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Artificial Intelligence (AI) for Manufacturing Workshop

Industrial AI Agents Beyond RAG: OT Data, STAMP Reasoning, and Deployment Barriers

- Field-Oriented Lessons from HMAX Industry Use Cases at Hitachi

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Kentaro YOSHIMURA R&D Group, Hitachi, Ltd.
Yoichi NONAKA R&D Group, Hitachi, Ltd.

1-1. Self Introduction: AI for Industrial and Safety-Critical Systems

Kentaro Yoshimura, Ph.D.
Principal Researcher, Hitachi, Ltd.

Research focus:
- AI-enabled engineering and safety systems
- Industrial and mobility applications
- Reliable deployment of AI in real-world control systems

Background:
- Software engineering
- Embedded control systems
- Operational technology

1-2. Our Business

Hitachi combines digital and AI technologies into real-world systems to **transform businesses and society more sustainably**.

HMAX：a suite of next-generation solutions that brings the power of AI to social infrastructure (Recurring service)

1-3. Partnering to accelerate AI innovation

Build a generative AI ecosystem leveraging the strengths of global partners

NVIDIA

HITACHI
Inspire the Next

Microsoft
Google Cloud
aws

Advanced AI software GPU technologies	IT × OT × Products Domain knowledge	Generative AI Cloud technologies and services

Examples of initiatives with each partner

Collaborative development of AI solutions

- "Hitachi iQ" with advanced GPU and next-generation storage
- Apply AI solutions to the OT domain such as energy and railways
- Advanced hybrid cloud solutions
- Establish Center of Excellence(CoE)

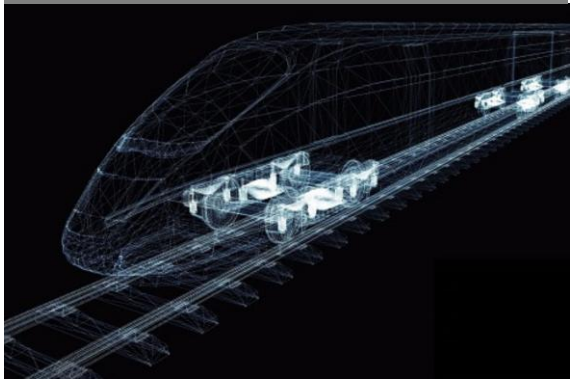
Talent development

- Develop highly-skilled engineers with deep knowledge of generative AI and cloud computing
- Significant improvement in internal productivity

1-4. HMAX by Hitachi: Industrial AI Built on Digitalized Assets and Domain Knowledge

From large-scale infrastructure → to factory deployment → to human–AI–robot coordination

Railway



- Large-scale deployment in railway asset management
- Continuous monitoring and optimization using OT data and AI

Source: Hitachi Rail, "Hitachi Rail Unveils the 'HMAX' AI Solution, Accelerated by NVIDIA, to Optimize Trains, Signaling and Infrastructure", Sep. 24, 2024.

Manufacturing

- Field-deployed an AI agent for equipment failure diagnosis
- Supports new failure analysis beyond past-case retrieval

Source: Kentaro Yoshimura, et al., "Generative AI Meets Operational Technology - A New Era in Equipment Failure Diagnostics", 2025 IEEE Enterprise Generative AI Summit, Aug. 21, 2025.

Kentaro Yoshimura, et al., "Managing Variability in Industrial AI Agents for Manufacturing: Experiences at Hitachi", CAIN2026, Apr. 12, 2026.

Frontline coordination

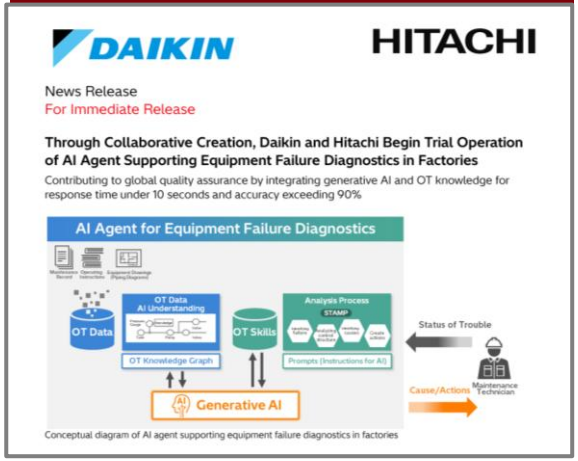
- Human–AI–robot collaboration platform
- Enables integration of knowledge, digital space, and physical operations

Source: Hitachi, "Hitachi develops 'Frontline Coordinator – Naivy' as a next generation AI agent", July 3, 2025.

2-1. Focus Case: STAMP-Based AI Agent Deployed in Real Factory Environments

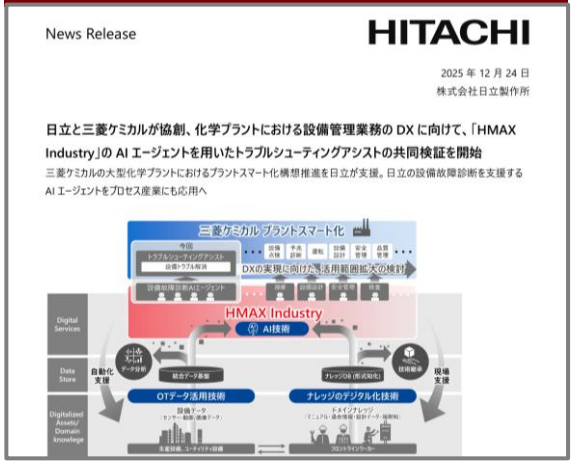
Today's discussion is based on field deployment and released solutions, not only laboratory evaluation.

Apr. 2025



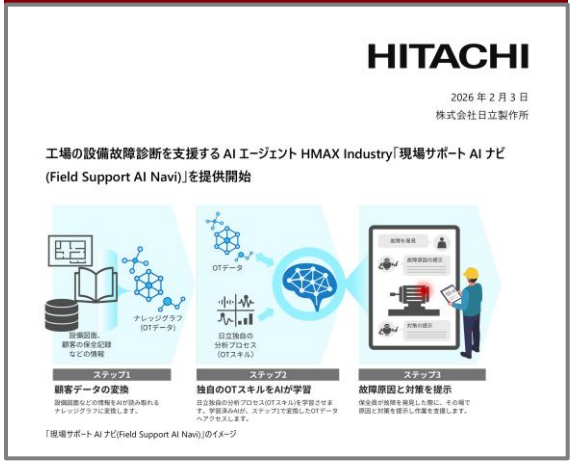
- Trial operation with Daikin for AI agent-based equipment failure diagnosis

Dec. 2025



- Joint verification with Mitsubishi Chemical for troubleshooting assistance in chemical plants

Feb. 2026

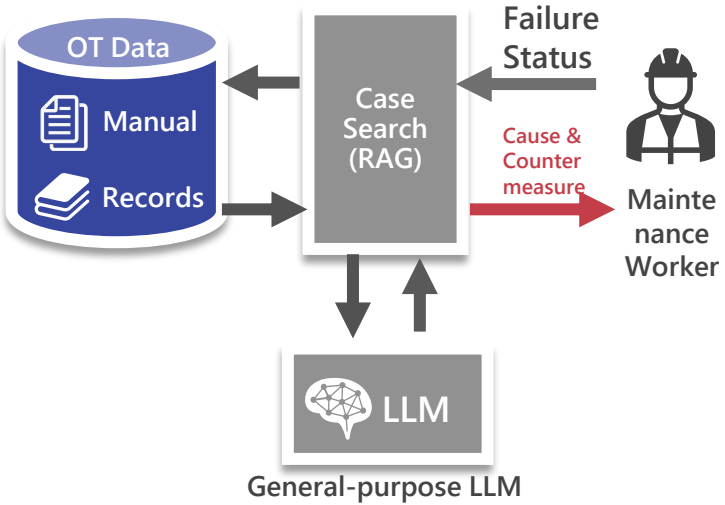


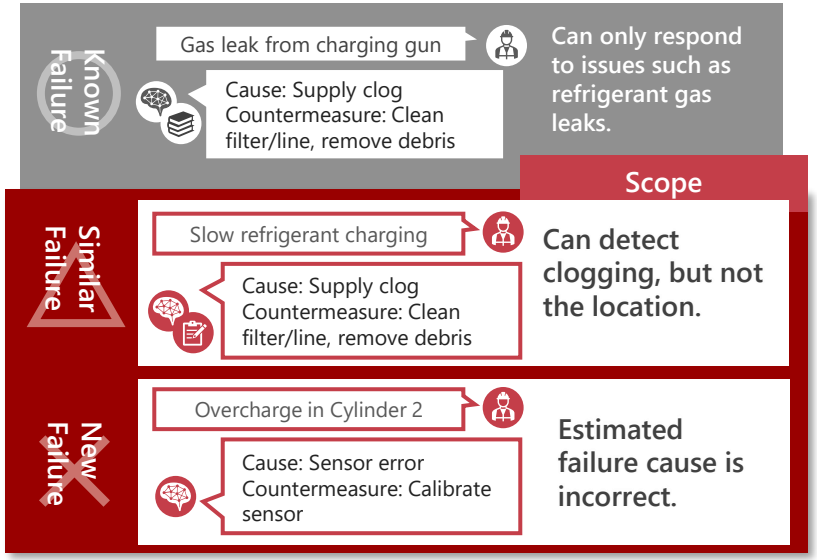
- Product release of HMAX Industry "Field Support AI Navi"

2-2. Field Lesson from Daikin Pilot: Why RAG Alone Was Not Enough

RAG is useful, but not sufficient for breakdown maintenance involving new failure modes.

Initial PoC Configuration



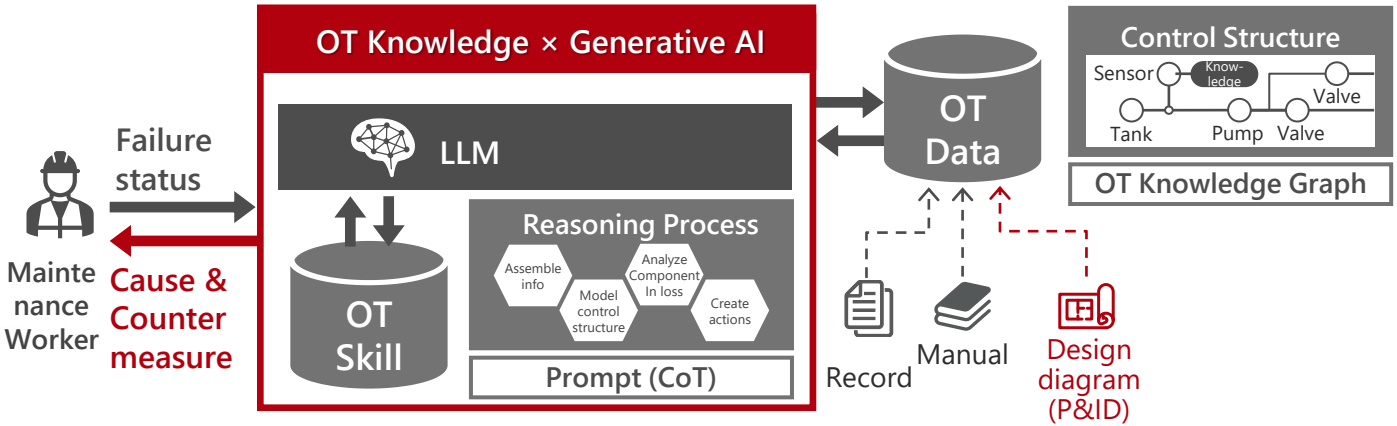


LLM: Large Language Model,
RAG: Retrieval-Augmented Generation

2-3. Overview of the STAMP-Based AI Agent for Root Cause Analysis

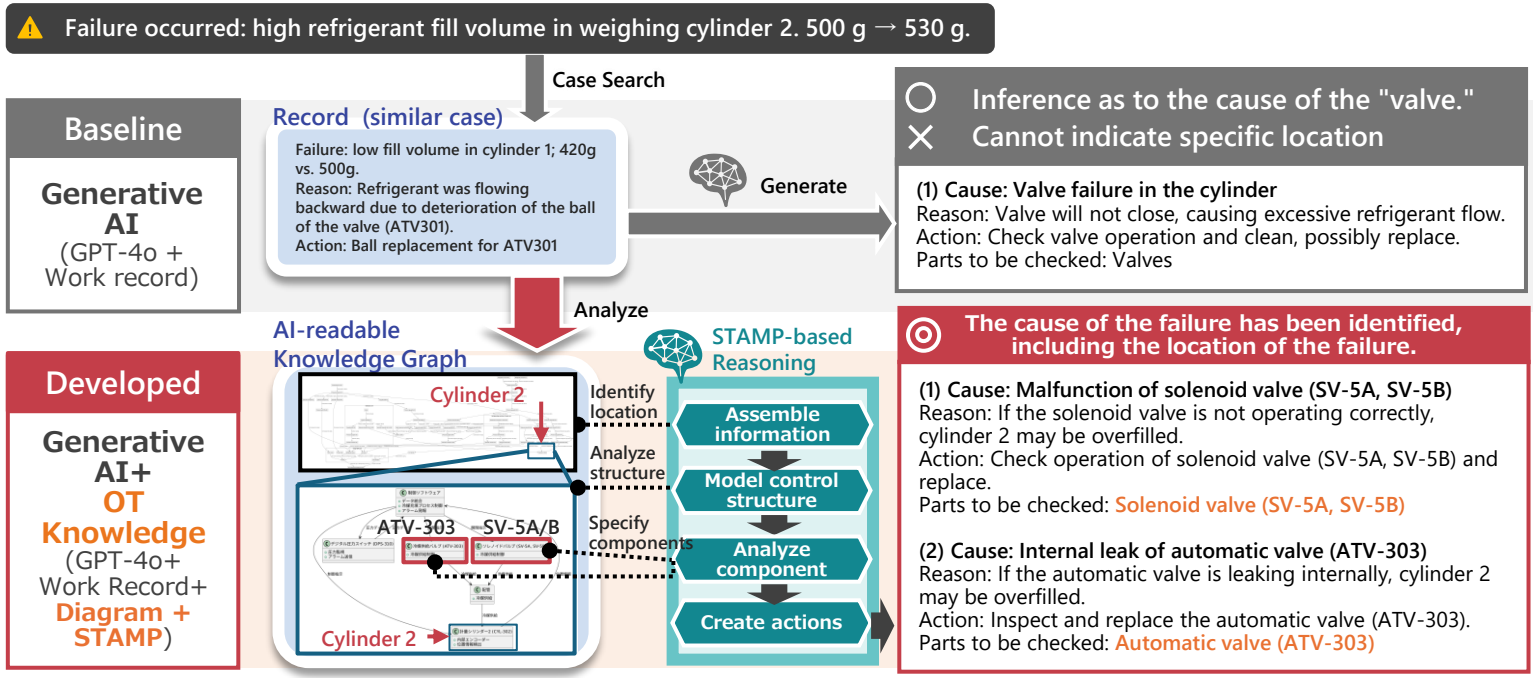
Design diagrams are converted into OT data, and analysis processes are modeled as OT skills to support on-site operations.

Feature	Design diagrams are converted into a knowledge graph, and a systematic cause analysis skill “STAMP/CAST” is applied for reasoning using generative AI.
Value	Estimation recall for causes and countermeasures: 90% (equal to or better than average maintenance engineers), with responses in under 10 seconds. (Baseline: recall 67% (LLM+RAG))



2-4. Daikin Use Case: Component-Level Diagnosis and Actionable Maintenance

Result: From vague cause estimation → to component-level diagnosis and actionable maintenance

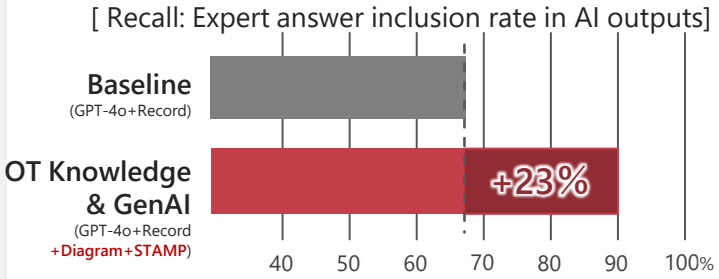


2-5. Performance Evaluation by Expert Maintenance Personnel

Rated by experts as practical on site and comparable to field maintenance work.

Evaluation results

- Improved by 23% over baseline AI, highly rated as “outperforming novice staff.”
- Validated in pilot operation in real factory environments (since April 2025)



Comments from Experts

"**As accurate as the** current **average worker, and in some situations outperforms them.**"

"**The more complex the failure situation, the** AI that has not read the drawings will give the wrong answer, but **the AI that has read the drawings will give the correct answer and is superior.**"

"By having them read the drawings, we're able to **identify specific failure factors**, and they're **at a level where we can use them in the field**."

3-1. From Data to Action: How Industrial AI Works in Real Environments

Industrial AI agents require OT data that is not only digitized, but semantically usable.

Codification of domain knowledge × **Operation and control based on domain knowledge**

Digital

Store

Extraction of customer knowledge
Codifying data into safely and immediately usable knowledge

AI

Transfer of data semantics and relationships

Think

Value realization through AI
Safety, productivity, quality, and environmental performance

AI

Physical

Sense

Field data	Explicit knowledge	Tacit knowledge
• Operation data • Sensor measurements • Image data	• Procedures / Manuals • Work records • Management records	• Expert know-how • Craftsmanship • Person-dependent tasks

Act

Products + Edge AI

Production equipment (PA / FA)

3-2. Deployment Barrier 1: AI-Ready OT Data

Industrial AI agents require OT data that is not only digitized, but semantically usable.

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Digital

Store

Transfer of data semantics and relationships

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Field data	Explicit knowledge	Tacit knowledge
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Key barriers:

- Legacy diagrams and documents
- Inconsistent notations and missing information
- Converting P&ID, ladder logic, and equipment diagrams into AI-ready structures
- Validating whether extracted semantics are sufficiently accurate for reasoning

3-3. Deployment Barrier 2: Deterministic Real-Time Assurance under Safety Constraints

For industrial AI to move from assistance to autonomy, deterministic real-time assurance based on safety constraints will be as important as the AI model itself.

Codification of domain knowledge × **Operation and control based on domain knowledge**

Digital

Store → Transfer of data semantics and relationships → Think

Extraction of customer knowledge

Value realization through AI
Safety, productivity, quality, and environmental performance

Think → Act

Physical

Industrial AI agents must be integrated with:
- **Explicit safety constraints**
- **Deterministic real-time assurance**
- **Runtime monitoring and intervention mechanisms**

- Operation data
- Sensor measurements
- Image data

- Procedures / Manuals
- Work records
- Management records

- Expert know-how
- Craftsmanship
- Person-dependent tasks

Products + Edge AI

Production equipment (PA / FA)

4. Key Takeaways for Industrial AI Deployment

The value of industrial AI is not only intelligence, but its ability to operate reliably and safely in the real world.

1. Industrial AI requires more than RAG
   → AI-ready OT data and domain-specific reasoning are essential

2. Deployment reveals real barriers
   → Data quality, semantics, and assurance for safety-critical applications

3. Future systems must integrate AI with real-time assurance
   → Deterministic control based on explicit safety constraints

Industrial AI must be evaluated not only by answer accuracy,
but also by deployability and safe operation in real environments.


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