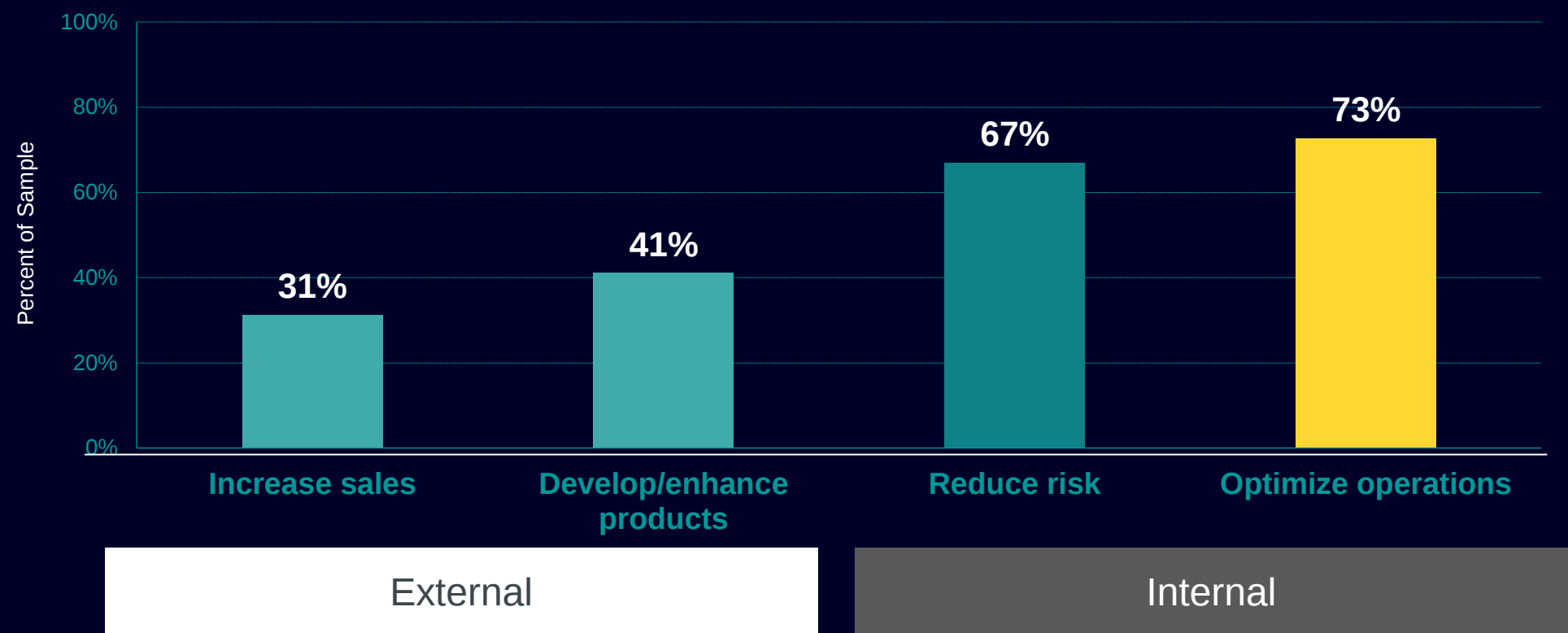




SEV: Business Intelligence and Internet of Machines

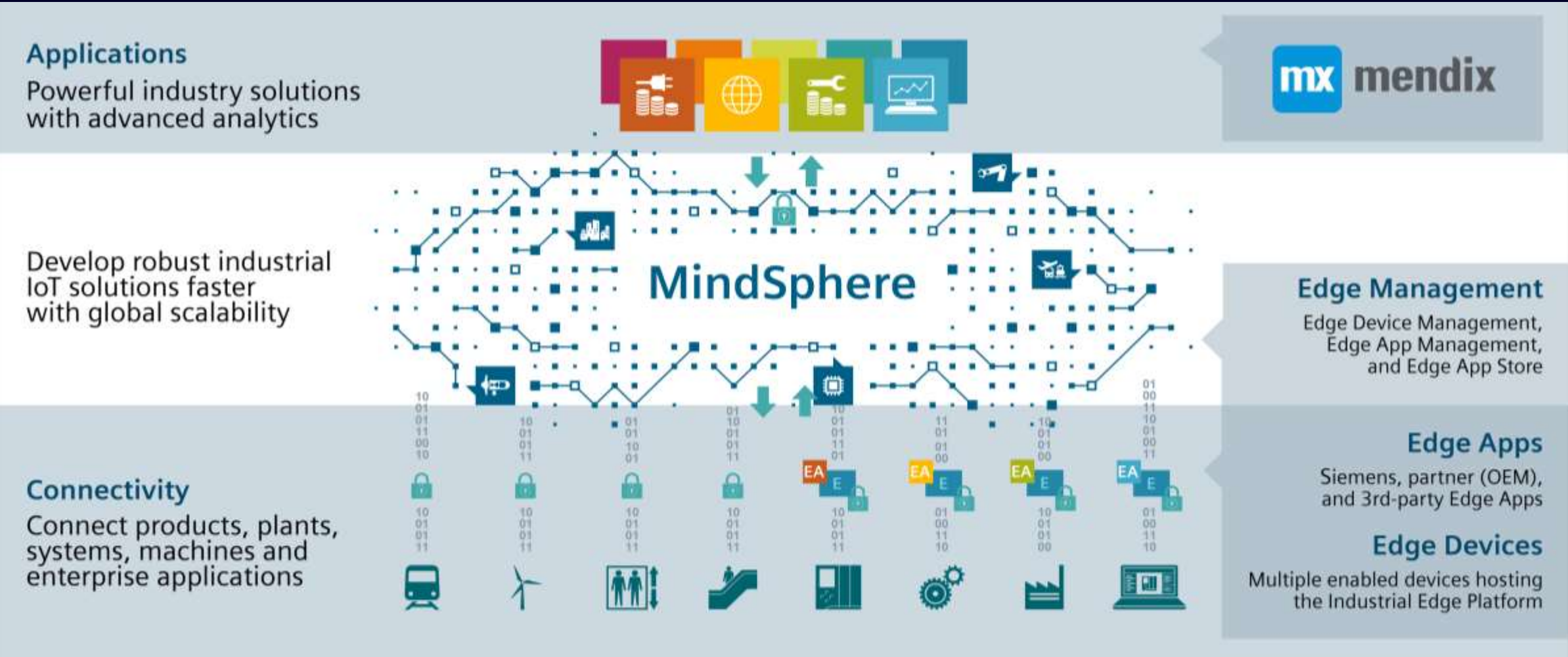
Optimize operations with Industrial IoT in 3 steps

Why are industrial enterprises deploying the IoT?

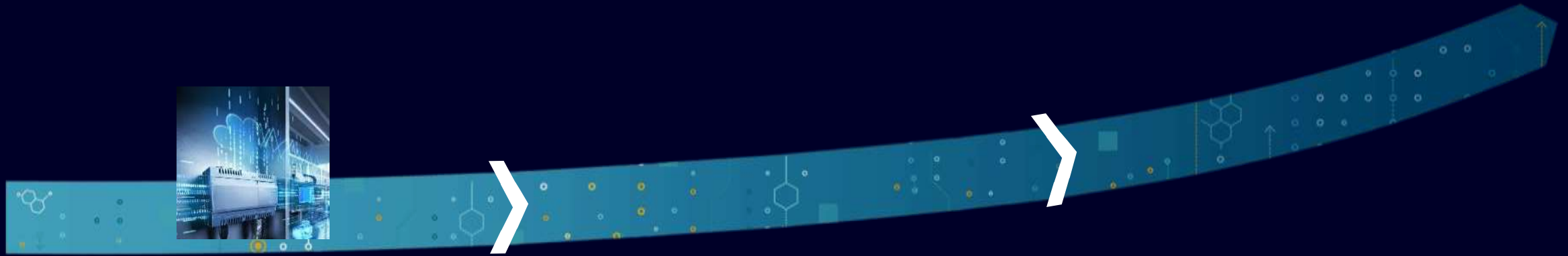


Source: 451 Research VoTE: Internet of Things, Organizational Dynamics 2017

MindSphere is the leading industrial IoT as a service solution



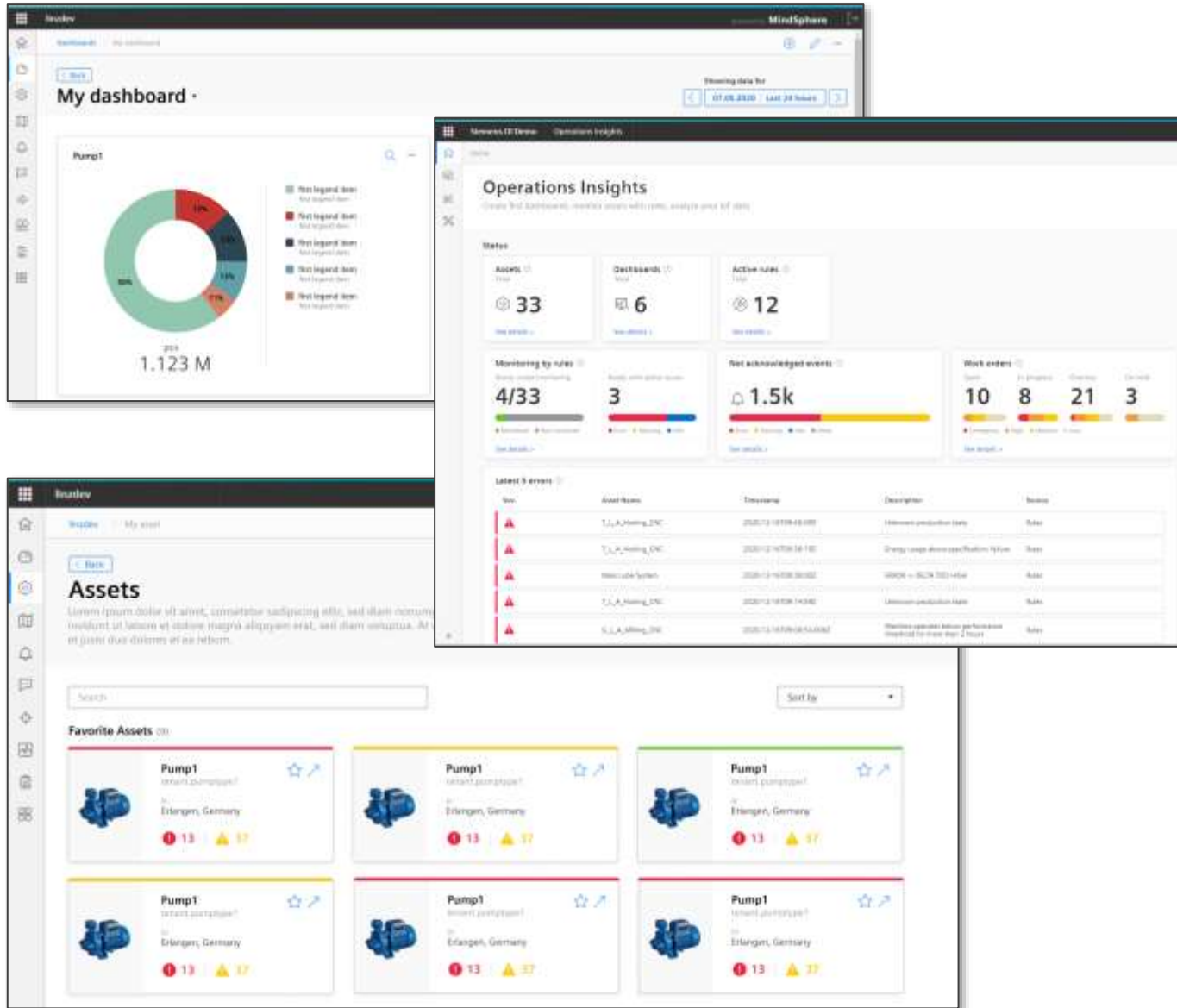
Realizing Business Value with MindSphere® industrial IoT



Explore Data

Start your MindSphere® journey, extend the experience by connecting your assets to the cloud, explore your data and develop your IoT strategy.

Data exploration



Increase productivity for any machine, line or plant

- Mashup an **overview** of your machines or production performance based on **widget-based dashboarding**
- Enable **cross linking** of data (KPIs)
- Easy identification of **asset health** via color coded status information
- Enable **preventive maintenance** with easy to configure **rules** to trigger events and notifications keeping users informed about asset condition
- Ad-hoc **data analytics and comparison** functions to spot anomalies easily with flexible filters
- **Predict** the values of production parameters using AI

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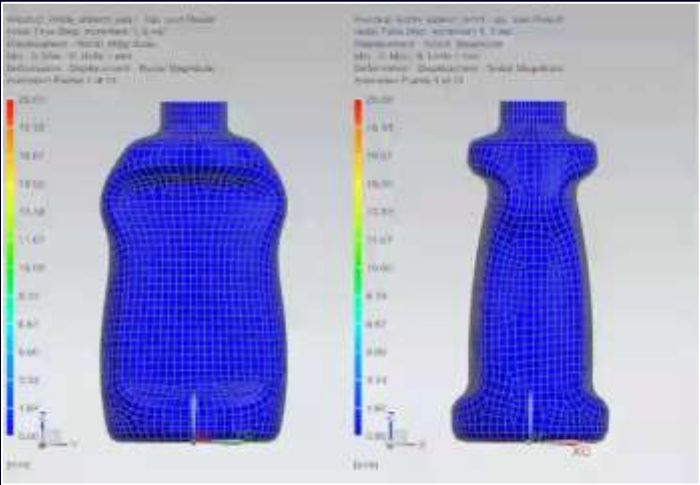


Discover Insights

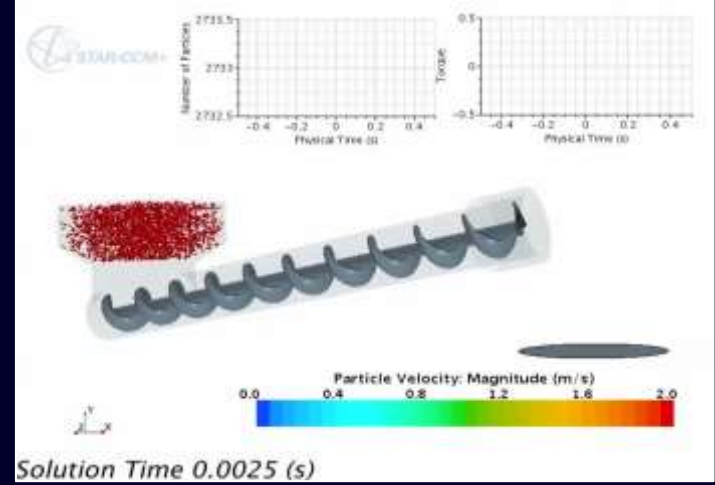
Use real production data in a digital model to replay a problem and understand the root cause. Once the problem is understood, changes can be implemented to the production with confidence.

Digital twin / simulation

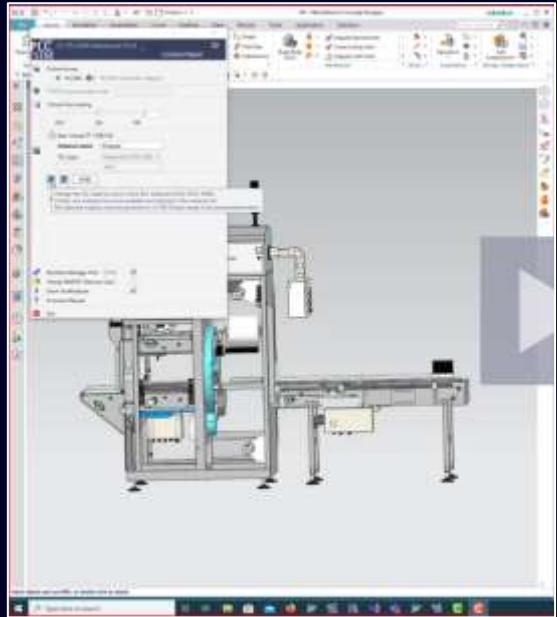
Mechanical System Simulation



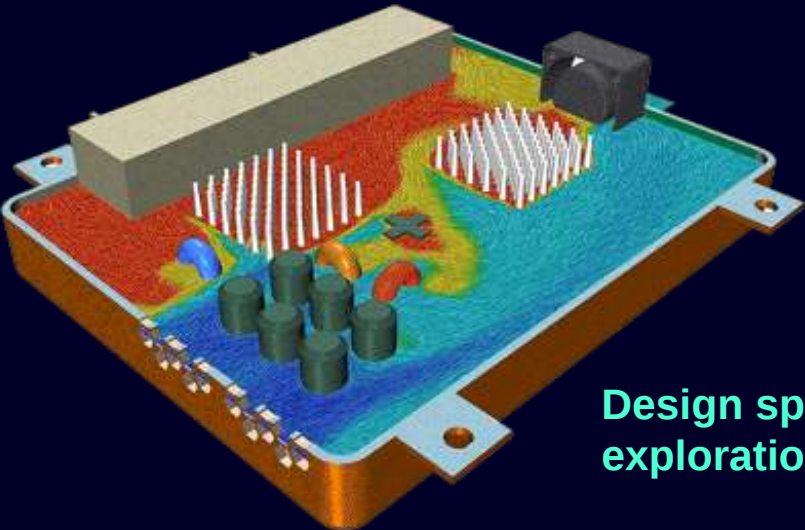
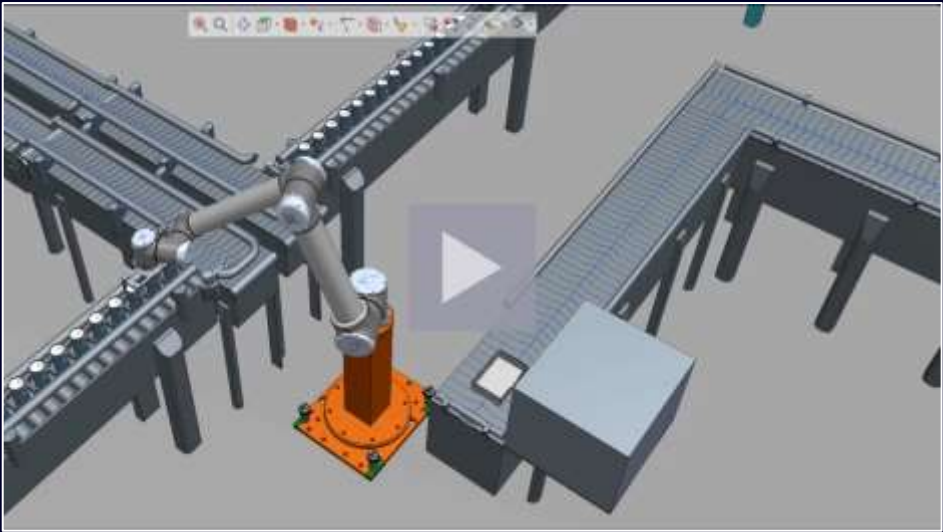
Computational fluid dynamics (CFD)



Machine Simulation



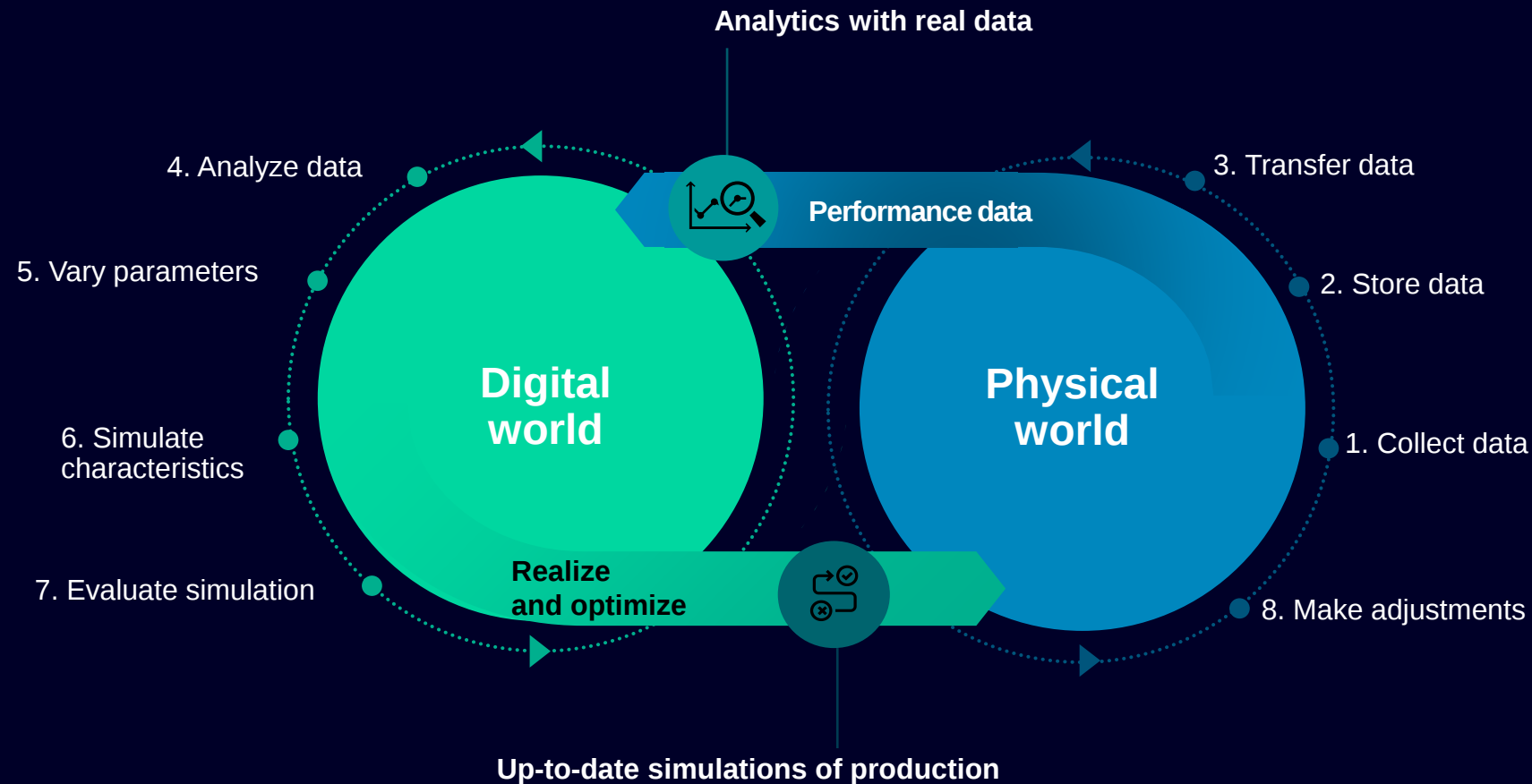
Plant Simulation



Design space exploration

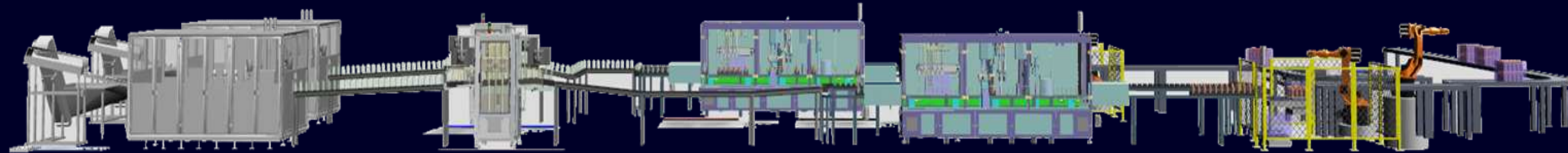
Closing the loop with the digital twin is the solution: Making digital thread a reality

Push *real* production performance data into your simulations



Background – Fresh Company Orange Soda Bottling Plant

Manufacturing Processes



1 Pet Blower

Creates blow-molded plastic bottles in this work station

2 Leak Testing

Tests for leakages in the bottles by injecting compressed air and checking the test pressure in the work piece

3 Filling

Injects the beverage into the plastic bottles

4 Capping

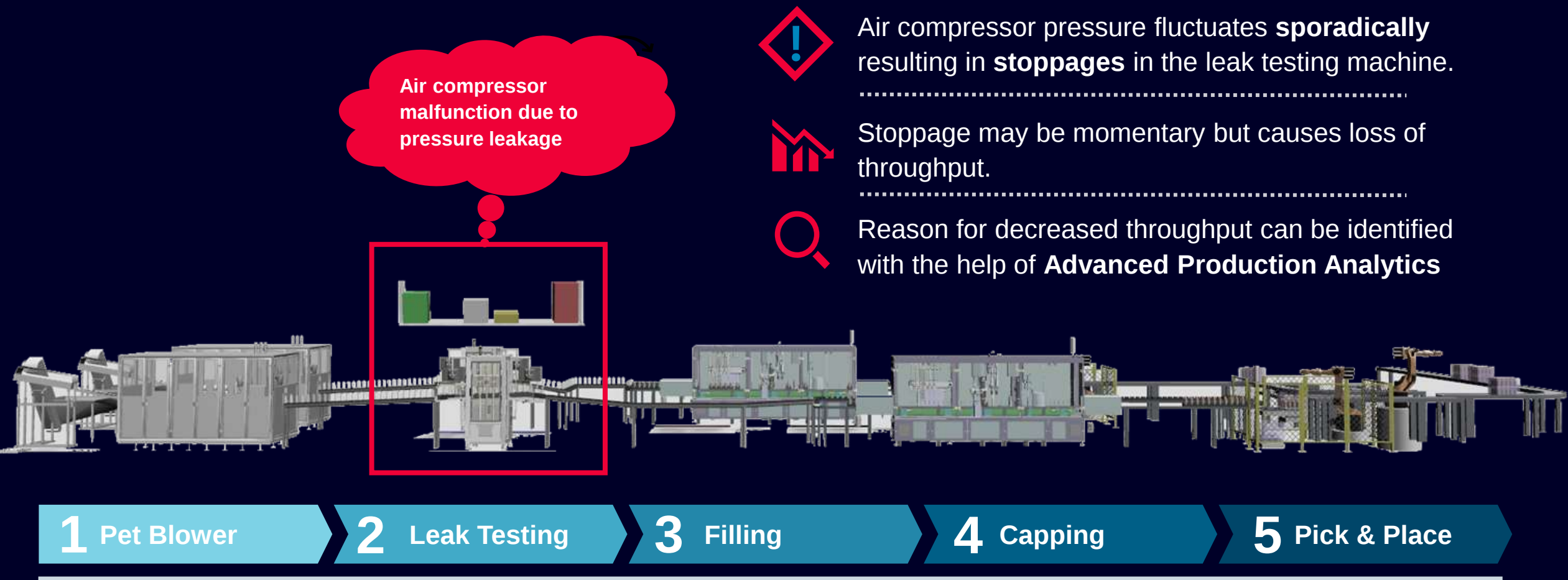
Putting the caps on the filled beverage bottles

5 Pick & Place

Picks filled bottles and puts them in crates, which would be subsequently stacked and sent for dispatch

How Advanced Production Analytics & Optimization works

Production replay, bottleneck analysis and what-if analysis on a bottling line



Advanced Production Analytics & Optimization

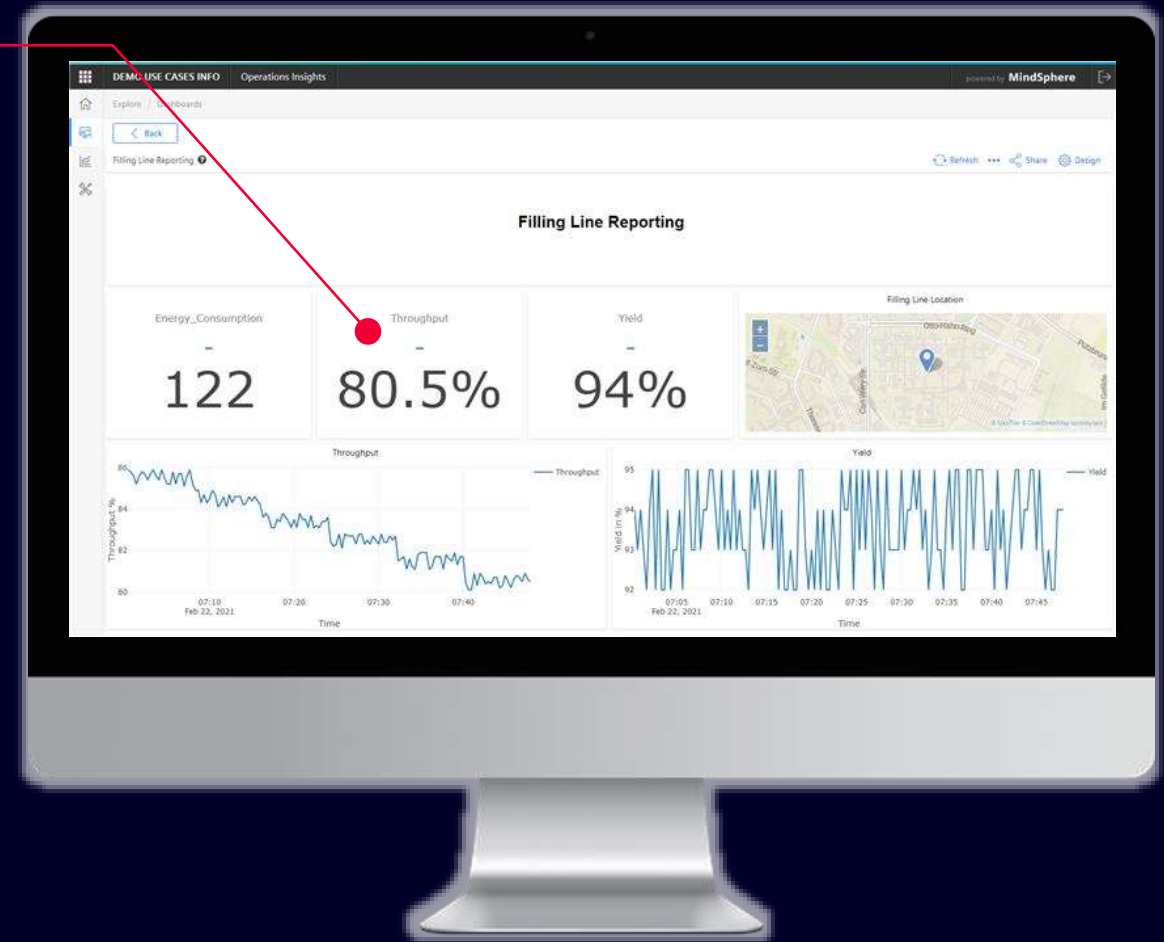
Plant manager: receives notification daily throughput is declining



Declining throughput

The plant manager is notified that a filling line is **running below optimal level** – his KPI dashboard shows a low utilization rate with a declining daily throughput.

A detailed analysis is required to understand which step in the bottling process is responsible for this decline. The plant manager tasks his team to **perform a thorough analysis**.



Advanced Production Analytics & Optimization

Industrial engineer: performs production replay



Underperforming machine identified



The industrial engineer executes a **production replay** during the period of decreased throughput by loading **operational data** from MindSphere into the simulation model in **Tecnomatix Plant Simulation**.

The **digital twin production replay** confirms decreased throughput.



Production replay

TECNOMATIX



Advanced Production Analytics & Optimization

Industrial engineer: executes bottleneck analysis



Locating the bottleneck



A **bottleneck analysis** is executed with the data from the production replay during the period in question. It indicates the **leak testing machine** is experiencing **high wait times** and it is identified as **the bottleneck** for all other machines downstream.

High wait times at the leak testing machines is a problem for which the root cause needs to be identified further.



Bottleneck analysis

TECNOMATIX

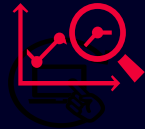


Advanced Production Analytics & Optimization

Maintenance engineer: identifies root cause and resolves issue



Analyzing IoT performance data



The maintenance team is contacted to further investigate the leak testing machine.

The maintenance engineer analyzes the **operational KPI's** of the leak testing machine using the **IoT data provided in MindSphere**.

The leak testing machine is experiencing sporadic pressure drops in the gas chamber, thus affecting the performance of the leak testing machine. This indicates that the air compressor needs to be replaced.



Advanced Production Analytics & Optimization

Industrial engineer: performs what-if analyses



Validating the solution

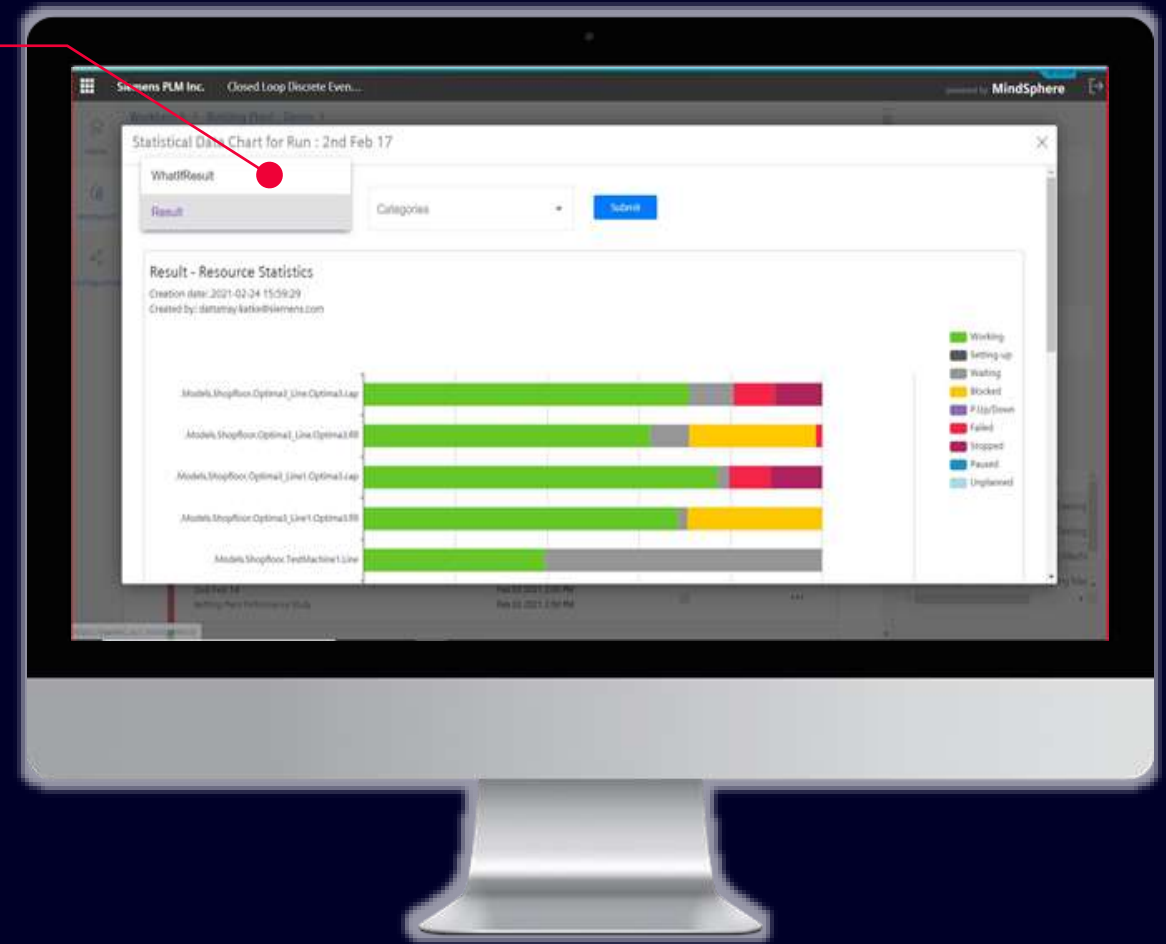
As part of continuous improvement, the **digital twin** is employed to perform a series of **what-if analyses**.

Alternative combinations of operational data are simulated to verify the set of **optimal operational characteristics** that restore production throughput to expected levels.



What-if analysis

TECNOMATIX



Advanced Production Analytics & Optimization

Plant manager: confirms issue is resolved and schedules future production replays

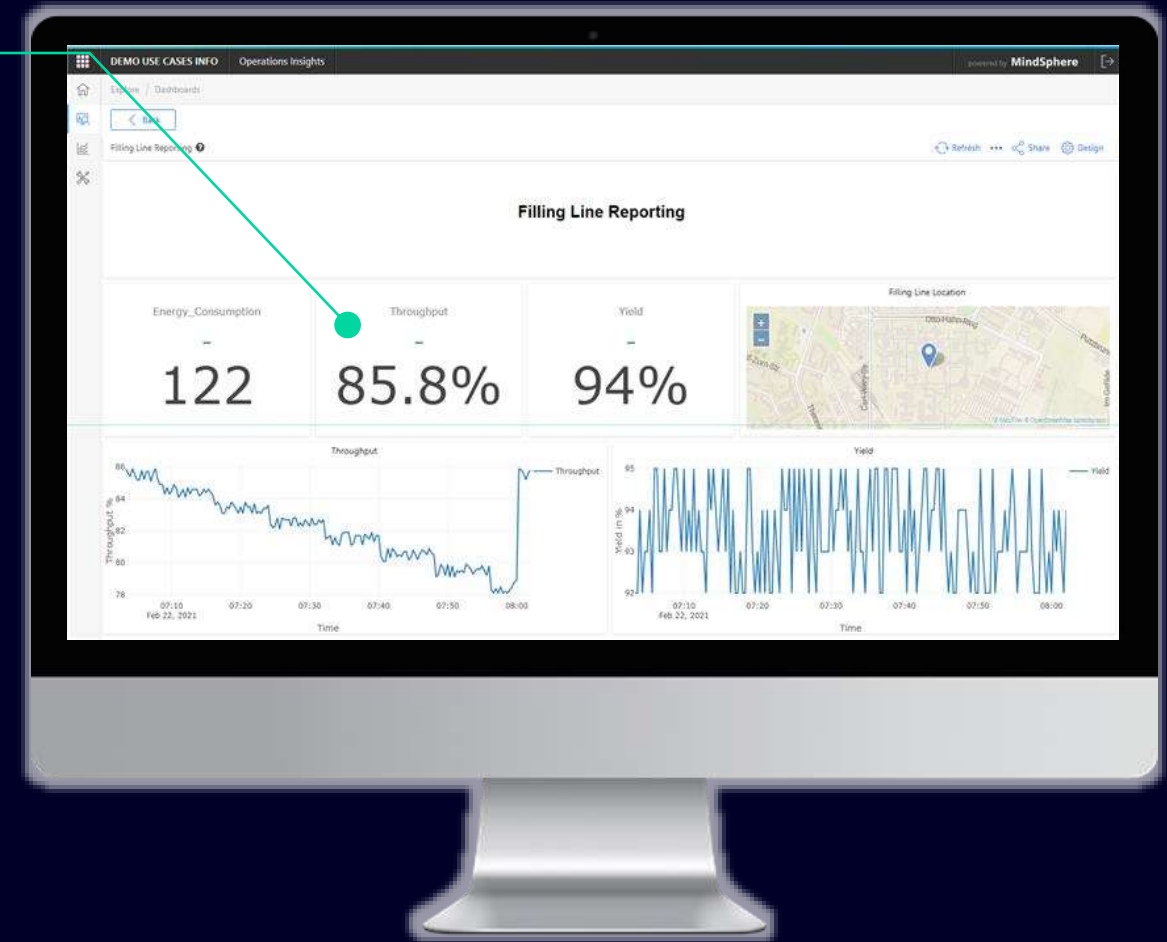


Confirming resolution



The plant manager confirms the bottle filling line **throughput & utilization** has returned to the **optimal level**.

For continuous monitoring of the throughput, periodic production replays are scheduled.



Advanced Production Analytics & Optimization

Use cases



ENERGY OPTIMIZATION

Use real data to

- analyze and reduce energy consumption
- lower energy costs to achieve sustainability goals



THROUGHPUT OPTIMIZATION

Use real data with your simulation model to

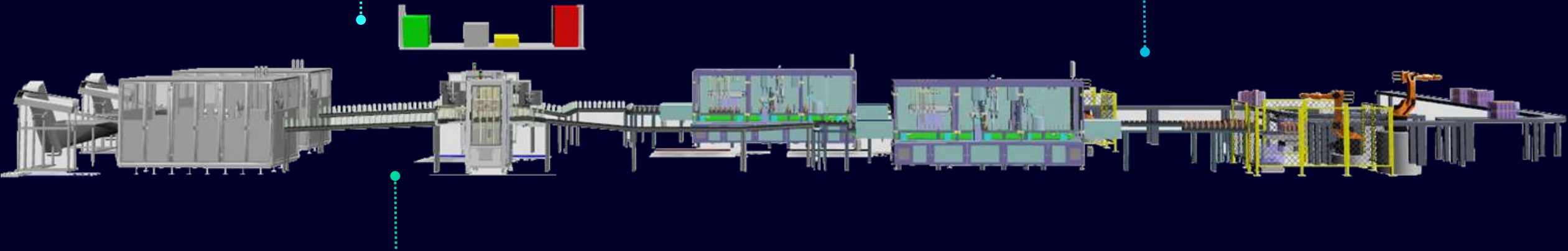
- analyze the impact of different production variations
- support dynamic analysis of performance parameters



LEAD TIME OPTIMIZATION

Use real data with your simulation model to

- accurately estimate production lead times
- avoid delays and eliminate wait times in your production flow



Increase output with simulated what-if scenarios based on real data

Advanced Production Analytics & Optimization



Engineering Company consults US car manufacturer

Machining transmission parts using 5 parallel CNC machines and 2 robots for placement



Industry challenges

- Identification of production blocks
- Output less than expected
- Heterogenic automation equipment
- No simulation model of production available

Customer benefits

- Calibrated model for production
- Reuse simulation model for future optimization jobs
- Sell insights to end customers

End customer benefits

- Optimized output



Solution: Advanced Production Analytics & Optimization

- Virtually remodel the existing production line with Tecnomatix
- Collect production data from shop floor using hardware agnostic connectivity layer
- Feed real data into simulation model with MindSphere connector
- Avoid production blocks on CNC lines running what-if scenarios based on real data and optimize output

Result

Several hundred more robot operations able to be completed

Improved revenue generation

~\$1 Million USD
annually

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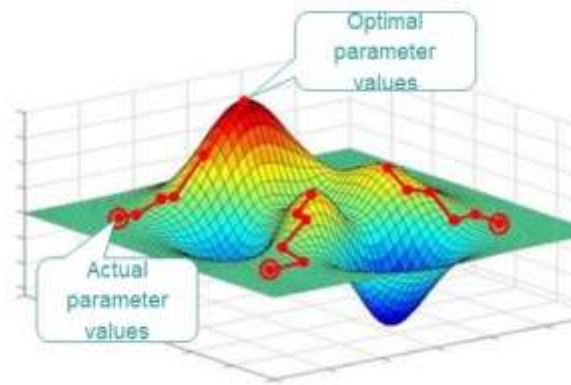


Transform Business

AI-supported machine operator
The Smart Machine Assistant solution provides machine operators AI guidance on how to choose machine settings for optimal production outcome.

Smart Machine Assistant (SMA)

Self-learning application for determining the optimal settings of an industrial machine



- MindSphere collects all relevant data continuously
- SMA uses machine learning techniques to train a model (= neural network): Keras, TensorFlow, SENN (Siemens inhouse)
- The model takes boundary conditions and machine settings as an input and provides a numerical value (= “result”) as an output
- SMA “searches” (e.g., via iterative optimization algorithms) alternative parameters sets (for a given and fixed set of boundary conditions) that yield a better “result”
- The optimized parameters are stored in MindSphere
- A GUI recommends the optimized parameters to the machine operator

Prevention of paper web breaks in a paper mill

Smart Machine Assistant



Industry challenges

- Paper web breaks happen average 4 times a day
- Paper web breaks are responsible for 2-7% total production loss
- Most paper web breaks happen randomly (unknown reason)

MindSphere IoT solution

- Combination of standardized app and customized services
- Machine learning is identifying unknown relationships and root causes of errors to reduce number of web breaks
- Concrete proposals for adjustment of production parameters during operation

Benefits

- Less unplanned downtime
- Higher production output
- Increase of machine availability through continuous analysis of production and best possible setting for operation

25%

Reduction of web breaks

2%

Higher output

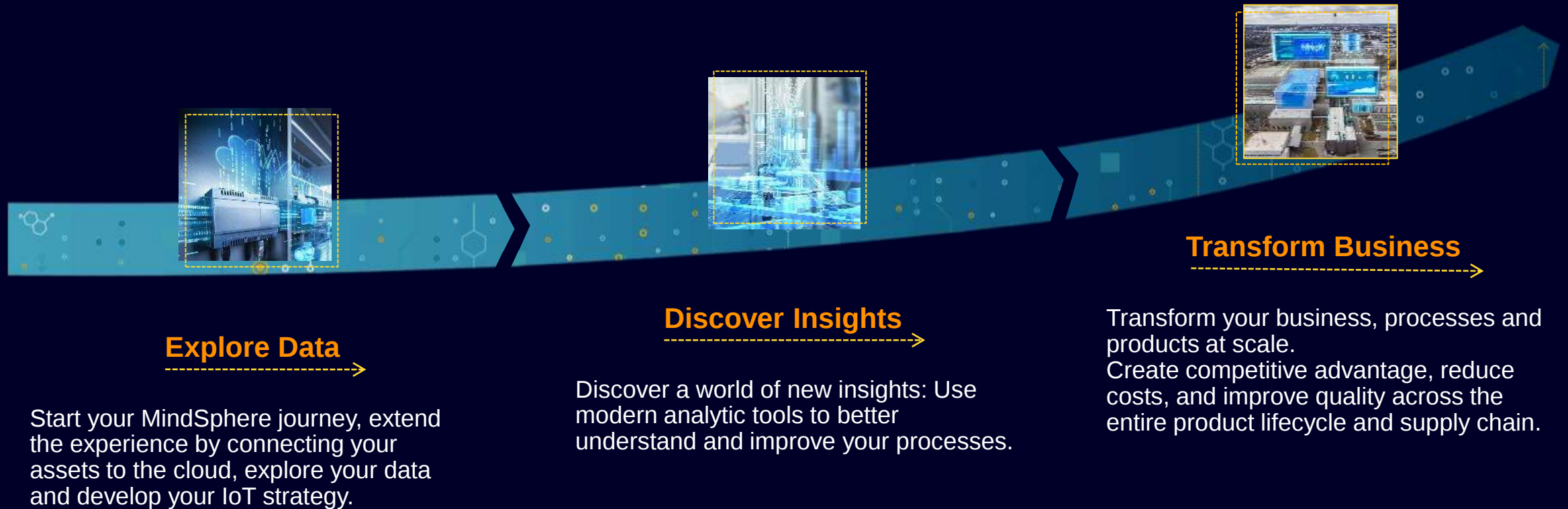
2%

Higher machine availability

Adding up to 1.750.000 Euro/y additional value on one paper mill

SIEMENS

Realizing business value with MindSphere industrial IoT



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