Ansys Digital Twin Update

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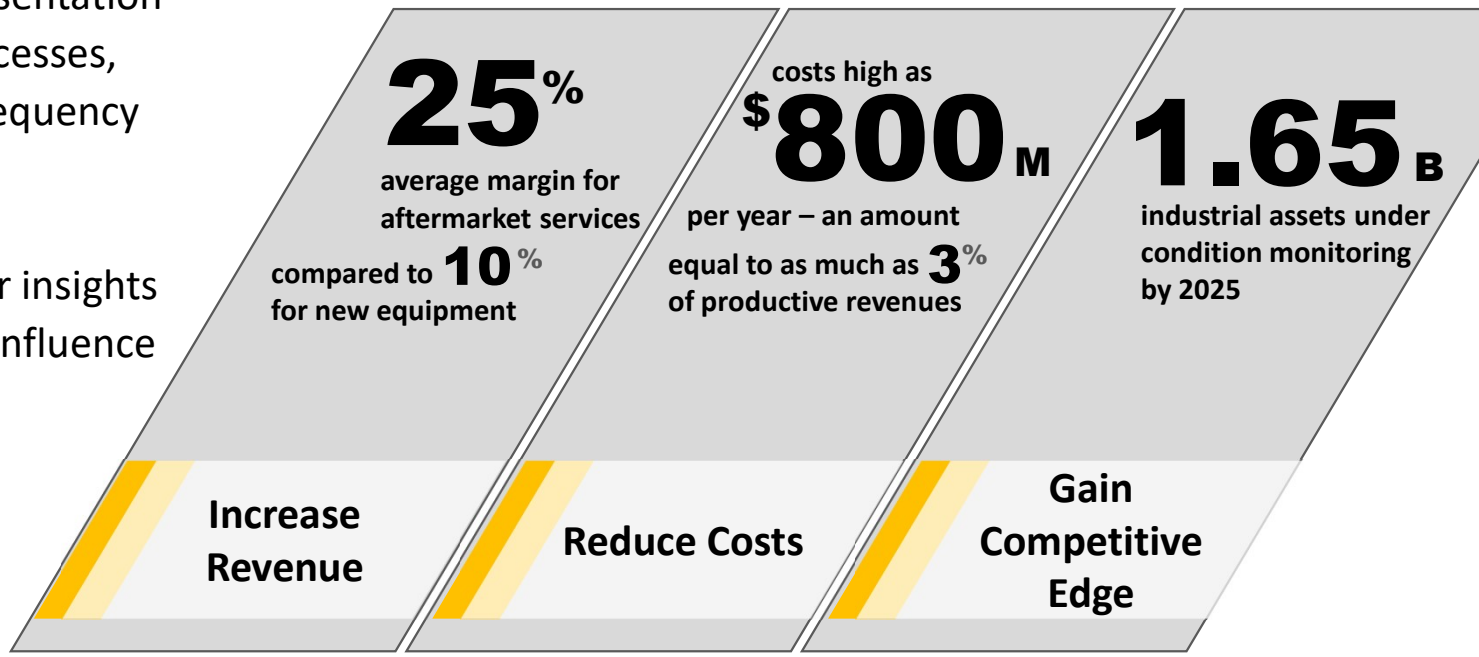
What is a Digital Twin?

Past, Present, Future, Simulate!

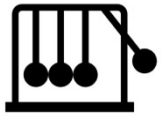
digital twin CONSORTIUM : "Virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity"

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.

Elements of the Digital Twin ecosystem



Simulation-Based and Hybrid Analytics

Data-Based Analytics

IoT/Edge Platform

Assets and Infrastructure

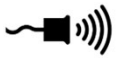
Open Ecosystems and
Key Announced Partners

Microsoft aws

Rockwell Automation ptc

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

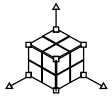
Simulation-Based & Hybrid Analytics



Create virtual sensors to "measure" missing data

Perform what-ifs before applying a solution

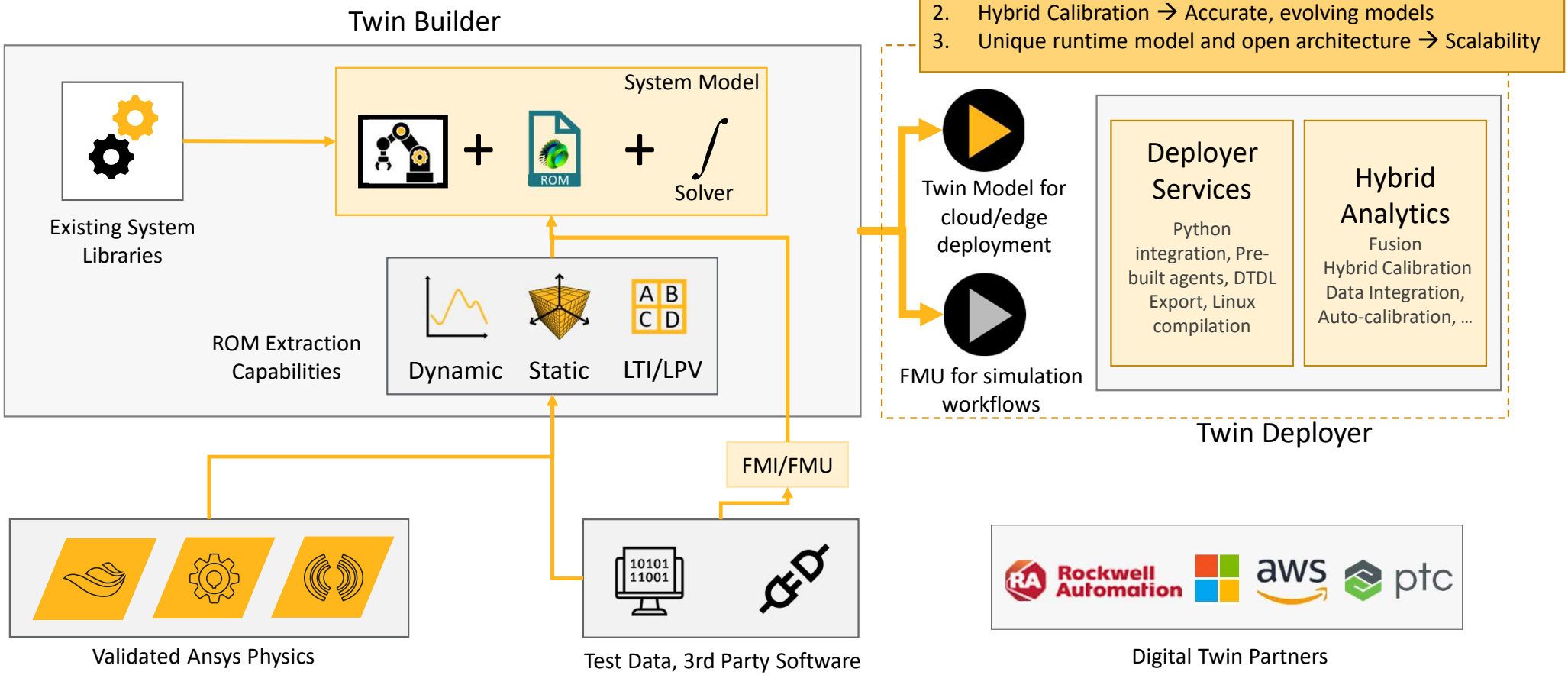
Analyze accurate and deterministic predictions based on physical principles



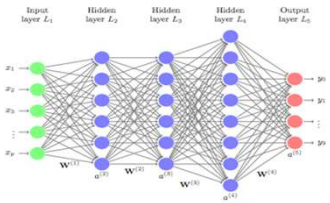
Explore causality and failure modes using physics

Our solution architecture fits seamlessly into our customers' stack

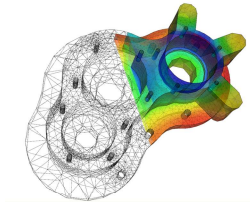
1. Best in class ROM capabilities → Reuse
2. Hybrid Calibration → Accurate, evolving models
3. Unique runtime model and open architecture → Scalability



Digital Twin Challenge: Accuracy, Time & Cost



Data-Driven Modeling

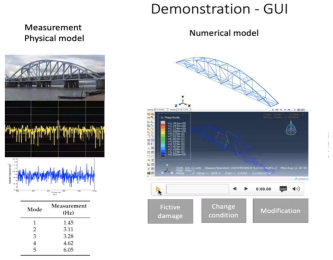


Design & simulation information not readily available / usable

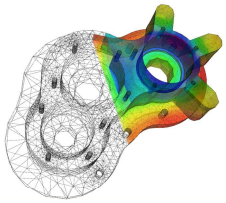
Model Development

Large volumes of process data required for training

Insufficient accuracy, limited by observed data



Simulation-Based Modeling



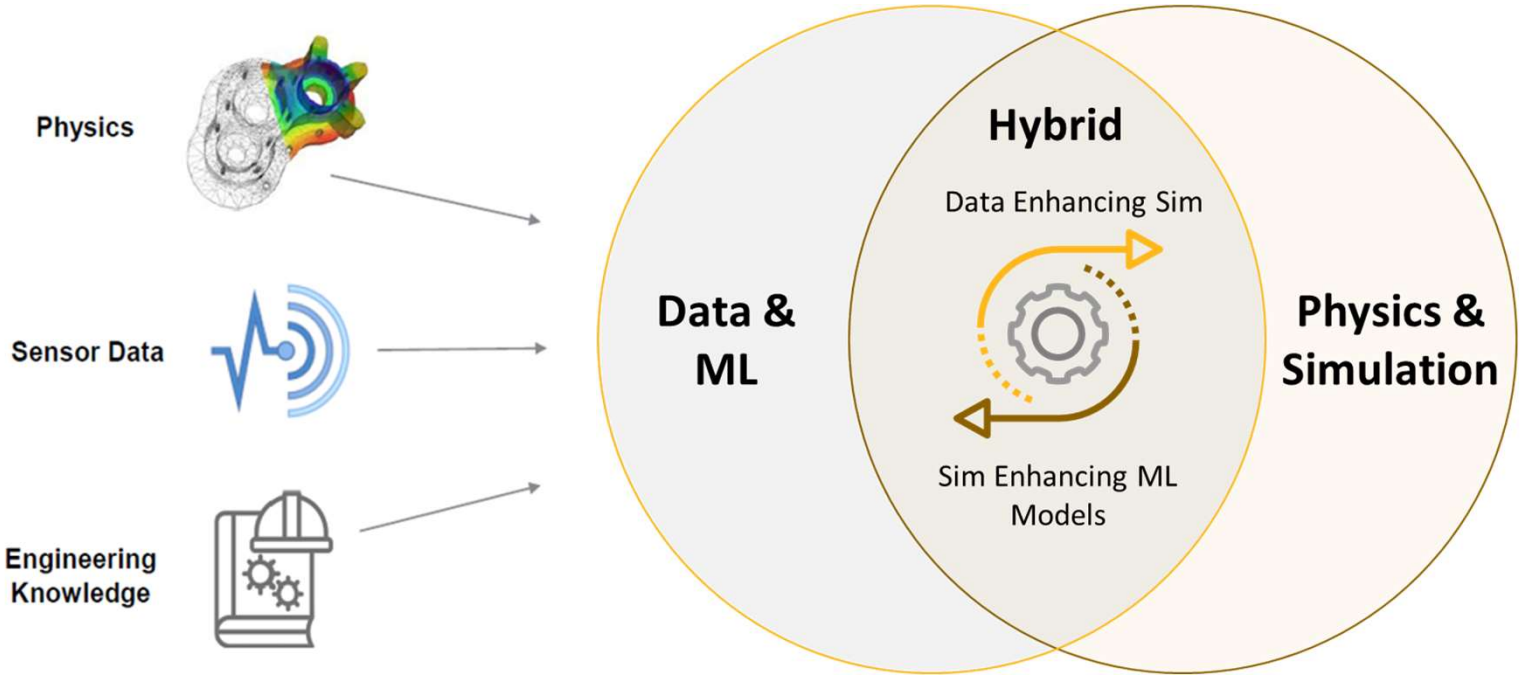
Difficult to accurately model the as-operated performance of equipment

Model Development

Lacking ability to incorporate available data into models

Long, expensive time scales to develop & deploy

Hybrid Digital Twins: Combining simulation and data



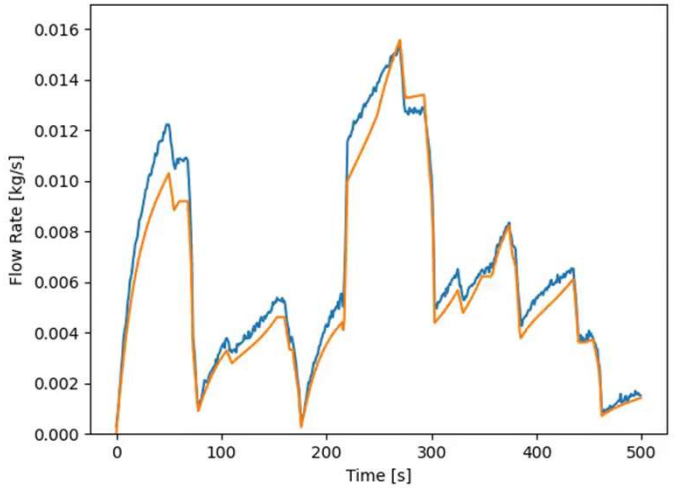
Hybrid Analytics combines data and physics to build **Hybrid Digital Twins**

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)

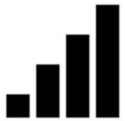
Details in IEEE Software publication: Hybrid Digital Twins: A Primer on Combining Physics Based and Data Analytics Approaches`

Digital Twin Use Cases

Typical use cases for Digital Twins

Virtual Commissioning and System Configuration

Predictive and Prescriptive Maintenance



Production Optimization

Virtual commissioning for battery storage system

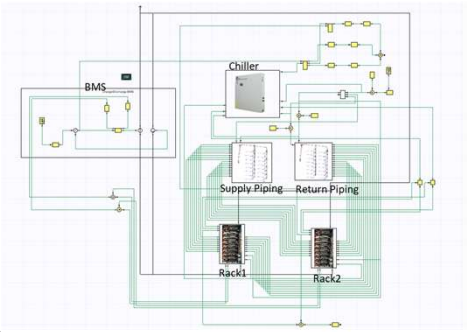
Challenge: Grid scale >1.5 MWh Battery Energy Storage Systems (BESS) require significant physical testing that can be very expensive and potentially dangerous. Typical systems weigh in the tens of tons.

Solution: Wärtsilä uses Ansys to build hybrid digital twins for their BESS including battery, chiller, and flow control models to accurately predict voltage, heat generation, and remaining useful life.

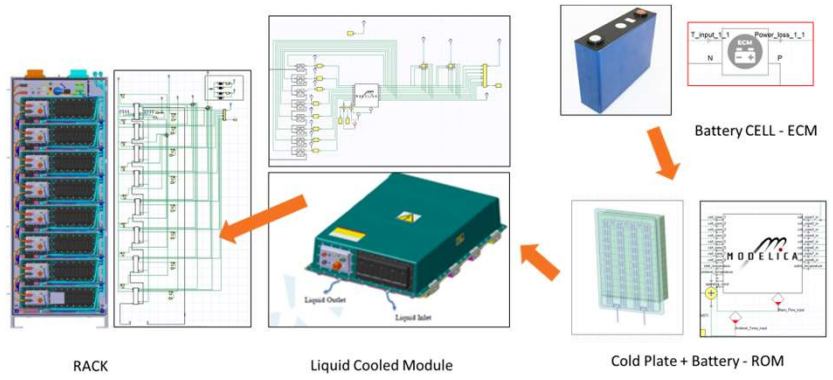
WÄRTSILÄ

Result: Using Ansys, Wärtsilä can significantly reduce the need for physical testing prior to commissioning – completing one-month of testing in about 24 hours – significantly reducing costs while ensuring safety

Battery Energy Storage System (BESS)



System Model in TB



Complex Battery System Storage Modeling with Ansys Twin Builder and Ansys Fluent

Webinar Link: Battery Energy Storage System Modeling in Ansys Twin Builder

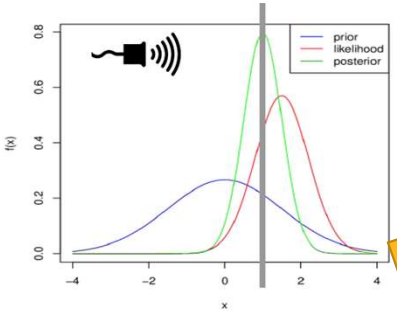
Pump manufacturer ensures reliable flow for utility

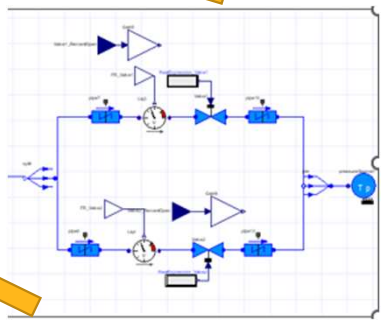
Predictive Maintenance

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





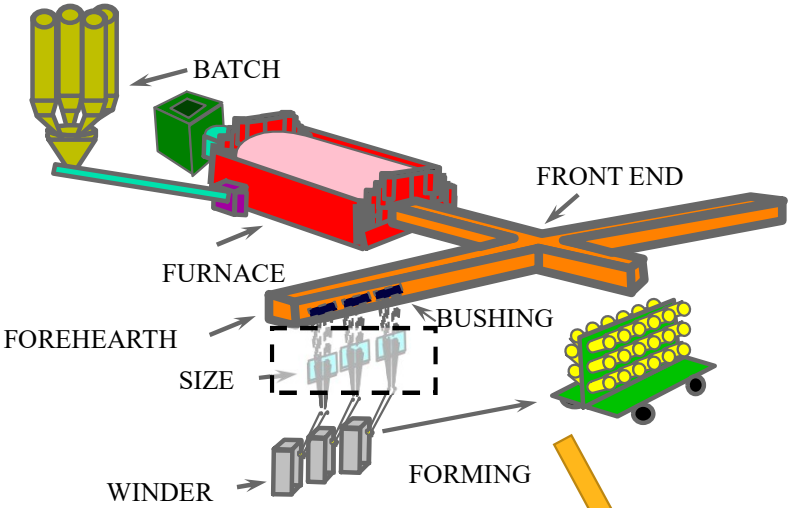
Production Optimization

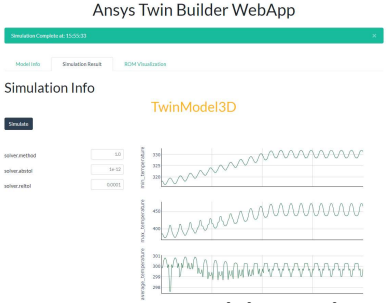
Improving production at global glass manufacturer

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.

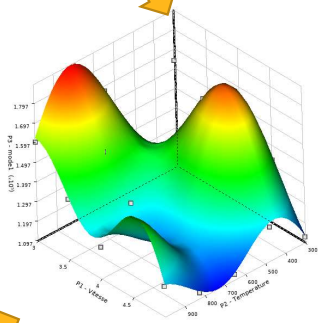
Solution: A reduced order model based digital twin to predict the entire temperature flow field of the forehearth. The reduced order model was created based on available non-linear CFD model and predicts temperatures

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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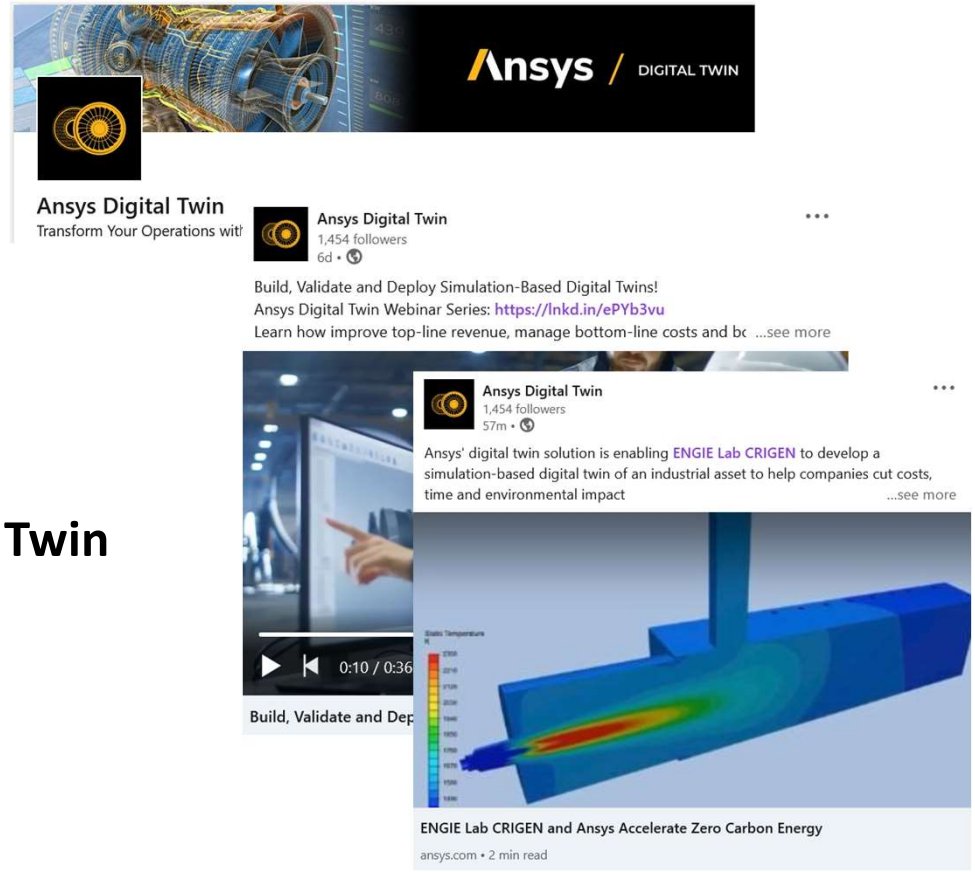

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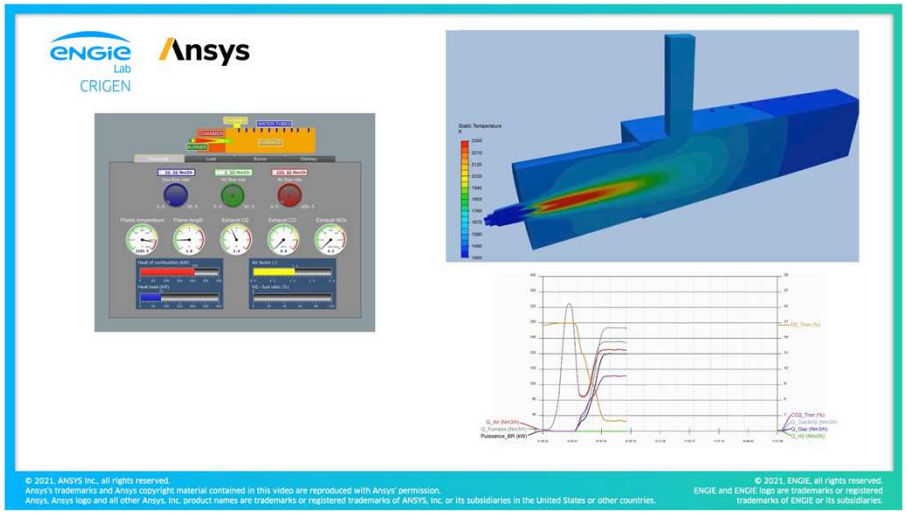
ENGIE: Accelerating Zero Carbon Energy

Predictive Maintenance

Challenge: ENGIE, one of the world's leading suppliers of energy efficiency services, is helping their customers accelerate the transition to zero carbon. To achieve this, ENGIE needs to be able to control operation based on real time quantities that are hard to sense.

Solution: By using Ansys' hybrid digital twins, Engie can provide real time insights into quantities like flame length and heat load

Solution/Results: Through its collaboration with Ansys, ENGIE is **improving product performance** during operation and provide **insight into predictive analytics** and asset performance management decisions



Production Optimization

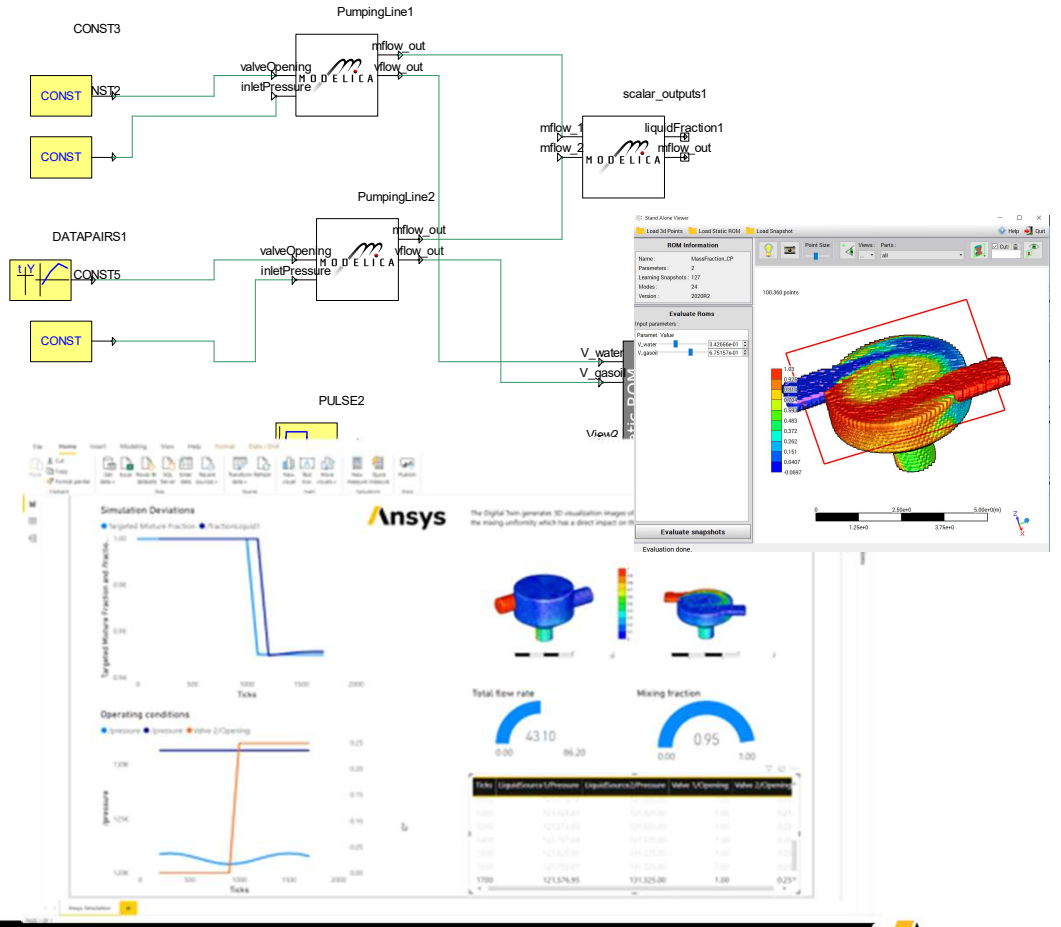
Global Energy Company: Optimizing Refinery Gasoline Blending Process

Challenge: With existing solutions, blend quality can typically only be determined after the blending process has completed.

- Caused by uncertain variations due to complex interactions between multiple fluid flows and equipment configurations

Solution: Augment available sensor streams with virtual sensors that help predict blend quality and allow real-time corrections

Results: Solution being implemented by customer. Expected to help realize operational improvements of ~2%, representing savings of millions of dollars per year per refinery



Microsoft

Ansys

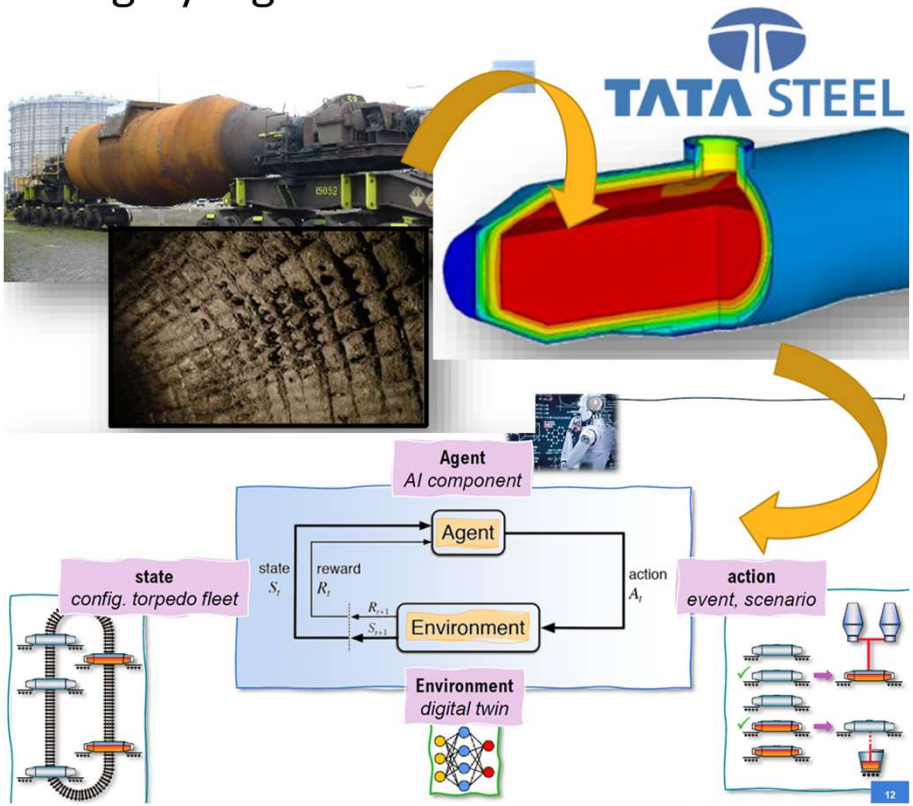
Energy efficiency optimization of iron & steelmaking by digitalization of thermal process management

Predictive Maintenance

Challenge: Torpedo refractory maintenance costs exceeded by several M€. Higher hot metal temperatures help with yield losses and CO2 emissions but lead to higher wear of insulation of torpedo car linings and higher energy usage.

Solution: A comprehensive (thermal) digital twin for the entire hot metal (HM) production route. AI based controls to optimize for refractory wear rate.

Result: Savings of ~M€ due to improved maintenance. Additionally, can optimize number of ladles and torpedo cars in use with respect to temperature and select best possible refractory lining



https://www.ansys.com/webinars/how-digital-twin-is-a-game-changer-for-tata-steel-nederland-to-achieve-their-targets