

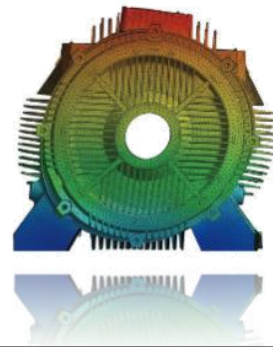
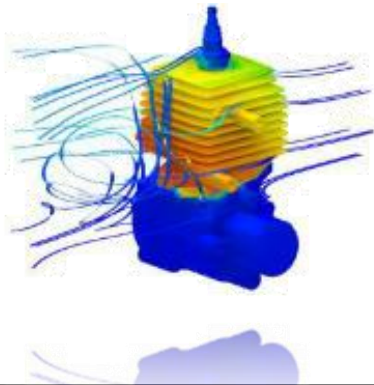
ANSYS Twin Builder Product Presentation

2020R2 Update



What is a Simulation Based Digital Twin?

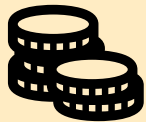
- Connected, virtual replica of an in-service physical asset, in the form of an integrated multi-domain system simulation, that mirrors the life and experience of the asset
- Enables system design and optimization, predictive maintenance and optimize industrial asset management



How Digital Twins help our customers



Increase topline revenue

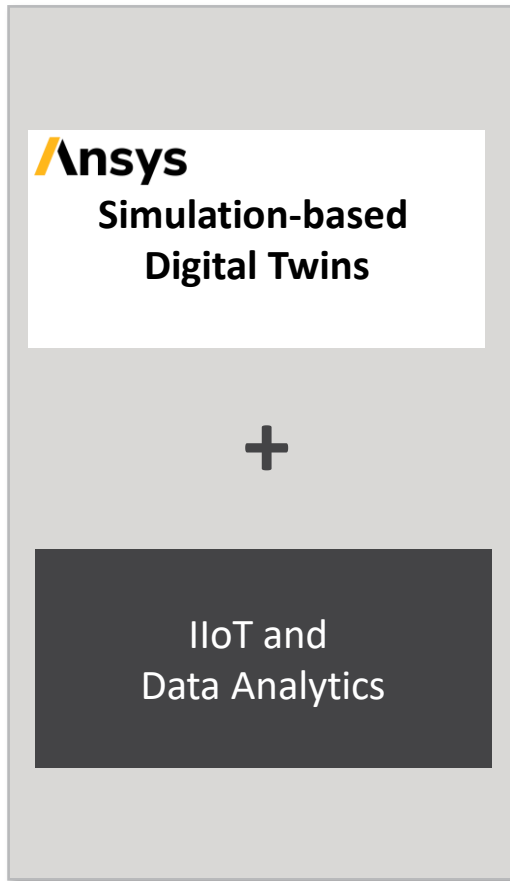


Manage bottom-line costs



Gain/retain Competitive Edge

Customers are putting simulation at the center of their Digital Twin implementations



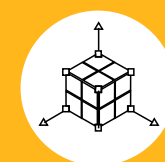
**Virtual Sensors to Simulate
Critical Quantities**



**Perform What-ifs before
applying a solution**



**Physics Based Accuracy,
Improved ROI**



**Generate baseline and
failure data using Physics**

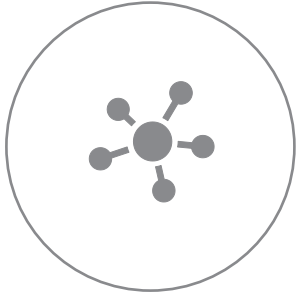


ANSYS Twin Builder Capabilities



Key Capabilities of ANSYS Twin Builder

Deploy



**System
Predictive
Maintenance**

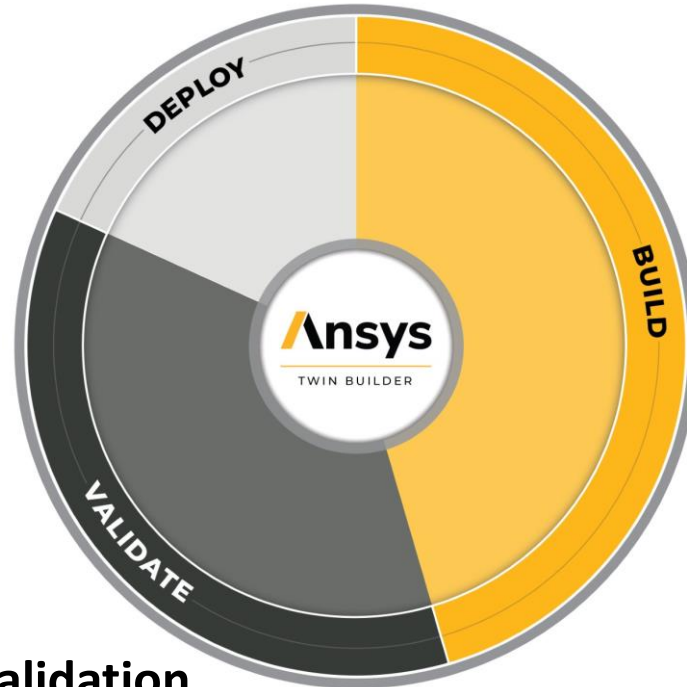
Connect the Twins to IIoT
Platforms and Deploy Run times
in operation

Validate



**System Validation
and Optimization**

Validate and Optimize the Twin



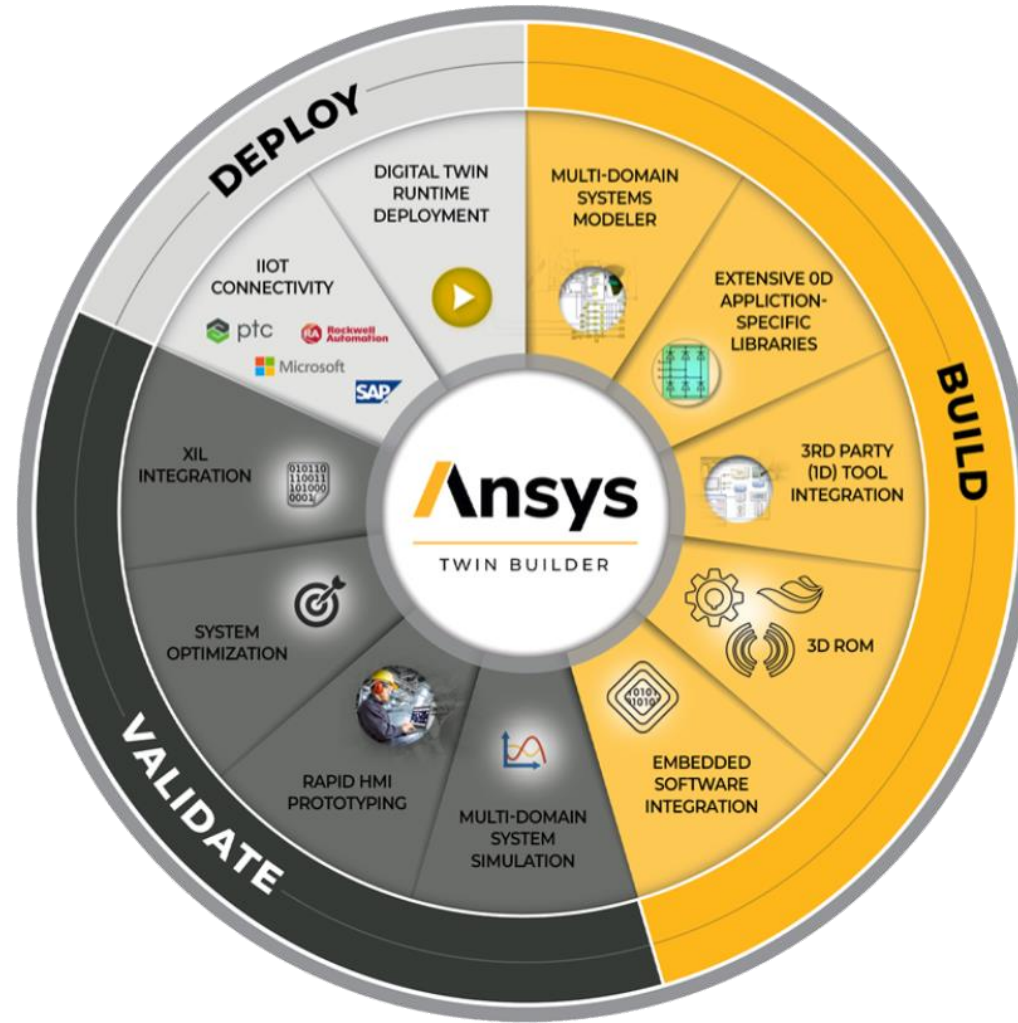
Build

**System
Simulation**

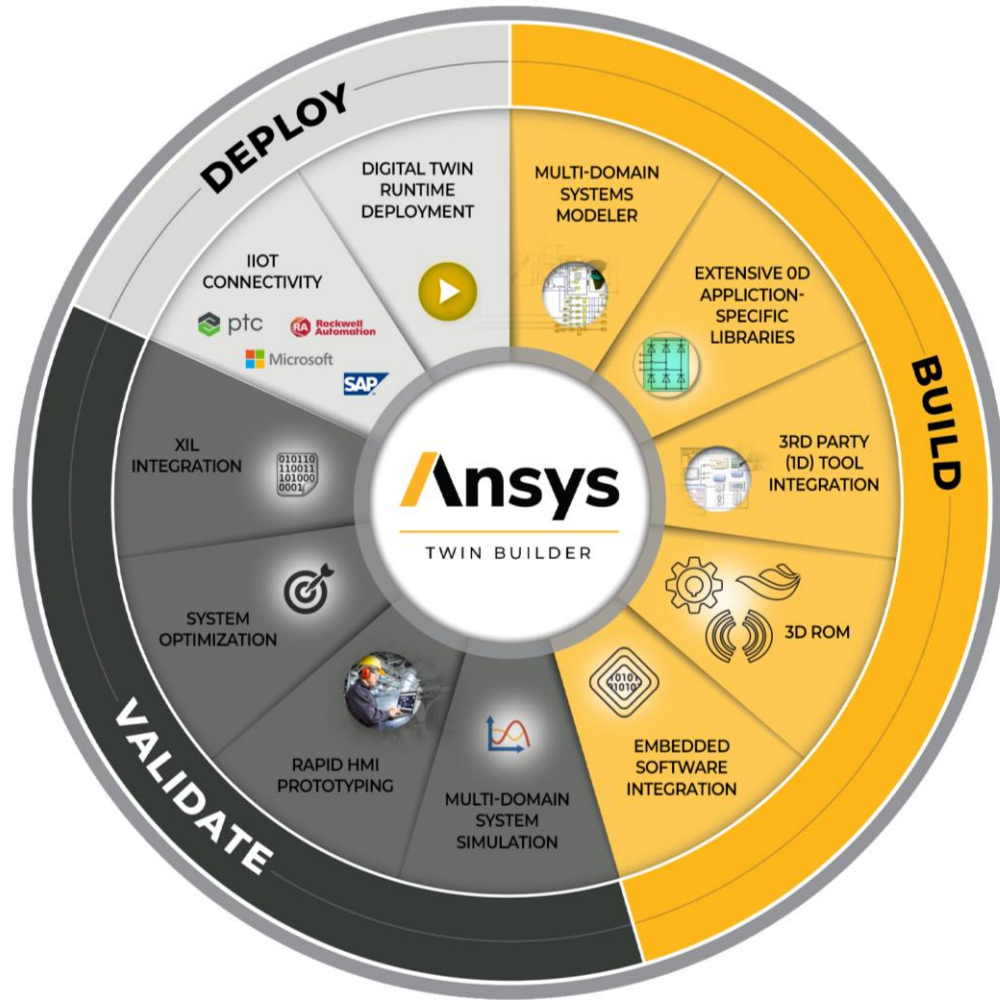


Build an accurate Physics-based
Digital Twin in record time

Technical Capabilities Overview of ANSYS Twin Builder



ANSYS Twin Builder: Capabilities and Strengths



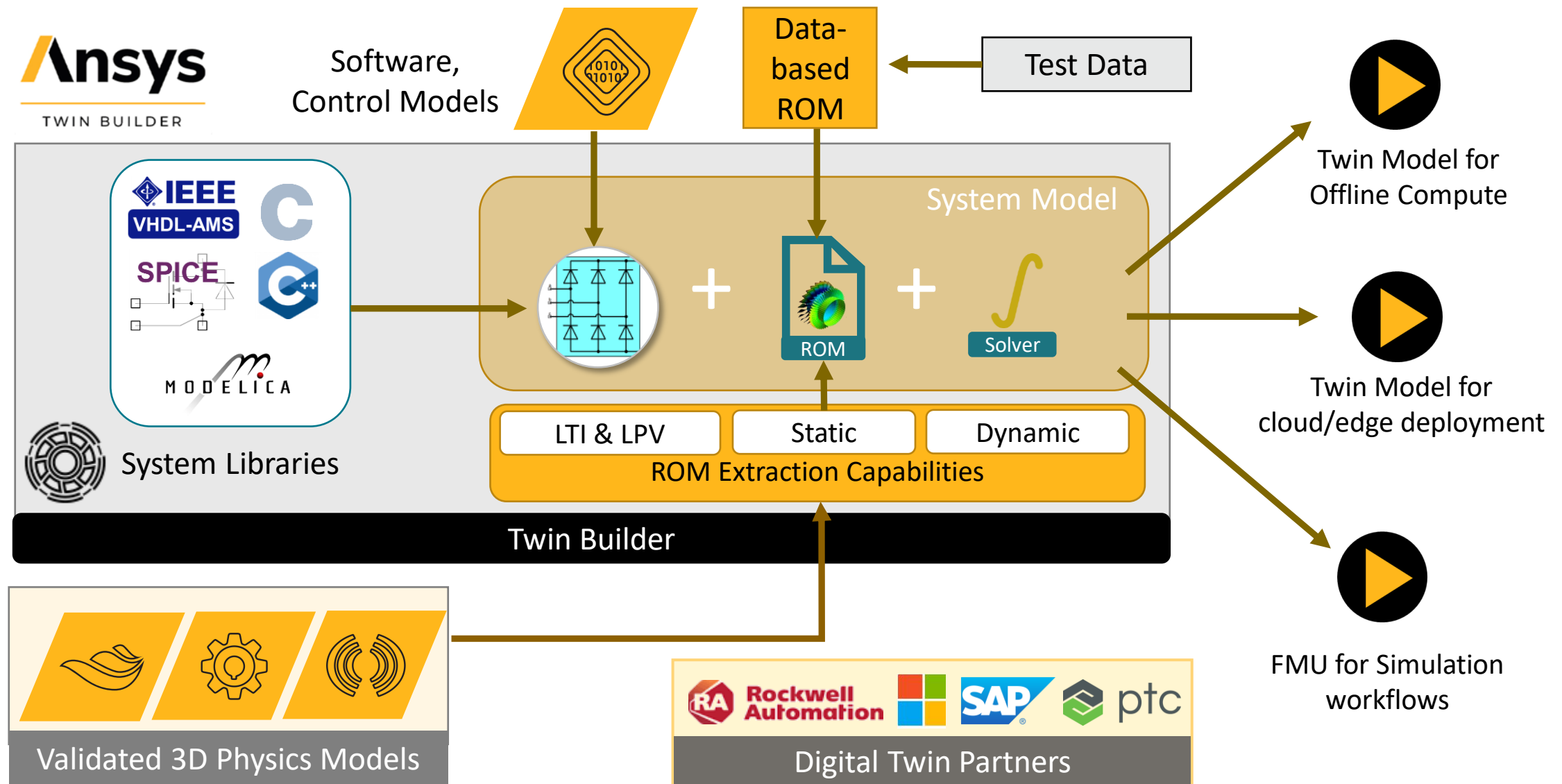
Multi-technology platform

State-of-the-art reduced order modeling

Interoperability support

Ability to deploy runtimes for Digital Twin

Twin Builder Architecture and Workflow

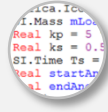


Technical Capabilities Overview: Quickly Build Digital Twins using Twin Builder

Build Phase Benefits and Capabilities

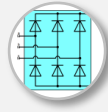
Easily assemble virtual replica from a variety of sources

Multi-domain, multi-fidelity, multi-language



Support for multiple modeling domains and languages

- Support for Modelica, VHDL-AMS, C/C++, SPICE and more



Extensive 0D Application Specific Libraries

- Electrical, Electronics, Std. Modelica Lib., Fluid Power, Thermal etc.



3rd Party Tool (incl. 1D) Integration

- Support for FMI/FMU, ANSYS 3D solvers and co-simulation



3D Reduced Order Model Creation and Integration

- Simplify 3D physics by use of ROM (Dynamic, Static and DX)



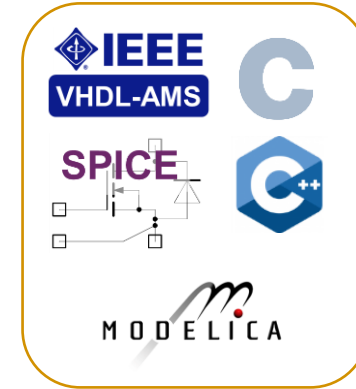
Embedded Software Integration

- SCADE Suite, SCADE Display and more

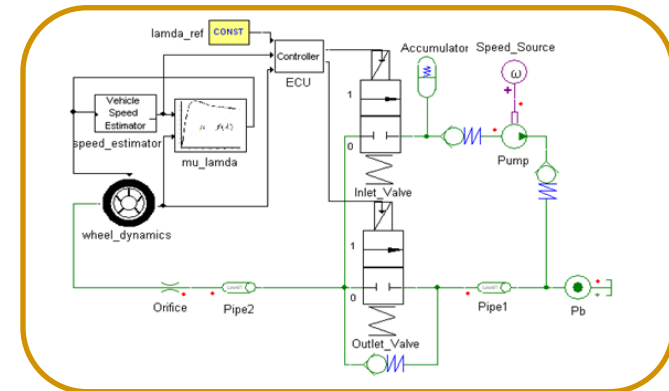
Multi-Domain Systems Modeler

Compose your system using multiple domains and languages

- Model with standard languages and exchange formats including VHDL-AMS and Modelica.
- Combine conserved (acausal), signal-flow (causal), and discrete event system behaviors.
- Compose your system by including multiple physical domains including Electrical, Mechanical, Hydraulic and other domains.



Language-Based Modeling



Multi-Domain Systems



Extensive OD Application Specific Libraries

Develop multi-domain system models using built-in and add-on libraries

- Develop multi-domain system models using built-in Modelica and specialized Twin Builder libraries.
- Build battery cell model with Twin Builder Modelica library that includes four templates for Equivalent Circuit Models(ECM) with SOC or SOC-Temperature dependency.
- Add-on library: Twin Builder Heating and Cooling library and Fluid Power Library



Fluid Power Library

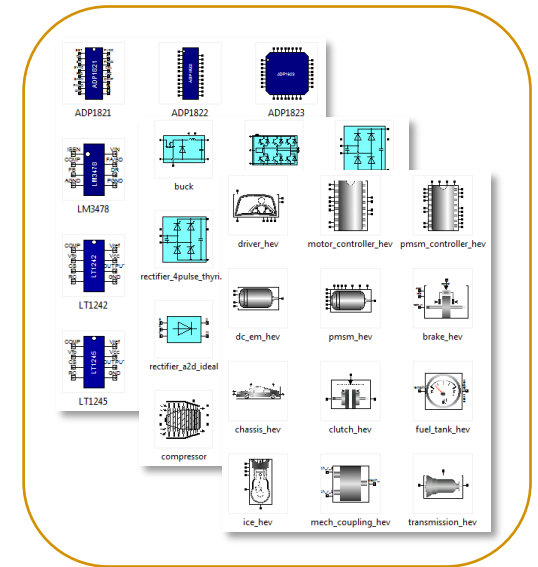


Heating and Cooling Library



EV Powertrain Library

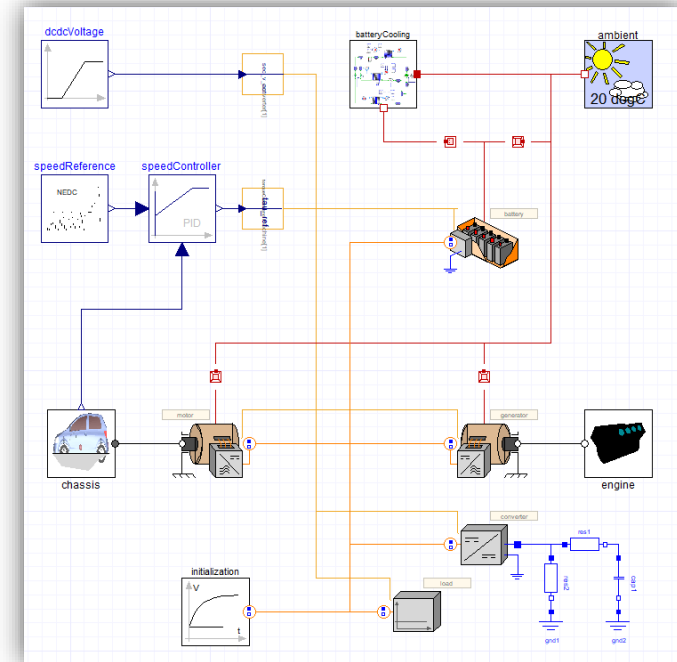
**Add-On Libraries
(Modelica)**



Built-in Multi-Domain System Libraries

New: EV Powertrain Library

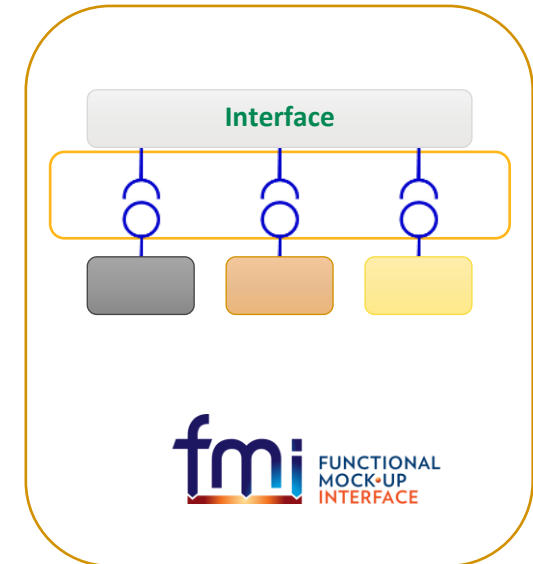
- EV Powertrain Library is a Modelica library for dynamic multi-domain modeling of electrified systems and ideal for design exploration of system modeling workflow
- Library supports multi-fidelity modeling for electrification applications and complements Twin Builder's high-fidelity ROM-based workflow
- Library of models to capture electrical, thermal, mechanical, and controls interactions for electrification applications including electric and hybrid vehicles, electric mobility, auxiliary power electric storage and electrification of engineered systems



3rd Party Tool Integration through standards

Enhance productivity and interoperability by leveraging standards

- Compatible with the functional mock-up interface (FMI) for model exchange to import models from all FMI-compliant tools and export Modelica models as FMUs
- Create or reuse C/C++ models with the Twin Builder C interface.

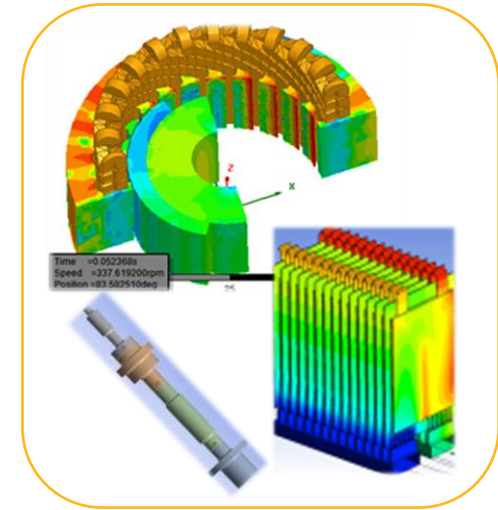


**Standard-Based
Interoperability**

3D Reduced-Order Modeling Interfaces

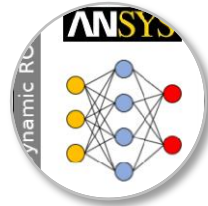
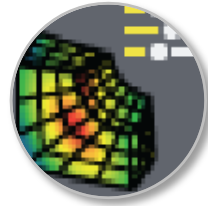
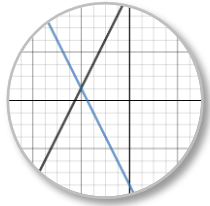
Transforms 3D simulation results into system-level models

- Use Reduced-Order Modeling (ROM) interfaces to generate accurate, compact models from detailed 2D and 3D physics simulations.
- Simulates in a fraction of the time required by 3D Techniques for all ANSYS physics
- Link to a variety of ANSYS tools to create high performing models.



**Connections with
3D Physics**

There are three major groups of ROMs used in Twin Builder

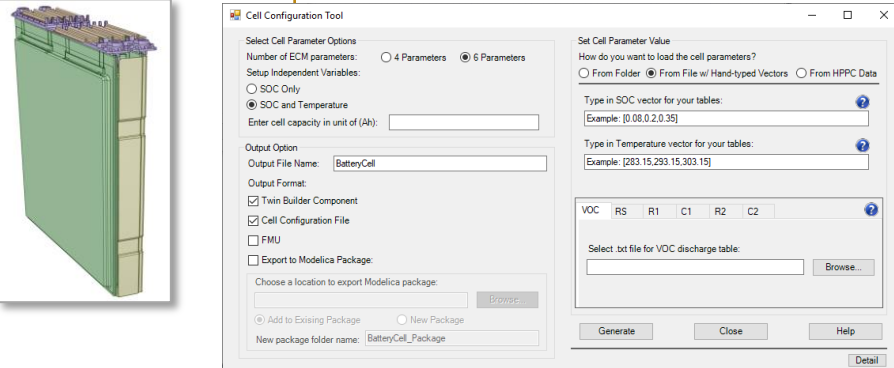


	Linear ROMS	Non-linear, Static	Non-linear, Dynamic
Techniques	State-Space/LTI Modal S-Parameter	Twin Builder Static ROM Builder Response Surface ROM OptiSLang	Twin Builder Dynamic ROM Builder Maxwell ECE
Supported Tools	Fluent, Mechanical, Icepak, Q3D, Maxwell, HFSS, Siwave	Twin Builder Static ROM Builder: All	Dynamic ROM Builder: All Maxwell ECE: Maxwell
Limitation	Linear system only Specific limitation for each tool Support enabled by tools	Static only Extending support for new tools requires effort	For Scalar only Limited input and outputs

Introducing ANSYS Twin Builder Battery Wizard

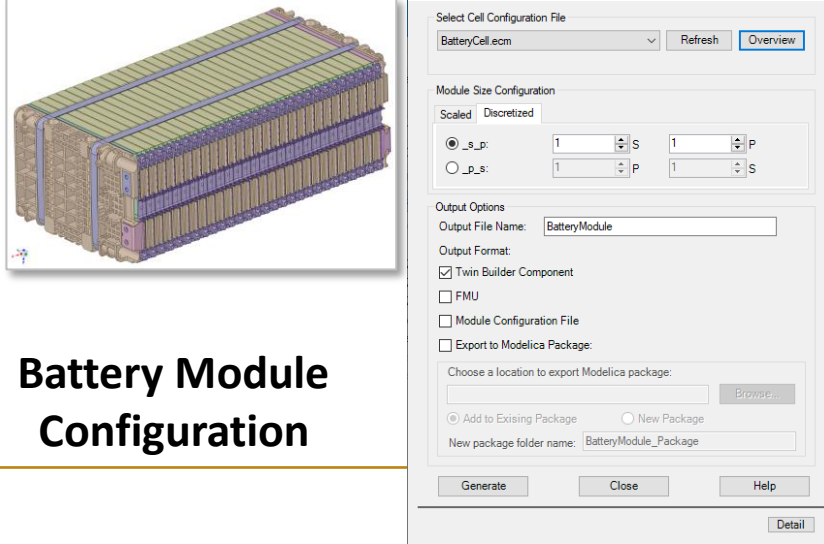
- Battery Wizard allows users to easily construct battery cells and assemble them into battery modules for use in electro-thermal simulations
- Streamlines the model creation and parametrization of Cell and Modules and allows export to multiple formats

1



Battery Cell Configuration

2



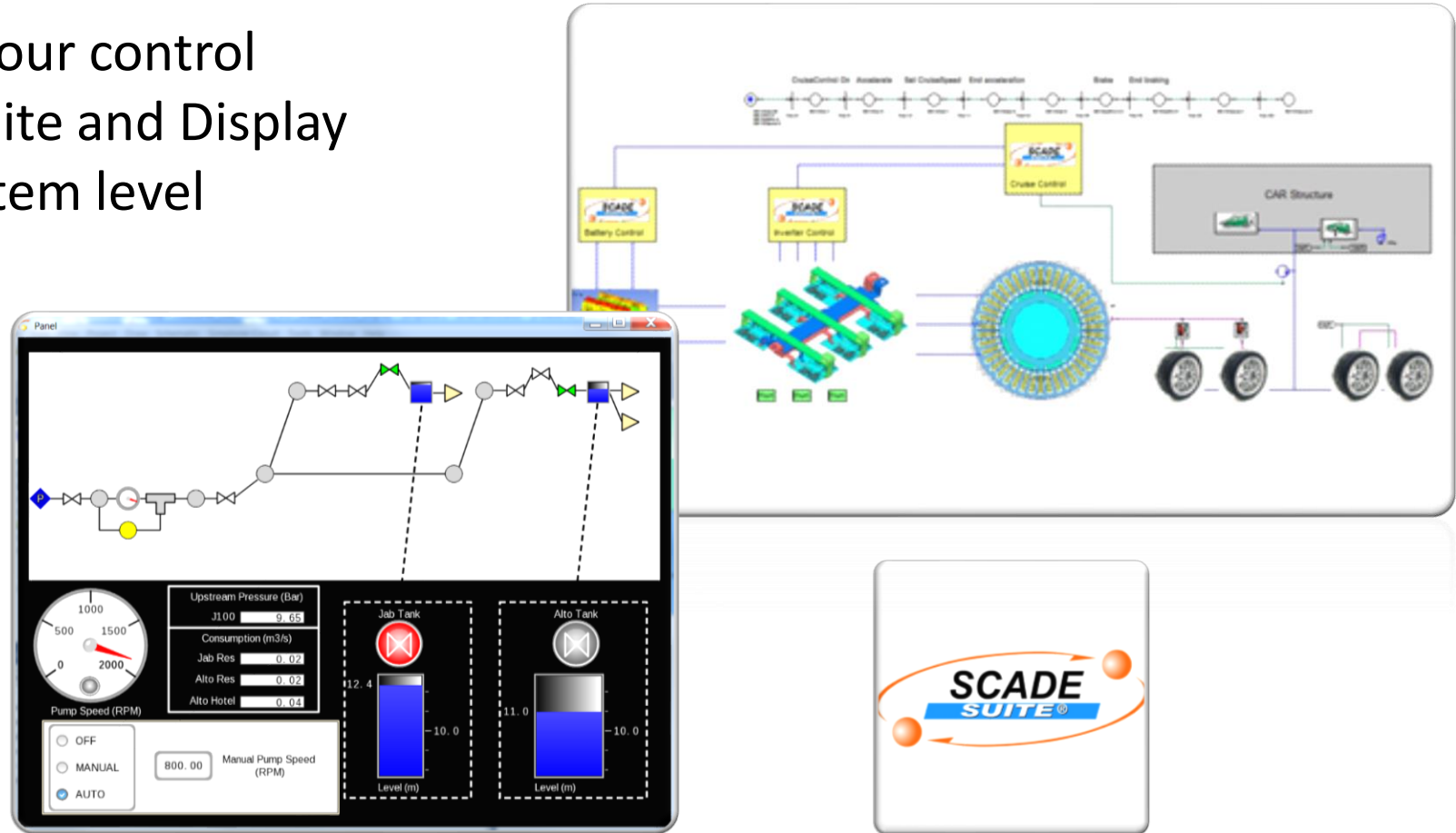
Battery Module Configuration

"A123 uses ANSYS Twin Builder to perform thermal simulation of their 48V battery pack development. A123 also utilizes Ansys Twin Builder's Reduced Order Model (ROM) technologies to simplify complex 3D thermal simulation to significantly reduce the simulation time from days to few seconds while keeping the required simulation accuracy."

- Shawn Zhang, Sr. Manager, Simulation Engineering, A123 System

Embedded Software Integration: Use SCADE family products to develop embedded applications

- Fast track development of your control applications using SCADE Suite and Display and seamlessly perform system level integration in Twin Builder.



Technical Capabilities Overview: Validate and Optimize the Digital Twin

Validate Phase Benefits and Capabilities

Ensure Product Reliability and Robustness

Optimize System Performance with built in Optimizers (or ANSYS DX and ANSYS OptiSLang)

Easily Integrate and validate with Test data



Multi-Domain Simulation with Integrated Post Processing

- Analyze and optimize the interactions among the multi-domain components in a system.



Rapid HMI Prototyping

- Enhances the simulation experience with powerful, easy-to-design, and interactive graphical panels. etc.



System Validation and Optimization

- Support for DoE, Parameter Sweep and Scripting (VBA/Iron Python)



XIL Integration

- Support for co-simulation for Model-in-the-Loop (MiL) and Software-in-the-Loop (SiL) validation workflow

Multi-Domain System Simulation: Integrate, Validate and Optimize multi-domain systems



Robust, High-Performing Solvers



Simulation Synchronizer



Analyses for Simulation-Based Testing



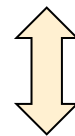
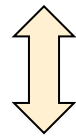
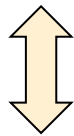
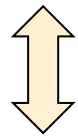
Optimization, Robustness & Reliability Tools



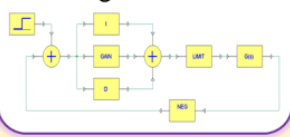
Waveform and Data Post-Processing



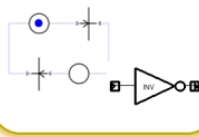
Reporting, Scripting & Automation



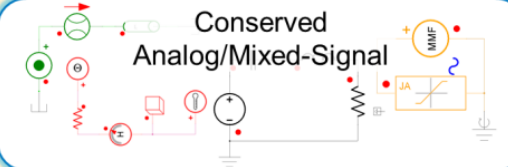
Signal Flow



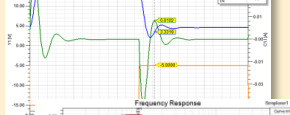
Discrete Event



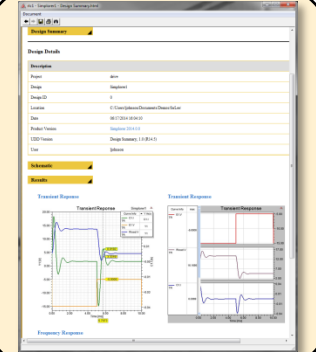
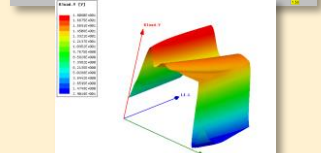
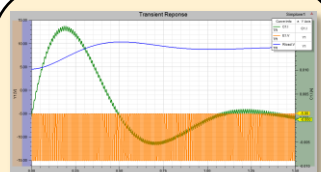
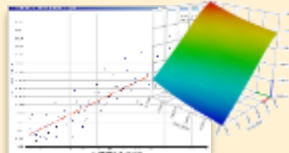
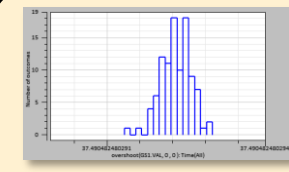
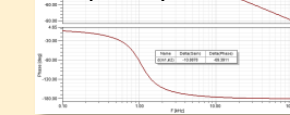
Conserved
Analog/Mixed-Signal



Time-Domain



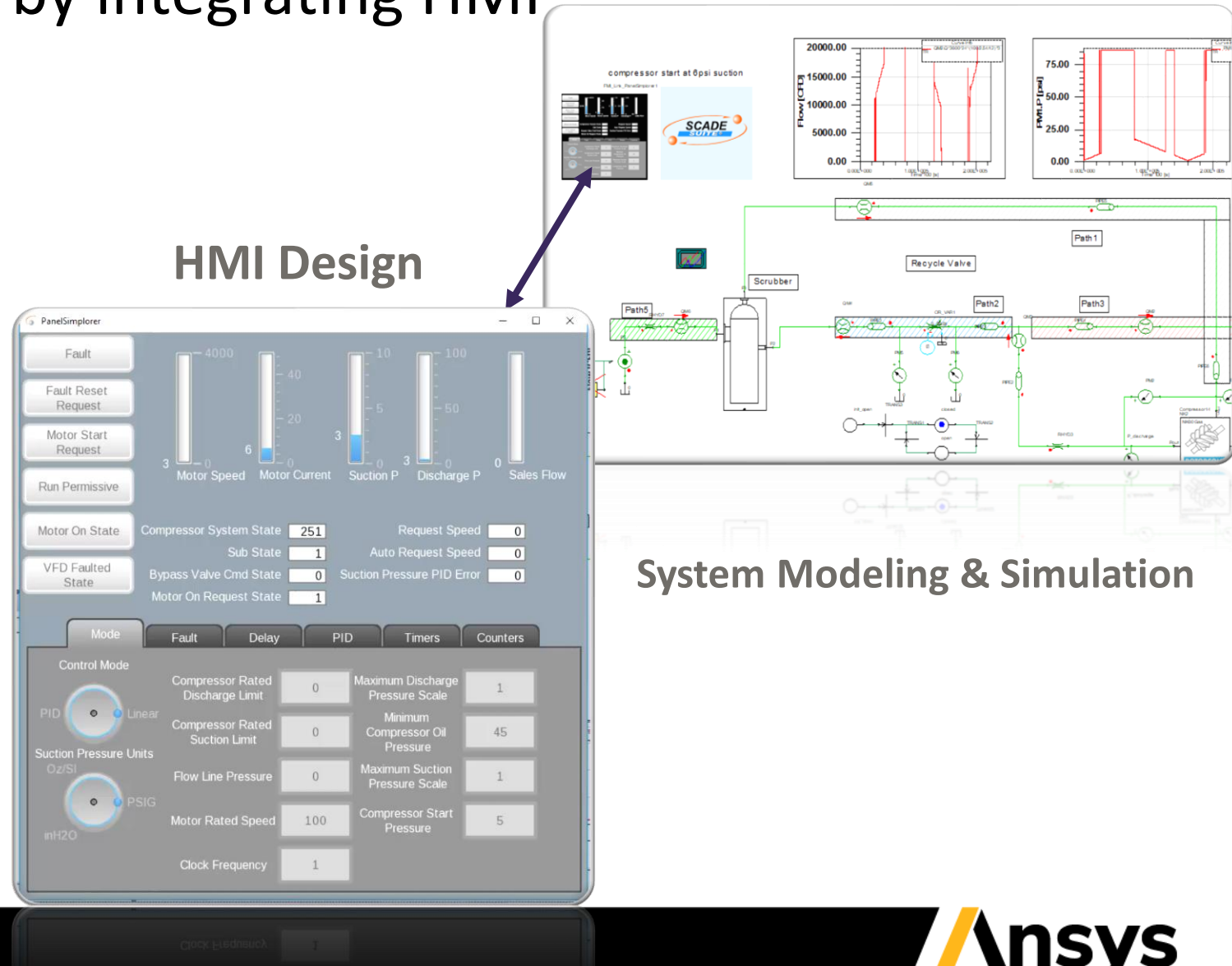
Frequency-Domain



Rapid HMI Prototyping

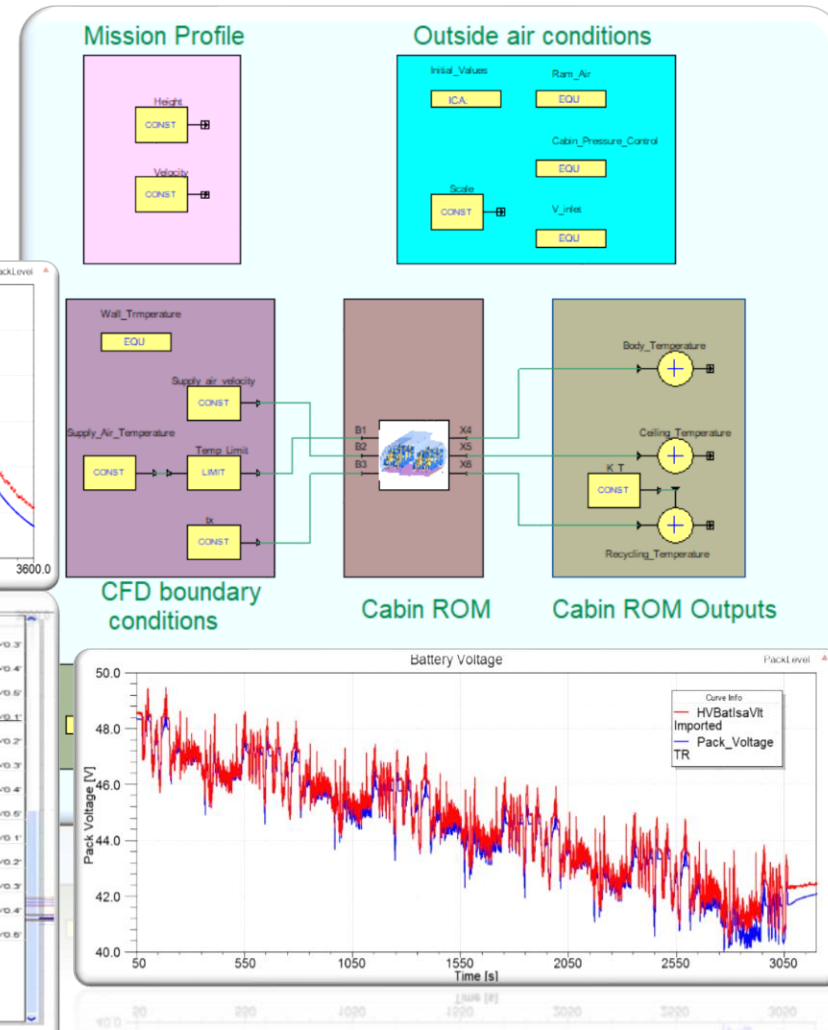
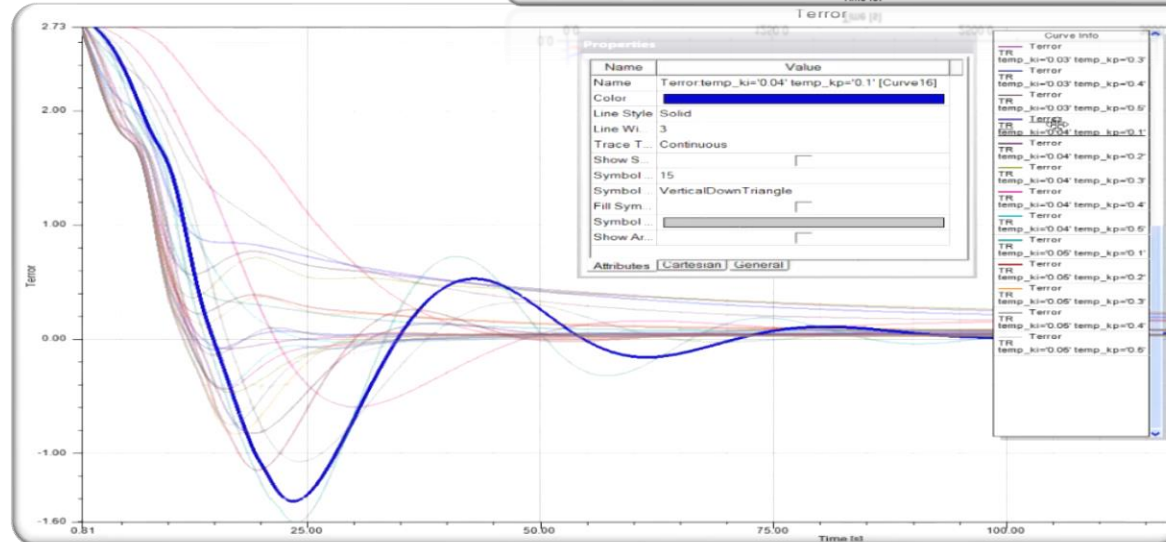
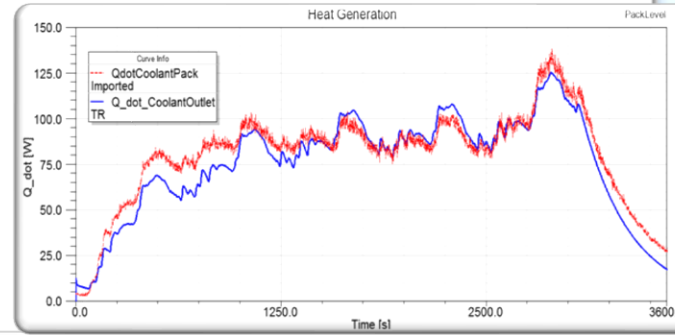
Increase testing efficiency by integrating HMI

- Rapid Prototyper enhances the simulation experience with powerful, easy-to-design, and interactive graphical panels.
- Use Rapid Prototyper to create interactive panels using predefined widgets (buttons, sliders, etc.) to interact with the application under test.



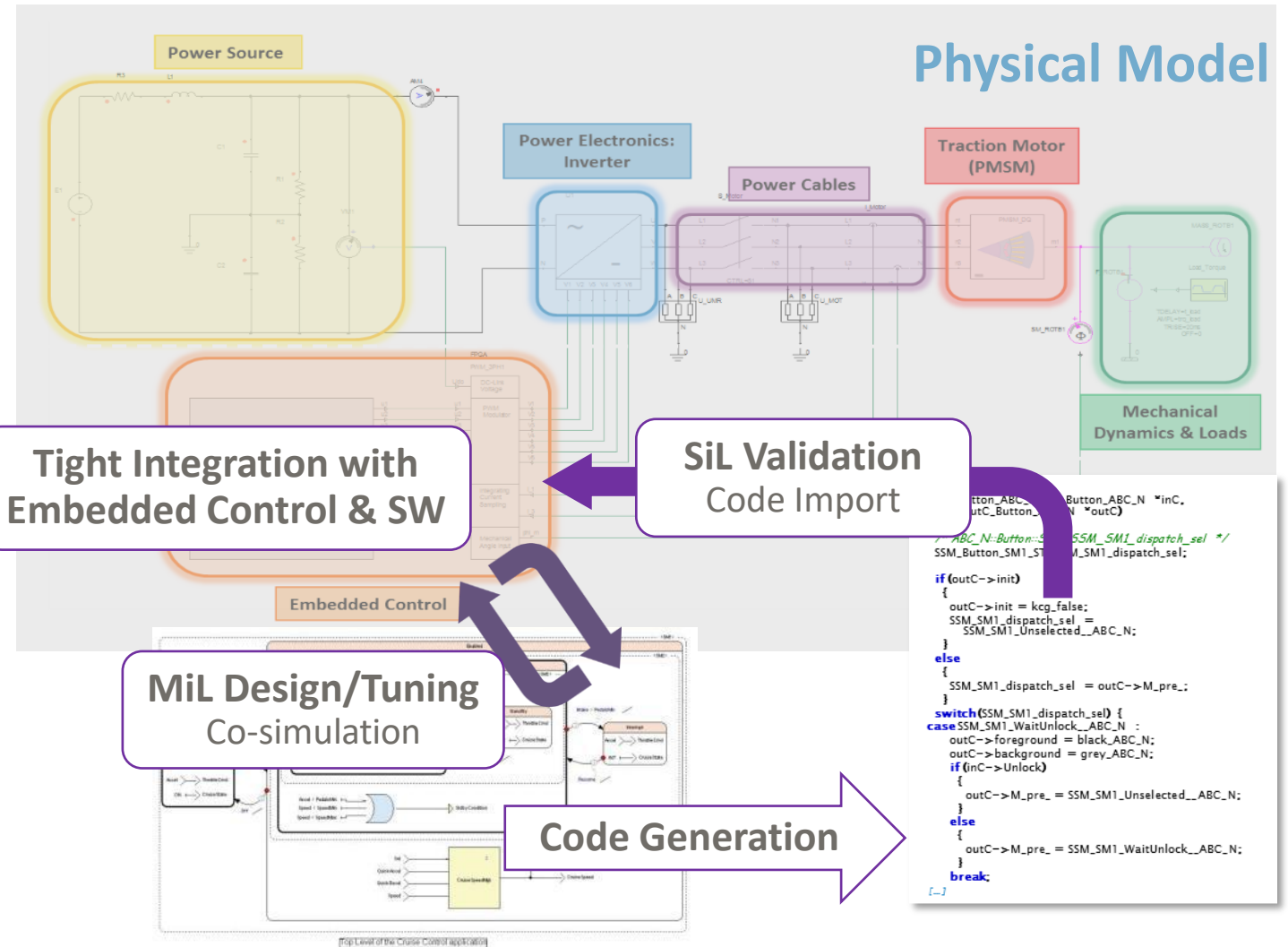
System Validation and Optimization

- Easily Integrate and validate with Test data.
- Optimize System Performance with built in Optimizers (or ANSYS DX and ANSYS OptiSlang)



System Validation and Optimization XIL Integration

- Co-simulation for Model-in-the-Loop (MiL) design and tuning of control strategies.
- Code Import for Software-in-the-Loop (SiL) validation of the real embedded code in the virtual system



Technical Capabilities Overview: Deploy Digital Twins on leading IIoT platform

Deploy Phase Benefits and Capabilities

Optimize Operations

Deploy for Preventive Maintenance



Quickly Connect to supported IoT Platforms

- Configure connector to connect to IIoT platform and send and receive operational data
- SAP Predictive Engineering Insights enabled by ANSYS
- Partnership with Rockwell Automation and Azure Digital Twins

Export and Deploy Generated Models

- Export from Twin Builder to generate portable, cloud deployable Twin

Easily Deploy Digital Twins with Ansys Twin Deployer

- Significantly reduce deployment time by performing validation and verification on Twins

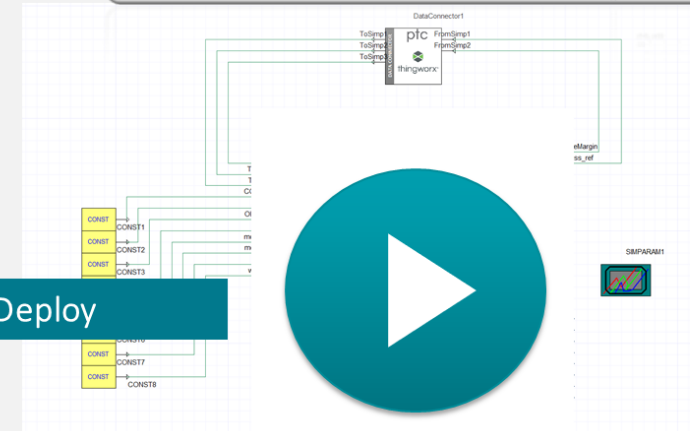
Twin Runtime SDK allows testing of exported Twin models and deployment to IIoT Platforms

Deploy Phase Benefits and Capabilities

SDK supports the testing and the deployment of digital twins on supported IIoT platforms, such as SAP, PTC ThingWorx, and Azure Digital Twins



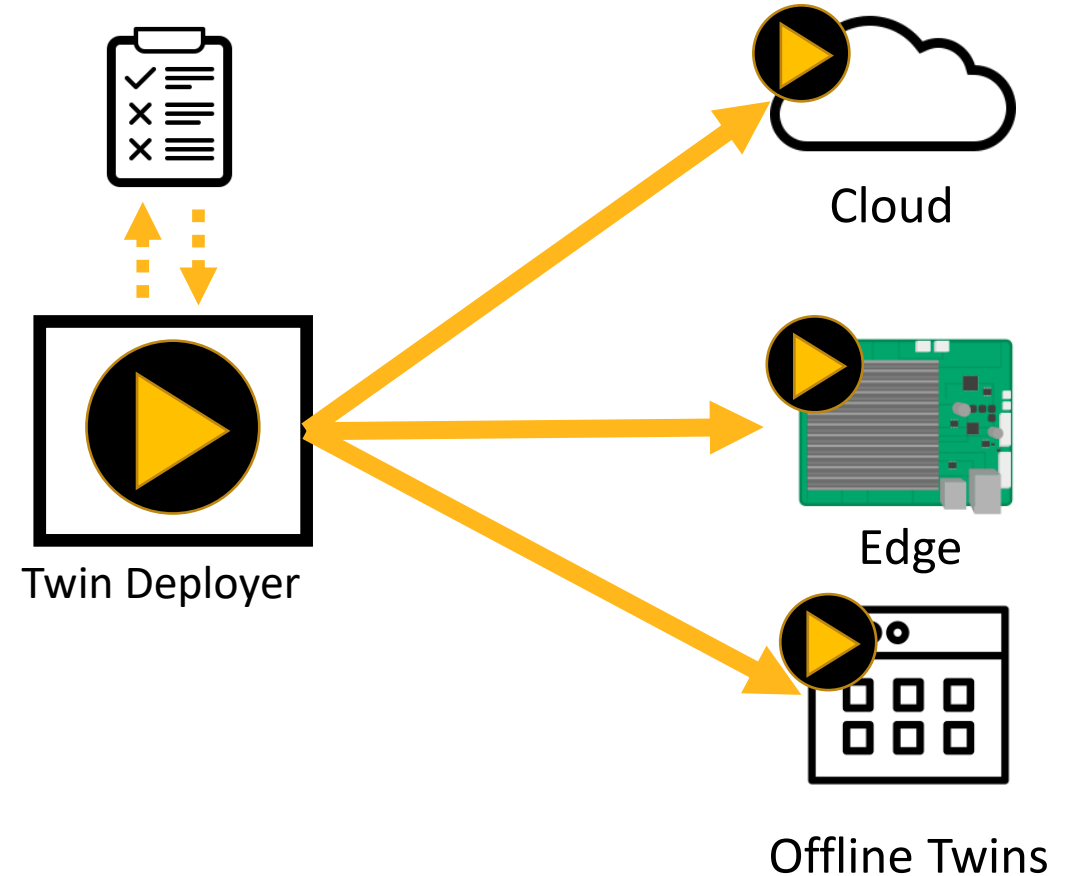
IIoT Platforms



New Capability: Easily Deploy Digital Twins with Ansys Twin Deployer

Ansys Twin Deployer

- Significantly reduce deployment time by performing validation and verification on Twins
- Easily deploy Twins on the cloud, edge or offline with just few clicks



ANSYS Twin Builder Packaging

	Twin Builder Pro	Twin Builder Premium	Twin Builder Enterprise
Twin Builder base (Modeling and basic libraries)	✓	✓	✓
Dynamic/Static ROM Builder (Incl. build UI and consumption)	✗	✓	✓
Runtime Generator (For IIOT platforms like SAP, PTC and for generic/FMI export)	✗	✗	✓

Add-On Libraries
ANSYS Twin Builder Heating and Cooling Library
ANSYS Twin Builder Fluid Power Library
EV Powertrain Library

Twin Validation and Deployment
ANSYS Twin Deployer
Ansys Twin Builder Generic Runtime (Low, Medium, High)





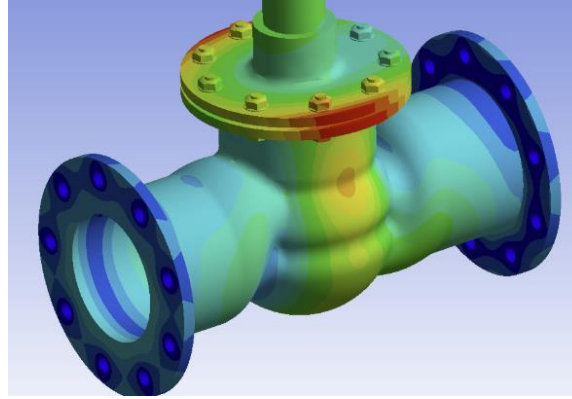
ANSYS Twin Builder Applications and Success Stories



Application Examples of Digital Twins with Twin Builder



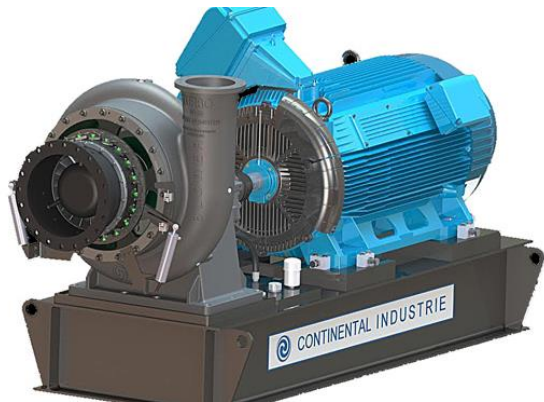
Battery/Electrification



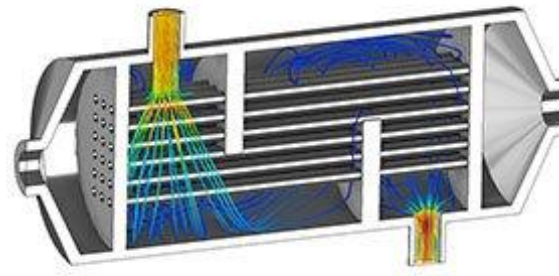
Structural



Industrial Automation



Electric Motors and Machines



Heat Exchangers



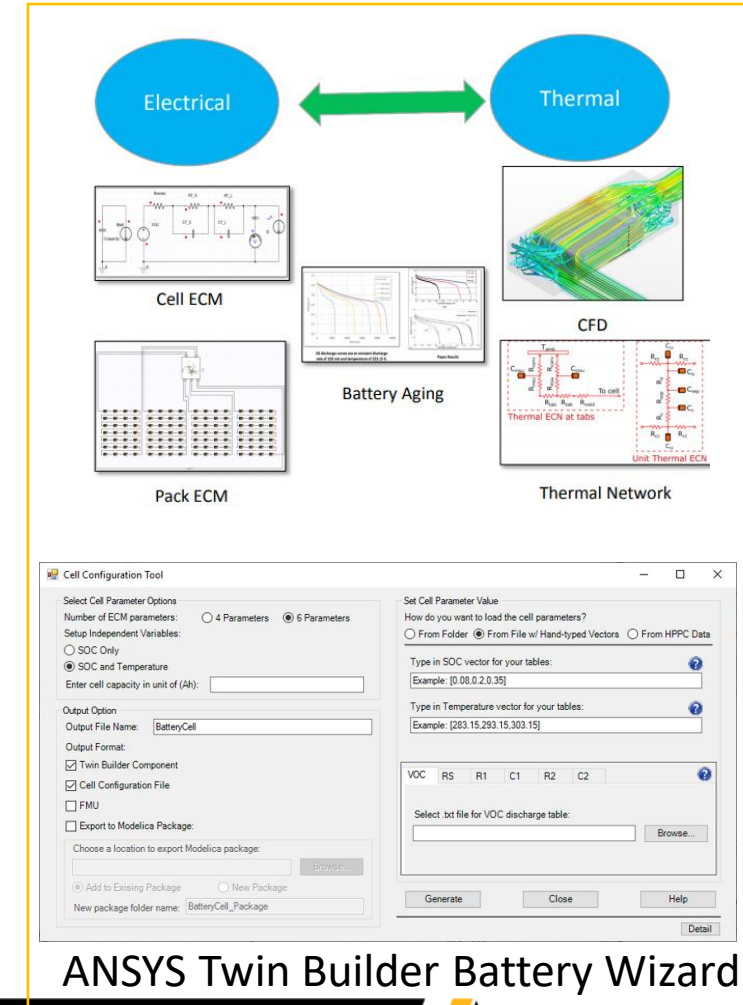
Rotating Machinery

Battery Modeling at A123 with Twin Builder Battery Wizard



"A123 uses ANSYS Twin Builder to perform thermal simulation of their 48V battery pack development. A123 also utilizes Ansys Twin Builder's Reduced Order Model (ROM) technologies to simplify complex 3D thermal simulation to significantly reduce the simulation time from days to few seconds while keeping the required simulation accuracy."

- Shawn Zhang, Sr. Manager, Simulation Engineering, A123 System



ANSYS Twin Builder Battery Wizard



EDF Pioneers Low-Carbon Power Generation Technologies with Ansys Multiphysics Solutions

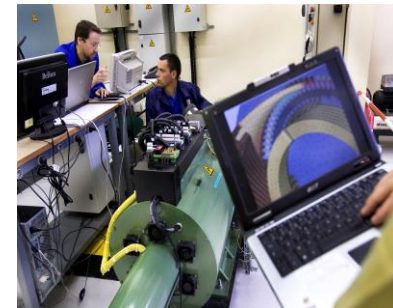
"Collaborating with Ansys to design leading-edge nuclear power plants accelerates the creation of renewable energy with unmatched efficiency and unparalleled customer accessibility. By digitally transforming our manufacturing processes, we can minimize emissions, slash maintenance costs and maximize our share of the power generation market while remaining in full compliance with strict international regulatory standards." - Levesque Benoit, Project Manager at EDF

The EDF Group is digitally transforming to drive the development of safe, dependable and affordable low-carbon power generation technologies by collaborating with Ansys. Through a new multi-year agreement, EDF will use Ansys to design state-of-the-art nuclear power plants and deliver unprecedented nuclear energy efficiency.

A key technological partner to ConnexiTy since 2017, Ansys helped design a highly advanced control room for a next-generation nuclear power plant. The program also leverages Ansys Twin Builder™ to create digital twins of plant turbo-alternators, enabling predictive maintenance and reduced repair expenses.

Digital transformation delivers exceptional energy efficiency, extends nuclear plant operating life well beyond 40 years

[Link to the Press Release \(March 10, 2020\)](#)



KAESER KOMPRESSOREN: How Will a Leading Compressor Company Reinvent Sales with a Digital Twin?

KAESER
KOMPRESSOREN

PUBLIC

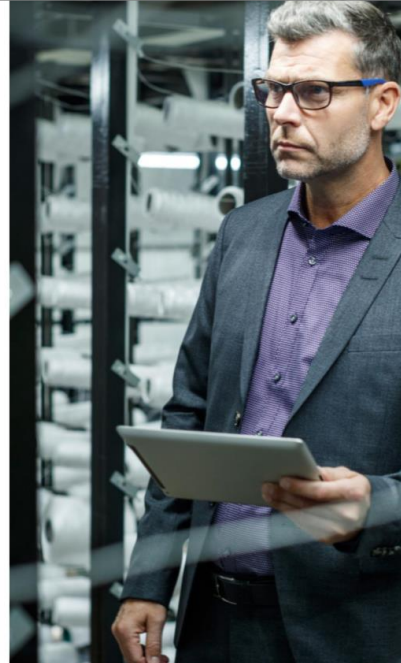
How Will a Leading Compressor Company Reinvent Sales with a Digital Twin?

Increasing sales efficiency with automated simulations of complete compressor stations

KAESER KOMPRESSOREN SE is one of the world's leading manufacturers and providers of compressed air products and services. Today, KAESER's Industry 4.0 strategy enables the company to run a **seamless digital thread from design to operations**, helping to detect potential issues in the compressed air network early. To increase the efficiency of its configure price and quote processes, Kaeser set its sights on a simulation-based digital twin that could enable the company to digitalize sales for new and improved insights.

CADFEM GROUP

THE BEST RUN 



KAESER connects engineering simulations with sales processes to create a **next-generation sales experience** for customers.

With the **SAP® Predictive Engineering Insights solution enabled by ANSYS** and ongoing solution support from partner **CADFEM Group, Inc**, KAESER KOMPRESSOREN plans to:

- Enhance business processes with engineering simulation models for improved decision-making across the value chain
- Introduce simulation as a service as part of the configure-price-quote process
- Increase sales efficiency by automating simulation tasks for technical verification of customer configurations
- Reduce administrative efforts by removing manual interfaces between lines of business
- Automate feasibility and applicability studies
- Run multiple what-if simulations to balance costs against customer requirements

"We can further improve our sales experience, gain greater efficiency, and break down silos between lines of business thanks to SAP Predictive Engineering Insights enabled by ANSYS. It helps us **reduce our cost of sales** by leveraging the strategic partnership between ANSYS and SAP."

Falko Lameter, Chief Information Officer, KAESER KOMPRESSOREN SE

CADFEM GROUP



KAESER
KOMPRESSOREN

KAESER
KOMPRESSOREN SE
Coburg, Germany
www.kaeser.com

Industry
Industrial
machinery and
components

Employees
6,500

Revenue
>€1 billion

Featured Solutions and Services
SAP Predictive Engineering Insights
enabled by ANSYS

THE BEST RUN 

• [Link](#)

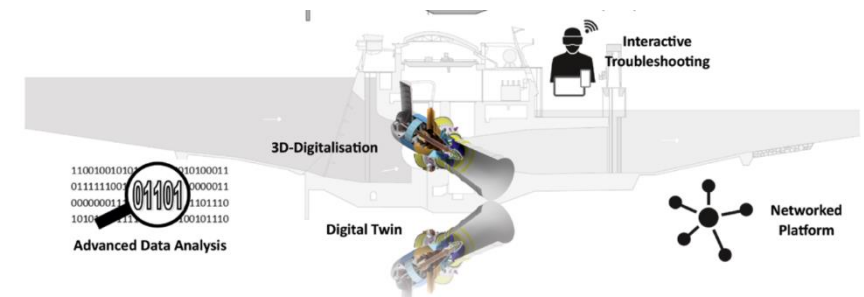
Verbund Hydro: Digital Twin for Water Turbine

Verbund

Challenge: Predict the wear on the turbine under different loading conditions to optimize the turbine output as unplanned downtime can cost up to **\$60,000/h**.

Solution: A simulation based digital twin of the turbine and surrounding component is connected with physical sensor data to predict accurate current stresses at the hot spots.

Results: Optimized operations of the turbines can save **~\$100k/year** per turbine. Verbund operates more than 120 plants and can deploy up to 120 digital twins.



ANSYS

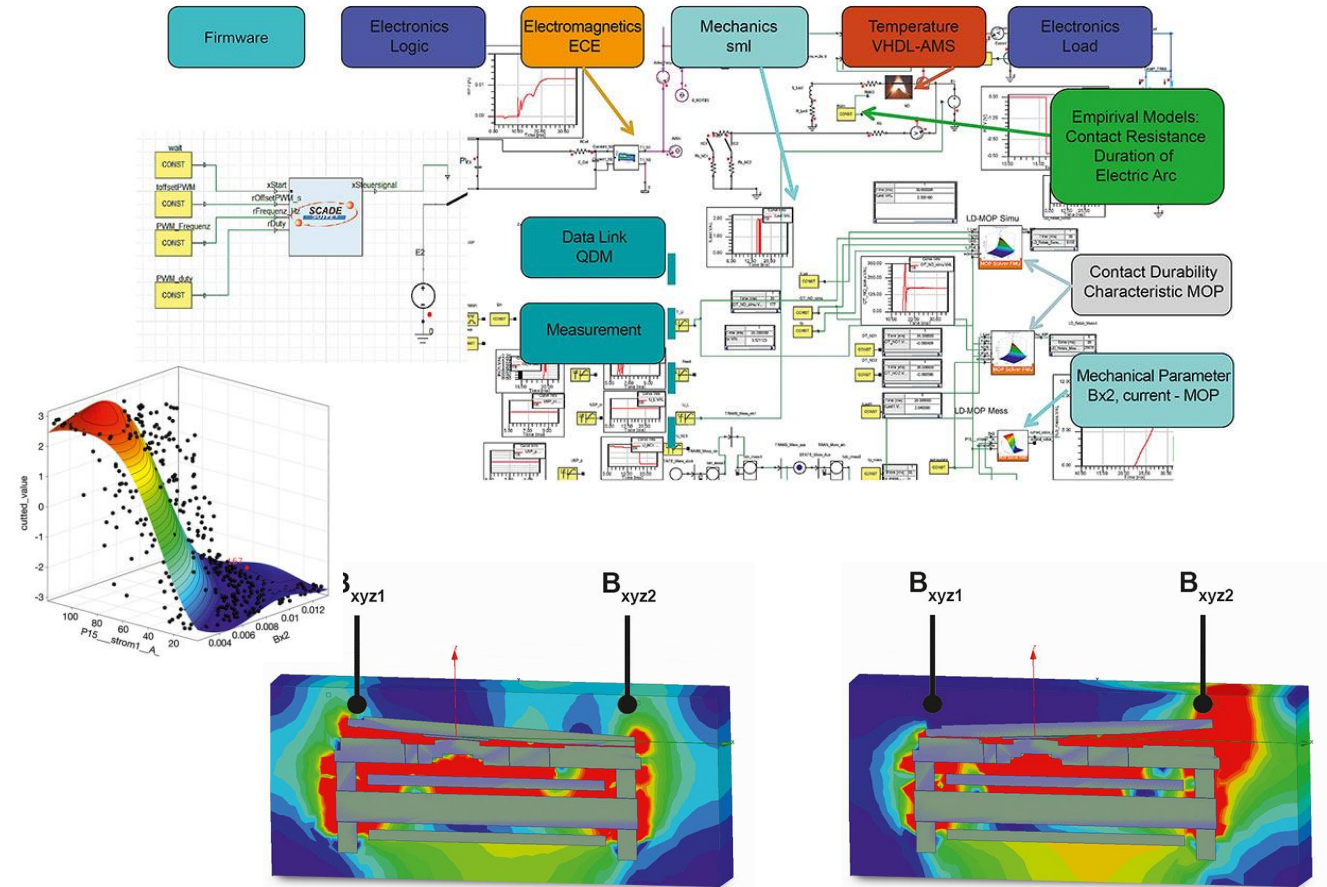
Phoenix Contact: Creating a Fail-Safe Digital Twin



Challenge: Unplanned downtime due to failure of a relay can cost tens of thousands of dollars per hour. It is very hard to predict relay failure as there is no wear sensor.

Solution: To predict component failure before it occurs, a simulation based digital twin was created that predicts the wear based on actual load and sensor data (temperature, switching frequency).

Results: By lowering unplanned downtime, Phoenix Contact's advanced relays can potentially save **tens of thousands of dollars per hour** for their customers.



ANSYS Maxwell simulation shows magnetic field at different armature positions



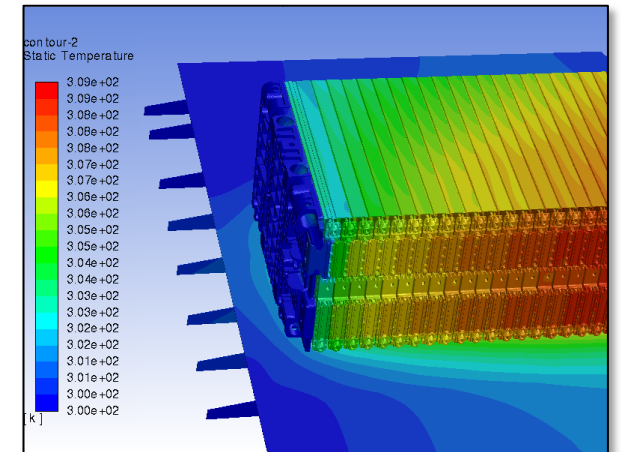
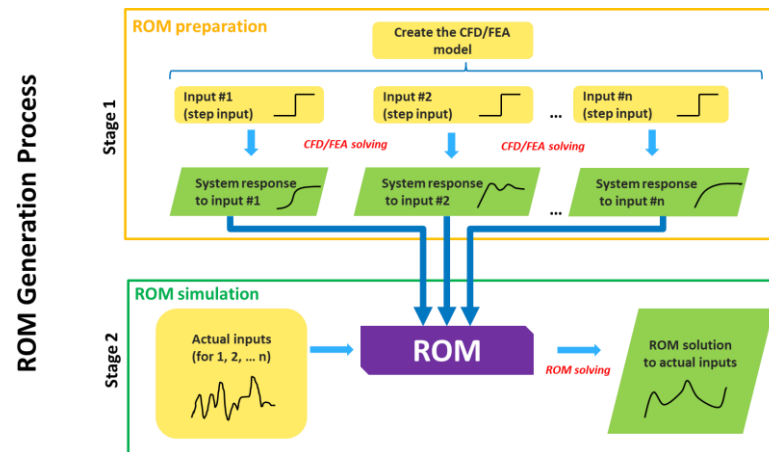
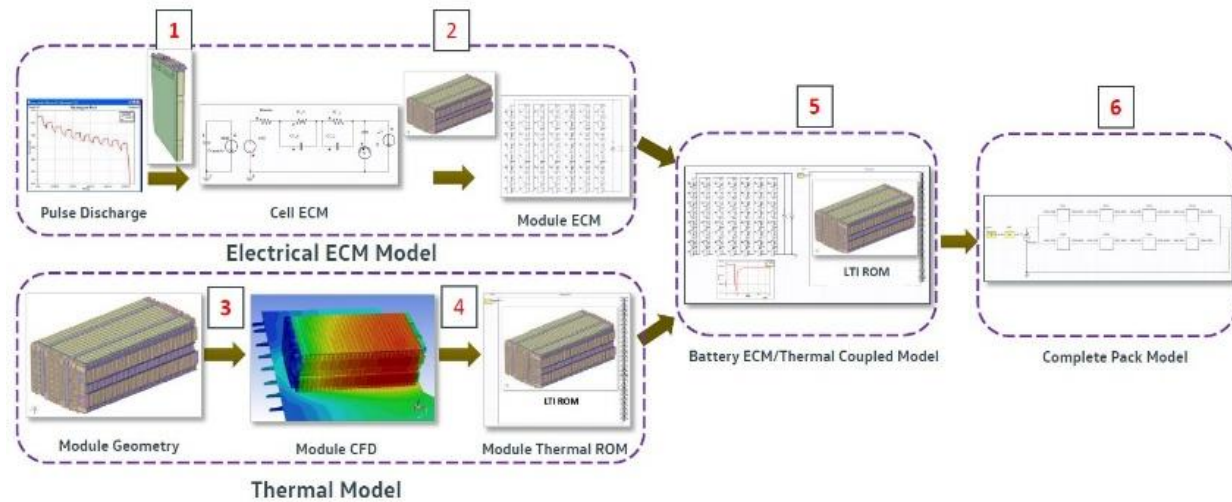
VWMS used the new ECM library and ROM techniques to model electro-thermal behavior of a battery pack



Challenge: Develop a fast electro-thermal model to optimize battery pack

Solution: Develop a Thermal LTI ROM, combine with new ECM library and simulate/optimize for complete drive cycles

Results: Won the race and beat the record by full 15 seconds on June 24, with help from ANSYS technology



Appendix