HITACHI
Inspire the Next

Anomaly Detection Solutions for Improved Equipment Availability

Big Data is the enabler for Hitachi's Anomaly Detection Technology

Advances in ICT have made it easy to collect and store massive amounts of operational data for a large number of devices. However, in many cases the data is not being used effectively.

Effective use of this "big data" can provide advance warning of problems and device status changes, leading to higher availability of plant.

Combining our maintenance service expertise with big data mining technology, Hitachi has developed an anomaly detection system.

Benefits of Hitachi's Anomaly Detection System

01

Reduce Maintenance Cost and Duration

Carrying out maintenance in accordance with equipment status lowers the time and cost of maintenance, improves availability

02

Reduce Unplanned Production Loss

Helps prevent losses from unexpected production facility shutdowns, and improves availability

03

Automated Diagnosis

Equipment status diagnosis previously required manual application of specialist engineering knowledge

04

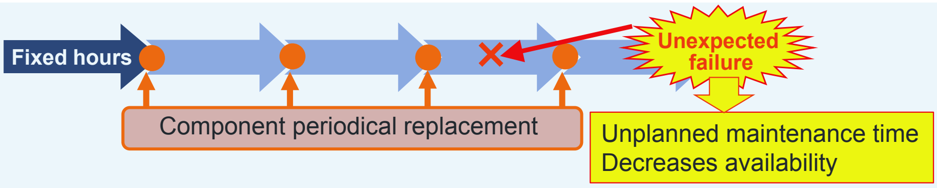
Enabler for Advanced Maintenance Strategies

Condition-based, risk-based maintenance

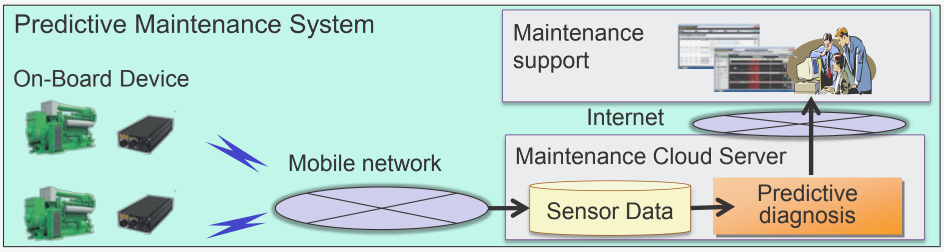
Applications

- Predictive Failure Analytics
- Condition Based Maintenance

Conventional Maintenance: Preventive maintenance with periodical inspections and parts replacements. Unexpected failures occur between intervals of periodical maintenance.



Predictive Maintenance: Collects sensor data in real time and predicts potential failures before machines break down.



Anomaly Detection Algorithms

The anomaly detection system uses our Vector quantization clustering (VQC) and local subspace classifier (LSC) algorithms.

These perform machine learning on normal-status sensor data and create indicators of differences between the data to be monitored and the learned normal data group. The system then evaluates whether the result is normal or abnormal.

Traditional Methods such as the Mahalanobis-Taguchi (MT) system can only be applied when sensor data has a normal distribution.

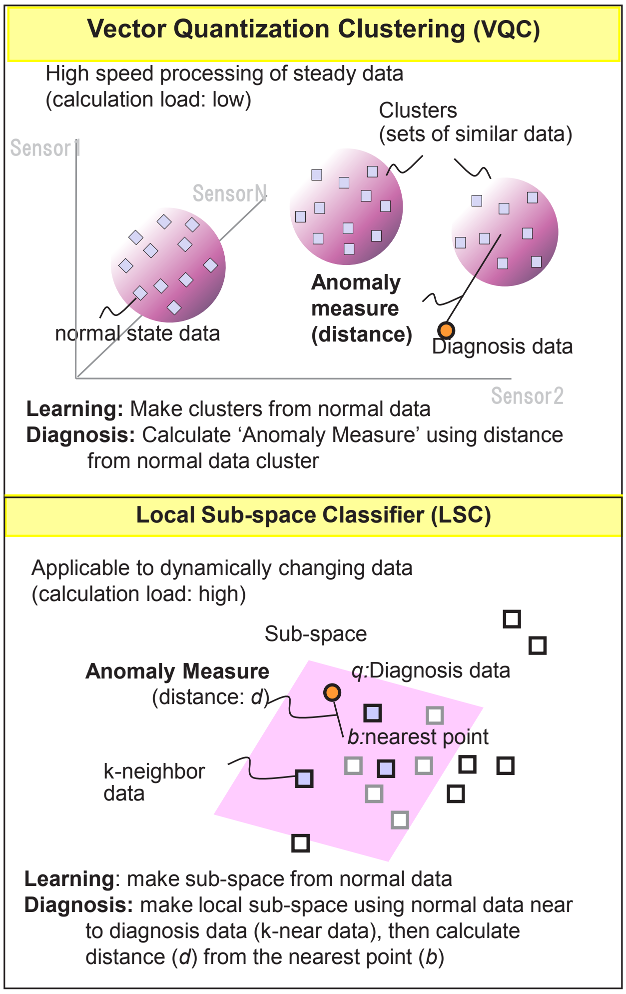
Hitachi's algorithms are resistant to affects from the data distribution.

Since the algorithms are model-free, they can respond flexibly without the need for model construction or simulations for each status change, even when there is a major change in a device or system operation status.

The optimum system configuration uses each algorithm separately according to the device or system to be monitored, or to the characteristics of the abnormality to be detected.

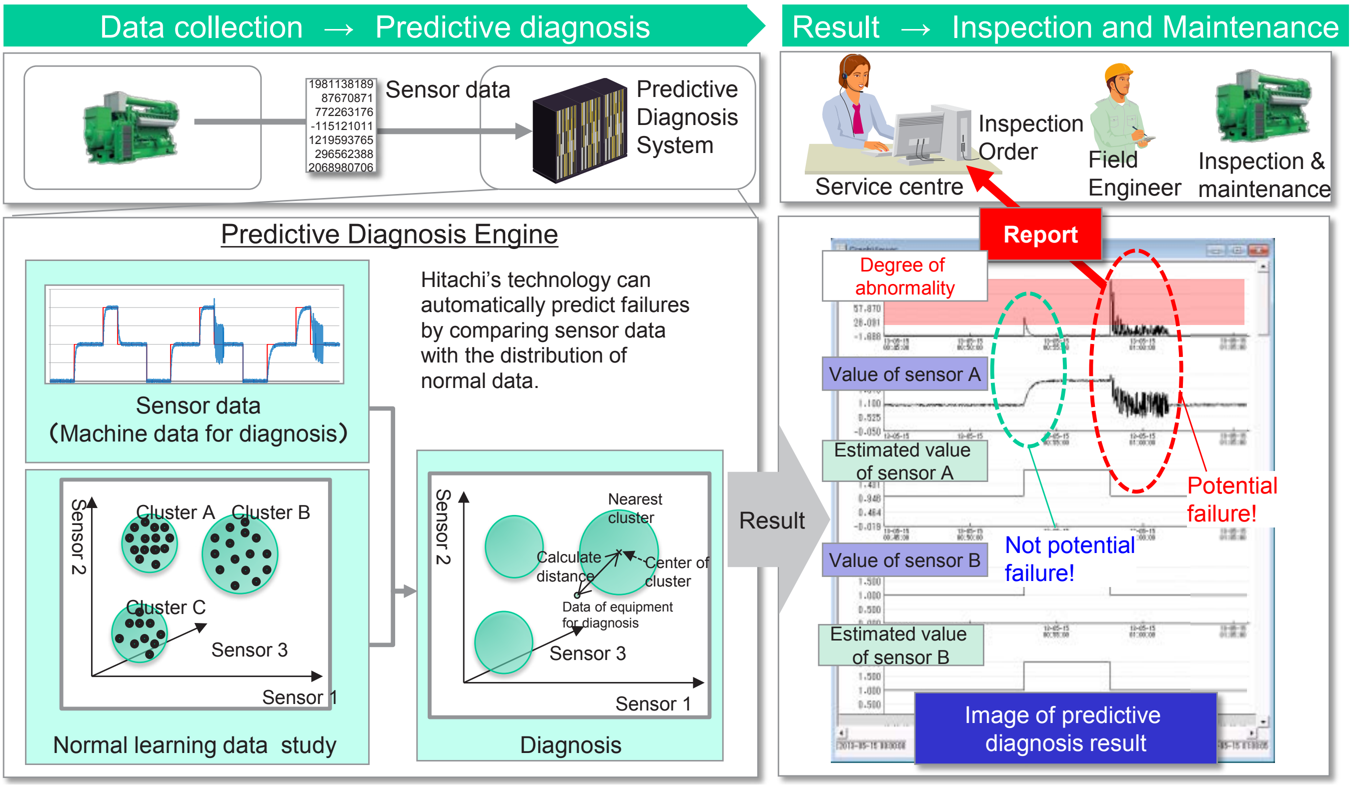
A drawback of conventional data mining functions is that causes are difficult to explain when diagnosis results are derived from complex sensor signal correlations.

Therefore, the Hitachi system has been designed to simplify the cause analysis by outputting an ordered list of the sensor signals responsible for a detected status change.



Predictive Failure Analytics Approach

- Machine data is automatically diagnosed by the Hitachi's data mining technology
- The failure signs are then reported to the maintenance service division



Condition-Based Maintenance

Why "Condition-Based Maintenance"?

- Realize an optimum maintenance plan based on a degradation level
- Minimize maintenance duration and increase operating duration
- Avoid unplanned shutdown by real-time monitoring & diagnosis
- Visualize and share the needs of maintenance by quantifying degradation level

A major challenge of asset operation is to balance reliability and availability

Reliability Point of View
Reduce breakdowns by ensuring best possible machine health and sufficiency of time for maintenance

Availability Point of View
Increase availability by reducing the frequency and duration of maintenance, and by reducing breakdowns

Approach to Condition-Based Maintenance

Condition-based maintenance is implemented using a combination of condition diagnosis and risk evaluation, leading to effective maintenance without damage to equipment or over-maintenance.

Traditional Maintenance

Corrective Maintenance	Maintenance after trouble occurred. High risk of damage or unplanned shutdown caused by degradation.
Time-Based Maintenance	Periodical maintenance by pre-evaluated lifetime of parts. Maintenance cost is high as condition of parts have no relation.

[Static Evaluation] Risk Rank Table ✖ [Dynamic Evaluation] Condition Diagnosis

Condition-Based Maintenance

Condition-Based Maintenance	Effective maintenance based on the degradation degree of component. Realise high reliability with avoiding damage to equipment and over-maintenance.

Maximisation of availability | **Maintenance suitability**

➢ The following steps are required to achieve condition-based maintenance

➢ Data cleansing, predictor identification

Through the analysis of equipment data,
- ✓ Predictor of equipment trip
- ✓ Degradation of component

➢ Knowledge accumulation

- ✓ Analysis of operational data
- ✓ Visualisation of key parameters

➢ Online system deployment

- ✓ Real-time system diagnosis
- ✓ Continuous enhancement

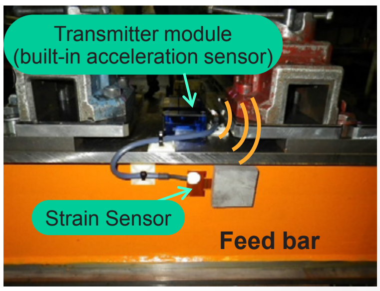
Case Study : Electronics Manufacturing Machinery

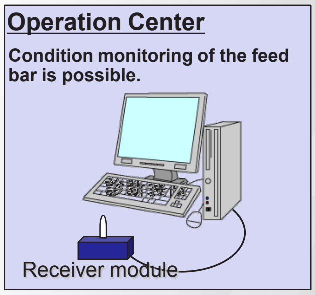
Damage of feed bar causes unscheduled stoppage of printing press

- Causes delay of production and spoilage cost.
- Few feed bar spare parts available,
- Procurement and repair is time consuming
- Damage causes damage of expensive moulds

Anomaly Detection Approach

- Collect sensor data from the feed bar via the communication network
- Analyze condition using data from multiple sensors

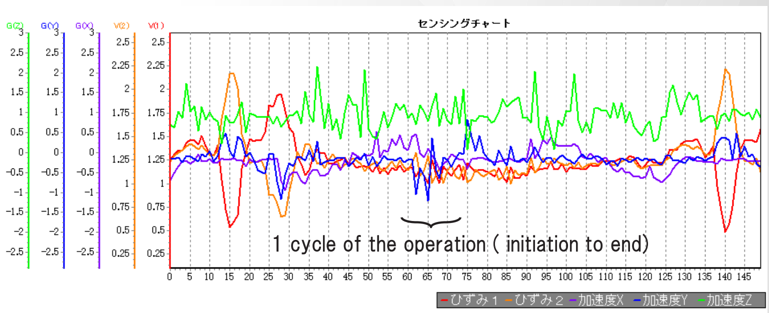




Features:

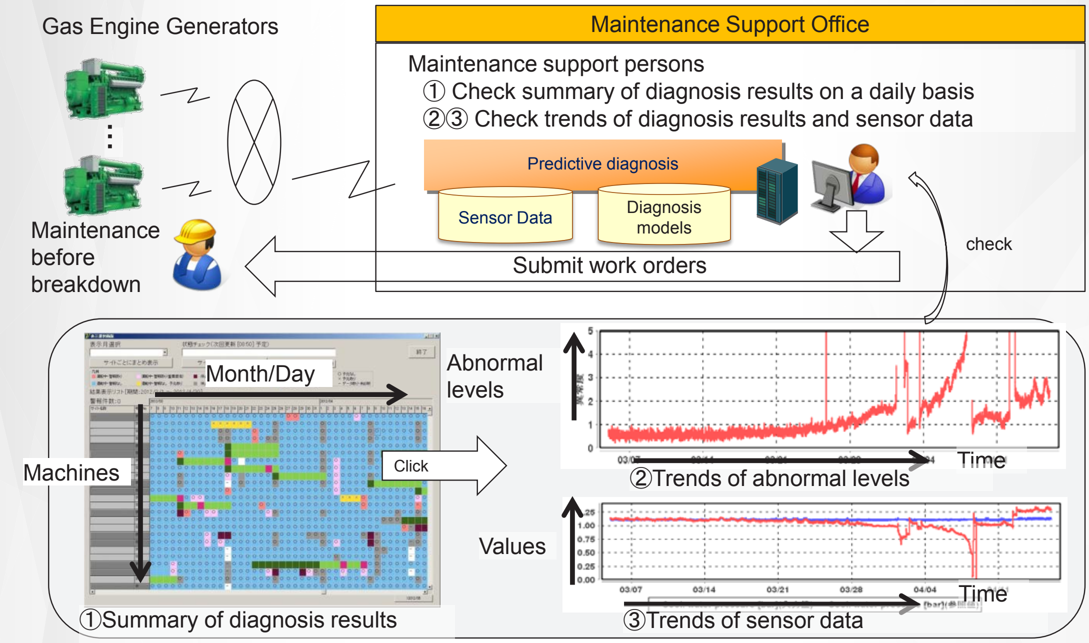
- Frequency: 1 press every 5s Sensors: acceleration (3 pole), strain gauges
- Sensing, diagnosis on a real-time basis
- Types of presses: ~ 300

1. Strain & acceleration data are collected regularly.
2. Condition monitoring of the feed bar is displayed on a chart.
3. Just after the initiation of the operation we can determine if the feed bar has become overloaded



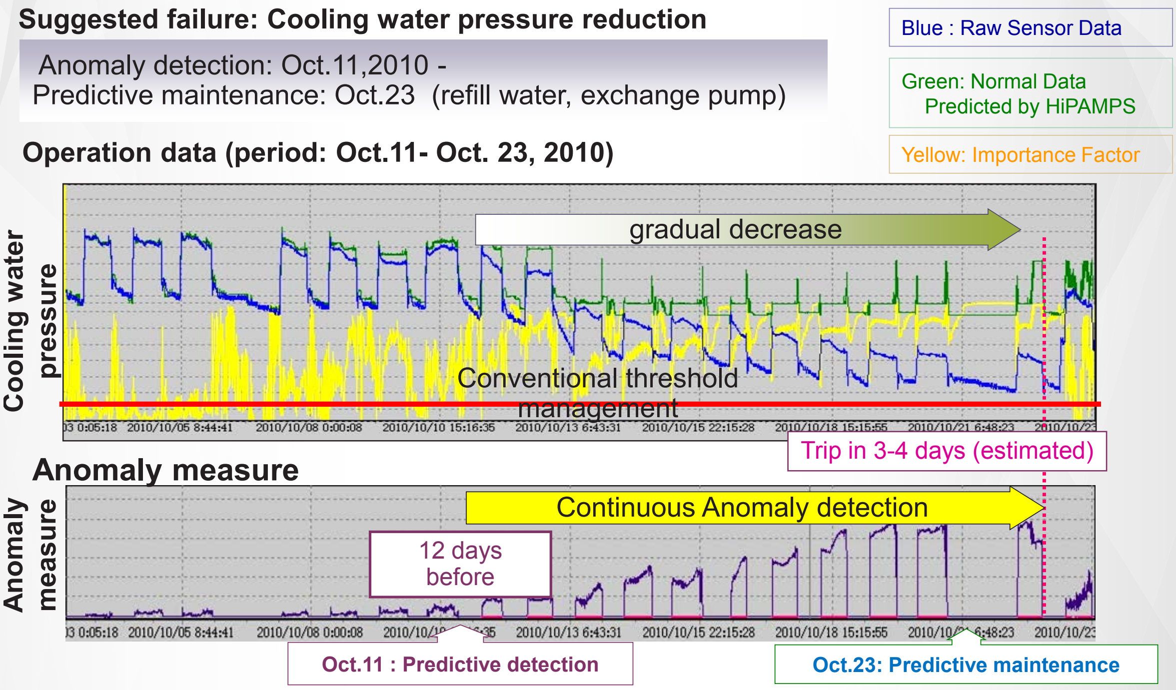
Case Study: Gas Engine Maintenance

Advanced predictive diagnosis technology has been applied to condition based maintenance system for gas engine generators on a commercial basis.



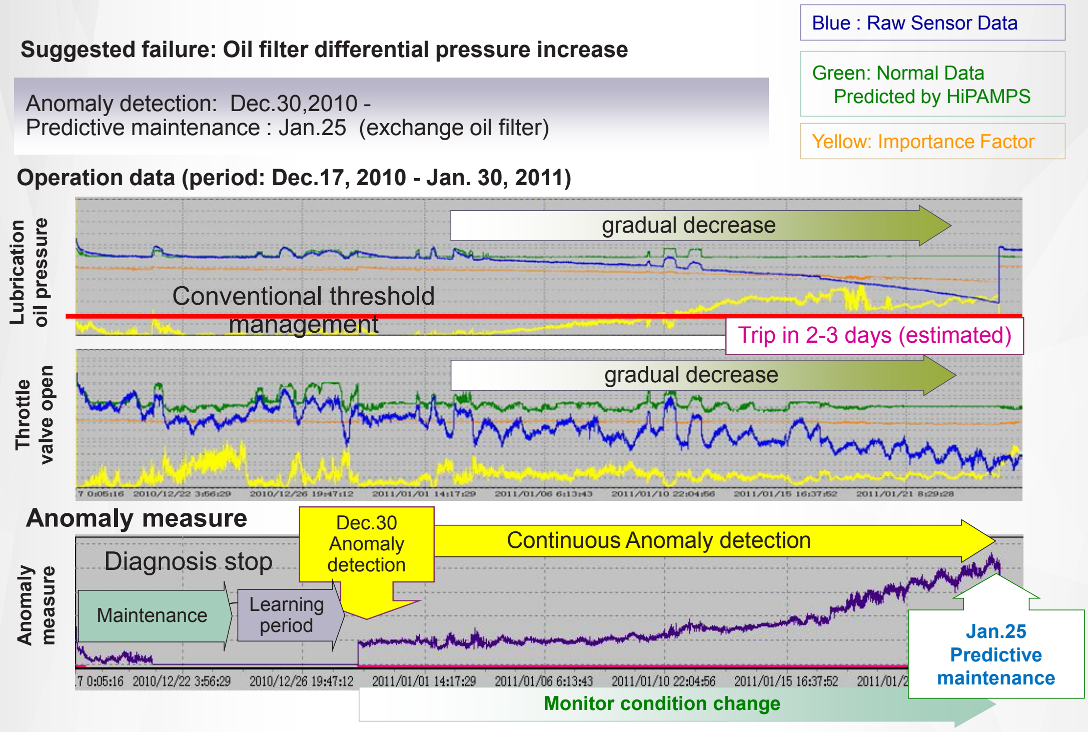
Anomaly detected 12 days before machine stops

(Unable to detect until equipment stop by conventional maintenance service)



Case Study: Gas Engine Maintenance

Anomaly detected 1 month before machine stops



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