MONOZUKURI Reforms Accelerated by Use of Digital Technology

The pace of factory reform needs to increase if businesses are to continue producing highly competitive products even as they expand globally. Having established its Lumada data analysis platform, Hitachi is accelerating its pursuit of digital transformation, meaning MONOZUKURI (manufacturing) reforms that draw on digital capabilities that include the Internet of Things, artificial intelligence, and business intelligence. A number of Hitachi plants have already achieved lower costs and shorter lead times as a result of improvement activities spanning multiple functions, including design, procurement, manufacturing, and inspection. In parallel with this, Hitachi is also seeking to make company-wide reforms by packaging particular improvement measures to facilitate their efficient replication across other parts of Hitachi. Moreover, successful examples of digitalization within Hitachi are also being offered to a large number of external customers in the form of digital solutions for MONOZUKURI reform.

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1. Introduction

The pace of factory reforms that boost efficiency or reduce costs need to increase if businesses are to continue producing highly competitive products even as they expand globally. To implement efficient and effective improvements in a timely manner, Hitachi is embarking on a digital transformation in the form of MONOZUKURI reforms that utilize digital technologies such as the Internet of Things (IoT), artificial intelligence (AI), and business intelligence (BI). This involves use of the IoT to utilize data that was previously unavailable, use of AI to obtain information from large amounts of data so as to assist with the making of decisions, and use of BI for the timely sharing of information. Through these technologies, Hitachi is able to accelerate reforms by devising advanced measures that would not have been possible in the pre-digital era.

This article describes things Hitachi is doing to bring about digital transformation, as well as examples on in-house reforms.

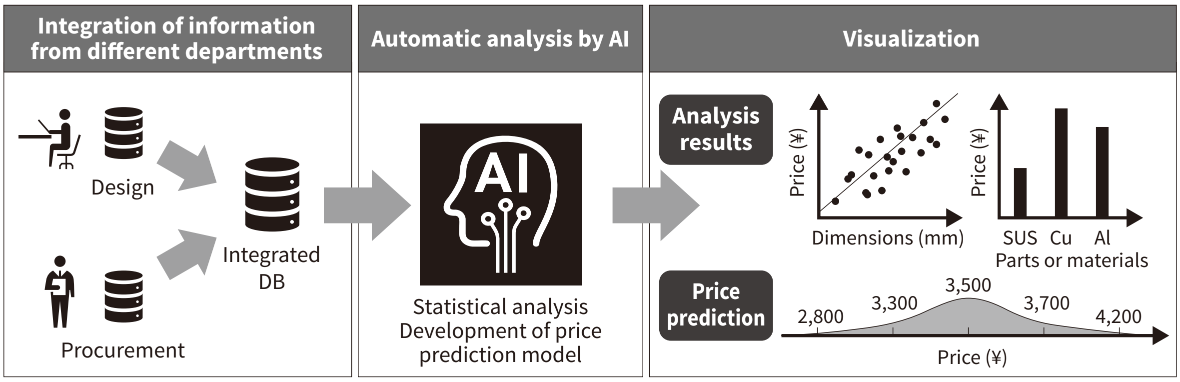
2. Digital Transformation Strategy

Hitachi has adopted the following three practices to overcome the obstacles to digital transformation and push ahead more rapidly with reforms.

(1) Top-down improvement activities

Each division appointed an internal digital transformation officer and formulated digitalization strategies that would prove effective in overall terms based on an in-depth appreciation of the issues they face.

Figure 1 — Price Analysis System
An AI-based price prediction model was developed by combining information on design and procurement. The model provides the information needed by design and procurement staff respectively and puts it to use.



DB: database AI: artificial intelligence

Moreover, to enable an ambitious approach to reform, resourcing and organizational support was offered to provide the skills needed to conduct proof of concept (PoC) projects.

(2) Establishment of Lumada platform

A secure environment was established that allowed for the use of data across different divisions of Hitachi by putting analysis infrastructure in place that could handle large amounts of data (the Lumada platform). By minimizing the amount of investment required by individual users, this infrastructure enabled PoC projects to proceed in a timely manner.

(3) Provision of analysis tools

To enable its use in a wide variety of projects, the Lumada platform incorporates a suite of analysis tools that include Pentaho and other open-source software as well as Hitachi's own proprietary AI. An understanding of the features of the different tools is essential if the right ones are to be used for each project. Expertise in the use of analysis tools was established through the PoC projects.

With these measures having provided the basis for the efficient implementation of digital transformation within the company, Hitachi has been proceeding with reforms.

3. Example MONOZUKURI Reforms

The following sections describe examples of MONOZUKURI reforms undertaken within Hitachi.

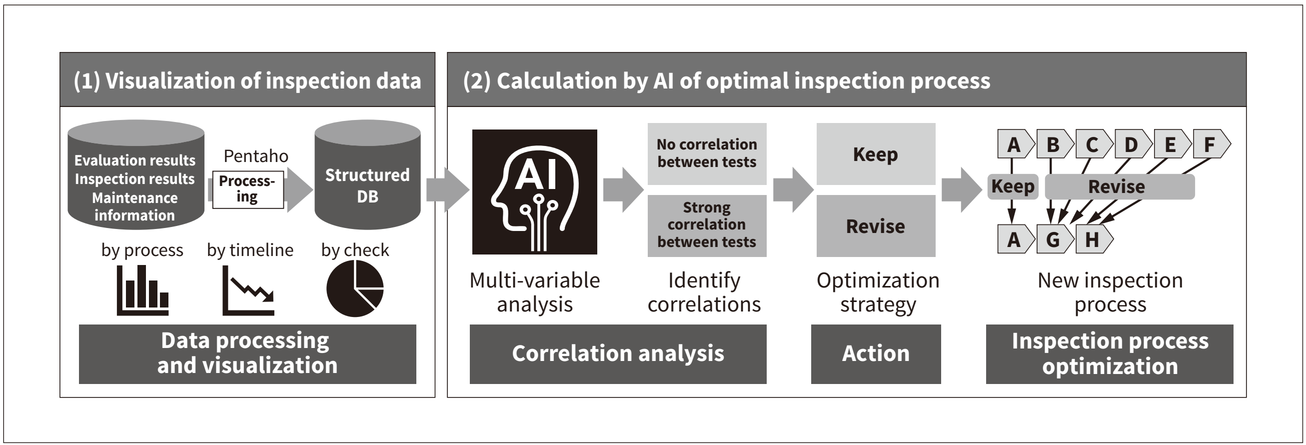
3. 1
Use of Price Analysis for Cost Reduction

The T&D Engineering and Production Division of the Power Business Unit manufactures highly reliable electrical transmission and distribution equipment, including transformers and switchgear. It is working on digital transformation as a means of reducing costs and enhancing quality to improve the competitiveness of its products. One example of this is the use of past purchasing specifications and procurement records to perform price analyses with the aim of reducing costs through the optimization of product designs and the appropriate pricing of purchased parts and materials.

A database that integrates knowledge and data on design and procurement was developed in order to understand the factors that influence purchase price. Unfortunately, the hands-on analysis of large amounts of data is time-consuming. This frustrates the timely use of the latest procurement information, which grows daily in volume, raising the likelihood that meaningful price-influencing factors will be overlooked. Accordingly, there was a need to establish ways of reducing the data processing workload of design and procurement staff so that they could focus instead on finding ways of cutting costs.

In response, a system was established that used AI to identify and quantify the factors that influence the price of purchased parts and materials from large amounts of data (see **Figure 1**). It was also equipped with a function for calculating price predictions for new order specifications. These functions are made

Figure 2 — Flowchart of Visualization and Optimization in Inspection Processes
Large amounts of data are presented and an AI used to select and optimize necessary checks.



available in the form of a web-based dashboard. It also provides a way to share the latest analysis information across different departments.

The system provides an easy way for the procurement department to determine appropriate prices for purchased goods. It means they are able to select suppliers and negotiate pricing based on an understanding of the impact that things like delivery times or buying in bulk have on pricing. At the design department, meanwhile, the system enables the quantitative assessment of the influence on price of specifications such as the choice of materials or dimensions. This provides a way for both experienced and inexperienced staff to come up with ideas for reducing costs based on data.

In this way, by allowing both design and procurement to go about cost reduction activities in an efficient manner, the use of AI to extract knowledge from data is helping to achieve an appropriate level of costs and enhance product competitiveness.

3. 2
Optimization of Inspection and Testing

Kanagawa Works manufactures the storage equipment and servers that underpin IoT platforms. The site conducts pre-delivery inspections based on management standards to ensure the delivery of high-performance and highly reliable products to customers. As the number of inspection checks rises as products increase in performance and sophistication, inspection had come to take up approximately 80% of lead times.

Because shortening lead times is crucial to improving the cash conversion cycle and keeping pace with fluctuating demand, the optimization of inspection is essential. The challenge, then, was to come up with an inspection process that takes less time without compromising quality standards.

To achieve this, Pentaho and Hitachi AI Technology /H (AT/H) (Hitachi's own AI) were used to calculate the optimal inspection process from a large volume of past inspection records (see **Figure 2**). A feature of AT/H is its ability to rapidly extract correlations from a complex mix of factors, making it suitable for this analysis where the inspection data ran to several billion records, a volume that conventional computational software would find difficult to handle.

First, Pentaho was used to process the inspection records and collate them into a database to facilitate the identification of trends based on numerous different analysis considerations (to find clues for identifying inspection checks with the potential to be shortened). Next, AT/H was used to perform a multi-variable analysis and identify correlations between inspection checks. Unnecessary inspections were identified and thresholds adjusted or revised for those checks that were highly correlated, while those checks that were not highly correlated were deemed to be necessary (and therefore, retained).

In this way, a new inspection process was devised. The old and new processes were then trialed in practice on the same products and the results compared. Having confirming that inspection quality was maintained, the new process was adopted for production.

In other words, it represents an optimization of the inspection process.

The use of an optimal inspection process reduced inspection times by about 30% (and as much as 75%) based on FY2016 figures, also making a significant contribution to financial performance by responding flexibly to fluctuations in demand. Furthermore, by providing an easy way to assess and analyze inspection records, the work has also helped shorten development times and reduce loss costs by enabling inspection checks for new products to be quickly optimized.

Inspection process optimization was achieved by having an AI rapidly execute analyses of inspection data in quantities too large to be dealt with manually. The AT/H analysis is currently being extended to operational data from the field and utilized in the development of fault prediction techniques, with the aims of improving maintenance and reducing costs and spare parts inventory.

3. 3
Using Greater Visibility of Workplace Activity to Shorten Lead Times

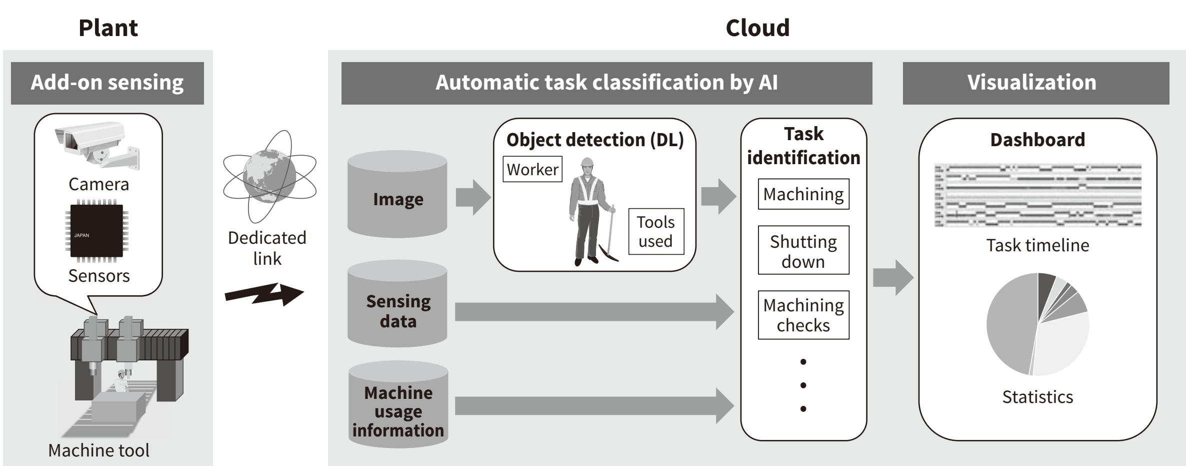
The Machinery Systems Division of the Industrial Products Business Unit supplies made-to-order heavy machinery for social and industrial infrastructure. With made-to-order production, unfortunately, the accuracy of production planning tends to be poor because of the difficulty of determining lead times. Precise production planning based on accurate lead times is needed to minimize delivery delays and avoid high inventory levels. In this case, the objective was to improve the machining processes that make up a large proportion of production lead times.

Records of when existing machine tools were in and out of use had already been collated. What was not available, however, but was needed to shorten lead times, was information on when machine tools were out of use due to staff spending time on ancillary activities. As the machining of large parts can take several days, it is difficult for someone to wait around to acquire detailed work information. Another challenge was how to perform realtime monitoring of the ever-changing conditions in the workplace and work rapidly through the plan, do, check, act (PDCA) cycle.

In response, an analysis support system was implemented that uses add-on sensing (the retrofitting of sensors to acquire meaningful information) and AI to distinguish information (see **Figure 3**). A range of different sensors, including cameras, microphones, current sensors, and rangefinders, are chosen as needed to provide accurate digital data on workplace conditions. The collected data is transferred to the cloud via a secure dedicated link where it is then used to automatically recognize different work tasks using deep learning (DL) and other AI techniques. Specifically,

Figure 3 — Automatic Task Classification System for Machine Tools

Data collected by add-on sensors is sent to the cloud where an AI performs automatic task classification. The analysis results are available for viewing on a dashboard.



DL: deep learning

the workers and the tools they use are identified from sensor data using object detection models for people and things that have undergone learning, and are then classified into tasks such as machining, shutting down, machining checks, control panel operation, and cleaning. The analysis results are made available in a timely manner by passing them to a dashboard application.

This system enables the timely collection and analysis of information and has been able to determine accurate lead times for use in production planning. Changes to machine operation programs and other improvements have also been made by identifying the factors behind times when machines are not in use. As a result, production lead times have been shortened.

In the future, use of the system is to be extended to machine tools and welding processes at the plant to enable accurate production planning. Hitachi also intends to expand the range of tasks able to be identified and to improve identification accuracy, and to proceed with further deployment at other plants.

4. Conclusions

This article has described how Hitachi has undertaken manufacturing reforms utilizing the Lumada platform and appropriate AI tools. Hitachi is also packaging examples of in-house reforms for shared use to create an environment in which they can be used by everyone. By doing so, the wider deployment of these within Hitachi can proceed efficiently, thereby helping to enhance the competitiveness of company products. Moreover, work has started on commercializing successful examples of digitalization at Hitachi in the form of digital solutions for MONOZUKURI reform, with the intention being to offer these more widely for use by customers.

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