

Physics Based Models and Digital Twins in Industry

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COLLABORATION WORKSHOP



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Ansys Digital Twin Update

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Changing the world through the power of simulation

50
YEARS OF
INNOVATION



Shatter Records



Unlock Possibilities



Make the Unmakeable



Save Lives

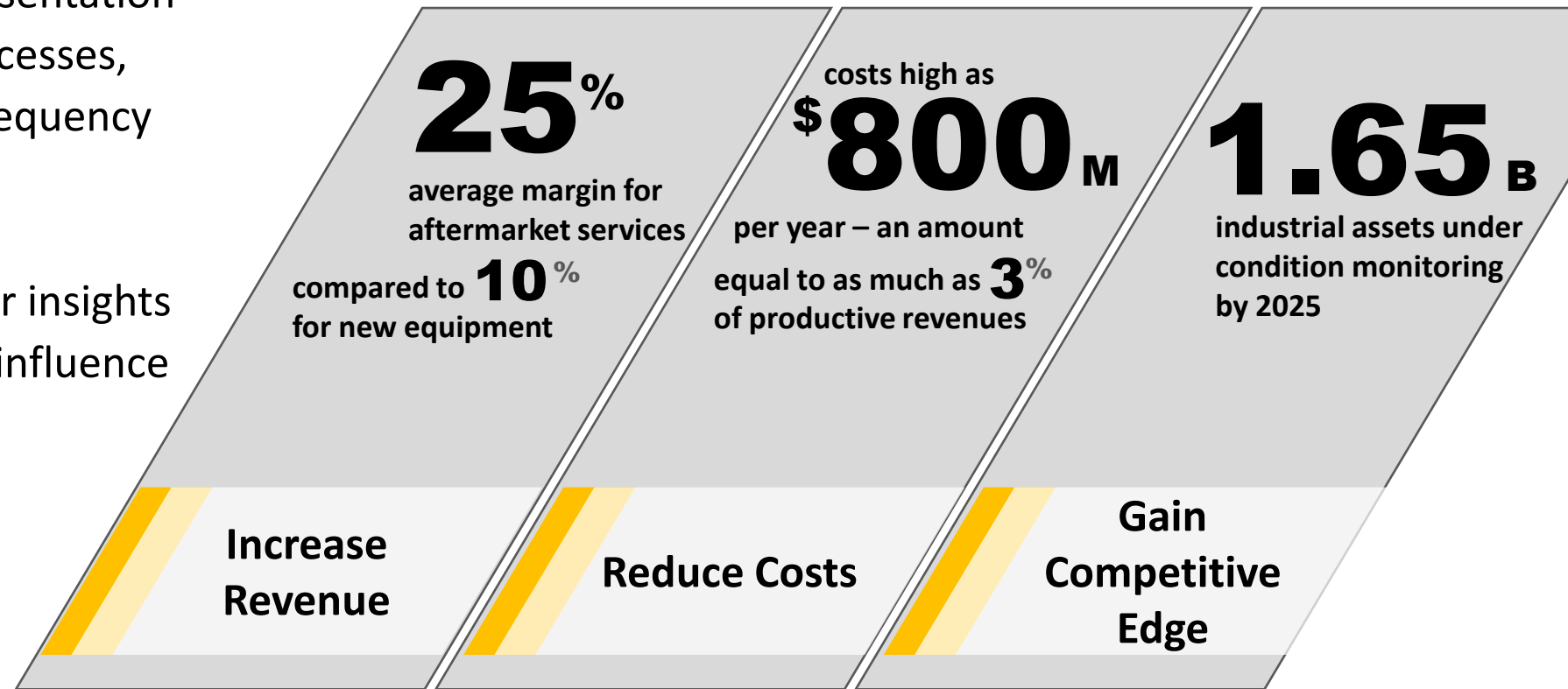
Ansys

What is a Digital Twin?

Past, Present, Future, Simulate!

digital twin™ : “Virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity”
CONSORTIUM

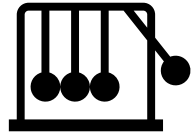
Track the past, provide deeper insights into the present, predict and influence future behavior



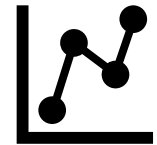
Sources:

1. “Industrial aftermarket services: Growing the core.”, McKinsey.com
2. “Controlling Warranty Costs by Preventing No Fault Found”, WIKA Group
3. Total addressable market (TAM) and compound annual growth rate (CAGR) information throughout presentation is based on third party study completed by Evaluserve Inc. in 2019 commissioned by ANSYS. Study was based on customer and industry expert interviews and review of industry analyst reports and commentaries. Refer to Cautionary Statement for a discussion of factors that could impact future financial results.

Key Elements of a Digital Twin



Simulation-Based and Hybrid Analytics

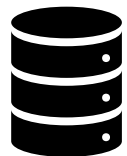


Data-Based Analytics

Open Ecosystems and Key Announced Partners



IoT Platform



Assets and Infrastructure

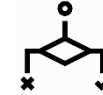


Customers are Putting Simulation at the Center of their Digital Twin Implementations

Simulation-Based & Hybrid Analytics



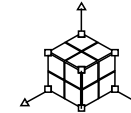
Create virtual sensors to “measure” missing data



Perform what-ifs before applying a solution

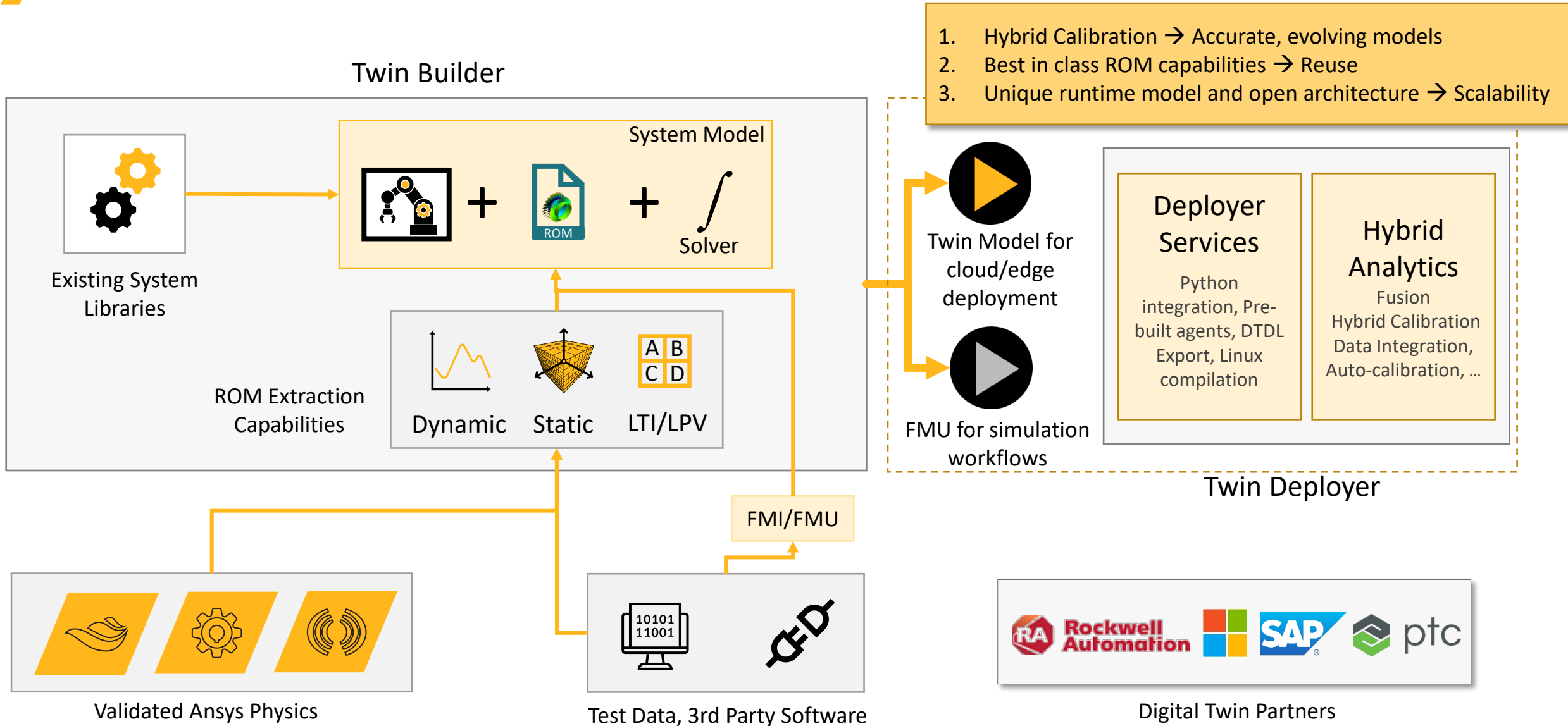


Analyze accurate and deterministic predictions based on physical principles

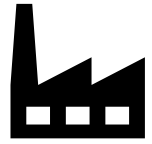


Explore causality and failure modes using physics

Our solution architecture fits seamlessly into our customers' stack



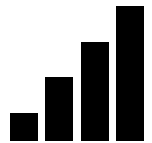
/ Typical Use Cases for Digital Twins



Virtual Commissioning, Trouble Shooting and System Configuration



Predictive and Prescriptive Maintenance



Production Optimization and Yield-as-a-service

Example: Accurate Digital Twin of BESS

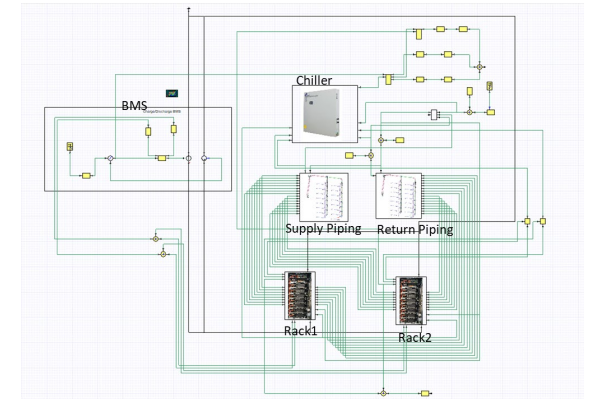
Challenge: Grid scale ~1.5 MWh Battery Energy Storage Systems (BESS) require significant physical testing that can be very expensive and potentially dangerous

Solution: Wärtsilä uses Ansys Twin Builder to build system models of BESS including battery, chiller, and flow control models to accurately predict voltage, heat generation, and remaining useful life.

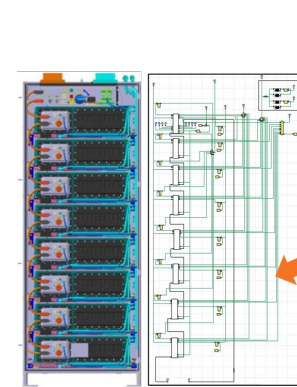
Result: Using Ansys Twin Builder, Wärtsilä was able to significantly reduce the need for physical testing and finish the computation of a one-month input data within 24 hours, reducing time to market



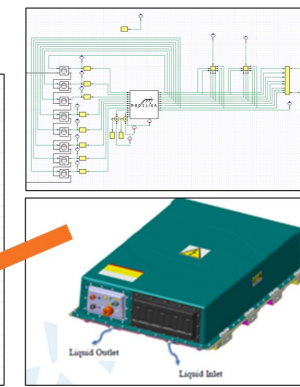
Battery Energy Storage System (BESS)



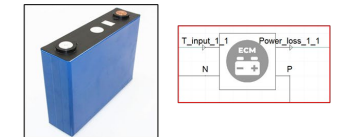
System Model in TB



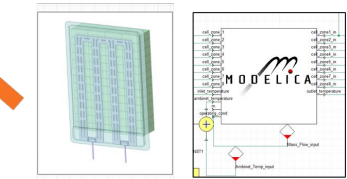
RACK



Liquid Cooled Module



Battery CELL - ECM



Cold Plate + Battery - ROM

[Complex Battery System Storage Modeling with Ansys Twin Builder and Ansys Fluent](#)

[Webinar Link: Battery Energy Storage System Modeling in Ansys Twin Builder](#)

Verbund Hydro: Minimizing Downtime for Water Turbine

Challenge: Predict wear on turbines under different loading conditions to optimize the turbine output; unplanned downtime can cost tens of thousands of dollars per hour

Solution: A simulation-based digital twin of the turbine to predict accurate current stresses at hot spots

Results: Solution in operation and being expanded. Expected to help save **~\$100k/year** per turbine by avoiding unplanned downtime



Example: Ensure reliable flow with Ansys Digital Twins

Challenge: Customers are unwilling to add diagnostic sensors due to cost (~\$15k/sensor + installation) and feasibility

Solution - Virtual Sensors: Using Ansys' Twin Builder and our new ML based Hybrid Calibration, build physics accurate representations of customers' flow networks
Resulting Digital Twin predicts multiple flow rates within 2% accuracy of actual flow rates

Result: A commercial IoT solution, powered by Ansys Digital Twins. Deployments ongoing at customers



ANSYS Digital Twins are delivering results today!



Global CPG company
with 70B+ Annual
revenue

Result: Reduction in
commissioning time
from hours to minutes



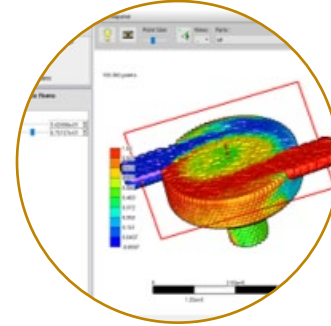
Kaeser Kompressoren:
Leading provider of
compressed air
products and services

Result: Shrink
configuration to quote
process (CPQ) from
weeks to hours



Verbund: Austria's
leading electricity
provider

Results: Savings of
over ~\$100k/year per
turbine by avoiding
unplanned downtime



Global Energy
company – one of the
7 super majors, 200+
revenue

Results: Operational
improvements of ~2%,
representing savings
of millions of dollars
per year per refinery



Volkswagen
Motorsports:
Rally/race car team
with top performing
electric racecars

Results: Ansys DT
technology helped
VWMS win Pike's Peak
and beat the track
record

Create accurate, evolving Digital Twins with Hybrid Analytics



Parameter Calibration

Closely match simulation results with measurement data by calibrating model parameters



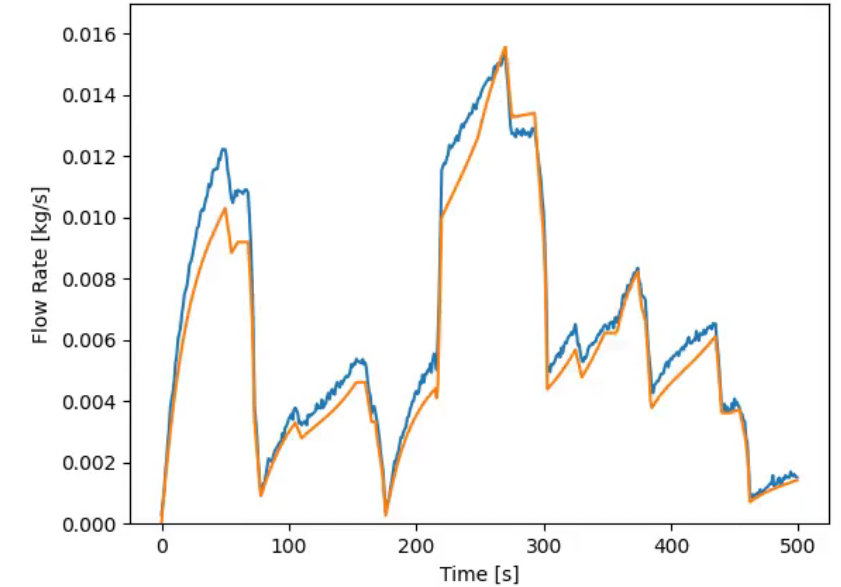
Uncertainty Quantification

Uncertainty quantification on parameters and outputs provides the confidence in fit



Fusion Modeling

Compensate for any unmodeled physics or other effects by modeling the difference between a physics model and data



~ **80% accuracy** - Purely ML-based analytics

~ **90% accuracy** - Physics-Based Simulation Digital Twin

~ **98% accuracy** - **Hybrid Digital Twin**

(ML-based analytics combination with the physics-based approach)

[Details in IEEE Software publication: Hybrid Digital Twins: A Primer on Combining Physics Based and Data Analytics Approaches`](#)

Ansys leading the way in global Digital Twin initiatives



Digital Twin Consortium

- Ansys is one of 8 founding members (200+ total membership)



- Drives the development and adoption of digital twin technologies
- Emerging standards body (part of OMG)

Digital Twin Definition Language (DTDL)

- Ansys and Microsoft collaborating on DTDL and on developing reusable reference architecture
- Enabling IoT solutions to provision, use, and configure IoT devices from multiple sources in a single solution

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Ansys' digital twin solution is enabling **ENGIE Lab CRIGEN** to develop a simulation-based digital twin of an industrial asset to help companies cut costs, time and environmental impact ...see more

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