Ansys
INNOVATION
CONFERENCE
2020

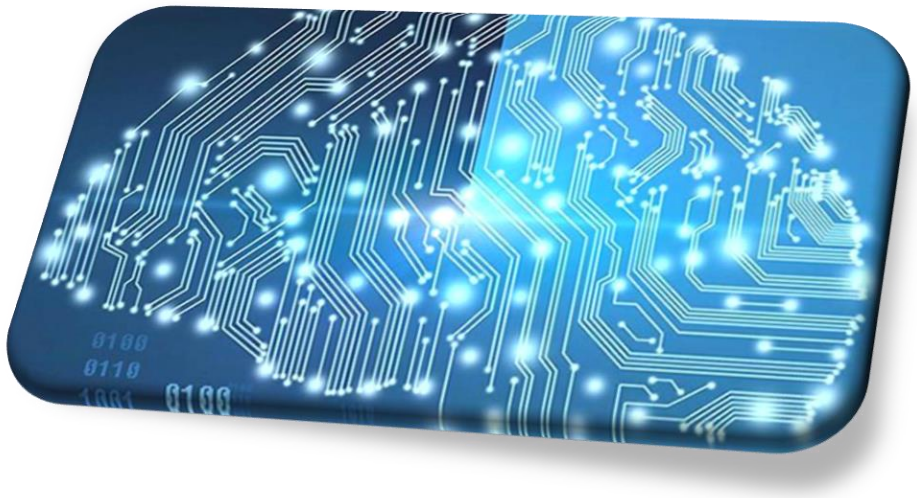
Digital Twin

Peyman Davoudabadi, PhD, MBA
Director, NA ACE, Platform

Accelerating Trends Reshaping Business

Deglobalization

Infusion of Data-Enabled Services



Automated Manufacturing & Operations

Innovation with Simulation-Based Digital Twins

"We're going to do five years of innovating in the next 18 months." – Anna Shedletsky CEO, Founder of Instrumental Inc.

Business Benefits of Digital Twin

15%
Revenue Gain[1]

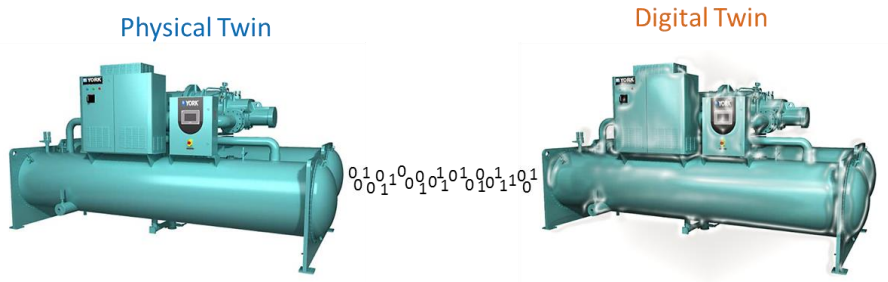
- New business models
- Improved productivity and accelerated new product introduction
- Competitive advantage

10%
Cost Reduction[1]

- Warranty cost reduction
- Operational efficiency
- Shortened design and development cycles

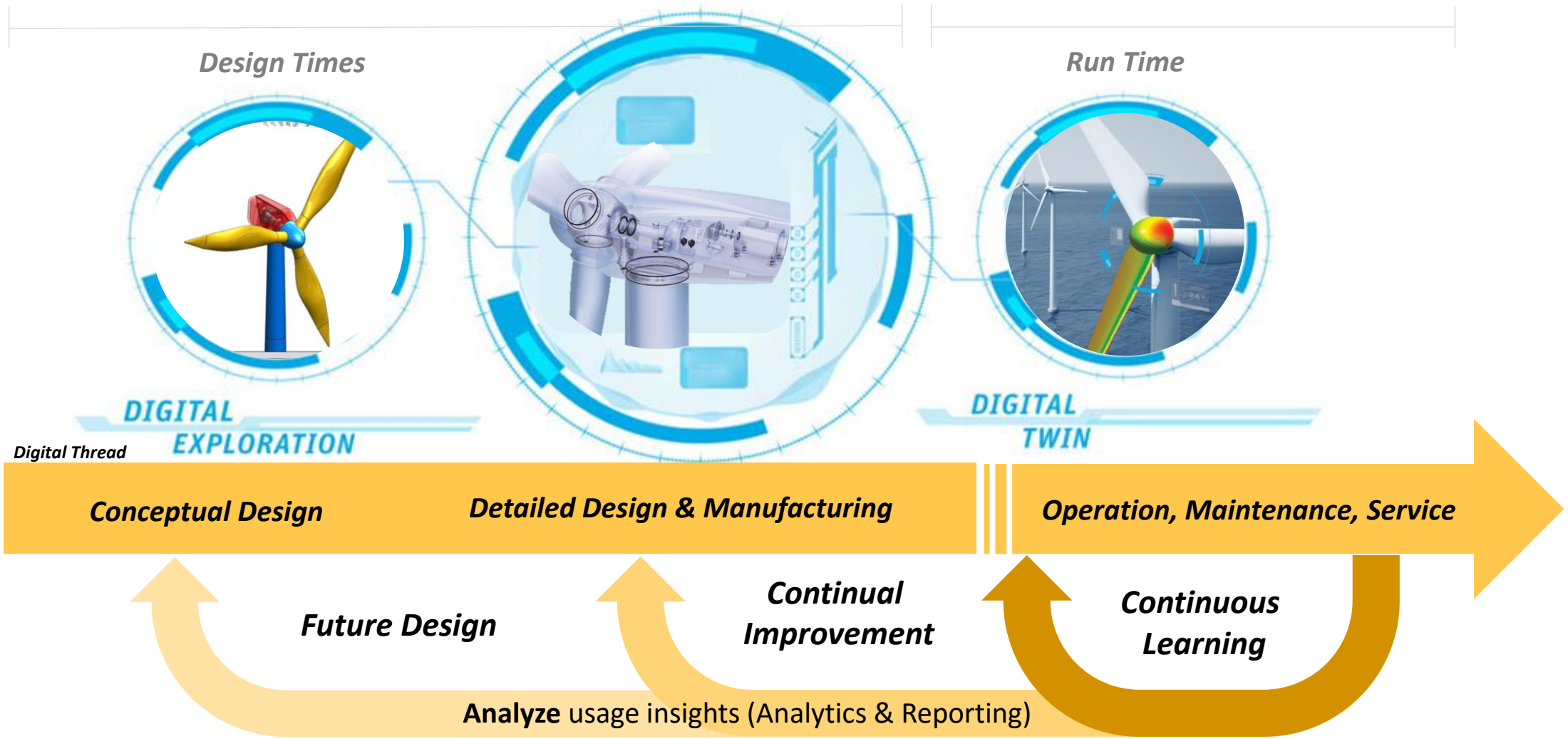
30%
Maintenance Cycle Time Improvement[2]

- Improved maintenance efficiency



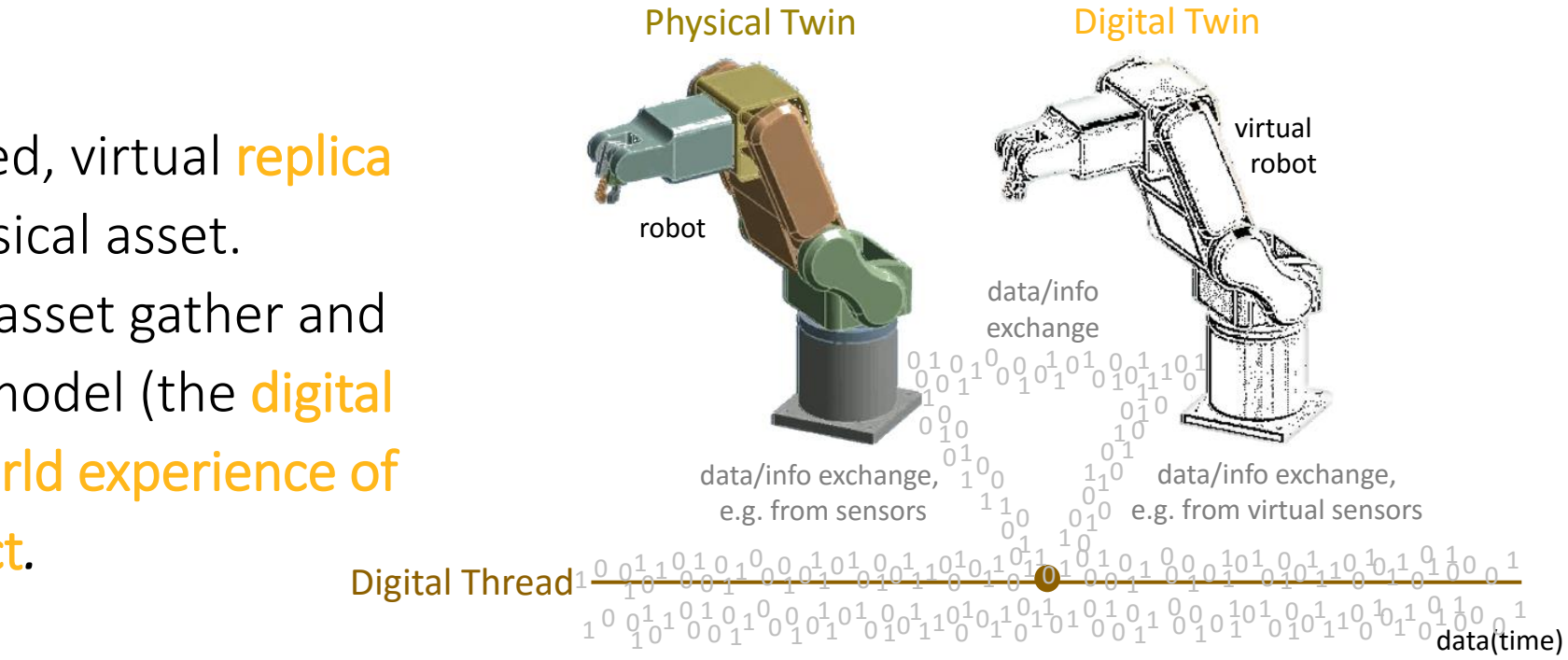
1. McKinsey & Company: Five Keys to Digitizing Aerospace and Defense
2. Companies Aviation Week MRO

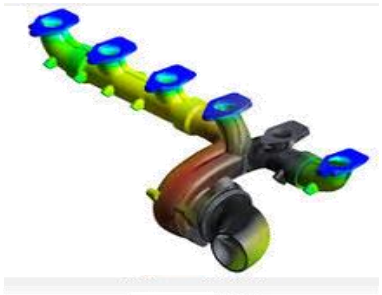
Simulation Engineering Insights throughout Product Lifecycle

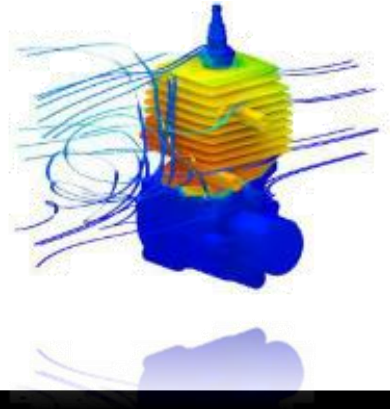


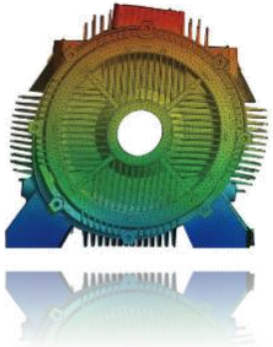
What is a Digital Twin?

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.









Simulation-Based Digital Twin Insights

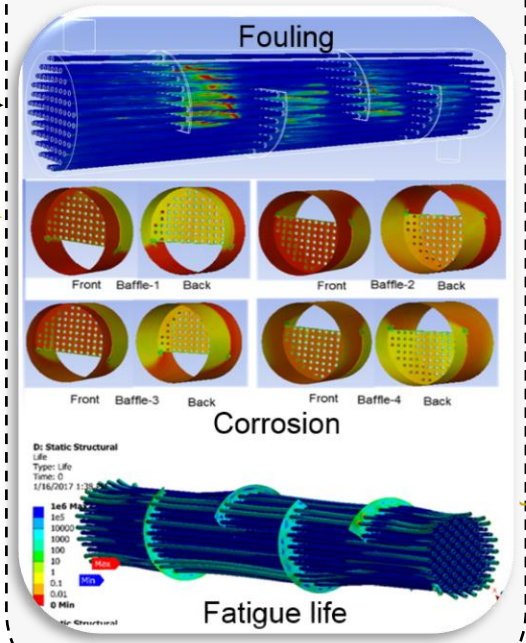
- **Predictive Maintenance**
  - Remaining Life
  - Predictive service: saving cost of repairs and services
  - Avoiding under/over maintenance
  - Prevent unplanned failure and down time: productivity gains
- **Virtual Sensors:**
  - Query for virtual sensor data where no physical sensors exist
  - Real time condition monitoring
  - 3D visualization and Performance insights
- **Operation optimization**
  - Remote operation control and troubleshooting
  - Virtual commissioning
  - Real time optimization: Increase efficiency
- **Generate Baseline and Failure Data**
  - Real time modeling of historical, current, and potential future conditions
  - Simulate failure modes without expensive physical prototypes or assets in long service
  - Define failure/fault indicators and generate failure data that cannot be collected
- **What-If and Trade-off Studies**
  - Improved business critical decisions by systematically studying outcomes of possible operational prescriptive scenarios.

Equipment/Asset

Sensor inputs

state

Virtual Equipment



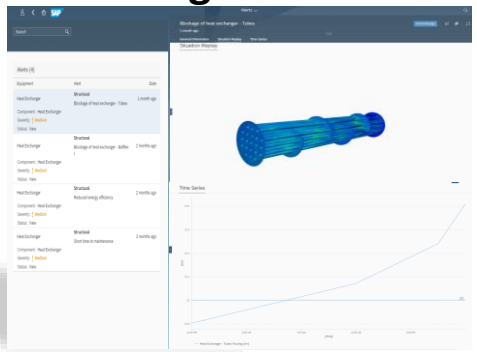
Virtual outputs

fouling

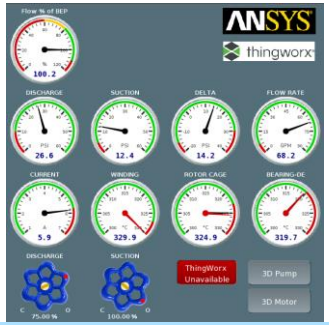
stress

remaining life

Digital Twin



Motor-Pump Digital Twin



Motor-Pump in Operation

Data

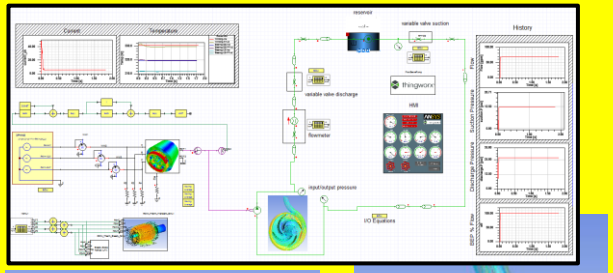
Industrial IoT Platform (PTC ThingWorx®)

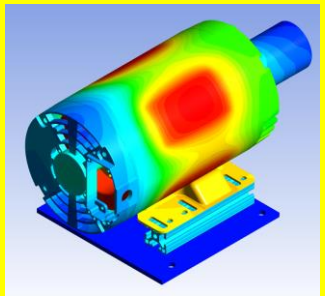
Sensor Data Streaming
Data Analytics
History, Triggers
Security
Connectivity

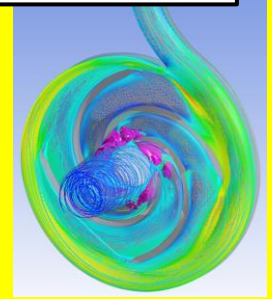
Inputs

Motor-Pump Digital Twin

ANSYS
Simulation Platform







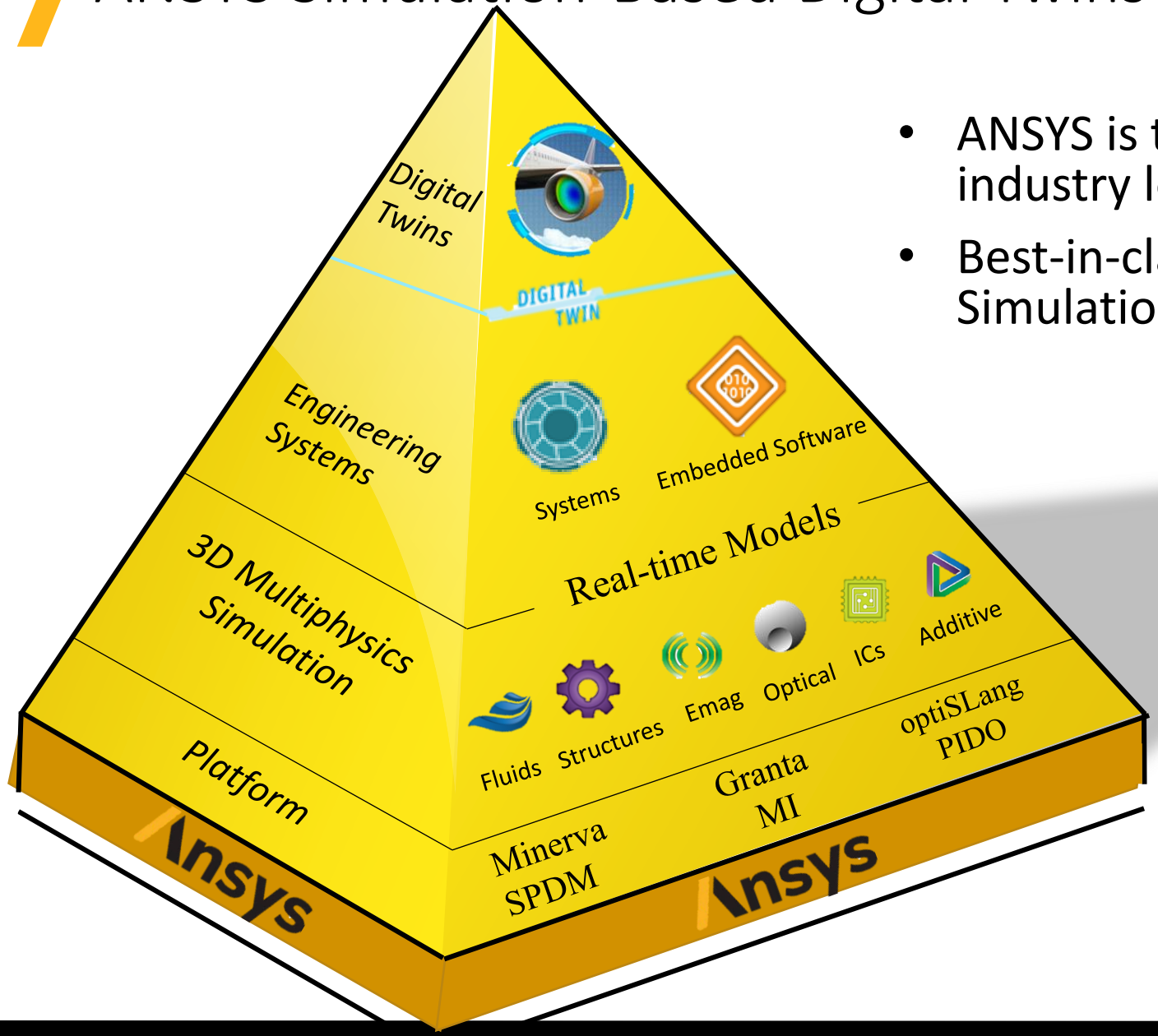
Simulation Outputs

Preventive Maintenance
Value Added Services
Feedback to Engineering

Motor courtesy of Regal Beloit
Pump courtesy of Flowserve

Connecting the Real Asset and its Digital Twin In Operation

ANSYS Simulation-Based Digital Twins

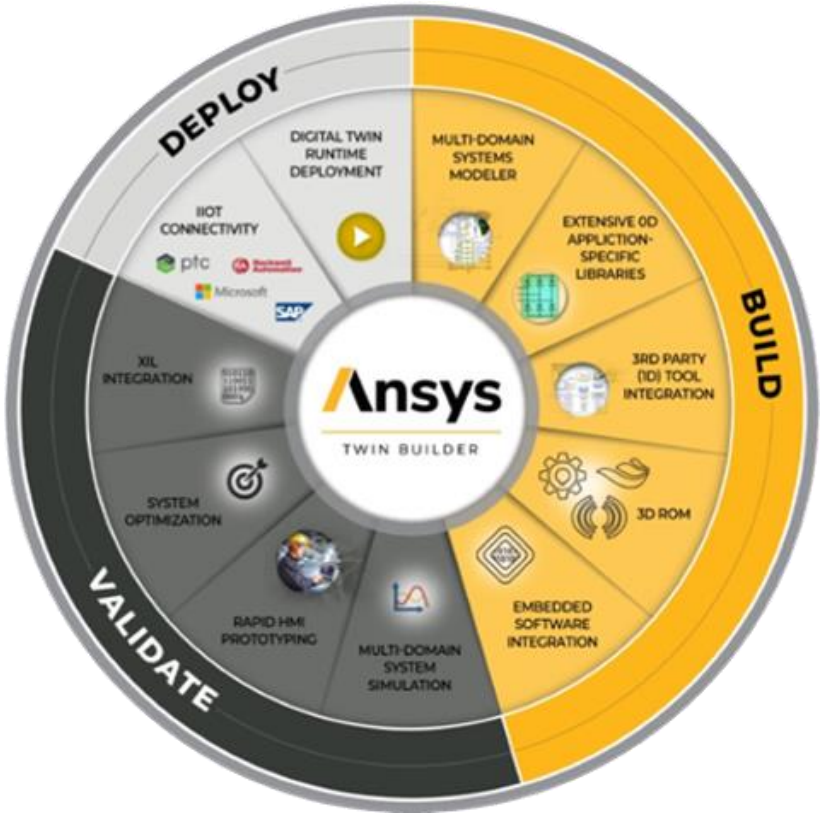


- ANSYS is the **market leader** in providing industry leading solutions across **all physics**
- Best-in-class simulations lead to best Simulation-Based Digital Twins

"Verdantix recommends that customers looking to embrace Industry 4.0 practices and work with a proven, established firm that has a large global support network should try out ANSYS Twin Builder. "

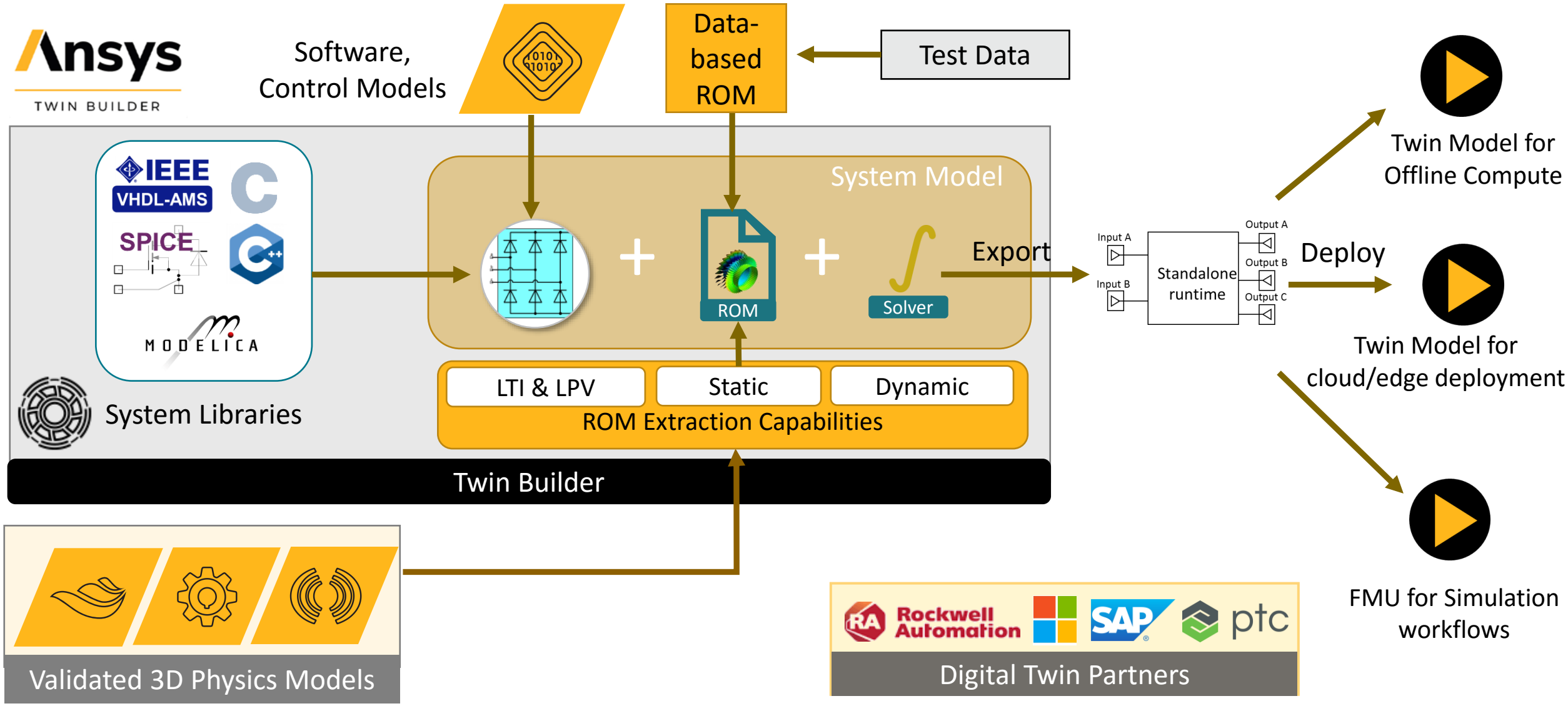
research.verdantix.com/report/operational-excellence/ansys-leverages-product-design-expertise-to-offer-a-digital-twin-builder

Solution Capabilities Required To Deliver Digital Twin Benefits



- Build an Accurate, Physics-Based Digital Twin
- Validate and Optimize the Twin
- Connect Twins to IIoT Platforms and Deploy Runtimes in Operation

Ansys Workflow for Simulation-Based Digital Twin



Use Cases

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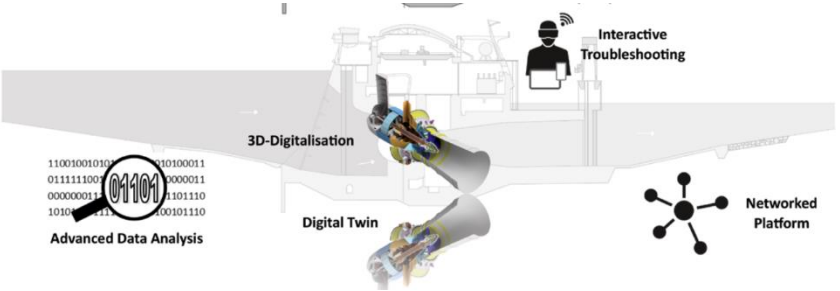
Verbund Hydro: Digital Twin for Water Turbine

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.



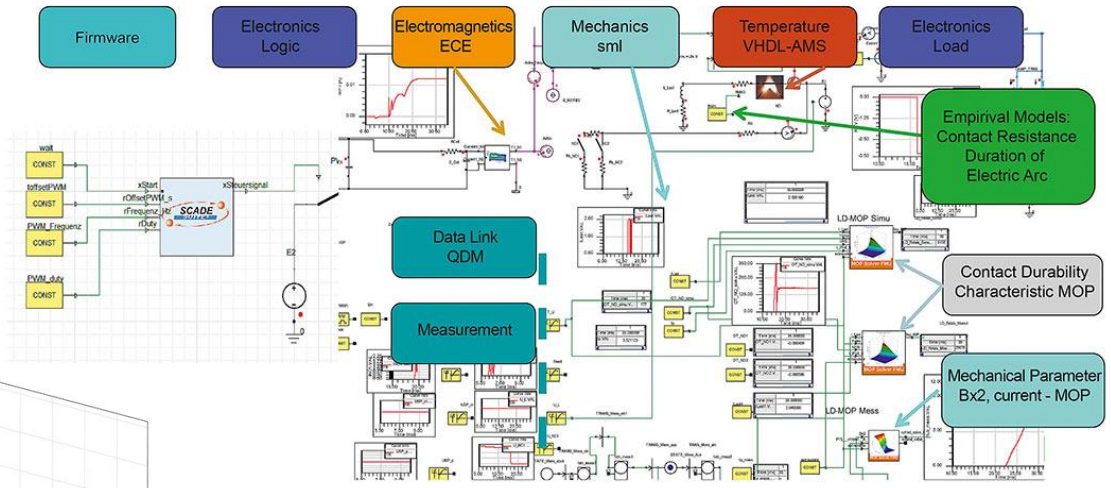
Verbund
in cooperation with
CADFEM
ITficient

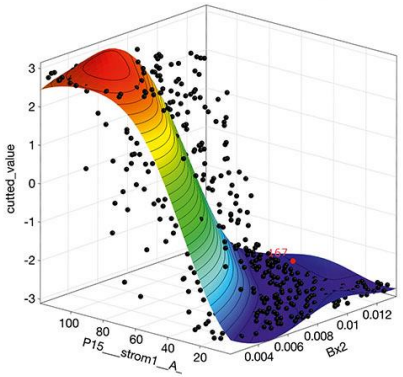
Phoenix Contact: Creating a Fail-Safe Digital Twin

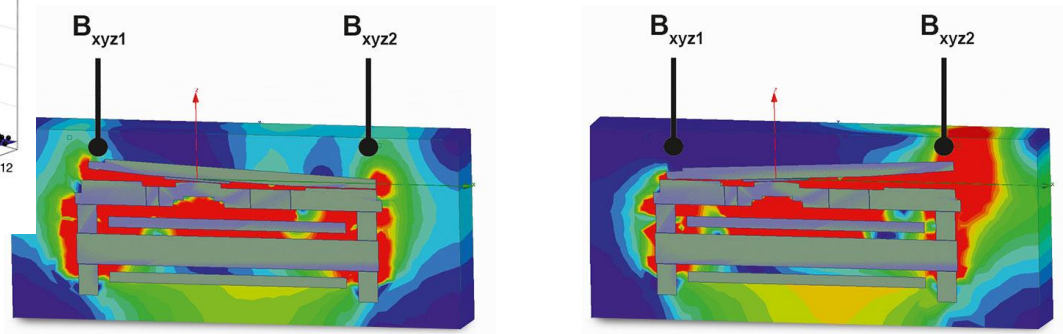
Challenge: The unplanned downtime due to failure of a relay can cost thousands of dollars per hour of lost production revenue and it is very hard to predict relay failure as there is no wear sensor.

Solution: To predict component failure before it occurs, a simulation model fed by actual load data computes the true state of the wear.

Results: Based on sensor data, this simulation model computes the actual wear of the contacts and the remaining life of the relay system for predictive maintenance, saving thousands of dollars of lost productivity.







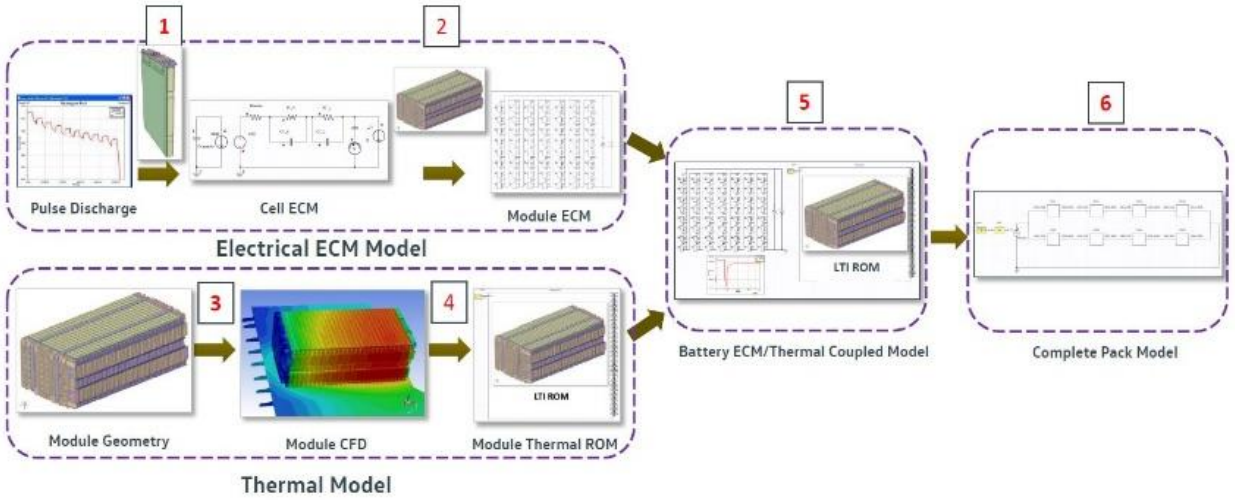
ANSYS Maxwell simulation shows magnetic field at different armature positions.

VWMS: Modeling 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, with help from ANSYS technology

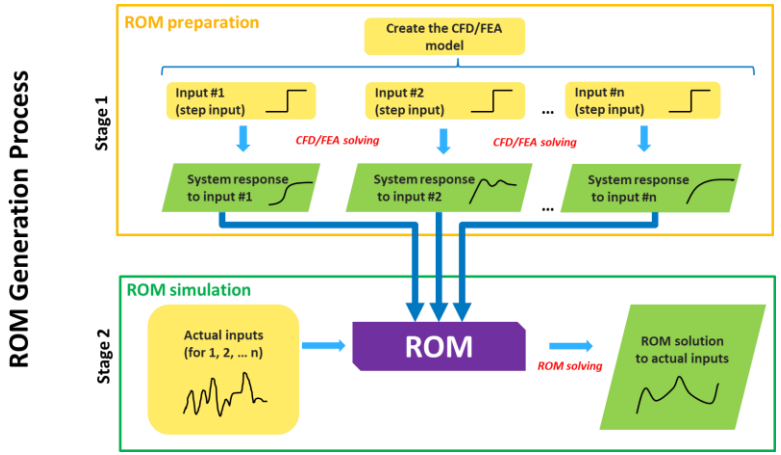


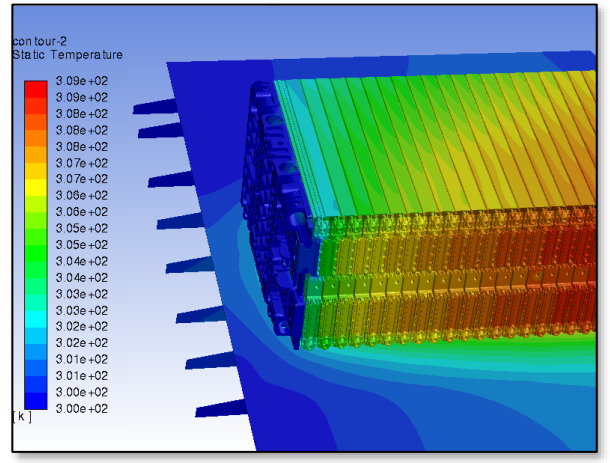

FAST, BUT BEAUTIFUL TOO —

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





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

KAESER KOMPRESSOREN

PUBLIC

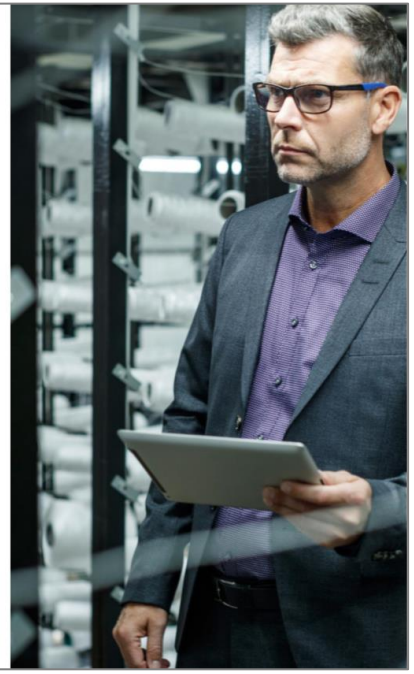
How Will a Leading Compressor Company Reinvent Sales with a Digital Twin?

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 SAP



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

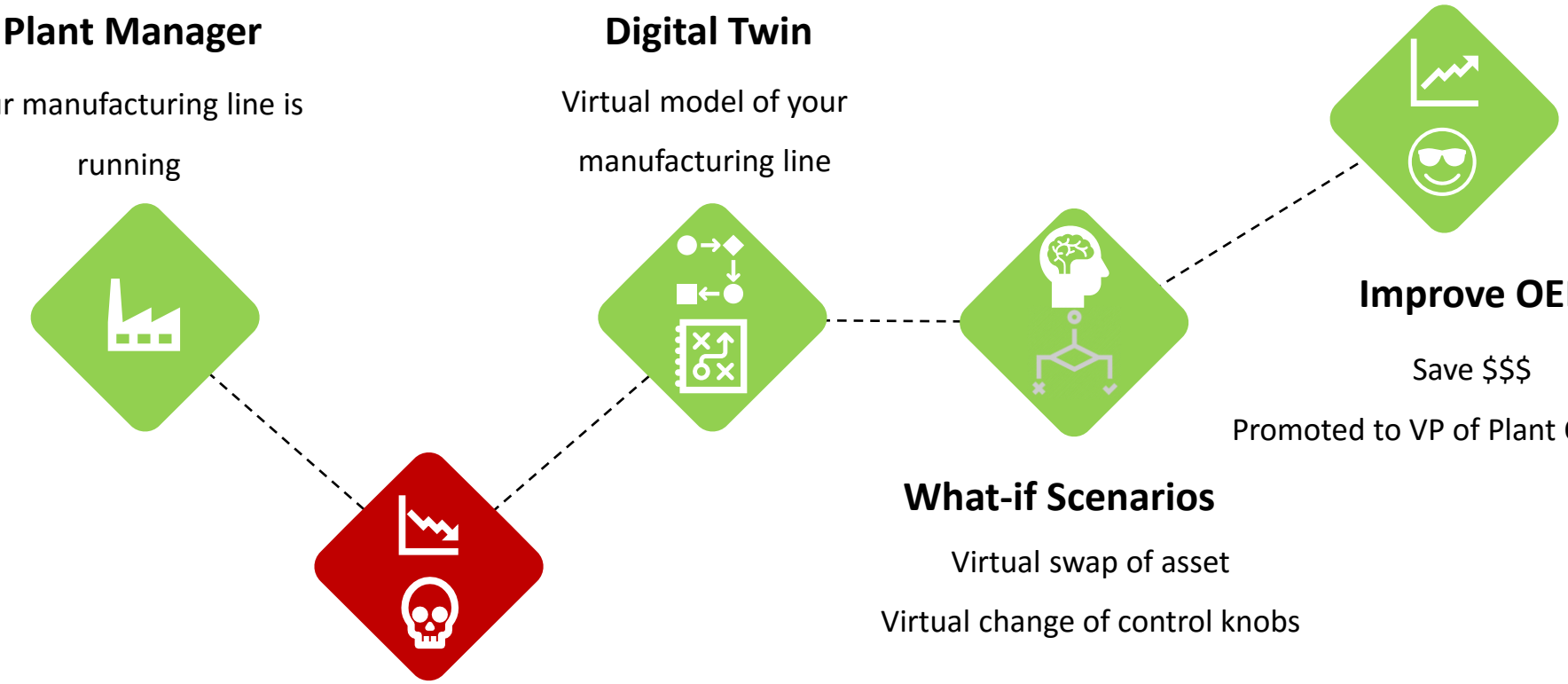
KAESER KOMPRESSOREN

KAESER KOMPRESSOREN SE	Industry	Employees	Revenue	Featured Solutions and Services
Coburg, Germany www.kaeser.com	Industrial machinery and components	6,500	>€1 billion	SAP Predictive Engineering Insights enabled by ANSYS

THE BEST RUN SAP

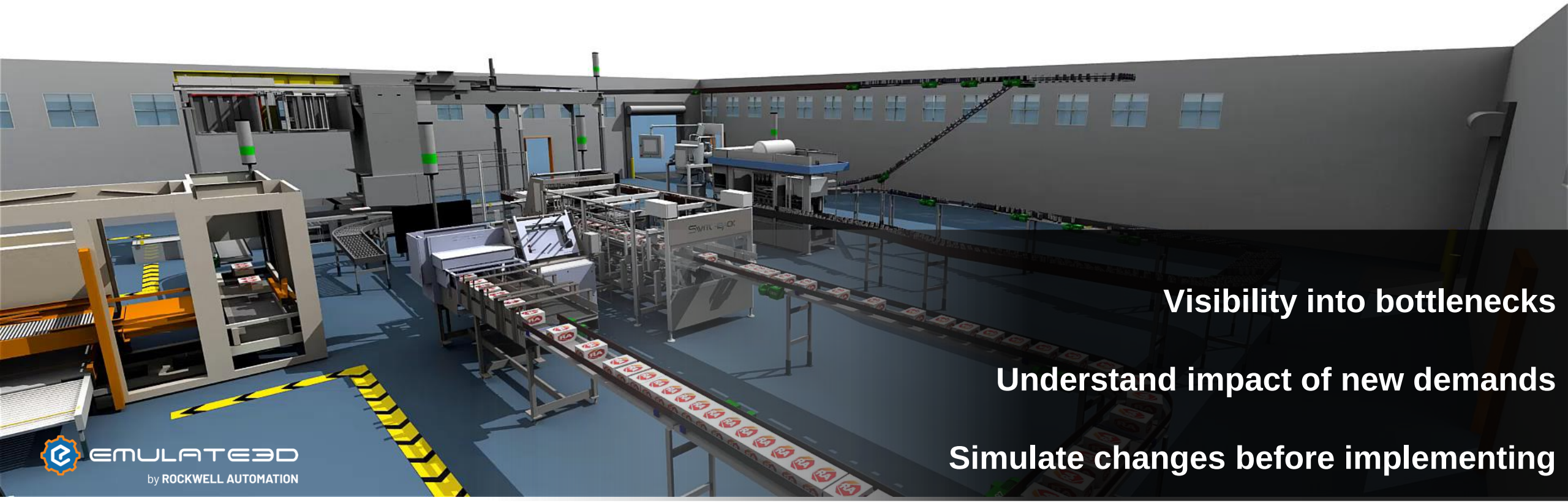
https://www.sap.com/documents/2020/02/ae761b82-837d-0010-87a3-c30de2ffd8ff.html

Digital Twins for Manufacturing and Industrial Automation

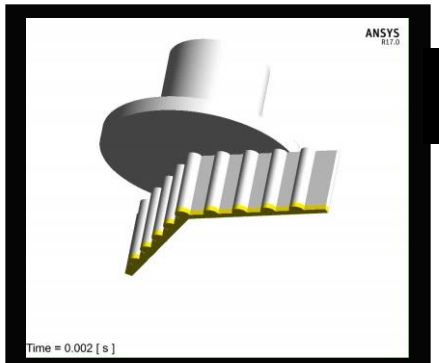


Virtual Commissioning

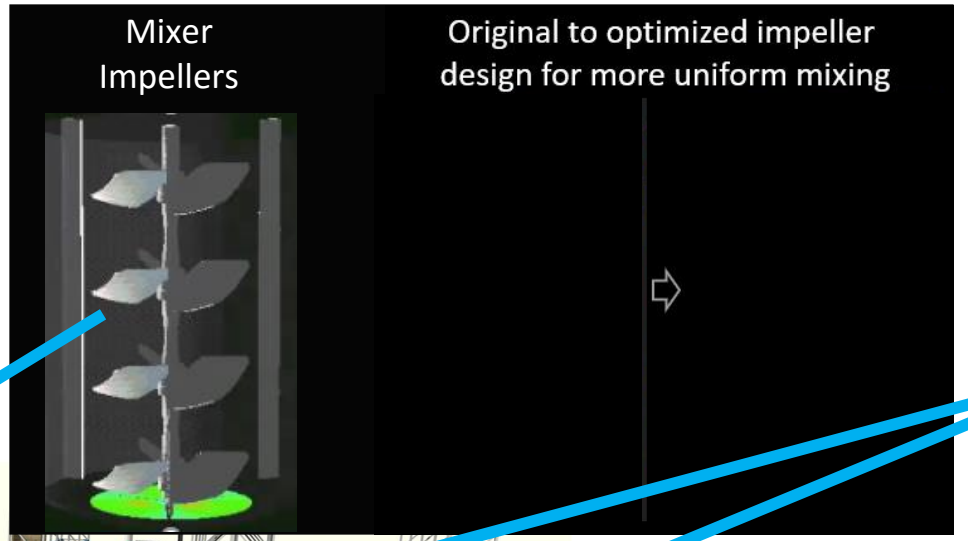
- In industrial automation
- Network view in addition to asset-centric view of products and processes

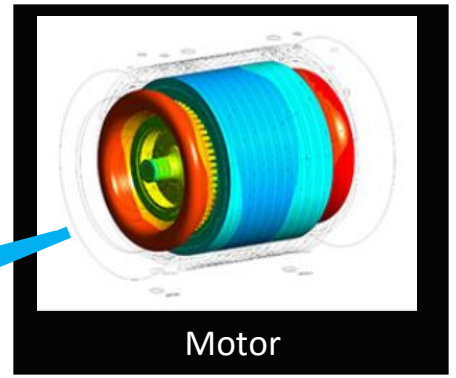


High-Fidelity Multiphysics and System Twins

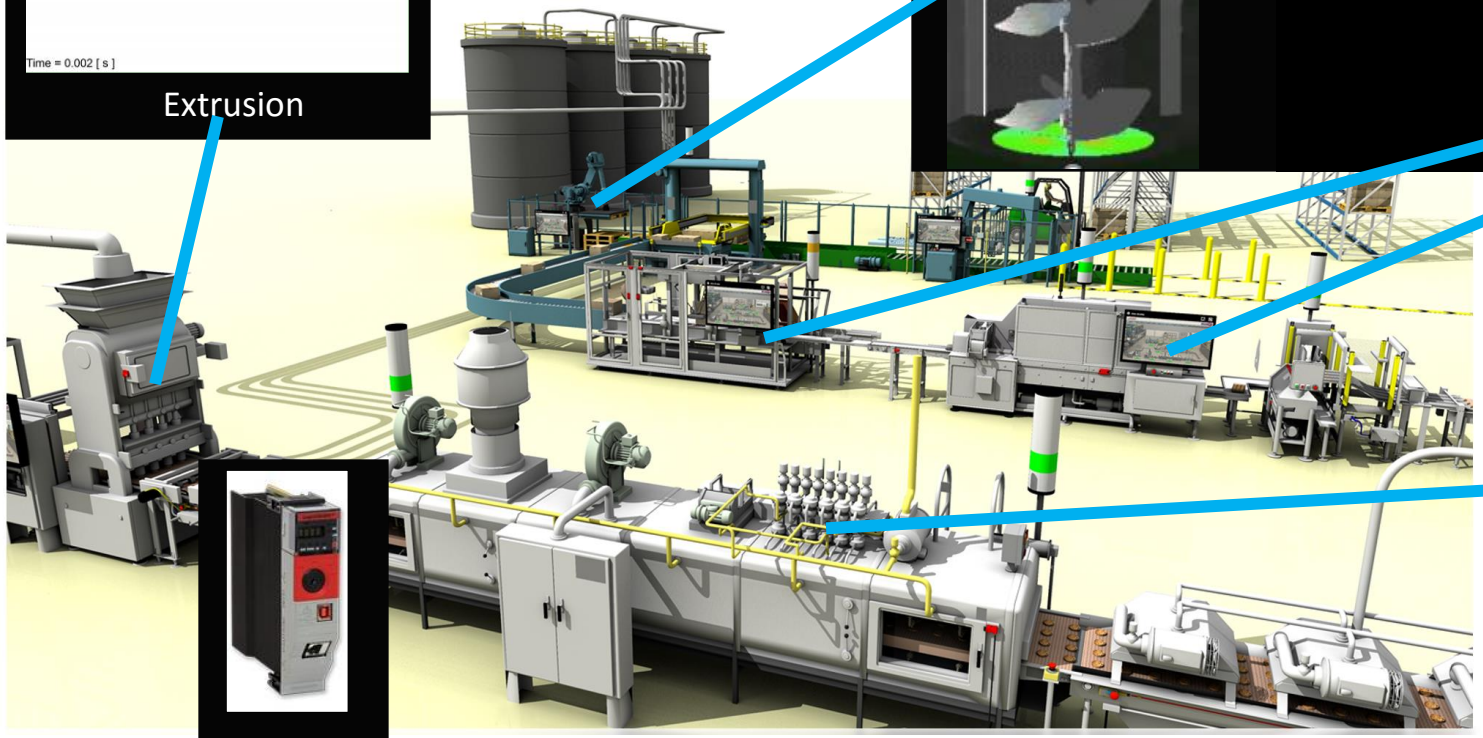


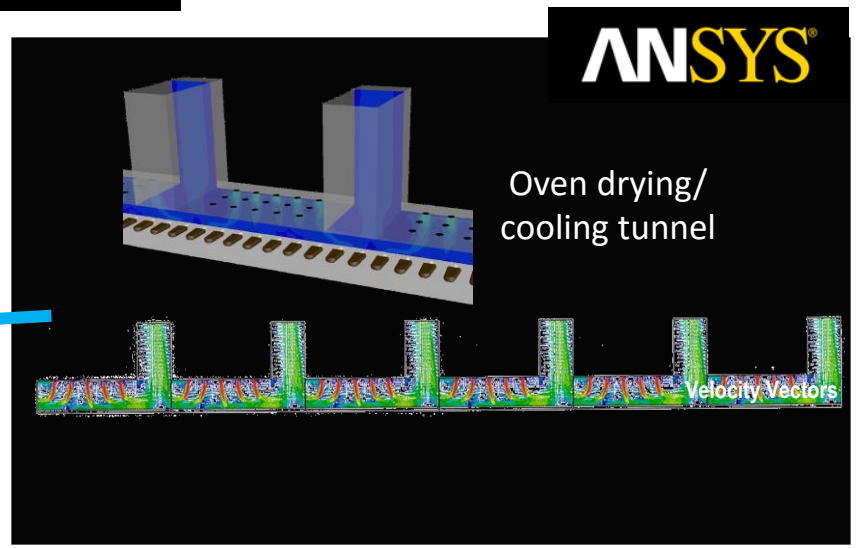
Extrusion





Motor





controller

Ansys leading the way in global Digital Twin initiatives

Digital Twin Consortium

- Ansys is one of 5 founding members
- Drives the development and adoption of digital twin technologies
- Emerging standards body (part of OMG)

Digital Twin Definition Language (DTDL)

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

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