

Mastering Noise and Vibrations of electrified powertrains with simulation

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Business Development Manager Simcenter Mechanical

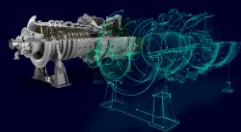
Simcenter Day in Seoul - July 6th, 2023

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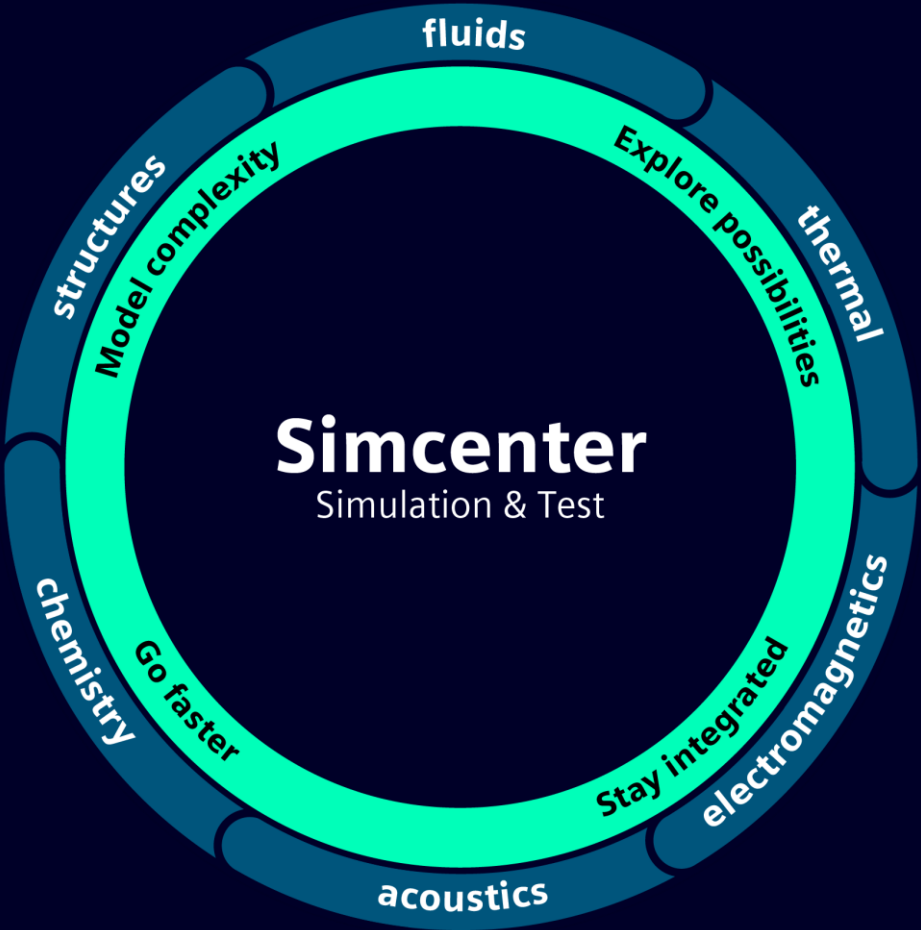


Simcenter, answering Industry's questions

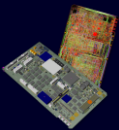
How can I **fix issues before** building a physical **prototype** ?



How can I make my **design process faster** ?



How can I **make design decisions** with **higher confidence** ?



How do I **keep** my simulation and test **data and processes current** ?



Where to focus?



Effective collaborative engineering



Shift left & shift right

Creating a life-time value from the Digital Twin



Personalized & adapted processes

Specific workflows, leveraging state-of-the-art technologies



Cloud-based operation

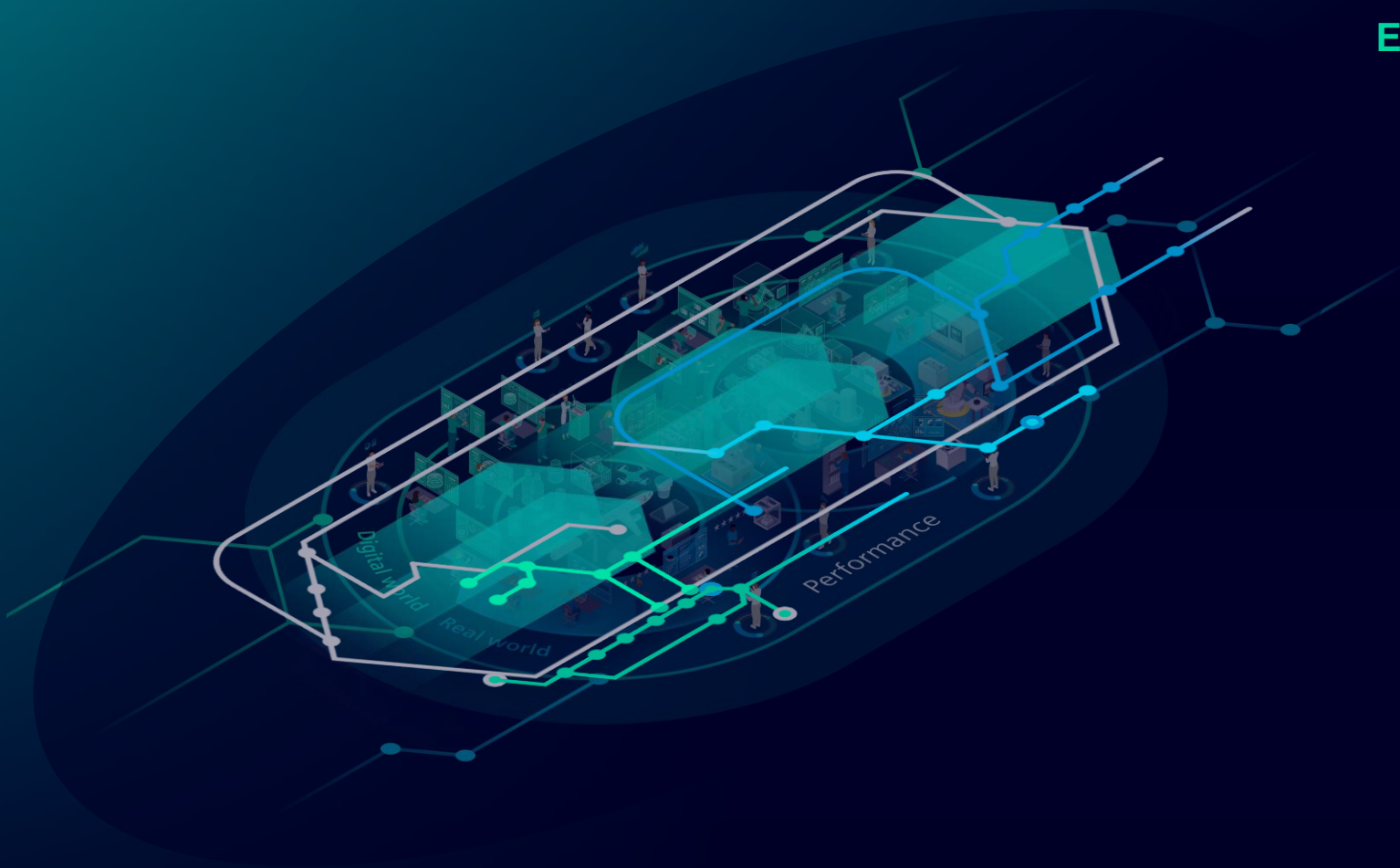
Strengthen collaboration

Personalized & adapted processes

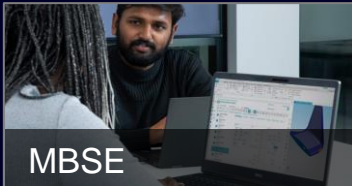


Personalized & adapted processes
Specific workflows, leveraging state-of-the-art technologies

Digital Threads & Integrated Workflows



Enabling Technologies & Processes





Electric cars are silent. So
NVH engineers can relax?



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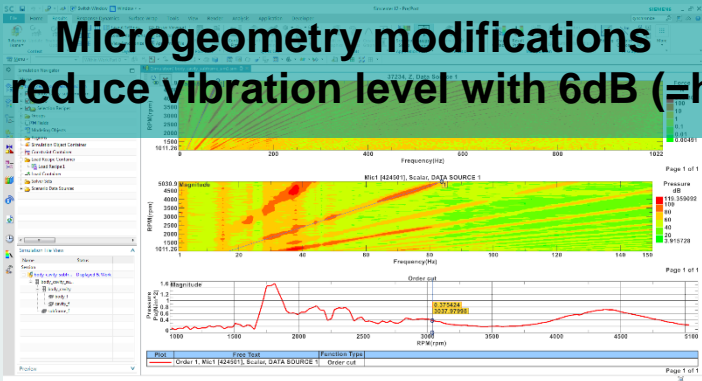
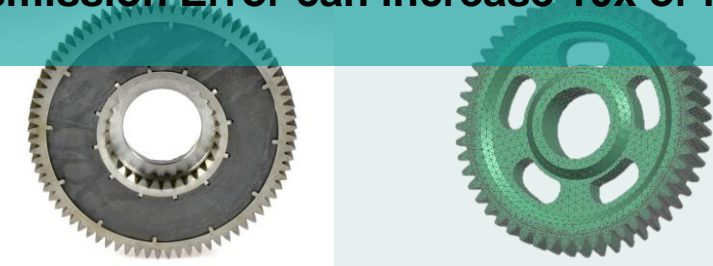
The reality...



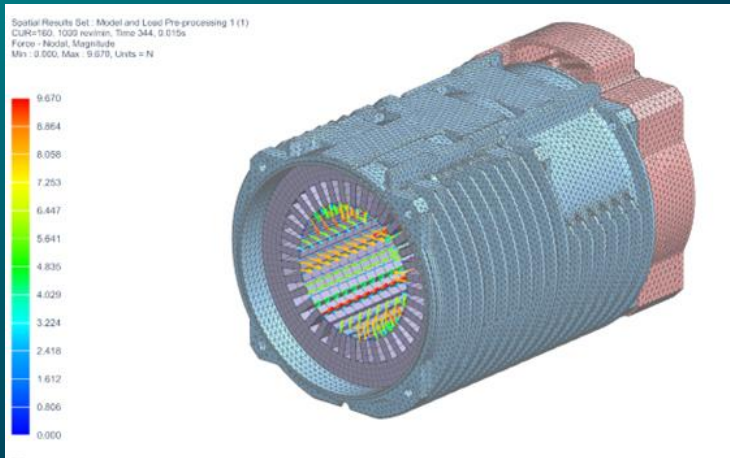
“You do not have an internal combustion engine on all the time, making a lot of noise, that forgives a lot of other evils.”

Bob Kruse, Chief Technology Officer of Karma Automotive

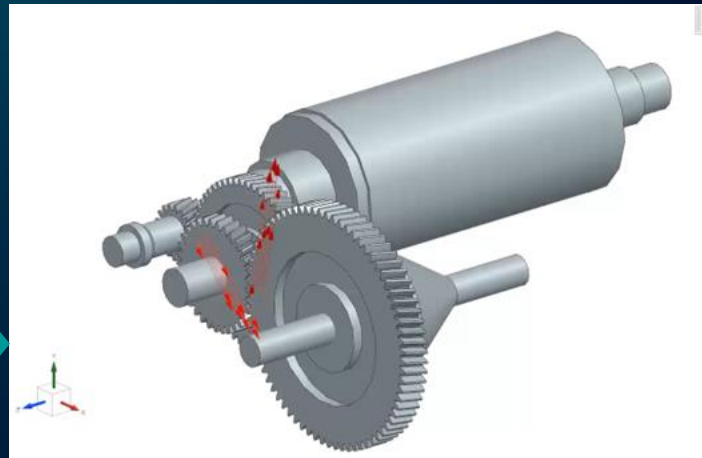
Electric Drive NVH Industry Challenges

Multiphysics	Reduce Time for Simulation
<p>Disconnected tools and workflows</p> 	<p>80% of time for manual model creation</p> 
Minimize Vibration and Noise Levels	Reduce Weight with Lightweight Designs
<p>Microgeometry modifications can reduce vibration level with 6dB (=half!)</p> 	<p>Transmission Error can increase 10x or more!</p> 

Transient Simulation of Electric Drives



Electromagnetic
Excitation

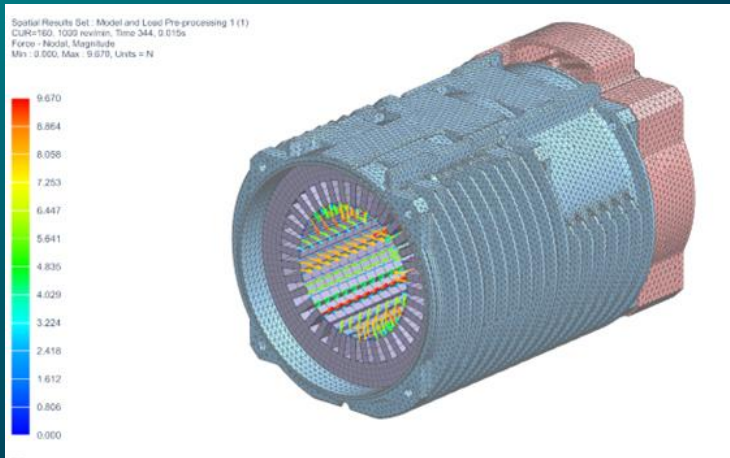


Transmission
Dynamics

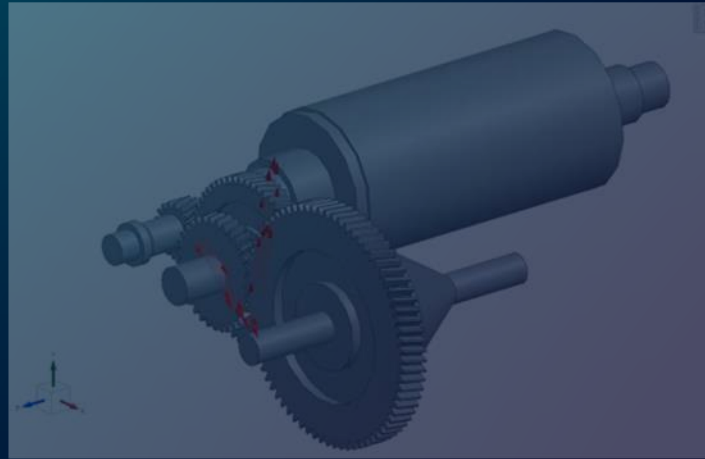


Acoustics
Simulation

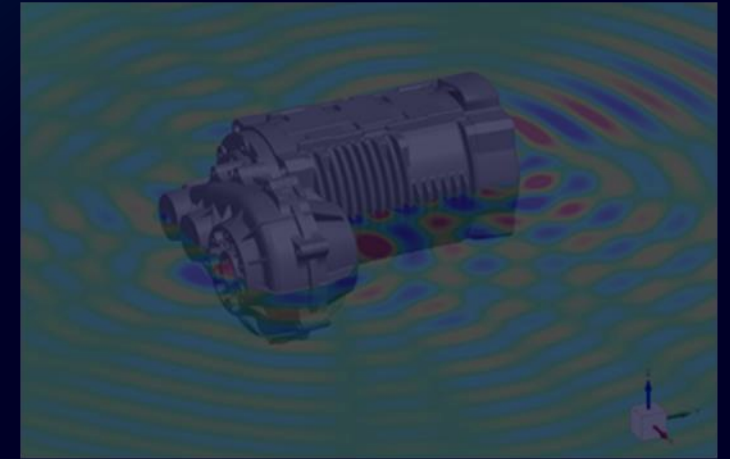
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Transmission
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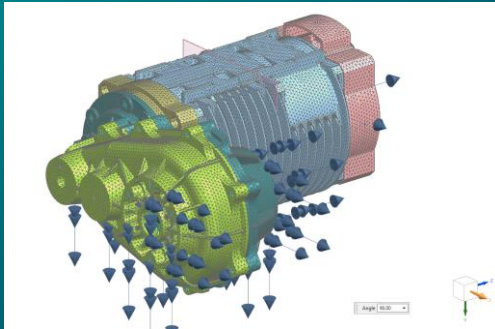


Acoustics
Simulation

Simcenter 3D

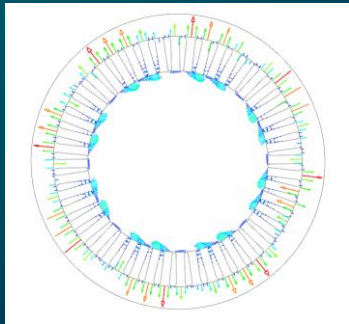
End-to-end process to consider EM and mechanical excitations

Simcenter 3D



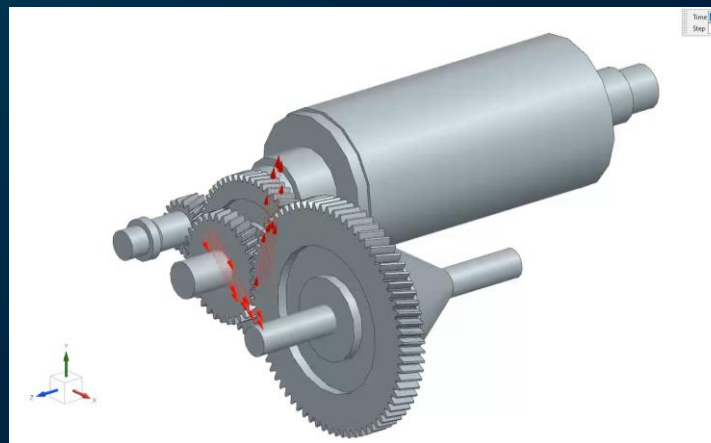
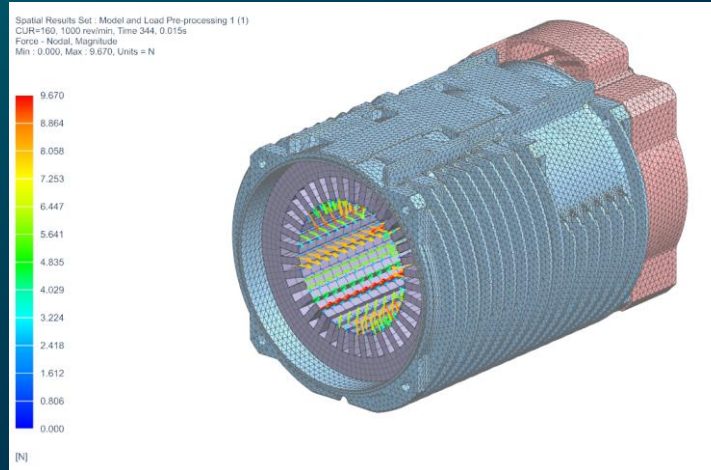
Structural FEA

Simcenter MotorSolve

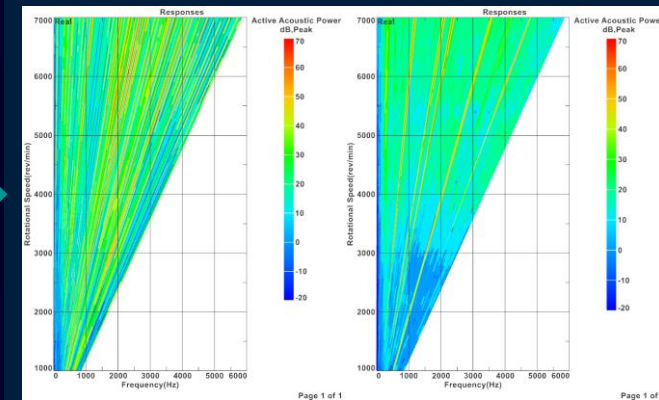


EM Analysis

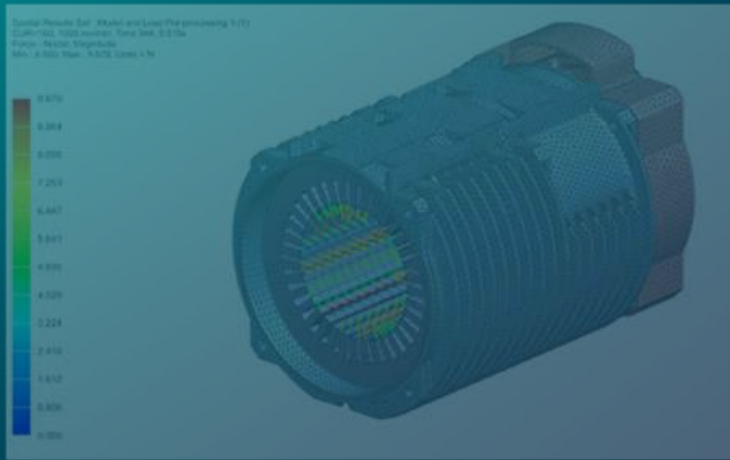
Simcenter 3D
Motion



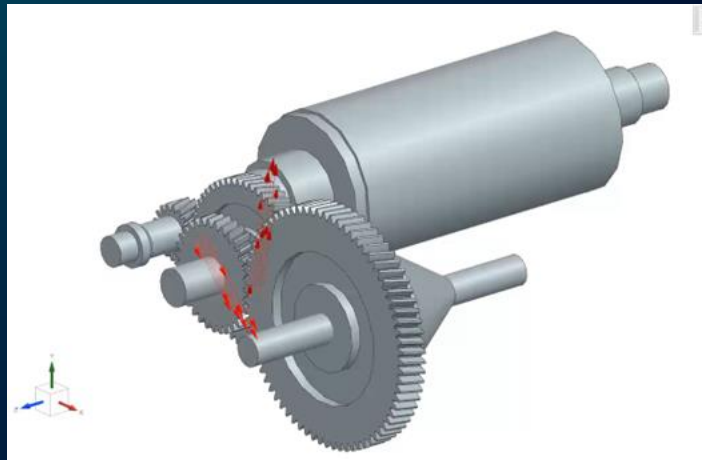
Simcenter 3D
Acoustics



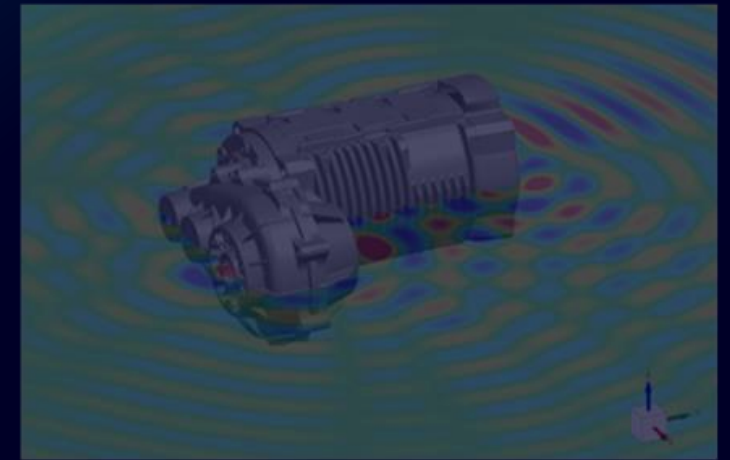
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Excitation

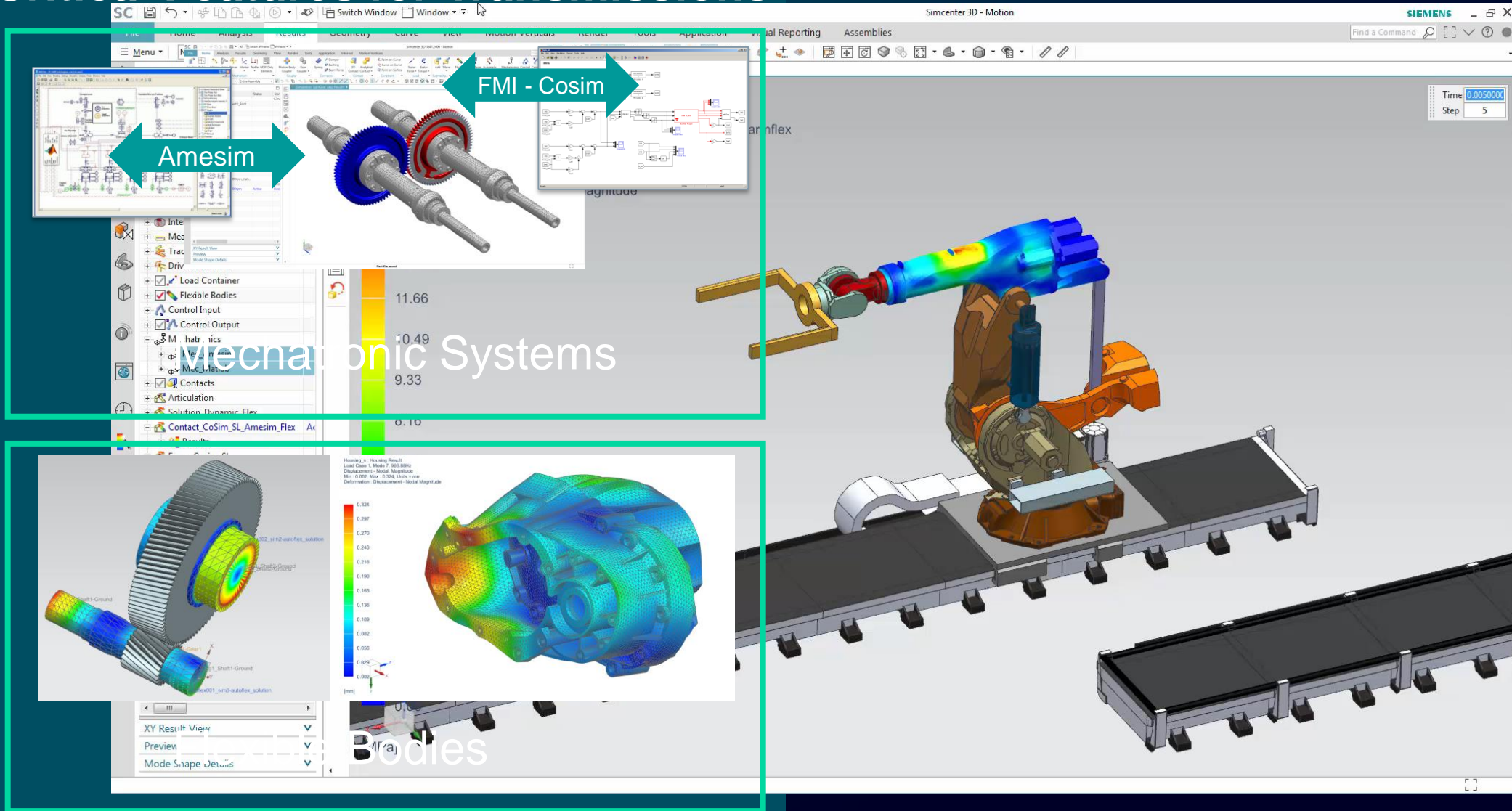


Transmission
Dynamics



Acoustics
Simulation

Critical Features for Transmissions

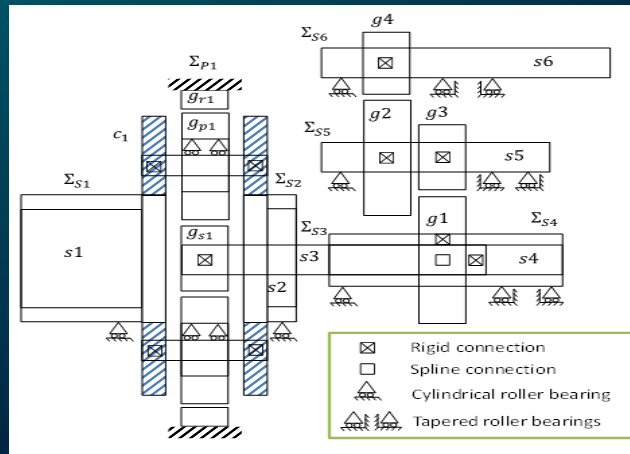


Simcenter 3D Motion Transmission Builder

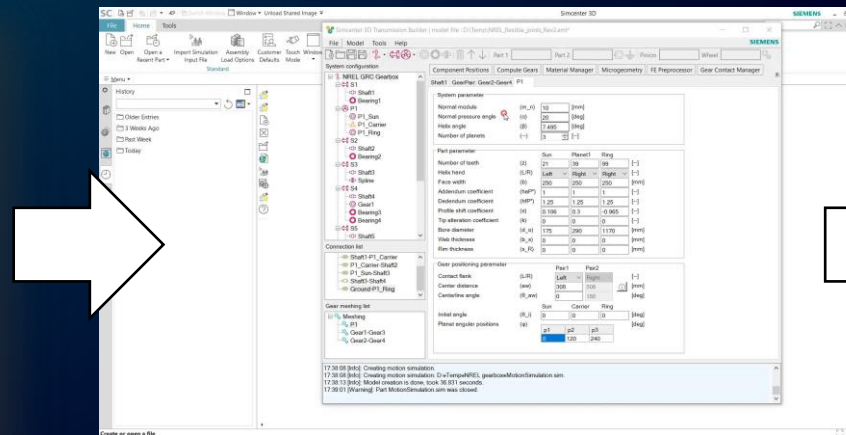
Problem: Even experienced 3D-Multi Body Simulation experts can struggle to

1. Model complex parametric transmissions
2. Capture all relevant effects correctly and efficiently
3. Update and validate their models

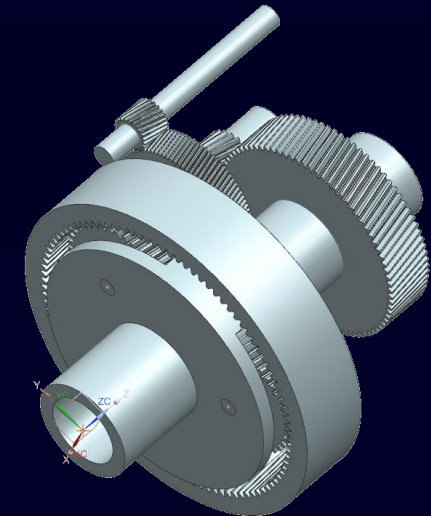
Solution: Transmission Builder → up to 5x faster Model creation process



**Gear train specification
based on Industry standards**

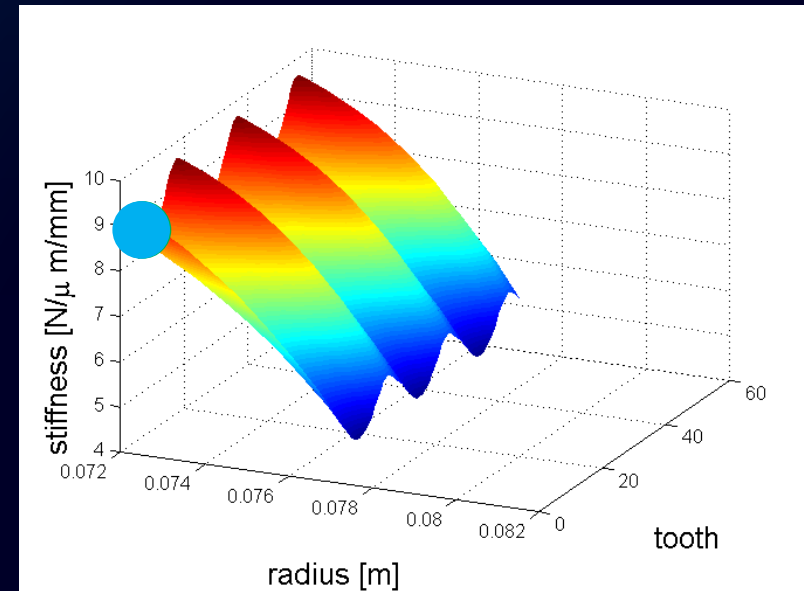
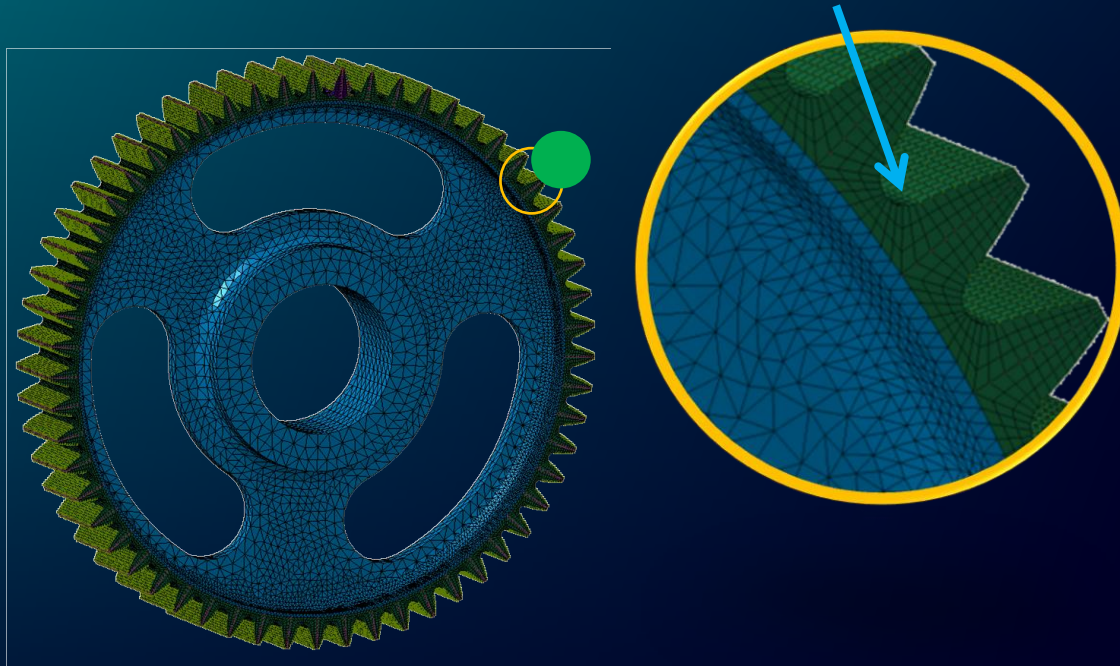


**Simcenter Transmission
Builder**

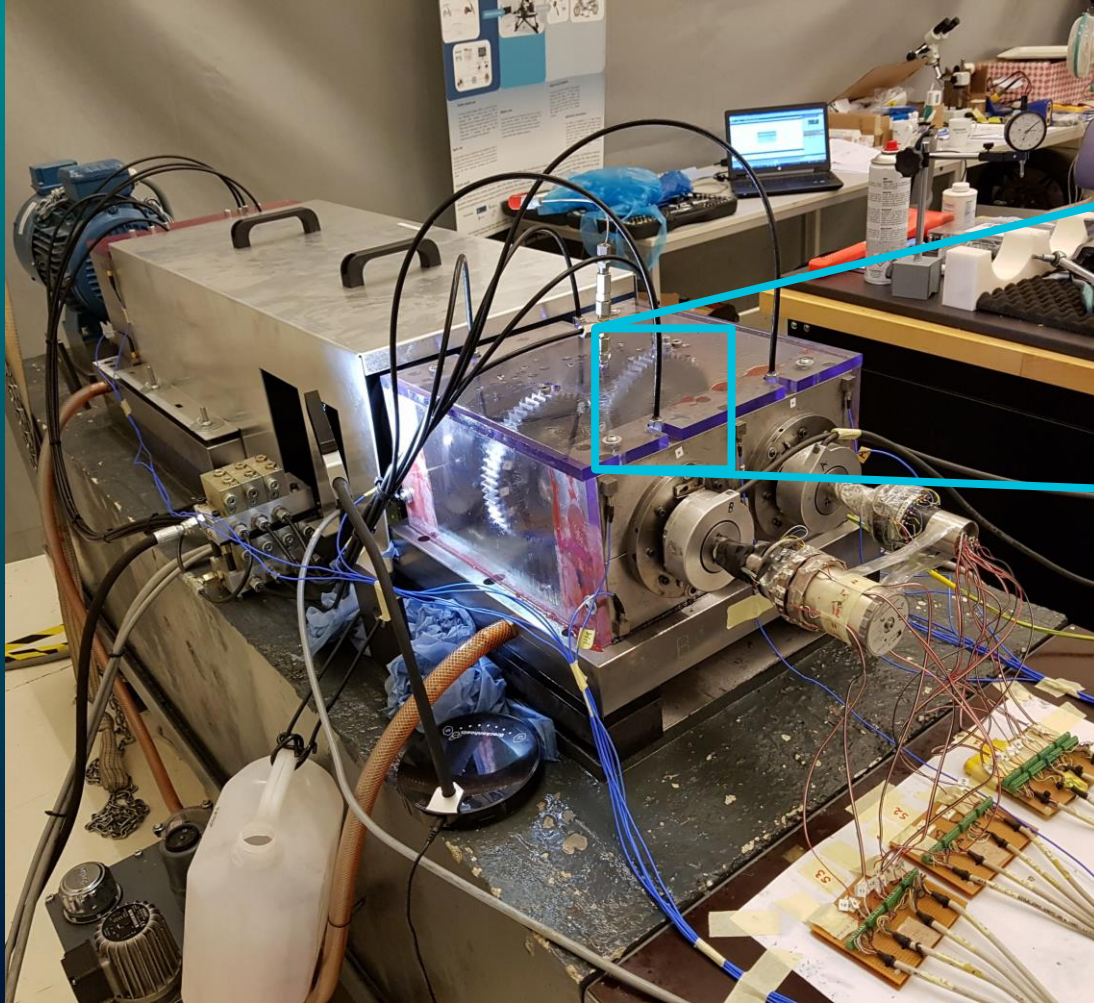


Multibody simulation model

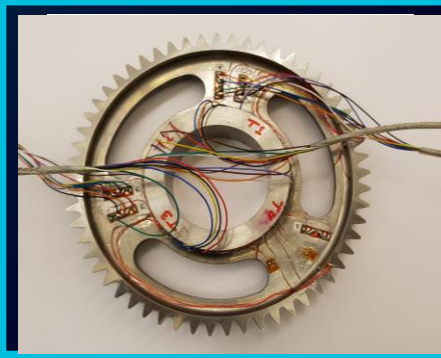
What about accuracy?



Test-based verification of unique methodologies



Spur gear pair, 3 holes

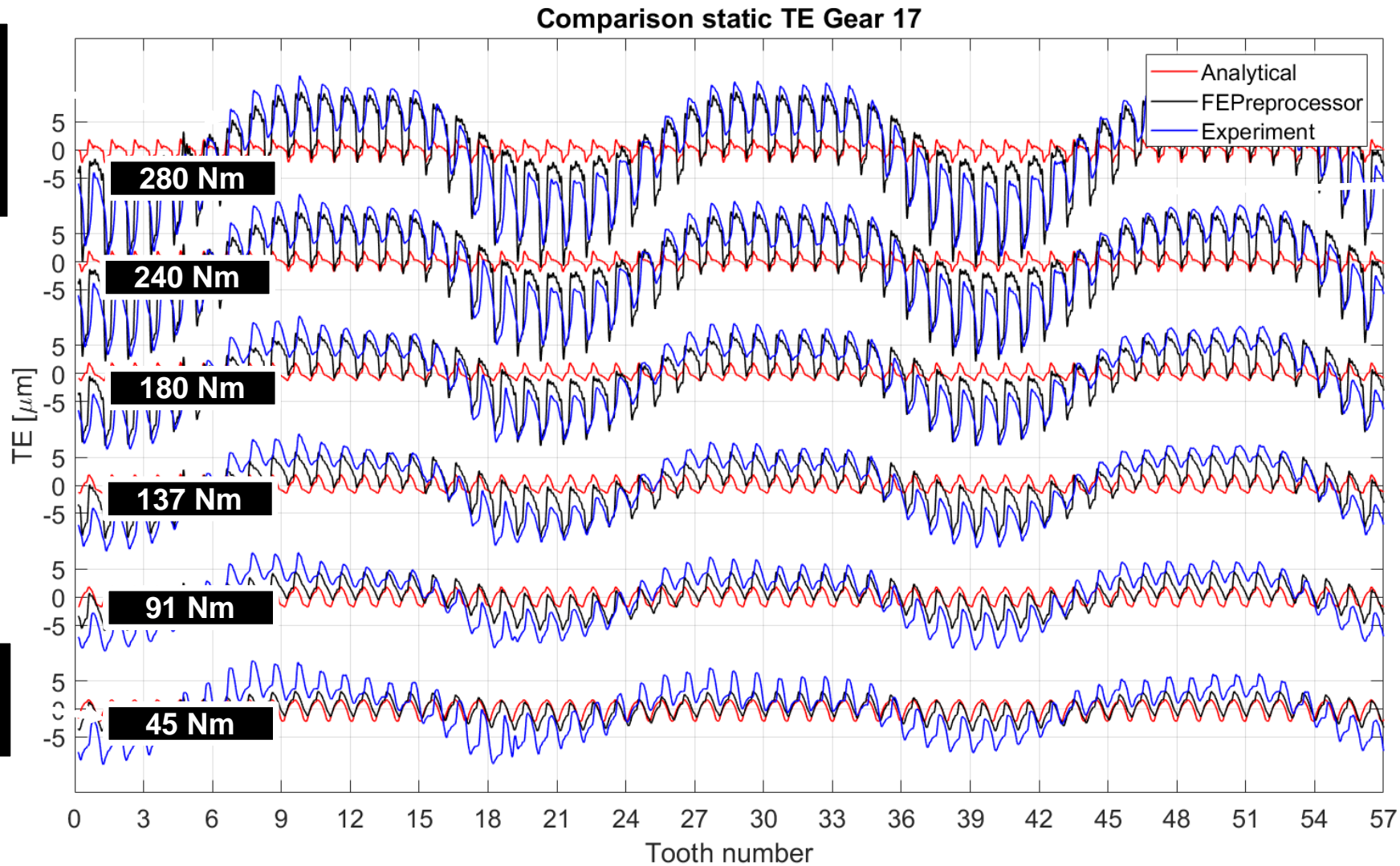


Siemens Testrig in Leuven, Belgium

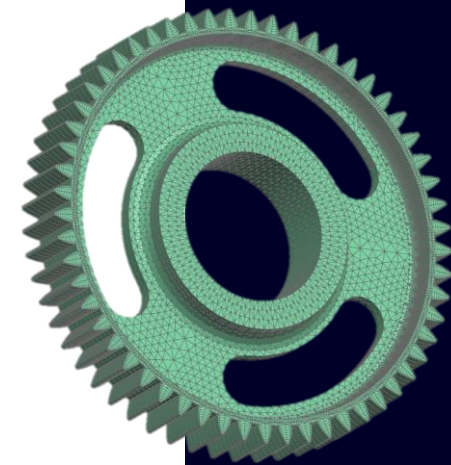
**In collaboration with KU Leuven and
University of Calabria**

Combined
friction,
microgeometry
and deformation
effects on TE

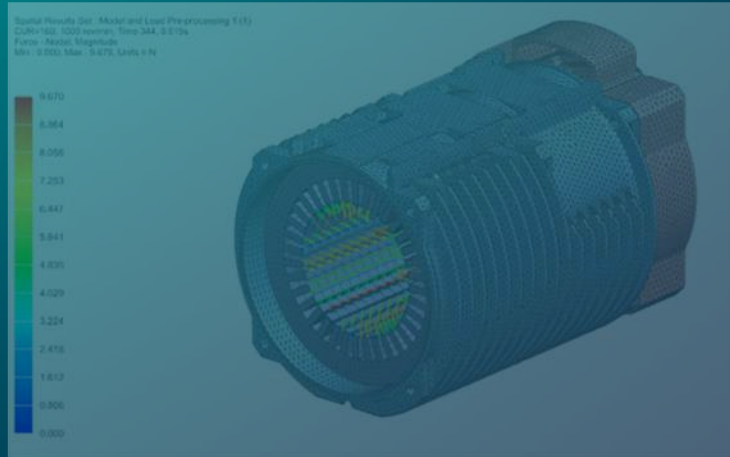
Microgeometry
matches well
(low loads)



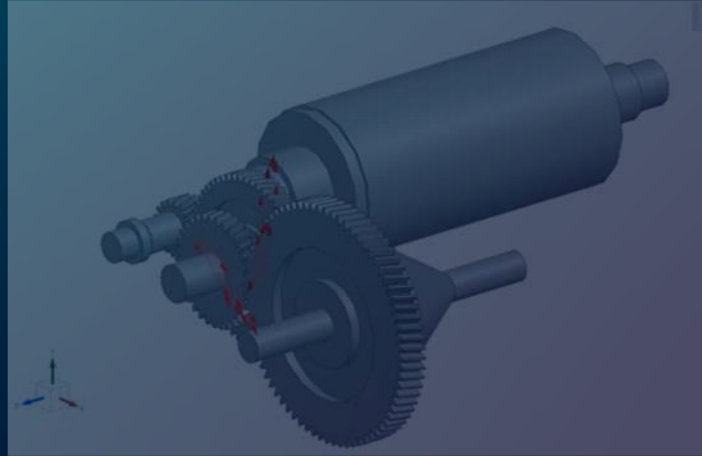
Low-frequency
oscillation due to
body compliance
(holes)



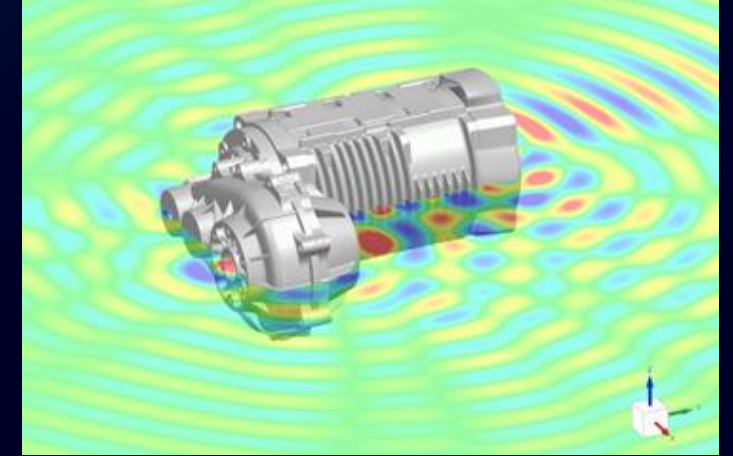
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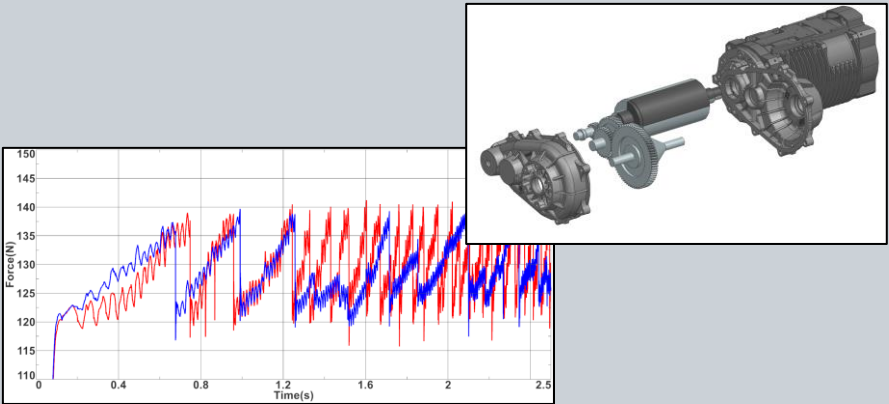
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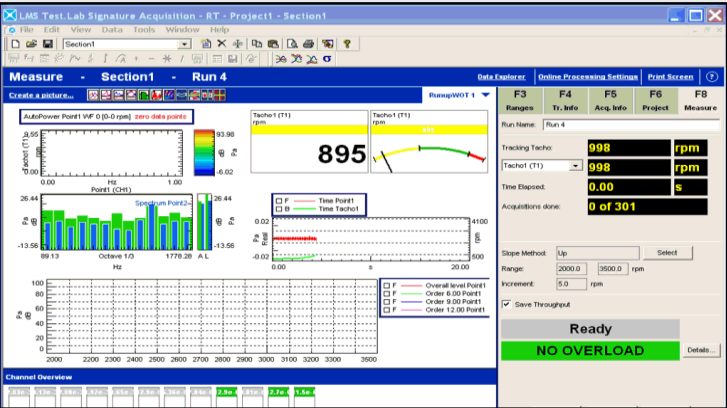
Acoustics
Simulation

Acoustic Simulation of Electric Drives

OR

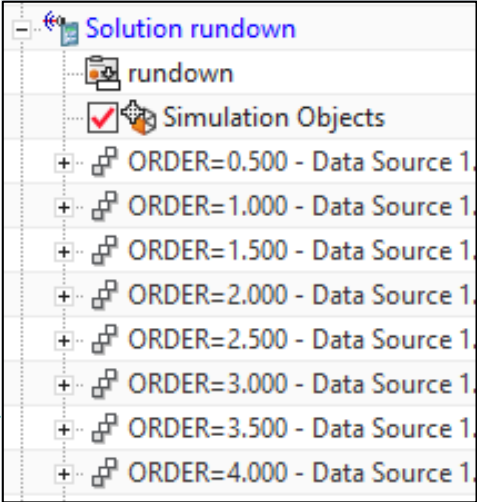


Multi-body simulation results

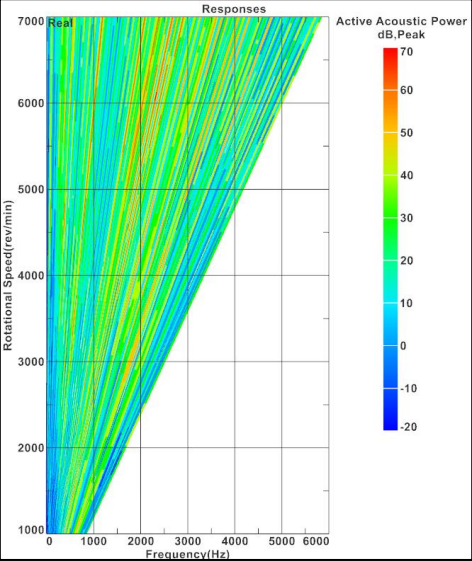
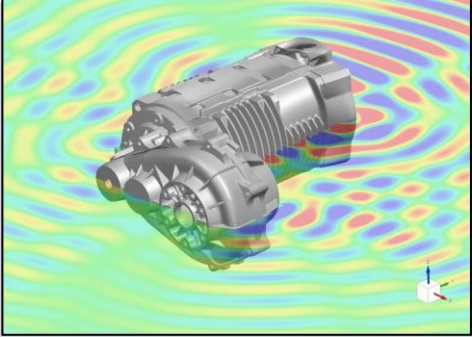


Measured data

Data processing and mapping



Load Recipe
Time series
Frequency spectra
Waterfalls
Orders



Noise Prediction

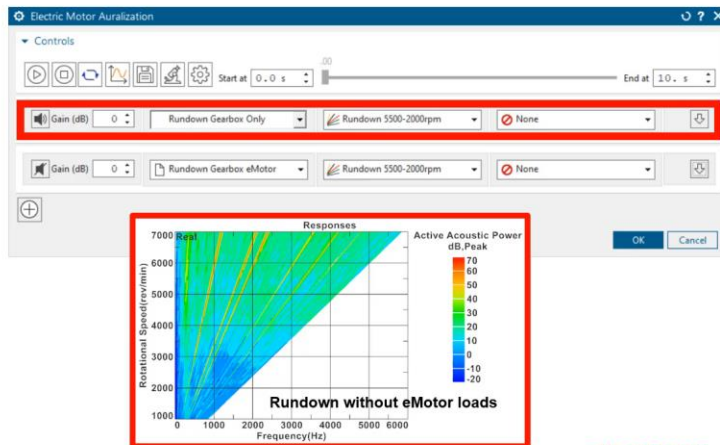
Listen to the electric powertrain in the design phase

Sound processing and Auralization

Listen to design changes and evaluate sound quality metrics

Build acoustic scenes to listen to simulation results

- Sources
 - Recorded sounds
 - Order cut data + rpm profile
- Transfers
 - Monaural and binaural impulse responses
- Listen to and plot sound pressure
- Calculate and compare sound quality metrics



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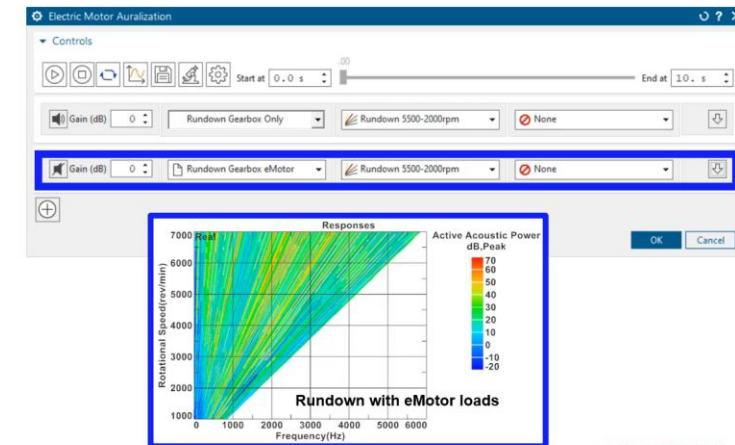
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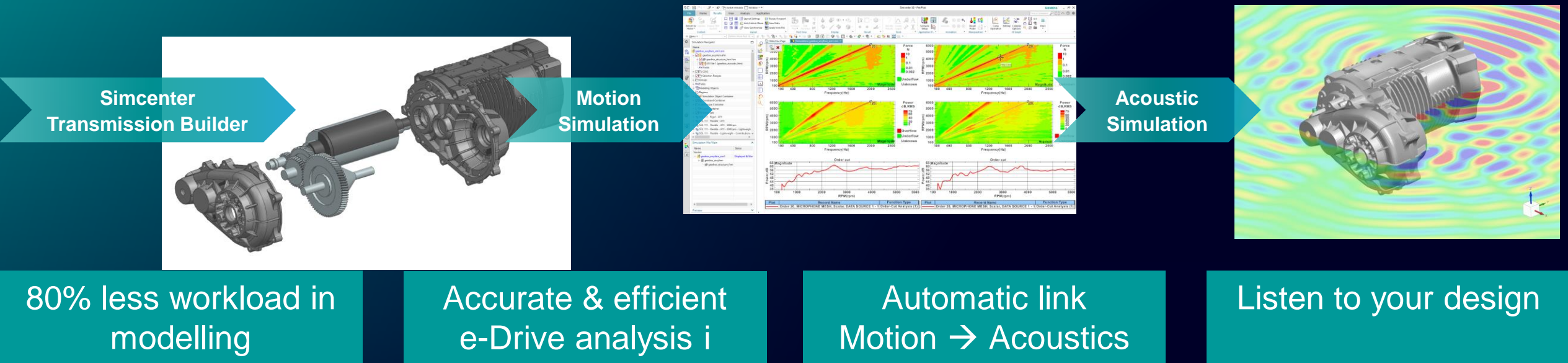
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Run down of transmission only

Run down transmission + eMotor

Predict and Reduce Motor and Gear Whine Noise 5 Times Faster



Thank you!

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