Overview

Hitachi Value Chain Solutions for Quality and Safety in Manufacturing

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1. Introduction

Problems such as global warming, concentration of populations in cities, and shrinking workforces caused by declining birthrates and aging populations are becoming increasingly difficult to ignore throughout the world. Growing worldwide efforts to achieve sustainable society are being taken in response, with a list of Sustainable Development Goals (SDGs) adopted at a meeting of the United Nations (UN) General Assembly in 2015[(1)]. Meanwhile, problems such as frequent natural disasters and the rise of COVID-19 are causing worldwide supply chain disruptions and economic stagnation, creating greater demand for risk preparedness measures designed to ensure that companies or communities can continue doing business as usual.

The Hitachi's 2021 Med-term Management Plan is aiming to help achieve sustainable society while improving people's quality of life (QoL) and enhancing its customer's corporate value. Hitachi's Social Innovation Business will achieve these aims by improving three kinds of value simultaneously—social value, environmental value, and economic value. To step up the pace of its Social Innovation Business, Hitachi will use operational technology (OT) and Lumada[(2)] to work on solutions to various issues. (OT is infrastructure operation and control technology, while Lumada is a platform combining IT areas such as data analysis and optimization.)

Hitachi's Industry Sector does business in the industrial field. It aims to provide solutions that seamlessly connect workplaces and management by combining OT, IT, and products such as industrial equipment. This article focuses on technologies for automation, remote work, and contact-free interactions, which are experiencing growth in demand as a result of COVID-19. It presents manufacturing value chain solutions that assist the key manufacturing values of quality and safety in conjunction with SDG 12 for responsible consumption and production.

2. State of Manufacturing in Japan

Since the solutions presented in this article are used by manufacturers in Japan, this section summarizes the state of the country's manufacturing sector by looking at the issues facing it along with its digitalization needs.

2. 1 Issues Facing Manufacturing Sites

Factors such as the yen's strength have greatly eroded the cost competitiveness of Japan's manufacturing sector since the 1990s, and global supply chains have increasingly been moving labor-intensive work to countries with lower labor costs[(3)]. Meanwhile, there are still many superior manufacturing workplaces in Japan that stay competitive through steady efforts, and the recent shrinking of the global wage gap has been making Japanese manufacturers look increasingly cost-competitive since the 2010s[(4)].

Along with these issues, the sector has also had to contend with product development restrictions imposed for aims such as reducing environmental load and managing product lifecycles. These restrictions have been getting more strict every year as product functions are continually enhanced, and they are partly to blame for the increasing complexity of product designs[(5)]. The rise of electrification has also made function development and verification for control software more complex. Consistent operation without discrepancies between the device and control software is a key requirement for mobility products such as vehicles, but this requirement results in greater complexity.

Japan's design and manufacturing workplaces are meanwhile facing problems such as labor shortages, aging equipment, and a rising average age among experienced workers.

These problems are becoming ever more apparent as the country's working population continues to shrink.

Increasingly complex products compounded with labor shortages have generated multifaceted restrictions often resulting in recalls, inspection errors, and other quality or safety problems that receive widespread media attention. While manufacturing workplaces have long been adopting robots and a number of other automation technologies, COVID-19 has now boosted automation demand and created high demand for technologies for remote operation and contact-free interactions.

2. 2
Need to Coordinate Value Chains

Japan's interest in the Internet of Things (IoT) and other digital technologies began around 2014 in response to Germany's Industrie 4.0 movement. This interest is largely the result of advances in computer technology that have made artificial intelligence (AI) and data analysis practical and relatively inexpensive to use. Japan's adoption of digital technology has been led by the manufacturing sector, where it is used for applications such as increasing manufacturing workplace transparency, automating manufacturing lines, and providing equipment maintenance services.

On the other hand, design departments have been adopting digital technologies since the 1980s. Computer-aided design (CAD) and computer-aided manufacturing (CAM) have been used for product design, and computer-aided engineering (CAE) for structural analysis and other simulations. Starting out as two-dimensional (2D) drawing creation tools, these technologies have gradually evolved toward three-dimensional (3D) applications. Many of today's tools integrate 3D CAD and CAE[6].

Achieving objectives such as wide variety and in small quantities production, faster development and manufacturing, or product lifecycle management requires the use of digital technologies to coordinate entire value chains that encompass processes extending from design to manufacturing engineering management or supply chain management. However, the work done on this coordination by many Japanese manufacturers is seen as lagging. Bill of material (BOM) data not being available and sequentially managed work processes are among the reasons for this lag[7].

Supply disruptions caused by natural disasters and COVID-19 have also exposed manufacturers to the risk of having to make hasty changes to product specifications or suppliers. This risk is something that all the companies in a value chain need to work together to handle, calling for a high degree of expertise in product and process design, supplier selection, and manufacturing line design[7]. So, there is now a genuine need to coordinate entire value chains through digital technologies.

3. Manufacturing Value Chain Solutions

This section presents some Hitachi solutions for manufacturing value chains that use AI and technologies for mathematical optimization, video processing, and simulation to solve the quality, safety, and automation issues facing manufacturers as discussed in section 2.1. Solutions that address the value chain coordination discussed in section 2.2 are also presented. In addition to the examples mentioned, they also include solutions that assist integrated traceability management and collaborative design work in remote environments.

Figure 1 shows how the solutions presented in this section can be applied to a diagram showing value chain coordination arranged along three axes taken from an Industrie

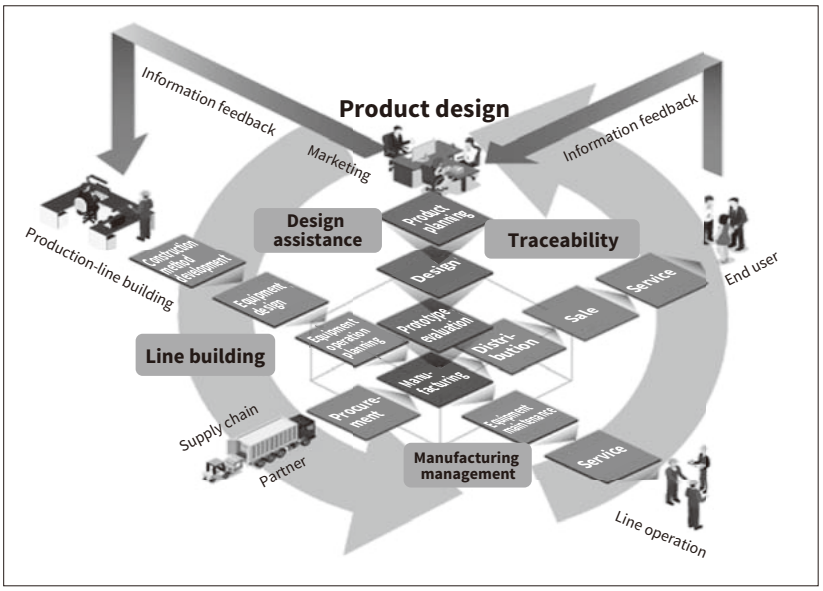


Figure 1 — Value Chain Relationship Diagram
Hitachi aims to optimize manufacturing by bringing a third axis to manufacturing done along two axes consisting of (1) the flow from product planning and design to manufacturing, and (2) the flow from procurement to manufacturing, sales, and service. The third axis is the flow from production line equipment design, to production line equipment operation and maintenance.

4.0 report[8]. The axes represent engineering management (extending from product design to manufacturing), supply chain management (extending from procurement of product and parts to distribution and after-sales service) and production line construction management (extending from production line design to construction and maintenance). The engineering, supply chain and production line flows overlap in the area of manufacturing, so processes in each flow are executed in coordination with each other.

3. 1
Collaborative Design Solution

Product design workplaces are collaborating on design work through collaborative work with suppliers and between overseas and domestic sites. By using this collaborative approach, the workplaces are working on making products more competitive by giving design work shorter lead times, higher efficiency, and higher quality. Design work also needs to be done remotely in preparation for the coming era of the "new normal" once COVID-19 is under control. Hitachi Digital Supply Chain/Design Service is a solution and service developed and provided by Hitachi that enables design work to be done collaboratively by multiple sites.

3. 2
Manufacturing Management Solutions

Figure 2 illustrates the sense-think-act concept common to the manufacturing management solutions discussed in this section. As shown, human-machine-material-method (4M) data from manufacturing workplaces is generated through sensing, and then analyzed to provide concrete control or instructions. Some of the solutions developed through this concept are presented below.

(1) Work recognition solution driven by video analysis

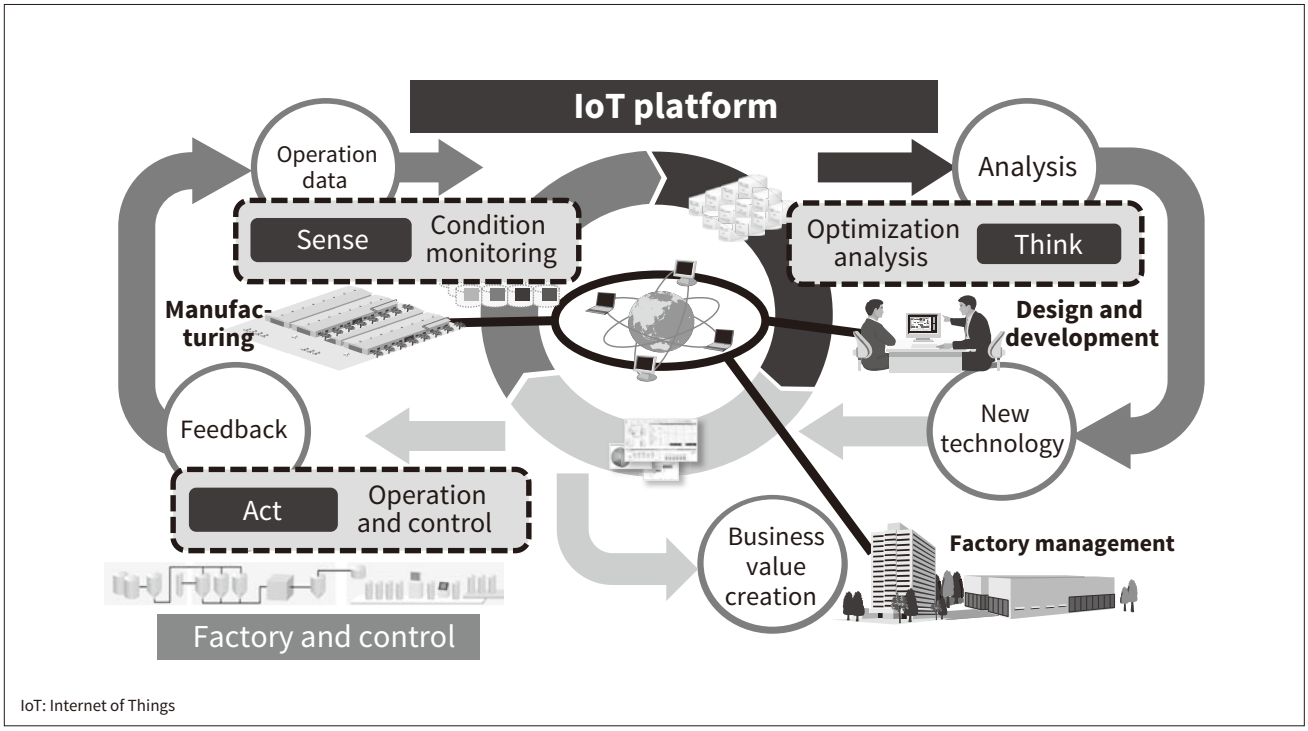
Hitachi has developed video analysis technology that uses AI technology to recognize human behaviors or movement features in real time from massive volumes of video data. The technology is being put to use at manufacturing workplaces. Human work operations are recognized in a remote and contact-free manner, targeting any of various levels as required by the objective. For example, the recognition targets could be human positions, lines of movement, work movements, or fine handiwork techniques. The human work recognition output is used as one type of 4M data to improve work quality, productivity, and safety in the manufacturing sector.

(2) Productivity and quality improvement solutions driven by 4M data analysis

Hitachi has released services that collect, record, and use 4M data related to workplace production resources in a composite manner. These services analyze the causes of any issues the customer is experiencing with production losses, quality, or maintenance, and examine ways of improving these issues. One example is the 4M loss analysis service. This service creates 4M data-based models of the perspectives and loss factor analysis expertise of production

Figure 2 — Sense-Think-Act Cycle

Various sensing technologies are used to continually operate a cycle of acquiring man-machine-material-method (4M) data (sense), analyze the data (think), and then provide feedback (act).



IoT: Internet of Things

management experts, providing its analysis methods in the form of analysis and graphic display functions and value.
(3) Technology for creating more advanced steel production value chains

Hitachi has been a global pioneer in adopting AI, optimization, and other technologies used in process automation solutions for the steel industry. Recent work in this area includes machine learning constraint programming (MLCP), a technique that uses big data analysis technology to reproduce the production plans of human experts and propose high-quality plans instantly. Another example is a service that helps increase the efficiency of motor maintenance work by applying predictive diagnoses to existing motor current signals using original data analysis AI technology.

3. 3
Manufacturing Line Building Solutions

Hitachi's factory automation work started out by achieving the aims of saving labor, improving or stabilizing quality, and shortening production cycles. Enabling operations to continue regardless of the workplace environment has been another aim. As mentioned in section 2, major changes have since been arising in factory automation environments. These changes have created the need for factory automation with dynamic capabilities that can provide feedback to downstream production processes as well as making effective use of digital technologies, providing visualization of production states, and analyzing production results. Hitachi has responded by working on developing solutions that bring these dynamic capabilities to manufacturing line building also.

3. 4
Traceability Management Solutions

Industrial products have recently been trending toward increasingly complex structures and diverse specifications. This trend is creating the need for traceability technology designed to solve quality problems by collecting, storing, coordinating, and managing data so that various types of manufacturing process information can be read from products. Hitachi provides comprehensive traceability that brings new value to customers by managing not only the visible parts and products, but also object-linked information describing how products were created, what worker operations were used, etc. The company is looking into ways of providing traces that span entire product lifecycles by encompassing processes ranging from product development or prototyping to manufacture, maintenance, and repair.

4. Conclusions

The rise of COVID-19 has brought on rapid worldwide digitalization. The manufacturing may also see growth in efforts to coordinate value chains using digital technologies.

Hitachi will continue to provide engineering management and supply chain management solutions while enhancing its solutions for production line building and continuing to develop solutions for coordinating manufacturing value chains. These activities are designed to help to create a sustainable society while improving people's QoL and enhancing the value of customer corporations.

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