Improving Manufacturing Operations through Hybrid Digital Twins

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Ansys

#1 IN SIMULATION

GLOBAL

6,000+ Full-Time Employees
90+ Offices Worldwide

PROVEN

$2.07 Billion USD
2022 Revenue

FOCUSED

Simulation is
All We Do

COMMITTED

93% 2022 Customer
Satisfaction Score

50 Years of Simulation Innovation and Leadership

Ansys ongoing investment in critical simulation capabilities

29
STRATEGIC ACQUISITIONS

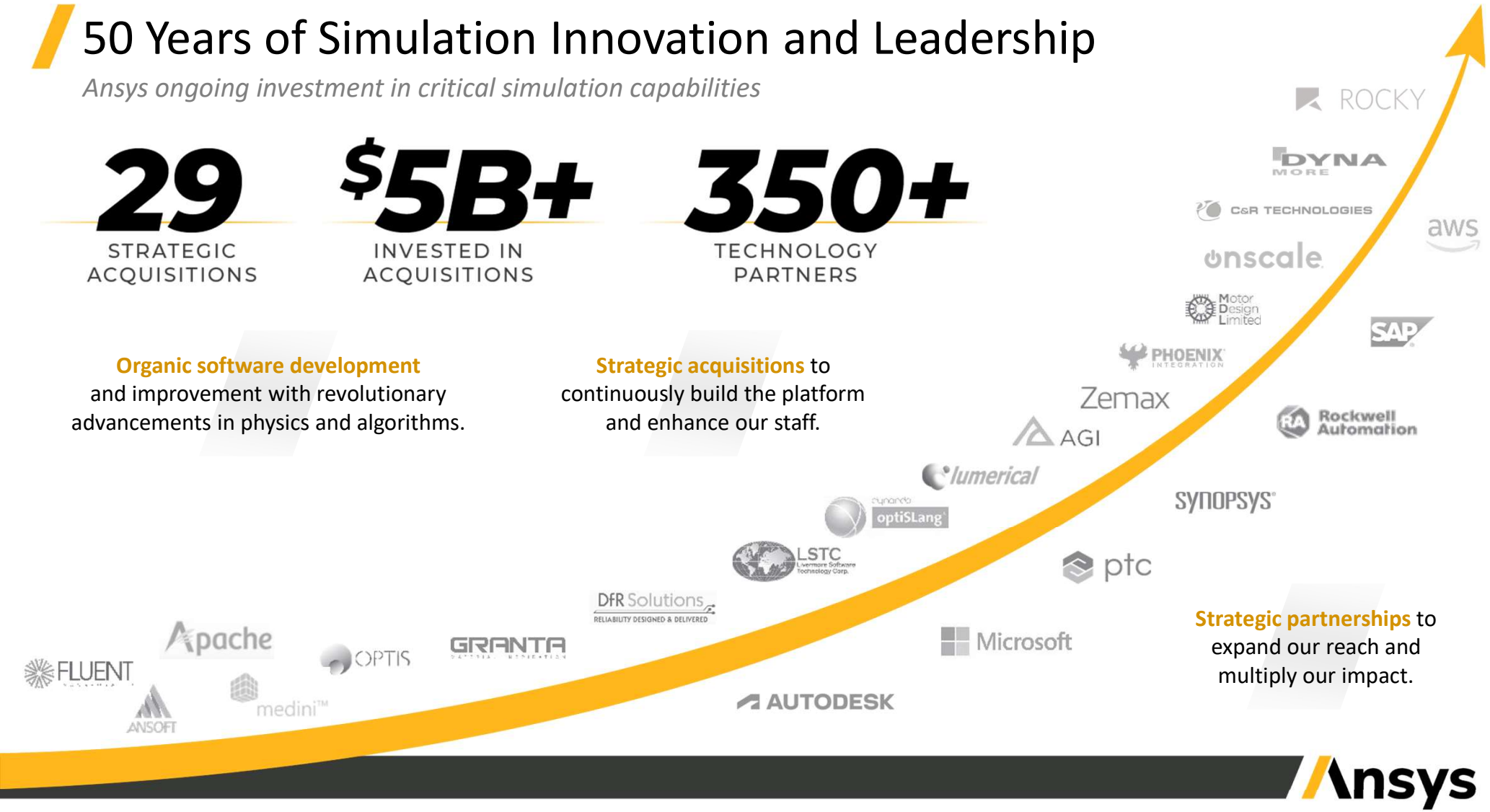
$5B+
INVESTED IN ACQUISITIONS

350+
TECHNOLOGY PARTNERS

Organic software development and improvement with revolutionary advancements in physics and algorithms.

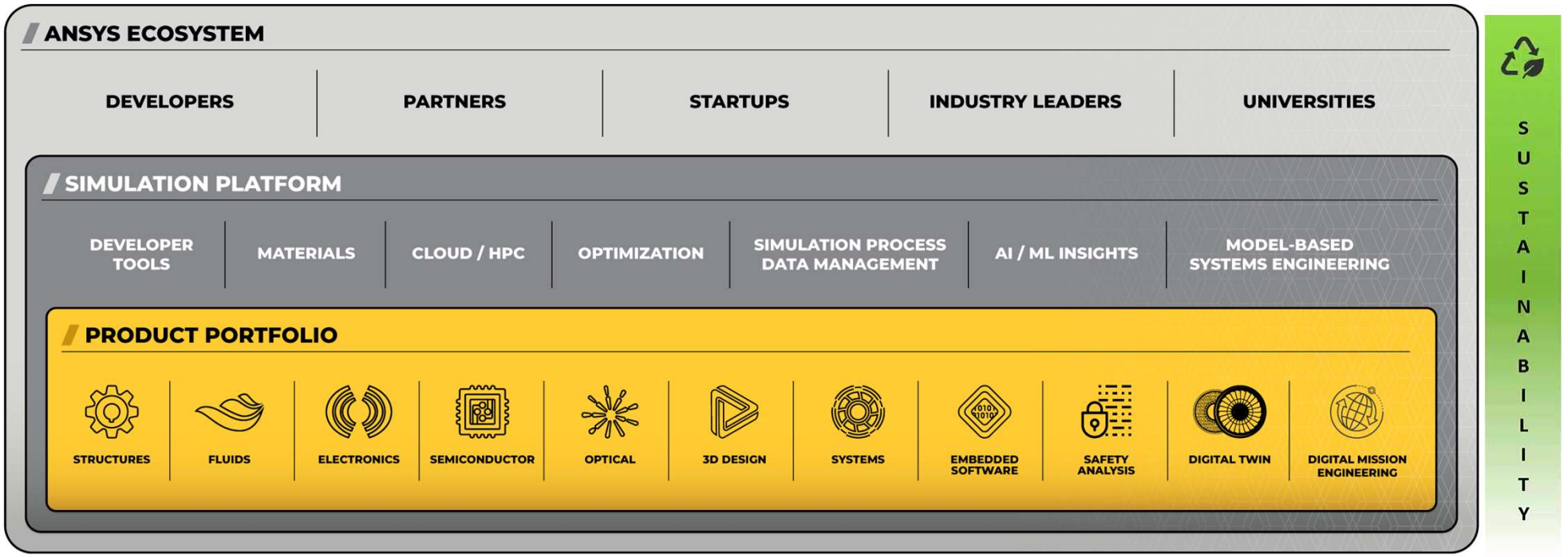
Strategic acquisitions to continuously build the platform and enhance our staff.

Strategic partnerships to expand our reach and multiply our impact.



Depth and Breadth of Ansys Simulation Portfolio

Unique design of the Ansys product portfolio, platform, and ecosystem fits our customer's development processes



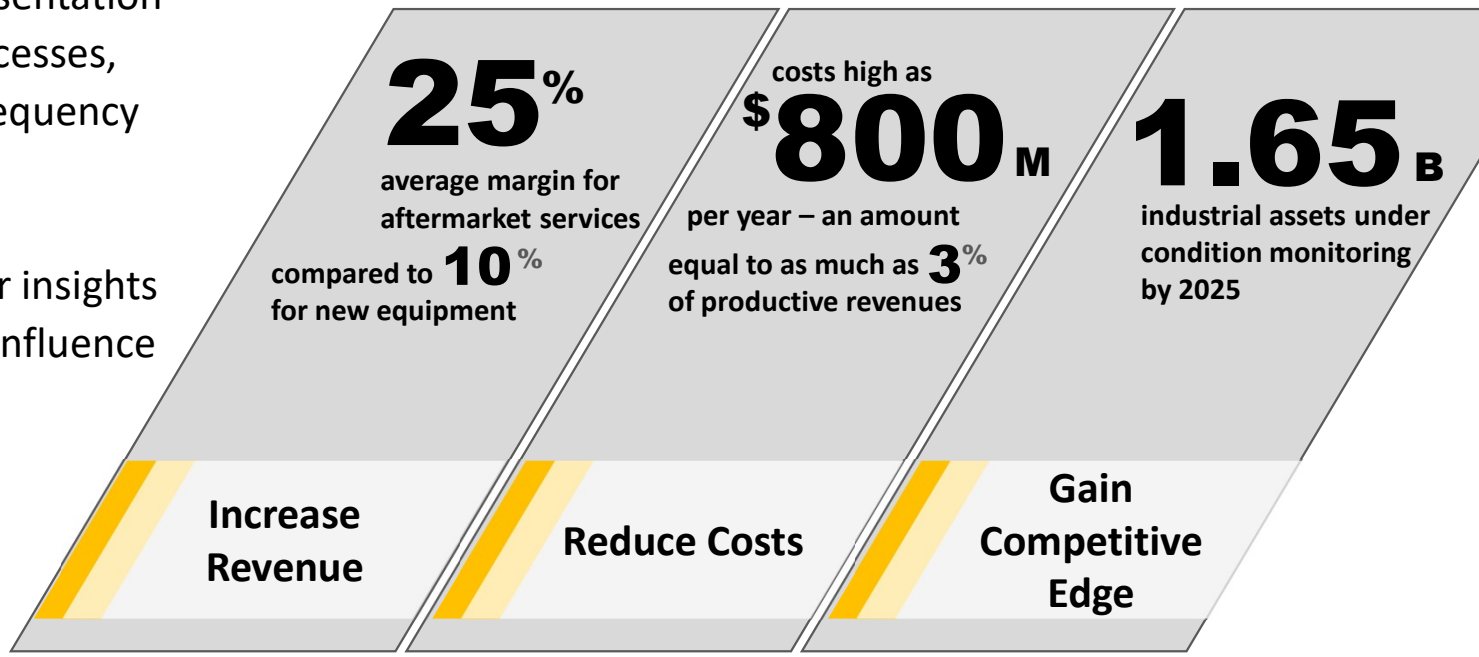
Digital Twins

What is a Digital Twin?

Past, Present, Future, Simulate!

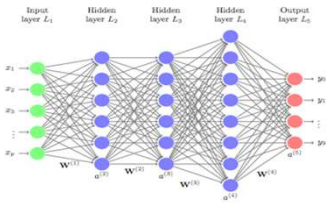
digital twin CONSORTIUM : "Virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity"

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

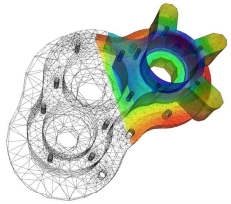


Sources:
1. "Industrial aftermarket services: Growing the core.", McKinsey.com
2. "Controlling Warranty Costs by Preventing No Fault Found", WIKA Group
3..Total addressable market (TAM) and compound annual growth rate (CAGR) information throughout presentation is based on third party study completed 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.

Digital Twin Challenge: Accuracy, Time & Cost



Data-Driven Modeling

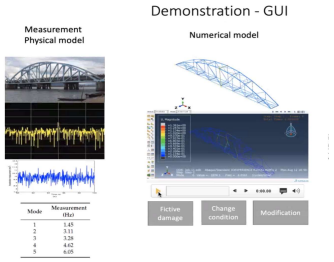


Design & simulation information not readily available / usable

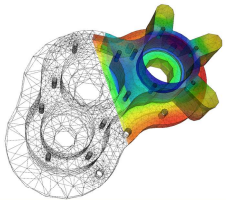
Model Development

Large volumes of process data required for training

Insufficient accuracy, limited by observed data



Simulation-Based Modeling



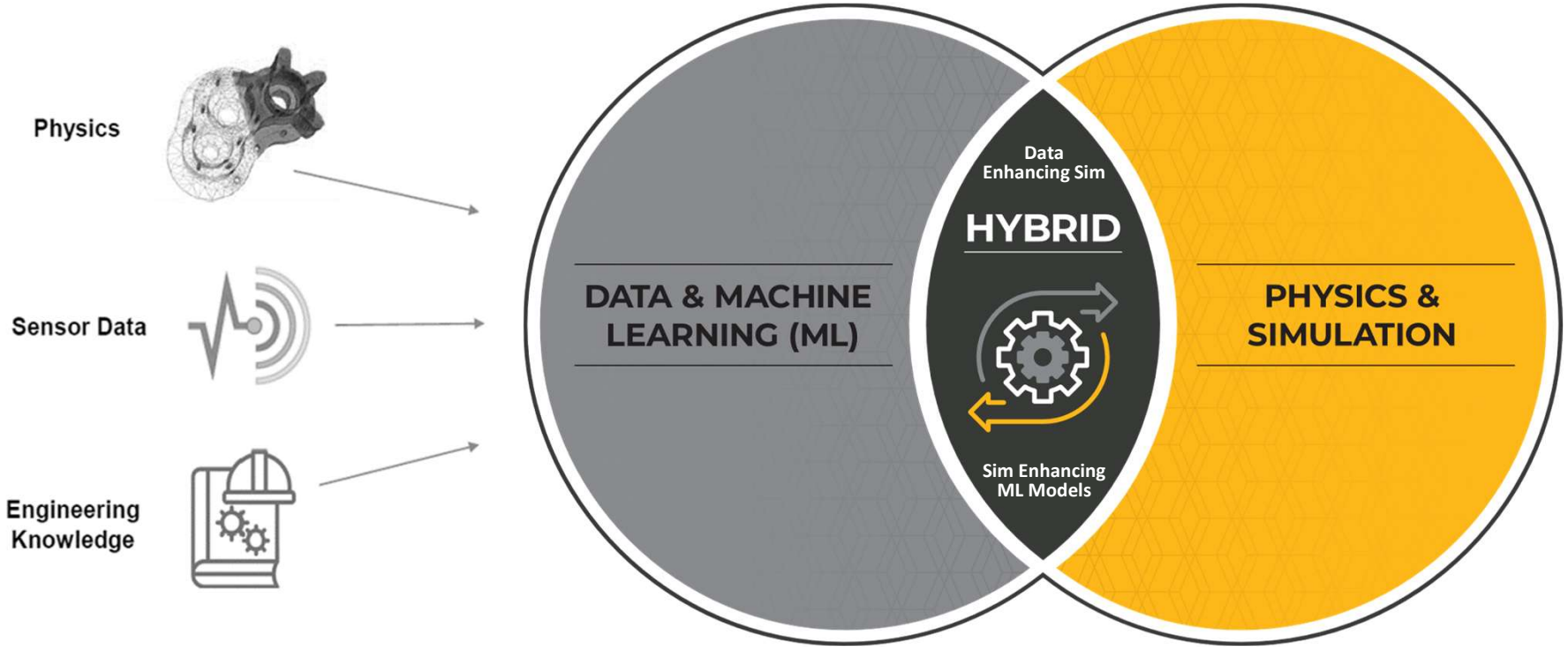
Difficult to accurately model the as-operated performance of equipment

Model Development

Lacking ability to incorporate available data into models

Long, expensive time scales to develop & deploy

Hybrid Digital Twins: Combining simulation and data



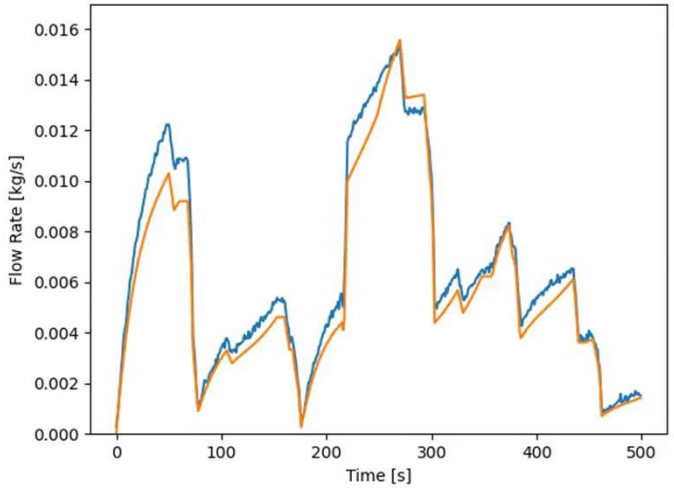
Hybrid Analytics combines data and physics to build Hybrid Digital Twins

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

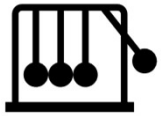
~ **90% accuracy** - Physics-Based Simulation Digital Twin

~ 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`

Elements of the Digital Twin ecosystem



Simulation-Based and Hybrid Analytics

Data-Based Analytics

IoT/Edge Platform

Assets and Infrastructure

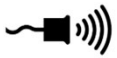
Open Ecosystems and
Key Announced Partners

Microsoft aws

Rockwell Automation ptc

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

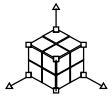
Simulation-Based & Hybrid Analytics



Create virtual sensors to "measure" missing data

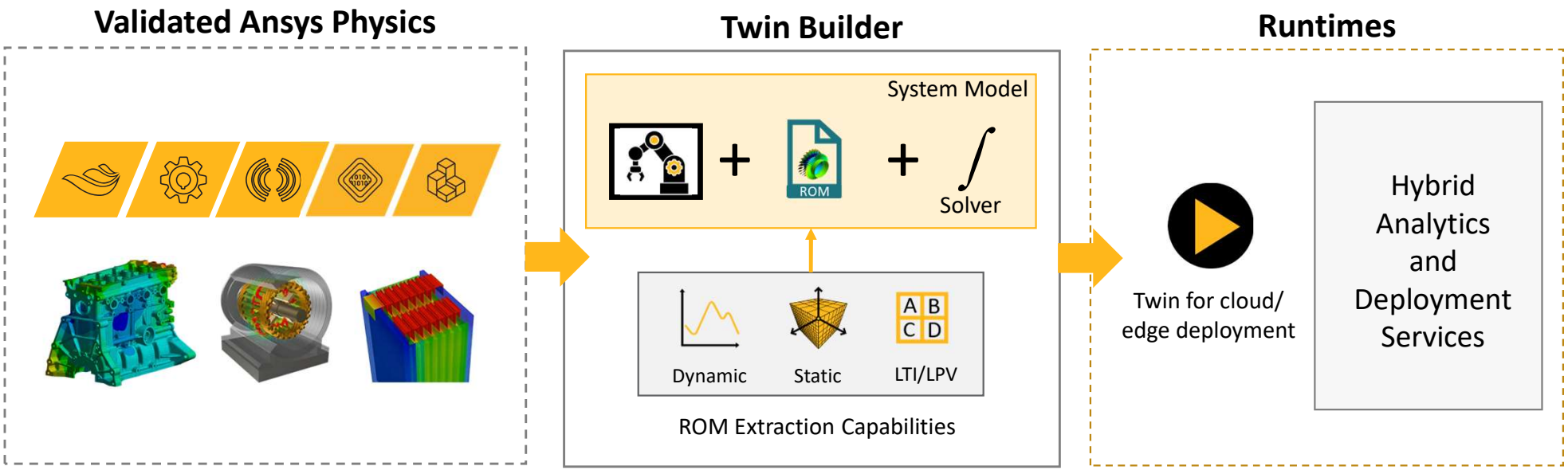
Perform what-ifs before applying a solution

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



1. Best in class Reduced Order Modeling capabilities → Reuse
2. Hybrid Calibration → Accurate, evolving models
3. Unique runtime model and open architecture → Scalability

Rockwell Automation aws ptc

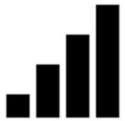
Digital Twin Partners

Digital Twin Use Cases

Typical use cases for Digital Twins

Virtual Commissioning and System Configuration

Predictive and Prescriptive Maintenance



Production Optimization

Kaeser Compressors: Monetizing Compressor Digital Twins to Accelerate Product Sales

System Configuration

Challenge: Providing a precise configuration and quote for a compressor installation requires weeks and multiple onsite visit, slowing down the sales process

Solution: A fully automated the process for creating a digital twin of a configured compressor installation and the using the digital twin to accurately quote performance and cost

Result: The resulting solution allows Kaeser to significantly reduce cost of sales and shrink the configuration to quote process from weeks to hours

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

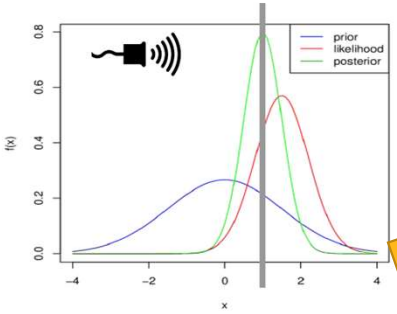
Pump manufacturer ensures reliable flow for utility

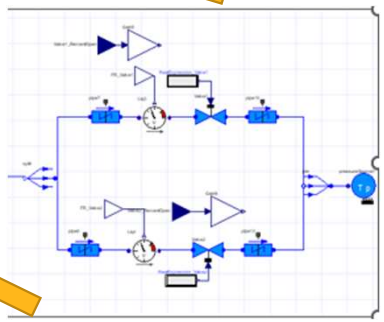
Predictive Maintenance

Challenge: Ansys customer, a leading flow equipment manufacturer, wants to provide a monitoring solution to its customer, a public utility. Utility is unwilling to add diagnostic sensors due to cost (~$15k/sensor + installation) and feasibility

Solution - Virtual Sensors: Using Ansys' hybrid digital twins, the equipment manufacturer has built physics accurate representations of utility's 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, that significantly improves reliability. Deployments ongoing at customers





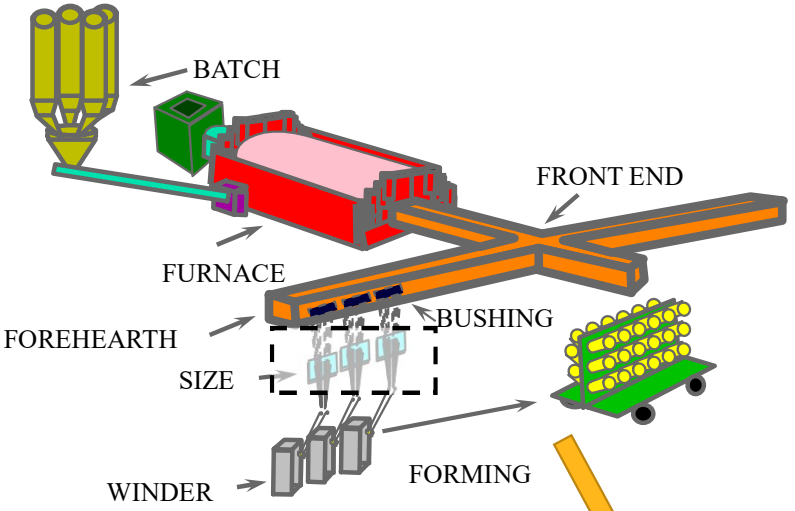
Production Optimization

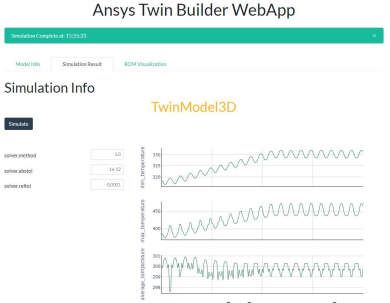
Improving production at global glass manufacturer

Challenge: For glass fiber manufacturing, consistent temperature (within 2-3 degrees at temperatures in excess of 1400C) in the glass flow path is vital to the quality of the output product. Positioning sensors along the entire flow path is infeasible.

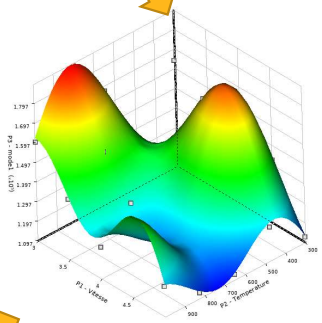
Solution: A reduced order model based digital twin to predict the entire temperature flow field of the forehearth. The reduced order model was created based on available non-linear CFD model and predicts temperatures

Results: Digital twin is deployed on the customer's asset, giving alerts to operators when temperatures are out of bounds. Twin runs in < 5 s, well under the budget allowed for the model execution. Real-time product optimization based on the temperature virtual sensor output in the pilot stage





Operator Dashboard



Field ROM

Summary

- Ansys has a robust Hybrid Digital Twin solution that combines the benefits of physics-based simulation with data-based ML techniques to create accurate, evolving representations of real-world assets
- Successful Digital Twin deployments require an ecosystem approach – Ansys' solution is platform agnostic, and we have built out a strong partner ecosystem
- Simulation is key to Digital Twin implementations, providing critical capabilities such as virtual sensors, what-if analysis and causality and failure mode analysis
- Our solution enables the reuse of existing simulation models (via ROMs), typically created during product design, and makes them fit-for-use during operations
- Ansys has demonstrated successful deployment of Digital Twins via several real-world use cases

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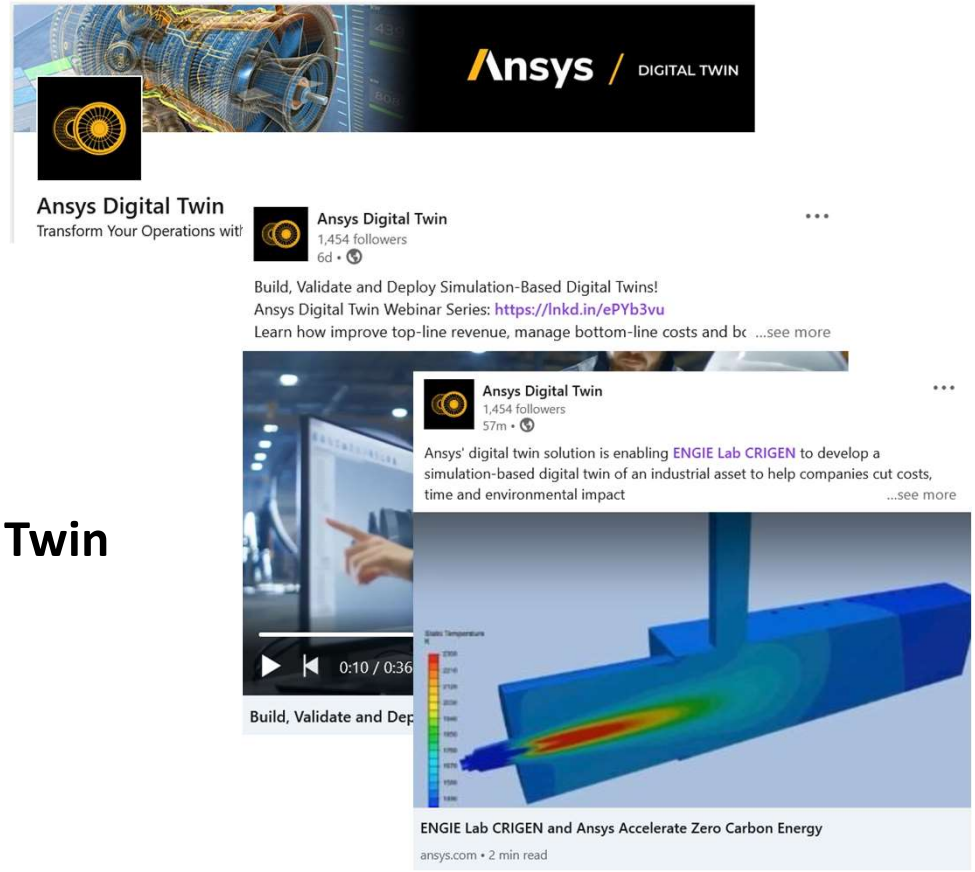

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