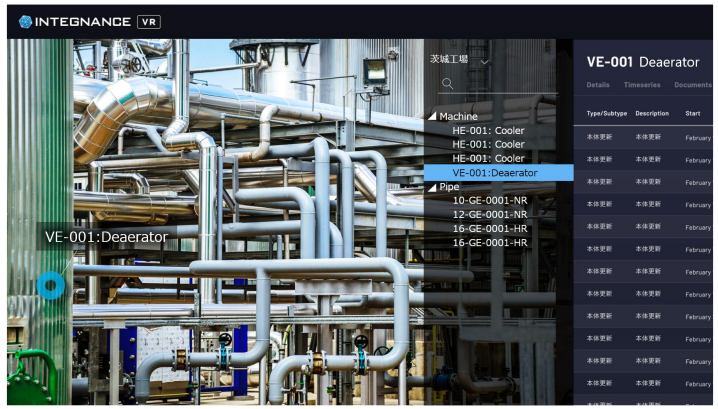
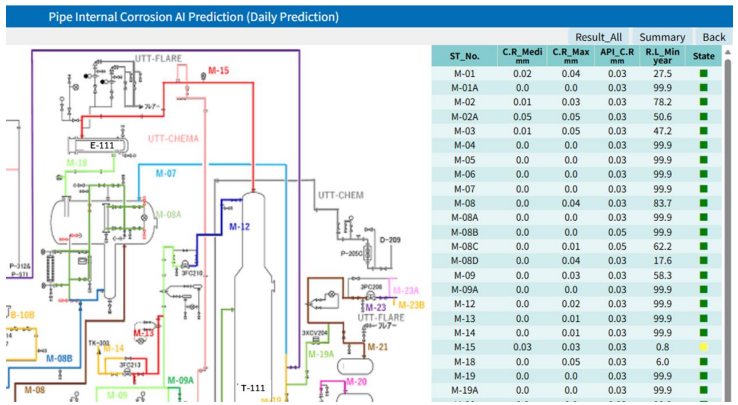
# Smart O&M Solutions

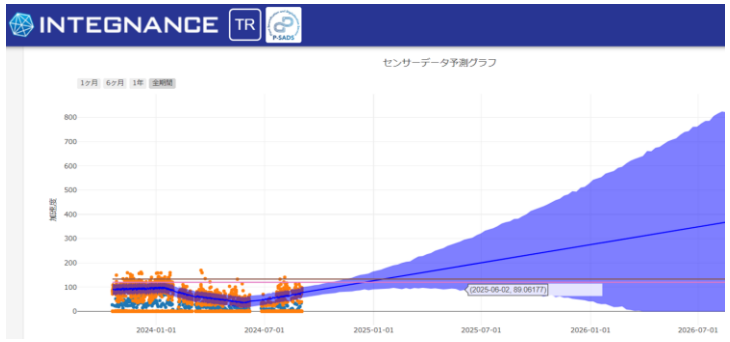
**JGC has developed digital solutions utilizing its extensive knowledge and experience from long-term O&M support to achieve work efficiency, sustainable technical transitions, and less manned operations. Additionally, cutting-edge digital twin technologies accelerate the transition of your conventional operation and maintenance to the next stage.**



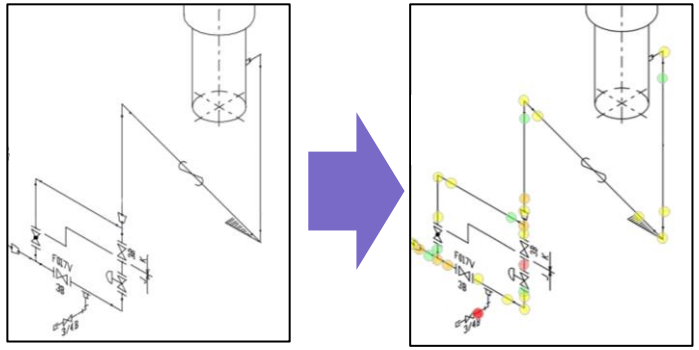

Fast Digital Twin Maintenance Viewer




Piping Remaining Life AI Prediction




Predicting Failure of Rotating Machinery



AI TML Assessment

## Service Menu

- **Maintenance Digital Twins Program**
  - INTEGNANCE VR (Fast Digital Twin Maintenance Viewer)
- **Smart Turnaround Management Program**
  - MODS - Connect
- **Plant AI Smartification Program**
  - Piping Remaining Life AI Prediction
  - AI TML Assessment
  - INTEGNANCE TR (Predicting Failure of Rotating Machinery)
  - Plant Smartification with AI Technology

# Operational Excellence Services

## Smart O&M Solutions

### INTEGNANCE VR

**Fast Digital Twin Maintenance Viewer**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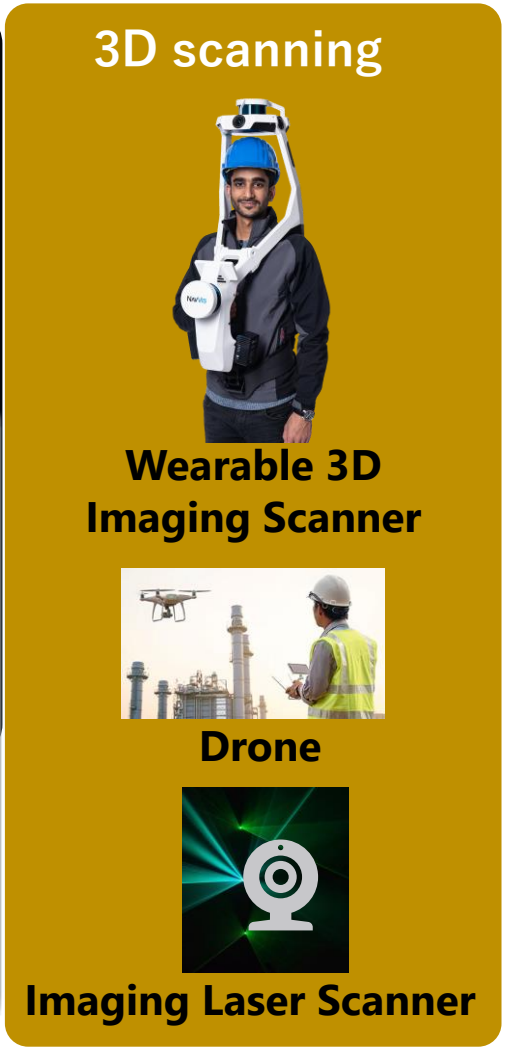
# INTEGNANCE VR-Fast Digital Twin Maintenance Viewer

## Do you have any of these issues?

- ☹ **Struggling with promoting DX to aging plant which doesn't have 3D model**
- ☹ **Wasting time on Site Visit for repair work planning, inspection planning, and daily maintenance work planning**
- ☹ **Outdated or missing blueprints**

## Our Solutions

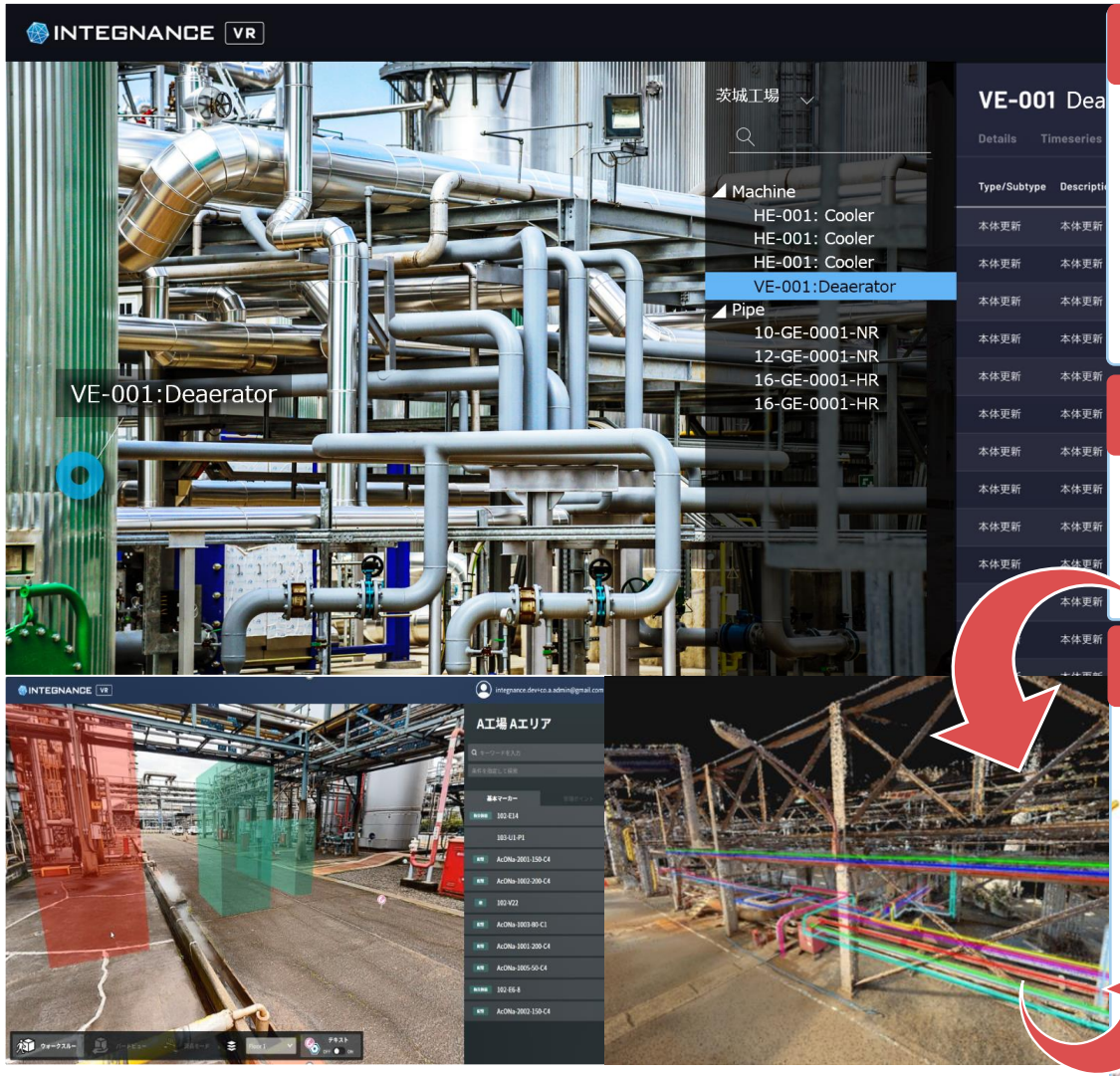
- **Our "Fast Digital Twin" replicates your plant as 3D model within 3 days at the earliest**
- **Without going to the site, maintenance planning can be developed via web**
- **Direct recording into a 3D model with tablets on-site is an efficient way to share site data without the need for blueprints**


(*)INTEGNANCE VR is developed by Brownreverse which is one of JGC group companies.

# INTEGNANCE VR-Fast Digital Twin Maintenance Viewer

## Key Features




### 3D Simulation

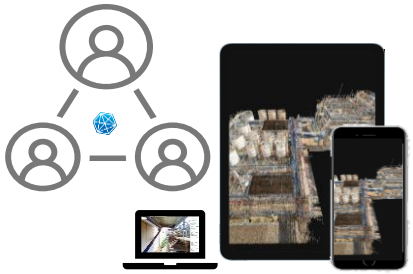
Planning of scaffolding area, Checking of material delivery routes, complicated construction, etc.

### Desktop Survey

Measure the length between two points on the display without reading the drawing or measuring the actual length in the site.

### Anytime Anywhere Access

No special hardware required.
Easy sharing thru URL. collaborative editing by multiple users.



Apps for Windows/iOS

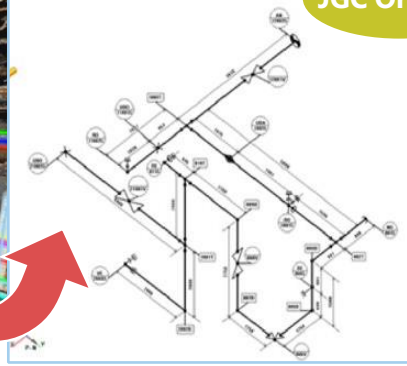
### Automatic Piping Recognition

JGC Original

Mapping of corrosive loops and corrosion /damage focus areas on 360 panorama image

### Automatic Isometric Output

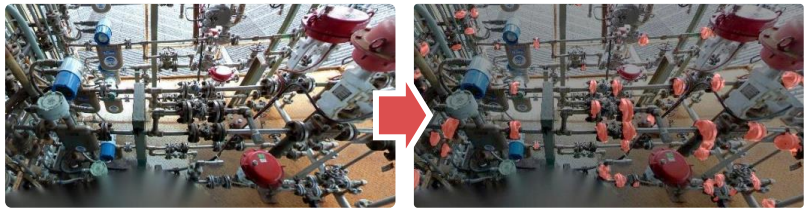
JGC Original



### Automatic Flange/Valve Detection

JGC Original

Auto detection of flanges/valves positions form 360 panorama image by utilizing AI machine learning technology



# INTEGNANCE VR-Fast Digital Twin Maintenance Viewer

Return to Smart O&M Solutions menu

## Use Case

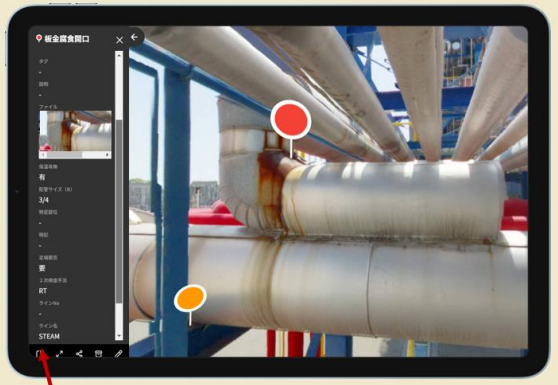
Direct recording of 3D model into tablets on-site saves 22,500hr annually. (45% reduction)

**BEFORE**

- Outdated drawings
- With sketching
- Complicated to manage

- Difficult to identify managing location
- Field survey is essential for planning

**AFTER**



Photographs/details/incidental work, etc.
Record all related information together

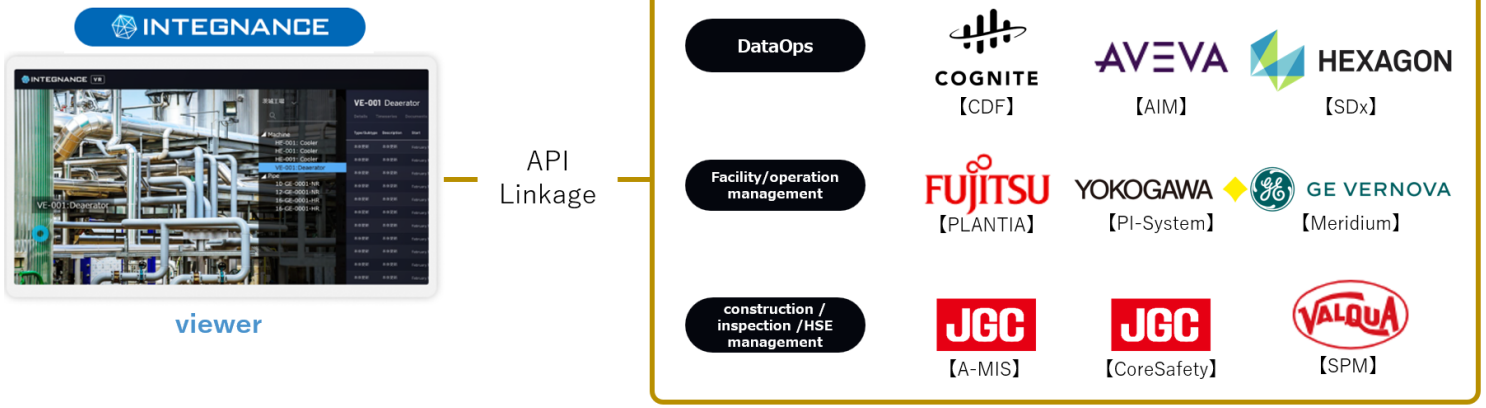
Direct on-site recording
⇒Reduction of time and work for preparation and reporting

Check information all at once
⇒Optimized planning

Record location information
⇒ Efficient information sharing

## System Integration

Integrating data infrastructures with WEB API makes it easier to reference and update related information on INTEGNANCE VR.




## Our Experiences

# Over 50 Sites

INTEGNANCE VR has been adopted to over 50 sites.

**Recent news**:
INTEGNANCE VR was adopted for an ammonia production base in Indonesia for a joint study on reducing GHG emissions.(Sep 2024)

# Operational Excellence Services

## Smart O&M Solutions

### MODS Connect

### Smart Turnaround Management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**Access to MODS Connect**

Industrial Construction Management Software | MODS Connect | MODS

# MODS Connect-Smart Turnaround Management

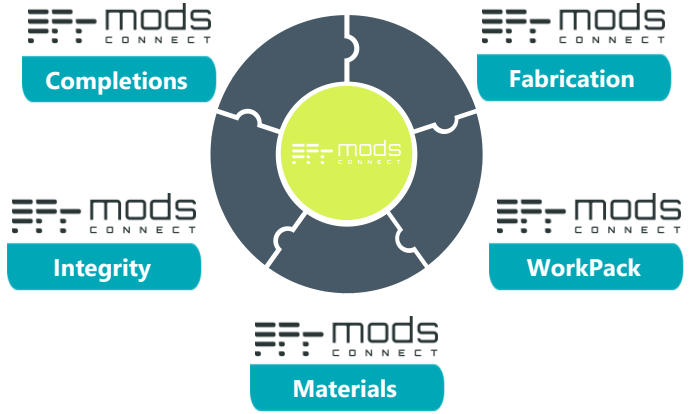
## Do you have any of these issues?

- **Desire efficient information sharing and status update with digital tools during turnaround**
- **Struggling with transitioning to paperless work management**
- **Need to optimize the turnaround plan effectively**

## Concept of MODS Connect for Turnaround

- A cloud-based solution that digitalizes, visualizes and automates Turnaround Project workflows, MODS Connect simplifies processes, improves safety, optimizes cost and time efficiencies.
- It enables remote collaboration and information sharing to help users make best decisions every day from turnaround planning to execution.

As flexible as comprehensive MODS Connect ecosystem includes 5 intelligent modules that connect in any combination.




### > Completions

Facilitate a controlled, staged transfer of responsibility under each discipline via an intelligent centralized database.

### > Fabrication

Intelligently track components throughout the upstream fabrication process to provide transparency, traceability and reliable supply-chain control.

### > Integrity

Provide the digital intelligence to ensure leak-free startup, process safety and major hazard avoidance.

### > WorkPack

Go paperless with digital work packs for more intelligent, transparent and accountable project execution

### > Materials

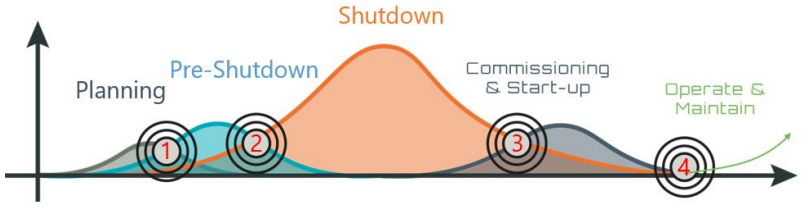
Intelligent inventory control of materials, equipment and components to ensure delivery on time, in sequence and to the correct location.

# MODS Connect-Smart Turnaround Management

Return to Smart O&M Solutions menu

## Seamless Turnaround Management

MODS Connect achieves seamless interface management during turnaround activities




### > 1.Planning to Pre-Shutdown

Manage the pre-shutdown work by assessing risks, scheduling tasks, and preparing resources based on the accumulate past experiences and knowledge in the database.

### > 2.Pre-Shutdown to Shutdown

Assign successors and predecessors to define the path of shutdown work, identify execution requirements to allow constraint management

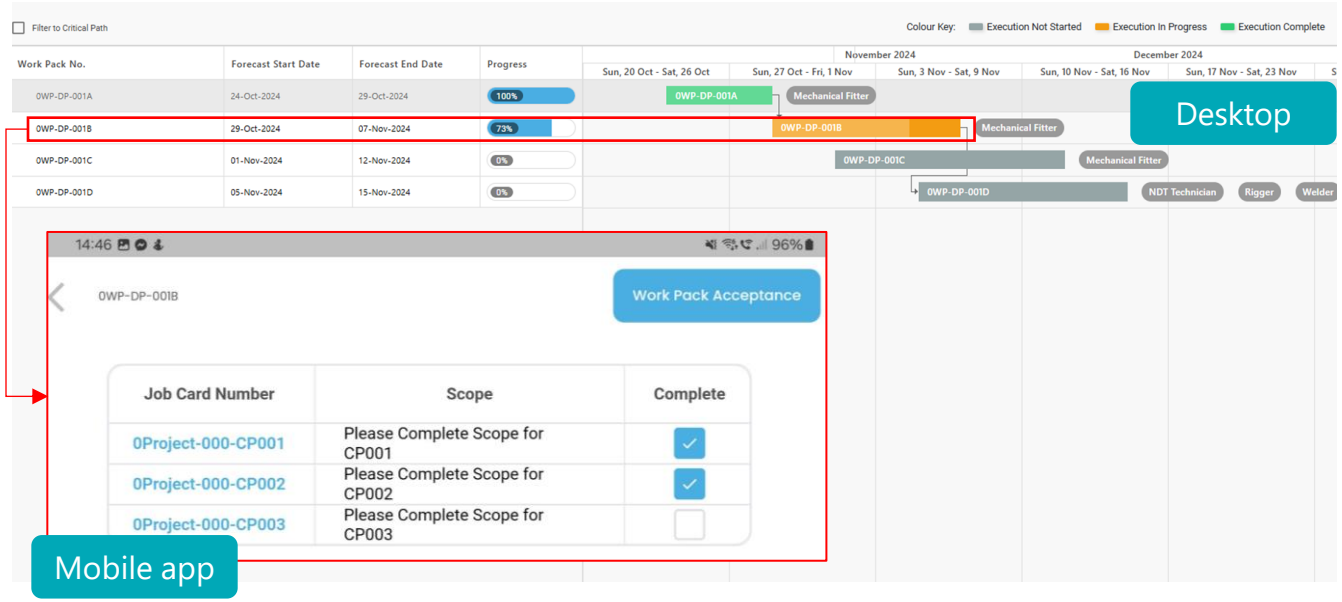
### > 3.Shutdown to Start-up

Monitor shutdown work progress utilizing mobile devices, complete installation and quality records on mobile technology to provide real time tracking.

Visualize shutdown to commissioning handover.

### > 4.Handover

Provide Realtime handover acceptance for operational hand over and stable operations




Gant chart monitoring and managing of activities on desktop and mobile app

## Client's Benefits

- Reduces costs, for example, by reducing time spent searching for data by ~50%.
- Improves safety through transparent, streamlined workflows to minimize risk and increase the awareness of teams.
- Streamlines complex processes and maximizes resource utilization and efficiency.

# Operational Excellence Services

## Smart O&M Solutions

### Piping Remaining Life Prediction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# Piping Remaining Life AI Prediction

## Do you have any of these issues?

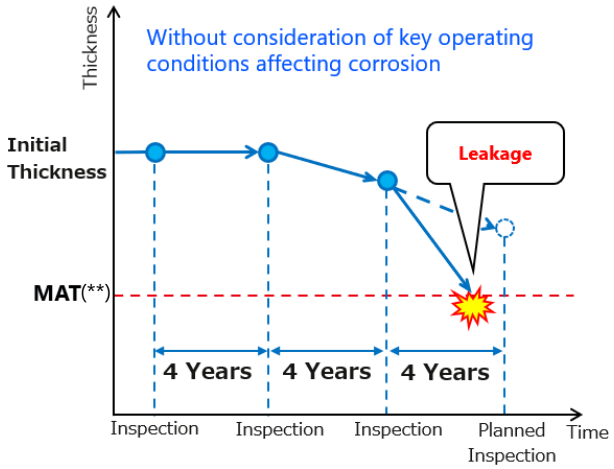
- **Unexpected incidents from piping corrosion**
- **Excessive inspection workload due to numerous TMLs (*)**
  *(Need to focus on critical locations)*
- **Inability to reflect operating condition changes in remaining life**
- **Difficulty securing skilled personnel**

(*) Thickness Measurement Location

## Conventional vs. JGC AI Method

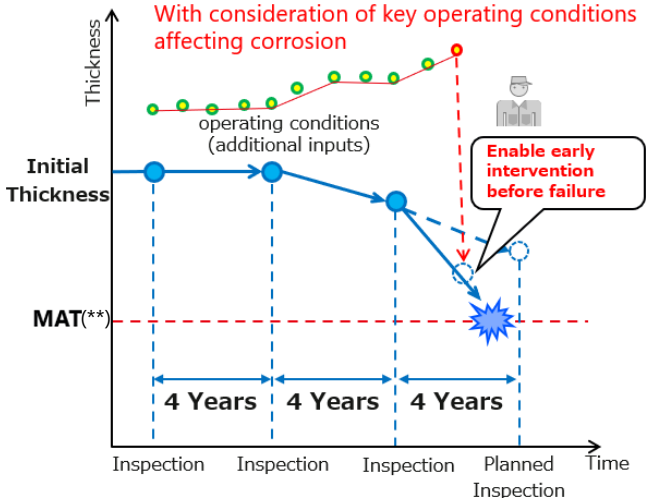
- **Conventional**
  - Based on past thickness data only
  - Static corrosion trend analysis
  - Inspection planning based on historical records
- **New AI Method (JGC solution)**
  - Combines thickness and operating data
  - Dynamic corrosion prediction
  - Data-driven, optimized inspection planning

**Enabling proactive and optimized integrity management**




**Conventional Prediction Methods**

(**) MAT : Minimum Allowable Thickness




**JGC AI-Driven Prediction Method**

# Piping Remaining Life AI Prediction

## Continuous Improvement Through Lifecycle Operation

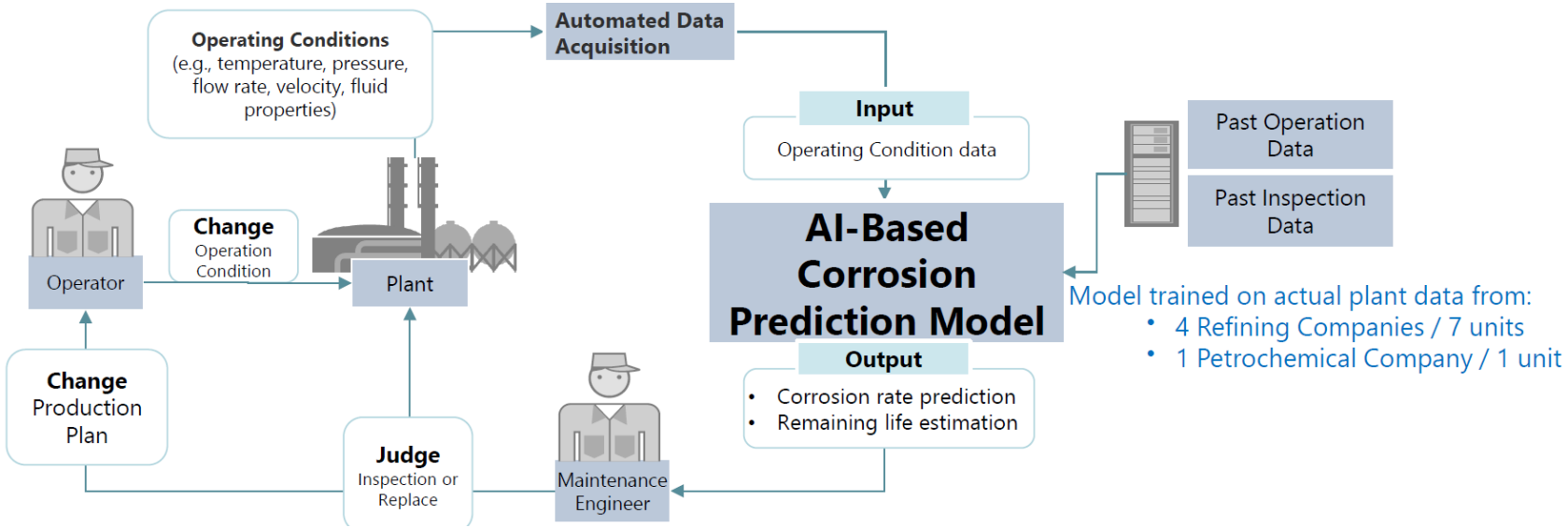
The system continuously improves accuracy throughout the plant lifecycle after initial development, through ongoing operation and periodic updates.

### Development Phase

- Initial AI model training using historical thickness and process data

### Operation phase

- Continuous prediction based on operating data (e.g., flow, pressure, temperature, pH)
- Model updated periodically with new inspection results (e.g., SDM)




## User Benefits

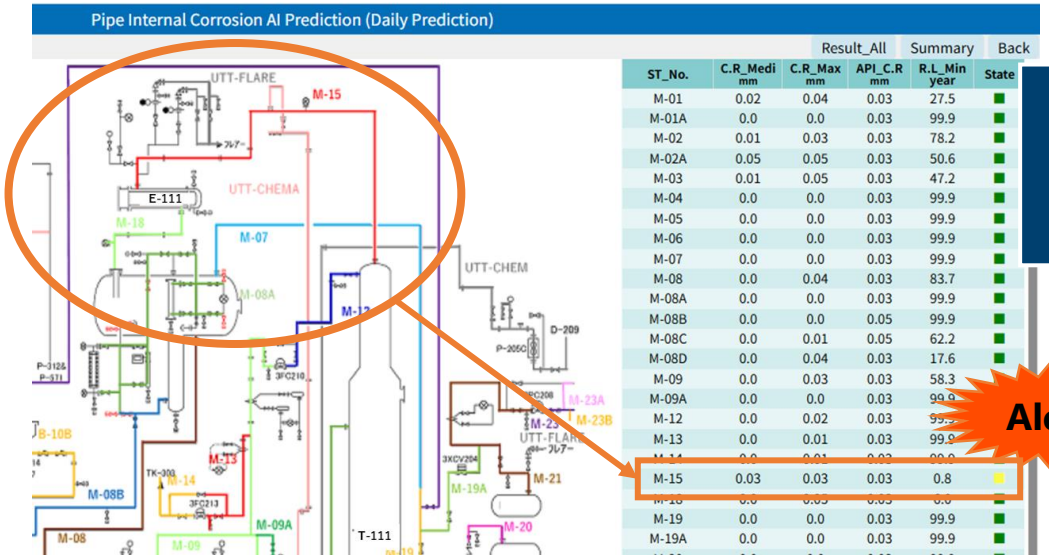
- **Condition-based predictions** under changing operating conditions
- **Highly accurate decisions** regardless of experience
- **Optimized operating conditions** based on corrosion behavior
- **Preservation** and sharing of expert **knowledge**

# Piping Remaining Life AI Prediction

Return to Smart O&M Solutions menu

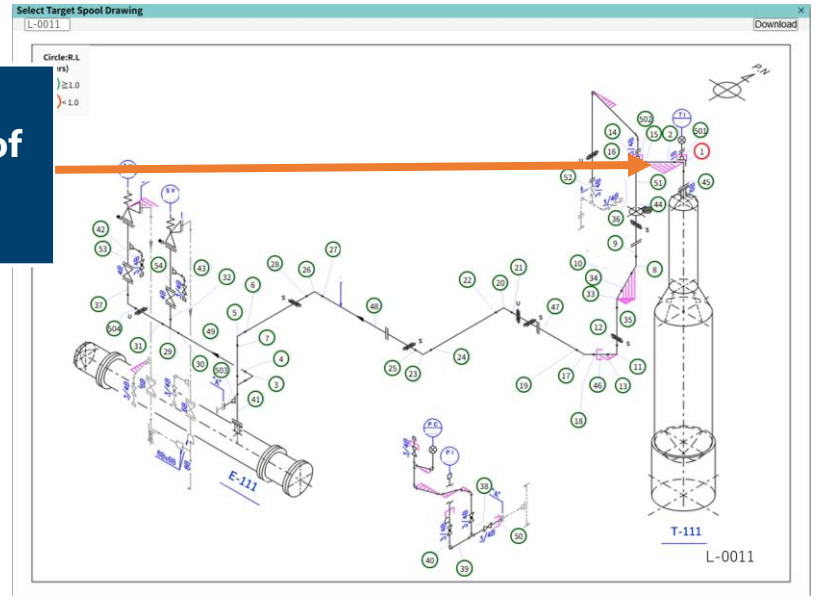
## Key Features

- **Daily Prediction**
  - Predict remaining life based on latest operating data (up to the previous day)
- **Planning Support**
  - Predict remaining life at specific future timings (e.g., next SDM)
  - Enables optimized inspection planning
- **Simulation**
  - Simulate remaining life under planned operating conditions
  - User-defined scenarios can be evaluated in advance




**Enable timely inspection of critical TMLs upon alert**

Click



# Operational Excellence Services

## Smart O&M Solutions

### AI TML Assessment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# AI TML Assessment

## Do you have any of these issues?

- **Experience with unexpected leaks in non-TML (*) piping.**
- **Concerns about adequacy and sufficiency of existing TMLs.**
- **Need for efficient allocation of TMLs for new piping in accordance with standards and regulations.**

(*)TML: Thickness Monitoring Location

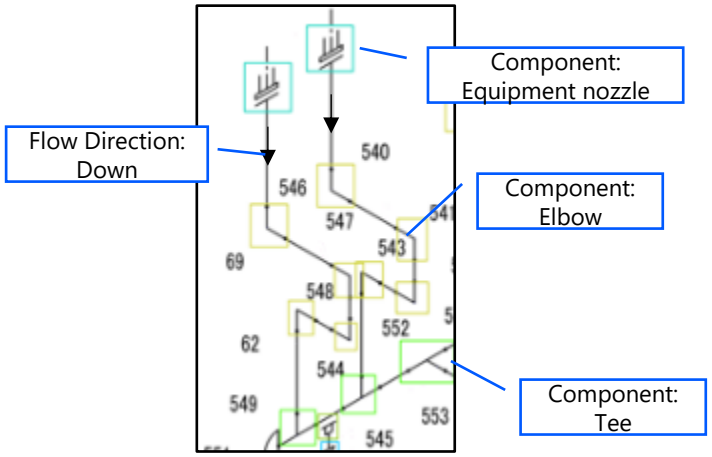
## What our solution is

### 1. Automated Identification of Component & Flow Direction

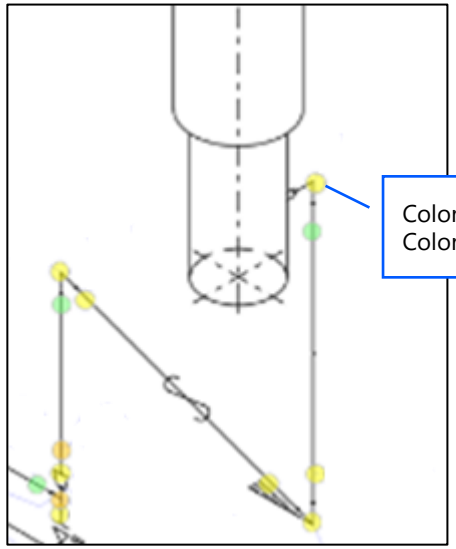
- Reads spool drawings to automatically extract and structure piping components, flow directions, and other related information.

### 2. Rule-Based TML Assignment

- Client-specific TML assignment rules can be pre-set.
  (e.g., place TML on piping at every 50 ft.)
- Then, TMLs are automatically assigned based on pre-defined rules.




**1. Automated Identification of Component & Flow Direction**



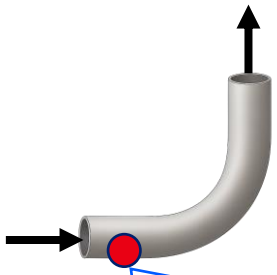

| Category | Inspection Interval |
|---|---|
| A | 2 years |
| B | 3 years |
| C | 4 years |
| D | 5 years |
| E | No fixed cycle / Opportunistic |

**2. Rule-Based TML assignment**

# AI TML Assessment

## TML Assignment Flow

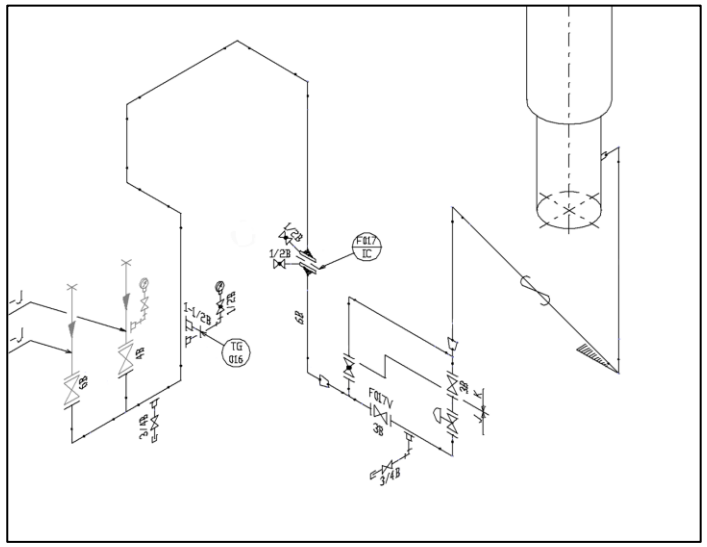
### Rule Definition



e.g.,
- TML position: Upstream side of an elbow
- Flow direction
  Downstream: Up
  Upstream: Horizontal
- Inspection interval: Every 5 years

- Defines rules for assigning TMLs to piping locations based on client's standards and/or procedures.

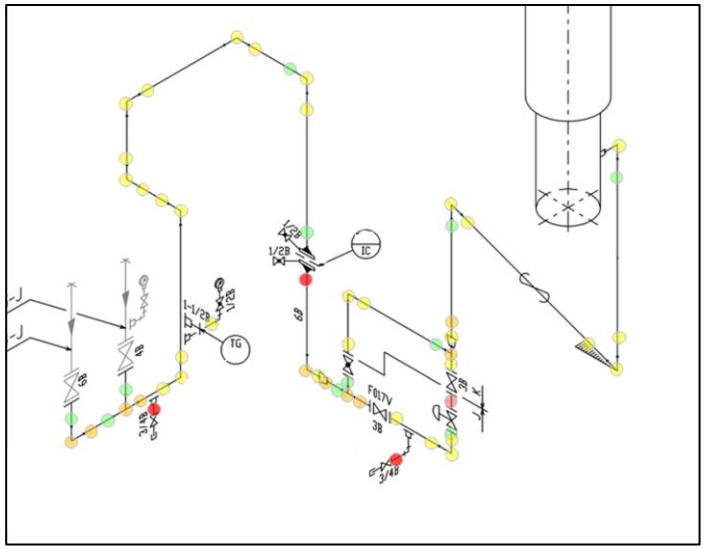
### Spool Drawing Input



- Supports multiple spool drawing formats (e.g., AutoCAD, PDF)

Note:
Can process 100 drawings in two weeks

### Automated TML Assignment



- Automatically assigns TMLs based on identified components, flow direction, and pre-defined rules.

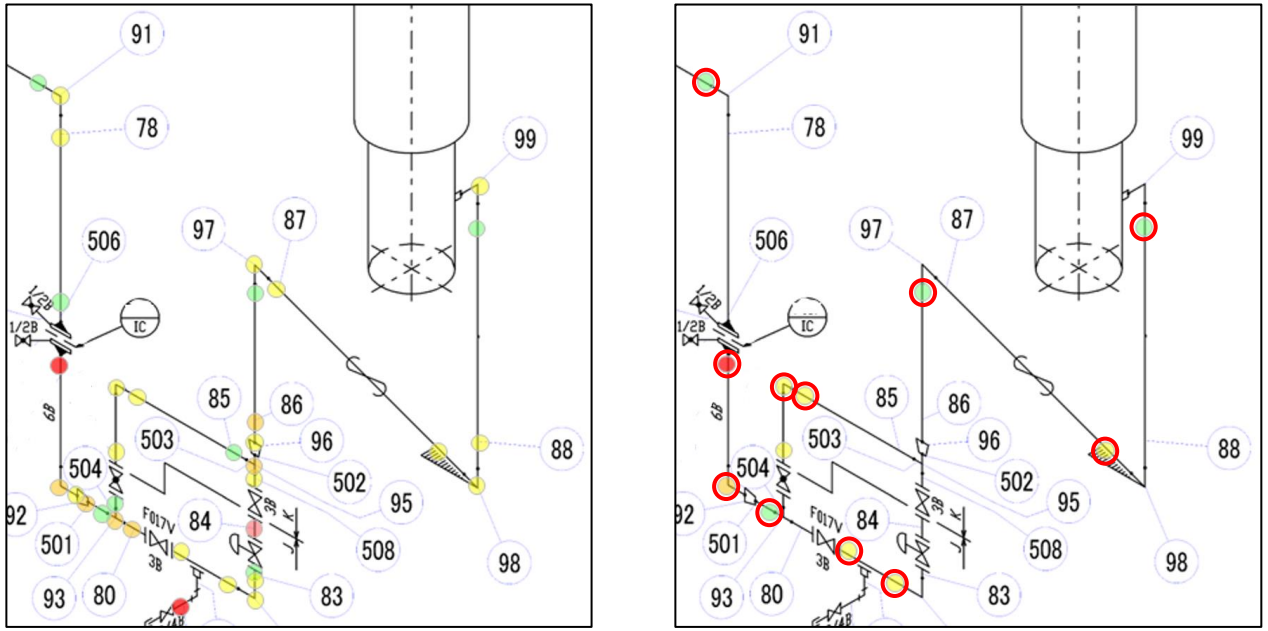
Note:
Colored dots : System-assigned TML.

# AI TML Assessment

Return to Smart O&M Solutions menu

## Identify Gaps in TML Coverage

- The system can compare existing TMLs with AI-recommended TMLs to identify gaps.
- The user can evaluate whether existing TML coverage is sufficient.




Note:
Right: System-assigned TMLs
Numbers: Existing TMLs
Red circles: Missing TMLs (gaps)

## User Benefits

- **Full Visibility Beyond TMLs**

  Enables complete TML visualization, including areas without predefined TMLs.

- **Rule-Based TML assignment**

  Automatically identifies inspection points and highlights missing TMLs.

- **Reduce engineering hours and human error**

  Eliminate manual drawing interpretation and reduce human error.

- **High-Speed Processing**

  Process 100 drawings in just two weeks.

# Operational Excellence Services

## Smart O&M Solutions

### INTEGNANCE TR

### Predicting Failure of Rotating Machinery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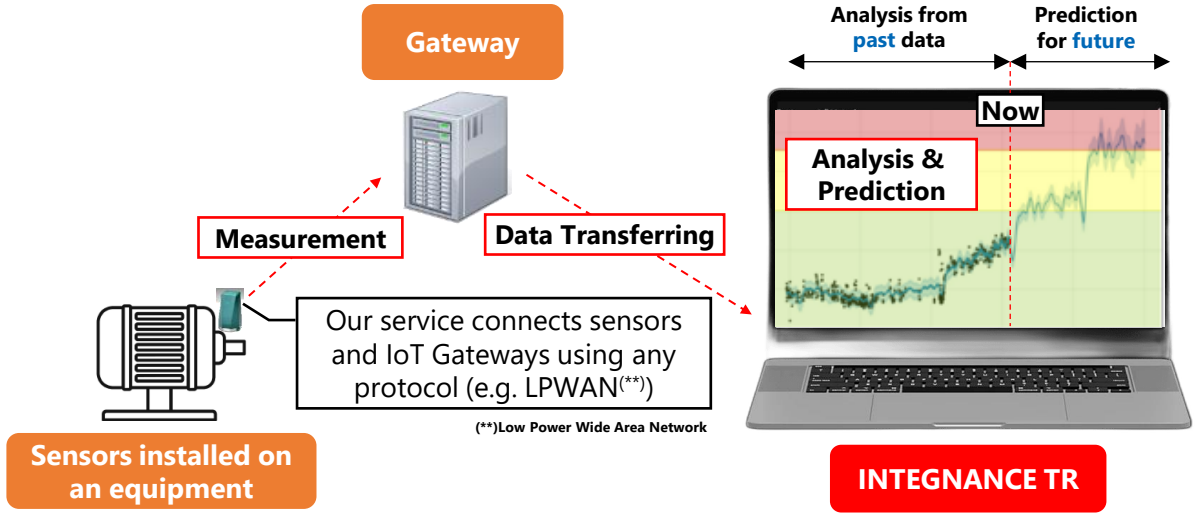
# INTEGNANCE TR-Predicting Failure of Rotating Machinery

## Do you have any of these issues?

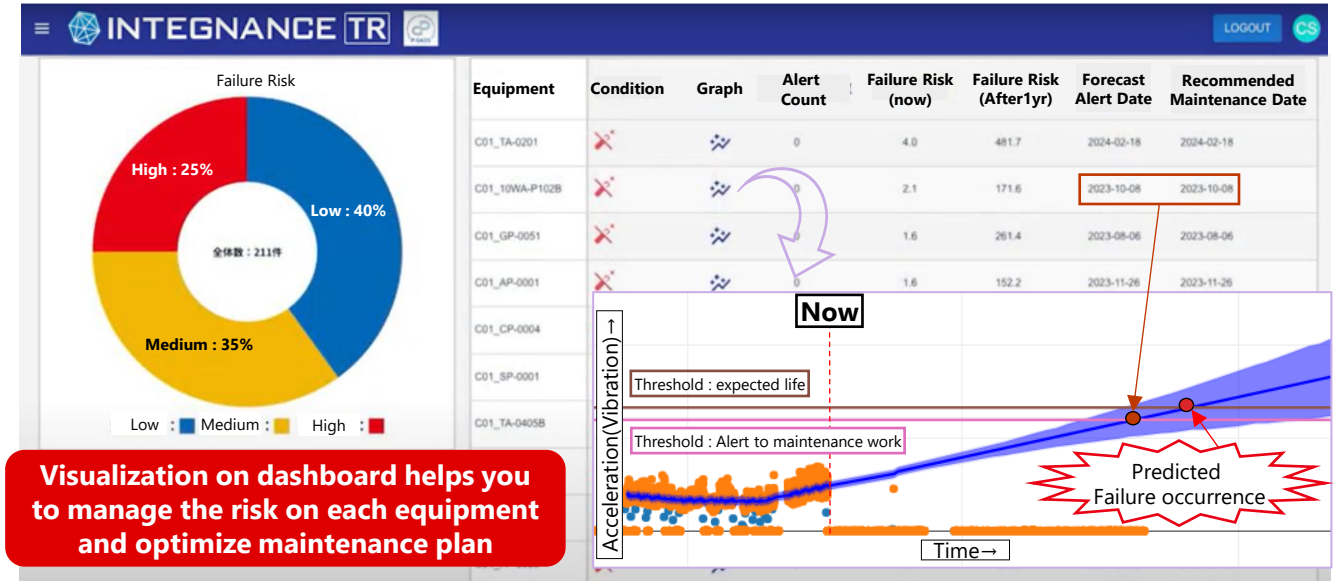
- **Need to predict failure event to minimize production loss**
- **Need to optimize maintenance plan and cost for rotating machinery with or without existing sensors**
- **Struggling to accumulate maintenance knowledge**




## What is INTEGNANCE TR(*)

- **Web-Based Analysis Tool:**
  INTEGNANCE TR, one of JGC in-house software, analyzes and visualizes the predicted condition of rotating machines by modeling time series data from sensors (e.g., vibration, temperature).
- **One-Stop Service:**
  Provides comprehensive services, including the installation of sensors and gateway devices to connect equipment to the cloud, AI modeling, and cloud-based visualization, all with secure data transfer protocols.

(*)Time series regression forecast for Rotating machinery




**Visualization on dashboard helps you to manage the risk on each equipment and optimize maintenance plan**

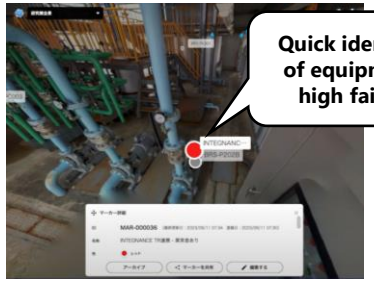
# INTEGNANCE TR-Predicting Failure of Rotating Machinery

## Linkage with Virtual Reality

- **VR-Based Visualization (INTEGNANCE VR)**
  Visualize equipment and failure risks from INTEGNANCE TR in a 3D plant.
- **Faster Anomaly Response**
  Technical staff can quickly identify issues and take action using 3D visualization.


INTEGNANCE TR

INTEGNANCE VR See Details




INTEGNANCE VR
(Fast Digital Twin Maintenance Viewer)

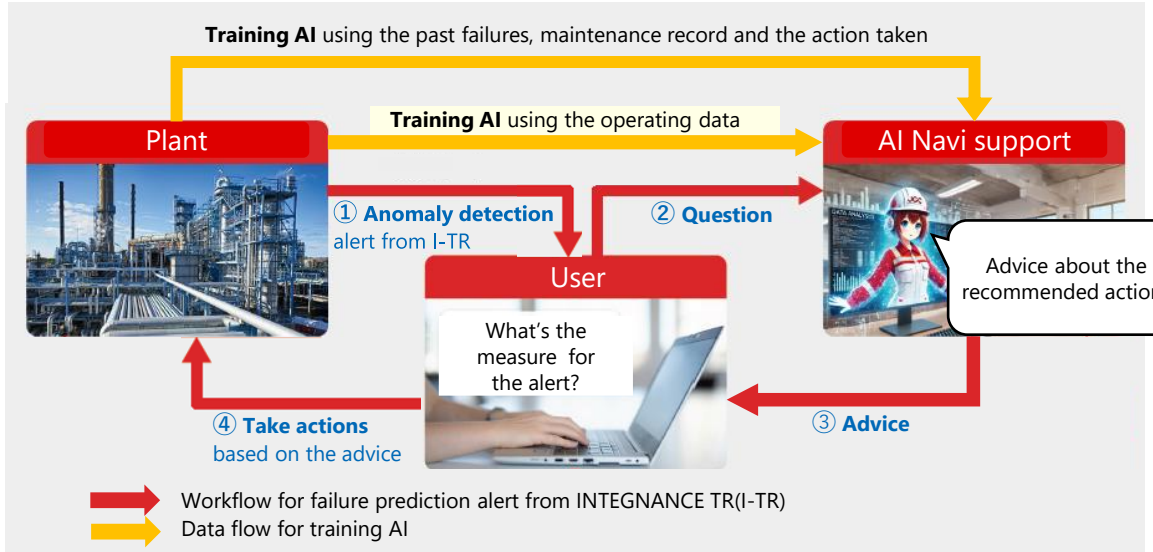
## Our Strengths

- **Customized AI Algorithms:**
  Leveraging extensive plant engineering expertise, we develop tailored AI algorithms for specific equipment and situations.
- **Flexible Integration:**
  Our system seamlessly connects with sensors from any vendor.
- **Cost-Effective:**
  We offer low implementation and licensing costs.

## Future Features of INTEGNANCE TR

- **AI Navi (*) Integration:**
  Get advice based on past failures, actions taken, and operating data.
- **Prescriptive Maintenance:**
  Combining INTEGNANCE TR and AI Navi for proactive solutions.
- **Knowledge Standardization:**
  AI Navi captures and standardizes expert knowledge for sustainable transitions.

(*)AI Navi is under development by JGC



# INTEGNANCE TR-Predicting Failure of Rotating Machinery

Return to Smart O&M Solutions menu

## Use Case : Failure Prediction in Oil Refineries

### Client: Japanese oil refinery

- Requires a maintenance for the equipment in offsite area
- Approximately 300 rotating machinery with a sensors which cause alarms when their value is over the threshold.
- The alarms included non-critical alarms such as spike noise, false alarms.

### Client benefit

- **Prevent Unexpected Shutdowns:**
  Timely maintenance prevents unexpected equipment failures.
- **Remote Monitoring:**
  Expanded from 300 to 800 rotating machines monitored remotely.
- **Reduced Maintenance Costs:**
  Optimize maintenance schedules to reduce costs.

**Pilot Implementation** → **Full-scale Operation**

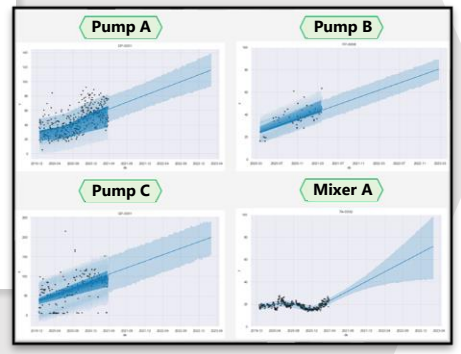
### Initial Setup

- **Utilize Existing Sensor:**
  Identified a vibration acceleration was most valuable data and utilized existing sensor.

- **AI Model Development:**
  Developed and trained an AI model using past sensor data.

### Validation of AI model

- **Trend Detection:**
  Identified increasing vibration acceleration trends in various types of rotating machineries.
- **Condition Check:**
  Client inspections confirmed failure symptoms actually in these rotating machineries.




### Go Live and Roll Over

- **Go Live:**
  Full-scale operation of INTEGNANCE TR has been commenced.
- **Roll Over:**
  Expansion of INTEGNANCE TR in the Client's other two plants as well and monitored approximately 800 rotating machineries in total.

# Operational Excellence Services

## Smart O&M Solutions

### Plant Smartification with AI Technology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# Plant Smartification with AI Technology

## Do you have any of these issues?

- ☹ Lack of specific expertise for O&M improvement
- ☹ Decline in productivity due to plant aging
- ☹ Accumulated large amount of data but not being used
- ☹ Knowledge gained through the experience of senior O&M personnel is not shared well with other members of the team.

## Why choose an AI Solution with JGC

| | |
|---|---|
| **Know your Process Design** | Extensive achievement in process engineering for various types of EPC project |
| **Longstanding O&M Service** | Our team has wide knowledge and experience in O&M service |
| **Multi-field Engineers** | Our engineers can propose AI solution with multiple fields including process, pressure vessels, rotating equipment, static equipment, electrical, instrumentation, HSE, etc. |
| **Excellent AI experts** | Extensive successful experience in providing AI solutions and well-developed implementation methodology. |
| **30+ Cases** | Prediction of catalyst degradation, Digital systemization of O&M, Equipment Failure Prediction System…etc. |
| **Various Types of Facilities** | Oil Producing, Power Plant, LNG Plant, Chemical plant, Space station, Waste treatment plant…etc. |

# Plant Smartification with AI Technology

## Our Solution

**Operation Visualization**

**Visualize plant operation data** to intuitively determine operating conditions

**Anomaly Detection**

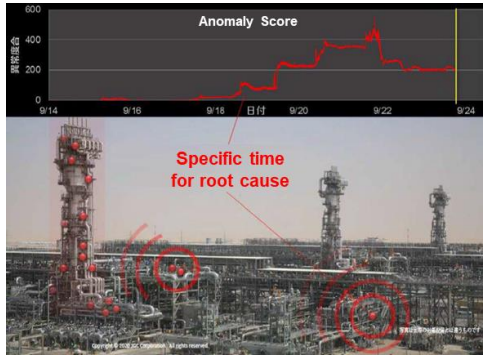
**Quickly detect abnormalities and analyze causes** to prevent any unforeseen events and trouble

**Prediction of age-related deterioration.**

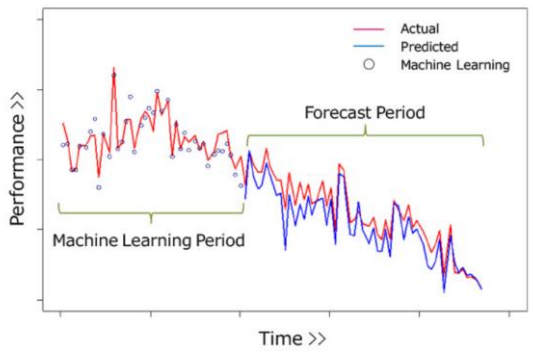
**Predicts age-related deterioration** of catalysts, solvents, etc., and suggests optimal replacement times.

**Productivity Improvement**

**Incorporating external factor** such as climate data into operational data analysis to improve productivity




**Trace the process determine the cause**




**Time-dependent catalyst deterioration**

## Our Approach

**Workshop**

**Proposal**

**Contract**

**Mobilize Team and Engineer**

Discussions between client and JGC data analysis engineers (1.5-2 hours/workshop x 1 or more times as required).

- Identification of customer recognized and potential issues
- Planning of problem-solving measures
- Confirmation of quantity and quality of data required for data analysis

Offer the best methods such as:

- Report on cause investigation, etc.
- AI software (GUI of customer's choice)
- Automation system
- Image identification equipment
- Consultant for customer's AI construction and use

**AI Digital Solution**

# Case Study: Analysis equipment clogging factors in Chemical plant

Return to Smart O&M Solutions menu

## (1) Issue

☹ **Equipment clogging occurs frequently**

☹ To clean the clogging, the plant had to be shutdown and resulting in a **significant loss of production.**

☹ Difficult to analyze **the large number of operating conditions** under which clogging occurs.

## (2) Our Solution

**Step-1** To develop AI model based on algorithms for LightGBM Classifier model to investigate operating conditions during clogging for the past 10 years

**Step-2** The model calculates clogging in real time during operation and extracts operational factors (e.g., sensor values) related to blockages sequentially.

**Step-3** Approximately 20 factors representing operating conditions that contribute to blockage were found. The top three factors were visualized as a three-dimensional plot. **(Fig. 1)**

**Step-4** The result allows engineers to properly analyze the elements causing the clogging and develop an efficient solution.

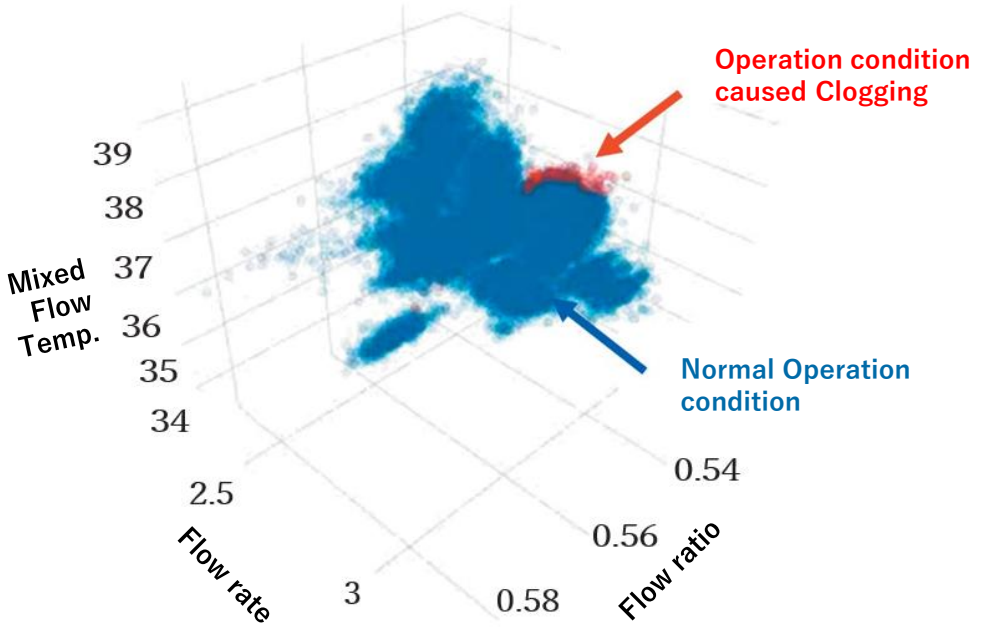



**Fig.1 3D visualization of elements causing clogging**

## (3) Client's Benefit

Improved productivity was achieved by operating to prevent clogging