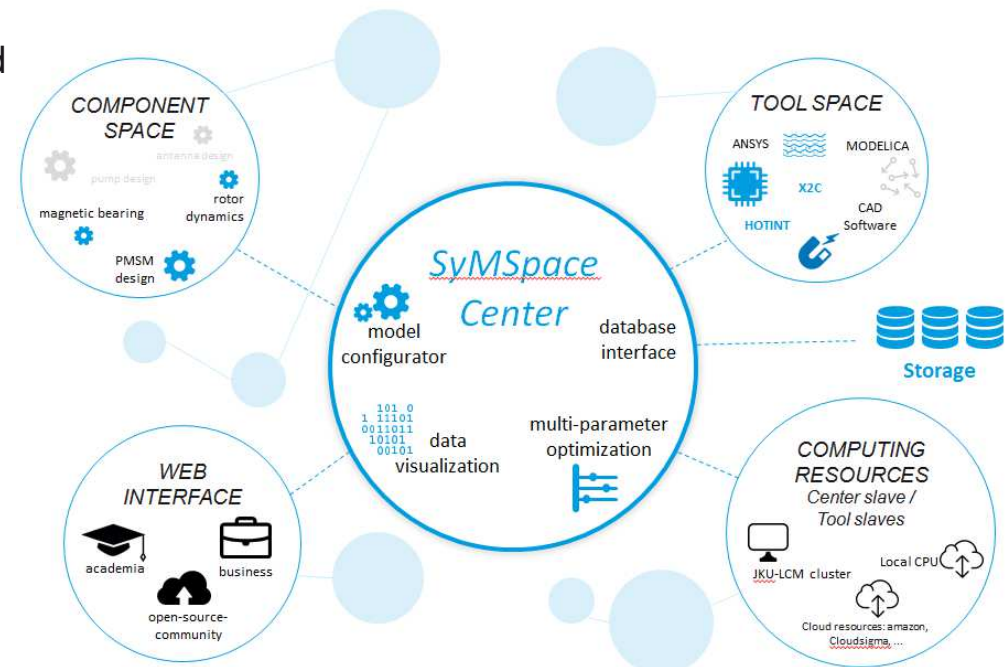
Applications

- Simulation and optimization of motors , electromagnetic actuators, magnetic bearings …

- Calculation of rotor stresses - especially important in high-speed applications

- Thermal design of electric machines
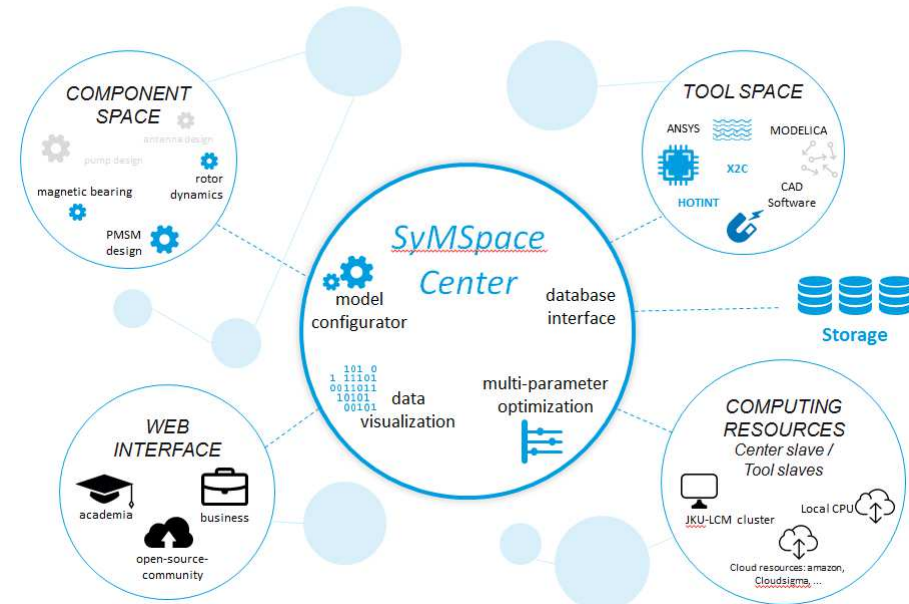
What's the benefit?

- Short development time of optimal design

- Automatic creation of the documentation and production data

- Comprehensive libraries for various machine topologies

This softwaretool can be part of SyM

VD
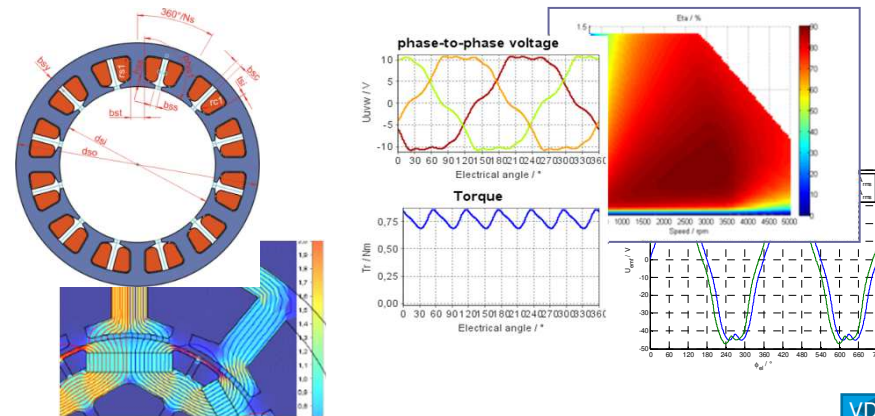
X2C – Rapid Software Prototyping Tool

Applications

- Model-based development of control algorithms for real-time systems

- C-code generator for real-time algorithms on μ-controllers und embedded systems

- Simulation of control systems

- Online system tuning und debugging
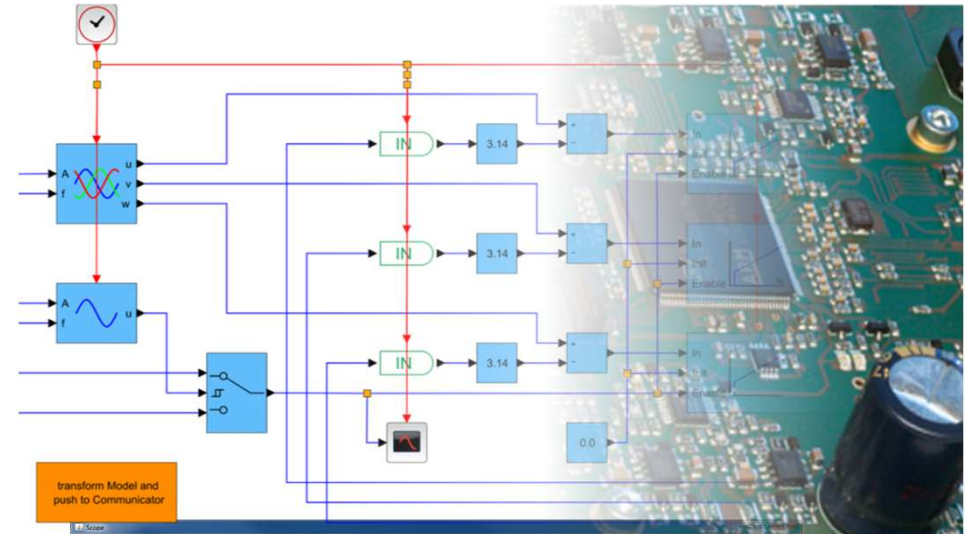
What's the benefit?

- No programming skills required

- Short development time

- Configuration and adaptation of the control in real-time

- Comprehensive and tested libraries

- Easily creatable documentation

- Easy commissioning of the system

This softwaretool can be part of SyM

Motor Test-Bench

Applications

Measurement of electric actuators/motors

- Efficiency test

- Motor characteristics

- Power range from a few wats up to 75 kW

- Test of liquid-cooled drives

- Vibration measurement

What's the benefit?

- Simple and cost-effective measurements due to our flexible test stands

- Customized measurement reports

- Fully automated measurements enable quick tests in the overload range
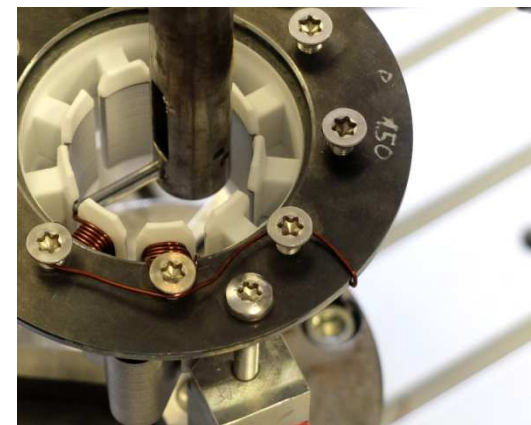
Prototyping
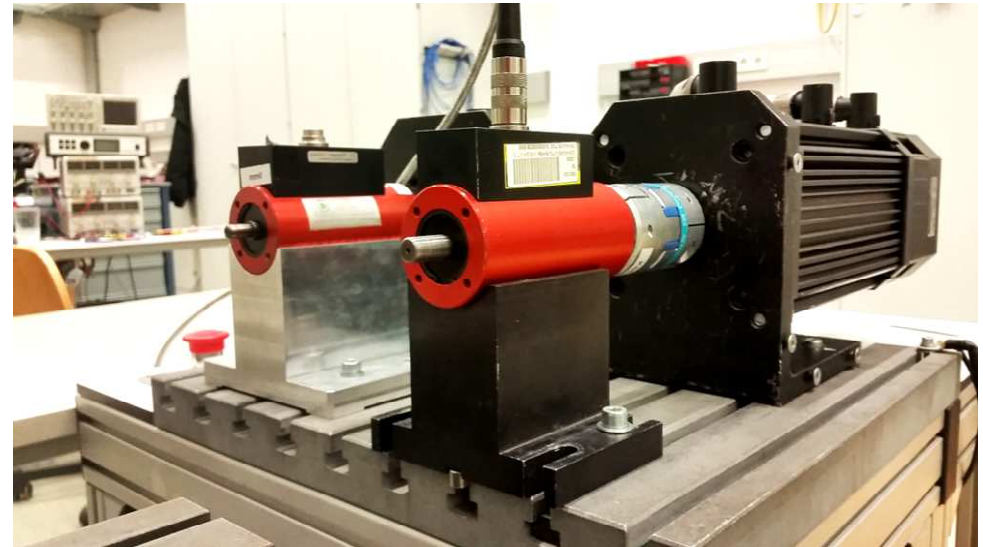
Applications

- 3D-CAD Construction
- Mechanical production
- PCB assembly
- Needle winding machine (motor windings)

What's the benefit?

- One stop shop:
  - o Design
  - o Construction
  - o Functional model construction
  - o Commissioning
  - o Control
  - o Measurement
- High flexibility
- Low organizational effort

Axial Flux Motor with Ferrite Magnets
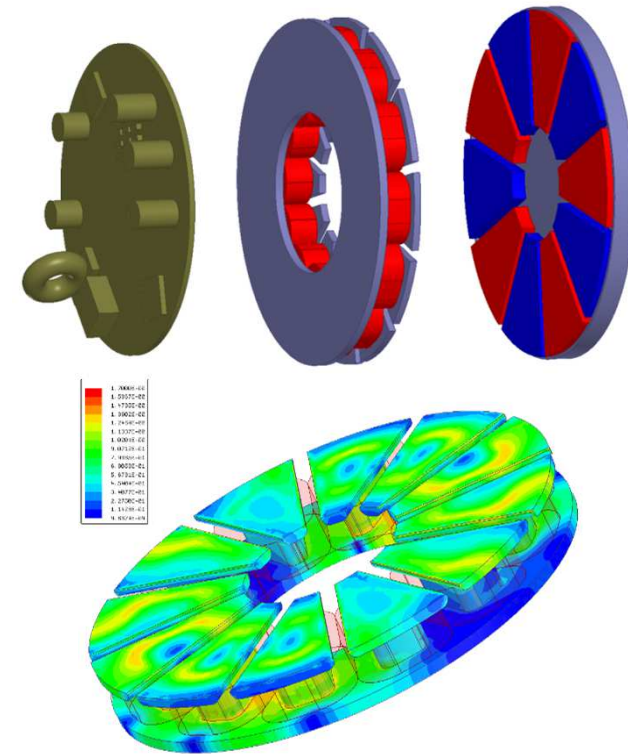

Requirement

- High torque density at a low price due to ferrite magnets
- High overload capacity
- Compact design
- 3D flux path
- Smooth operation

Solutions

- Use of SMC material (Soft Magnetic Composite) in combination with ferrite magnets
- Magnetic design in combination with thermal modeling
- Optimization by 3D-FE software in combination with SyMSpace post-processing

Example: Small Low-Cost Hydroelectric Generator

Permanent Magnet Generator on the Power Grid

Requirement

- Single quantity product (first design must fit – no chance for redesign)

- The induced voltage at idle must match the mains voltage as closely as possible

- High power factor and low current harmonics

- No active control – the generator has to be designed for a wide power range

- Permanent magnets must not demagnetize during short-circuiting

Solutions

- Parametric models provide a cost-effective design even for single quantity products

- Complex requirements can be considered and optimized

- Mismatch between the simulation and measurement below 1%
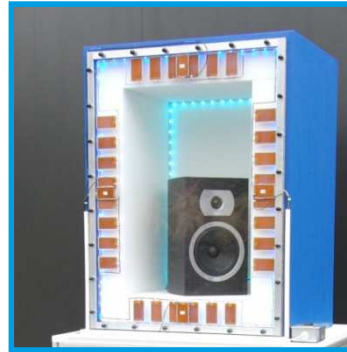
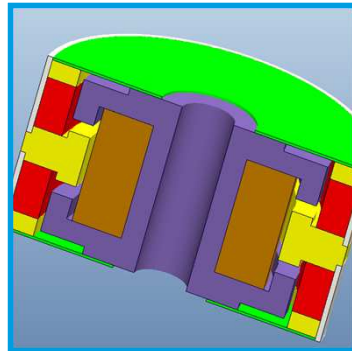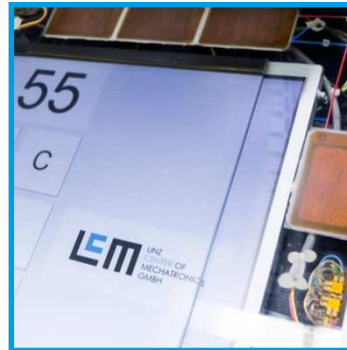| Performance Parameters	
Rotational Speed	187.5 rpm
Continuous Power Output	700 kW
Continuous Torque	36500 Nm
Efficiency	97.9%
Short-Term Power Output	900 kW
Short-Term Torque	52500 Nm

Vibration Engineering
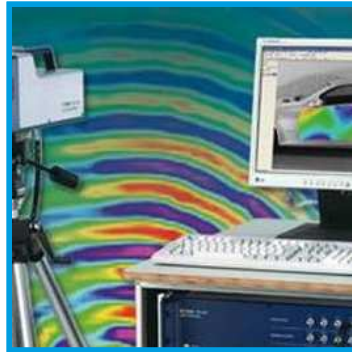
Measurement Technology

Piezoelectric Sensors and Actuators

Electromagnetic Actors
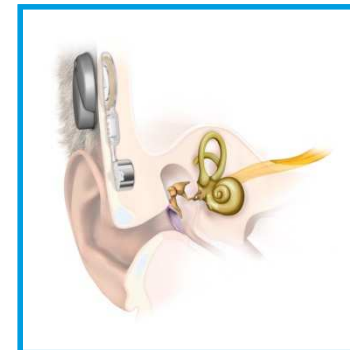

Example - Haptic Display

Control Engineering

Example - Home Appliances

Example - Automotive

Example - Bonebridge

Measurement Technology

Applications

- Modal analysis
  (eigenfrequencies and eigenmodes)

- Operational vibration analysis

- Location of acoustic sources

- Fault analysis
  (e.g. faulty bearings, inaccuracies of assembly)
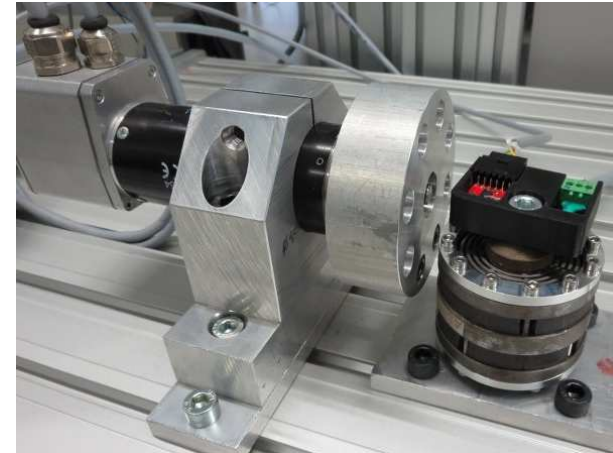
What's the benefit?

- Enhanced understanding of system behavior as basis for suggestion of design improvements or simulation models

- Detection/damping of vibration excitations

- Verification of certain system behavior

Vibration Engineering Electromagnetic
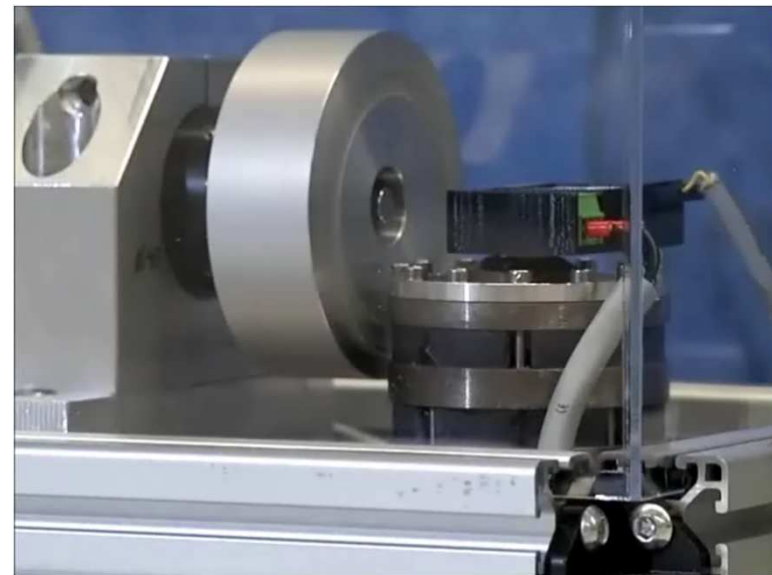
Applications

- Generation of (counter-)vibrations in the lower frequency range (< 1 kHz) with large amplitudes (> 0,1 mm)

- Mechanical engineering and construction, robotics, medical engineering, home appliances, …

What's the benefit?

- High power density / small installation space

- Actor and power electronics individually designed and optimized for specific application

- Active vibration damping and generation

- Enhancement of quality, comfort, speed,…

- Reduction of noise emissions, vibrations of machines/plants, coupling to environment (e.g. seating)

Vibration Engineering Piezoelectric

Applications

- Generation of (counter-)vibrations in a broad frequency spectrum within or above the hearing range with small amplitudes (< 1 mm)

- Sensor technology

- Medical engineering, home appliances, ventilating and air-conditioning systems, mechanical engineering and construction, robotics, …

What's the benefit?

- Large actuating forces and frequencies

- Active vibration damping or generation (reduction of sound radiation, active noise control)
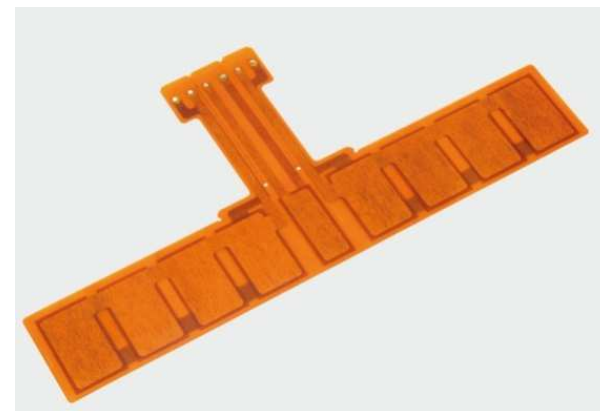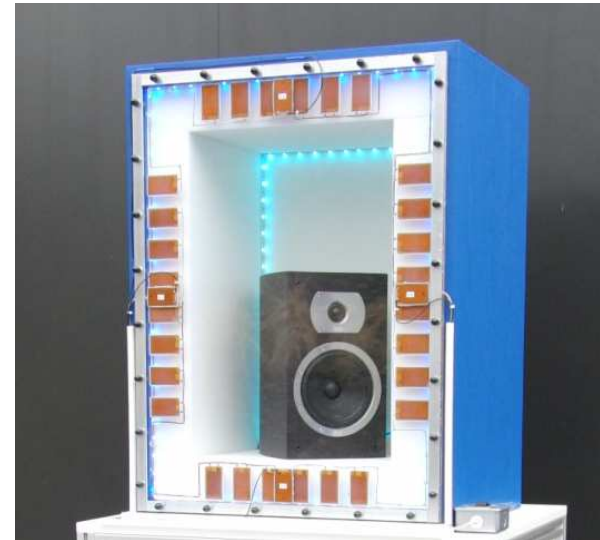
# Example: Vibration Damping in Home Appliances

Requirement

- Pumps, drives, etc. with varying speeds and, hence, varying vibration excitation

- Limited installation space for actors

- Often measures for passive vibration damping already installed

Solution

- Selection and positioning of suitable actors based on measurements and computational analysis

- Optimal control strategy for active vibration damping of a distuingished but varying frequency component

without control

with control

Sensor signal (V)

Frequency (Hz)
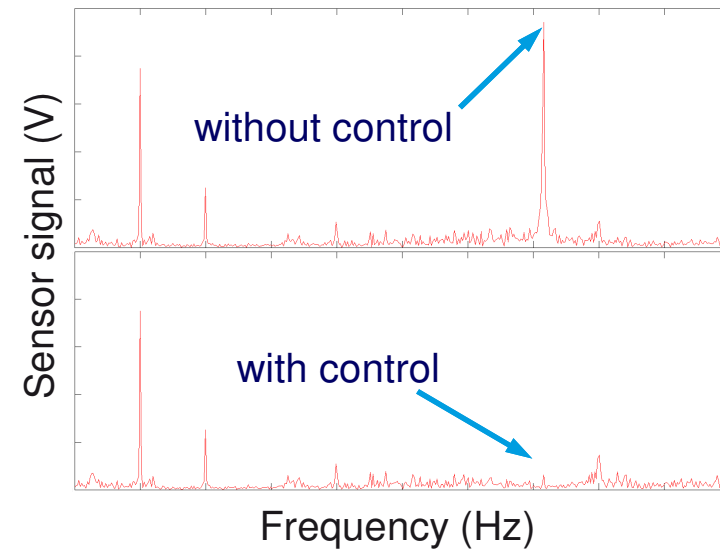
Example: Vibration Active Damping Automotive

Requirement

- Noise reduction in the vehicle interior

- Increase of driving comfort

- Improvement of the audio quality of the entertainment system

Solution

- Analysis & Simulation

- Demand-oriented design of control, actuators and power electronics

- Production and commissioning of a prototypical active damping system

- Used actuators:
  - Piezoelectric surface converter
 - Electromagnetic linear actuators
  - Loudspeaker

Vibration Engineering Control

Applications

- Systems with fast dynamics

- Requirement: control is accessible (e.g. current, torque, trajectory,…)

- Robotics, handling systems, mechanical engineering and construction

What's the benefit?

- Significantly enhanced dynamics, faster motions

- In many cases no additional parts required

- Prevention of vibration excitation or damping of (remaining) oscillations

- Protection of mechanical components
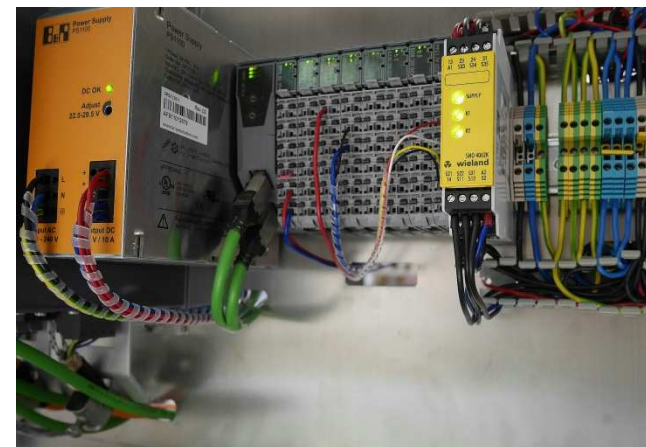
Example: Haptic-Display

Requirement

- Tactile sensation similar to a mechanical button

- Compatibility with capacitive touch sensors

- No influence in the field of vision

- Easy integration into existing systems

- Compact design and low energy consumption

- Robust construction without moving parts, simple and reliable sealing

Solution

- Patented method: jerky bending of the front panel when reaching a defined pressure point

- Recording the contact force (= pressure point) by measuring the strain in the edge area

- Active deformation of the plate by two-dimensional piezo actuators (placement also in the edge area)

Vibrant Bonebridge
World's first fully implantable bone conduction hearing instrument

LINZ CENTER OF MECHATRONICS GMBH

### *Cooperation partner: MED-EL*

Requirement

- Fully implantable system

- No skin penetration

- Maintenance-free

- Compatibility to magnetic resonance imaging (MRI)

- 90% hearing ability
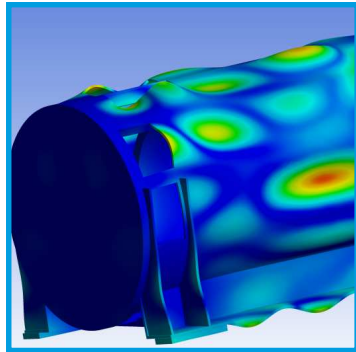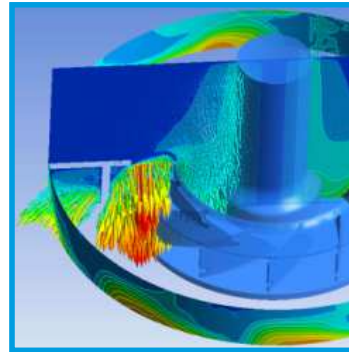 (for previously almost deaf patients)

Solution

- Design and optimization of a highly efficient electromagnetic actor taking into account strict and complex contraints

- Optimization of the inductive transfer system and the demodulator circuit
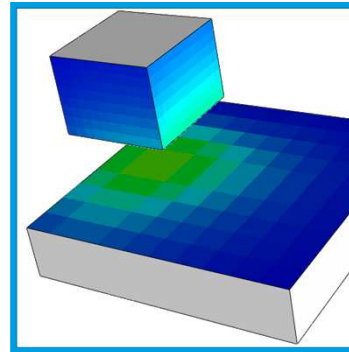
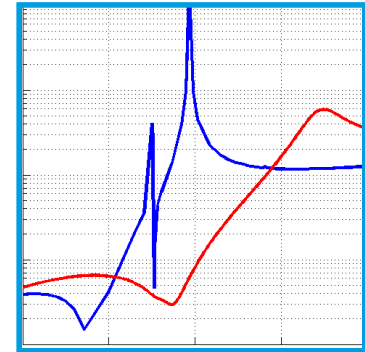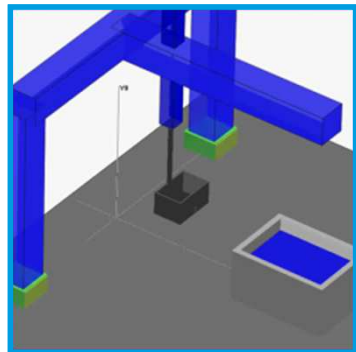- Patented MRI-compatible magnetic assembly system

Simulation

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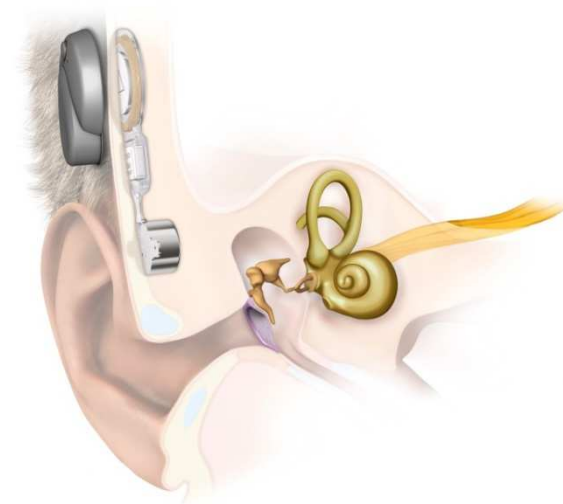
Vibro-Acoustics

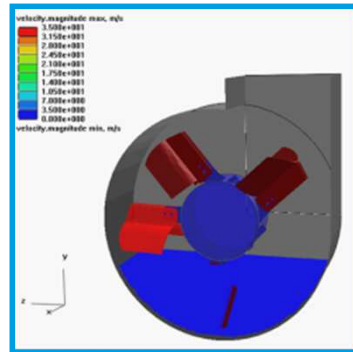**(Thermo-) Fluid dynamics**

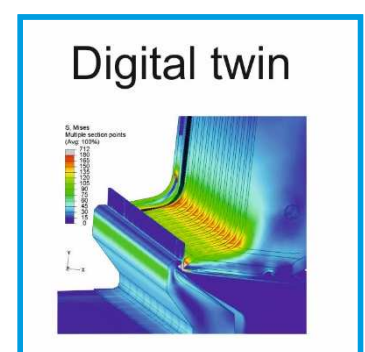**Thermo-Mechanics**

Material

Fluid-Structure Interaction

Particle-Structure Interaction
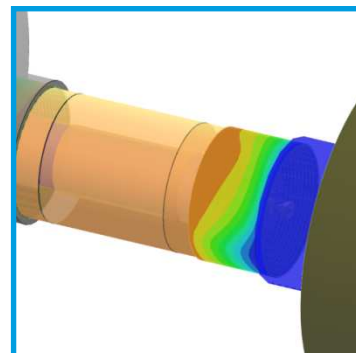
Co-Simulation
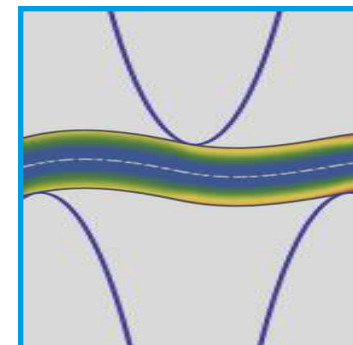Modal
Reduction
HNT
MKS
Mechatronic
Systems

Simulation Tool HotInt

Digital twin

Autonomous Digital Twin

Rotor Dynamics

Forming

Mechatronic Simulation
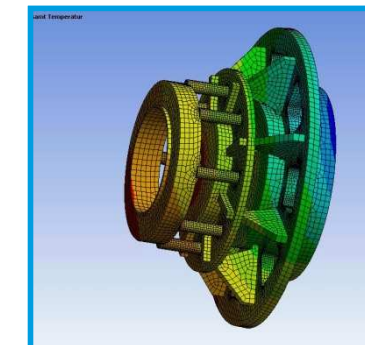
Conventional Finite Element Analysis

Vibro-Acoustic Simulation

Applications

- Prediction of vibrations and acoustic properties of/in vehicles and machines

- Acoustic analysis, e.g., airborne and structure-borne noise

- Derivation of measures to minimize spurious vibrations/noise
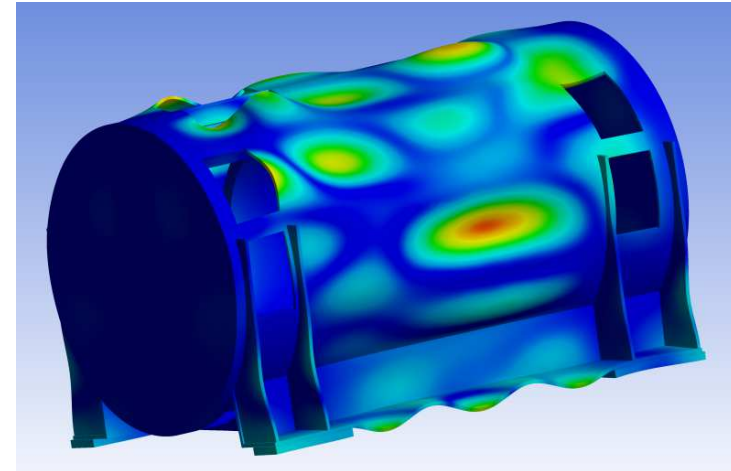
Example: alternator

What's the benefit?

- Analysis of vibration-induced noise at an early stage in the design process

- Optimization of components/systems/machines using virtual prototyping

- Design and optimization of passive and active vibration damping

(Thermo-) Fluid Simulation

Applications

- Analysis of fluid dynamics, heat transfer, and temperature fields in machines and plants

- Optimization of fluid-dynamical properties during design and development process
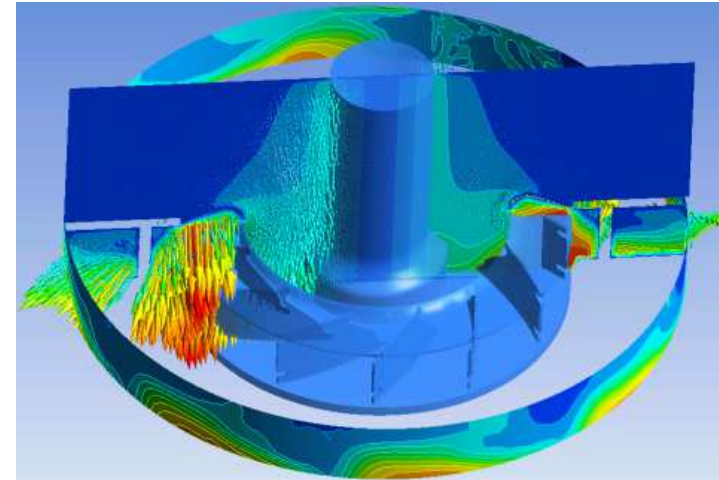
- Field of application: heat exchange / cooling, aerodynamic losses, aerodynamics, ventilating and air-conditioning systems, thermal analyses

Sample application: optimization of a radial fan

What's the benefit?

- Investigation of properties which are difficult to access via experiments/measurements

- Enhanced assessment of design variations and optimization (significant reduction of time and costs compared to tests and variations of real prototypes)

- Visualization of complex fluid dynamics

- Product/process optimization and enhancement of performance (cooling efficiency, drag coefficients, aerodynamic losses)

Simulation: Thermo-Mechanics

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Applications

- Forming and process simulation (e.g. hot forming, thermoforming)

- Analysis of heat transfer and radiation in components and tools
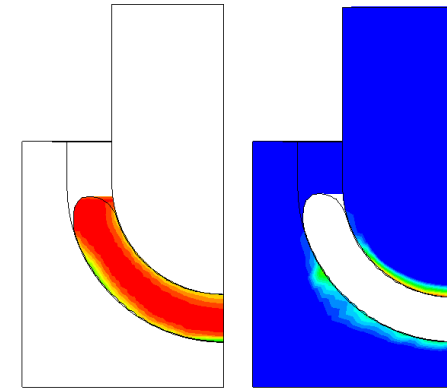
- Analysis of components subject to varying thermal conditions
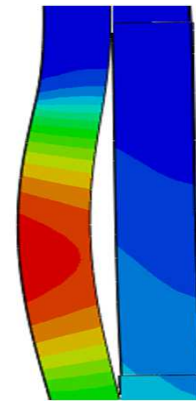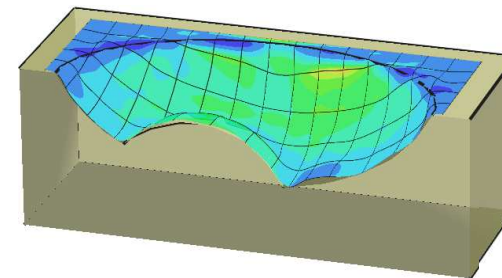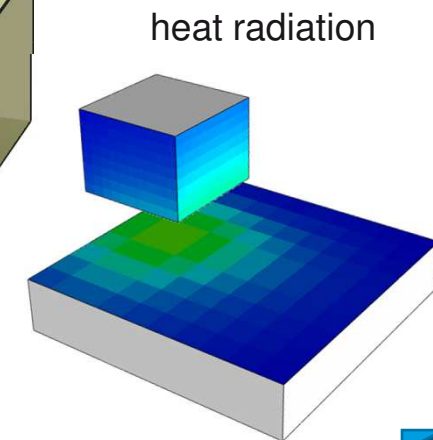

heat transfer

swaging

What's the benefit?

- Enhanced product quality due to optimized production processes and tools

- Adaption of components before the actual prototyping phase

thermoforming

heat radiation

Material Modeling and Simulation

Applications

- Modelling and simulation of metals, plastics, composite materials,…

- Various material characteristics, e.g., viscoelasticity, hyperelasticity, plasicity, anisotropy, piezoelectric, thermo- and electromechanical properties

- Homogenization of complex (hierarchic) structures

What's the benefit?

- Optimization of components (e.g. reduction of weight, costs)

- Enhanced quality of simulation results by means of an accurate modelling of the material behavior

- Model reduction and enhanced efficiency using homogenization

plasticity

viscoelasticity

Reaktionskraft (log)

— Ohne Dämpfer
— Mit viskoelastischen Dämpfern

Frequenz

Simulation: Fluid-Structure Interaction
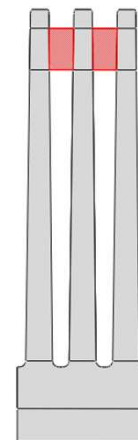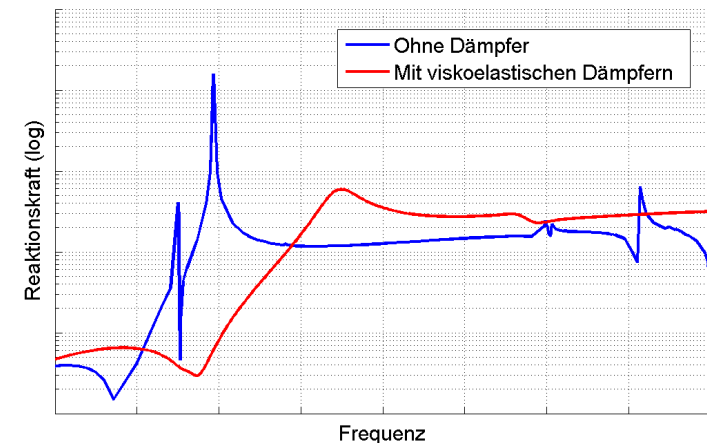
Applications

- Coupling of flexible structures with fluids

- Non-conventional fluid dynamics problems, free-surface flows, large structural displacements or deformations

- Fields of application: tank sloshing, transport processes, flow-accelerated motion/oscillation, biomechanics, offshore applications,…

What's the benefit?

- Fully coupled interaction of fluids and structures

- Understanding of complex systems and processes
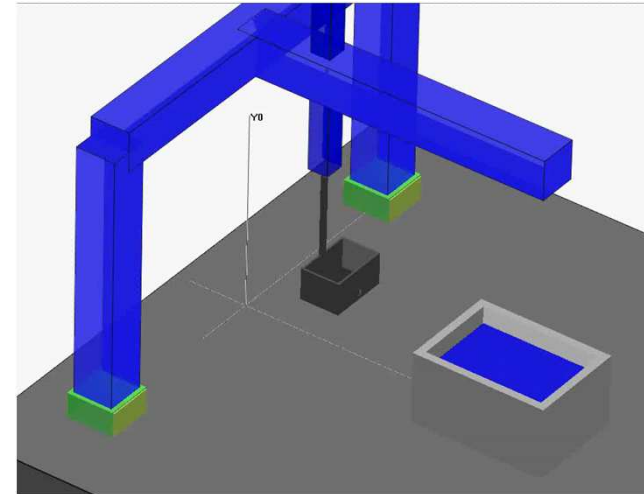
- Optimization

Example: Scooping process with a robot

Airplane ditching on free water surfaces

Simulation: Particle-Structure Interaction

Applications

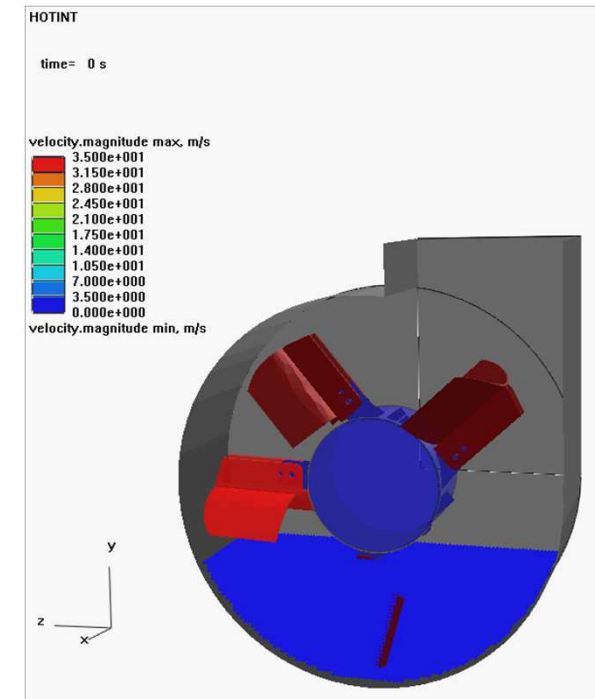- Particle systems (granular material: sand, gravel, granules,…) interacting with flexible multibody systems

- Blending and pouring processes

- Coating processes

What's the benefit?

- Enhanced understanding of complex processes

- Model-based process optimization

- Increase of quality

Simulation Tool HotInt

HNT

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Applications

Freeware / open-source tool for the simulation of complex mechatronics systems:

- Static/dynamics/modal analysis

- Realistic modeling of flexible components

- Versatile coupling of components and bodies

- Parameter identification and optimization
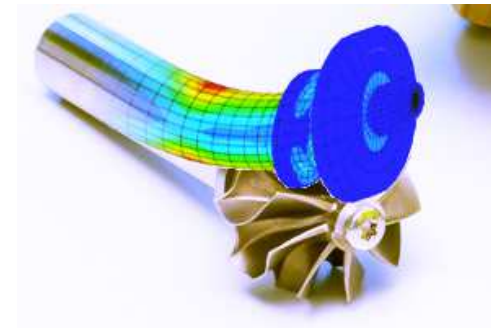
What's the benefit?

- User Interface, flexibility, modular extensibility

- Interfaces to other simulation / software tools

- Modular framework for efficient modelling and implementation of problem-specific solutions

---www.hotint.org---

This softwaretool can be part of **SyM**

VD
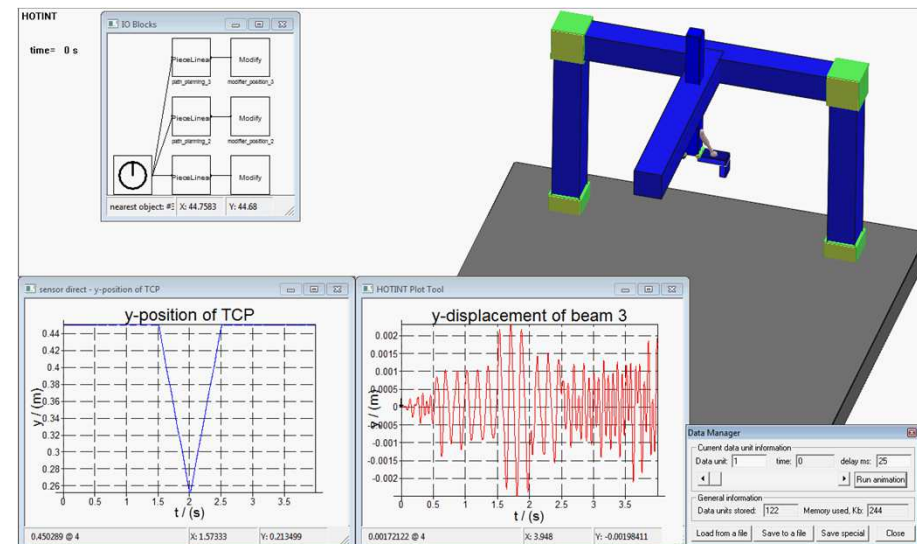
Autonomous Digital Twin

Applications

- Virtual prototyping

- Adaptive production processes

- Digital product development

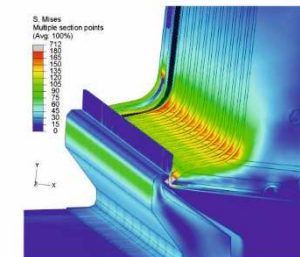- Fields of applications: machine tools, industrial plants

What's the benefit?

- Enhanced product quality

- Optimized machine design

- Reduction of commissioning efforts

- Reduction of errors, optimization of operation

- Lot-size one production

Real production system
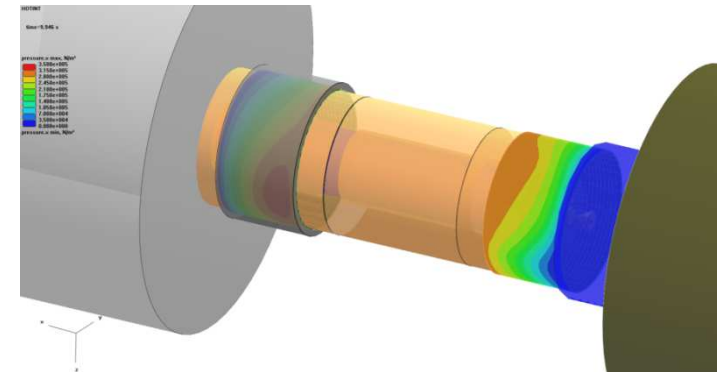
P4

Digital twin

S, Mises
Multiple section points
(Avg: 100%)

Simulation: Rotor Dynamics
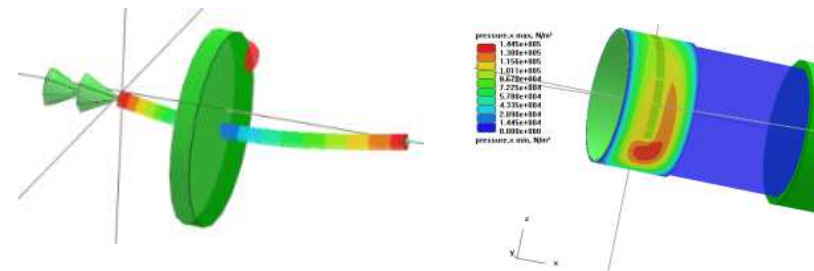

Applications

- Efficient modeling and simulation of rotor systems

- Analytical and numerical bearing models

- Campbell diagrams, spectrograms, FFT analysis

- Application example: run-up simulation and modal analysis
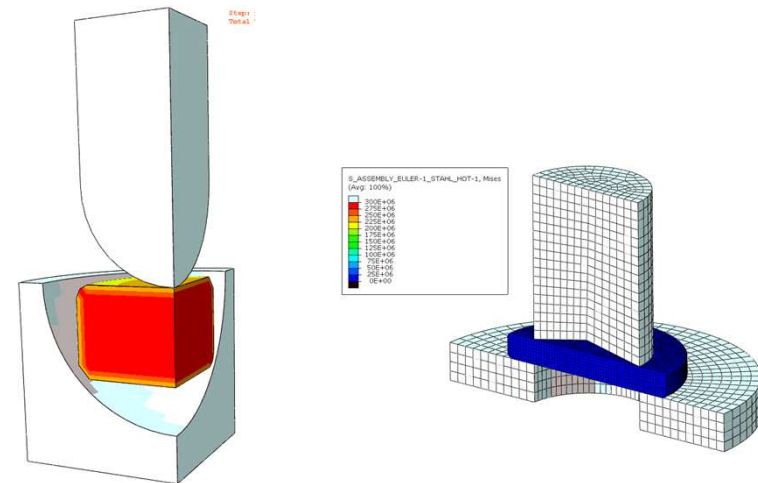
What's the benefit?

- Design and optimization of (high-speed) rotors / drives / bearings

- Reduction of losses, vibrations, dynamic stresses

- Strength analysis

Simulation: Forming

Applications

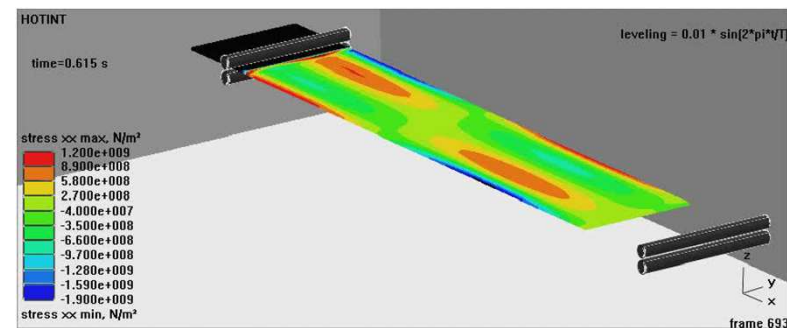- Stell production (roughing, rolling, levelling)

- Metal processing (bending, cutting, punching, swaging)

- Thermoforming of plastic films

Example: metal processing

What's the benefit?

- Enhanced understanding of the process

- Efficient production by means of process optimization

- Enhanced product quality

- Reduction of costs due to minimization of rejects

Example: rolling process

Mechatronic Simulation

Applications

- Virtual prototyping

- Simulation of coupled mechatronic systems

- Fields of application: complex processes in the steel industry, mechatronic systems in the field of automation, robotics, automotive
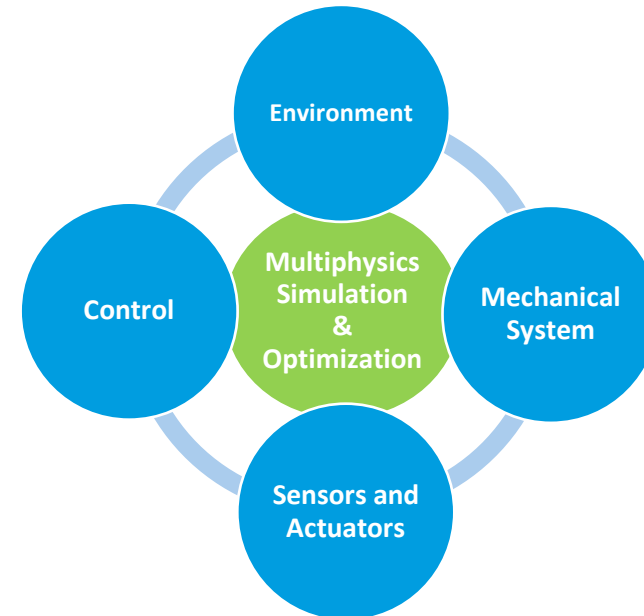
What's the benefit?

- Model-based product design and development

- Reduction of development times / time to market

- Optimization of systems and processes

- Enhancement of efficiency

Conventional Finite Element Analysis
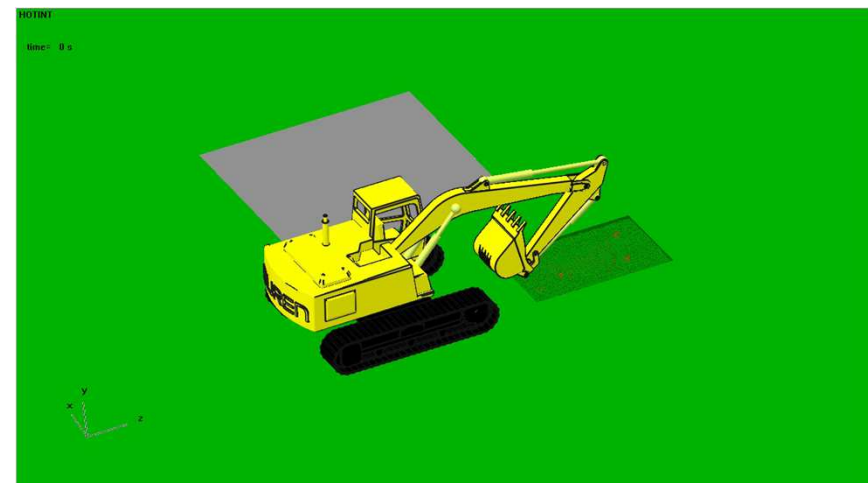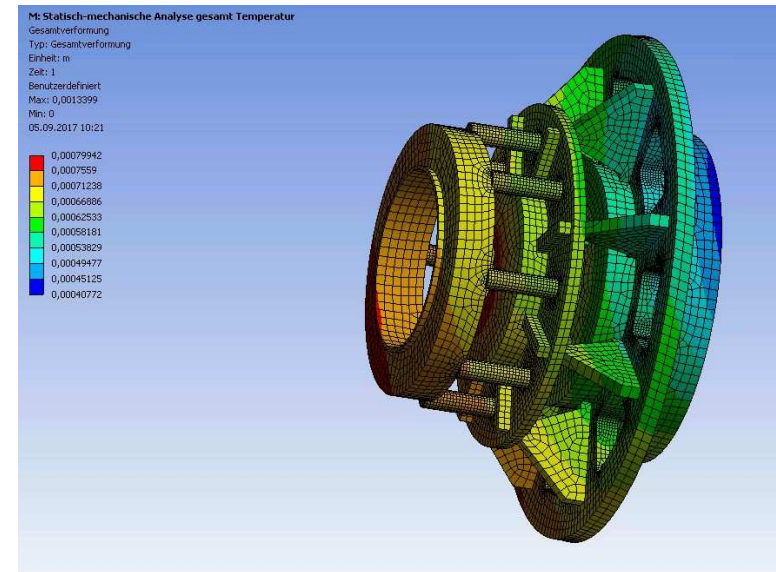
Applications

- Static, dynamic, transient analysis
- Modal analysis
- Modeling of complex geometries, materials, loads, contacts,…
- Topology optimization

What's the benefit?

- Assessment of strength and fatigue limits already during the design phase
- Virtual design and optimization
- Problem identification
- Parameter variation

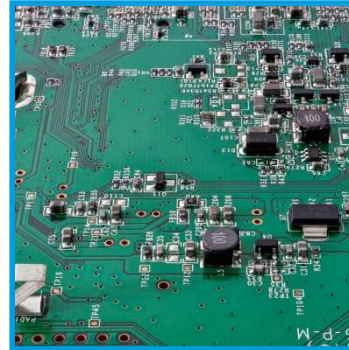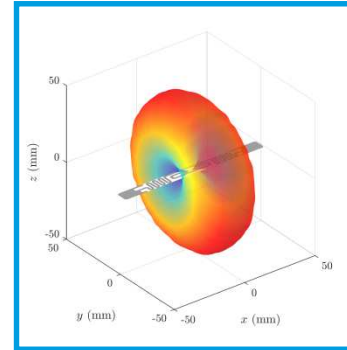Sample application: static FE analysis

Electronics, Sensornetworks and Wireless Communication

Electronics

Circuit Simulation

Field Simulation

Wireless Sensor Networks

Example – Smart Real time Positioning System optimized for power consumption

Example - Automotive Sensornetwork
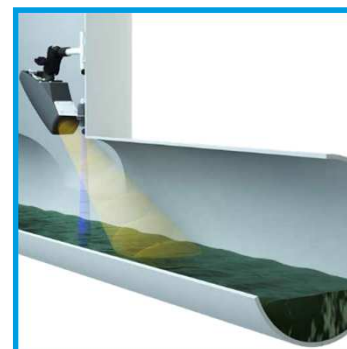
Example - Radarmeasurement in Sewer

Example - Lowpower Wireless Communication

Electronics
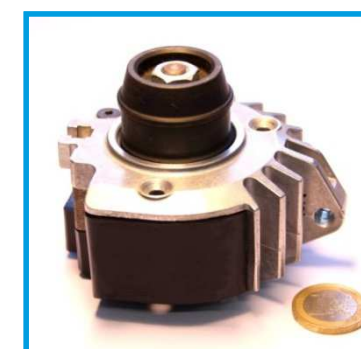
Application

- Concept and design of circuits
- Concept and design of firmware
- Development and production of PCBs
- Miniaturization and mechanical integration
- Automatic placement of components

What's the benefit?

- In house development from the first idea up to the production of prototypes
- Electronic that fits the application
- Electronic and firmware from one supplier
- Design of low power electronics
- Energy self-sufficient with energy-harvesting

Circuit Simulation

Application

- Frequency and time domain analysis

- Tolerance analysis

- Filter calculation and simulation

- Temperature distributions

- Simulation and validation of high-speed channels

- EMC analysis

- Analysis of power and signal integrity

What's the benefit?

- Saving development steps with simulation

- Accurate analysis of critical components from concept phase on

- Circuit optimization already in the development phase (energy consumption, temperature, disturbance radiation, production costs)

Field Simulation

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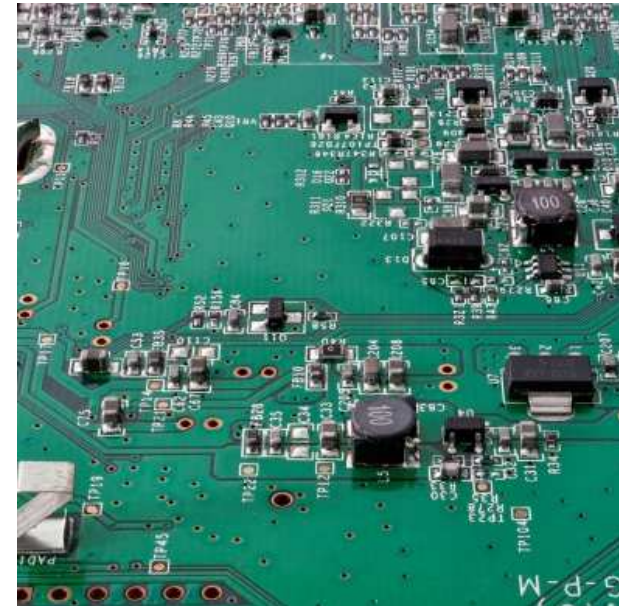
Application

- 3D field simulation of RF components

- Antenna simulation and optimization

- Frequency domain EM Solver

- Transient EM solver
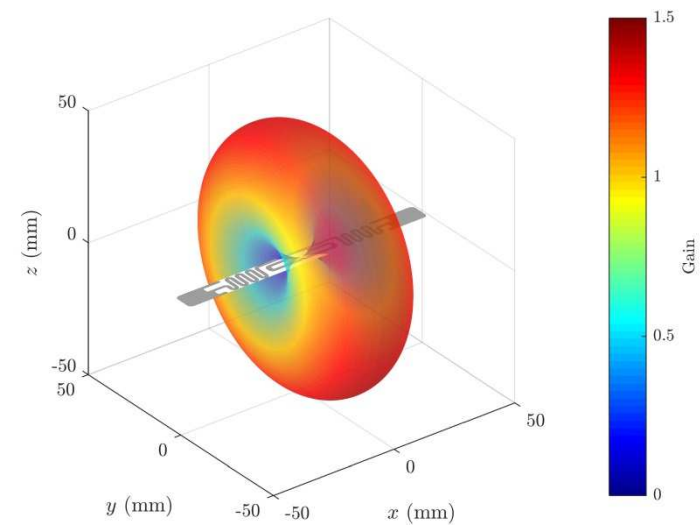
What's the benefit?

- Integration, simulation and optimization of RF components in actual installation situation

- RF interference analysis

- Antenna design customization and optimization

- Complete system simulation from transmitter to receiver

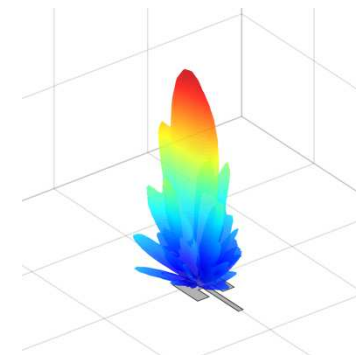# *Wireless Sensor Netzworks*

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Application

- Wireless communication between self-sufficient sensor nodes and / or gateway infrastructure in industrial applications
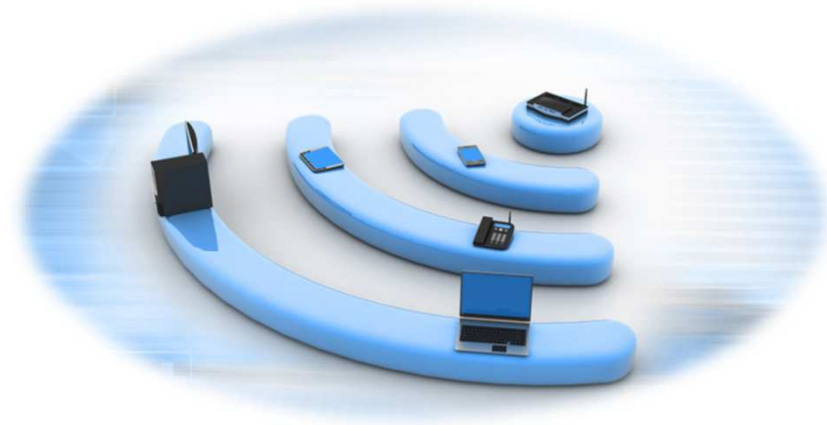
What's the benefit?

- Real-time capability

- Robustness and transmission reliability (diversity)

- Energy-optimized for long battery life or energy harvester operation

- Assignment of radio subscriber to physical sensor node

- Security, authentication

Quelle: http://www.temperaturealert.com
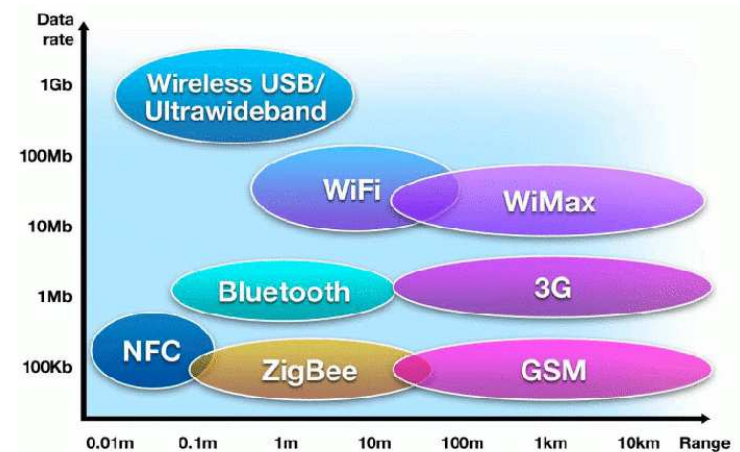
Example: Real time Positioning System optimized for power consumption

Application

- Energy-efficient localization systems
- Real-time location system for farm animals
- Complete system development from the animal's ear tag via base station to localization and pattern recognition software

What's the benefit?

- Long duration of life of the tags (> lifespan of the animals)
- Real-time data of all animals available
- Early detection of diseases
- Optimization of insemination dates
- Reduction of medication consumption
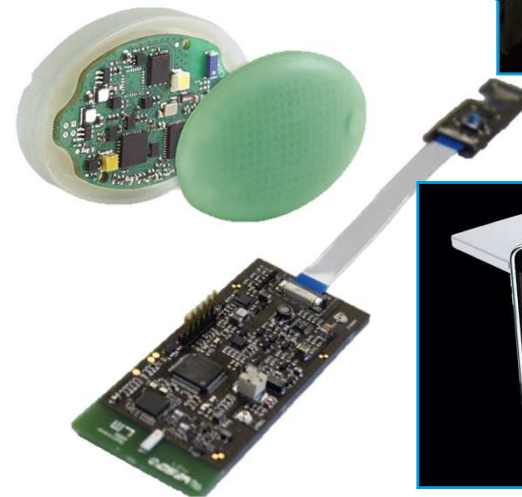
Example: Radarmeasurement in Sewer

Application

- Measuring system for sewer

- Radar system for measuring flow velocity and volume

- Intrinsically safe electronics - operation in potentially explosive environments
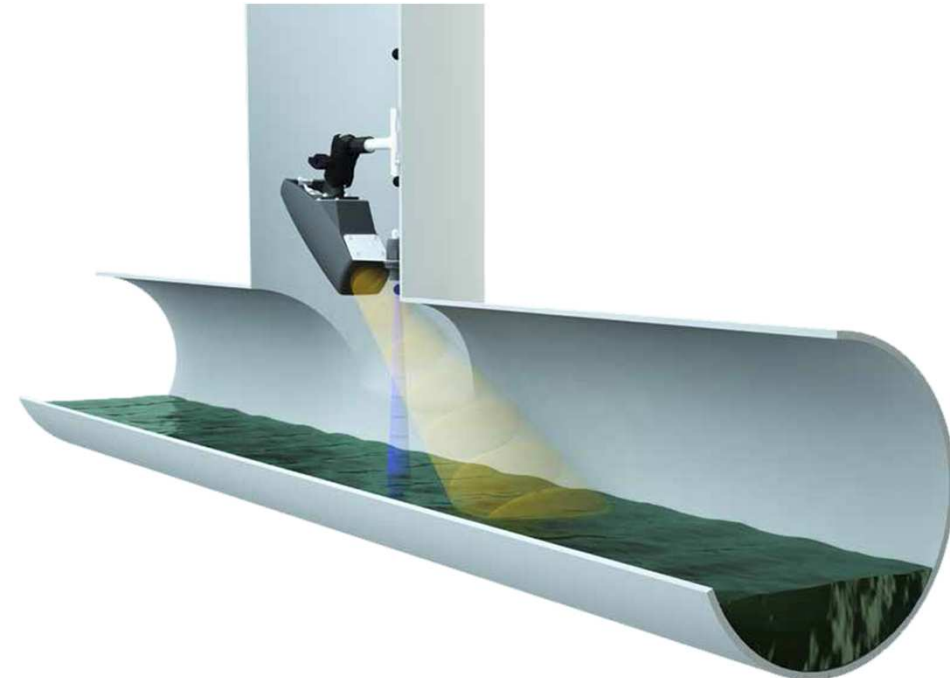
What's the benefit?

- Accurate determination of consumption and billing in industrial plants

- Possible use even at very low flow rates

- Intrinsically safe electronics development enables ATEX certification

Example: Automotive Sensornetwork

Requirement

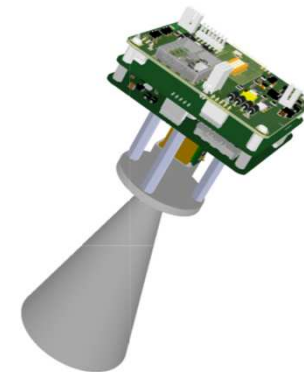- Equipment of test benches with a large number of sensors

- Equipment of machines or production lines with distributed sensors for condition monitoring and predictive maintenance

Solutions

- Setup station is moved away from the test bench (no set-up time at the test bench)

- High number of simultaneously localizable nodes

- Power supply of sensor nodes via solar cells

- Sensor - data series assignment happens automatically via the sensor position

- No cabling
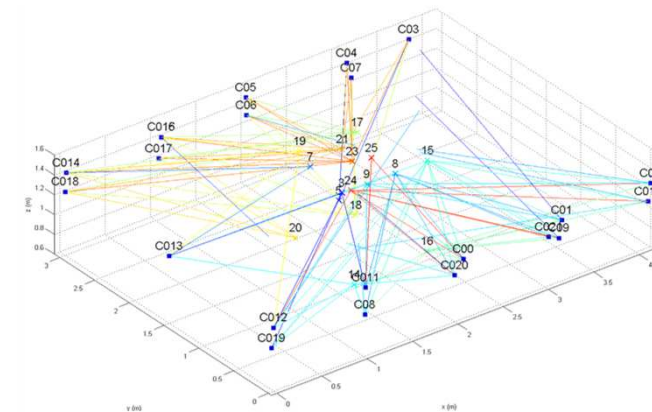
Example: Lowpower Wireless Communication

Requirement

- Energy-saving wireless communication between contactors for bidirectional transmission of operating data and setpoints

- Energy harvester "Dynamo" (brushless DC Generator from 60 to 4000 rpm)

- Network assignment via RFID

- Cabling of the sensors is almost impossible due to the rotation

Solutions

- Several systems can operate in parallel without losing the data assignment.

- Enables the detection of yarn breaks without the need for cumbersome wiring
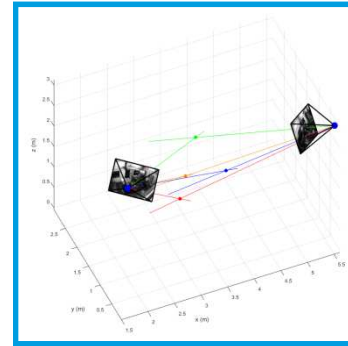
Localisation / Positioning

UWB

Optically

Bluetooth

Example - Mining

Example - Magic Shoe

Example – Smart Bow

Localisation using UWB

Applications

- 2D or 3D localization of mobile tags for tracking objects, people, animals - planes or vehicles
- Indoor navigation systems
- Monitoring of security areas
- Wireless position controls
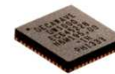- Automated tracking of goods flows
- Data for behavior analysis

What's the benefit?

- High accuracy from cm to dm range
- High achievable measuring rates
- Small size, long battery life
- Simultaneous transmission of data e.g. additional sensors
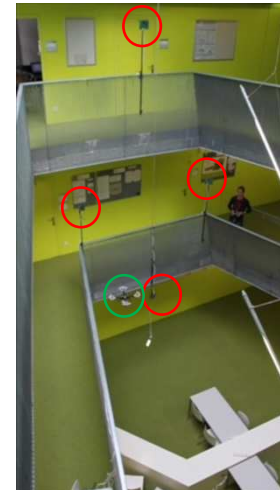- Robustness against multipath propagation, applicable even in difficult environments
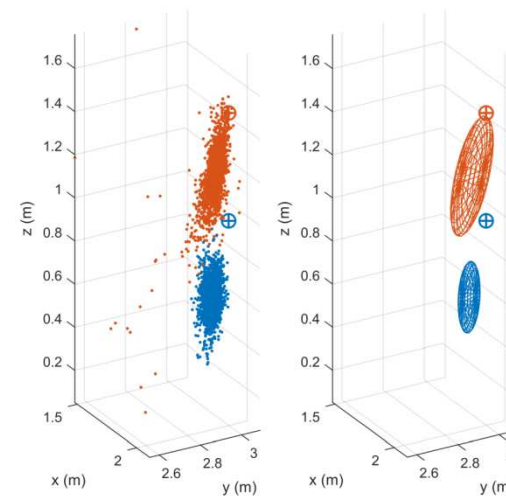
Anchor ○

Tag ○

Video

3D-Localisation

Optical Localisation

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Application

- 3D localization of wireless sensor nodes in low-pollution areas

- Localization of smartphones and other systems that can emit coded light signals

- Tracking Position and Orientation of Mobile Vehicles by Visual Odometry or Simultaneous Localization and Mapping (SLAM)

What's the benefit?

- High accuracy down to the mm range

- High number of simultaneously localizable nodes

- Energy supply of sensor nodes via solar cells

- Possible Combination with image recognition for person detection or monitoring of security areas
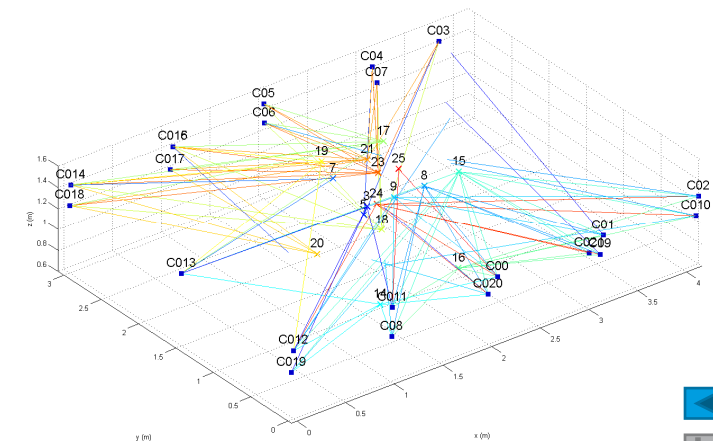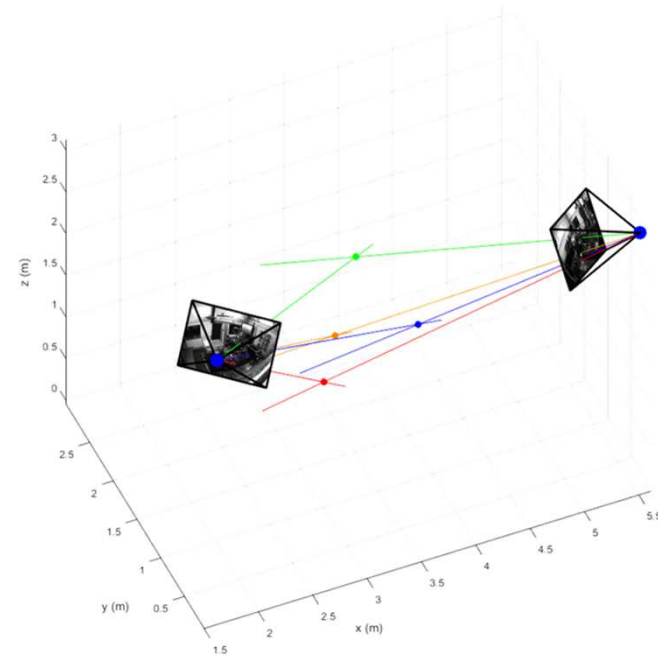
Bluetooth Localisation

Application

- Localization of individuals in retail, industrial or office environments

- Presence detection of persons in certain rooms

- Indoor navigation systems for emergency application

- Asset tracking with accuracies in the meter range

What's the benefit?

- Use of commercially available smartphones as a mobile, localized device without additional hardware for the user

- Possibility for simultaneous data traffic for the transmission of additional information

- Long battery life of Bluetooth beacons
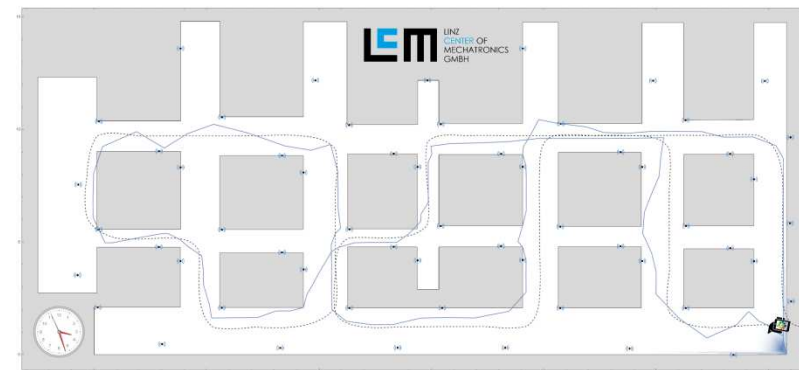
Example: Smart Bow

Requirement

- Long tag-life (> Lifespan of the animals)
- Real-time data of all animals available
- Early detection of diseases
- Optimization of insemination dates
- Reduction of medication consumption

Solutions

- Energy-efficient and highly accurate localization systems for harsh environments
- Real-time location system for farm animals
- Complete system development from the animal's ear tag via base station to localization and pattern recognition software
- Automated analysis of movement patterns and deriving health information
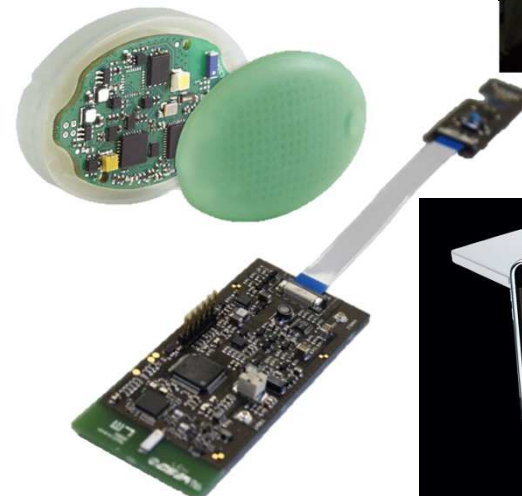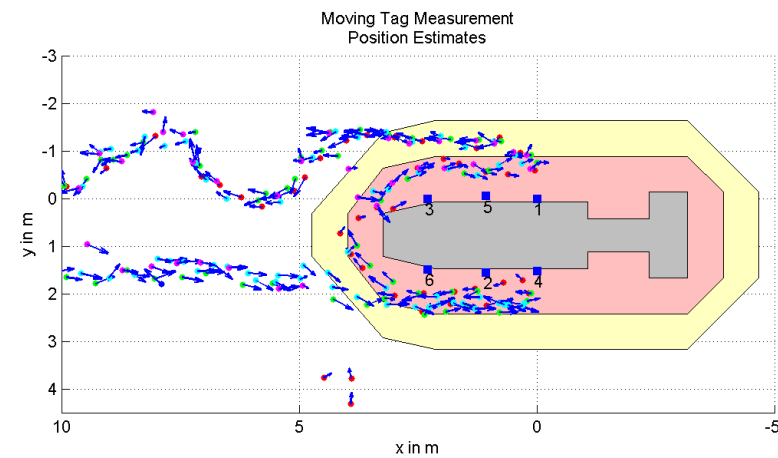
Example: Mining

Requirement

- Safety systems for mines (for example in underground coal mining)

- Locating systems in dusty, dirty and metallic environments

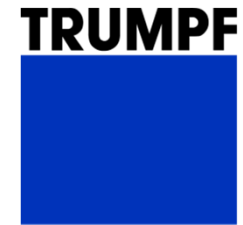- Localization systems for unmanned use and in areas with ear protection

Solutions

- High ranges through the use of audible sound

- High precision

- Insensitivity to dirt

- Robustness

Example: Magic Shoe

Requirement

- Non-contact activation and operation of machines through an innovative man-machine interface integrated in the shoe

- Localization of persons in industrial environments

- Systems for personal safety

Solutions

- Improved ergonomics by eliminating the foot switch

- Hands are free for machining the workpiece

- Operation of several machines with the same shoe

- Security by preventing unauthorized operation

EMERGING I TECHNOLOGIES
Technology Radar

Application

- Using strategic foresight to identify evidence of relevant developments as early as possible

Weak signals

Today   **Future**

Trends – Chances - Risks

What's the benefit?

- Anticipating together possible trends, opportunities, risks and new business ideas, looking ahead to the Future

- Finding solutions to complexity paradoxes

- Increasing the effectiveness for the customer

Example: HMI

Requirement

- New user interfaces for devices, machines and applications through rapid development of consumer electronics
  - Gesture control
  - Voice response systems
  - Augmented reality
  - Virtual reality

- Technical environment is becoming more complex: investigate control concepts

Solutions

- Making the user's life easier
  - Fully understanding requirements
  - M2M replaces HMI
  - Simple interface
  - HMI with situational awareness

- Transparency with how we handle data
  - Portals and data platforms
  - Data versus confidentiality
  - M2M between customers and suppliers
  - Security

Example: current project "Blockchain"

Contact

Thank you for your kind attention

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