Featured Articles

Current Activities and Future Prospects for Industry-specific MESs
—Recommendations for Operational Optimization and Service Businesses—

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OVERVIEW: *The role of industrial MESs has been changing in recent years due to a variety of factors such as rapid advances in IT and greater operational diversity at manufacturing sites. Hitachi supplies MESs tailored to specific industries, such as the automotive and pharmaceutical manufacturing industries, and has been further developing MES functions to keep pace with user needs. One of these is the MES package for process industries (such as food and chemicals), which have a particular need for workplace improvements. Hitachi MES package provides solutions that can be adapted flexibly to workplace changes, including management functions based on SOPs. Recognizing the demand from users for operational optimization, environmental and equipment maintenance, and other workplace management tasks that are expanding in scope, Hitachi is also investigating the future potential for implementing systems that can expedite the PDCA cycle and provide seamless coordination with service businesses.*

INTRODUCTION

INDUSTRIE 4.0 is an advanced technology strategy introduced by the German government in 2011. The concept is based on a joint industry-academia-government project, with the release of a final report in Germany in 2013 being a recent development. In the information technology (IT) field, meanwhile, it is evident to everyone that cloud technologies such as software as a service (SaaS), platform as a service (PaaS), and big data are making a place for themselves in the wider world.

Manufacturing execution systems (MESs), too, are becoming widely used, particularly in factory automation (FA) applications such as the automotive and semiconductor industries, and in process industries such as chemicals, pharmaceuticals, foods, and cosmetics. However, the functions required of MESs are changing in various ways as greater operational diversity at manufacturing sites and shorter lead times for activities such as product development cause manufacturing plants and user needs to become more complex across a range of industries. Taking note of this background, Hitachi supplies a variety of packages to suit different customer activities (see Fig. 1).

This article describes Hitachi's current activities and the future prospects for industry-specific MESs.

BACKGROUND TO ADOPTION OF IT SYSTEMS AND EXPECTATIONS FOR MESs

The process of adopting IT systems in many industries has started with the automation of manufacturing plants, followed by the installation of core business systems with functions such as accounting, procurement, and warehousing. For these core business systems to function adequately, however, there is a need to use a variety of manufacturing workplace data as information in an organic way, including the results of work performed manually and by automation systems. To make good use of this information, MESs have been installed in various industries over the last dozen or so years to act as intermediaries. Many users have come to recognize the worth of MESs, whose benefits include improving productivity and maintaining quality.

In recent years, however, the number of issues related to workplace and management has risen, including how to deal with operational optimization at plants that produce a wide range of products with variable production runs, environmental and
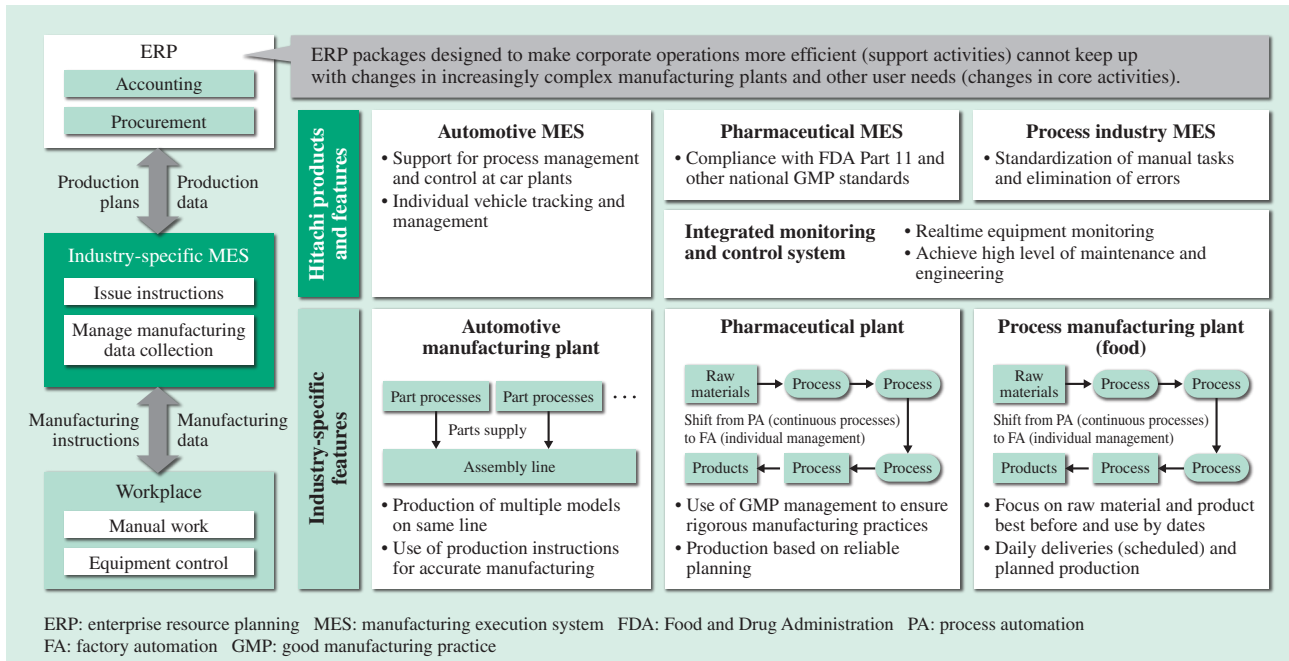
Fig. 1—Industry Features and MES Products for Different Industries.
The philosophies behind the MESs for manufacturing plants in specific industries depend on factors such as the regulatory environment and manufacturing processes required to produce the end product.

equipment maintenance, and other workplace management tasks that are expanding in scope. Growing expectations have been placed on MESs in recent years to resolve these issues.

MESs DESIGNED FOR SPECIFIC INDUSTRIES

MES for Automotive Manufacturing Featuring Realtime Processing and Data Collection Management

The MES for automotive manufacturing was developed by consolidating Hitachi's experience of more than 30 years in implementing process management systems for automotive manufacturing, and provides fine-grained process management for automotive manufacturing plants. Its functions extend to support for equipment control, primarily manufacturing management functions that provide realtime delivery of production information from core business systems to the continuously changing vehicle production process.

In the future, Hitachi will enable the system to be expanded progressively and supplied in stages by breaking the management of parts manufacturing processes down into individual modules based on the assembly line. With the aim of satisfying user needs for expediting overseas deployment, Hitachi is also focusing on improving the expandability of the system

and adding multilingual capabilities to enable its use throughout the world by unifying the architecture, which in the past has been set up separately in different countries.

Hitachi Pharmaceutical Manufacturing Execution System Featuring Compliance with Regulations and Strict Quality Standards

To ensure that quality standards are maintained, the pharmaceuticals industry needs to comply with strict rules such as good manufacturing practice (GMP), which is a set of standards for manufacturing and quality management for pharmaceuticals and other products of a similar nature.

A major feature of systems designed for pharmaceutical manufacturing is that they must support "validation," which means documenting how to ensure that the equipment, procedures, processes, and so on required for pharmaceutical production, quality management, and other tasks deliver the expected outcomes. As an MES designed specifically to comply with the regulatory requirements of the pharmaceuticals industry, Hitachi for pharmaceutical manufacturing can reliably execute complex procedures, provide efficient record-keeping, and support reliable production. To satisfy the requirement that has arisen in recent years for MESs for the pharmaceutical, food, and other process industries to support control integration with
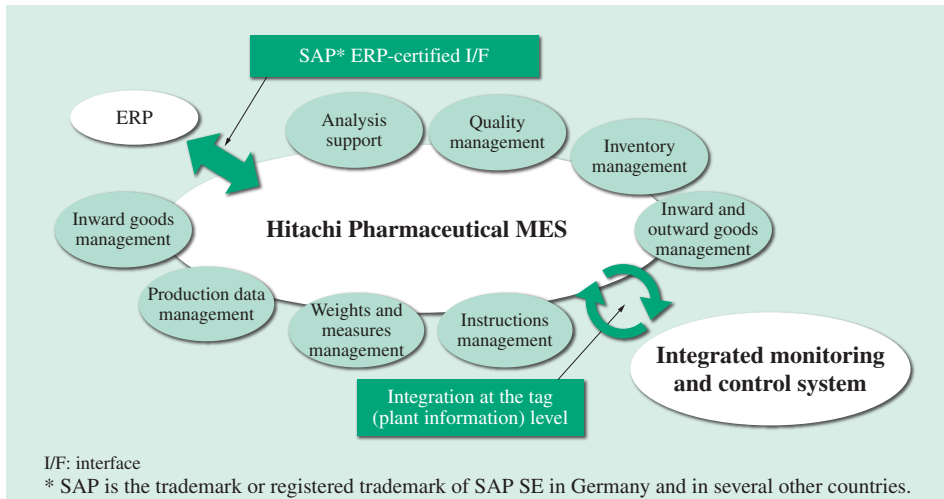
Fig. 2—Overview of Hitachi Pharmaceutical MES.
Ease of global deployment, including compliance with various national GMPs, is one of the MES's features.

on-site equipment, Hitachi Pharmaceutical MES can interoperate closely with the integrated monitoring and control system (see Fig. 2). Hitachi has also anticipated global deployment by adapting the product to the Chinese and Indian markets.

MES FOR PROCESS INDUSTRIES FEATURING ENHANCEMENT OF WORK QUALITY AT MANUFACTURING PLANTS

MES for Process Industries
The MES for process industries has undergone ongoing development in response to ever-changing user needs based on Hitachi's experience in implementing food industry MESs since the 1990s. It was released in FY2009 as a simple MES for standardizing work practices, preventing errors, and so on by using standard operation procedures (SOPs) for workplace tasks to manage manual activities such as measurement and mixing processes. Further growth has taken the form of solutions that can more flexibly keep up with changes in the workplace, including the provision of tools that Hitachi developed in FY2013 to enable customers to perform their own engineering work after system installation.

Distinctive Functions for Efficient Operation
(1) Using SOPs to prevent errors
Hitachi's approach to the use of SOPs for things like standardizing operations and preventing errors is to treat as a design prerequisite the provision of displays simple enough that all workers at the site can understand how to perform operations. In relation to work instructions that in the past involved the use of paper and other checklists, Hitachi MES for process

industries enables the provision of clear guidance to workers by displaying appropriate screens for each step of the work instructions. Workers can avoid making mistakes or missing steps by consulting the next SOP screen after completing each task. This also helps reduce the strain on workers by ensuring they can do the work regardless of how proficient they are (see Fig. 3).
(2) Centralized management of information through interoperation with the monitoring and control system
The MES can automate instructions and data collection from production equipment through interoperation with the monitoring and control system supplied by Hitachi. As a result, it can provide centralized management of work instructions and data collection by covering entire processes that combine both manual and automatically controlled steps. Specifically, issuing instructions to equipment (such as to add ingredients automatically) and instructions to workers (such as to add ingredients manually) can be performed seamlessly from the SOP screen without dividing operations between separate systems. Also, because process information (automatic and manual) is managed centrally, the MES helps supervisors reduce the amount of investigation time required for tasks such as responding to inquiries about quality (see Fig. 4).
(3) Provision of self-engineering tools
Hitachi MES for process industries enables the provision of engineering tools that can visually edit or modify SOP master copies to reflect user requirements using spreadsheet software that has easy-to-use editing functions for maintaining master data records (see Fig. 5). By enabling supervisors to update work instructions as appropriate to match

Fig. 3—SOP Screens.
The screens show standard operation procedures (SOPs) displayed by Hitachi MES for process industries. Features include multilingual support and the ability to use text, images, video, and audio.
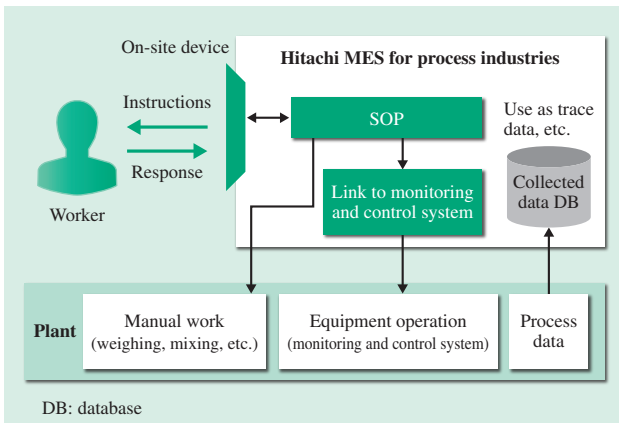

Fig. 4—Overview of Coordination between Manual Work and Equipment.
An SOP can include instructions for people or equipment and data collection.

Fig. 5—Self-engineering Screen.
The screens, text, and other information to be used (right) can be assigned to work procedures (left).

workplace operation, this keeps the MES up to date with the workplace. Using these tools, users can also generate and edit reports based on information in the database.

CONFIGURATION REVIEW AND FUTURE PROSPECTS FOR NEW MESs

Issues and Countermeasures Required in MESs

Along with the industry trends and advances in IT described earlier in this article, industry-specific MESs need to continue resolving a growing number of issues. One such issue is the search for ways to establish efficient work practices in the workplace that

can ensure consistent lot-by-lot quality for variable-length production runs of a wide range of products. Managers and supervisors, meanwhile, need to look at how to handle compliance with environmental and energy efficiency regulations as well as things like life cycle management of equipment and efficient maintenance. Hitachi deals with issues that cannot be resolved by either the workplace or management in isolation through integration with solutions and other services based around its industry-specific MESs. To achieve this, Hitachi believes there is an urgent need to adopt standardized information platforms, such as methods for integrating master records and other data across its industry-specific MESs and other solutions and services (see Fig. 6).
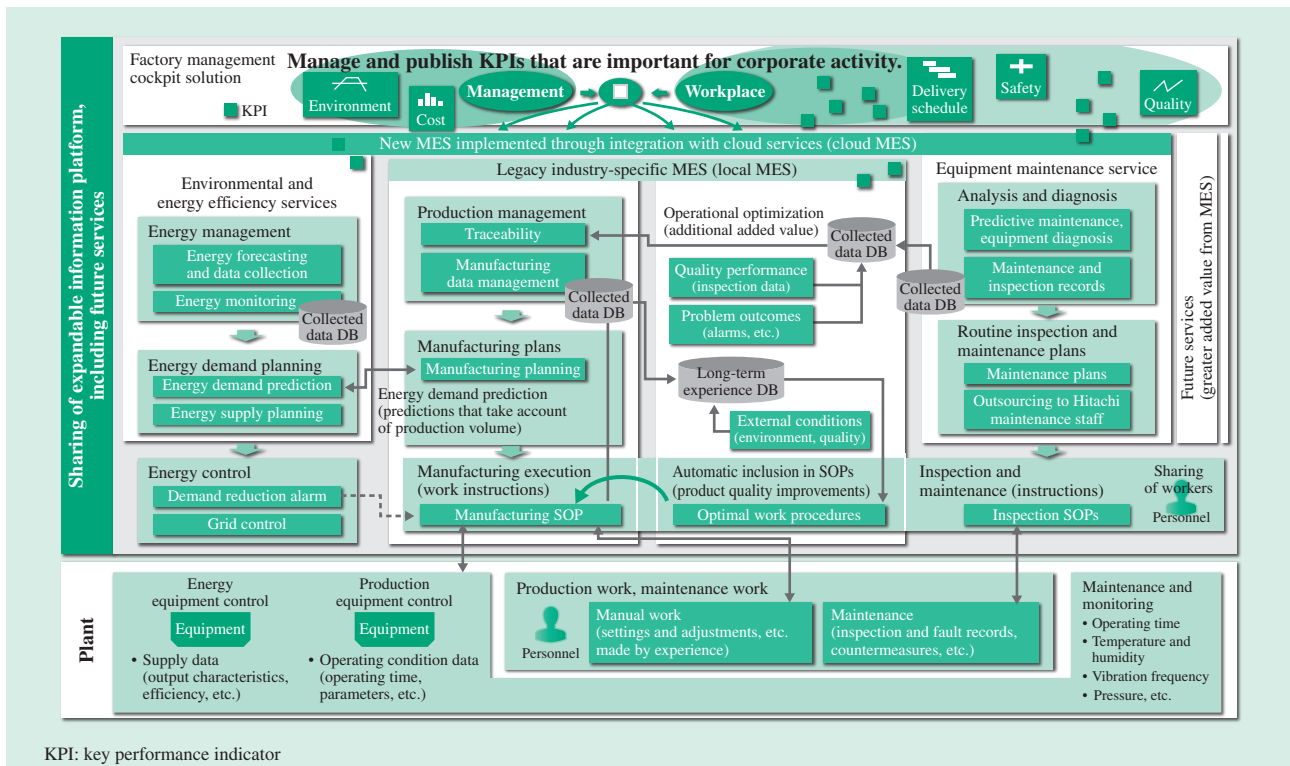
Fig. 6—Future Outcomes Made Possible by New MESs.
The scope of industry-specific MESs includes production management, and this along with other MES functions associated with manufacturing plants will be implemented through integration with services.

Future Outcomes Made Possible by New MESs

(1) Operational optimization by collating know-how from skilled workers

With conventional SOPs, it is difficult to provide appropriate guidance from an IT system for manual tasks performed by skilled workers in accordance with workplace rules of thumb. However, through the long-term collection of the process data described above together with correlations to the factors that skilled workers use to make judgments (quality of upstream processes, external environment, etc.), it is possible to obtain approximations from accumulated information by using the factors that are relevant during actual work as search values. Hitachi believes it can implement this approach by using technologies developed in its laboratories, such as memory-based reasoning (MBR)[*1] and warning sign modeling[*2].

As a result, this can contribute to things like productivity and product quality by enabling even inexperienced workers to do the work using standardized guidance based on operational know-how that enables skilled workers to take appropriate steps in response to factors such as an external environment, which varies in realtime, and the unreliable quality of upstream processes.

(2) Factory management cockpit solution for increasing work activity

Defining the key performance indicators (KPIs) required to manage a factory and providing a realtime view of the manufacturing workplace are good ways to keep up with workplace information. Factory management cockpit solutions provide realtime monitoring of factory KPIs relating to production (yield and output, etc.), quality (defect rate, etc.), equipment (equipment utilization, alarms, maintenance schedules and records, etc.), and environmental performance (basic unit energy consumption, etc.) so that appropriate and timely decisions can be made based on an understanding of the situation in the workplace. When a problem arises, for example, a quick response can be achieved at all levels by making details available to everyone from workers to factory managers, allowing the production manager to obtain an early resolution by focusing on dealing with the problem; the logistics manager to

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*1 A prediction technique for calculating approximations from a base of collected data
*2 A modeling technique for identifying unusual behavior and predicting outcomes

Fig. 7—Factory Management Cockpit Solution Screens.
The screens show KPIs for each level from a global
management perspective (top) down to a factory perspective
(bottom), and also workplace information.

quickly adjust finished product delivery schedules; and the factory manager to quickly determine what impact the problem will have on factory operation. By clearly identifying who is responsible for KPIs at each level, this helps the workplace's ability to make improvements by individually working through the plan-do-check-act (PDCA) cycle, and aids the early detection of hidden problems (see Fig. 7).

(3) Use of the cloud to supply MES functions as a service

Based on cloud technology, Hitachi supplies cross-industry services that provide simulation and other analyses for the energy management and equipment maintenance functions that are within the scope of an MES.

For example, Hitachi plans to develop and supply cloud-based energy management services for environmental and energy management, which has arisen as a new way for companies to look at their business since the Great East Japan Earthquake. In one example involving interoperation with an MES, Hitachi has implemented a function that seeks to reduce peak electric power demand by simulating the energy requirements of production plans. Other examples include a service that supports timely maintenance by identifying and analyzing warning

signs of equipment faults, and that enables the proactive provision of maintenance and maintenance infrastructure by sharing operational know-how with Hitachi maintenance personnel. In this way, diverse user needs can be satisfied without imposing a burden on the workplace by taking advantage of services supplied by Hitachi, as required, rather than implementing all MES functions on a single system.

Hitachi's Next Generation of MES Solutions

In the future, Hitachi will achieve seamless integration between the MES functions that customers require by establishing the capability to provide industry-specific MESs and other functions and services that utilize cloud technology. Specifically, this will enable appropriate workplace operation by having local MESs take account of the results of simulations performed on a cloud MES based on information collected from multiple sites, where these simulations include risk assessment and other complex analyses, such as warning signs of equipment faults, process modeling, and production capacity allocation. Because work can be performed based on standardized work instruction screens, workers can be assigned without being split into departments that each have a separate responsibility, such as production or maintenance. By becoming deeply integrated into the company's operations rather than just its manufacturing plants, this can improve service levels above what has been
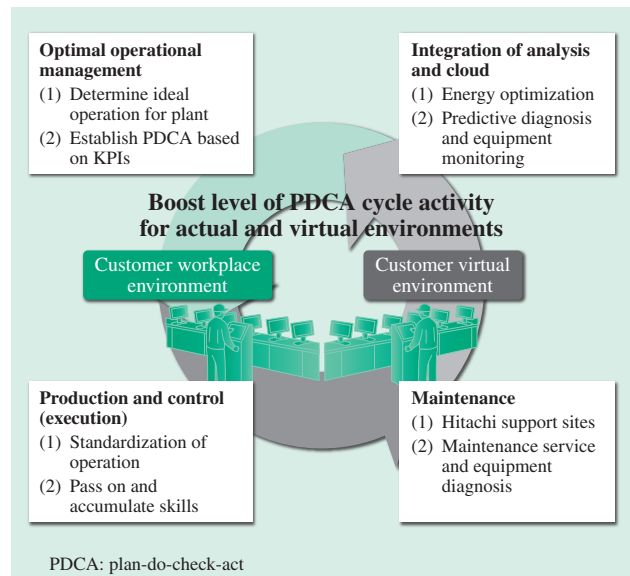

Fig. 8—Hitachi's Next Generation of MES Solutions.
The solutions are intended to boost the level of PDCA cycle
activity for actual and virtual environments in accordance with
the customer's workplace.

provided by local MESs in the past, further expediting the PDCA cycle and delivering more efficient workplace improvement and flexible management (see Fig. 8).

CONCLUSIONS

This article has described Hitachi's work on industry-specific MESs and their future prospects, including giving an overview of the MES for process industries.

Along with changes in social and other environmental factors, it is anticipated that workers and managers will be called on to deal with a growing number of issues in the future. Hitachi intends to continue contributing to manufacturing sites and other corporate workplaces through the ongoing delivery of additional value in the field of MESs in ways that suit these changing user needs.

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