Overview

World-leading Advanced Factory "Lighthouse" and Its Information and Control Systems

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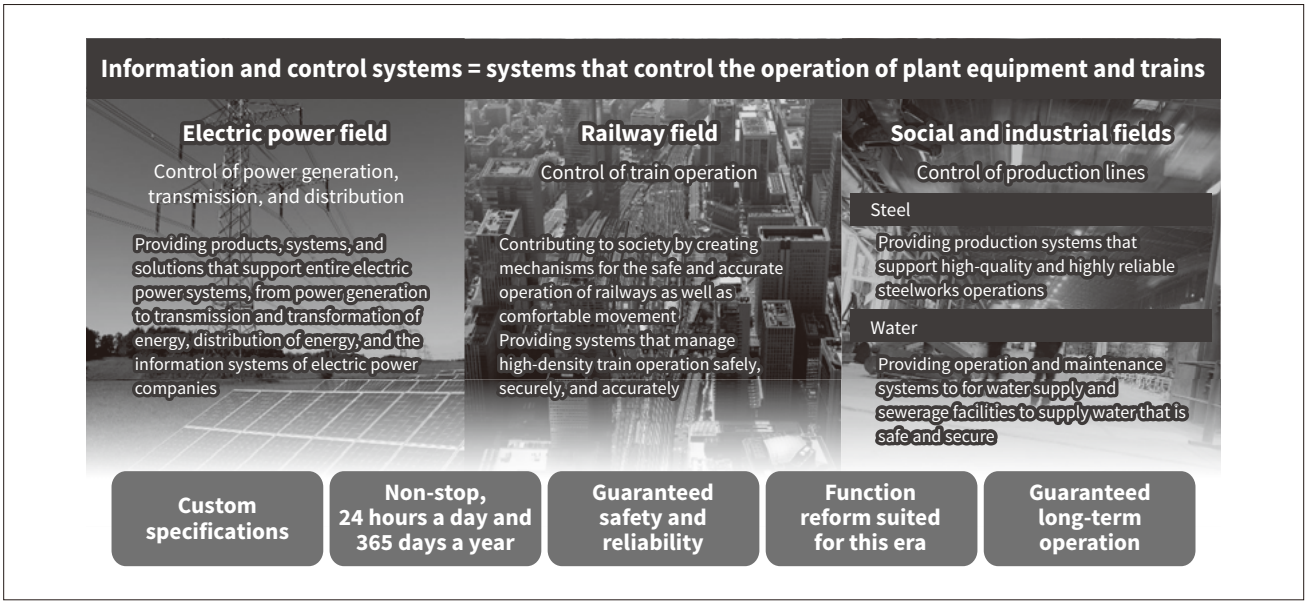
1. Introduction

Ever since it was founded in 1969, Hitachi Ltd.'s Omika Works has provided information and control systems for use in social infrastructures and industry, such as power generation, transmission, and distribution systems, railway traffic management systems, water supply and sewerage facility operation and maintenance systems, factory and steelworks production systems, and so on (see **Figure 1**). High reliability and high performance are required for information and control systems, since they must monitor and control the infrastructure equipment that supports the lives of people in society 24 hours a day, 365 days a year. The operating life of infrastructure equipment is generally long, and functions must be both expandible and maintainable so that infrastructure equipment can be kept in an optimal state throughout its long life cycle.

Hitachi has been advocating for autonomous decentralized systems as the architecture of information and control systems. Control nodes such as controllers or control servers share the information necessary for control, and the individual control nodes autonomously operate based on this shared data in a decentralized system. This type of control system offers excellent reliability as well as expandability.

Figure 1 — Information and Control Systems Provided by Omika Works

Omika Works provides information and control systems for social infrastructures and industrial fields, such as power generation, transmission, and distribution systems, railway traffic management systems, operation and maintenance systems for water supply and sewerage facilities, and production systems for factories and steelworks.



Recent advances in sensing, networks, and big data analysis technologies have made it possible to sense on-site information and to consider solutions to problems based on this information, and efforts are underway to continuously increase the intelligence of system operations while improving on-site control systems[1), 2)].

Since information and control systems are constructed according to the optimal operating conditions of facilities for a diverse range of social infrastructures and manufacturers, they are custom-made. Furthermore, in order to reduce the social cost, it is critical to secure manufacturing quality while achieving productivity comparable to that of mass production. As strategies for solving this issue, Hitachi has pursued mass customization utilizing the Internet of Things (IoT) as well as data analysis. In recognition of these efforts, in January 2020 the World Economic Forum designated Omika Works as the first Japanese manufacturer to be selected as a "Lighthouse," a world-leading advanced factory that is ushering in the Fourth Industrial Revolution[3)].

This article outlines the efforts Omika Works is taking as a Lighthouse advanced factory providing the information and control systems that support social infrastructures.

2. World-leading Advanced Factory "Lighthouse"

Known for its Annual Meeting in Davos, the World Economic Forum selects advanced factories leading the Fourth Industrial Revolution as "Lighthouses" (guides). While more than 70% of corporations in the manufacturing industry around the world are said to be searching for a way out of the pilot phase aimed at introducing advanced manufacturing technologies, the Lighthouse program is working toward a goal of raising the standard of digital transformation (DX) in the entire manufacturing industry by sharing efforts. This community of Lighthouse factories is known as the "Global Lighthouse Network," and as of March 2021, 69 factories have been selected to participate from around the world[4)]. These factories are selected from over a thousand candidate factories worldwide, not only based on improvements in productivity, but also on a wide range of perspectives including business sustainability, social and environmental impact, human capital development, and ways of working.

3. Efforts as a Lighthouse Factory

Omika Works seeks to optimize the entire value chain by constructing integrated systems encompassing the development of information and control systems, manufacturing, quality assurance, and maintenance. Of these distinctive efforts, Omika Works presented the World Economic Forum with the following five efforts to consider during the Lighthouse selection process (see **Figure 2**).

(1) High-efficiency production model

Omika Works includes a diverse range of production areas, including those focusing on manual work such as sheet metal working and fabrication of the control panels that make up information and control systems, as well as those focusing on automatic machining such as the production of printed circuit boards. To pursue both high efficiency as well as high quality in these diverse lines, a high-efficiency production model is adopted that focuses on the human, machine, material, and method (4M) data of a production site. Omika Works seeks to make continuous improvements through the establishment of a cyclical system based on this 4M data: sense (collect), think (analyze), and act (take measures).

(2) Autonomous decentralized framework

Omika Works proposes a framework for a unique autonomous decentralized systems architecture that combines the real-time features and advanced fault resistance necessary to

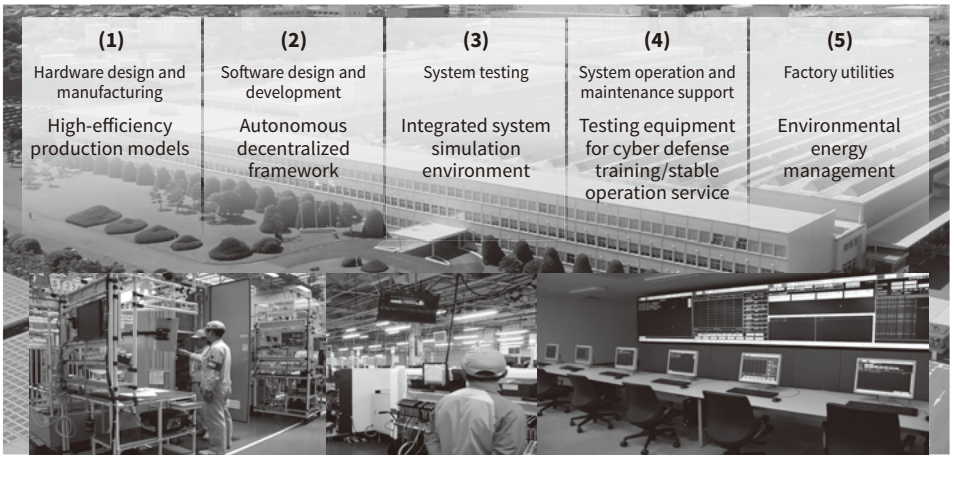


Figure 2 — Efforts as a Lighthouse Advanced Factory

Omika Works presented five unique efforts to consider during the Lighthouse selection process. The factory develops information and control systems while constructing integrated systems from manufacturing and quality assurance through maintenance, with a focus on optimizing the entire value chain.

monitor and control systems with maintainability, expandability, and reliability. Taking advantage of each subsystem's ability to function autonomously, this framework enables online expansion during operation and fault recovery without the need to stop the entire system through information and control systems predicated on stable operation over a long period of time. As of the current date, this framework has been applied to approximately 4,000 social infrastructure systems.

(3) Integrated system simulation environments

Omika Works is also constructing integrated system simulation environments that enable system testing at Omika Works both before the system is delivered to the customer as well as after operations begin. This construction of system environments in cyberspace that are identical to the ones on-site makes it possible to run comprehensive system tests that cannot be performed in an actual operational environment. Such an environment can also be utilized in cases where system improvements and repairs must be conducted in a short period of time, by guaranteeing the quality of these measures through rehearsals before transition.

(4) Testing equipment for cyber defense training

Omika Works utilizes integrated system simulation environments in the construction and operation of facilities for training and testing ways of countering cyberattacks. As DX advances expand the risk of cyberattacks on key social infrastructures, this has increased the importance of preventing and minimizing damage as a security measure for supporting the stable operation of systems. Therefore, Omika Works simulates the actual operating environments of systems in order to test information control security technologies, while conducting training and testing in order to strengthen the skills of human capital as well as organizational management.

(5) Environmental energy management

Omika Works is engaging in environmental energy management that saves energy while at the same time providing robustness in the face of disasters. Energy usage is streamlined through the visualization of power usage with smart meters as well as peak shifting that links the energy management system (EMS) with production plans. In addition, backup power is provided for use during outages and other emergencies with on-site solar power generation systems and storage batteries that work independently, so that business continuity is maintained without the need to stop design, manufacturing, and maintenance operations.

4. Information and Control Systems Supporting DX in the Fields of Social Infrastructure and Industry

In order to continue providing the highly reliable information and control systems that support the stable operation of social infrastructures over a long period of time, evolution corresponding with the constantly changing social issues and values is a must.

This section includes articles that introduce the transition to the next generation of core technologies Omika Works has cultivated as a Lighthouse advanced factory, as well as the latest case studies of information and control systems that support DX in social infrastructures and industrial fields including water supply and sewerage, steel, energy, and railways.

4. 1
Transitioning to Next-generation Core Technologies

In response to the need for the rationalization and advancement of operations, the transition to intelligent on-site technologies is proceeding with innovations in areas such as artificial intelligence (AI), data utilization, edge computing, universal communication including fifth-generation (5G) mobile networks, cyber security, and others.

It is against this background that Omika Works is moving forward with its transition to the next generation of its autonomous decentralized system architecture, based on the concept of AI and control incorporating the latest information technology such as image AI as control technology [as described in the article "Next-generation Autonomous Decentralized Architecture and DX-ready Industrial Edge Computers" (page 37)]. Furthermore, Omika Works is undertaking efforts toward digitalization and seamless coordination on-site with the variable quantity production systems cultivated using high-efficiency production know-how [as described in the article "Highly Efficient Production Solutions Linking Design and Operations for Manufacturing DX" (page 43)], as well as development of a unique support platform that consolidates the technology and knowledge to achieve stable operations in social infrastructures for the new normal [as described in the article "Stable Operation Service for Control Systems Based on Maintenance Service Platform Combining OT and IT: Total Support across Entire System Lifecycle" (page 49)].

4. 2
Information and Control Systems in Industrial Fields

As opportunities for collaboration with a wide range of stakeholders expand along with globalization, the transition to digital collaboration is accelerating due to the pandemic. Even domestically, regional collaboration of life lines is proceeding through the integration of bases.

In the field of steel, Omika Works is focusing its efforts on analysis and diagnostic DX for the sake of achieving quality and productivity gains in the manufacture of steel products, as well as a transition to remote operations including facility trial runs and maintenance work [as described in the article "Digital Solutions for Steel Industry: From Operations to Production and Maintenance Support" (page 54)]. In the water and sewage industries, which are faced

with societal issues such as aging facilities and decreases in staffing and fee income due to the shrinking population, the streamlining of management planning, operation, and maintenance has become an urgent priority, and so Omika Works is working to advance on-site maintenance work utilizing long-term demand prediction based on AI and big data as well as augmented reality (AR) technology [as described in the article "Optimal DX Solutions for Smarter Water and Sewage Operations" (page 60)].

4. 3
Information and Control Systems in the Energy Field

As opportunities expand for the achievement of a carbon-neutral society, not only are large amounts of renewable energy being adopted in the field of energy, there is also a need for the construction of electric power systems that can achieve a stable power supply at the same time as economic rationality.

To meet these challenges in electric power systems, in the Republic of Slovenia, Hitachi is collaborating with the New Energy and Industrial Technology Development Organization (NEDO) on a project to demonstrate energy management that can utilize storage batteries and other decentralized energy resources in order to avoid power outages while securing the quality of electric power. The project aims to achieve economic rationality by constructing a cloud type system while holding both initial investment and maintenance costs in check [as described in the article "Grid Edge Solution for Overcoming Challenges of Large-scale Renewable Energy Deployment: System Trial in the Republic of Slovenia" (page 74)]. Efforts are also underway in the area of advanced preventive maintenance in the energy field, to solve the social issue of a lack of human resources, with remote facility monitoring, facility deterioration determination using AI, the consolidation of on-site work knowledge, and other measures [as described in the article "Cloud-based DX Solution for O&M and Staff Training at Electricity Generators" (page 68)].

4. 4
Information and Control Systems in the Railway Field

In the railway field, as the area of influence of the transportation operations expand due to developments such as direct train services in line sections, expectations are high for improvements in the maintenance of railway services as well as advanced operational support.

Omika Works is focusing on developing advanced operational support that can guide network controllers with optimal traffic schedules in order to deal with schedule disruption, by incorporating AI-based machine learning into railway traffic management systems [as described in the article "Railway Traffic Management Systems by Machine Learning: Recovery from Traffic Timetable Disruption by Hybrid AI" (page 87)]. Passenger information displays inside railway cars are also being expanded in order to improve services for passengers. Development work also includes functions to display the state of abnormal occurrences involving passenger vehicles, designs aimed at improving advertising value, and so on [as described in the article "Digital Transformation of On-board Passenger Information Using Smart LCD Display Unit" (page 81)].

5. Conclusions

As innovations are being made in social infrastructures and industrial fields in response to increasingly complicated societal challenges, there is also a need for evolution in the information and control systems that must operate in a stable fashion over long periods of time. Starting with the information and control systems introduced in this section, Omika Works will continue seeking to achieve an affluent society that combines safety and peace of mind with comfort and convenience for people, by providing solutions that support DX in social infrastructures and industrial fields, while continuing to evolve as a Lighthouse advanced factory even as unpredictable changes continue to occur in this new normal.

References

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