# From Models to Minds:
## Six Sigma, Digital Twins, AI

From problem-solving to intelligence: powered by KNIME

# **Agenda**

**1** ZF Group Introduction

**2** DMAIC – the backbone of Six Sigma

**3** KNIME as enabler for each phase

**4** Outlook – What's next?

# Facts & Figures
# of the ZF Group

# Financial Overview 2024

**€41.4 billion**
Sales

**3.6%**
adjusted
EBIT margin

**€0.3 billion**
adjusted free cash
flow

**161,631**
Employees

**€3.6 billion**
Research &
Development

**€2.3 billion**
Investments in
property, plant,
and equipment

# Key Figures - Locations



**North America**
Locations: 28
Employees: 34,787

**EMEA**
Locations: 80
Employees: 92,580

**Asia-Pacific**
Locations: 45
Employees: 28,685

161 production locations
in **30** countries

20 main development locations
in **10** countries

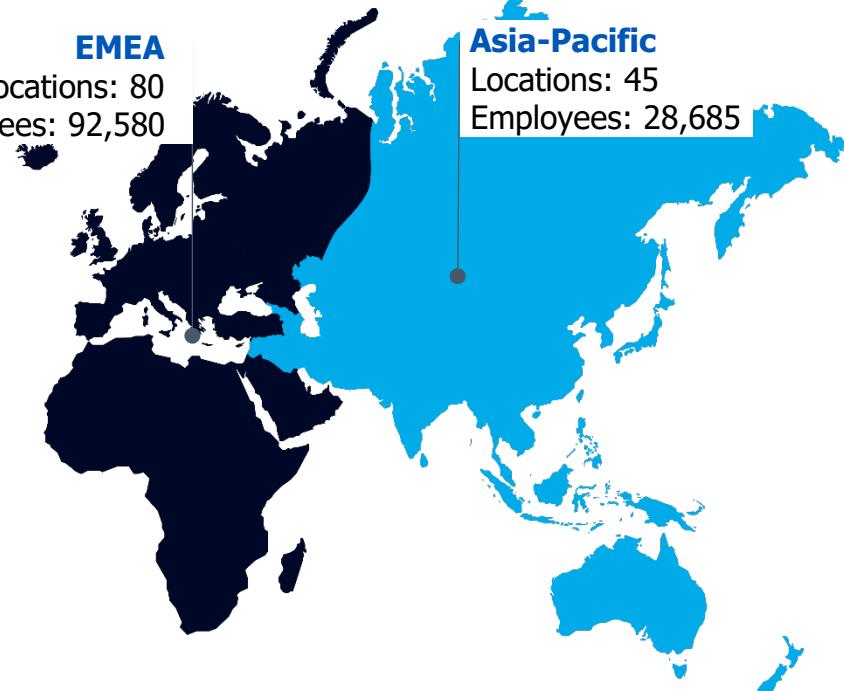Global service network with more
than **20,000** workshop partners

**South America**
Locations: 8
Employees: 5,579

**Worldwide Presence – Production,
Development, Sales and Service**

ZF USP: Transfer of Technology Expertise Between Different Segments

Electrified Powertrain

Chassis Solutions

ZF Lifetec

Electronics and ADAS

Commercial Vehicle Solutions

Industrial Technology
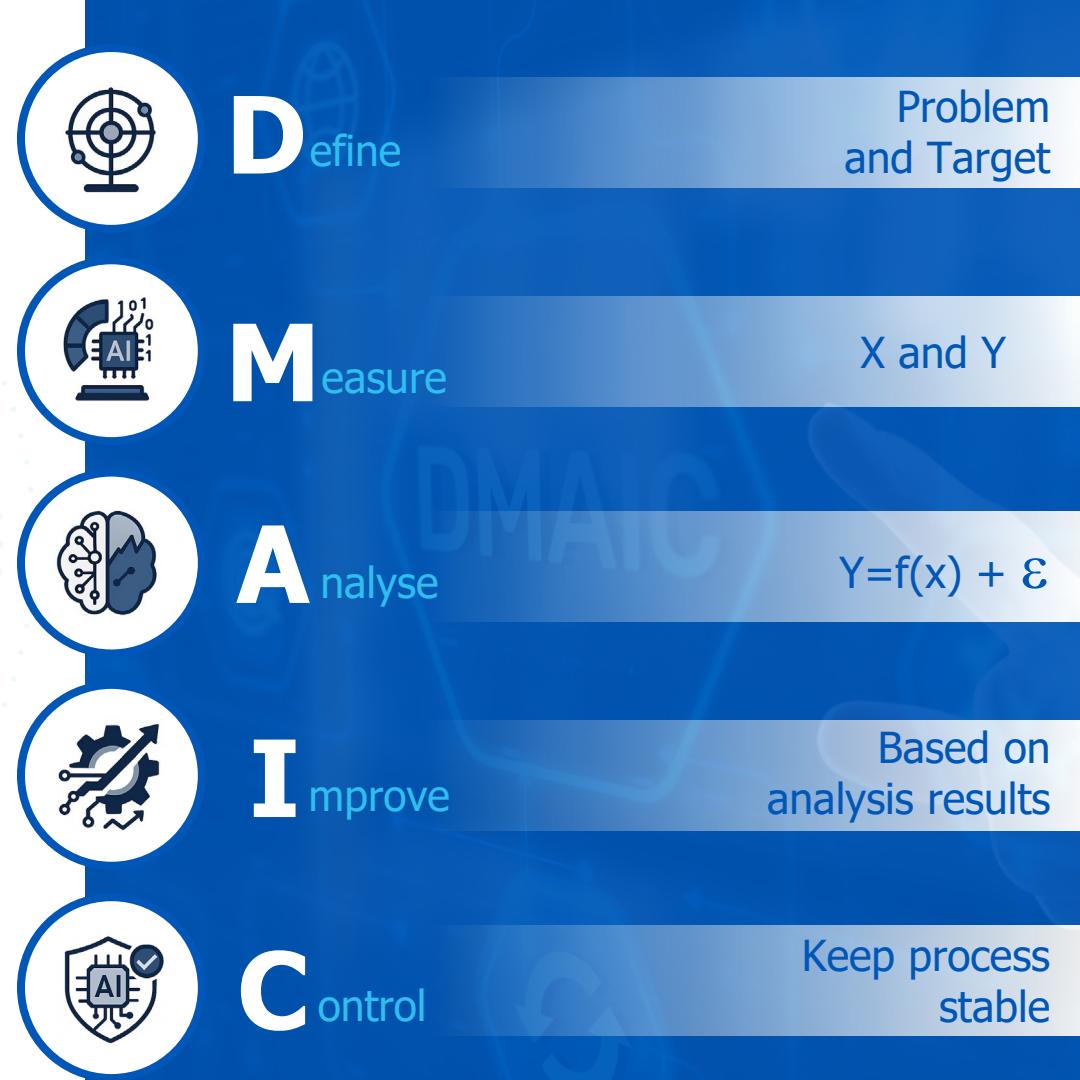
Aftermarket

# Six Sigma

Fit for the Future?

# DMAIC the Backbone of Six Sigma

**Six Sigma is a structured methodology for process improvement to**

- understand the process in a mathematical, statistical way ($y=f(x)+ \varepsilon$)
- reduce variation, improve quality



**D**efine — Problem and Target

**M**easure — X and Y

**A**nalyse — $Y=f(x) + \varepsilon$

**I**mprove — Based on analysis results

**C**ontrol — Keep process stable

# Define → Blueprint for Digital Twin

**1** Define VOC, involved processes **and data sources**

**2** Define data sources, visualize process & data flow

**3** Visualize first data insights



SUPPLIERS → INPUTS → PROCESS → OUTPUTS → CUSTOMERS
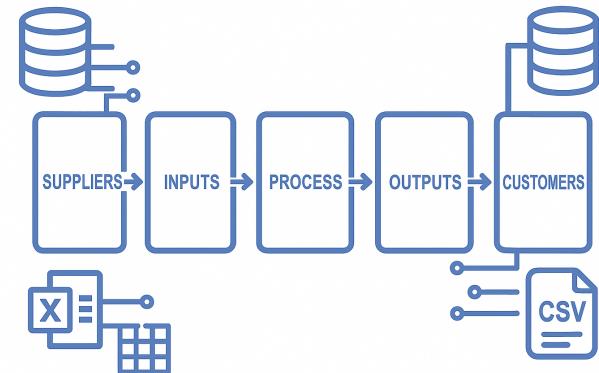
Output: **Conceptual structure (SIPOC)** of the process flow, data sources and scope

# Measure – Traditional Six Sigma Way
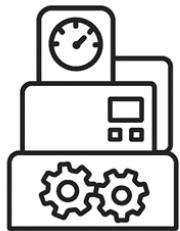
# Measure – New Way with KNIME & Data Apps



Connection of various different data sources

Automated ETL Process

Joined data from different sources

Automated data quality validation

Process performance check

Dashboard / Output via Data Apps

# Measure Example: Data Sources

**8.600.000**
Production data

**6000 Reports**
from CMM Machine

Field data from
Customer (Excel)
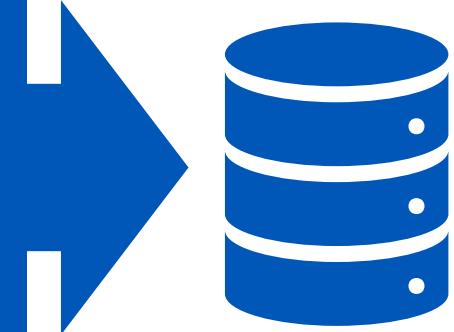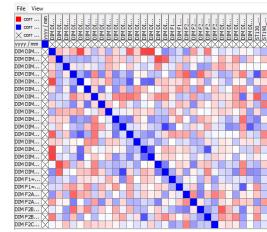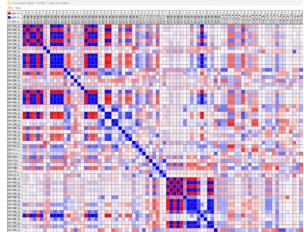
# Analyse – From Data Exploration to Root Cause

- Dimensional Reduction
- PCA, clustering, and visualization
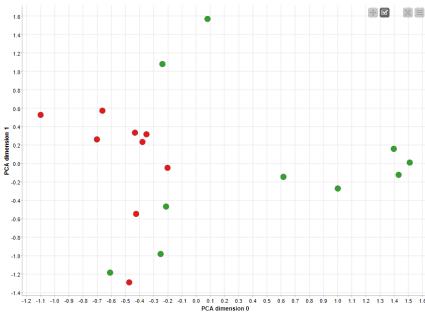- Decision tree for prioritisation
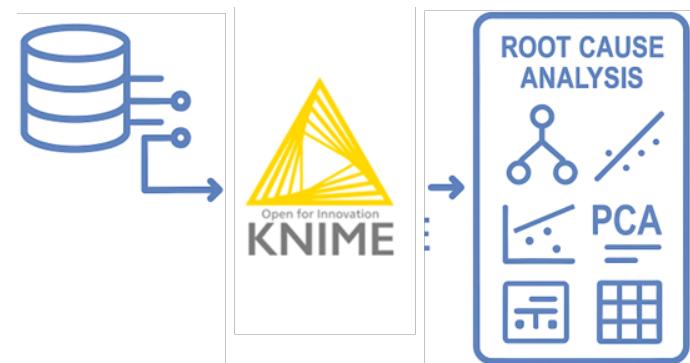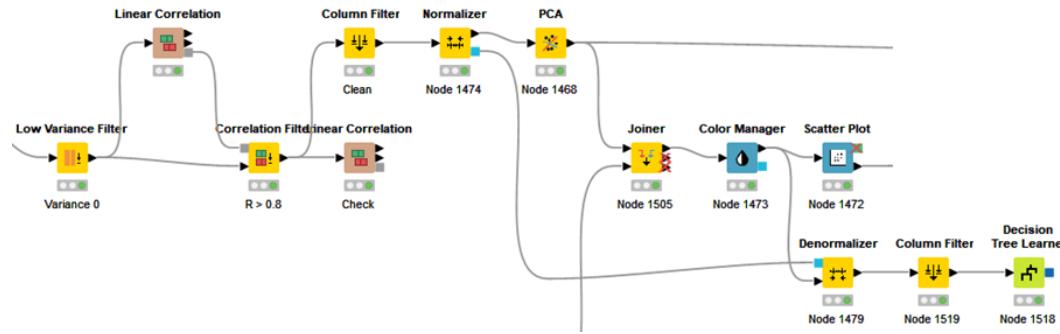
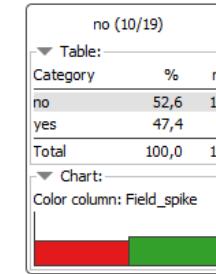# Analyse – From Data Exploration to Root Cause
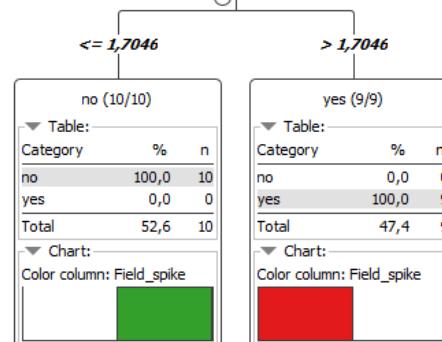
**Data check:**
- **Dimensional reduction**



- **PCA / Clustering**



- **Parameter prioritisation/ Decision Tree**

# Digital Twin?

A **Digital Twin** is a **virtual model** of a physical object, process, or system. It uses **mathematical models and real-world data** to mirror behavior and performance.
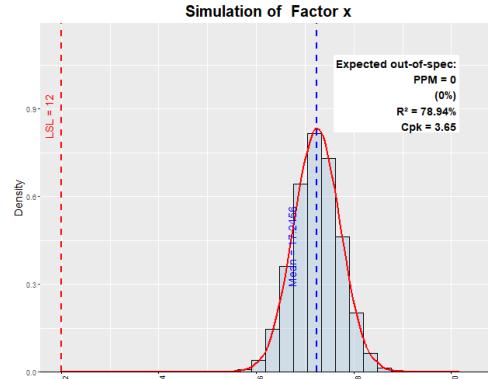
$$Y = f(x\text{'s}) + \varepsilon$$

# Improve – Modeling for Process Understanding

## Create the digital twin, reduce the error

- Create a model for the process
- Simulate before implementation
- Check process parameter specification
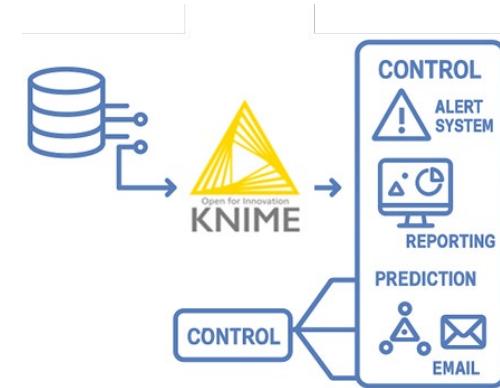- Optimize process output performance
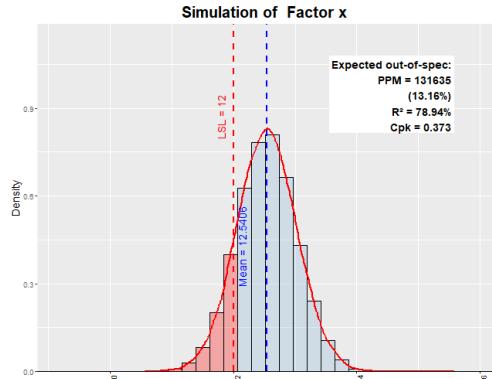


Monte Carlo Simulation for optimal setting

# Control – Embed Learnings into the Process

- Continuous data collection and monitoring

- Alerts for deviations and trends

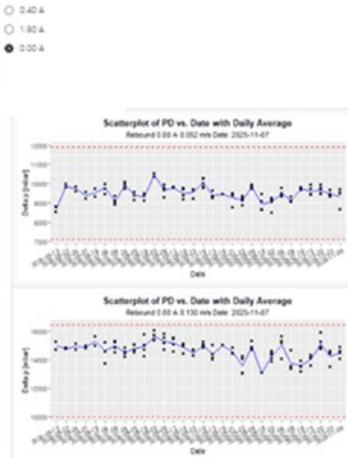- Visual dashboards for nearly-real-time insight



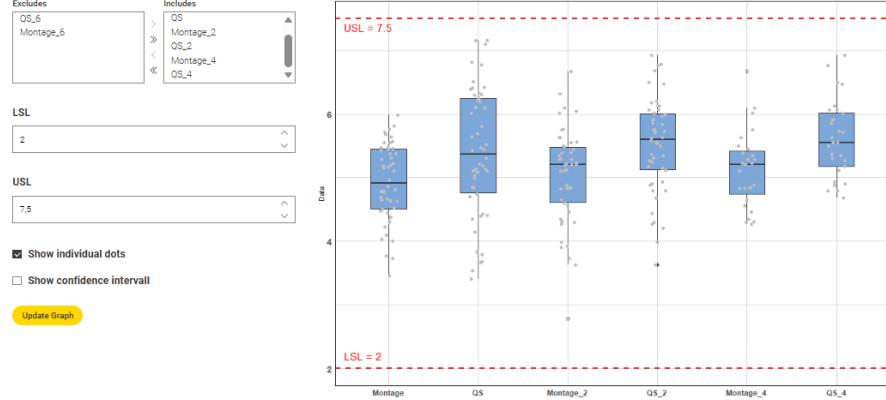**Move from static control charts to dynamic, data-driven monitoring**

# Control: Automated Data Visualisation / Data Apps

# Summary: KNIME as Enabler for Six Sigma

**DMAIC**
Evolution

**Define → Process Blueprint with real data**
SIPOC enriched with integrated, real-time data sources

**Measure → Data Accessability**
Automated data collection, preparation and visualization

**Analyze → Intelligent Insights**
Feature selection, reduction & root cause identification

**Improve → Predictive Optimization**
Virtual scenario testing before implementation

**Control → Sustainable Monitoring**
Continuous dashboards & alerts for long-term stability

# Outlook – Preparing For Next Level

**1** **What's Next?**

> Agentic AI: Digital Twins become reusable assets for autonomous decision-making
> Today's effort is foundation for tomorrow, not one-time work

**2** **Additional skills for Six Sigma experts?**

> - Data literacy & basic data science
> - Simulation & model training
>
> This is about development for Six Sigma experts, not a replacement

**3** **What is changing?**

> Data literacy, simulation & model training are standard practice
> Adopt a new mindset: make predictive tools part of daily operations.

**We're not just improving processes —
we're building a future-ready system for intelligent automation**

# Thanks for your attention

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