

Leveraging Simulation-Based Digital Twins to Improve Predictive and Prescriptive Maintenance Outcomes

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Agenda

- Digital Twin Overview
- Role of Physics Simulation in Digital Twins
- Combining Physics and Data Analytics leads to a complete solution
- Open Ecosystems enable faster ROI and ease adoption
- Global Digital Twin initiatives starting up now – get involved!



Digital Twin Overview and Example Use Cases



What is a Digital Twin?

A digital twin is a connected, virtual replica of an in-service physical asset.

Sensors mounted on the asset gather and relay data to a simulated model (the digital twin) to mirror the real-world experience of that product.

Digital Twins enable tracking of the past behavior of the asset, provide deeper insights into the present and most importantly, they help predict and influence future behavior

A digital twin is a connected, virtual replica of an in-service physical asset. Sensors mounted on the asset gather and relay data to a simulated model, allowing the digital twin to mirror the real-world experience of that product.

More than providing the ability to monitor the performance of assets, digital twins provide an opportunity for manufacturers to **transform their businesses**.



Increase Revenue.

A digital twin enables the creation of new revenue streams, in the form of high-value service offerings. Rather than just selling a piece of machinery, manufacturers can sell the uptime associated with that piece of machinery. One McKinsey analysis across 30 industries showed:

25% average margin for aftermarket services compared to **10%** for new equipment

Reduce Costs.

A digital twin enables true predictive maintenance for expensive assets. This enables manufacturers to save on warranty and insurance costs and proactively optimize a product's operations. Some mobile machine manufacturers' warranty costs are high:

costs high as **\$800M** per year – an amount equal to as much as **3%** of product revenues

From both the top line and the bottom line,

digital twins have the potential to revolutionize how manufacturers do business in industries from oil and gas, to automotive, aerospace and defense, and more. Gartner predicts:

50% of large industrial companies will be using digital twins by 2021

Benefits of Digital Twins



Increase Topline Revenue

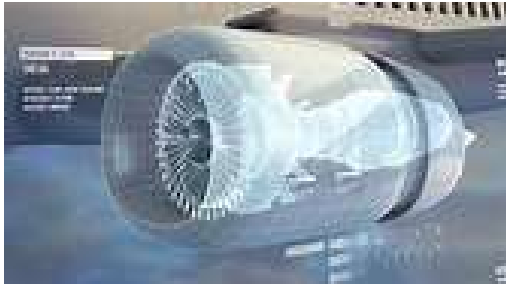


Manage Bottom-Line Costs



Gain/Retain Competitive Edge

/ Digital Twins in...



/ Aerospace



/ Automotive



/ Manufacturing (incl. Semi)



/ Buildings and Infrastructure



/ Oil and Gas




Role of Physics Simulation in Digital Twins



Customers are Putting Simulation at the Center of Their Digital Twin Implementations

Ansys
Simulation-Based
Digital Twins



 IIoT and
Data Analytics



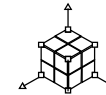
**Virtual Sensors to Simulate
Critical Quantities**



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



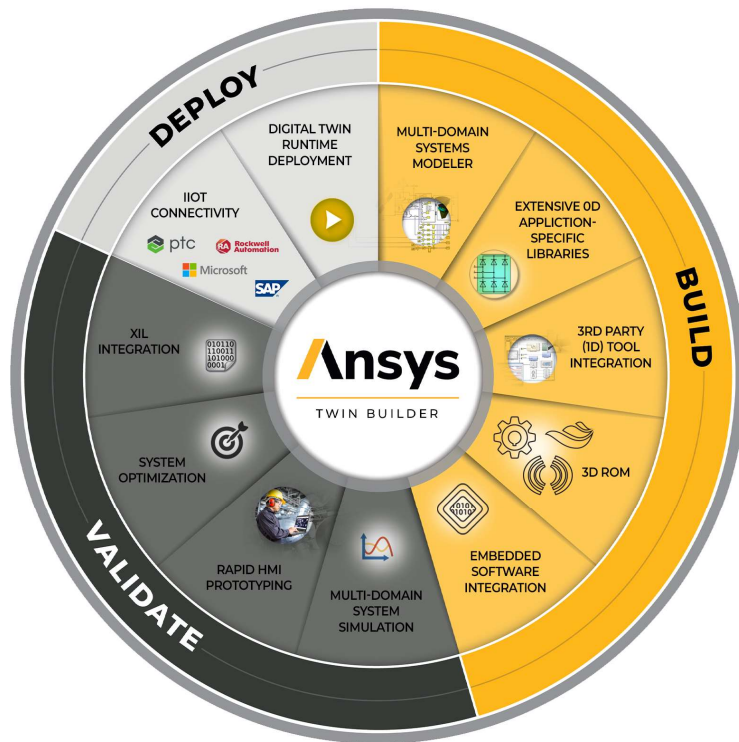
**Physics Based Accuracy,
Improved ROI**



**Generate baseline and
failure data using Physics**

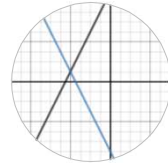
Ansys Twin Builder

A Unique Product to Build, Validate and Deploy Simulation-Based Digital Twins

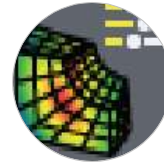


- / Multi-technology platform
- / State-of-the-art reduced order modeling
- / Interoperability support
- / Ability to deploy runtimes for Digital Twin

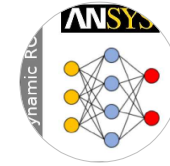
There are Three Major Groups of ROMs in Twin Builder



Linear ROMS



Non-Linear, Static



Non-Linear, Dynamic

	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 LPV ROM Maxwell ECE
Supported Tools	Fluent, Mechanical, Icepak, Q3D, Maxwell, HFSS, Siwave	Static ROM Builder: All	Dynamic ROM Builder: All LPV ROM: Fluent, Icepak Maxwell ECE: Maxwell
Limitation	Linear system only Support enabled by tools	Static only Extending support for new tools requires effort	For Scalar only Limited inputs

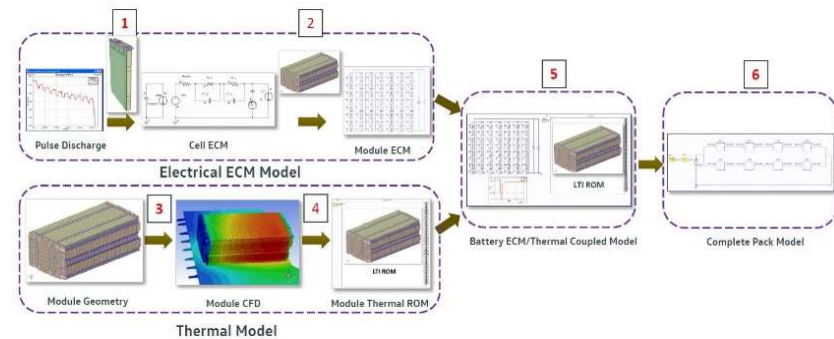
VWMS Used the New ECM Library and LTI ROM Techniques to Model Electro-Thermal Behavior of a Battery Pack



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



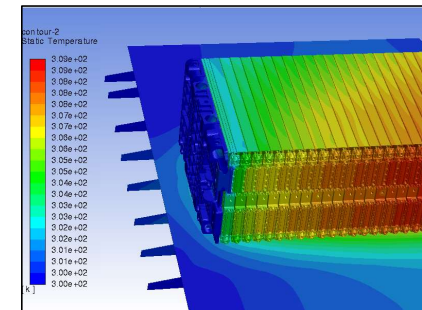
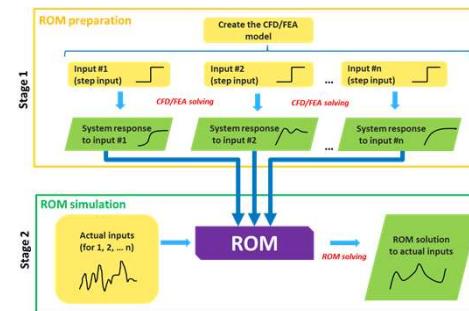
FAST, BUT BEAUTIFUL TOO —
7:57:148—Volkswagen makes racing history with record-breaking electric race car


Electric power beats the internal combustion engine fair and square in major motorsport

JONATHAN M. GITLIN - 6/29/2018, 7:30 AM



ROM Generation Process

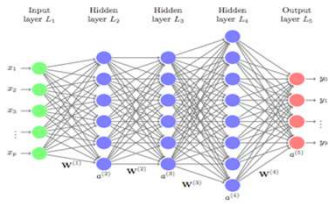




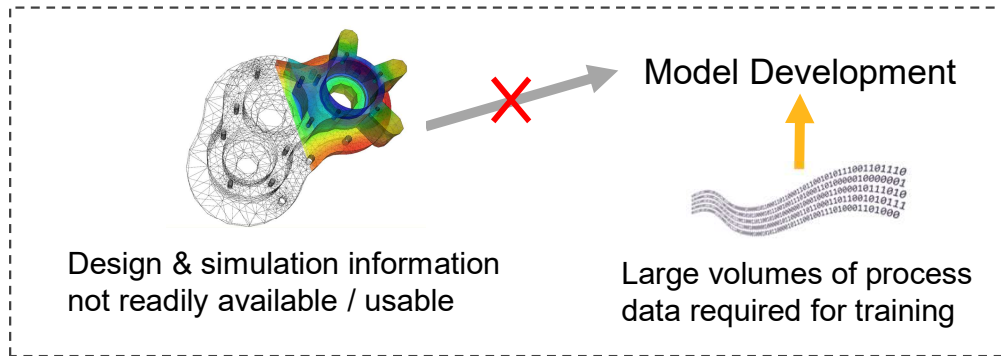
**Combining Physics and Data
Analytics Leads to a Complete
Analytics solution**



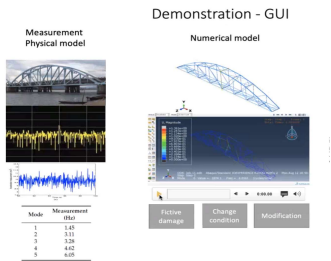
Digital Twin Challenge: Accuracy, Time & Cost



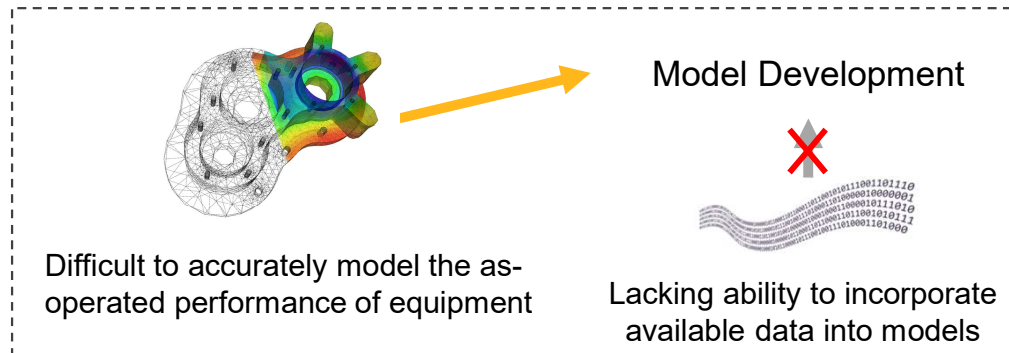
Data-Driven Modeling



Insufficient accuracy, limited by observed data



Simulation-Based Modeling

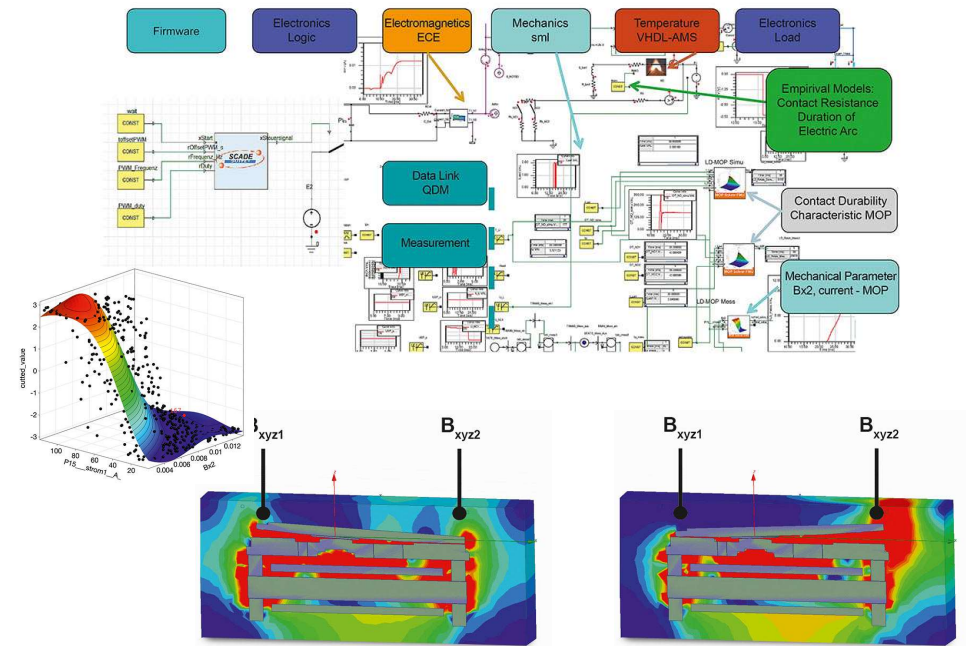


Long, expensive time scales to develop & deploy

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.

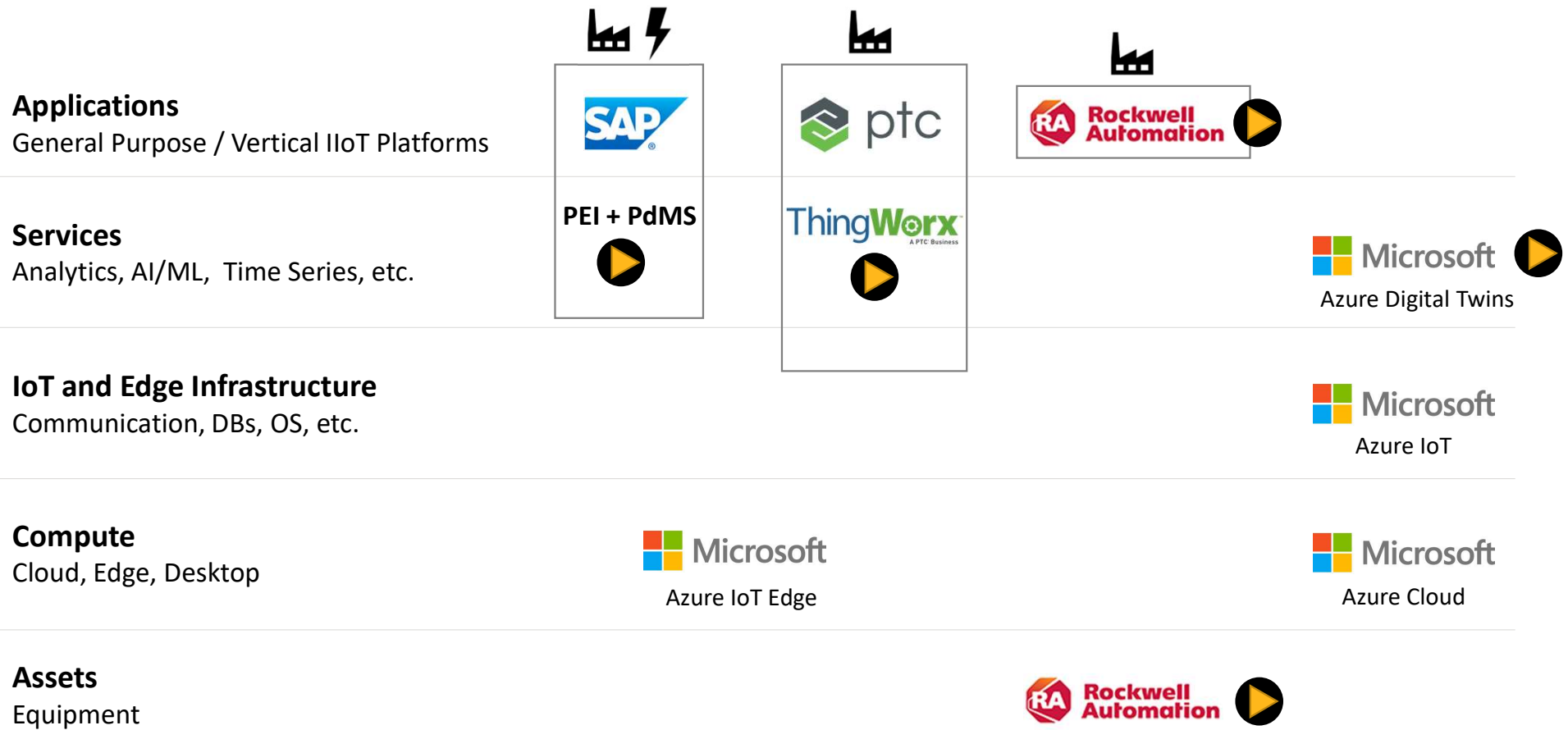




Open Ecosystems Enable Faster ROI and Ease Adoption



Ansys' Partnering Landscape for Digital Twins



Ansys Leading the Way in Global Digital Twin Initiatives



Digital Twin Consortium

- Ansys is one of 6 founding members
- Drives the development and adoption of digital twin technologies
- Emerging standards body (part of OMG)

Digital Twin Definition Language (DTDLD)

- Ansys and MSFT collaborating on DTDLD
- Enables IoT solutions to provision, use, and configure IoT devices from multiple sources in a single solution

Digital Twin Consortium



**Technology, Taxonomy,
& Terminology**



Infrastructure



Manufacturing



Natural Resources



Defense & Aerospace



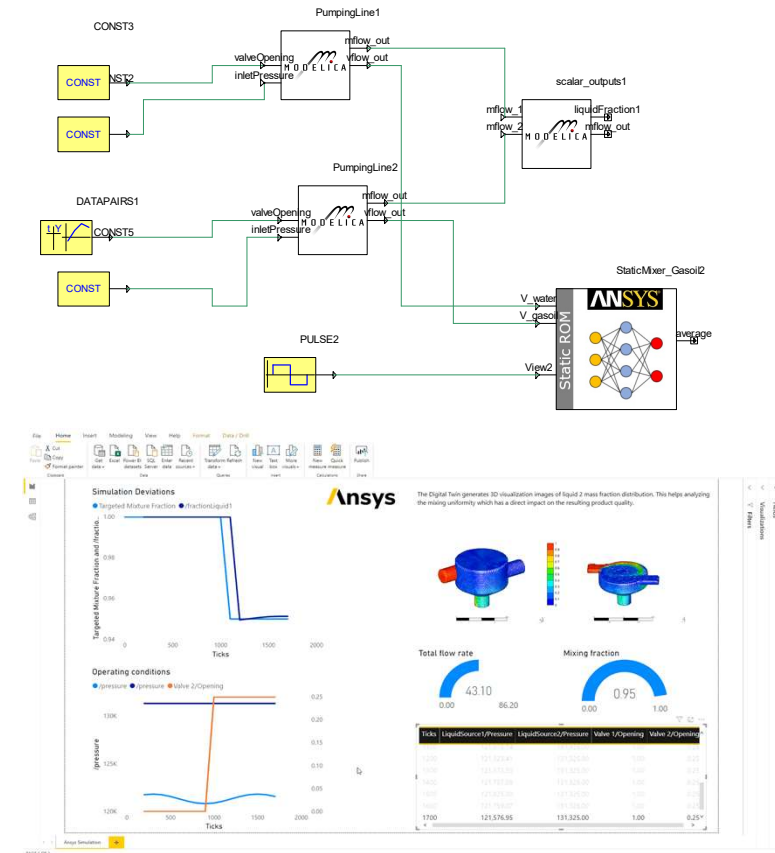
Marketing

Current Members of Digital Twin Consortium



Optimizing Refinery Gasoline Blending Process

- Challenge: Efficient blending is critical to make target gasoline grades. With existing solutions, blend quality can typically only be determined after the blending process has completed. This leads to blend downgrades or fixes (giveaways), costing time and money
- Solution: A Simulation-Based Digital Twin of the blending process augments available sensor streams with virtual sensors that help better predict blend quality. In addition, issues such as insufficient pressure/flow can be quickly detected and remedied in near real-time to ensure efficient blending
- Results: The solution should help refinery customers realize operational improvements in the range of 10%, representing savings of tens of millions of dollars per year per refinery



Summary

- Digital Twins are an accelerating trend in Industry
- Physics-based Simulation is at the center of the Digital Twin activities
- Combining Physics and Data Analytics leads to the most complete solution
- Open Ecosystems enable faster ROI and ease adoption
- Global Digital Twin initiatives starting up now – get involved!



Thank you

