

Industry & Distribution

1 IoT Infrastructure Services for the Manufacturing Industry

Hitachi's Internet of Things (IoT) infrastructure services for the manufacturing industry are solutions that contribute to creating new value for customers by enabling the rapid analyses, evaluations, and trials that lead to improvements on the manufacturing site.

Traditionally, there has been a problem where it is difficult to use the same data scattered across different departments, each of which builds separate problem-solving systems, leading to increased total costs. In response, these services offer a factory IoT utilization framework with open connectivity, data utilization, application distribution, security, operations management, and the function set necessary to implement these capabilities.

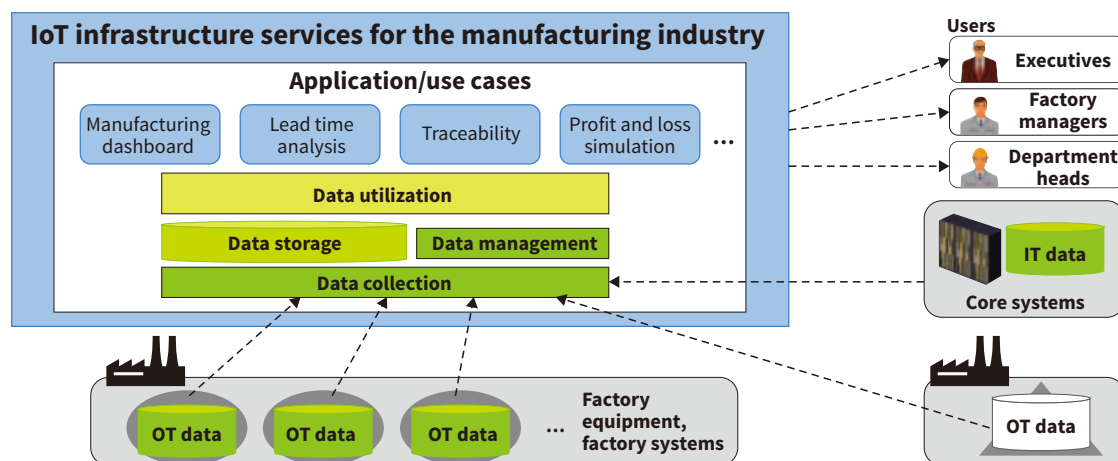
These services enable the sharing and utilization of data across departments or throughout the entire company and achieve overall optimization through the sharing of applications and know-how. Also, for customers who want to verify effectiveness while proceeding by expanding target facilities, systems, or factories, Hitachi provides an IoT infrastructure that can expand the necessary functions in a scalable manner. Furthermore, startup tools that quickly enable the visualization of data are also available for customers who

want to start out by collecting and visualizing the data of an assembly site. Hitachi offers services to customers who want to move forward gradually while collecting, storing, and utilizing data.

2 Hitachi Digital Solution for Logistics

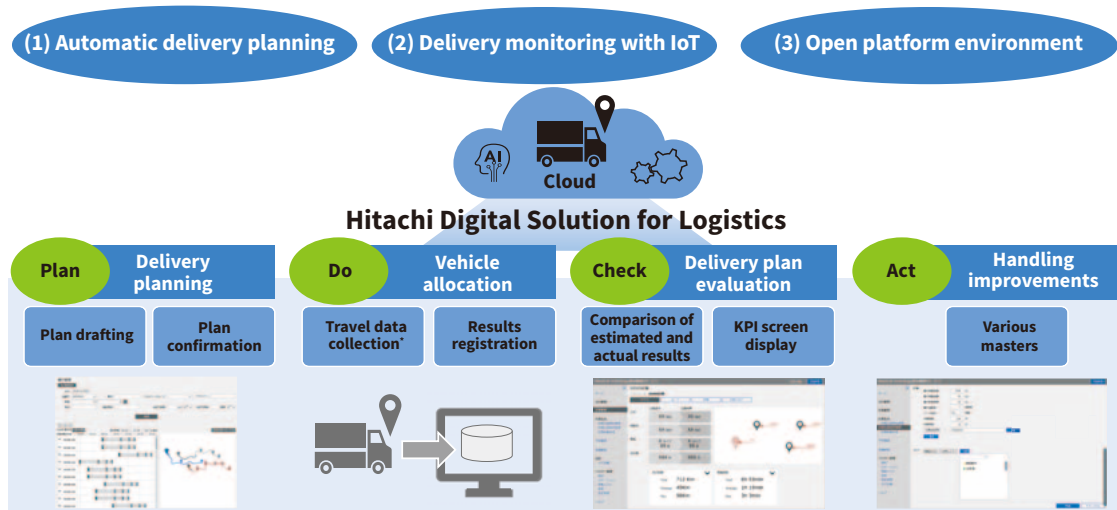
The Hitachi Digital Solution for Logistics contributes to the streamlining and safety of transportation and delivery by linking and collecting data that is generated through coordination between procurement, production, and sales departments, as well as between different corporations, through the storage of operational data (IoT data) from onboard terminals and smartphones. Hitachi is using its digital technology in this way to foster a logistics revolution that can achieve sustainable corporate growth.

This solution incorporates the experience of experts while utilizing artificial intelligence (AI) and data analysis technology by digitalizing all of the important conditions involved in transportation and delivery planning operations (delivery dates and times, distribution centers and base positions, travel routes and times, traffic congestion information, loads, time spent in shops, vehicle types, driver conditions, etc.). The solution also



OT data: operational technology data (various types of on-site data obtained from devices and sensors)

1 Overall structure of IoT infrastructure services for the manufacturing industry



2 Overview of Hitachi Digital Solution for Logistics

offers very effective automatic delivery planning that other companies cannot match, as well as functions such as delivery monitoring during plan execution and budgetary control after planning, thereby contributing to the automation of delivery planning and improvements in load factors.

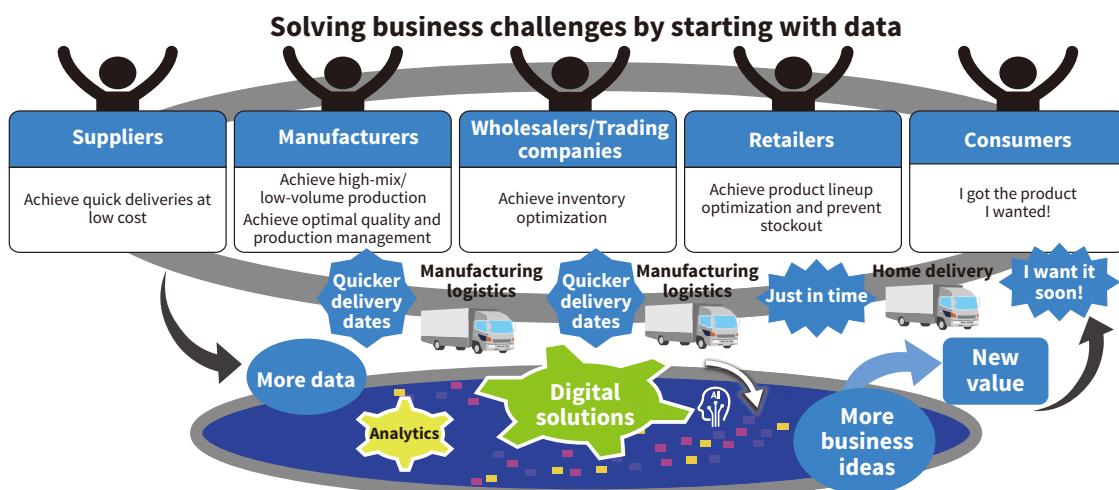
However, it takes much time to collect, receive, understand, clean, transform, and analyze the data involved in data utilization, and it is not possible to immediately validate the true value and effectiveness of data utilization.

To respond to these challenges, Hitachi offers its Hitachi Digital Solution for Retail, which stores, cleans, transforms, and analyzes various data such as data retained by customers and external data, with built-in analysis based on proven results from implementations that Hitachi has conducted up to now, and AI. With a service lineup that supports the utilization of AI, the solution includes features such as automatic replenishment based on demand forecasting, demand forecasting, the optimization of candidate locations for opening stores, digital sales promotion, etc.

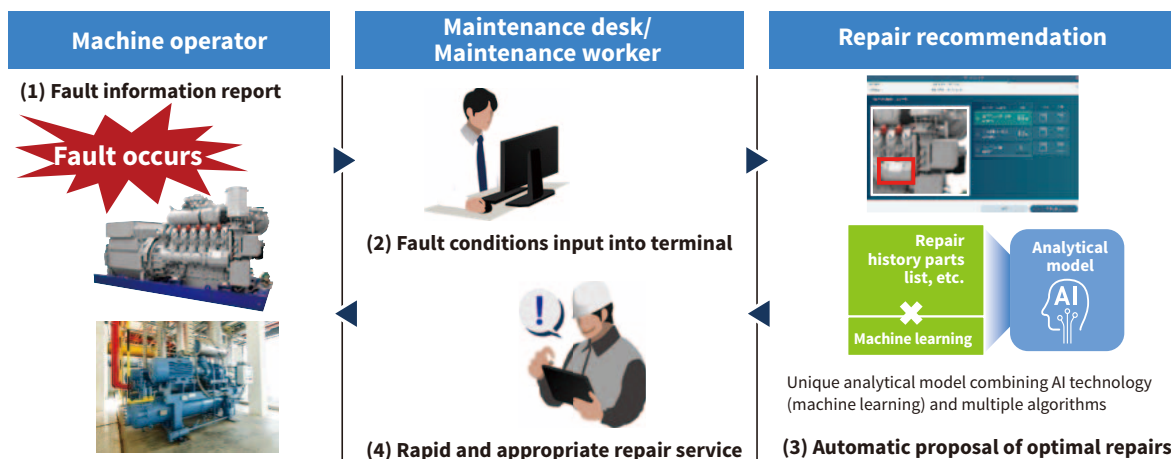
In addition to providing these services, by managing purchasing and other data from suppliers, manufacturers, wholesalers, trading companies, retailers, and

3 Hitachi Digital Solution for Retail Providing Integrated Management of Distribution and Retail Data

Trends such as diverging lifestyles, labor shortages brought on by declining populations, and increasing concerns about environment problems are having a great impact on many industries. It is against this background that the distribution industry is also adopting digital solutions aimed at labor-saving and streamlining efforts.



3 Supply chain connected by data



4 Repair recommendation usage scenario

consumers in an integrated way, Hitachi will continue contributing to the realization of a society that is both sustainable and prosperous by connecting value chains to help resolve the challenges faced by consumers, employees, and society as a whole.

4 Repair Recommendations Utilizing AI Technology

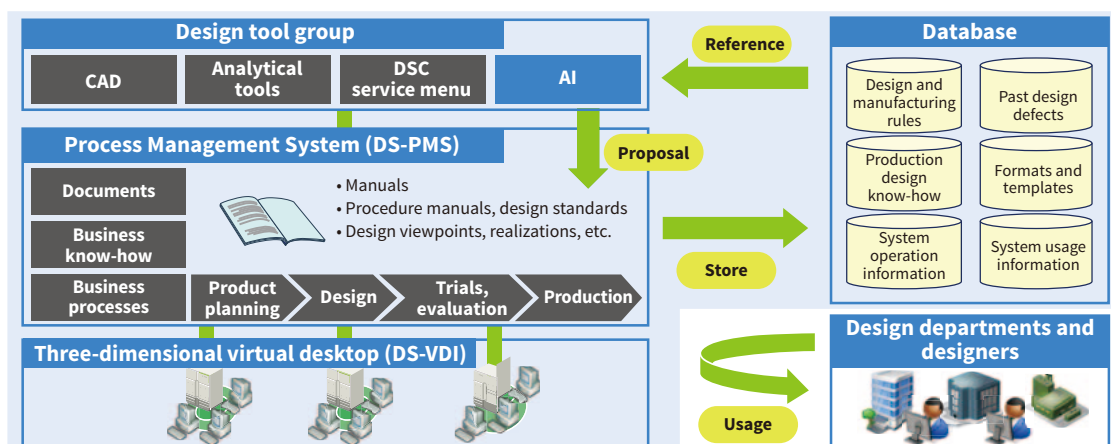
The repair recommendation service, based on repair records, makes judgments equivalent to that of an expert so that average maintenance workers are able to do high-quality repair work using this service. The service extracts appropriate repair results by applying analytical and IT technology utilizing Hitachi's maintenance knowledge to analyze the historical fault and repair data of the customer's target devices, and creates unique analytical models combining AI technology (machine learning) and multiple algorithms. The repair recommendation service can also automatically propose optimal repairs based on the predictions of a unique

analytical model by inputting the fault conditions.

Since the fault conditions and historical repair data are described in written form by humans, the service parses the Japanese text before recommending repairs, which are categorized in a manner designed to be useful during the actual repair work. Instead of searching fault data for previous cases to recommend repairs, this service recommends multiple candidates with the accuracy (%) added to the repair content. This enables maintenance workers to make quick judgments without any omissions, and to provide appropriate repair service.

5 Hitachi Digital Supply Chain/Design

For the automobile industry and other manufacturing industries that are expanding globally, business competition demands that they meet the market needs of each country and region by reflecting local characteristics in each product and rapidly responding to changes in the marketplace. Designers must effectively utilize massive



5 Overall image of DSC/DS

amounts of very confidential design information in three-dimensional computer-aided design (CAD) work.

To assist designers in this work, Hitachi is developing and supplying the Hitachi Digital Supply Chain/Design System (DSC/DS). By using the DSC service menu options such as Virtual Desktop Infrastructure (DS-VDI) making up the DSC/DS, and Process Management System (DS-PMS), it is possible to achieve “design data sharing,” “unification of design environments and tools,” and “standardization of design processes and rules.” Hitachi is also currently promoting efforts to utilize quality information and constraints related to the production process in design work, while using AI to analyze and systematize design-related data in the cloud and seeking to further improve quality and streamlining of design work by applying these results.

6 Cold Chain/Refrigeration Systems Maintenance Streamlining and Operational Efficiency Improvement Support Service

Cold storage facilities are an important part of every cold chain used to distribute frozen food, perishable food, and other products at a low temperature. The stable operation of refrigeration equipment is indispensable for maintaining the quality of products kept in cold storage, but various challenges have emerged:

- (1) Optimization and streamlining of maintenance
- (2) Early detection of signs of fault
- (3) Accumulation and inheritance of the operational and management know-how of skilled engineers

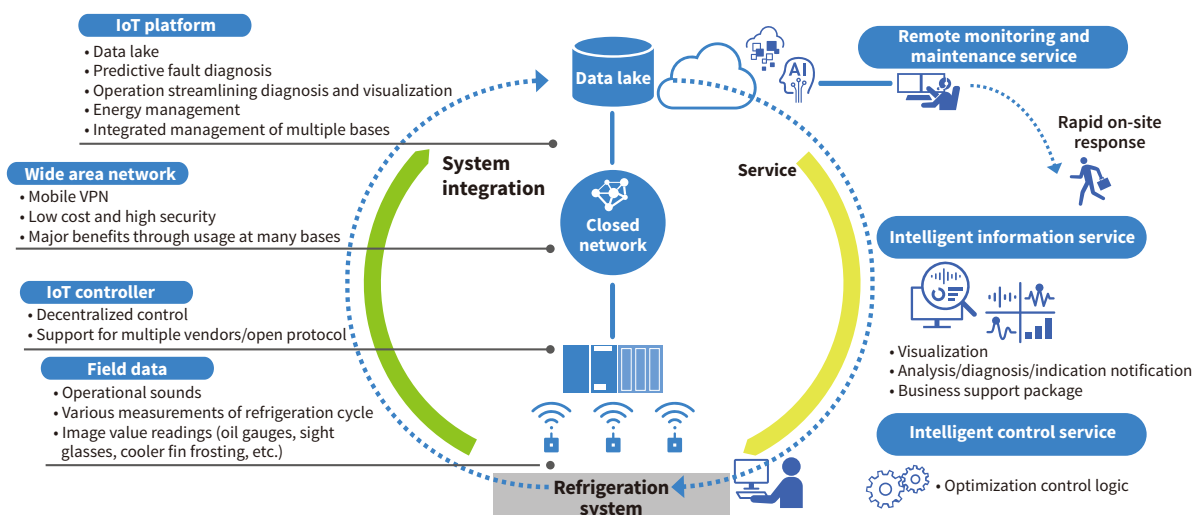
(4) Energy efficiency and reduction of CO₂ emissions

Hitachi has developed a new maintenance streamlining and operational efficiency improvement support service utilizing IoT technology as a concrete measure aimed at overcoming these challenges.

This service is comprised of a field data collection system, a cloud service infrastructure, and a virtual private network (VPN) that ties both together.

The field data collection system uses a central IoT controller to collect data regarding equipment operation and refrigeration cycles. In addition, microphones are used to collect sound data from equipment operation, image process technology is used to collect digital data regarding thermodynamic functions (warehouse cooler frosting quantities, etc.), and the system makes full use of new sensing technology in order to collect various types of information that facilitate high-precision analysis and diagnosis.

The cloud service infrastructure collects field data online to be used as a basis for predictive fault diagnosis and the effectiveness of operation streamlining. Predictive fault diagnosis compares operational data for ordinary operation and current operation in characteristic vector space in order to detect signs of fault by looking for deviations. Operation streamlining diagnosis involves the visualization of correlations between factors such as equipment operation and energy consumption, while generating various types of indicator and operational support information with the goal of supporting high-efficiency operations. These diagnostic outputs are used to provide base and equipment managers with feedback via the business intelligence (BI) dashboard.



6 Overview of maintenance streamlining and operational efficiency improvement support service



7 Example of plant predictive maintenance screen

This service improves preventive maintenance while supporting the achievement of maintenance according to equipment conditions as well as efficient equipment operations, thereby leading to solutions for the emergent challenges described above. Hitachi will continue deploying this system widely in the domestic market while contributing to the stable and efficient operation of the refrigeration equipment that supports cold chains.

7 Predictive Maintenance Service for Petrochemical Plants

Petrochemical plant operators need to understand the operational state of the plant as it changes from moment to moment, and to perform maintenance at the appropriate times. To achieve this, Hitachi has started offering its predictive maintenance service, which detects state changes and abnormalities that can be signs of faults by automatically categorizing and analyzing operational states in real time.

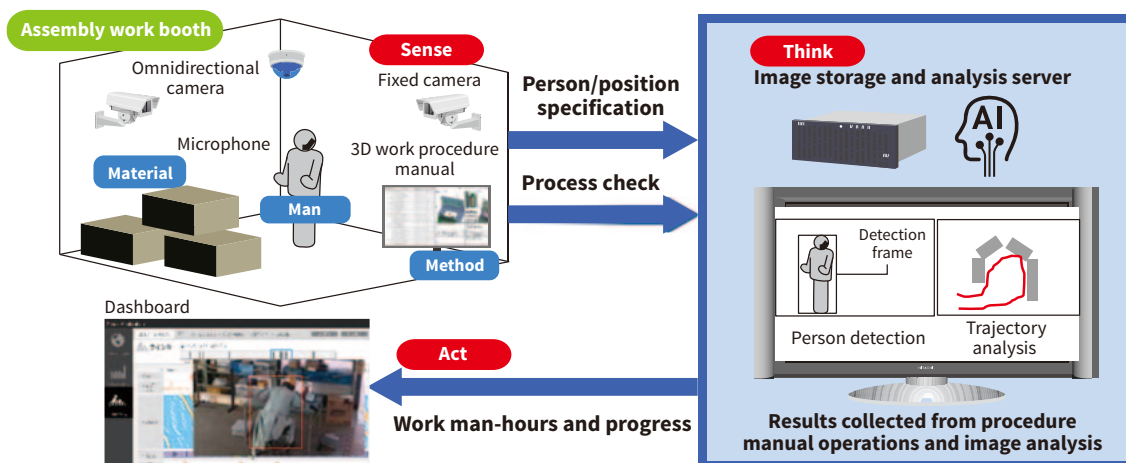
This service detects abnormalities by analyzing collected operational data using data clustering [adaptive resonance theory (ART)], which is a type of AI

technology. Prior learning about past normal operational data enables the system to automatically sort data into the normal data category as a standard for predictive diagnosis. Furthermore, the system automatically categorizes new data acquired during actual plant operation, diagnosing whether or not an operational state is normal by comparing the data with the normal category. When a new data category arises, the operator causes the system to learn how to judge normality/abnormality based on the factors that differ between the plant's operational state and the normal category, thereby increasing subsequent diagnostic accuracy.

Not only does this service reduce the burden on the operator responsible for monitoring operations, it also supports the safe and stable operation of petrochemical plants by streamlining operations and maintenance by reducing the fault occurrence rate.

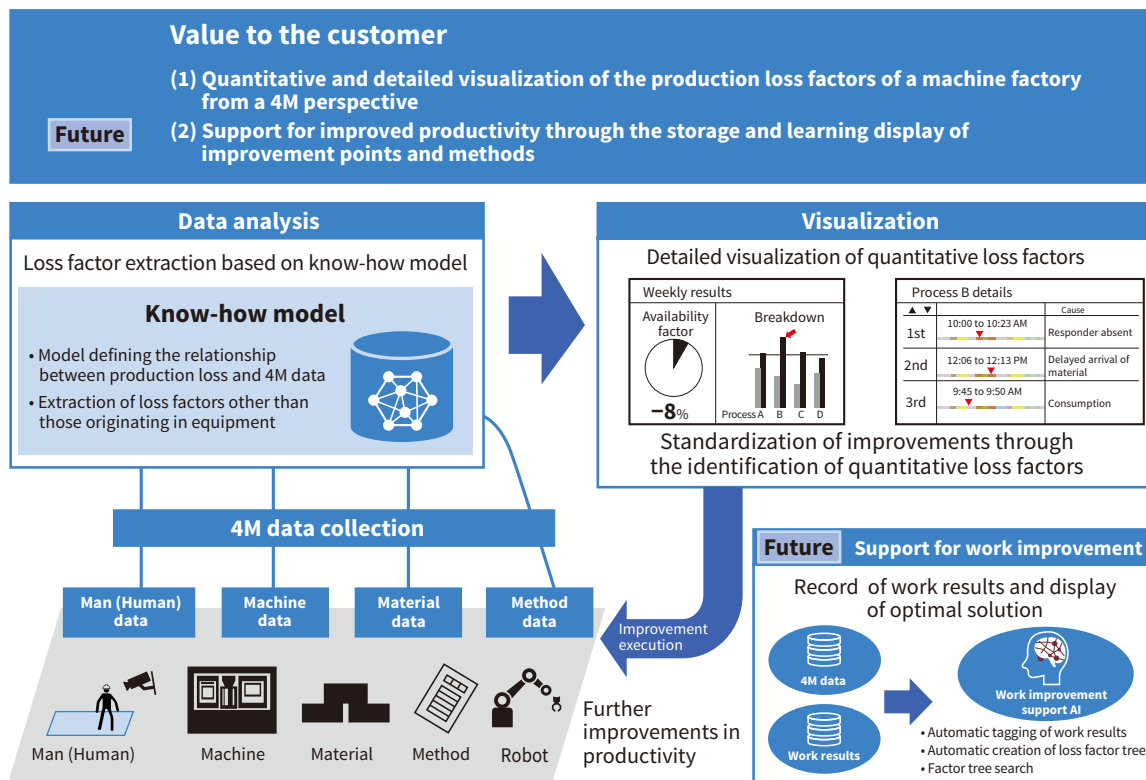
8 Work Engagement Time Understanding System Using Deep Learning Technology

In the manufacturing industry, there is an active movement to innovate quality and productivity using



3D: three dimensional

8 Hands-free assembly work support system



9 Overview of production loss analysis service based on 4M data management aimed at machine users

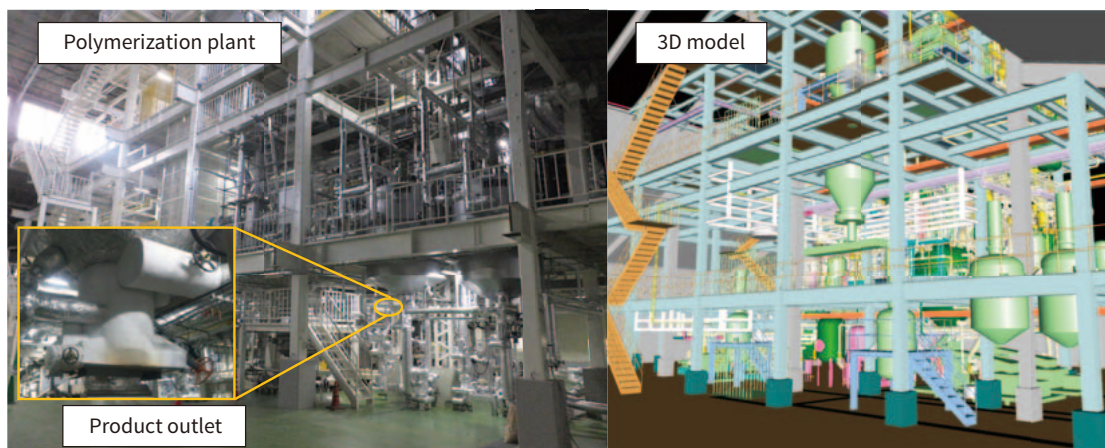
information and communication technology (ICT) such as the IoT to digitize man, machine, material, method (4M) data for achieving advanced prediction and control. For safe and efficient assembly work, Hitachi developed a hands-free assembly work support system that does not rely on the expert's skill by analyzing human information. The system features hands-free procedure manual operations that are controlled by voice, and collects very precise man-hours through image analysis functions.

As a means of specifying workers and understanding results and system man-hours, the system cameras installed on the manufacturing floor are sensors and detect and track humans by deep learning technology. Additionally, by affixing two-dimensional codes to workers, the system is able to understand the trajectories of specific workers by combining the two-dimensional code recognition technology with tracking technology. The system then uses the obtained trajectories to tabulate the amount of time workers spend in a work area, which makes it possible to understand work engagement time. Feeding this back into work design is expected to help achieve an understanding of costs that conforms to actual conditions.

9 Production Loss Analysis Service Based on 4M Data Management

Hitachi is working toward transitioning to the IoT on the manufacturing floor as well as the digitalization of know-how through a fusion of manufacturing floor data and know-how (OT), AI, and other types of IT. Furthermore, Hitachi has launched a service that assists with the analysis of factors and improvement considerations related to the customers' production losses by collecting, recording, and utilizing (managing) 4M data regarding production resources on the manufacturing floor in a complex way.

This "production loss analysis service based on 4M data management" models loss analysis know-how from the viewpoint of a production management expert, and provides this analytical technique in the form of analysis and visualization functions. This system features the ability to measure information about humans (the "Man" in 4M) using digital image analysis technology, and during verification of automated machinery with robots, proved useful in analyzing and quantifying loss factors that were difficult to discern before. For instance, the system made it clear that loss caused by human factors (for example, loss caused by workers not being present) was occurring at a rate of 10% or higher



10 Photograph of multiproduct production polymerization plant equipment (left) and 3D piping diagram (right)

compared with time spent moving around. Hitachi plans to make this service available to the machine tool industry and others starting in 2020.

10 Basic Design of Multiproduct Production Batch Polymerization Plant and Delivery of Major Equipment

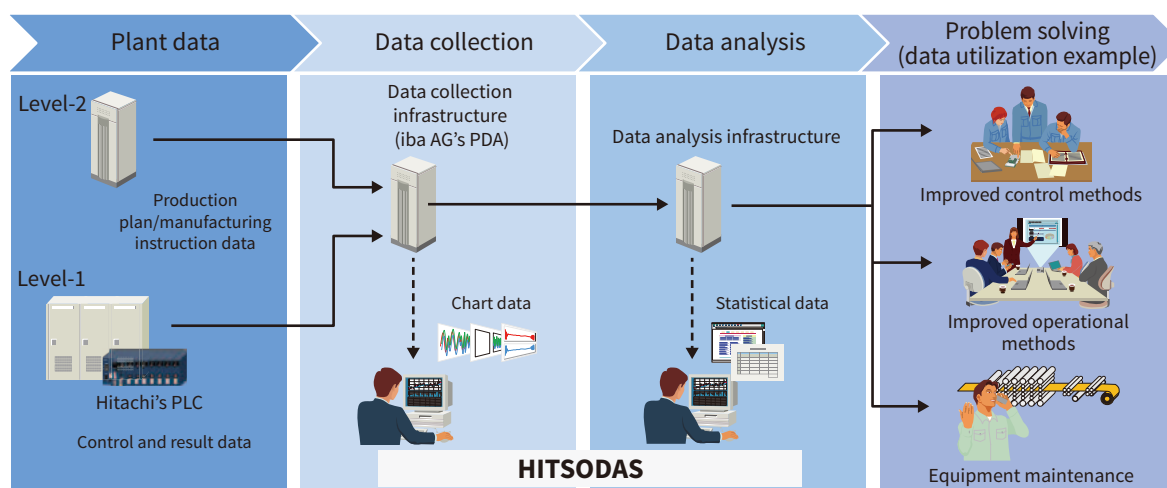
Chemical plants in Japan have been focused on producing high value-added products and multiproducts in recent years. Hitachi has a truck record of design and equipment delivery for a wide variety of polymerization plants. The company has recently completed basic design and parts of detailed design of the equipment for a state-of-the-art multiproduct polymerization plant for Bell Polyester Products, Inc. (BPP), as well as the delivery of the major equipment (the main reactor along with equipment accompanying the reactor). Hitachi has delivered a main reactor to BPP in the past, and participated in the project from the planning stage,

considering how to optimize equipment specifications based on the customer's vision for the future and existing operational data, creating basic engineering drawings and specifications, and supporting the customer's feasibility study (FS).

BPP completed construction of the plant in June 2019, and is verifying performance through commissioning. As BPP wants to expand the facilities further and integrate with existing equipment, Hitachi continues to provide customer support from the planning stage.

11 Intelligent Maintenance Support System The New HITSODAS Commences Operation

Steel plants demand reductions in steel thickness tolerance failures, prevention of strip breakage, shape stabilization, and other measures to improve the quality of produced steel strips as well as yield. Factor analysis is indispensable for these kinds of improvements, but since a wide range of combinations are rolled during



11 HITSODAS intelligent maintenance support system

actual operation including different steel grades, strip thicknesses, strip widths, etc., an enormous amount of time is required to perform the analysis manually. This also leads directly to a problem where the results differ depending on the analytical skills of the people carrying out the work.

In response to these challenges, Hitachi has developed and supplied a unique intelligent maintenance support system called Hitachi self-organized diagnosis and analysis (HITSODAS) that can apply the abundant knowledge Hitachi has accumulated over the years by automatically collecting huge amounts of plant data, performing advanced analysis, calculating feature values, and enabling data mining.

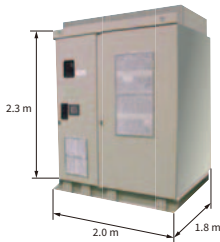
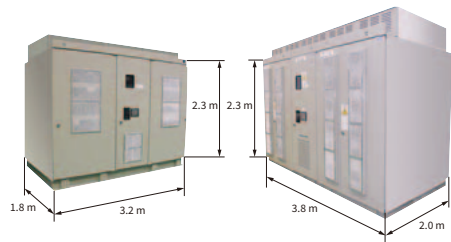
Now, to add even more value, Hitachi has created a new HITSODAS by adopting iba AG's Process Data Acquisition (PDA) system as its data collection infrastructure. iba AG's PDA system has a large number of interfaces, high affinity with Hitachi's programmable logic controller (PLC), well-established global reputation regarding graphical functions, and user friendliness. Hitachi made its first delivery of the new HITSODAS to an international customer in July 2019, and began operational support services utilizing HITSODAS beginning in September 2019.

12 Cell Concept Motor Drive System that Contributes to Facility Management

The motor drive system for steel plants is an application of the cell concept*. Since 2012, Hitachi has been working to reduce the number of panels through a drastic review of cells according to function. Then, in 2018, Hitachi introduced integrated cells with multiple cells by function (two in one), and in 2019, one panel could handle a motor capacity of up to 800 kW, two panels could handle up to 3,000 kW, and three panels could handle up to 10,000 kW.

For example, a tandem cold mill that had a total of approximately 60 panels up until 2011 can currently manage with just 18 panels, having achieved a high degree of size reduction. Also, when the improvement or elimination of a cell occurs by function in the future, it is possible to extend the life of the system by retrofitting at the cell level.

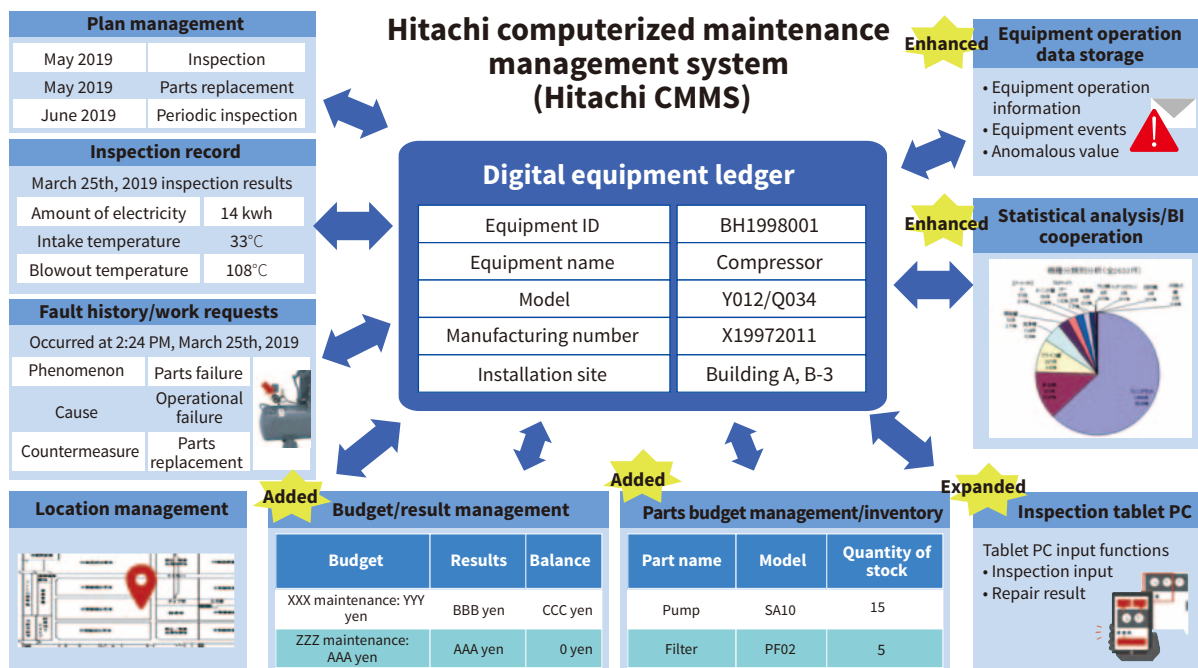
Achieving facility management that can comprehensively administer and utilize plant equipment is one of the business challenges faced by Hitachi's customers, and the optimization of equipment life cycle costs is conceivable as a solution. To this end, the cell concept motor drive system can contribute to the optimization of costs during both system installation and operation through size reduction and retrofitting.

Model name	MTA (2in1)	MH2A (2in1)	MH2A, H2
Drive motor capacity*	800 kW or less	3,000 kW or less	10,000 kW or less
Appearance (converter + inverter)			
Number of panels	One panel	Two panels	Three panels
AC voltage output (V)	1,155	2,250	2,250(MH2A) 4,500(H2)
Main circuit topology	Two levels	Three levels	Three levels
Cooling system	Air cooling type	Water cooling type	
Overload specifications	150% (one minute)		
Efficiency	98% or higher (at rated output)		

* Drive motor capacity is a rough standard

AC: alternating current

12 Cell concept motor drive system (for main rolling mill)



13 Image of management data and function enhancement in Hitachi CMMS version 3.0

In the future, Hitachi will deepen this concept further while developing it into a motor drive system that can contribute to overcoming customers' challenges.

* A design approach that achieves total functionality by dividing system functions into minimum units (cells) and selecting and combining cells as needed.

13 Predictive Maintenance and Preventive Equipment Maintenance Using Hitachi CMMS Version 3.0

Since releasing version 1.0 of the Hitachi computerized maintenance management system (Hitachi CMMS) in 2011, Hitachi has continued to upgrade the system, leading up to the release of version 3.0 in March 2019. Version 3.0 focused on predictive maintenance and preventive maintenance, which are two of the major themes of product development.

Categories of equipment maintenance methods include corrective maintenance, scheduled maintenance (time-based maintenance), and preventive maintenance (condition-based maintenance). Interest in preventive maintenance as a means of constructing an efficient equipment maintenance cycle has been on the rise recently, as problems such as the deterioration of equipment built during high growth periods and labor shortages have been increasing the workload of onsite maintenance workers.

To implement this equipment maintenance cycle, version 3.0 of Hitachi CMMS uses the operation information storage function Hitachi CMMS/Monitor as the core of a mechanism that enables efficient inspection operations by maintenance workers based on the coordination of equipment operation information storage, equipment monitor definitions, and anomalous value alarms sent to maintenance workers.

In concrete terms, Hitachi enhanced the anomalous value alarm function of the existing equipment operational data storage functions by allowing the person in charge to set standard values in advance that are judged to lead to faults and stoppages, so that the system can automatically collect operational data and notify the person in charge with email notifications and on-screen warnings if it detects anomalous values. In addition, by enhancing advanced analytical functions through statistical analysis and BI coordination, Hitachi has taken the indications of equipment stoppage that previously required the experience and intuition of skilled engineers, as well as data relating to equipment maintenance that was only understood by specific individuals, and made it possible to manage and visualize these data so that even operators without specialized knowledge could understand the precursors of equipment faults and stoppages while taking the initiative in formulating maintenance plans. Also, by adding management functions such as budgets, results, spare parts, inventory,

etc., not only has the system improved onsite operating efficiency, it has also expanded the range of data that can be controlled in a centralized fashion, while letting managers apply data to management in a way that leads to optimization of the entire factory.

(Hitachi Industry & Control Solutions, Ltd.)

14 Manufacturing Operator Work Support Solution

Although most companies in the mid-sized manufacturing industry still rely to a great extent on paper-based work management of the manufacturing floor, the trend towards the digitalization of manufacturing floor operations is accelerating thanks to the shift toward the IoT. However, this drive toward digitalization involves installation costs that can be a major hurdle for any company seeking to introduce an integrated manufacturing execution system (MES). There is a great need to adopt a system that can place the focus on manufacturing floor issues such as visualizing work progress, preventing operational errors, etc. Hitachi's manufacturing operator work support solution meets this need.

The main features are as follows.

(1) By specializing in functions that are needed more,

the solution allows companies to introduce it gradually as they notice the benefits of the IoT for themselves

(2) Paperless functionality through the digitalization of work instructions and results collection

(3) Prevents work errors through the use of digital work instructions sent to the manufacturing floor, while assisting in ensuring uniform work quality

(4) Visualizes the state of progress on the manufacturing floor in real time, and reduces the risk of delays in delivery dates by enabling the immediate implementation of improvement measures

(5) In addition to direct work time, collects work stoppage time and reasons as result data, thereby enabling work improvement through the utilization and analysis of data

The following functions meet particularly strong needs:

(1) Creation of work instructions

Registration of production orders and generation of work procedures

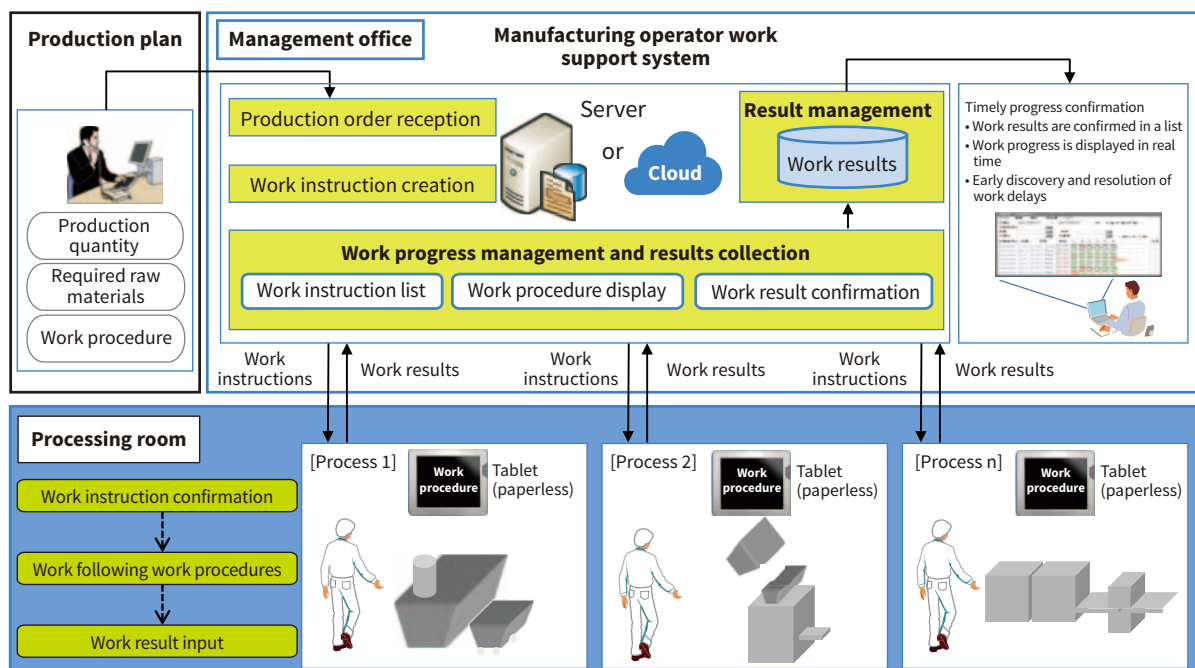
(2) Management of work progress

Work procedure instructions and checks based on standard operating procedure (SOP)

(3) Collection and management of results

Collection of work results and visualization of work progress

(Hitachi Industry & Control Solutions, Ltd.)



14 Manufacturing operator work support solution system configuration