Featured Articles

TSCM Cloud Services for Implementing the Global Mother Factory Center Concept

Hirotaka Morita
Shigenori Tanaka
Yoshimitsu Hiro
Manabu Naganuma

OVERVIEW: In the midst of proposed initiatives for new approaches to how manufacturers operate that aim to implement intelligent production systems able to collect and store a variety of information automatically so that it can be processed, analyzed, and used, Hitachi is working on measures that utilize its in-house manufacturing technologies and know-how along with IT solutions, sensors, and other technology. As part of this, and with greater use being made of overseas production, Hitachi has proposed what it calls the global mother factory center concept for optimizing the entire value chain using TSCM, which encompasses design and development, production management, production technology, and quality management, and is seeking to develop and strengthen the TSCM cloud services that support this.

INTRODUCTION

CONCEPTS such as Industrie 4.0 and the Industrial Internet have for some years been put forward as initiatives aimed at establishing new ways of undertaking manufacturing[1), 2)]. Across design, production, sales, and operations, these concepts involve seeking to implement intelligent production systems that use sensor network technology to collect and store data from production equipment automatically and use big data for the analysis, processing, and use of information. This is seen as a new industrial revolution that will provide manufacturers with enhanced competitiveness. Along with these background trends, there is also considerable activity in the reviewing of information systems for the collection, storage, analysis, processing, and use of data.

Recognizing these trends, Hitachi has proposed its global mother factory center concept, which optimizes the entire manufacturing value chain with the aim of creating a new approach to manufacturing, and is proceeding to implement the cloud services that will support this concept. This article describes these initiatives.

GLOBAL MOTHER FACTORY CENTER CONCEPT

Current Situation for Global Manufacturers

Prompted by the expansion of markets in emerging economies and the intensification of global competition, an increasing number of manufacturers are seeking to establish manufacturing capabilities based on a "local production for local consumption" model in which products tailored to a particular market are produced and supplied from a location close to that market. Accordingly, there is growing demand for the supply on a global scale of information technology (IT) systems that support design and development, production management, production technology, and quality control (QC).

For new overseas plants, many Japanese manufacturers in the past have chosen deployment and implementation based on the operational support IT systems from their plants in Japan. However, as the commissioning of new plants becomes more frequent due to the transition to a production model based on "local production for local consumption," the horizontal deployment of IT systems by a limited number of staff with knowledge of company operations has led to the problem of operation commencing without sufficient skills transfer and other training having been completed. This has led to a capability gap between existing Japanese plants and new plants in the areas of work quality, product quality, and design quality.

Capability Gap between Plants

The capability gap between existing Japanese plants and new plants is creating the sort of problems described below.

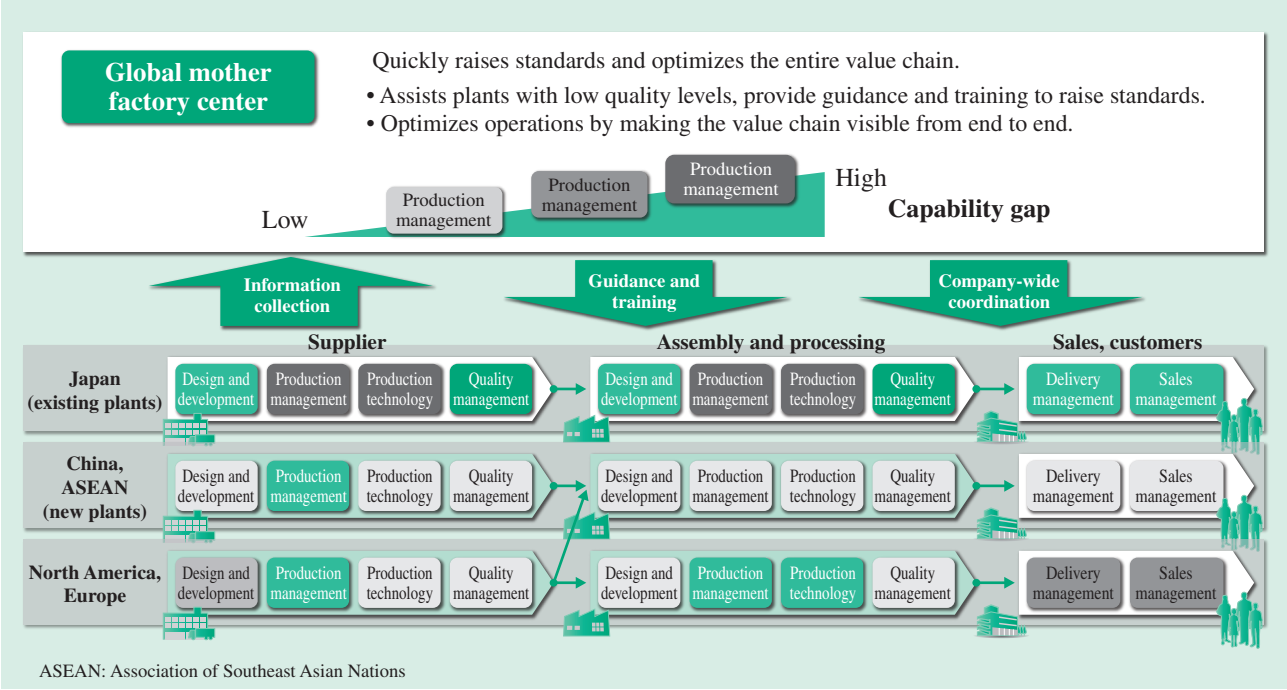


Fig. 1—Global Mother Factory Center Concept.
Global mother factory centers seek to raise overall standards by eliminating capability gaps between existing and new plants and by providing supervisory management aimed at company-wide optimization.

One manufacturer of precision components was unable to respond to fluctuations in demand from customers and only discovered at the last minute that its production plans were not workable, a situation that arose because production plans for its overseas plants were produced infrequently. As a result, it suffered significant financial losses, being forced to switch production back to Japan and frequently needing to resort to emergency airfreight delivery to avoid delays to customer production.

At another manufacturer of precision products, problems with worker proficiency due to high staff turnover led to frequent instances of poor workmanship at a new overseas plant, which unlike plants in Japan used a mixture of automated production lines and manual labor. This included a case in which a problem occurring in production led to a major recall involving wide-ranging product inspections because of a lack of work behavior monitoring and no way of linking product defects resulting from poor workmanship to particular lots. Also, despite increasing use of local design as part of a production model based on "local production for local consumption," there were no processes for sharing design information with existing Japanese plants, managing customization, or using analysis tools to improve design productivity. This led to rework at the prototype development stage and delays in the release of new products.

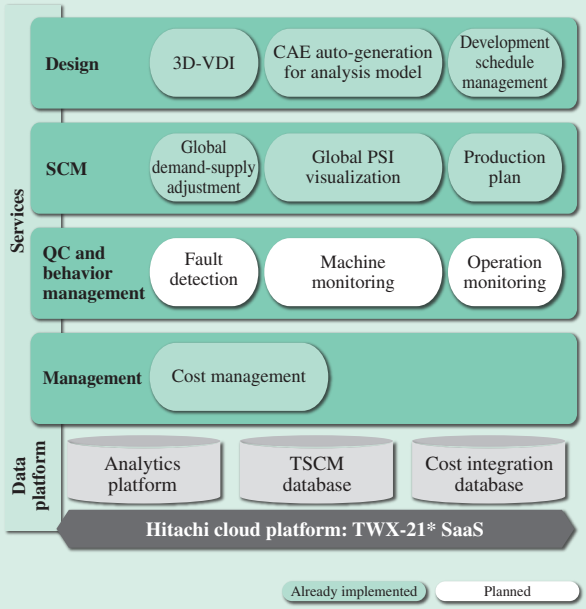
Global Mother Factory Center Concept

In seeking to raise the overall standard of its operations, Hitachi has formulated the global mother factory center concept for optimizing the entire value chain by eliminating the gap between existing Japanese plants and new plants in the areas of work quality, product quality, and design quality, and has embarked on steps aimed at implementing the concept in practice (see Fig. 1). A global mother factory center carries out the following three missions for a number of manufacturing sites.

(1) Standardization of operational and IT systems
(2) Visualization and sharing of information
(3) Automation and optimization of operations

In addition to observing and reviewing the operations of new plants where operational quality is low, a global mother factory center provides guidance and other training on how to raise standards in order to augment plant operations. It also optimizes operations by making the value chain visible from end to end and coordinating the overall production plan, which is not possible to achieve at the individual plant level.

To realize this global mother factory center concept, Hitachi has started supplying cloud-based



3D: three-dimensional VDI: virtual desktop infrastructure
CAE: computer-aided engineering SCM: supply chain management
PSI: production, sales, and inventory QC: quality control
TSCM: total supply chain management
SaaS: software as a service
* TWX-21 is a trademark of Hitachi, Ltd.

Fig. 2—Overview of TSCM Cloud Services.
Hitachi aims to provide services that support operations from design, SCM, and QC and monitoring to management, and that can be used globally.

services that enable the service functions that support design and development, production, and QC and monitoring to be used at a global level, in a timely manner, at low cost, and with flexibility. The following sections describe these services.

TSCM CLOUD SERVICES

Hitachi is progressively launching total supply chain management (TSCM) cloud services that support the operations of the global mother factory center.

Fig. 2 shows an overview of these TSCM cloud services. The figure includes services that have already been deployed and those that are under consideration. They provide service functions that cover the support of design work as well as supply chain management (SCM), QC and monitoring, and management; TSCM and other databases collected from the use of these service functions; and an analytics platform for the analysis of data used in the service functions and information collected and stored in databases. User companies are able to automate and optimize operations by deploying these services at the global mother factory center for design, production, and sales sites that are dispersed based on the "local production for local consumption" model. The following sections describe cloud services for specific types of work.

SCM Cloud Service

With multi-site deployment based on local production for local consumption, differences between sites manifest in areas like the accuracy of production planning and ratio of plan achievement, making it

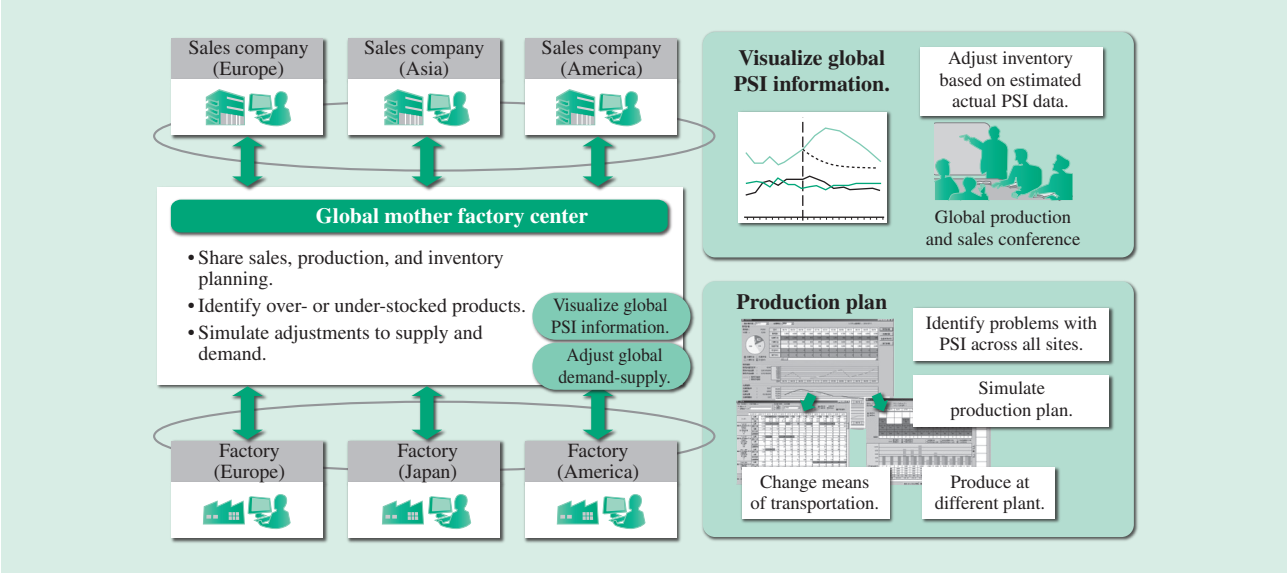


Fig. 3—SCM Cloud Service.
The service makes available global PSI information and production plans for each plant, and adjusts global demand-supply when a problem occurs to keep to delivery schedules, reduce inventory, and minimize loss costs.

difficult to respond to variations in demand at individual plants. The SCM cloud service not only encourages global standardization of operations through the centralized management of data and systems for each business process, from sales to design, production, and procurement, it also enables appropriate decision-making at the global mother factory center (see Fig. 3). The main features are as follows.

(1) Global production, sales, and inventory (PSI) visualization feature

This feature integrates past, present, and future PSI information for each site and shares information between manufacturing and sales.

(2) Production plan formulation and revision feature

Identifies instances where parts, production capacity, or other resources do not match what is required to achieve a plant's production plan and provides a feature for revising the plan to make it achievable.

(3) Supply and demand adjustment feature

This is used at the global mother factory center to issue instructions to each site to change their production plans if a problem arises that a site cannot resolve on its own. This is done with reference to PSI information from throughout the world and the plans for each production site by running instantaneous simulations of supply and demand across different sites, making changes such as using a different means of transportation or shifting production to a different plant.

These features enable preemptive measures to be taken throughout the global supply chain to prevent problems such as delivery delays or excess inventory.

Design Cloud Service

A common practice for developing products that suit the requirements of the places where they will be used is for the global mother factory center and the local site to collaborate on development. The design cloud service provides functions for resolving issues such as how to share design information, maintain design quality, and maintain security (see Fig. 4).

A virtual desktop infrastructure (VDI) for three-dimensional (3D) computer-aided design (CAD) enables the sharing of 3D-CAD data, the most important part of the design information, in a secure environment. A design environment that uses a VDI for 3D-CAD enables the secure sharing and use of design information, eliminating the need to implement and operate a product data management (PDM) system at each design office. This allows the supervisory management of information such as designs and development schedules and facilitates the global maintenance of design quality. When creating analysis models for computer-aided engineering (CAE), detailed mesh models take a long time to build and require specialist know-how. This service enables rapid automatic generation by giving access to past analysis model information accumulated in Japan. Using this technique improves the design quality of design departments in Japan and overseas. Using the service at the global mother factory center and at development centers in destination markets enables the consolidation, sharing, and use of design data spread across different sites, while expanding access to include suppliers enables supervision of design quality for the entire product.

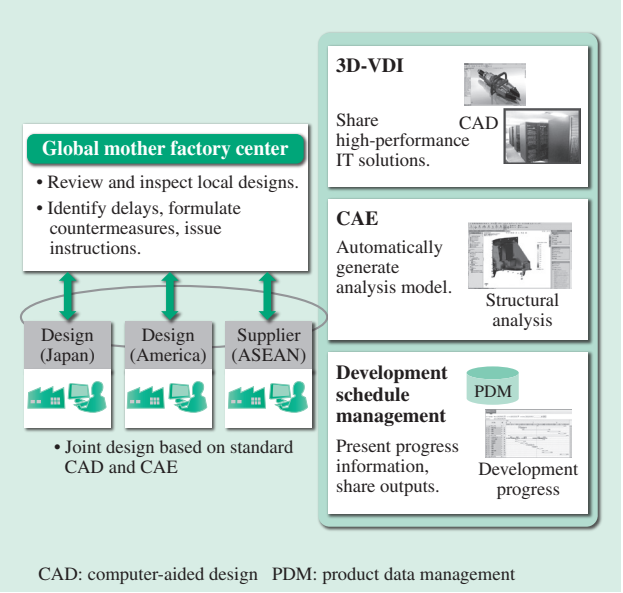


Fig. 4—Design Cloud Service.
This service improves quality and shortens design times by standardizing CAD and CAE practices and performing design jointly with suppliers.

Cloud Service for Quality and Behavior Management

As local production for local consumption has been expanded globally, quality improvement of locally made products is becoming an urgent issue. New assembly and processing plants built in emerging economies have a relatively high number of people at the production site across all processes compared to plants in Japan that make use of advanced automation and robotics. Despite human-resource-based efforts to reduce operational errors in the workplace, it is not possible to eliminate defects entirely. Also, support from the "mother factory" in Japan to instruct and

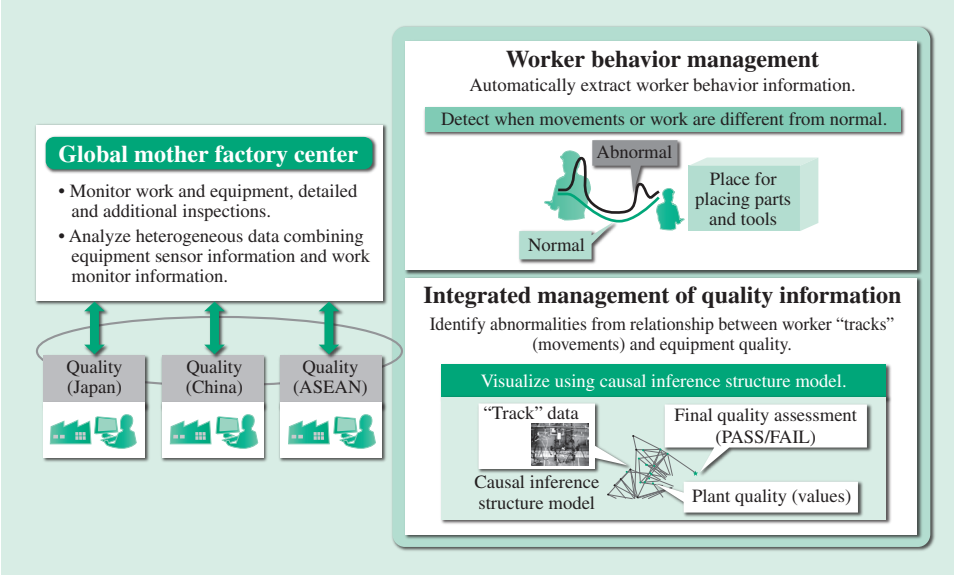


Fig. 5—Cloud Service for QC and Behavior Management. This service minimizes quality dispersion between sites and improves quality by performing monitoring and remote management of what is happening at overseas plants.

monitor local factory workers (training and skills transfer) has not been enough and what local staff members can do by themselves has been very limited. As a result, the error detection rate in local factories has been low and quality gaps have remained in areas such as manufacturing practices and products.

To resolve these issues, Hitachi is preparing to provide ways of minimizing quality dispersion between sites and improving quality by performing monitoring and remote management of what is happening at overseas plants and other sites through the cloud service for quality and behavior management (see Fig. 5).

Hitachi's proposed method to achieve quality improvement is the automatic extracting of "track" patterns (people's movements) that influence quality to identify the relationships between faults and people's movements, and designating these as things to look for in fault detection. When an abnormal track is identified, special checks are conducted before the product leaves the factory to preemptively prevent defects from reaching the market. For worker track patterns, the tracks are analyzed using information from images captured by fixed cameras located around the workplace. However, it is not possible to capture adequate images of the work using external cameras in situations where something passes between the fixed camera and worker to block its view. Accordingly, the next step will be to install 3D cameras at appropriate locations for work processes to capture not only the workers' tracks but also to acquire their operations and actions from the images and to monitor them as part of fault detection. In this way, information will be collected and analyzed to make further quality improvements.

Furthermore, Hitachi will provide services for achieving high-quality manufacturing at any site by using a causal inference structure model to infer the relationship between track data and quality data measured by the equipment, and by identifying abnormalities and performing integrated management of quality information so that it can be used as quality information (traceability).

CONCLUSIONS

This article has described the global mother factory center concept, a form of future global manufacturing, and the TSCM cloud services that support it.

While these services are currently being deployed mainly within Hitachi, in the future Hitachi intends to continue developing leading-edge technologies that nobody else can achieve, and to supply services through collaboration with leading companies both inside and outside of Hitachi.

REFERENCES

(1) The German Standardization Roadmap Industrie 4.0, VDE Association for Electrical, Electronic & Information Technologies, https://www.dke.de/de/std/documents/rz_roadmap%20industrie%204-0_engl_web.pdf
(2) The Industrial Internet@work, General Electric Company, https://www.ge.com/sites/default/files/GE_IndustrialInternetatWork_WhitePaper_20131028.pdf

ABOUT THE AUTHORS

Hirotaka Morita

Total Supply Chain Management Solution Center, Industrial Systems Division 2, Enterprise Solutions Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in the planning and development of the SCM solutions business.

Yoshimitsu Hiro

Total Supply Chain Management Solution Center, Industrial Systems Division 2, Enterprise Solutions Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in business planning in the digital engineering field and is in charge of development CAE software. Mr. Hiro is a member of the Japan Society for Computational Engineering and Science.

Shigenori Tanaka

Automotive System Department, Enterprise Solutions Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in the development of the automotive industry system solutions.

Manabu Naganuma

Business Planning Department, Enterprise Solutions Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in business planning in the manufacturing & retail/ distribution fields.