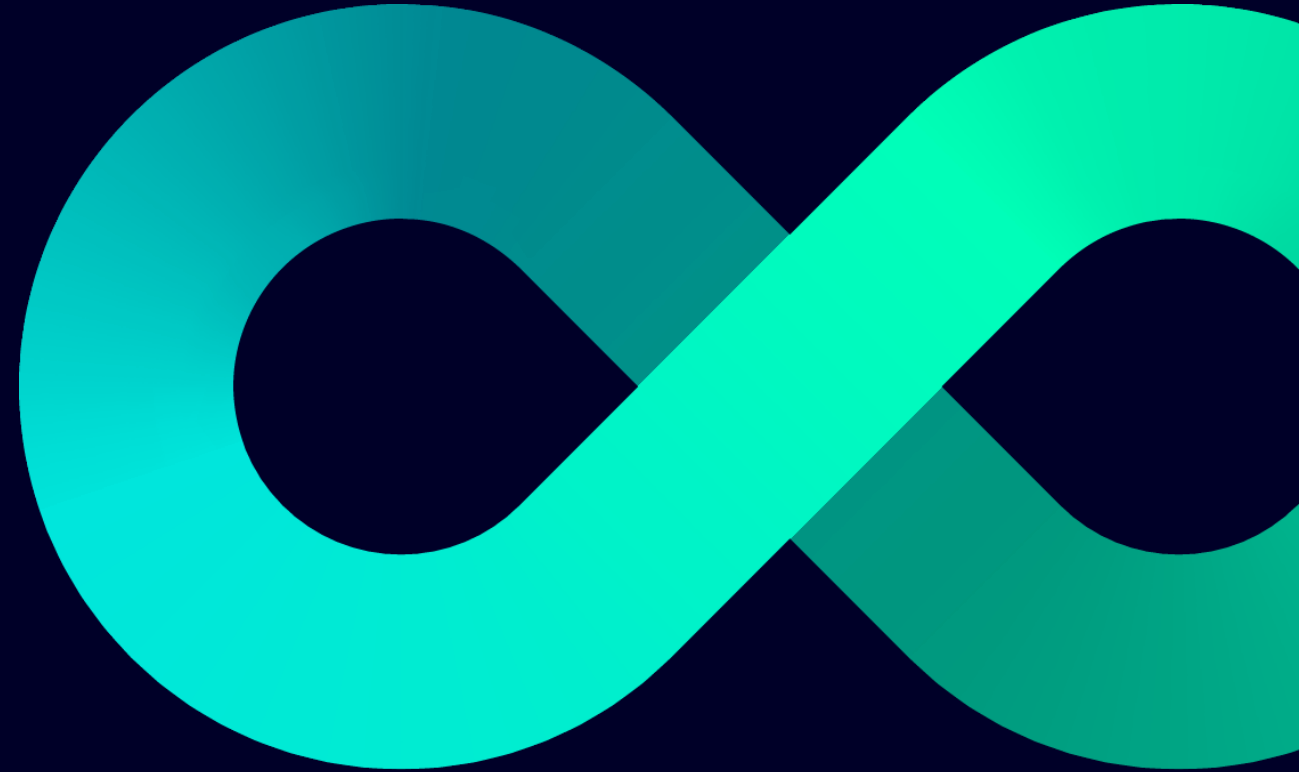


# Simulation for Hybrid Production



# Megatrends having impact on machine builders

## Disruptive technologies



## Volatile markets



## Changes in labor market



## Challenges

- IT technologies entering automation engineering, demanding workflow adaptation
- Complex initial effort for implementation
- Accommodate diverse engineering demands and capacities

- React fast to changing market requirements
- Ensure high engineering and software quality while increasing output
- More flexible machine concepts

- Lack of skilled workforce
- Engineers perform repetitive tasks
- High training effort

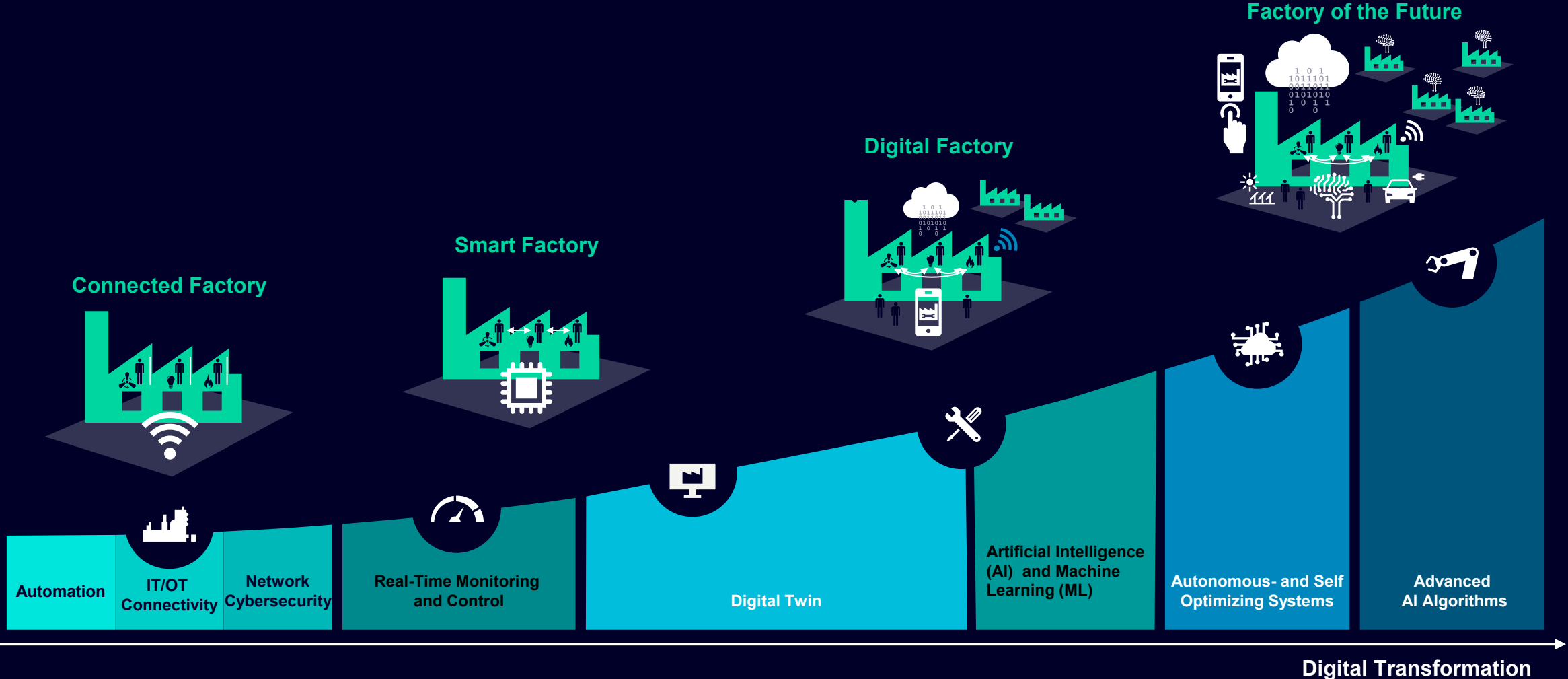




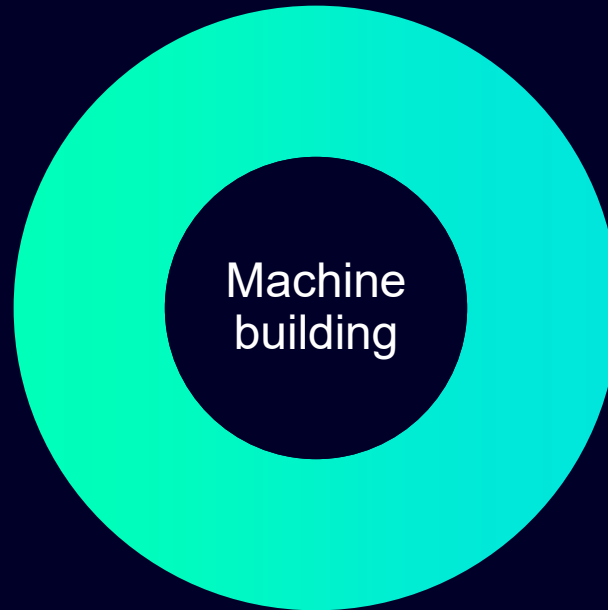
Change is the law of life and those who look only to the past or present are certain to miss the future.

John F. Kennedy

# Where Are We ?

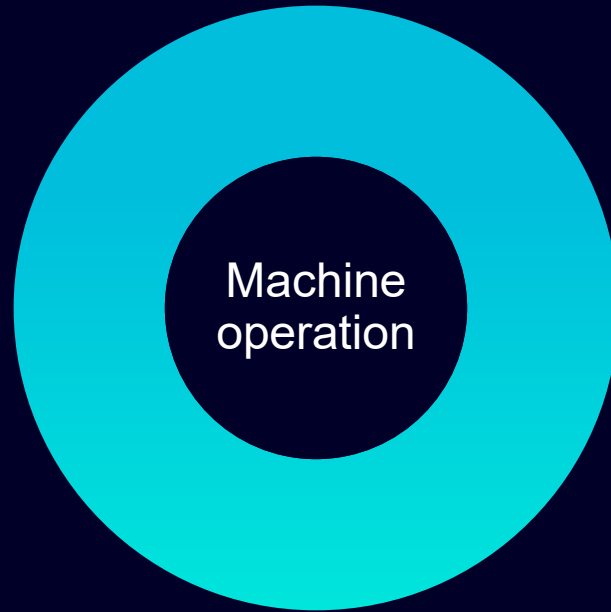
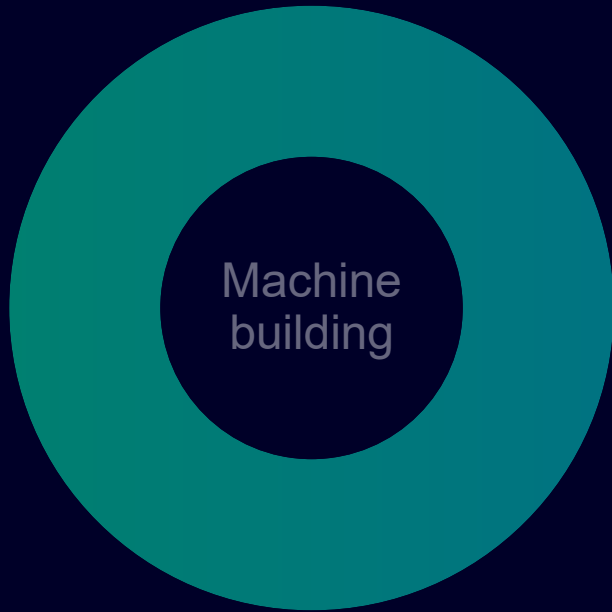


**Digital world**



**Real world**

# Digital world

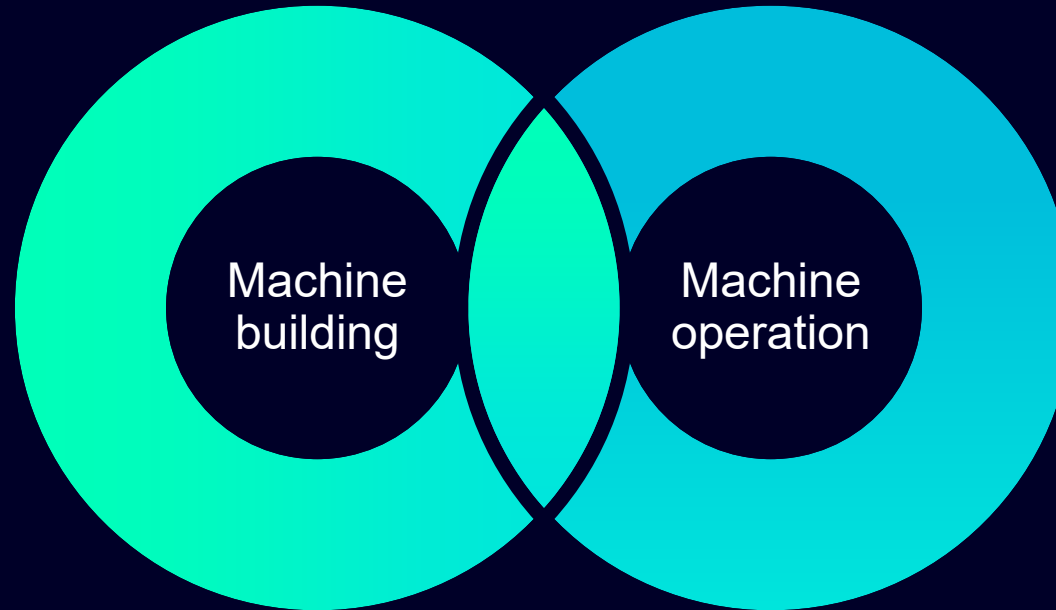


# Real world

# Digital world

Design & Engineering

Virtual Commissioning



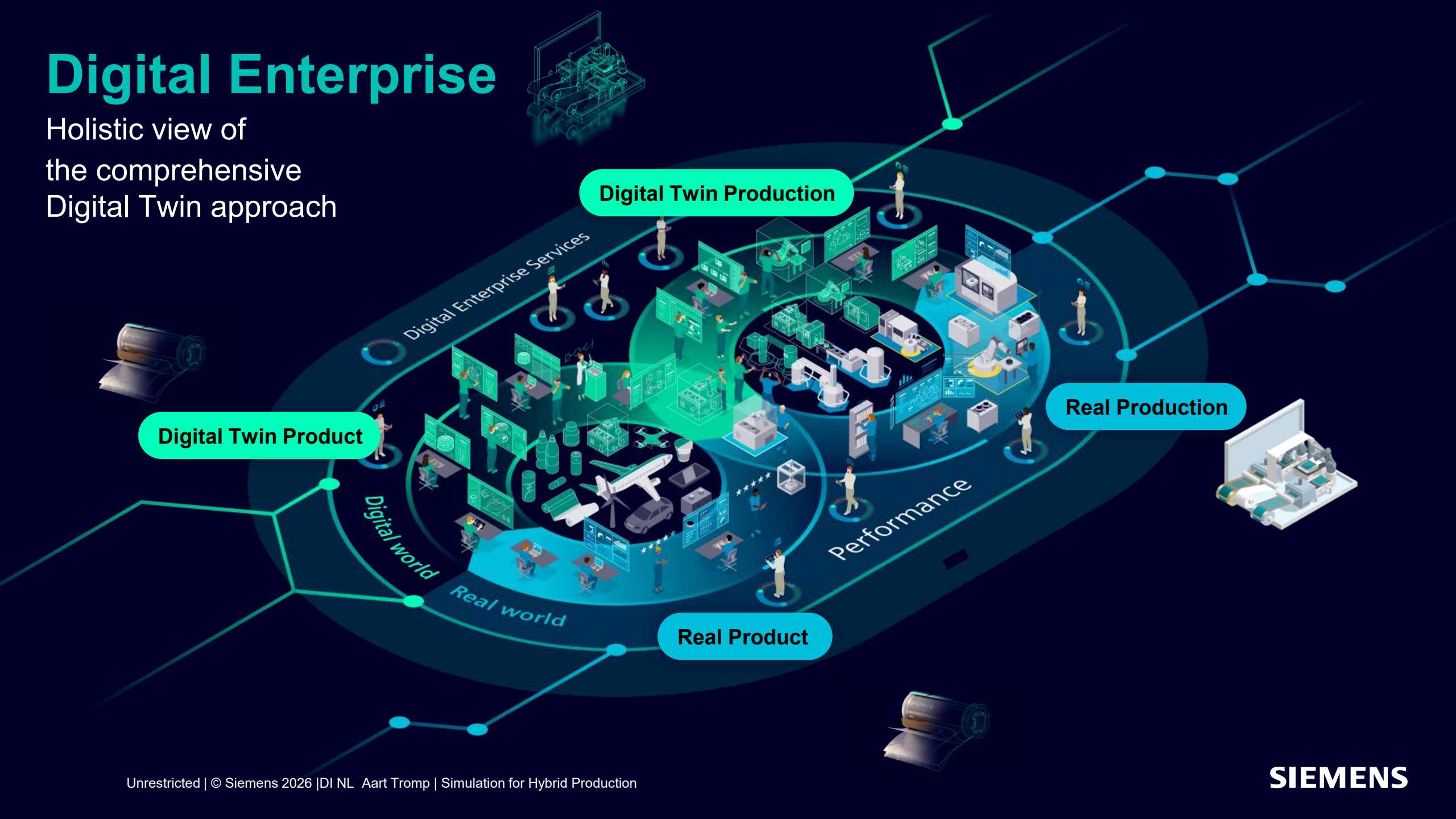
FAT

SAT

# Real world

# Digital Enterprise

Holistic view of the comprehensive Digital Twin approach



# The traditional approach to manufacturing does not provide all the answers to the complex challenges of today's battery industry and of our customers

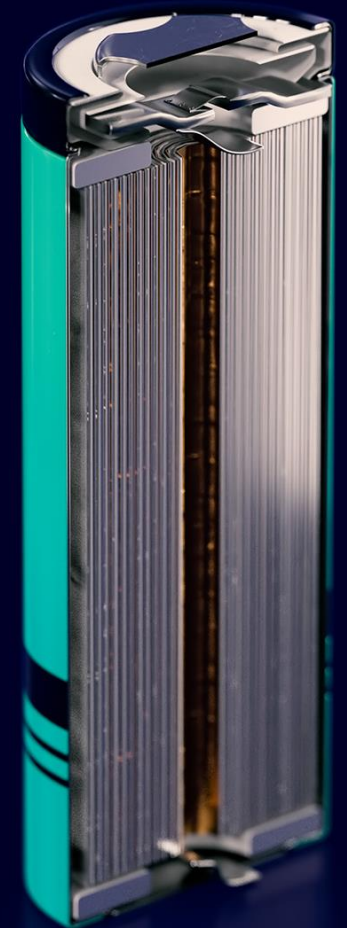
Complex hybrid production i.e., from process, and discrete industries

Increasing pressure to design battery production sustainably from the start incl. infrastructure i.e., building, power supply (SI)

Implementation of cross-regional projects w/ experienced machine builders mainly located in Asia

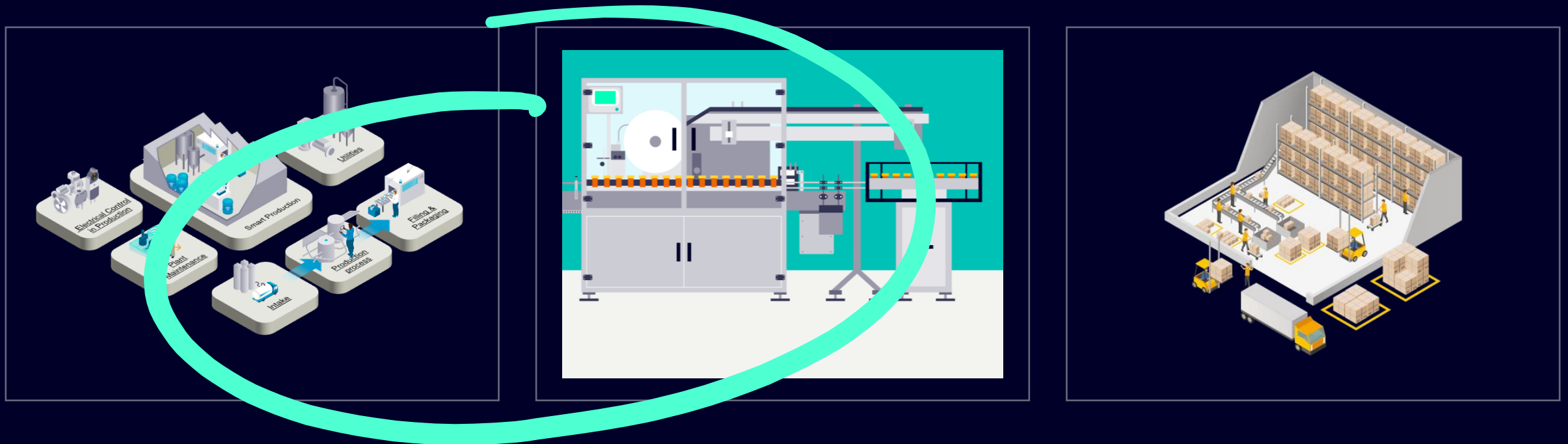
Rapid build-up of capacities to meet demand, often combined with lack of own battery know-how

New battery technologies are influencing battery production facilities and machine designs in near future



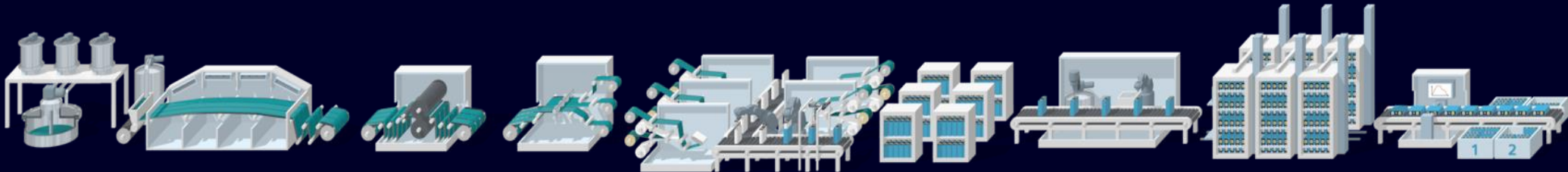


# Different industries require different core manufacturing processes

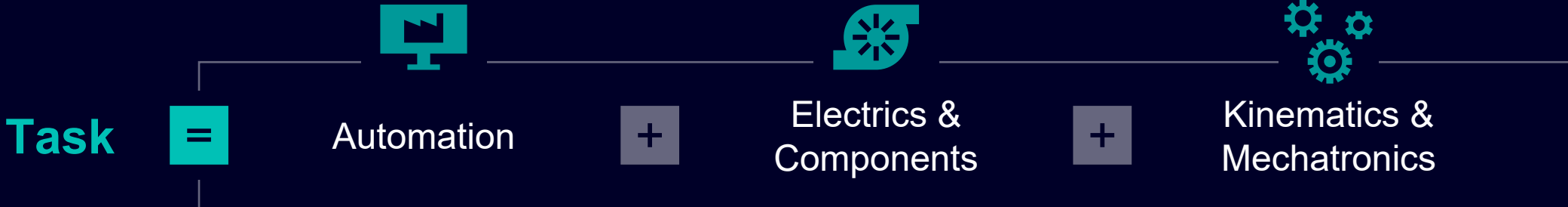


# There are different dimensions we need to consider on machine level to build up a comprehensive Digital Twin

**Plant Level**



**Machine Level**



**Process Level**

Mixing Dispersion	Coating & Drying	Calendaring	Drying	Slitting & Punching	Assembly <sup>1</sup>	Electrolyte Filling	Formation	Grading	Packaging	Module Assembly	Pack Assembly

<sup>1</sup> Stacking, Contacting, Housing, Sealing

# There are different dimensions we need to consider on machine level to build up a comprehensive Digital Twin


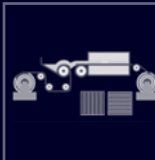




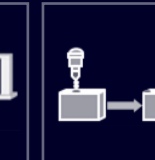





Plant Level



Machine Level

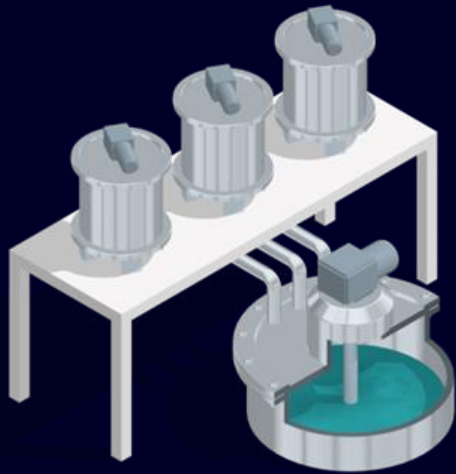


Process Level

Mixing Dispersion	Coating & Drying	Calendaring	Drying	Slitting & Punching	Assembly <sup>1</sup>	Electrolyte Filling	Formation	Grading	Packaging	Module Assembly	Pack Assembly
											

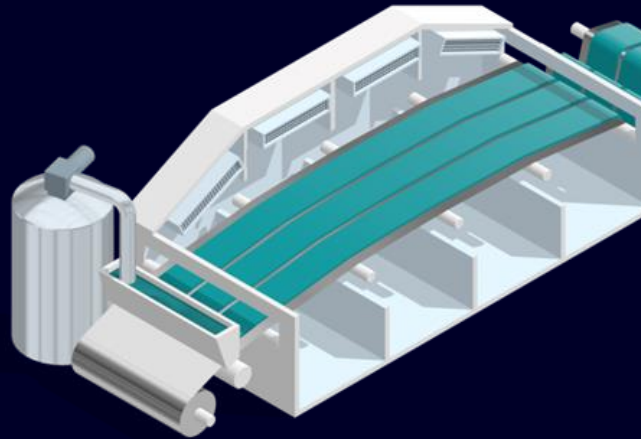
<sup>1</sup> Stacking, Contacting, Housing, Sealing

# CFD simulation using help you gain clear structural and process insight



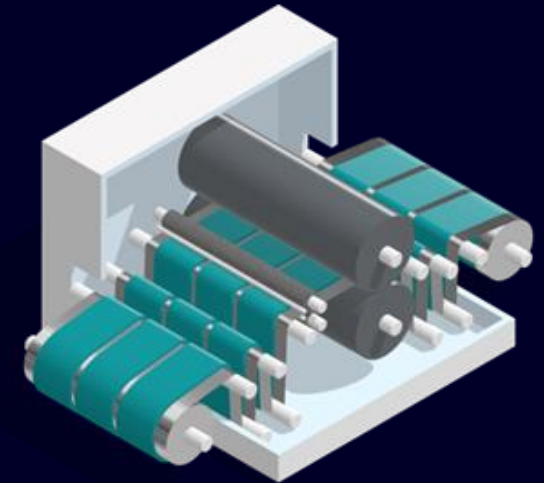
**Mixing**

“Impact of mixer design and time regarding the material quality”



**Coating**

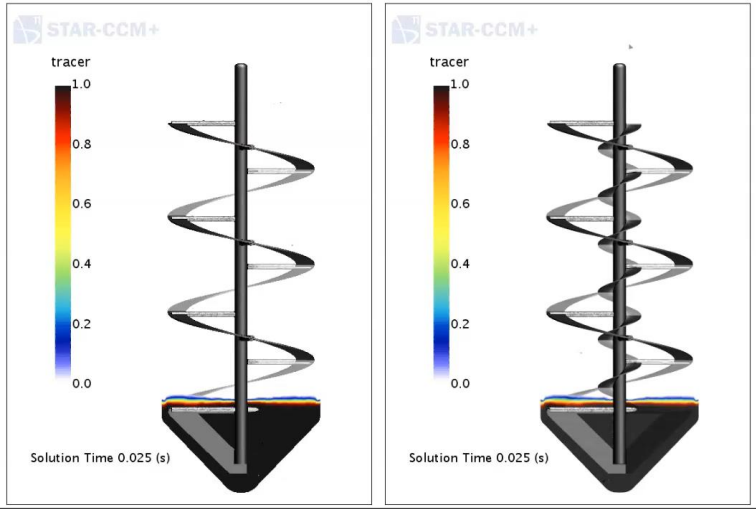
“Impact of speed and time for coating quality”



**Calendaring**

“Impact of calendaring speed to the foil structure”

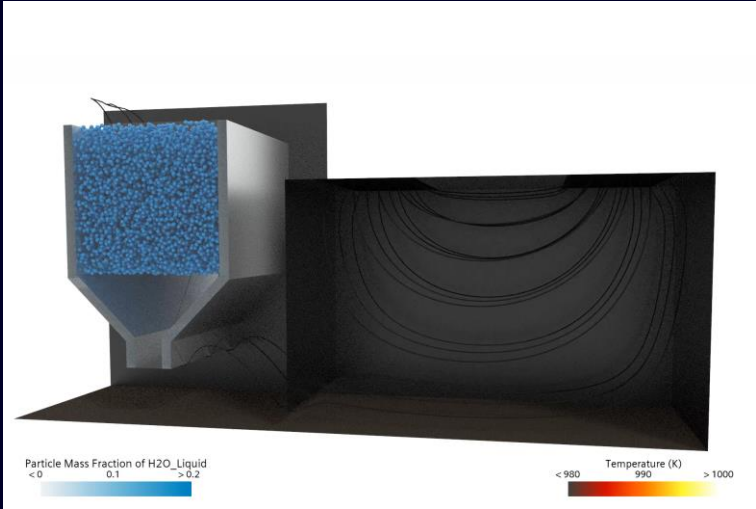
# CFD simulation with High-Fidelity Models can help you with various challenges



## Mixing



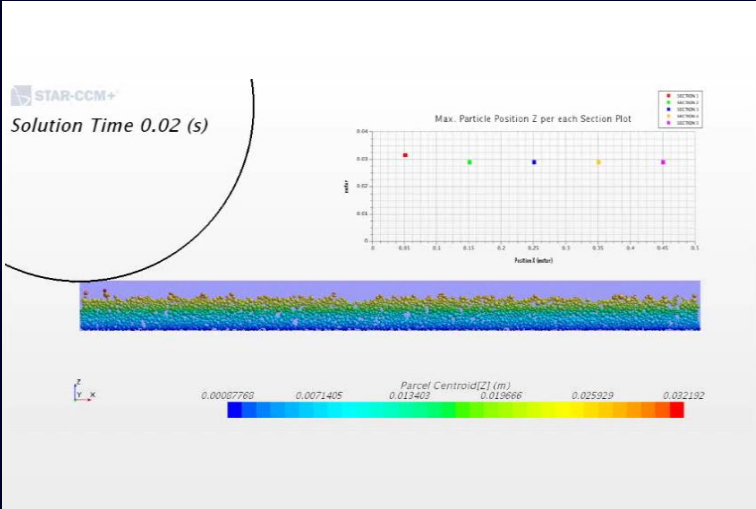
“Impact of mixer design and time regarding the material quality”



## Coating



“Impact of speed and time for coating quality”



## Calendaring



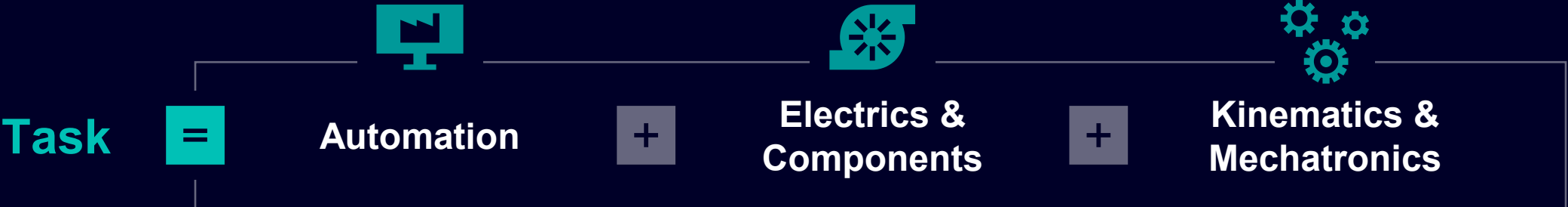
“Evaluate speed and web tension in comparison with the structure”

# How to build up a comprehensive Digital Twin

Plant Level

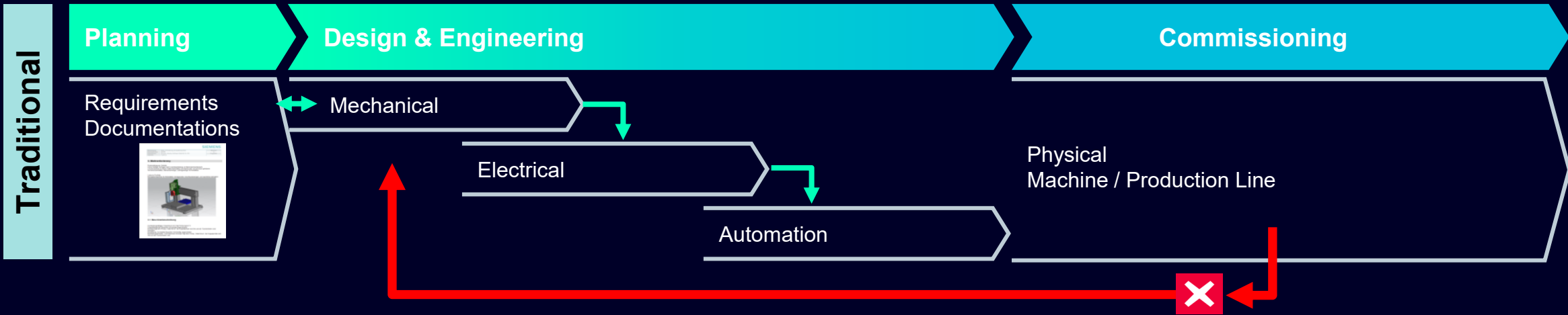


Machine Level

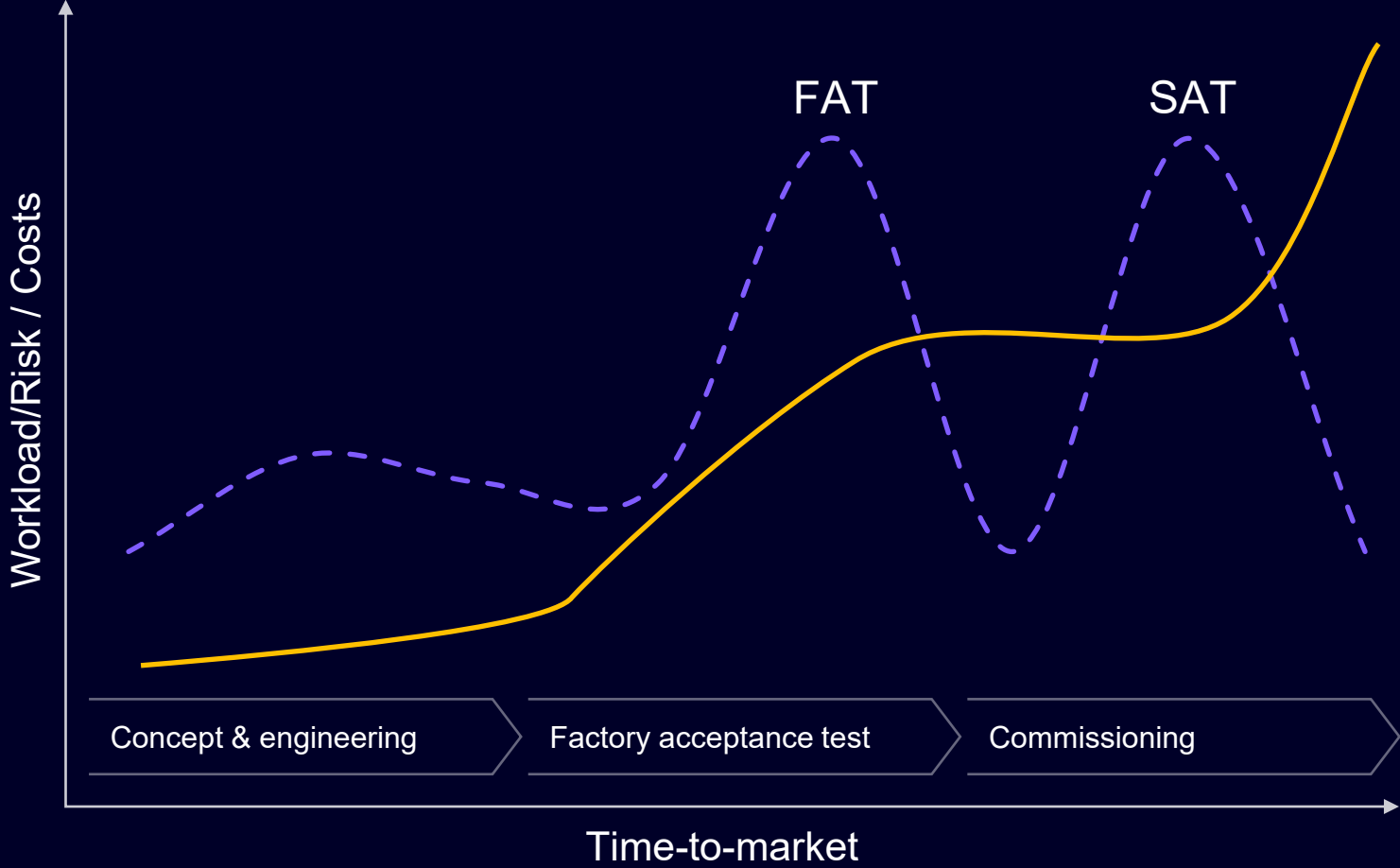


Process Level

Mixing Dispersion	Coating & Drying	Calendaring	Drying	Slitting & Punching	Assembly <sup>1</sup>	Electrolyte Filling	Formation	Grading	Packaging	Module Assembly	Pack Assembly

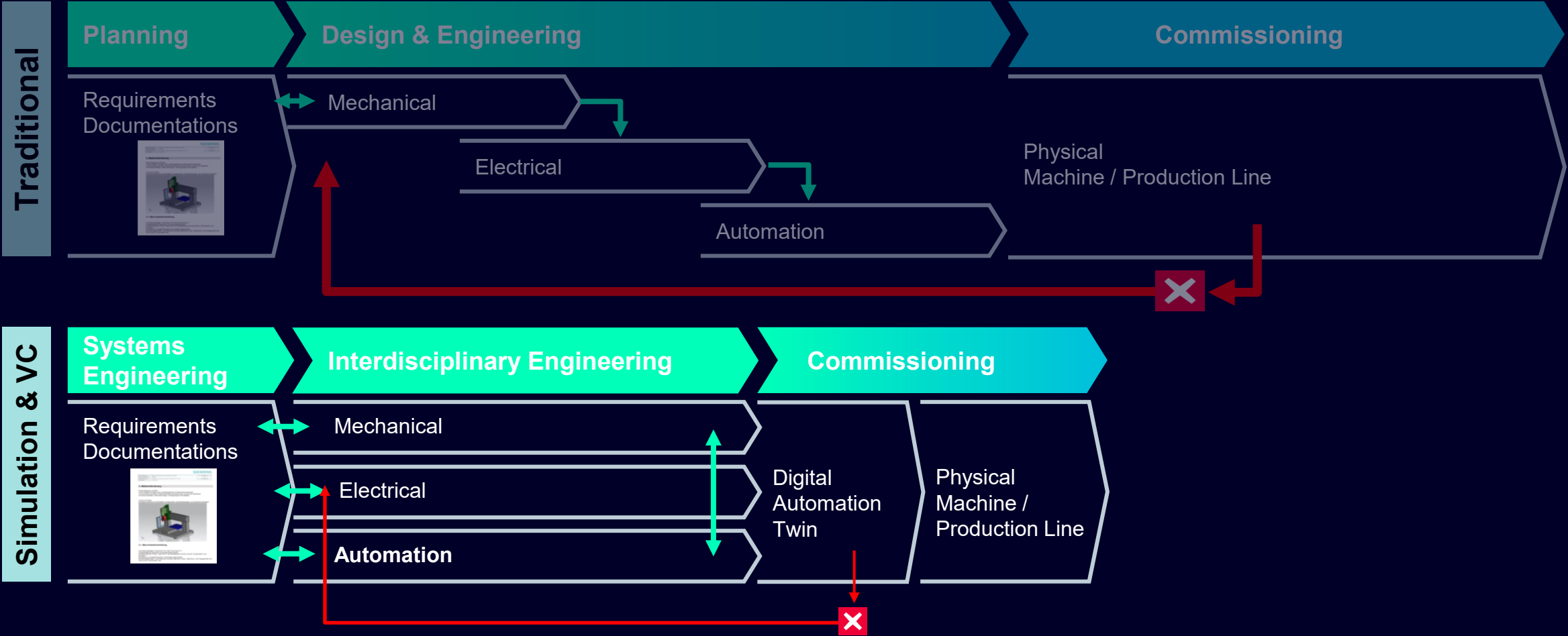


# Physical Commissioning

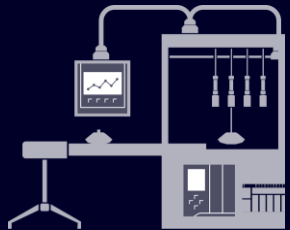


-- Without simulation      — Rule of ten (errors) = costs

# Virtual Commissioning with Simulation



# Basis for different simulation scenarios



=

**Automation model**

+

**Electrical model  
and behavior model**

+

**Any Simulation Model**

**Logic of the PLC  
program and  
visualization**

**Component e.g. drives  
and periphery behavior**

**e.g. Physical;  
Mechanical; Process; ...**

# Mapping between Real and Virtual World

Real

Automation Simulation Twin

HMI

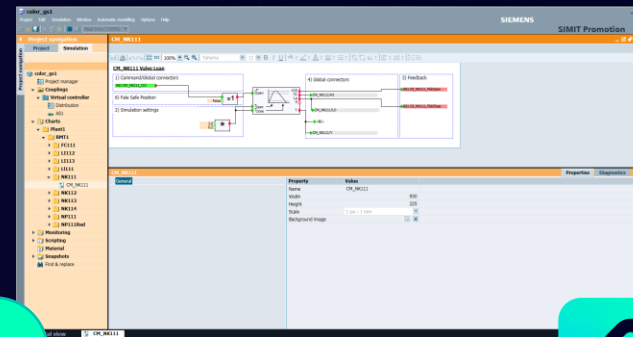


Automation System / PLC



Software-in-the-loop  
Hardware-in-the-loop

Remote IO



Simulator Engine / Orchestrator

Actuators / Sensors



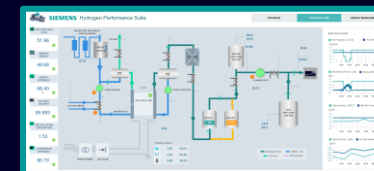
Process / Machine



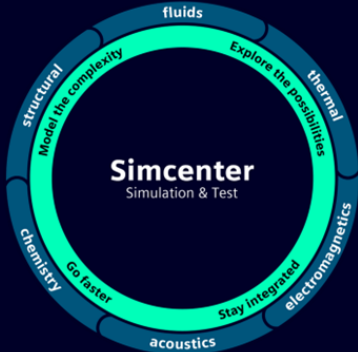
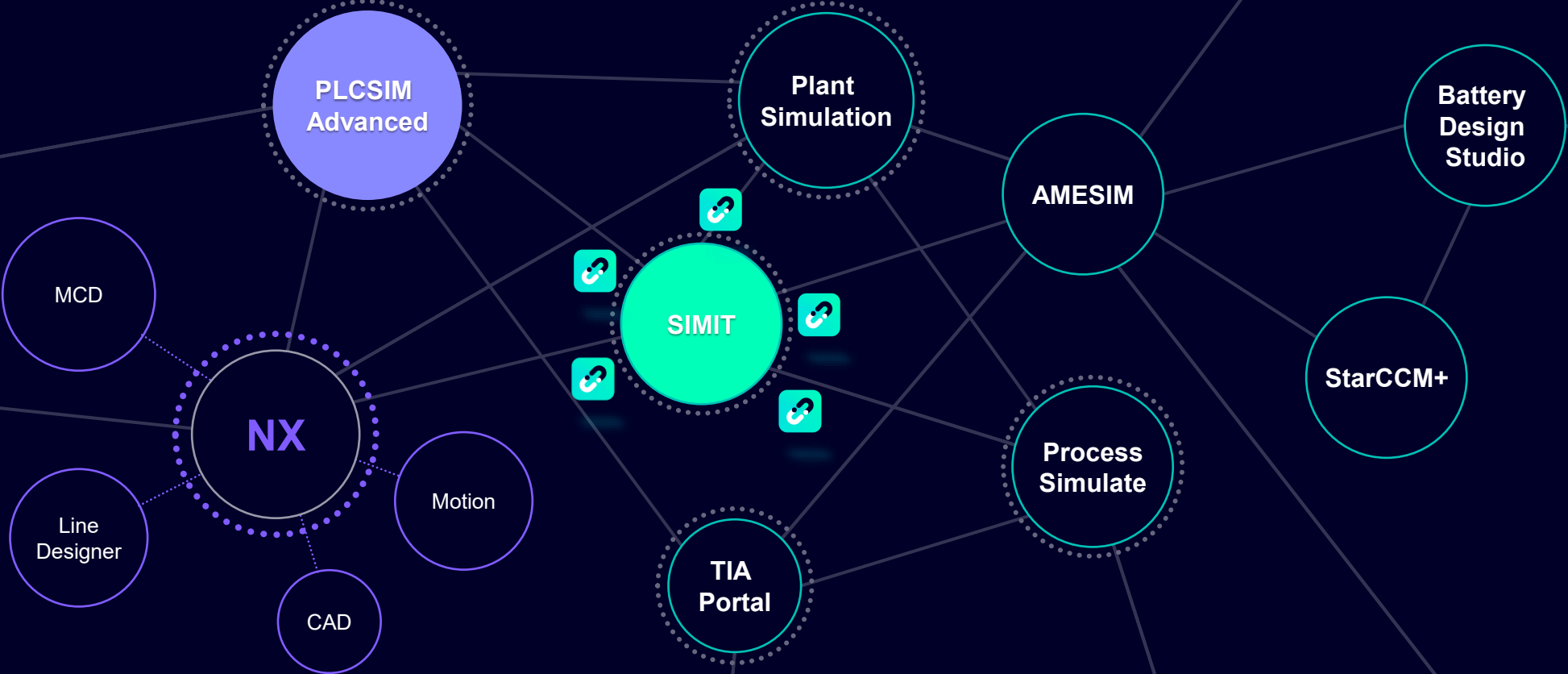
Simulation Libraries



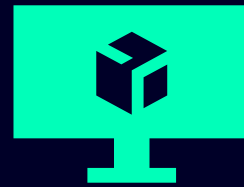
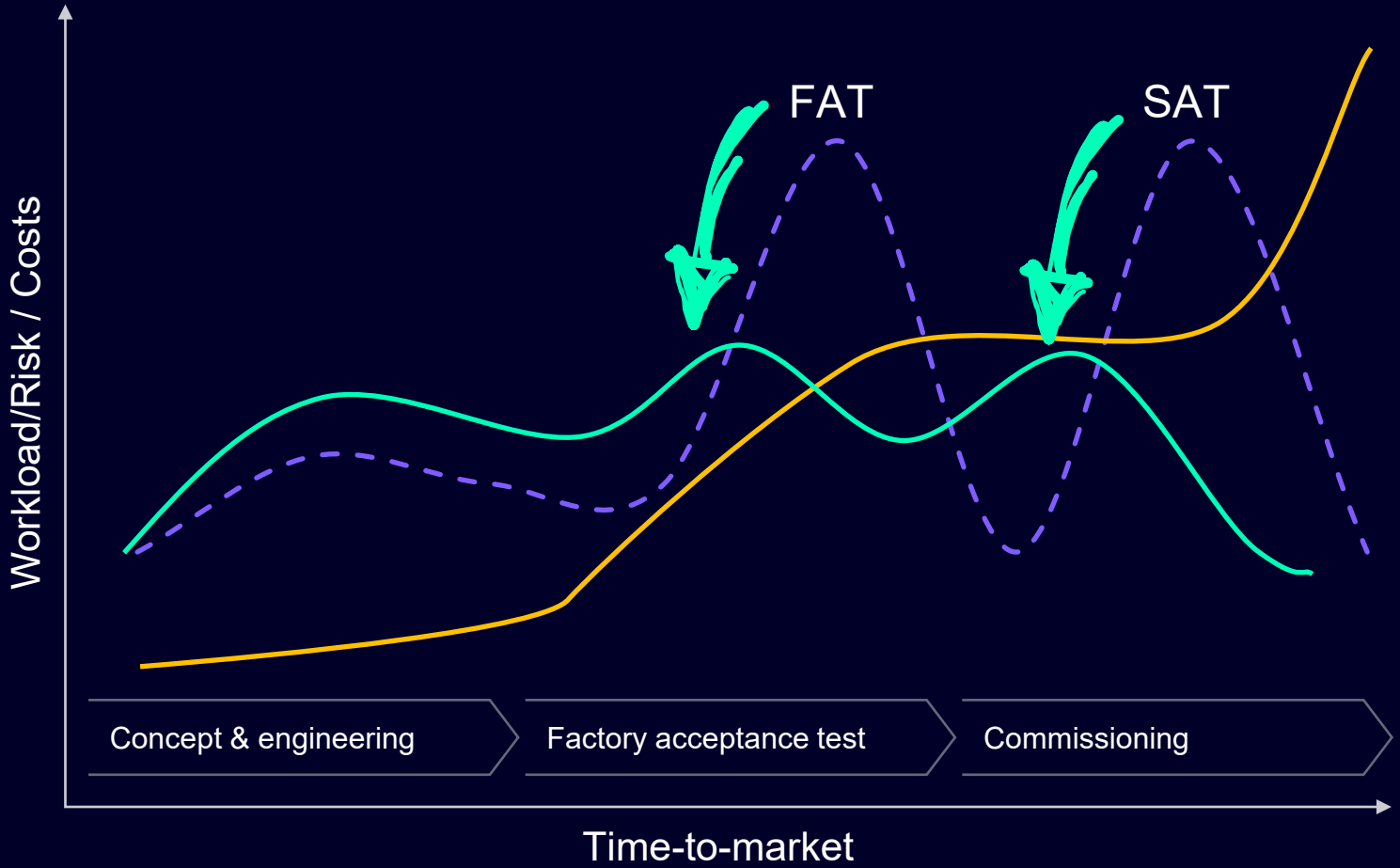
High-Fidelity Models



# The simulation landscape covers a broad range of software for various use cases, allowing to start small and scale-up



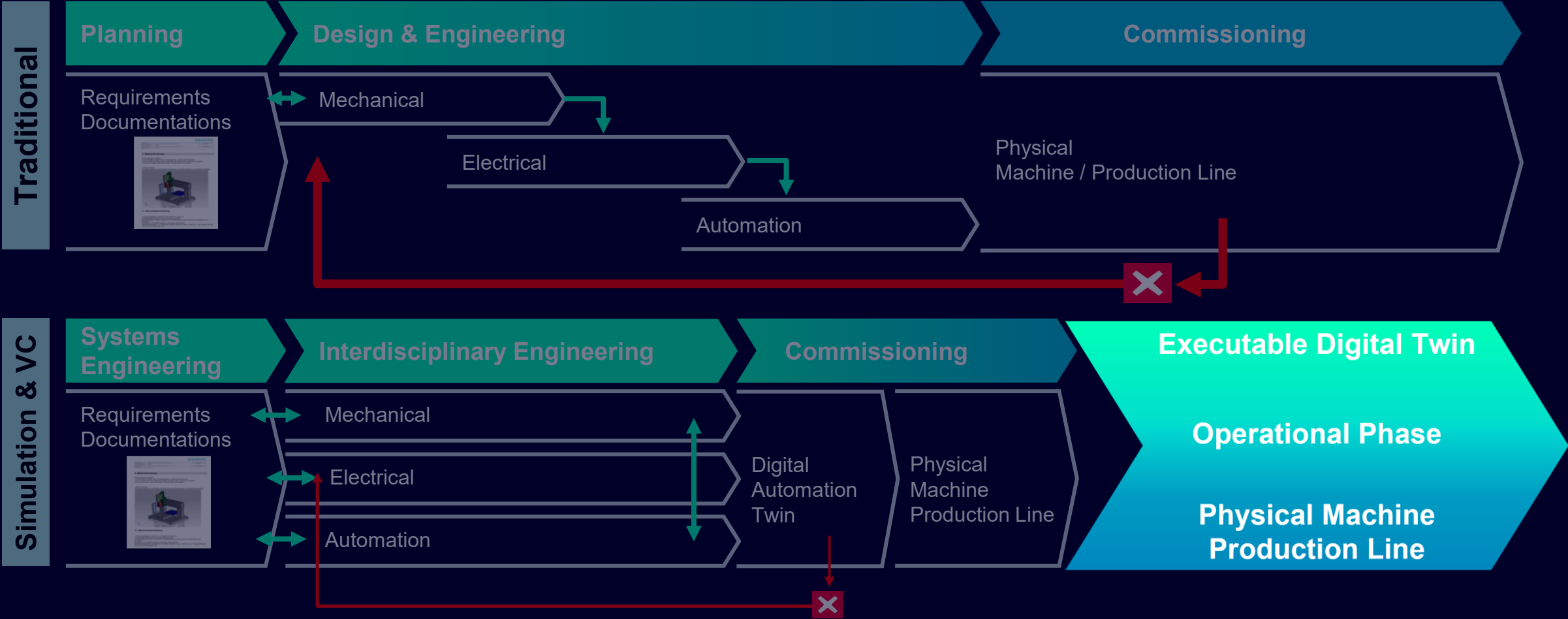
# Simulation @ Virtual Commissioning



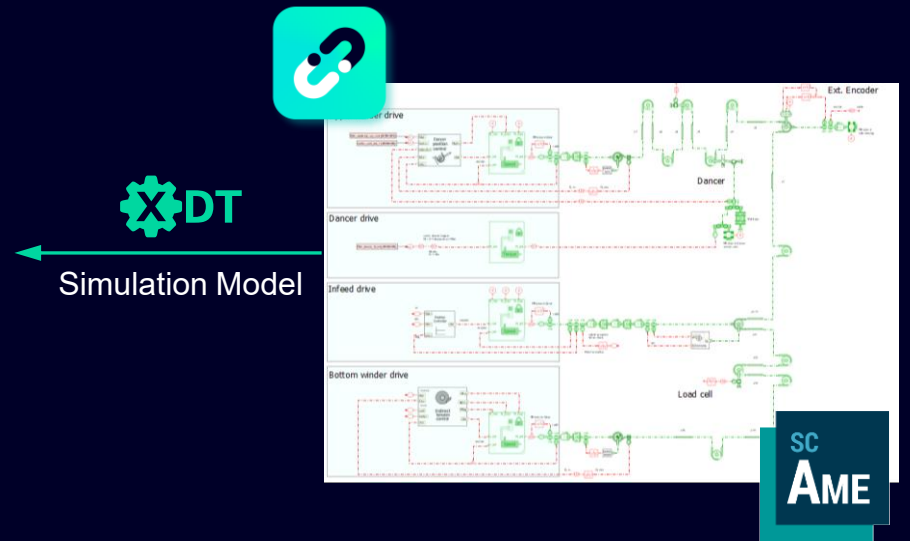
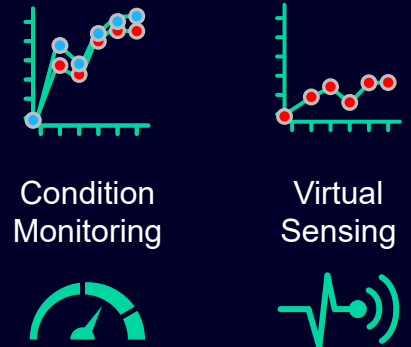
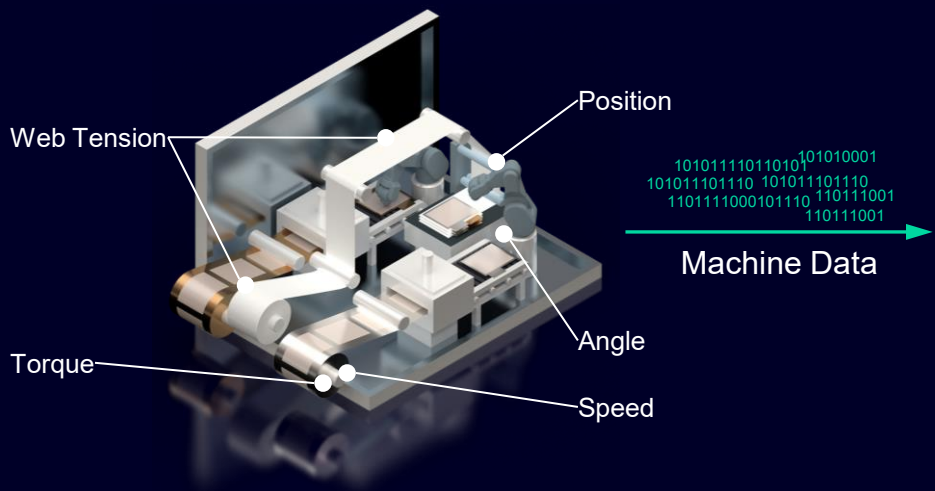
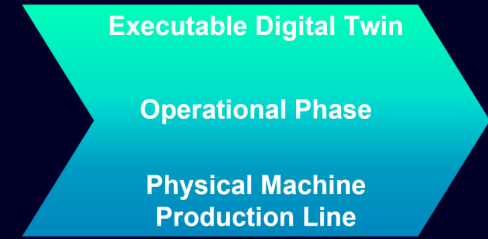
**Simulation**

-- Without simulation      — Rule of ten (errors) = costs      — With simulation

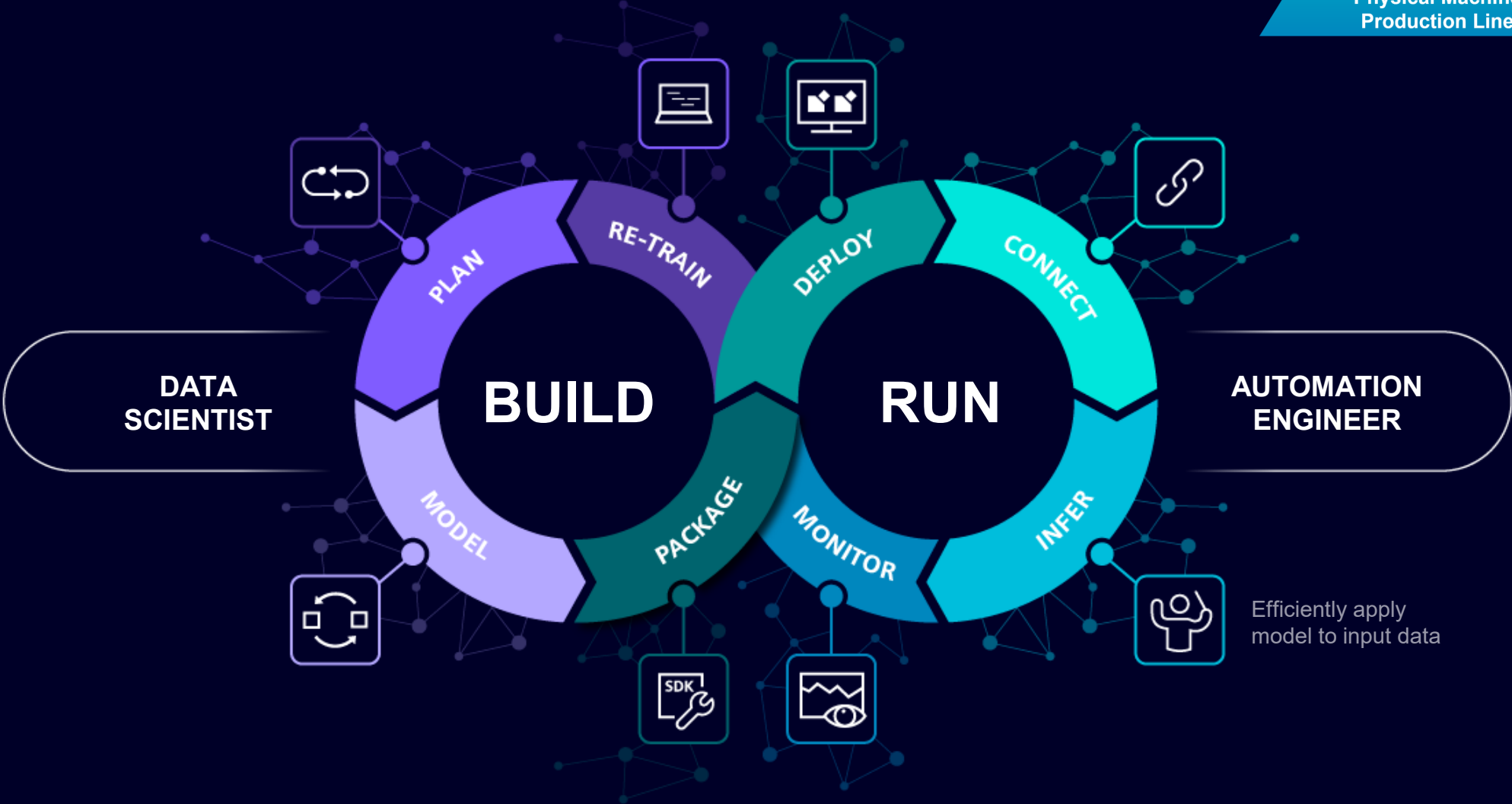
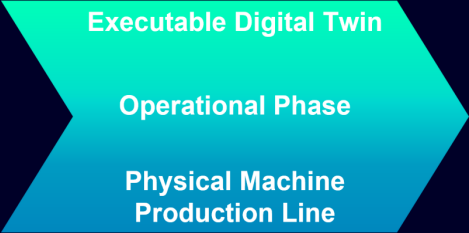
# Simulation for OTS / Live Twin for Process Optimization



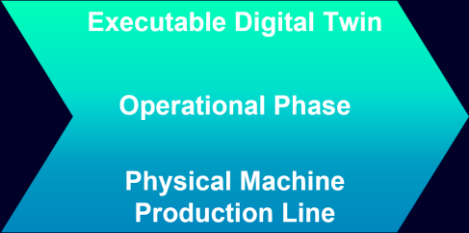
# Model-based Monitoring of Production Machines in Real Time Using a Simulation Model to observe and evaluate Machine Status



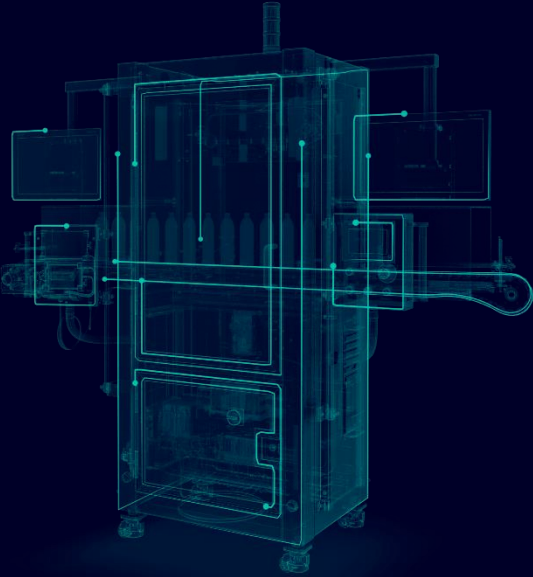
# Industrial AI: building and operating AI models at scale



# Siemens Executable Digital Twin is an end-to-end solution



## Virtual World

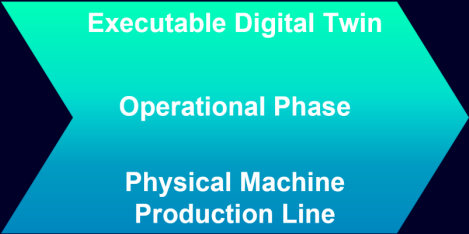


## Real World



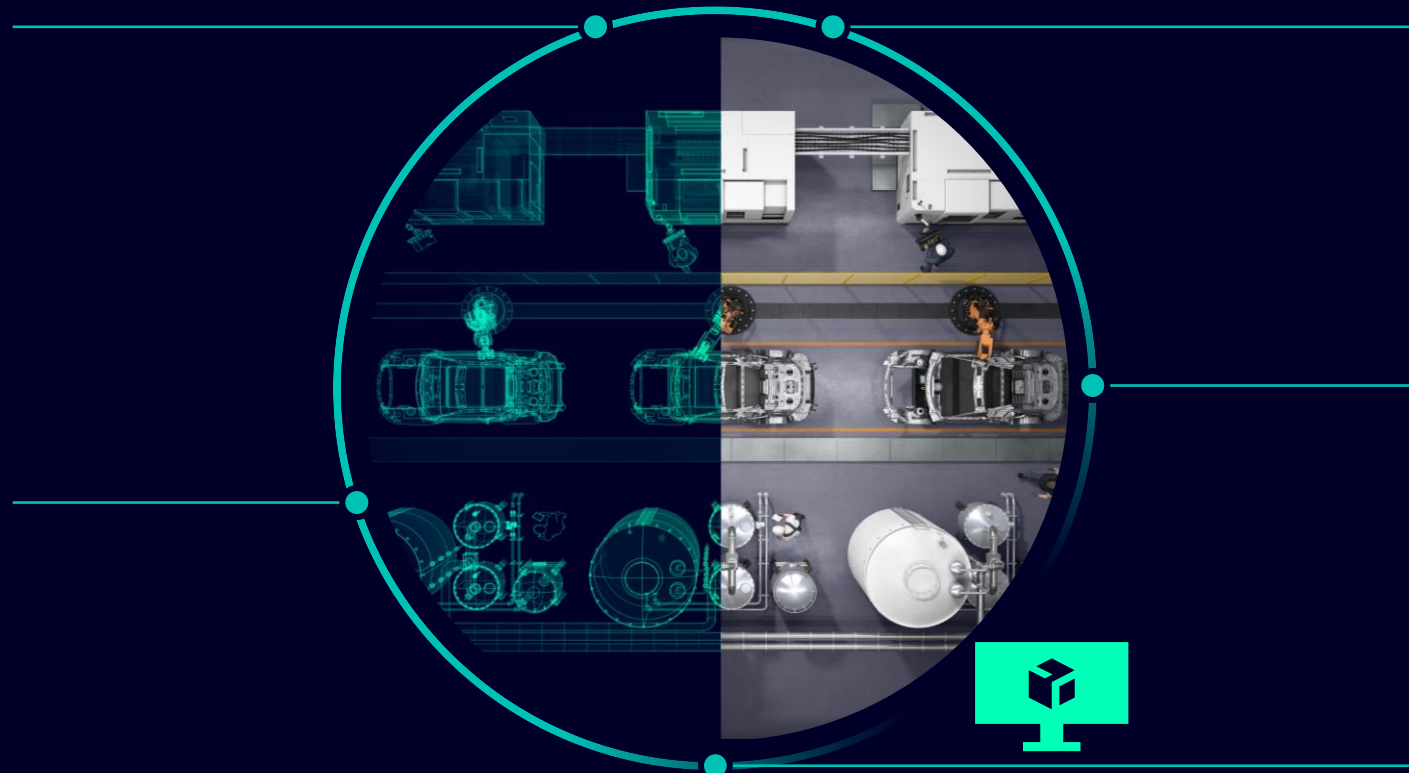
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# Accelerate innovation, improve efficiency and ensure quality with the Digital Twin for Production



**MARKETING & STAKEHOLDER ENGAGEMENT**

**CONCEPT DESIGN & ENGINEERING**



**OPERATIONS INSIGHTS & OPTIMIZATION**

**OPERATIONS TRAINING**

**VIRTUAL COMMISSIONING & ACCEPTANCE TESTING**



**Simulation**

Model extension and continuous re-use

# Our customers and partners have shared the following results



# Thank you for your attention!

Simulation  
Virtual Commissioning  
Operator Training System

**SIMIT**

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[www.siemens.com/simulation](http://www.siemens.com/simulation)



**Aart Tromp**

**Siemens NL**

**Sales Architect Simulaties**

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