# How Simulations boost engineering across different domains

Siemens Simulation

Where engineering meets tomorrow



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# “Closed Loop” System Driven Product Development

*The Strategic Role of Simulation and Test in Systems Engineering*

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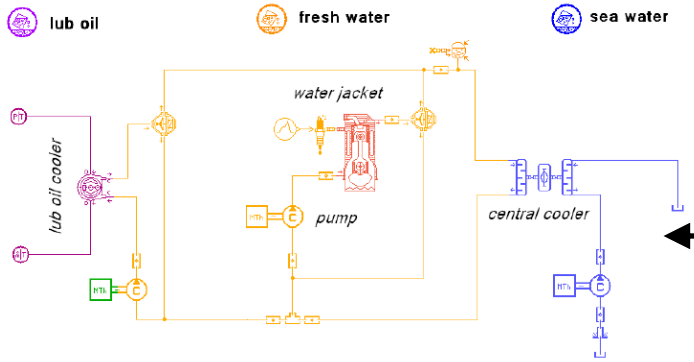


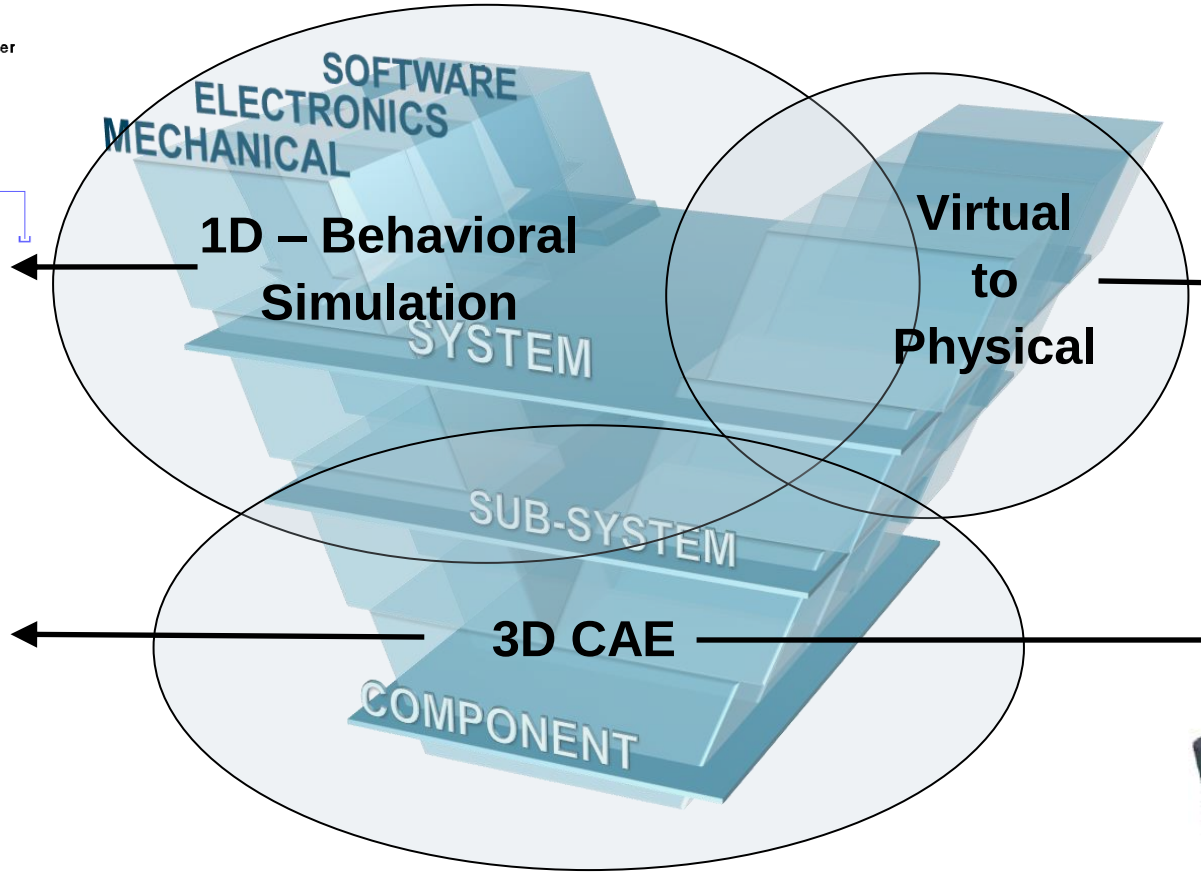


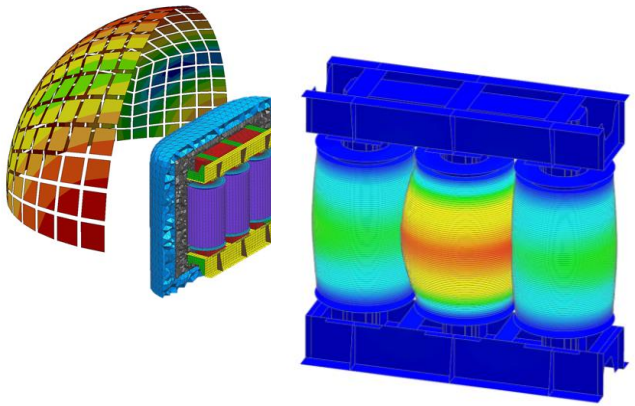

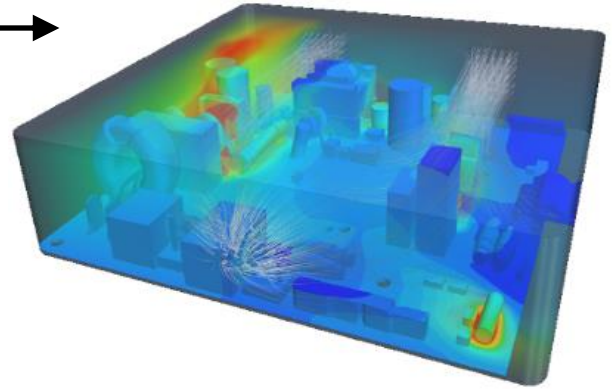

**“Closed Loop” System Driven Product Development**

# From disconnected models and data …

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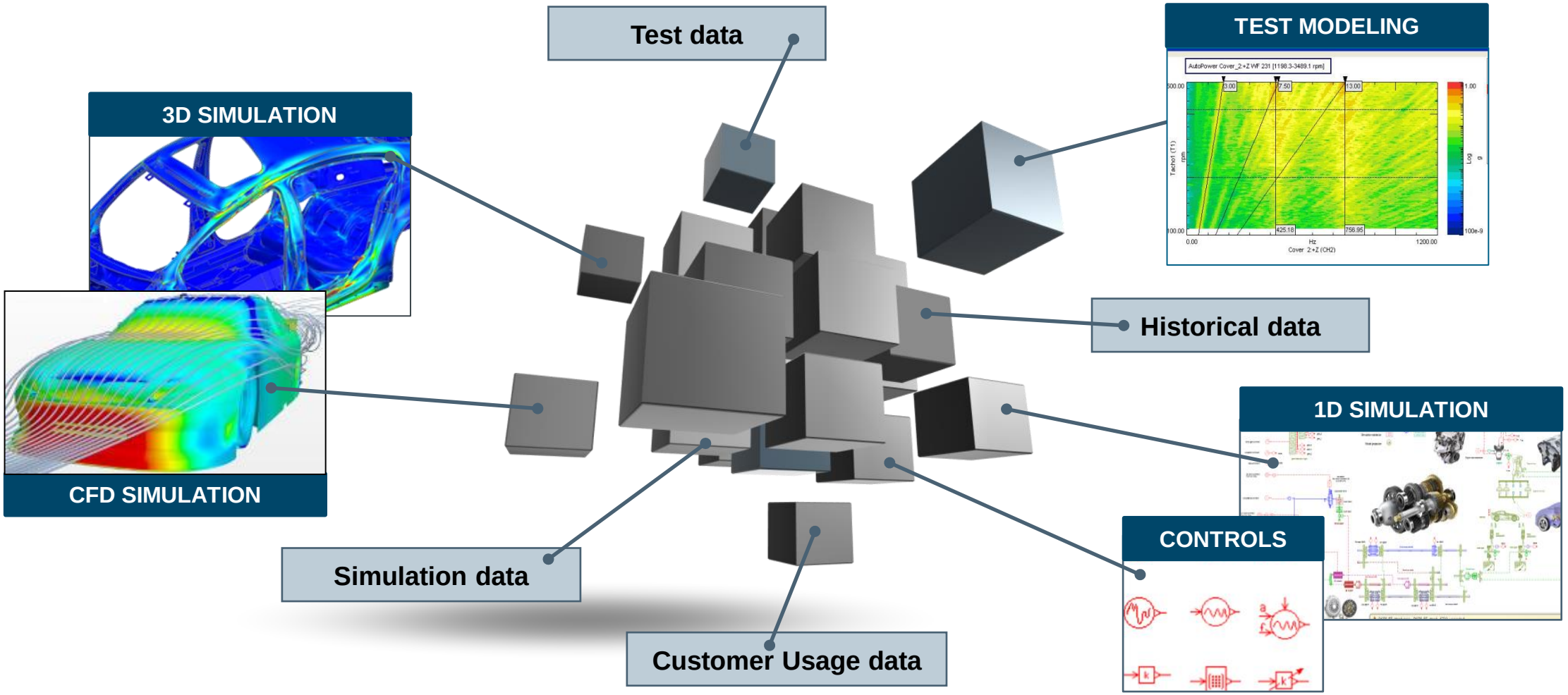

# …to a performance Digital Twin

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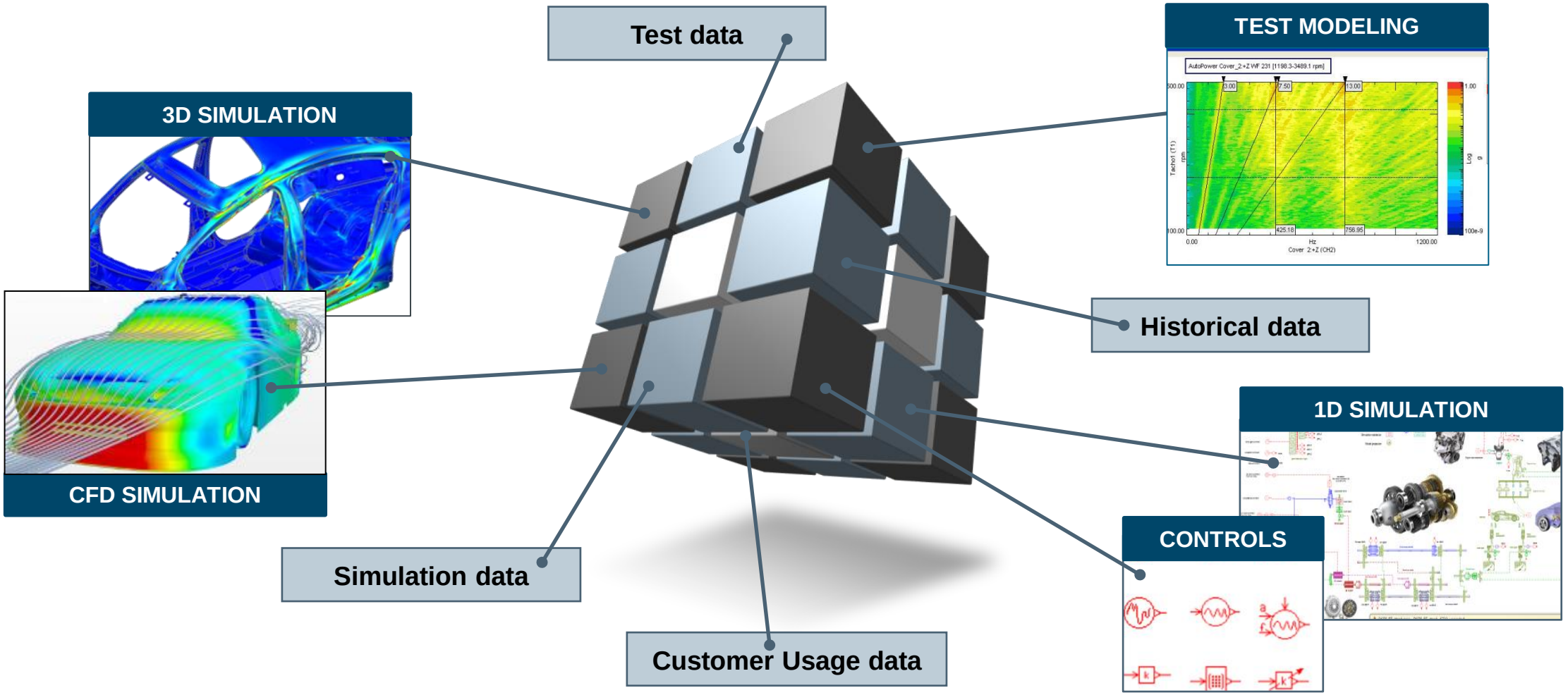
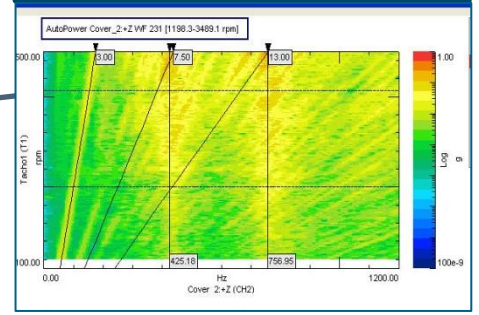


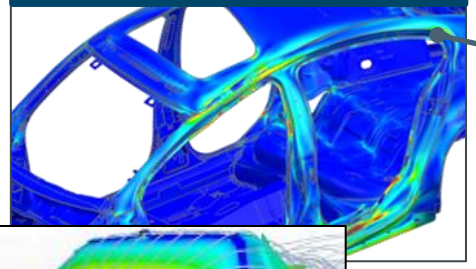
# … enabling Predictive Engineering Analytics

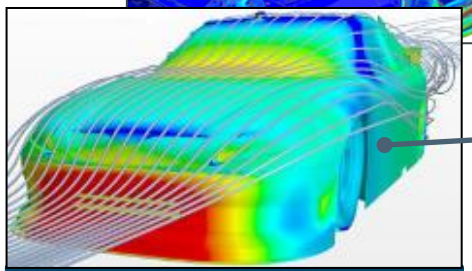
Test data

TEST MODELING



3D SIMULATION

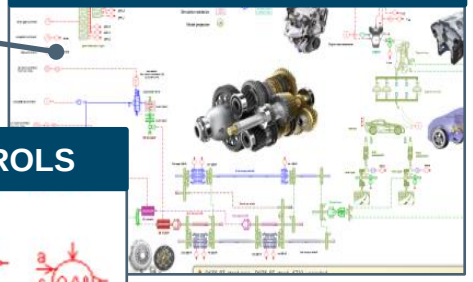




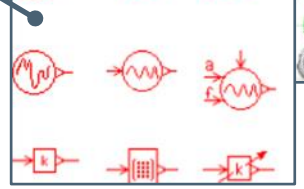
CFD SIMULATION

Historical data

1D SIMULATION



CONTROLS



Simulation data

Customer Usage data

# Why do we need to consider simulation?

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**Simulate earlier in the design process**

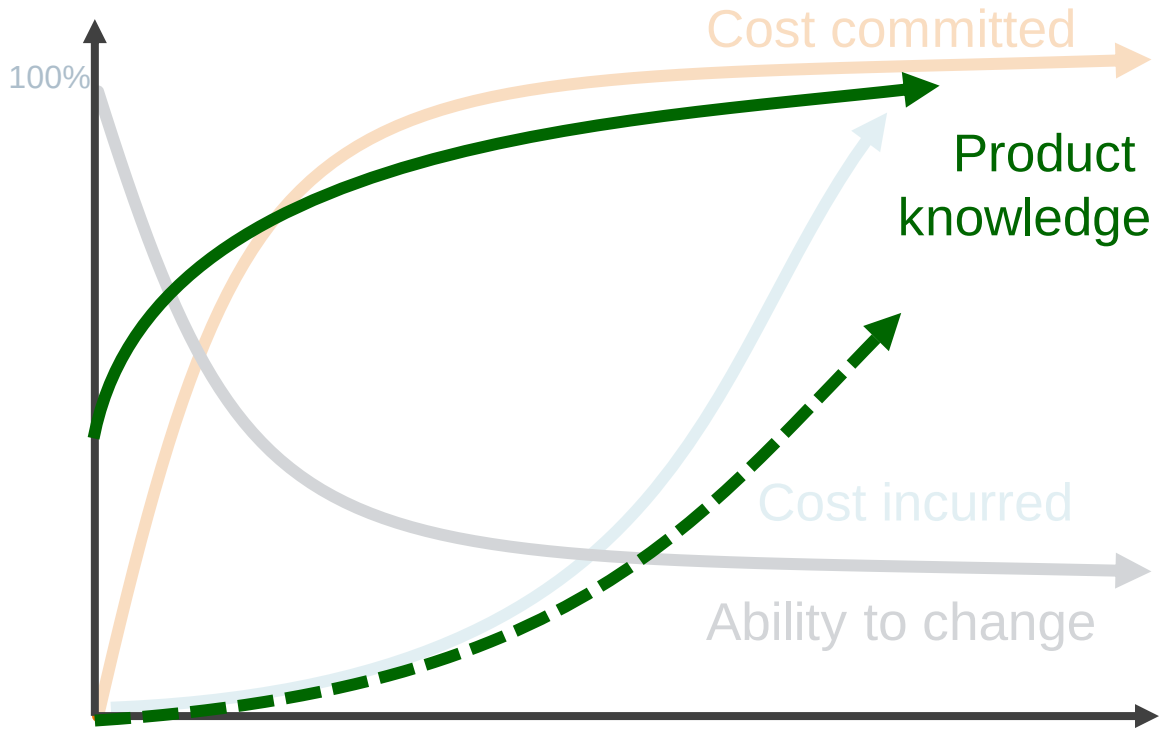
- Maximise impact on cost drivers
- Maximise the ability to iterate early in the design process

**Increased simulation capability and capacity**

- Reduce product development costs
  - e.g. reduce physical prototypes
- Optimise product characteristics
  - Innovation and quality

**The need for broader access to simulation tools**

- Limited specialist analyst capacity
- Better understand the impact of design changes within the engineering community



# THE BENEFITS OF SIMULATION-DRIVEN DESIGN

**73%**

of Best-in-class organizations use simulation during detailed design

**-29%**

Reduction in development time for best-in-class designers using Simulation Driven Design

# Samsonite uses Simcenter 3D to design the lightest impact-resistant suitcases on the market

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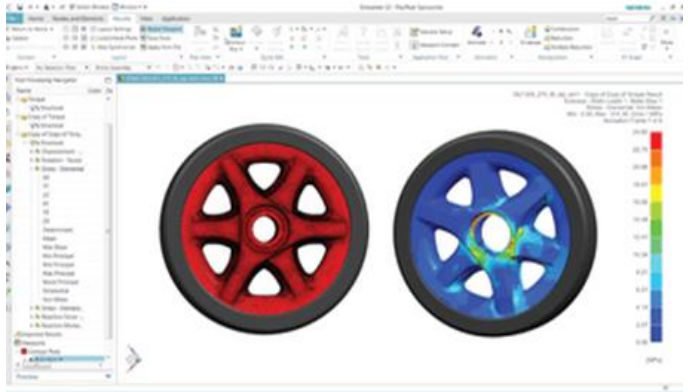
**Siemens PLM Software simulation solutions helps Samsonite dramatically reduce product lead time through virtual prototyping.**

**16 weeks**

**from former physical prototype testing process**



FEA analysis of wheels

# E2M Technologies uses Simcenter, Teamcenter and NX to reduce product lead-time through virtual testing

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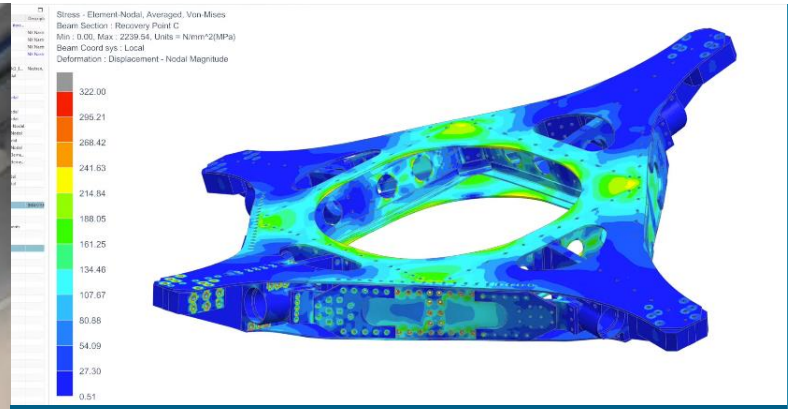
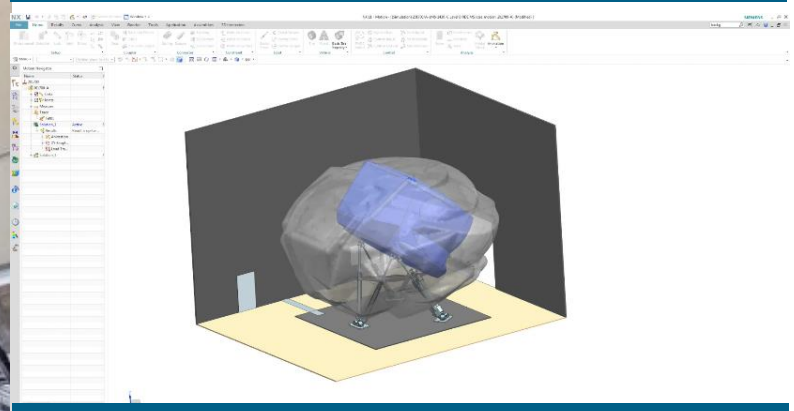



Structural simulation



Motion skeleton model

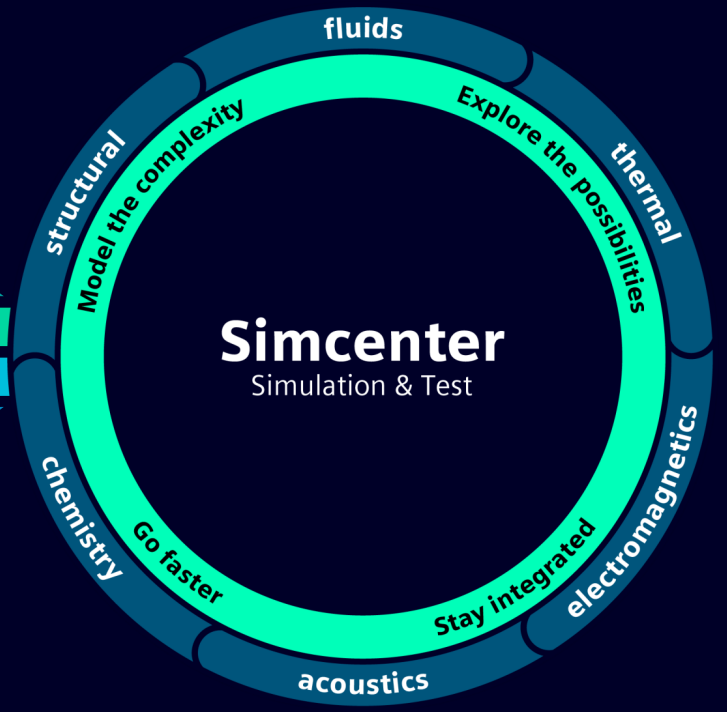
# Where engineering meets tomorrow
# Investment imperatives for a comprehensive digital twin strategy

## Model the complexity
**Ensuring decision confidence**

## Explore the possibilities
**Enabling insights**

## Go faster
**Achieving speed and agility**

## Stay integrated
**Connecting all activities**



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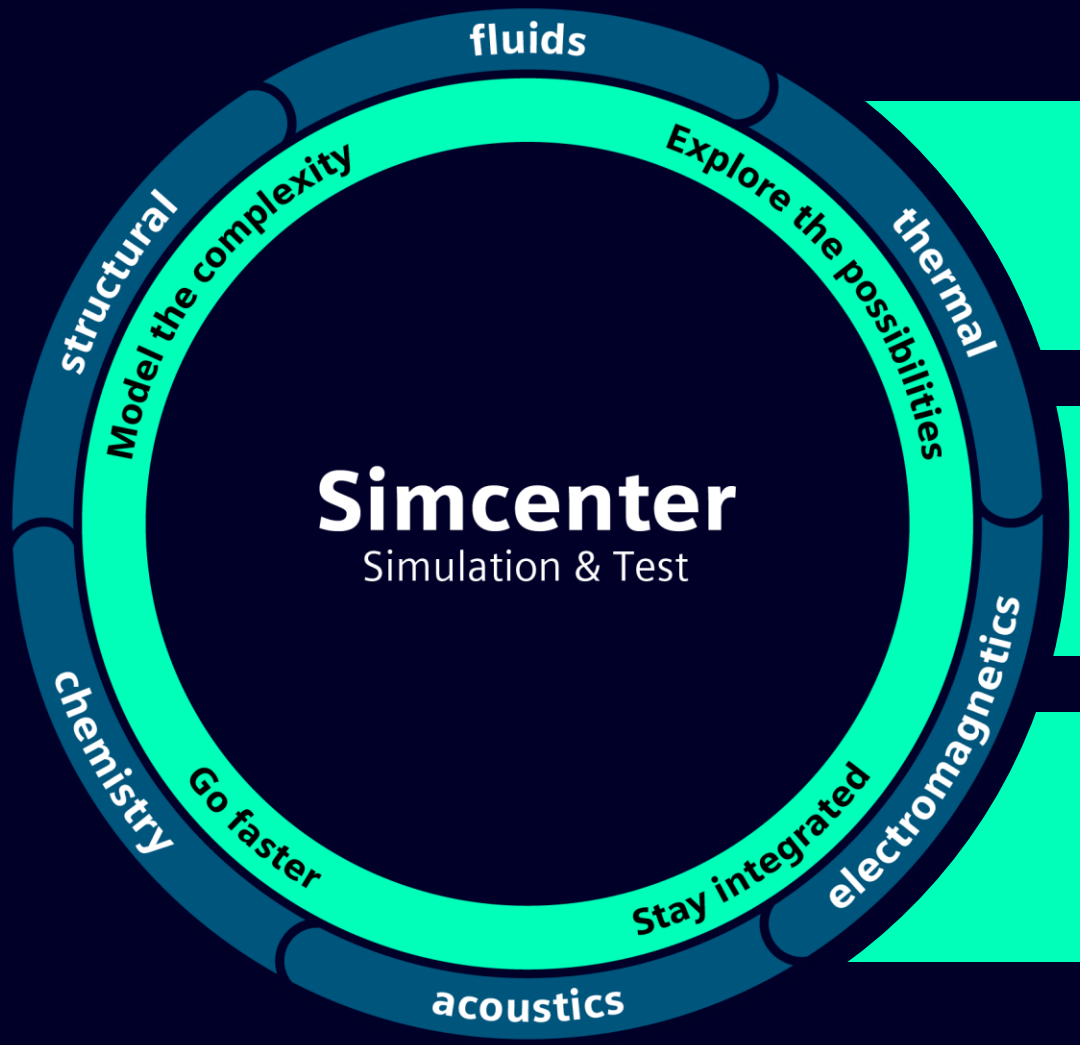


system simulation

3D simulation

physical testing

exploration & analytics

data & process management



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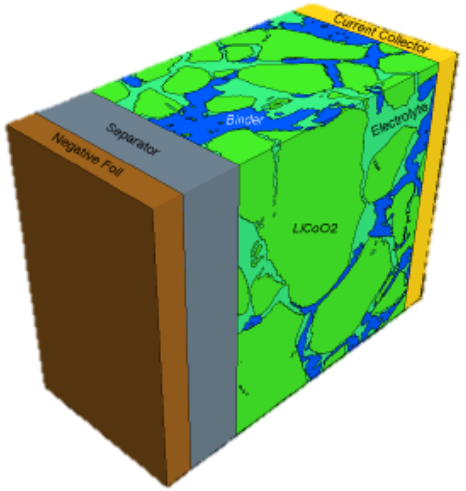
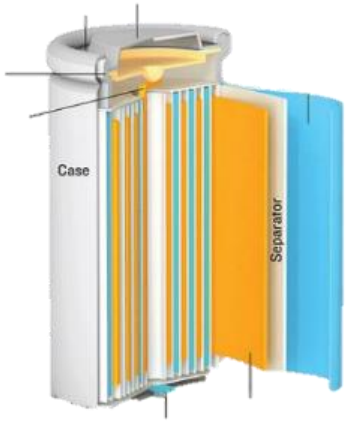
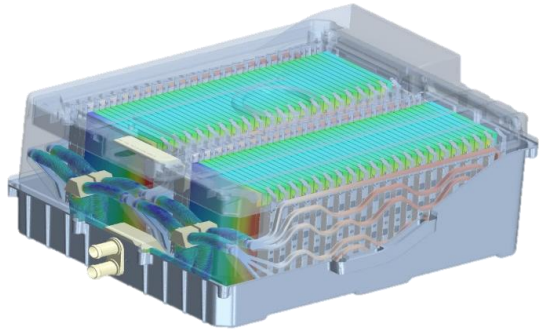
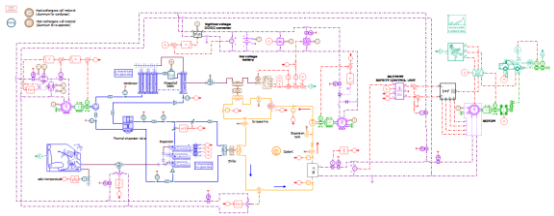
# The Battery Modelling Process

## From micro-structure electrochemistry to cell, pack and system design





### Micro-Structure Electrochemistry

Virtually test SEM produced electrode geometry

Conduct design studies on new concepts

### Virtual Cell Design/Test

Detailed geometrical representation coupled to performance model to build cell digital twin

### Battery Pack Design

Flow, thermal & electrochemistry analysis of complex power systems

Study detailed spatial effects at cell, module & pack level

### System Design

Simulate electrical & electromechanical systems from concept design to control validation

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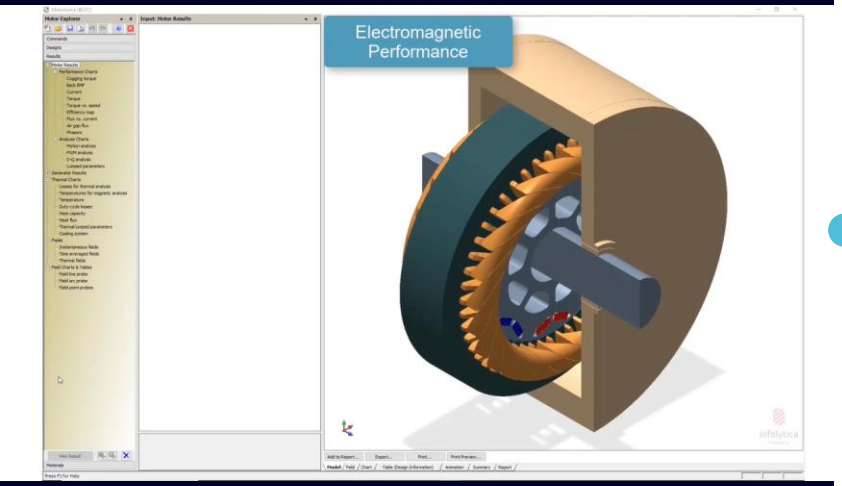
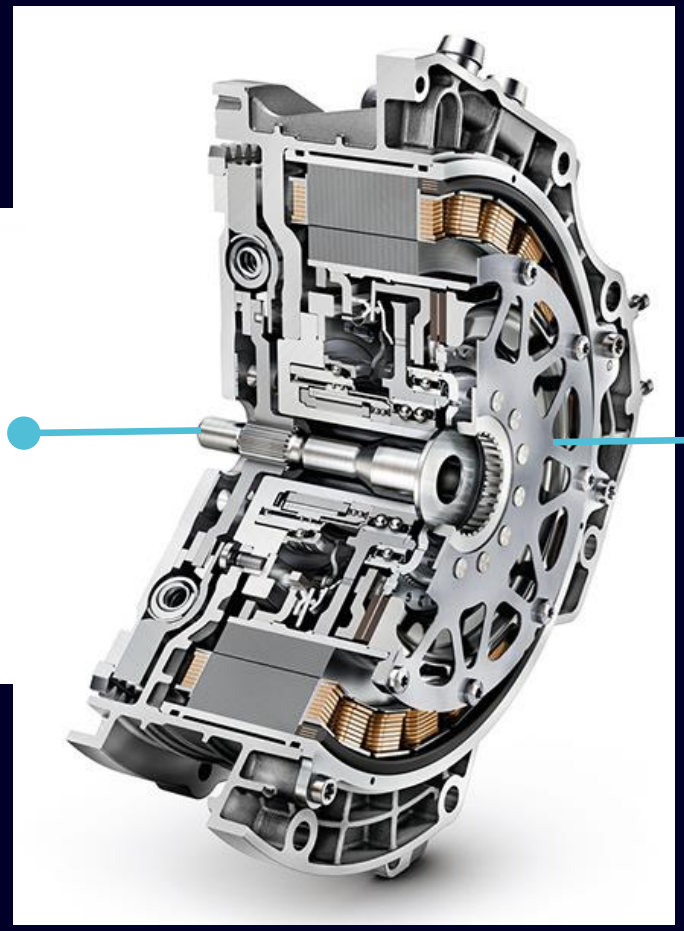
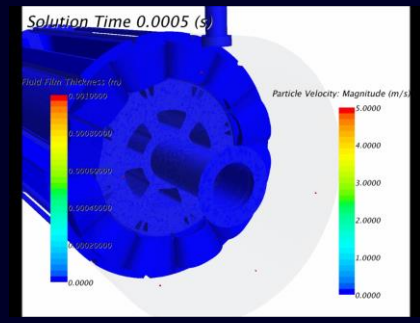
# Integrated eDrive design captures complex interactions

**Motor performance, life & system integration**

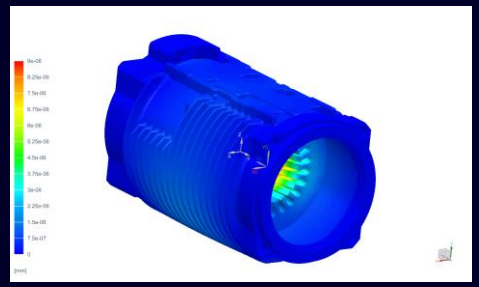


**Thermal Management**




**Structural/ Vibro-acoustics Simulation**



**Motor/ electric drive NVH Testing**

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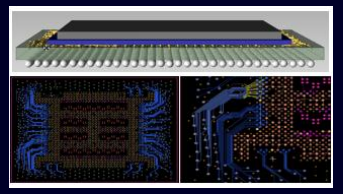
# Siemens Integrated High Density Advanced Packaging Workflow
# The only company providing end-to-end integration

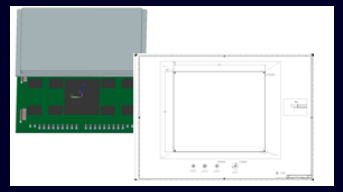
## Semiconductor Lifecycle Management
(Teamcenter)

### Electrical Design



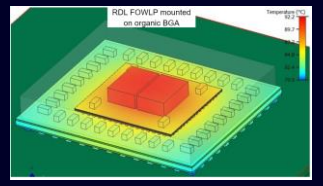
- Rapid Development of ‘what-if’ prototypes
- Enables system connectivity viewing and management without error-prone spreadsheets
- Flexible multi-direction flow for die, package or PCB- driven optimization

### Mechanical Design



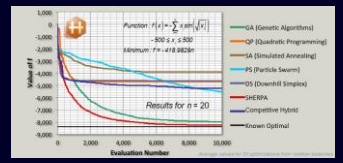
- MCAD/ECAD Collaboration workflow
- 2D/3D clearance checking
- Characterize materials for simulation
- Advanced modeling, surfacing, and drafting capabilities

### Analyze




- Comprehensive die and package level extraction
- Detailed thermal modeling from die to system level
- Stress analysis to identify unexpected stressors impacting performance

### Optimize




- SHERPA, proprietary design optimization algorithm
- Explore the multimodal design space at unparalleled efficiency
- Continuous product improvement

### Test/Calibrate

- Non-Destructive test
- Ability to predict infant mortality and future failures
- Integrated into original thermal model to update assumptions
- Assure Quality

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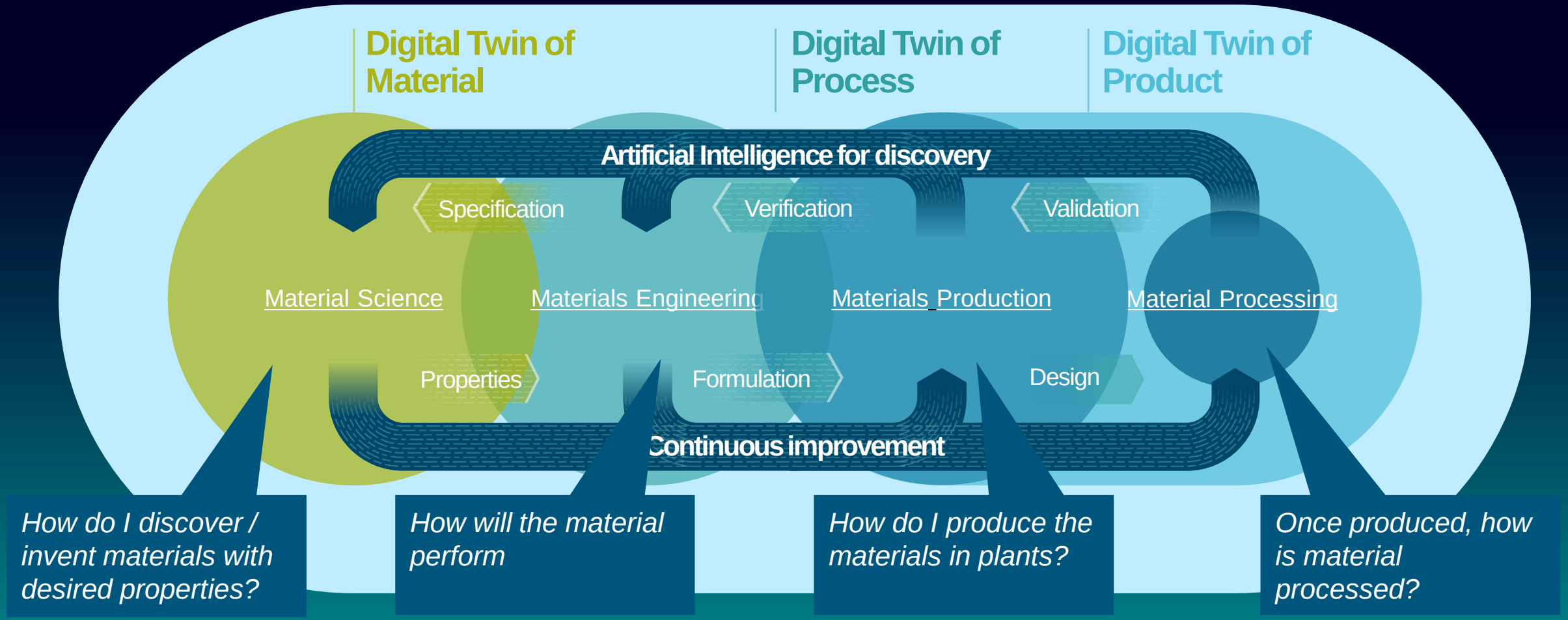
# Digital approach to material innovation, engineering, production & processing



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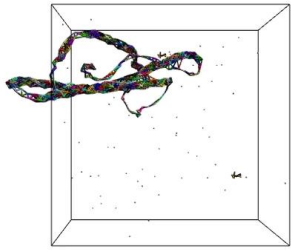
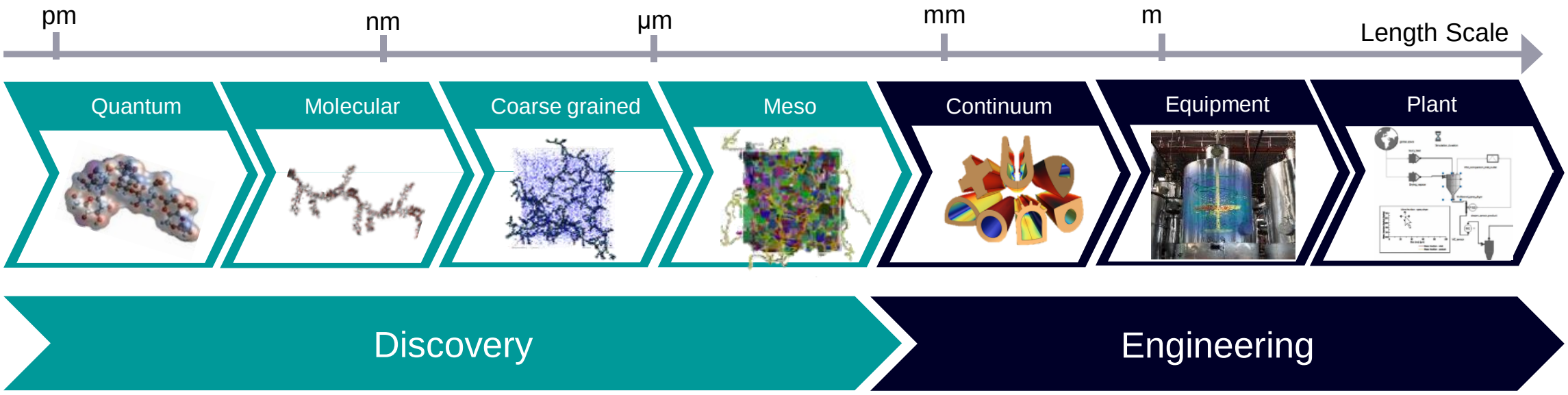
# From quantum to meso-scale, to continuum: the essence of multi-scale

- From Quantum level we derive molecular force-field parameters
- From molecular force-field calculations, we derive coarse-grained force-field parameters
- From coarse-grained force-field parameters we derive mesoscale parameters
- From mesoscale, we calculate properties that are exhibited at the continuum level, such as surface tensions, viscosities, shear-strain relations: the things that define product performance



Protein-excipient interaction







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Challenge

# Efficiency

Use 3D printing to improve efficiency of its own 3D printers.

Solution

# Integration

Leverage the entire digital thread for Additive Manufacturing (AM) design, simulation, 3D printing and performance analytics.

**>34%**
Part cost reduction

**75%**
Faster development

**>22%**
Flow control improvement

# Driving Innovation Through Design Exploration

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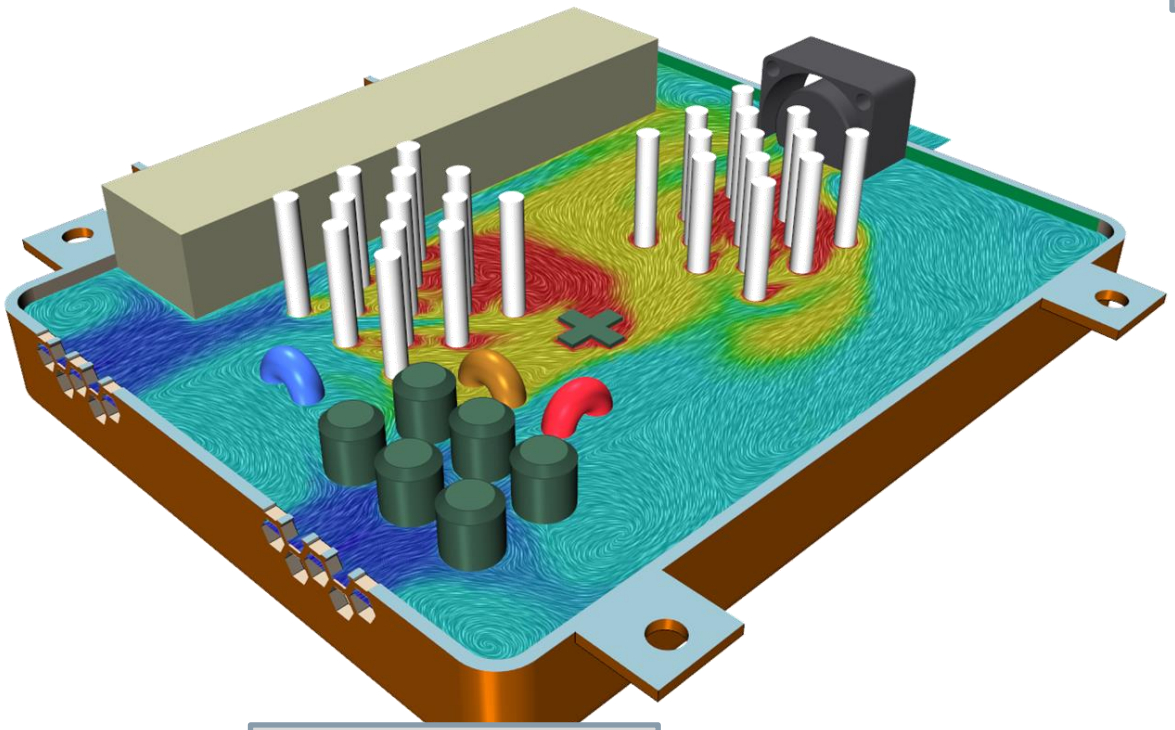
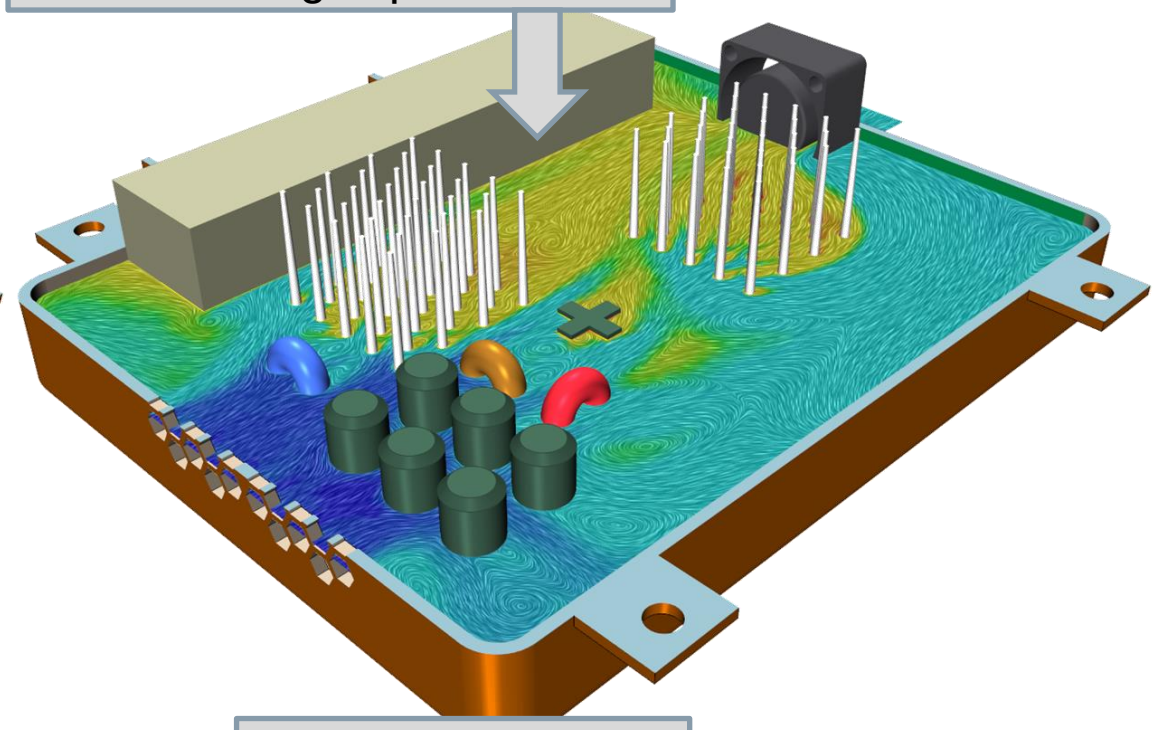
51% reduction in mass
25% cooling improvement



Baseline Design



Improved Design

# Redefining Simulation Strategy for Innovation

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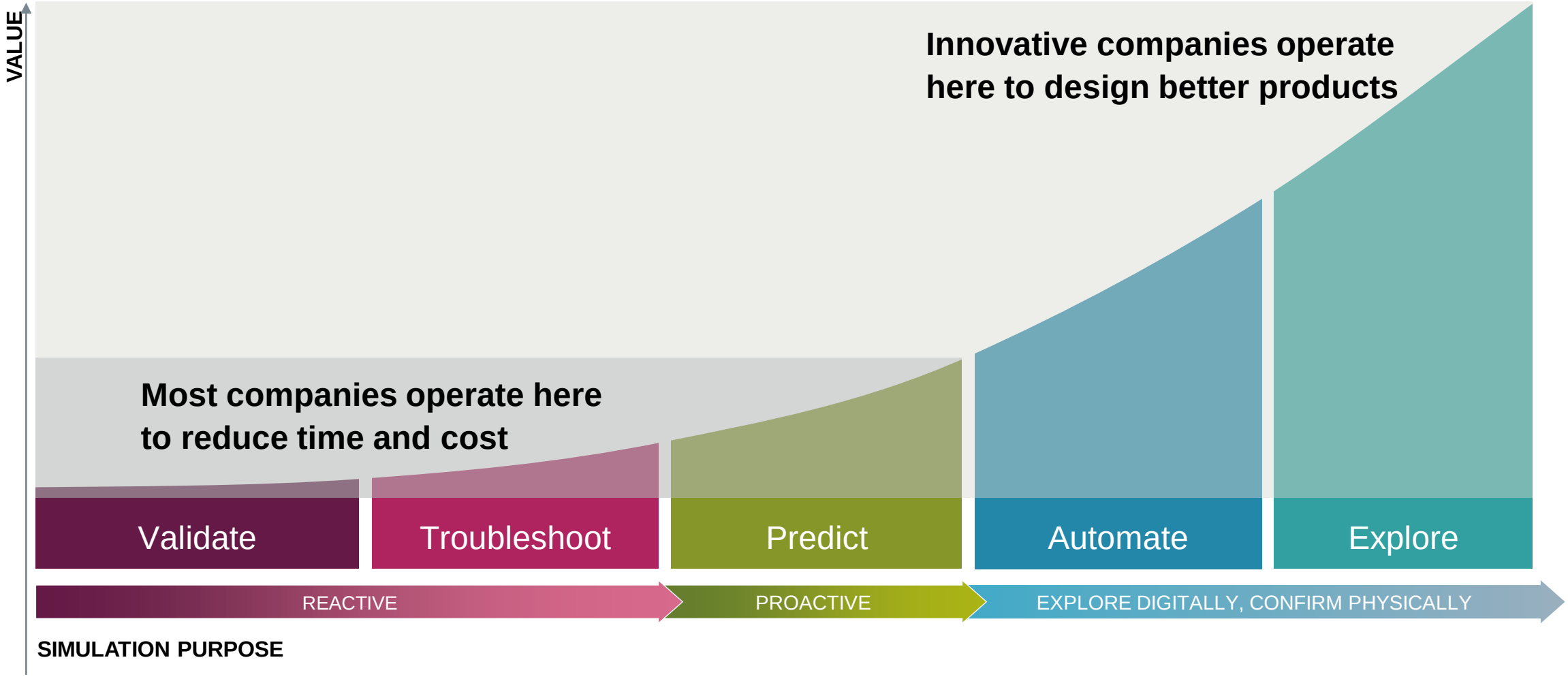

# Discover Better Designs, *Faster!*
## Innovative Products and Technologies

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BUILD → TEST → EXPLORE → ASSESS

**HEEDS**

Multidisciplinary Design Exploration Platform

| CAD Portals | CAE Portals | Python | VCollab |
|---|---|---|---|
| Geometry Exchange | Simulation Tasks | Scripting | Visualization |

**Automate Virtual Prototyping and Find Better Designs**

- Process Automation
- Distributed Execution
- Efficient Search
- Insight & Discovery

# Discover Better Designs, Faster

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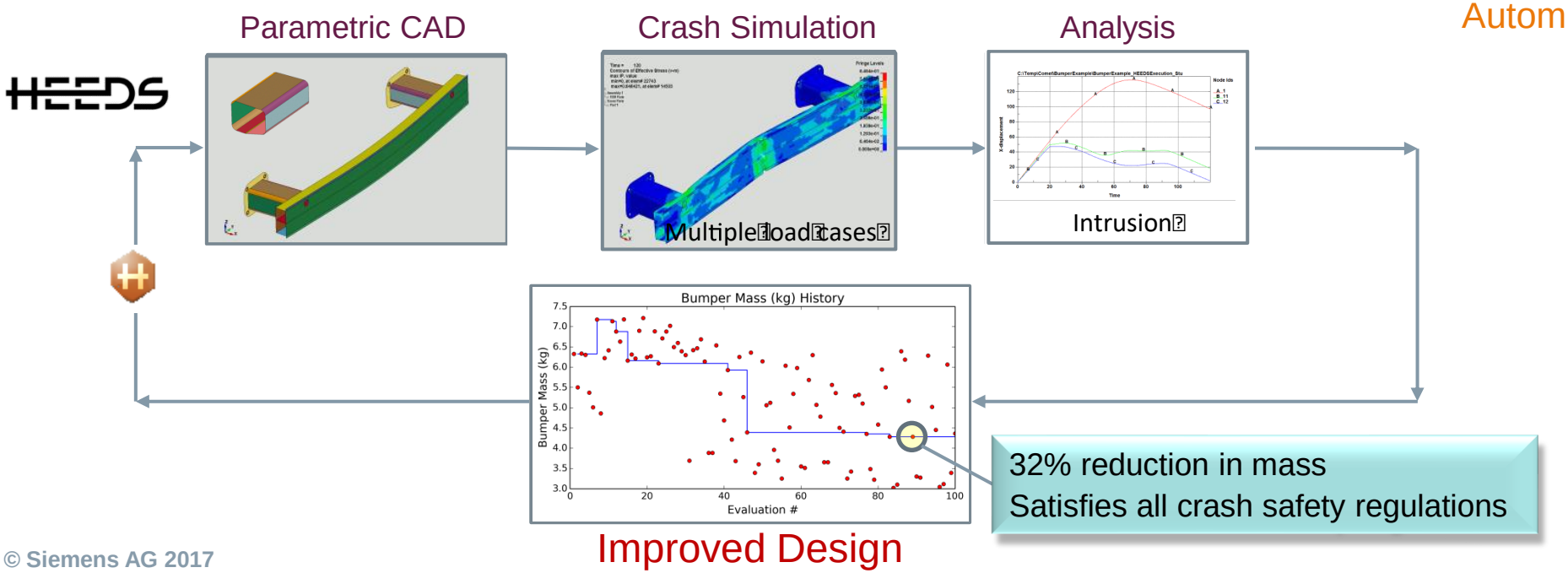
## Design Space Exploration

- Process Automation (Automate building of virtual prototype)
- Distributed Execution (Accelerate testing of virtual prototype)
- Efficient Search (Look for better design alternatives)
- Insight & Discovery (Ensure reliable product performance)

Automotive Bumper



# Better designs in much less time
## Lacks Wheel Trim Systems

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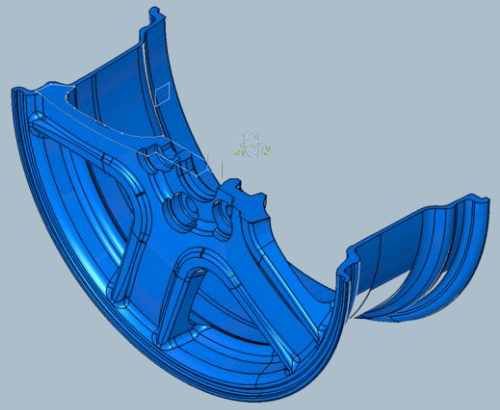
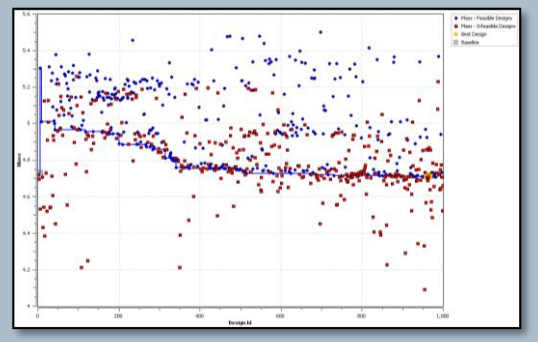
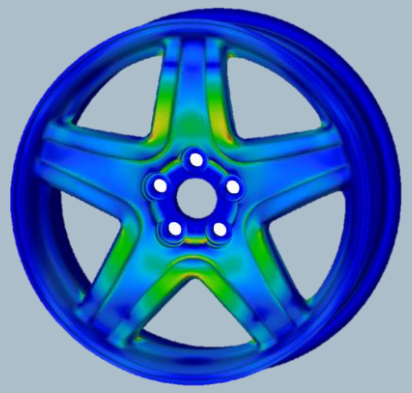
- 1.1 lb reduction in wheel weight (10.4%) while maintaining SAE standards for strength
- 75% reduction in design time vs. manual design studies
- Lightweight design minimizes adverse effects of wheels on fuel consumption

### Lightweight wheel design reduces vehicle fuel consumption







17 geometric shape parameters + Intelligent design exploration = 10.4% reduction in wheel weight

**"HEEDS® has revolutionized the way we are designing wheels, enabling lighter wheel designs, faster than was once thought possible."**

– Kevin Chinavare – Lacks Wheel Trim Systems

# Wind farm layout design

## Optimization of the turbine locations within the wind farm

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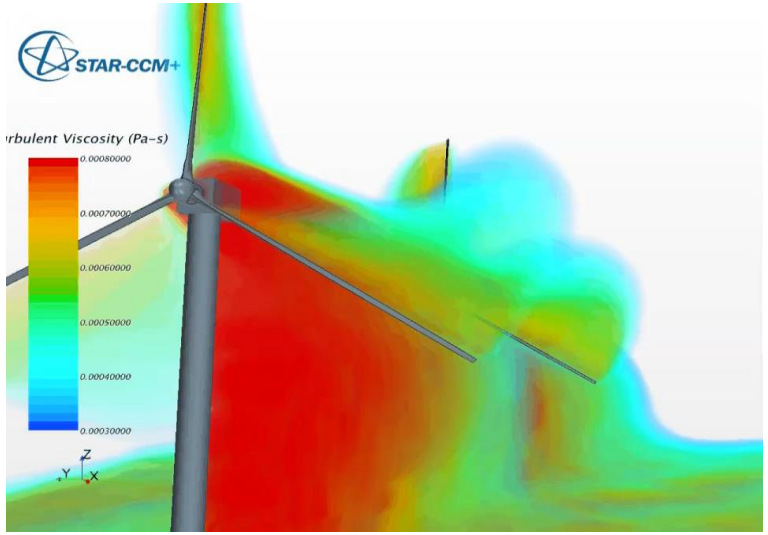



### Challenges

- Improve annual power of a wind farm
- Maximize Annual Energy Produced (AEP)

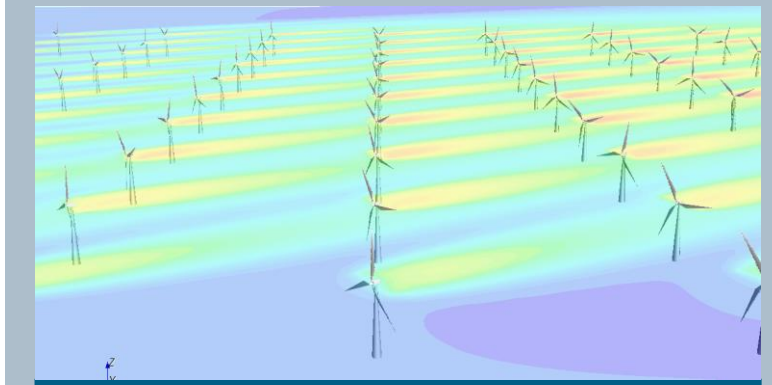
### Constraints

- Terrain and multi-turbine wakes effects

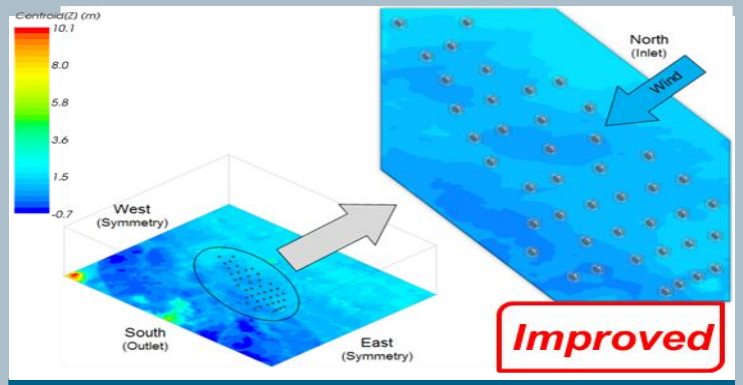
### Design variables

- Location of each turbine

### Aero-dynamic simulation in combination with design exploration



Wake effect in caused neighboring turbines




**Optimized layout of turbine locations**

- Detailed analysis in Simcenter STAR-CCM+
- Terrain and multi-turbine wake effects were causing energy output to suffer
- A design exploration process was initiated to identify a new layout of turbines

"Increased Annual Energy Production (AEP) by 8.5% compared to the original design"

# Plant Simulation

## Energy efficiency as additional criteria for optimization

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## Integrated in production planning

- Maximize mixing uniformity
- Minimize power requirement
- Validate Tank dimensions
- Adjust filling line capacity to match primary production

# How does it work ?

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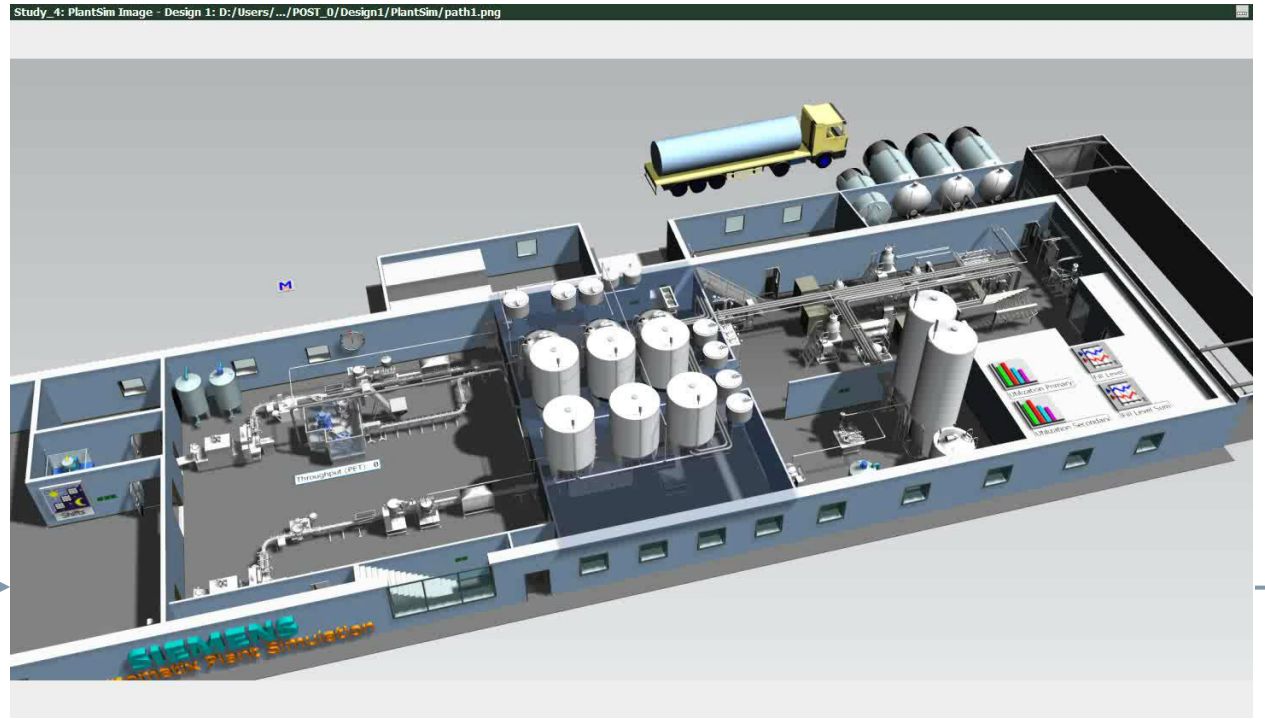
## Dairy Plant Simulation

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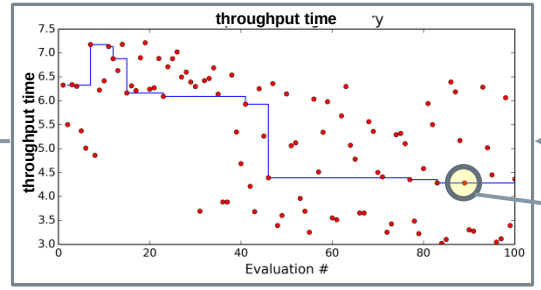



## Optimization Loop

Improve Dairy Factory Efficiency
➔ Reduce throughput time (flow time) across the dairy plant

Data Based Models

AI / Machine Learning

Process models

data

Model Reduction

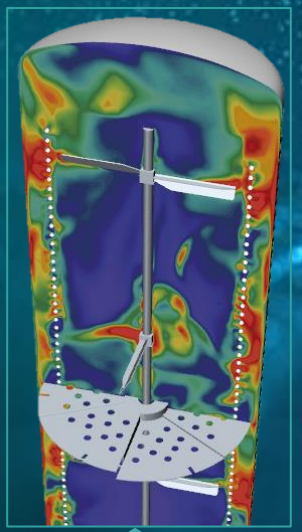
Real Plant

Digital Twin

Physics Based Models

Data

Prediction



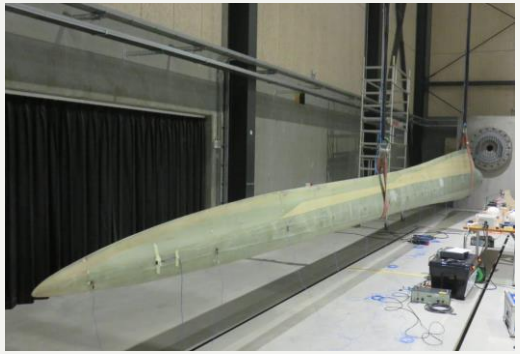
**Executable Digital Process Twin**

Pilot or Lab Data: validation

# Executable Digital Twin
# Measure the unmeasurable with smart virtual sensors

## *Challenge*

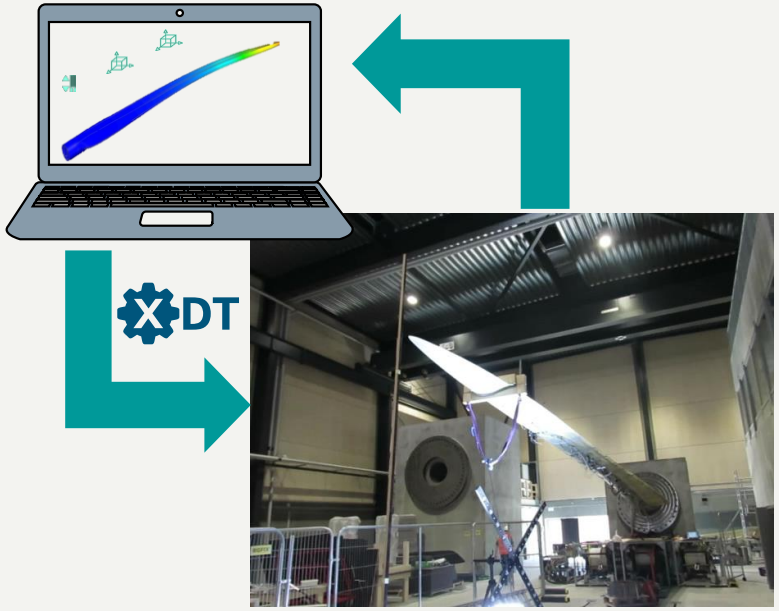
**Improve accuracy of durability testing for composite blades**



- Currently relies on a few physical sensors
- Suboptimal sensor positioning decreases accuracy of durability results
- Model updating can be lengthy and complex

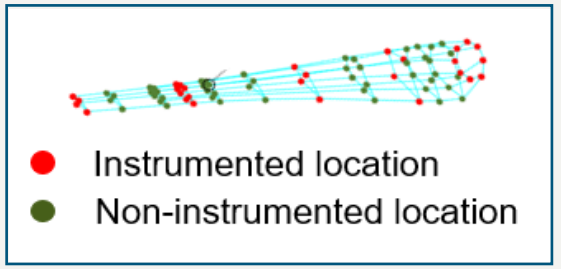
## *Solution*

**Estimate full field stress and strain response with smart virtual sensor**




## *Benefits*

***Detect critical locations on the full blade***




**Expand strain data from 10's of data points to 100's**

↑↑ **Accuracy of durability testing**

*Up to*

**50%** **Time reduction for model updating and instrumentation**

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# Towards continuous development
# Drive closed loop innovation leveraging IoT and Cloud

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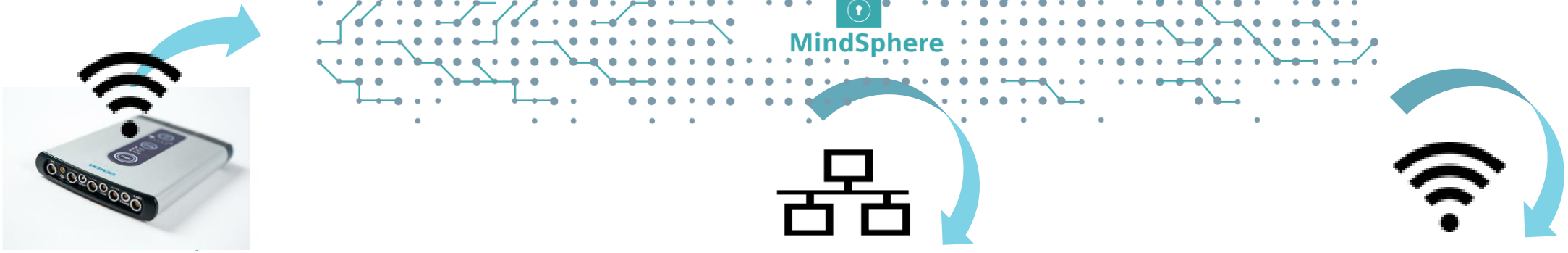
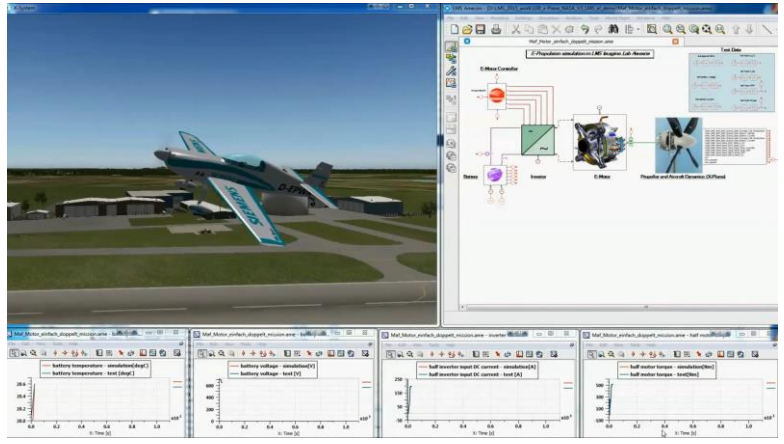


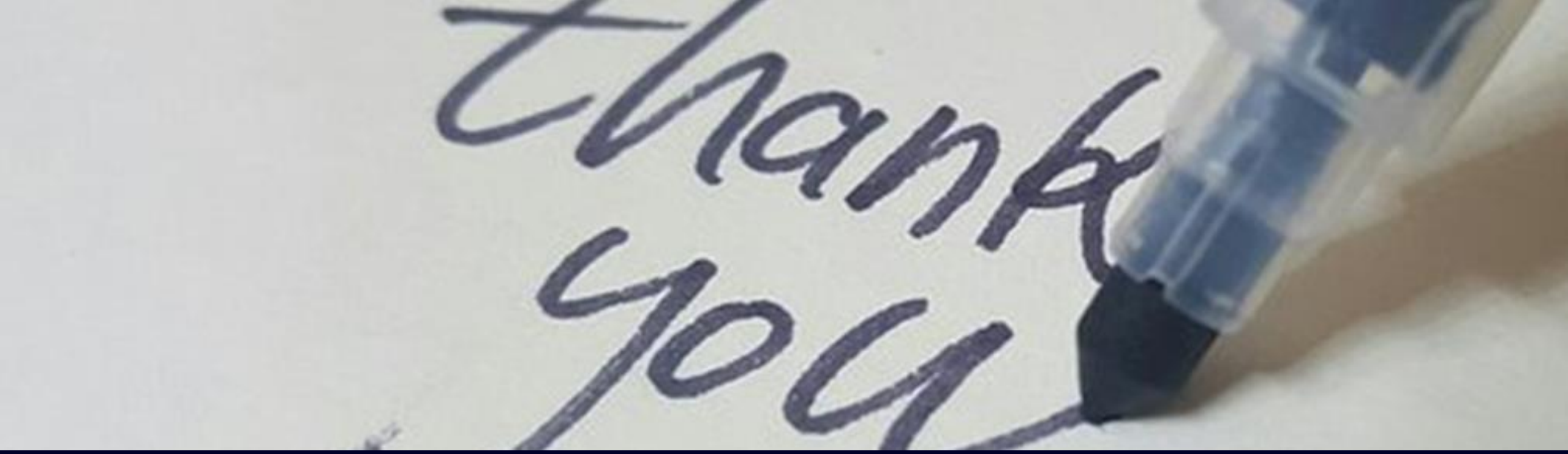

Field Data Collection
(Simcenter SCADAS XS)



“Model-in-the-Loop”
Virtual Sensors
(Simcenter Amesim)

Remote Monitoring
(Simcenter Testlab)

Ref.: Demonstrated at Hannover Messe, 2016

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