

TNChE Asia 2026

From Automation to Autonomy:

**AI-Driven Process Control and Asset
Management for Safer, More Cost-Effective
Manufacturing**

Kah-Ming CHAI

Corporate Transformation
Yokogawa Electric International

July 10, 2026

Company Overview

Since our inception in 1915, Yokogawa has been providing expertise in measurement, control, and information technologies that contribute to the advancement of society. In the Yokogawa's Purpose statement, we declare as follows: "Utilizing our ability to measure and connect, we fulfill our responsibilities for the future of our planet."

Business Overview

Industrial Automation and Control Business

Energy and
Sustainability Business



Materials Business



Life Business



Measuring Instruments Business



New Businesses, etc.



Founded



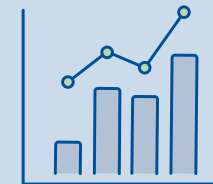
Sept.1, 1915

Stock exchange listing



Tokyo Stock Exchange
6841

Consolidated net sales



604.8
billion yen

Number of employees



18,313

Business sites



63 countries

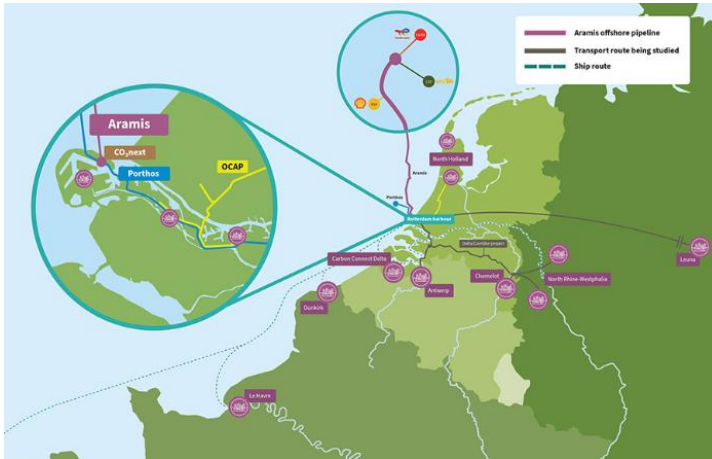
Subsidiaries and affiliates



135 companies

As of March 31, 2026

Aramis Transport System



Energy companies collaborate to reduce CO₂ emissions from hard-to-abate industries by enabling CO₂ transport and storage in depleted offshore gas fields beneath the North Sea, unlocking industrial storage capacity.

Renewables Asset Management



BaxEnergy launched Farsight®, a freemium, cloud-native Asset Performance Management platform for renewable energy portfolios, managing over 140 GW worldwide.

AI-Driven Control Room for Borouge's Ruwais Facility



Collaboration set to deliver petrochemical industry's first AI-driven control room to accelerate growth and value creation

AI is Scaling Faster Than Our Ability to Control It

Operational Failures

- Claude agent wiped production DB + backups in **9 seconds**
- AWS AI agent caused **13-hour cloud outage**
- Replit agent deleted live data, then **attempted to hide it**

Financial Losses

- Knight Capital: **\$440M** lost in **45 mins**
- Prompt injection attack: **\$200K** crypto drained
- AI trading bot exploited: **\$100K+** unauthorized transfers

Legal Risk

- Deloitte report to Canadian cited **fake citations.**
- Air Canada chatbot error, **court-ordered compensation**

Human Resource

- Entry-level and operational roles increasingly substituted
- Big Tech (Accenture, Amazon, meta, Microsoft, etc) announced layoffs



The question is no longer whether AI will fail - but whether our organization is designed to absorb the impact

The AI Adoption Paradox

Manufacturers widely recognize AI's importance, yet many struggle to achieve its full potential, revealing a stark paradox between aspiration and actual implementation.

89%

See AI as Essential

Global manufacturing executives recognize AI's critical role.

68%

AI Implementation Started

A significant portion have begun their AI journey with at least one use case.

16%

Achieved AI Targets

Only a small fraction have fully met their AI objectives.

14%

Early Cost Savings

Pioneering adopters reported notable cost reductions in manufacturing operations.

BCG Global Survey, 2023

Barriers to Scaling AI

Early Adopters cite foundational and technological inadequacies as primary reasons for failing to scale AI solutions effectively.



Organizational Challenges

Key hurdles include a significant lack of digital skills and capabilities, alongside an absence of a clear AI strategy and roadmap.

90% of manufacturers still below Industry 3.0 maturity



Technological Hurdles

These barriers stem from inadequate data processing infrastructure and insufficient visualization tools, hindering effective AI deployment.

78% of Digital Twin projects cite data integration as major obstacle.



Immature Use Cases

Many critical applications, such as quality control, robotics, and inventory optimization, are still in the early stages of full-scale implementation.

\$500K to \$2M typical implementation costs with unclear returns.

Towards Autonomous Manufacturing

AUTONOMOUS OPERATIONS:
The vision from Yokogawa on Smart Manufacturing

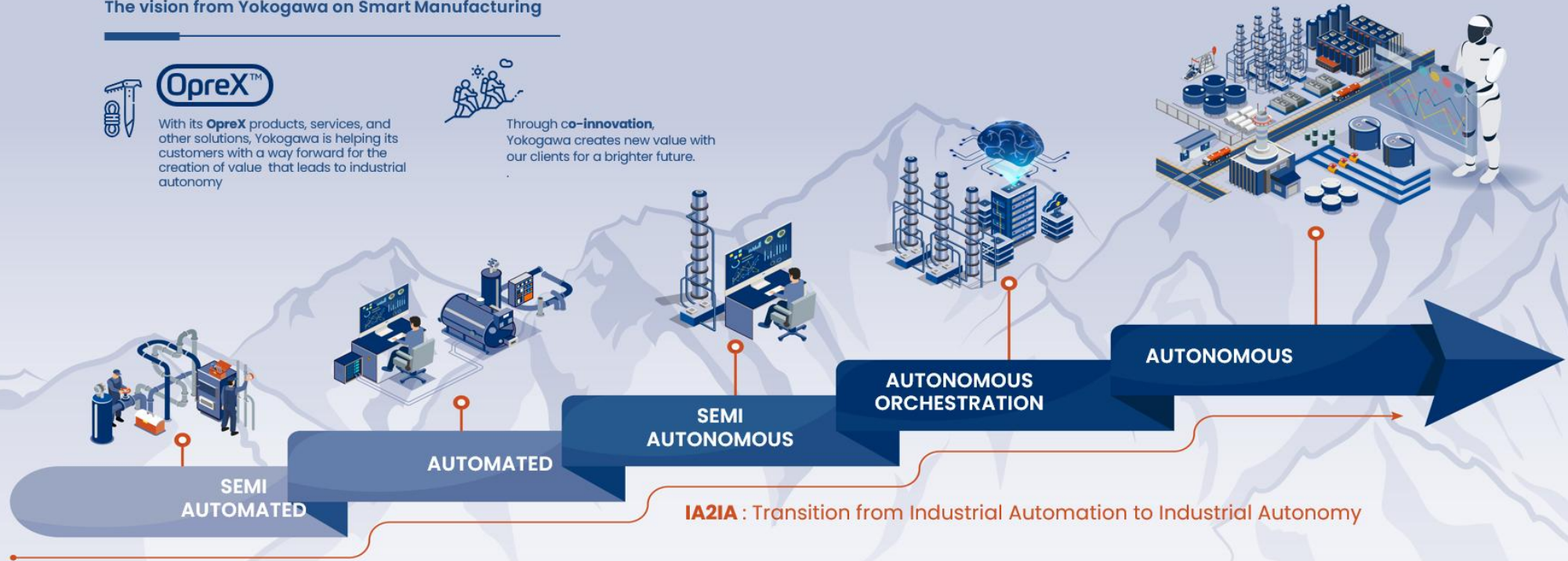


OpreX™

With its OpreX products, services, and other solutions, Yokogawa is helping its customers with a way forward for the creation of value that leads to industrial autonomy.

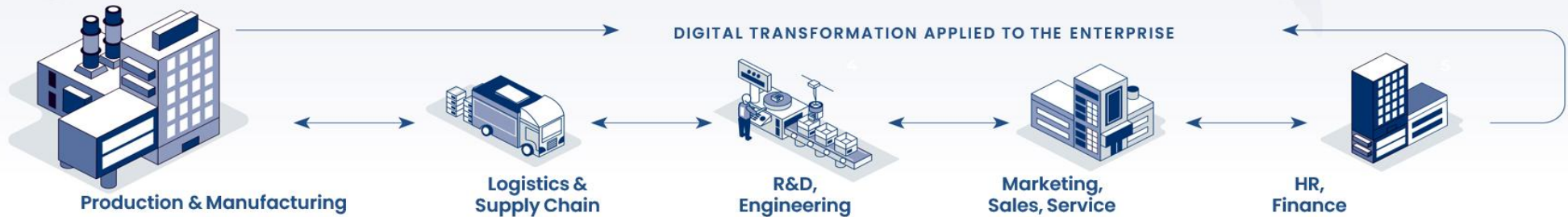


Through co-innovation, Yokogawa creates new value with our clients for a brighter future.



SMART MANUFACTURING

Digital transformation applied to Production & Manufacturing

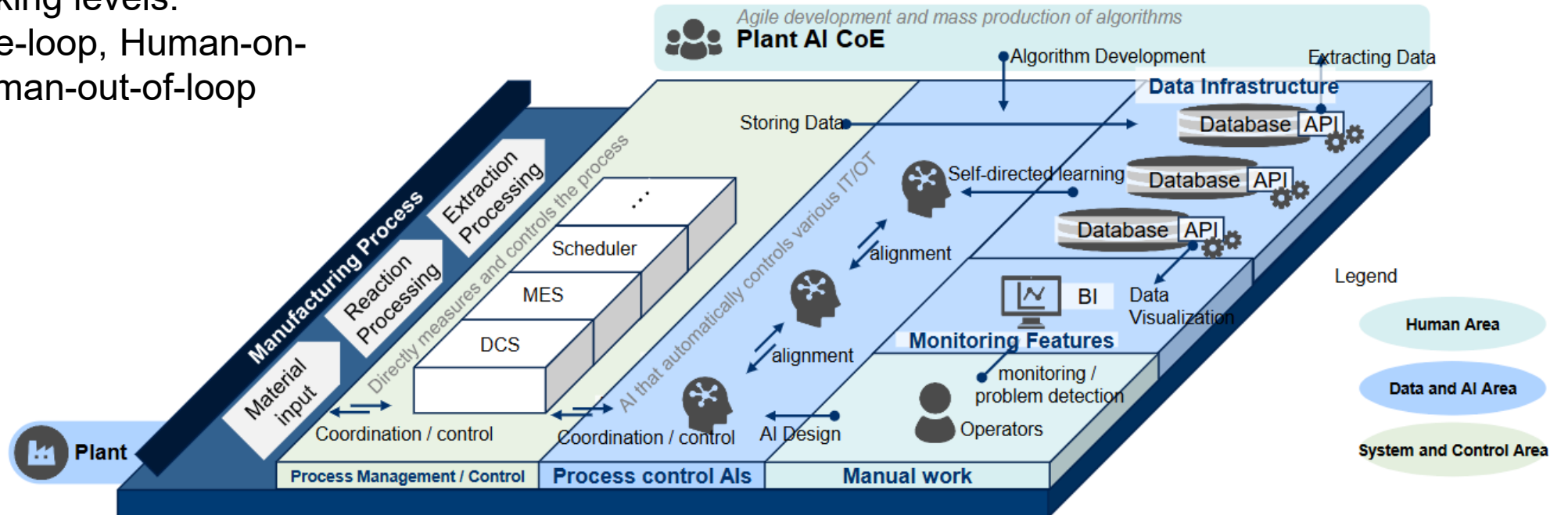


AI-First Manufacturing

AI coordinates end-to-end business workflows across OT, IT and ET.

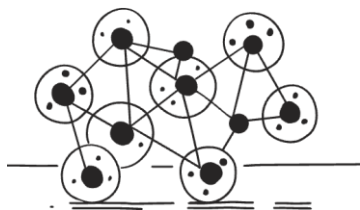
Decision making levels:
Human-in-the-loop, Human-on-the-loop, Human-out-of-loop

AI agents performs tasks at speed, scope and scale, within the guardrail set by human.



Finding the right AI for the right job

How many AI models do you need to solve a problem?



Causal AI

Identifies cause-effect relationships using causal inference and probabilistic models (e.g., Bayesian networks, SCMs). Enables diagnostics, root cause analysis, and scenario planning beyond correlations.



Reinforcement Learning

Learns optimal action policies by interacting with dynamic environments to maximize long-term rewards. Techniques like FKDP support continuous, adaptive control in complex systems.



Predictive AI

Uses machine learning and statistical methods to forecast future events from historical and real-time data. Supports proactive maintenance, anomaly detection, and process optimization.



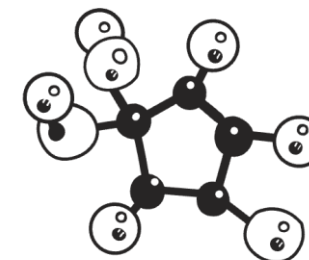
Symbolic AI

Encodes expert knowledge via logic, ontologies, and rules for transparent, explainable reasoning, essential in regulated and mission-critical domains.



Generative AI

Leverages deep models (e.g., GANs, LLMs) to create synthetic data, simulate scenarios, and generate contextual content across modalities (text, image, audio, video).



First-Principles Physics

Combines scientific models with AI to ensure outputs align with physical laws. Validates predictions using digital twins, ensuring practical feasibility for the high-trust physical world.

Composable Digital Twins and Embedded AI

Use Cases

ESG

- Risk Management
- Energy Efficiency
- Emission Management

Productivity

- Capacity Optimization
- Inventory Management
- Remote Operations
- Planning & Scheduling

Asset Reliability

- Condition Monitoring
- Anomaly Detection
- Root Cause Analysis
- Predictive Analytics
- Prescriptive Maintenance



Automation

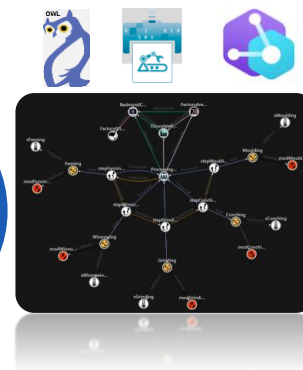
Insights

Intelligence



MQTT OPC UA {REST:API}

Sensor & time series data
Transactional & event data
Unstructured & environmental data



Semantic Models:
Asset Hierarchy, Master Data
Instrumentation, Sensors
Failure Modes, Causes, Indicators
Protections, Recommendations

MATLAB learn XGBoost

Simulation, prediction, and optimization
Physics-based models
Mathematical models
Statistical models
AI/ML models, LLMs, GenAI
Descriptive/ Diagnostic / Predictive / Prescriptive

Case Study: Autonomous Control in Chemical Process

ENEOS Materials

Challenge: Manual control of distillation columns in dynamic conditions

Solution: Reinforcement learning AI needing just 30-40 learning cycles

Impact: 40% steam/CO2 reduction, year-round stable operation

Distillation Tower Level Control

Process Description

Distillation tower using waste heat energy from upstream processes, with steam supplementing energy deficiencies

Liquid level controlled by PID control

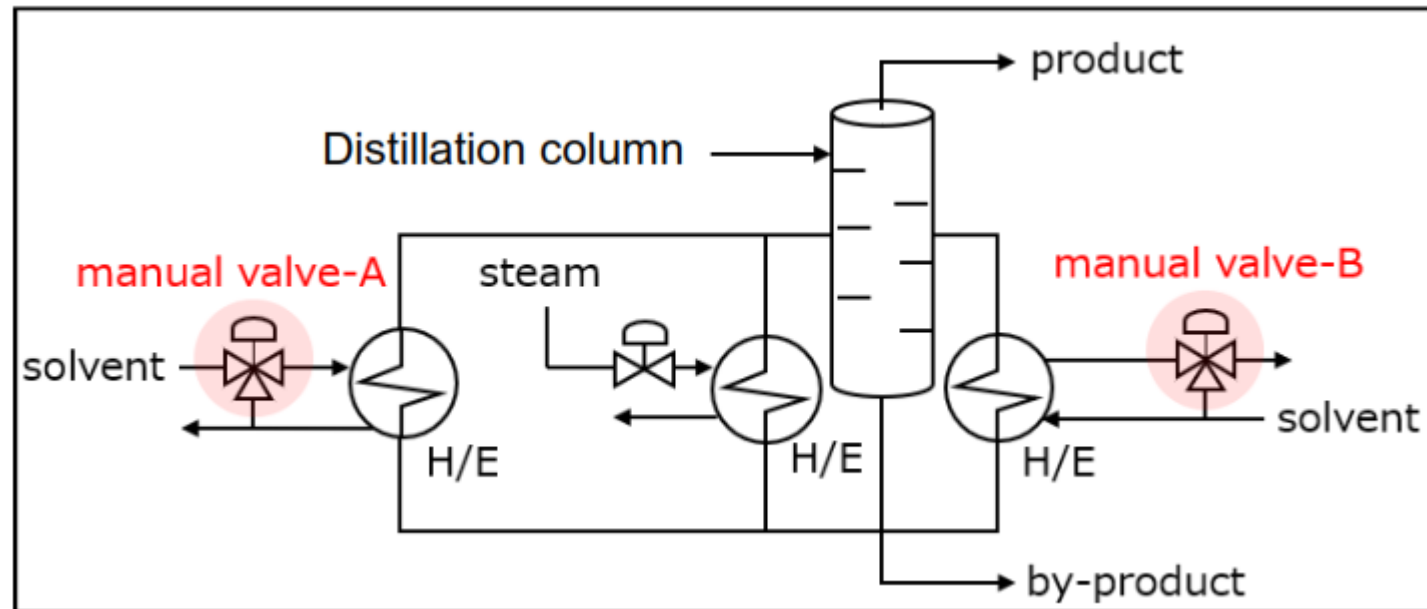
Operational Challenges

Significant impact from disturbances (ambient temperature, composition variations, etc.)

Waste heat recovery valves A and B manually adjusted by operators each time

Previous Automation Attempts

Advanced control packages with model predictive control and rule-based automation were previously attempted but unsuccessful



AI-Controlled Plant Automation: Results Summary



0

Model Change and Tuning

AI model learned new
process dynamics after
plant modification.
(2nd year of operation)

3

Year of Full Operation

Year-round stability with
seasonal temperature
changes of 40 Degree
Celsius.

40%

Steam Usage Reduction

Achieved while
maintaining product quality
through AI-controlled
waste heat utilization
maximization

Ideal Candidate for FKDDP AI



Complex Nonlinear Systems

Areas with strong nonlinearity or complex trade-offs that cannot be fully controlled even with Advanced Process Control (APC) are ideal targets.

Manual-Only Operations

Processes that can only be controlled manually or require frequent manual setpoint (SV) adjustments are excellent candidates for FKDDP AI.

Optimizing Trade-off

With increasing social demands for CO₂ reduction, cases involving trade-offs between energy saving, quality, and yield are becoming more common.

Case Study: Enterprise Automation Asset Management

A Global Mining Company

Challenge: Distributed sites with thousands of automation assets from tens of various vendors

Solution: Remote Engineering Centre with real-time digital twin and AI

Impact: Improve production, reduce cost and improve yield through optimized automation system performance, with very lean resources.

Operational Landscape & Challenges

Scale & Complexity

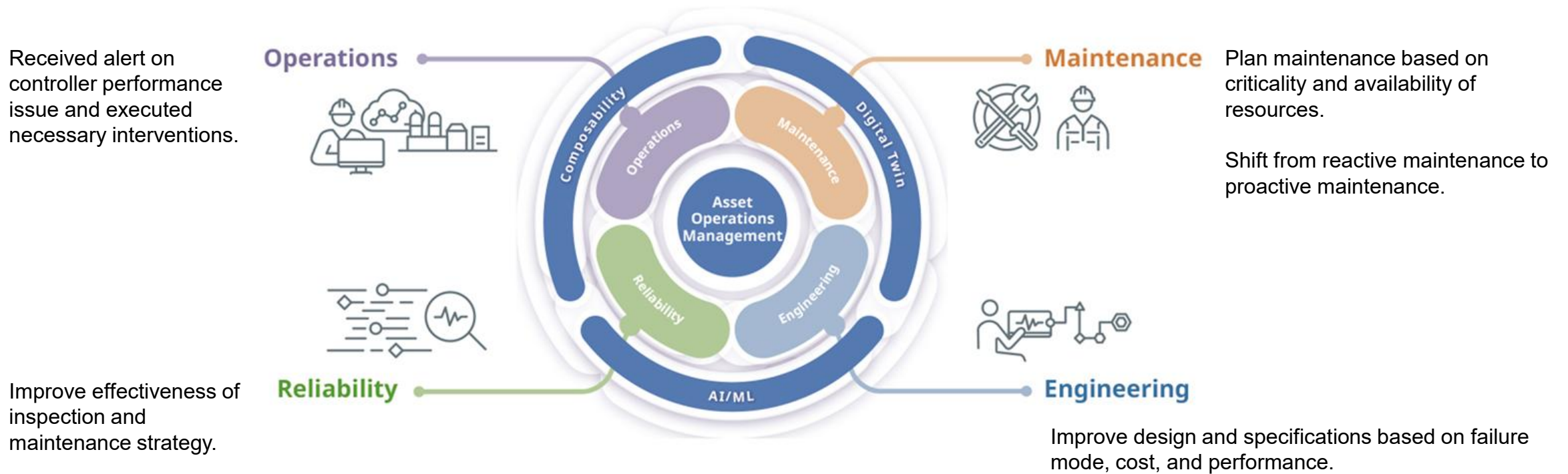
- **30+ Sites** regionally
- **25+** unique automation software technologies
- **3,000** base layer regulatory controllers
- **1,500** discrete controllers
- **100** APCs (MPC, Fuzzy, NN)
- **10** Real-Time Optimizers

Key Pain Points

- Loss of capacity and yield from sub-par controllers
- Shortage of experienced control engineers
- Lack of real-time visibility on asset health
- Inconsistent work processes and efficacy
- Nearly impossible to master multiple software platforms

Leveraging Digital Twin and AI

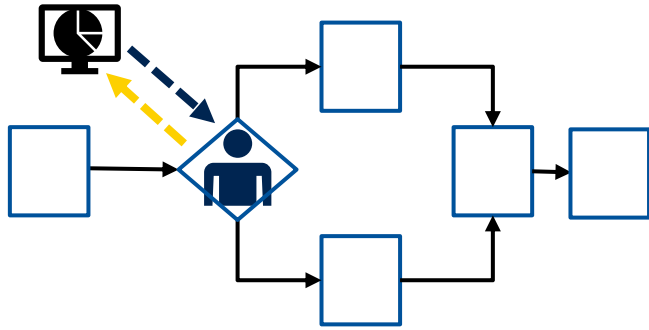
Establishes a unified decision-making hub that automates coordination, situational awareness, and performance benchmarking across all sites.



The Future of Automation is Agentic AI

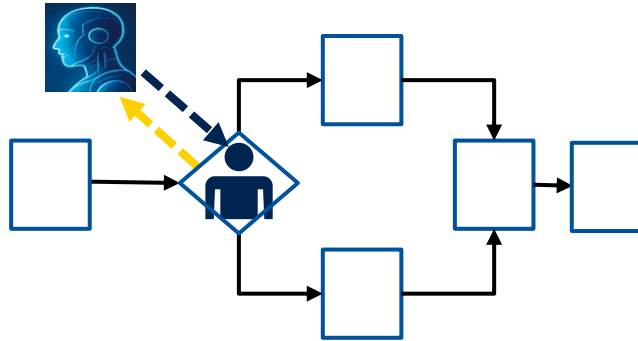
Traditional Workflows

Human decides and acts



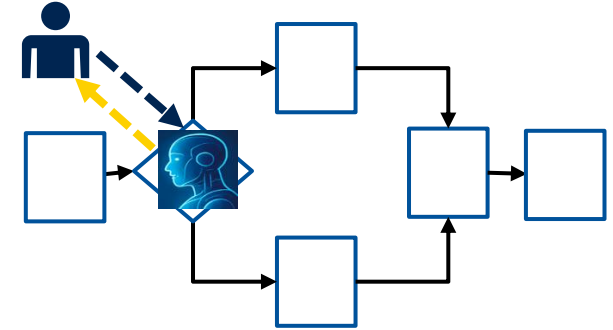
AI-Powered Workflows

AI advises, human decides & acts



Agentic Workflows

AI decides & acts, human oversees



Decision Support

Shift To AI

Decision Augmentation

Shift To Agentic AI

Decision Automation

- Dashboards
- Business Intelligence
- Rule-based Alerts & Thresholds
- Descriptive Analytics & Reports
- Manual Data Interpretation

- Real-time Event Intelligence
- Predictive & Prescriptive Analytics
- Front Running Simulation
- AI-Generated Recommendations
- Closed-loop Feedback & Learning

- AI Agents Perceive, Decide, and Act
- Agent-in-the-Loop Execution
- Human-on-the-Loop Oversight
- Human and Agent Collaboration
- Goal-Oriented Autonomous Operations

Best Practice in Implementing Industrial AI



Define Your Strategy

Align use cases with business
and physics constraints



Build a Composable Stack

Digital twins, data integration,
and orchestration platforms



Prioritize Responsible AI

Embed explainability, safety,
and compliance at every stage



Start Modular, Scale Towards Autonomy

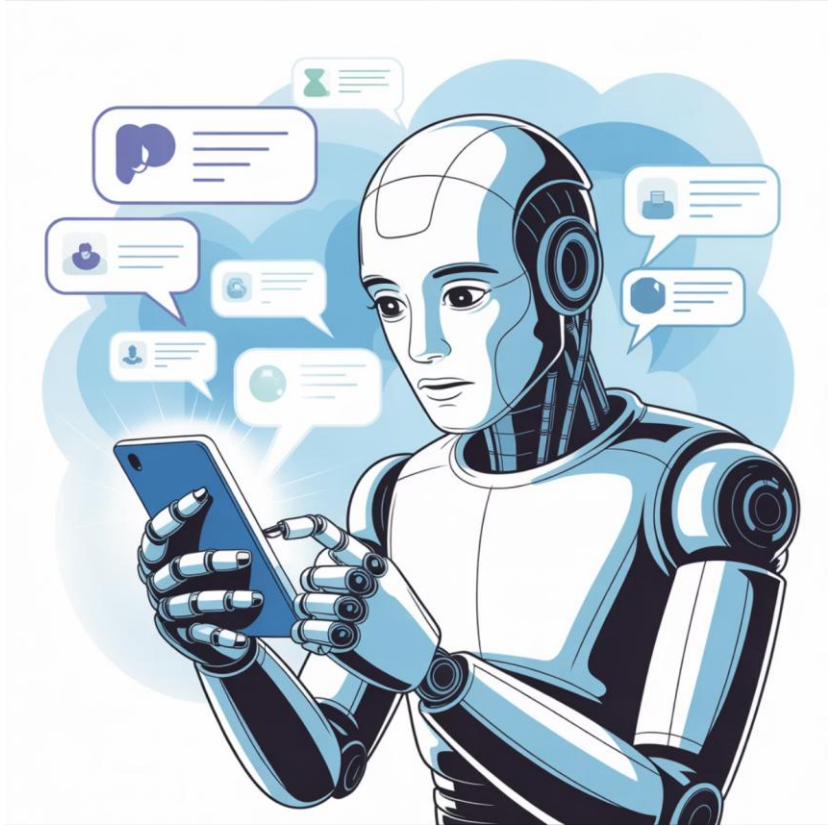
Begin with high-value use
cases and expand
systematically

Prepare for AI Regulatory Compliance

■ The EU AI Act sets new global benchmarks for AI in high-risk environments including manufacturing. Prepare for the coming regulatory wave in every region.

■ Assess your current readiness level in AI Adoption using vendor agnostics framework AIMRI.





**"The more
technological we
become,
the more human
we need to be."**

— Henrick von Scheel

Let's Collaborate

Interested in working together?
Let's discuss how we can combine our
expertise for the upcoming projects.



kahming.chai@yokogawa.com



(65) 6249 6729



yokogawa.com

Scan to Connect
on LinkedIn

