

Industrial AI

Building Next Generation
Autonomous Operations

Yokogawa AI Vision

Yokogawa creates
a new normal with
customers to
open up tomorrow's
opportunities.

Perceive the present
Predict the future
and Optimize
operations

Are you sure you have the data
you need?

Are you using your data in the
right way to meet your objectives?

Most end-users imagine what could be,
but lack the means to meet their objectives.
This usually leads to a lot of worries & frustrations.

Yokogawa AI Value Proposition

Maximize operational efficiency and performance via a unified data fabric

Yokogawa's approach to analytics centers around weaving data of different types into a single tapestry (or fabric) that is straightforward to access, transform and analyze. Yokogawa's unparalleled Industrial AI solutions enable users to leverage this data fabric to perform advanced data analysis and visualization.



Create actionable intelligence that is readily usable by process experts

Yokogawa has developed user-friendly analytical tools that transform data into easily comprehensible, yet powerful recommendations and rules that guide key operational decisions. These solutions make it simple for operators of all experience levels to obtain actionable intelligence from data.

Identify and resolve operational pain points by comparing customer words with the data

Yokogawa helps operations leaders harness the varied perspectives of stakeholders from all levels to implement AI in a manner that makes sense to all users. This enables leaders to adopt data-driven decision-making processes that enjoy a high degree of support; a hallmark of high performance manufacturing.



Leverage operational knowledge through connected factory nerve centers

Yokogawa helps customers deploy factory nerve centers that act like the human nervous system, pinpointing areas of operational distress and giving early warning of looming issues. This grants managers real time visibility of the health of their manufacturing operations, reducing downtime, prolonging equipment life cycles and creating a digital repository of worksite wisdom.

Definition of Industrial AI



Artificial Intelligence

An umbrella term for computing techniques that allow machines to replicate the cognitive aspects of the human brain – becoming capable of perception, logic and learning



Machine Learning

A subset of AI that leverages algorithms which learn from data without being explicitly programmed – unlike classic (or symbolic) AI techniques

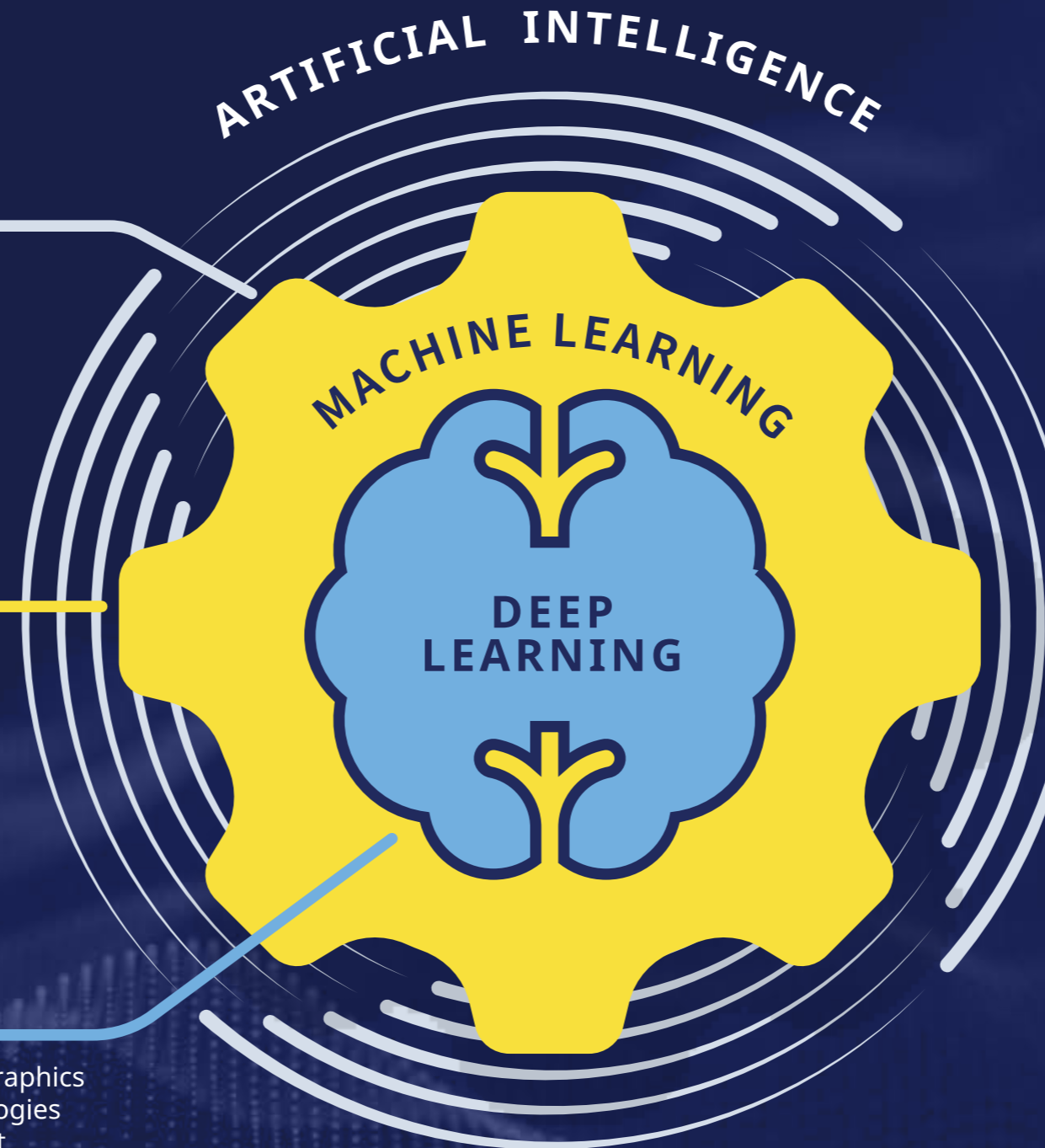
Machine learning has become mainstream in recent years as the big data revolution produced large amounts of data to learn from



Deep Learning

A subset of machine learning in which multi-layered neural networks are used to build algorithms that learn from vast sets of data

Developments in GPU (Graphics Processing Unit) technologies have allowed the efficient creation of additional layers in neural networks (going “deeper”) accelerating the adoption of deep learning techniques



Industrial AI in this context refers to digital solutions that merge domain expertise and AI techniques to improve business outcomes across the industrial and energy value chain and enable the journey towards autonomy

Overall AI Market Forecast & Drivers

The global AI Market is expected to grow at a rate of 42% YoY to reach a size of US\$ 197.7 billion in 2025, largely driven by the need to unlock value of data as enterprises focus on creating a strategic advantage in the era of Industry 4.0 (4IR) and/or Digital Transformation (DX)

197.7



34.3



2020

2025

Global AI Market Forecast
– USD Billions



Demand for AI to unlock value from growing global volumes of data

As enterprises, governments and consumers produce more data, it is unfeasible for them to manually analyze reams of data to guide their decisions. AI tools assist these organizations analyze large volumes of data to find patterns and correlations that would either go unnoticed or consume an inordinate amount of time for human analysts, helping to uncover new sources of competitive advantage in less time



Access to enabling digital infrastructure to generate, process and store data has made it easier for customers to implement AI solutions

With the ubiquity of cloud computing, the rapid expansion of wireless communication networks and the increasing reliability of low-cost sensors, customers have witnessed a decline in the technical barriers associated with deploying AI solutions allowing them to implement AI solutions quicker with less spending on AI-related hardware (FPGAs, GPUs, ASICs etc)

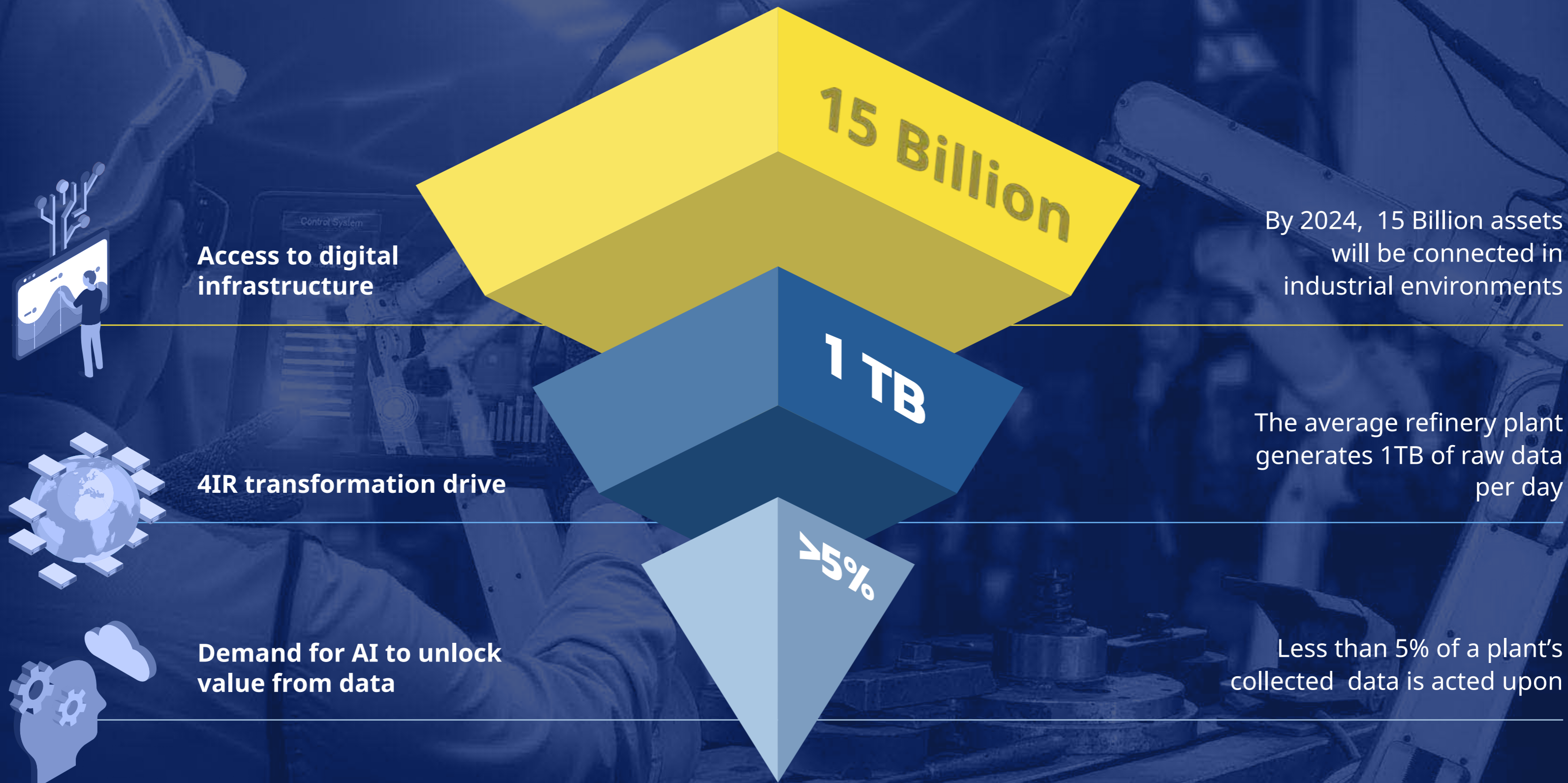


Industry 4.0 transformation efforts generating demand for Industrial AI tools

One of the key sectors driving the demand for AI solutions is the Industrial sector. The global race for Industry 4.0 has stimulated demand for Industrial AI tools to not only unlock insights from data but also to autonomously monitor and control industrial processes to raise productivity, improve flexibility, and enhance quality; ultimately fulfilling the vision of “Lights-out” facilities

Source: Frost & Sullivan

AI Adoption: Data generation & Connectivity



Source: Frost & Sullivan

Critical Customer Issues for Industrial AI

MEGATRENDS



SHORTAGE OF MANPOWER



ESCALATION OF
GLOBAL COMPETITION



DIVERSIFICATION OF
CUSTOMER NEEDS



SUPPLY CHAIN RISKS



IT - OT CONVERGENCE



Greying workforce



Shorter product lifecycle



High-mix low-volume production



Diversification of suppliers &
variation in quality



Increased risk of cyber attack

AI Priorities Explained

Evolving megatrends have led to challenges in the business environment for many industrial and energy firms. Yokogawa has identified key priority areas where Industrial AI can help firms navigate these business challenges and improve business outcomes.

Design optimization

Improve the yield and efficiency of an industrial plant by using AI to optimize the design of facility layout

Operation optimization

Reduce energy usage, manufacturing costs by using AI to monitor, control and extract peak performance levels from assets and labor

Trouble loss minimization

Reduce losses in production by quickly detecting and/or proactively predicting damage to equipment

Supply chain efficiency

Reduce costs and time to market by monitoring and managing the movement and storage of raw materials and finished goods

Quality stabilization

Monitor raw material quality, manufacturing machinery, labor practices to understand their impact on the quality of output

Advanced operations

Analyze best practices of high performing plant operations and use insights to provide live digital support to all operators across the firm

Digital infrastructure upgrade

Integrating manufacturing OT systems with networked IT hardware and software while minimizing cybersecurity risks



Unplanned Asset Downtime Prevention



Unexpected downtime is the #1 enemy of production. It directly leads to loss of production opportunities and risk of accidents, which can be serious business problems. Due to ageing assets and plants, in recent years, the need for maintenance is growing. Furthermore, we face the problems of declining birthrates leading to labor shortages, and the retirement of skilled workers leading to skill shortages. If you take on an average, industrial plants have <15% critical assets and ~85% non-critical assets(*). With a lean onsite workforce, it is becoming cumbersome to effectively monitor and manage a diverse and a wide fleet of assets.

Therefore, in addition to “Condition Based Maintenance - CBM”, which performs maintenance at the appropriate time according to the condition of assets and equipment, and “Predictive Maintenance” is required to detect early signs of equipment failure or abnormality and performs maintenance more quickly and efficiently. The technology stack to enable this is as outlined below:

- **Sensing** which enables trend monitoring and data collection on the status of various equipment and facilities by using a wide variety of sensors
- **Edge computing** which enables the development of applications using machine learning libraries, and helps in real-time control and interface with various cloud services
- **AI and machine learning** which automatically analyze collected data and capture the “Anomaly” that are signs of abnormality earlier than trend monitoring

By adopting advanced equipment maintenance practices, organizations can significantly reduce unnecessary equipment upgrades and minimize downtime while preventing equipment stoppages and accidental trouble. It also reduces the burden on maintenance personnel, drive responsive field resolution, and enable stable product quality.

Learn more about *Yokogawa's AI Analysis software and Sushi sensor* [here](#).
Learn more about *Yokogawa's Industrial AI Platform* [here](#).

Production Process & Quality Stabilization



Achieving stable quality, competitive cost, and on-time delivery, while improving productivity and maintaining safety in a dynamically changing production and manufacturing environment, it is necessary to correctly understand and respond to the effects of changes in the 4M's (Material, Machine, human, and Method). The 4M's are the key elements to ensure proper quality control operations in the manufacturing industry. By quantifying and digitizing the knowledge and know-how accumulated in factories and plants, and aligning the 4M data analytics, plant operators can pinpoint root causes and identify actionable improvement measures. These measures positively impact KPI's such as product quality variations and manufacturing process abnormalities.

Complex continuous processes involves processing of huge amounts of process data. In addition, evaluation models using AI and machine learning can detect signs of deviation from the required quality and take measures to prevent such sudden operational anomalies from occurring. By predicting changes in conditions in the manufacturing environment, it is possible to present operators with optimal improvement measures and decision-making support that enables a platform to achieve more flexible and resilient operations.

Learn more about *Yokogawa's Process Data Analytics* [here](#).

For more details, please refer to the useful case studies of *Mitsubishi Gas Chemical* [here](#) and *Sumitomo Seika Chemicals* [here](#).

Also, please click [here](#) to *Osaka Gas Chemical case study of Yokogawa's Digital Plant Operational Intelligence*.

Standardize Best Operating Procedures / Alarm Improvement for Matured Plant



Plant production efficiency and safety in process industries, depend on operators who manage the control system. Distinct practices of individuals and entry of inexperienced workforce have caused plant to experience inconsistency in operational performance. At the same time, production plants seek to achieve optimal operating conditions, maintain consistency across various process variables and share best-practices across facilities.

Under these circumstances, machine learning is a technology that helps standardize plant production effectively by gaining insights from control system data. There are two key areas, where it can provide maximum benefit:

- (1) Operating Procedure Analysis:** Machine learning can mine event data logs to visualize the actual operating procedure. The event log facilitates comparison and analysis of data to identify the differences and helps organizations determine areas of improvement and standardize plant operations.
- (2) Alarm Behavior Analysis:** Mining of alarm logs helps in visualization of the cause-and-effect relationship between related alarms and system operations. The visualized report helps the alarm improvement activity and maintain the alarm system performance to ensure resilient operations.

Continuous optimization can be achieved by adapting machine learning technology to identify optimal operating procedures and maintain alarm system performance.

Learn more about *Yokogawa's Operating Procedure Analysis by Machine Learning Technology* [here](#).

Please click [here](#) to see the informative white paper "*How Machine Learning Unlocks the Potential of Operational Excellence in Manual Operation*"

Learn more about *Yokogawa's Alarm Behavior Analysis* [here](#).

Advanced Characterization of Live Cells



High Content Analysis (HCA) is widely used in cell-based screening assays of live cells, microtissues, cell aggregates in drug discovery and cell biology laboratory. It has also been used in studying cell behavior, mechanistic and proliferation studies as well as safety and toxicological assays. The technology continues to evolve significantly over the past decade.

In recent years, the importance of cell characterization by live-cell imaging, which is closer representation to the living body, has been increasing in the drug development research. To overcome the challenge of fluorescent labeling, label-free imaging is now being used.

The next big challenge, post the image acquisition, comes data analysis. Deep learning capabilities are ideal for improving the accuracy of object recognition, reducing the manhours required to create protocols, and analyzing label-free images, which is difficult to achieve with conventional methods.

Learn more about **Yokogawa's High Content Analysis Software - CellPathfinder** [here](#).

Future Prediction Accelerated by Embedded AI Capabilities



Industrial plants generate a significant amount of process values (Temperature, voltage, current, flow, and pressure). These values are usually collected, visualized and used to predict operational performance. However, this usually has a degree of latency associated with it. In particular, real-time actions need to be taken to improve plant operational performance. In this case, the data needs to be processed and predicted at the edge.

Paperless recorders are purposeful instruments that collect, display, and record data on these process values. When these products converge with AI, there is a whole new aspect that is generated. Solutions that incorporate AI can use acquired data to predict future data, draw future waveforms alongside the real-time performance of the plant. This helps users detect possible process value deviations/anomalies and take responsive actions at an early stage.

In modern day plants, operators need to perform online AI analysis on streaming data. Leveraging data acquisition platforms with AI capabilities will help users simplify analysis, while having a firm grasp on understanding future process values of operations. This assists them in responding to future situations before it actually happens.

Learn more about *Yokogawa's Smart Data Acquisition Solution* [here](#).



AI Enabled Plant Optimization – Komagane Case Study

A large number of Yokogawa's AI-related technologies are already in use at customer facilities, as well as on Yokogawa's production sites. The next generation of AI technology is also developed and practiced at our own Komagane Plant.

KOMAGANE'S CHALLENGE

Yokogawa's Komagane Plant, located in Nagano, Japan, produces semiconductors for the pressure sensors which are the heart of Yokogawa's differential pressure /pressure transmitters. There are hundreds of processes performed in the manufacturing of semiconductors. Microfabrication processing takes place, and as some of these processes are conducted internally, quality control is one of the key issues.

To solve this issue, the Komagane plant uses an AI-based analytical tool developed by Yokogawa to analyze the quality of manufacturing process data. The plant realizes to reduce unplanned downtime, decrease maintenance costs, and optimize the workforce, as a demonstration site.

Furthermore, the Komagane plant is currently working on improving energy-saving performance and operation rates using AI analysis tools. These are initiatives implemented to effectively use limited energy and contribute to a sustainable local community.

KEY SOLUTION IMPLEMENTED & OUTCOMES

Applying data analytics: In order to optimize the maintenance schedule, a data collection system using sensors has been implemented to reduce the failure rate and maintenance costs by leveraging IoT data. Furthermore, they have introduced a multi-dimensional analysis tool that uses the IoT data and AI technology to reveal complex fluctuations that could impact quality. Quality assurance through quality analysis of manufacturing process data is also realized.

93% reduction in failure rates

Significant reduction in maintenance costs

Quality assurance through data quality analysis

Improving the efficiency of air conditioning control in clean rooms: In order to achieve both energy-saving operation and stable control, they have shifted from manual control to automatic control using reinforcement learning algorithms. Taking advantage of reinforcement learning in search-based applications, the AI predicts the optimal operating conditions while learning on its own. Revealed improved energy-saving performance through air conditioning control that reuses discharged heat.

10+% reduction in use of LPG for air conditioning needs

Automatic control without human intervention

Effective reuse of discharged heat energy

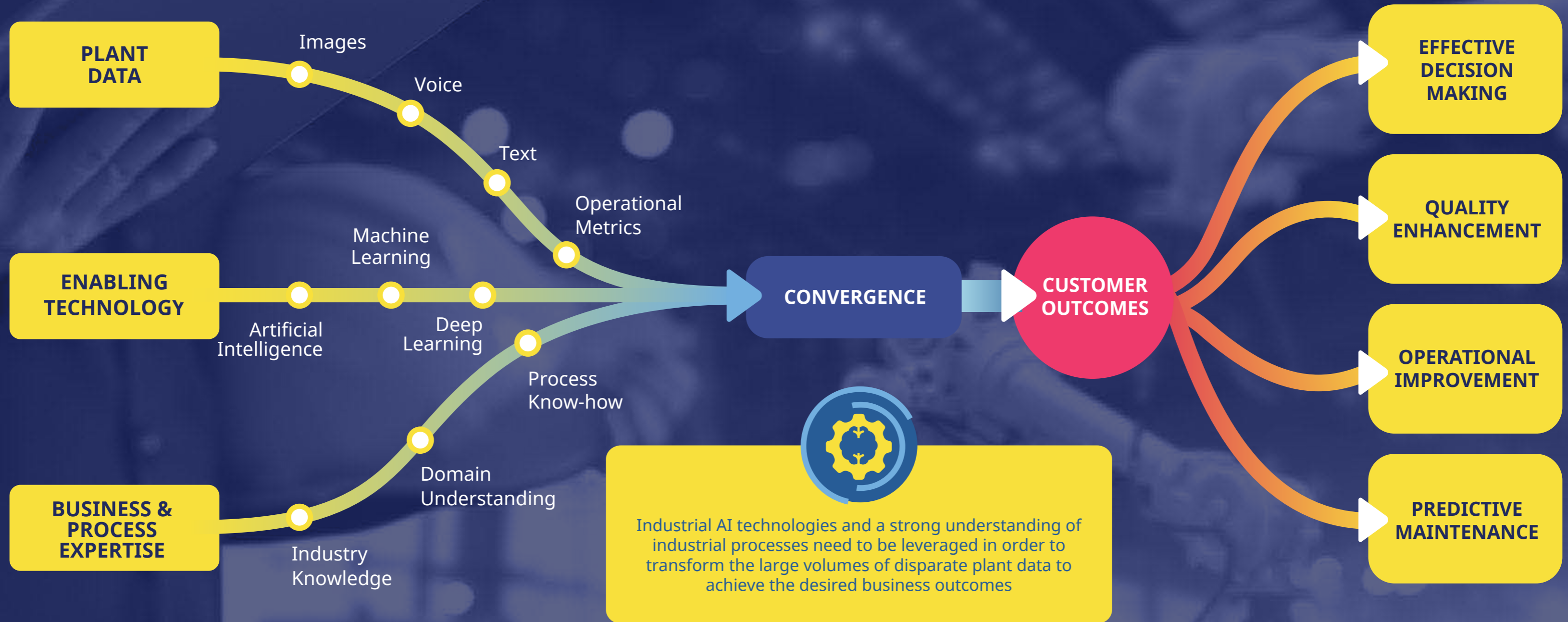
Setting conditions after diffusion furnace maintenance: Diffusion furnace, which grows oxide films on the wafer surface at high temperatures, requires periodic cleaning to remove impurities and particles adhering to the furnace, and efficiency in setting conditions after maintenance has been an issue. The film thickness on the wafer surface must be kept constant, but the setting is affected by conditions such as the temperature and gas flow rate that fill the furnace. It used to take time to set each condition, but they applied AI technology to analyze past film thickness data to create a stable film thickness prediction model. By leveraging the best setting value of the prediction model, stable film thickness quality and highly efficient maintenance have been demonstrated.

52% reduction in maintenance time

2% increase in annual uptime

High efficiency of total maintenance

Key Pillars for Industrial AI Enablement



The path forward is – Realizing Autonomous Operations

Technology implementation to realize autonomy should not be done in isolation, rather in convergence. AI technology, along with autonomous robots, augmented reality, digital twin, smart sensing, 5G, edge, cloud, and cybersecurity are a portfolio of key technologies that accelerates the realization of Industrial Autonomy.

AI as a stand alone technology would not benefit much on plant operations. Along with these technologies, AI can be of real value when combined with domain knowledge that can identify business pain points. This will enable AI to be utilized for self-learning, self-healing, and self-optimizing autonomous operations.

You need a reliable and trusted technology partner, like Yokogawa, who can help you in your journey towards autonomous operations.

Learn more about *Yokogawa's IA2IA, transition from Industrial Automation to Industrial Autonomy* [here](#).

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