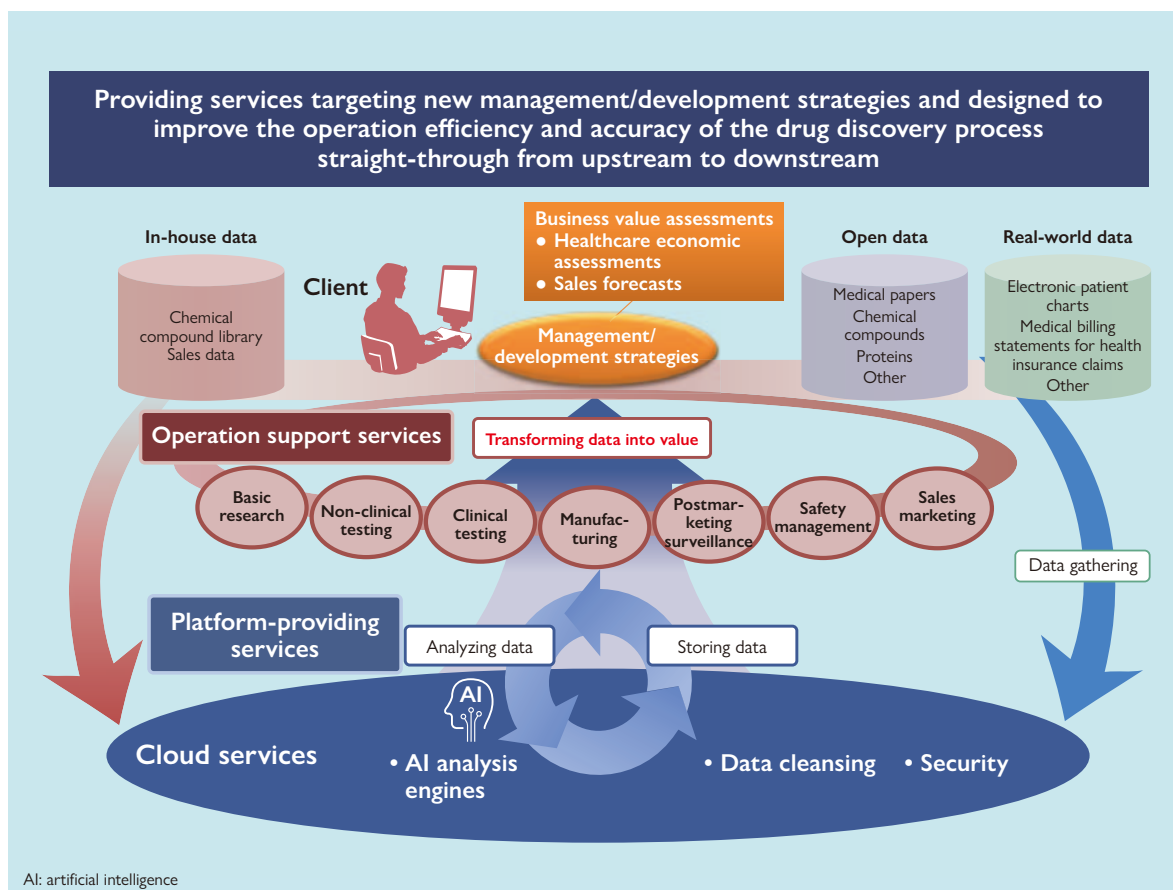


Industry & Distribution

1 Hitachi Digital Solutions for the Pharmaceutical Industry

Hitachi's Research & Development Group has drawn on the analysis expertise it has accumulated over the past 10 years to develop new digital solutions with names such as Black Box Breaker (B3) and Clinical Semantic Linker (CSL). B3 is a deep learning technology with medical explanatory capabilities. CSL is a natural language processing technology specialized for text analysis in the medical field. These technologies have been used in proofs of concept (PoCs) with clients in various business areas, and have demonstrated benefits. They form the core of a project begun in 2017 called Hitachi Digital Solutions for Pharma that provides services for improving the efficiency of client operations. These services include solutions for patient stratification, assisting clinical trial plans, and target searches.

The pharmaceutical industry is facing increasingly demanding conditions caused by challenges such as falling drug prices due to rising healthcare costs, and rising research and development (R&D) costs caused by increasingly advanced medical technologies (individualized healthcare and regenerative medicine). These demanding conditions are forcing the industry to carry out more accurate business value assessments. Countries around the world are also introducing healthcare economic assessments to weigh the costs and benefits of medical technologies during decision-making on healthcare policy in areas such as medical technology insurance reimbursement and price setting. The presentation of scientifically corroborated evidence is being demanded as a result.



1 Organization of Hitachi Digital Solutions for Pharma

Seeking to help clients grow their businesses and improve patient quality of life (QoL), Hitachi is responding to the demands of the current environment by releasing development strategy solutions, adding simulation services for business viability assessments and healthcare economic assessments, and providing services designed to improve the operation efficiency and accuracy of the drug discovery process straight-through from upstream to downstream.

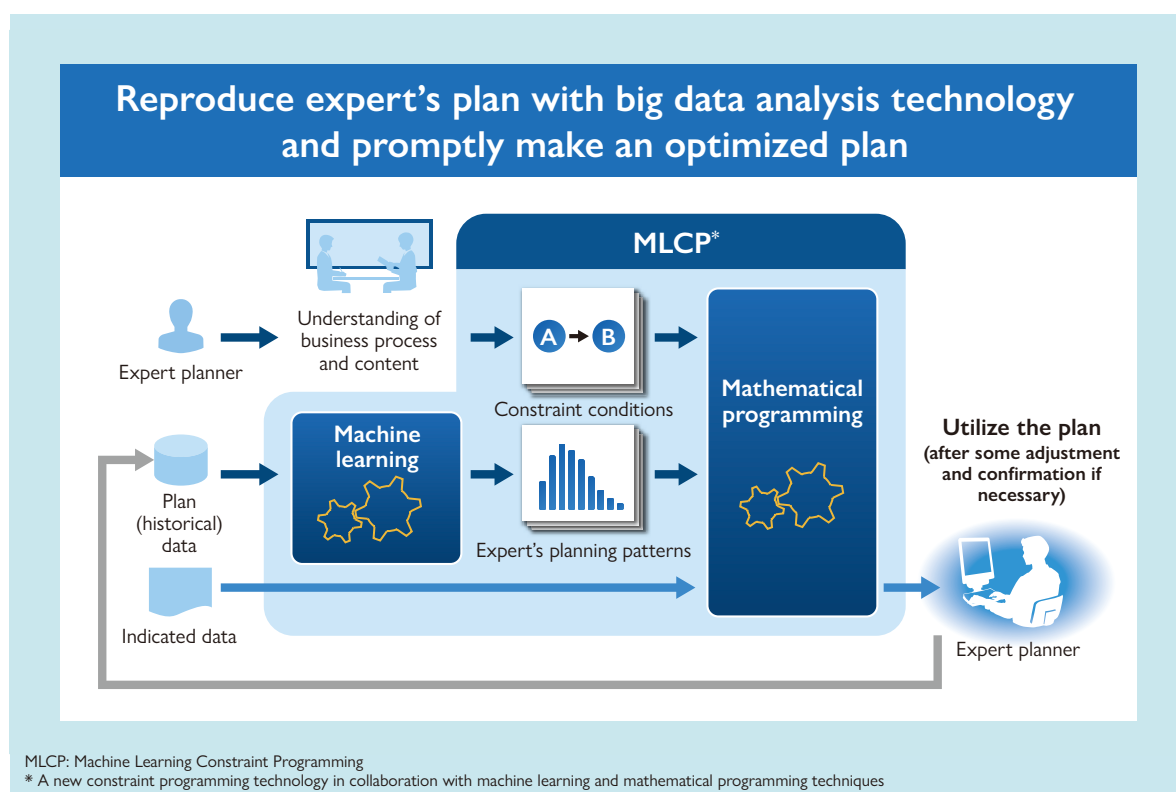
Hitachi will continue to expand the application of this project into the area of medical devices and the entire healthcare industry.

2 Using AI to Help Optimize Planning: Hitachi AI Technology/MLCP

Hitachi AI Technology/Machine Learning Constraint Programming (MLCP) is a plan optimization service that provides a new planning system for deriving more optimum solutions by recreating plans incorporating the implicit knowledge of experts.

Digitalization technology using artificial intelligence (AI) enables machine learning-based system growth along with previously impossible conditional mitigation resembling the work of experts. The design approach used is different from conventional system configurations, enabling constraint conditions and plan patterns to be revealed that would previously have been overlooked.

The service surpasses the abilities of package products, with the potential to connect different processes, different plans, and people with plans. It is being used in a wide range of areas such as the steel, non-ferrous metal, oil, and food industries. In addition to production plans, it also supports a wide range of plan types such as vehicle dispatch plans and staff plans.



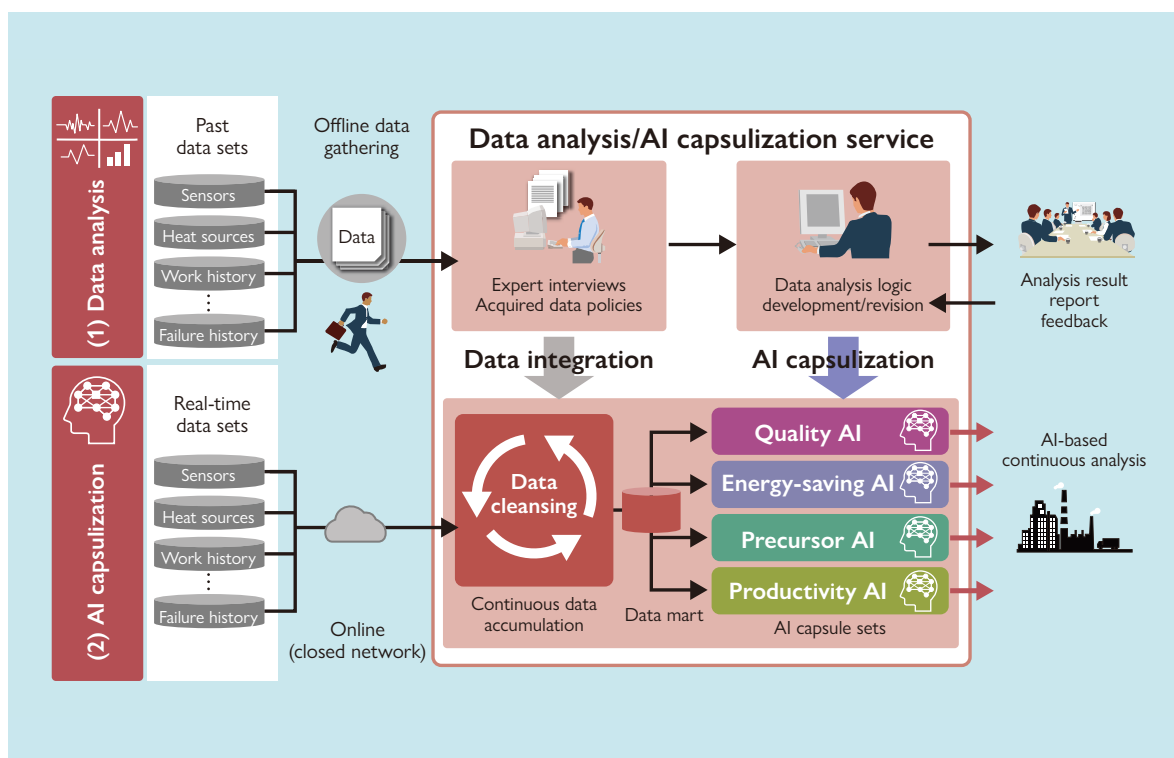
2 MLCP plan optimization service

3 Using Manufacturing Data for Quality Improvement Analysis and AI Servitization

Demand for the use of manufacturing data and AI to ensure quality stability and reduce defects has recently been growing at manufacturing industry production sites. To meet this demand, Hitachi has been providing a data analysis service run by data scientists that is designed to improve product quality.

To enable clients to use the analysis logic created by this data analysis service, Hitachi has started to provide a service that creates AI capsules from this logic. These capsules enable clients to continuously analyze manufacturing data created in real time, enabling faster problem-solving for quality improvement.

In 2018, Hitachi began offering an AI servitization designed for quality improvement to manufacturing industry clients with process-based production equipment. Hitachi also plans to start offering the service to clients in the pharmaceutical, chemical, and other industries.

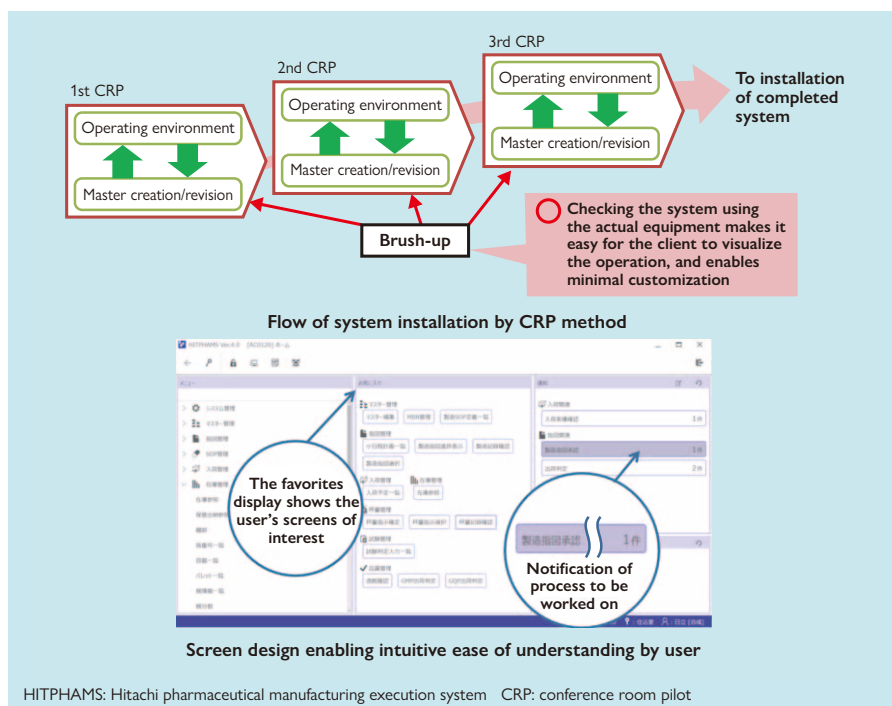


3 AI servitization

4 HITPHAMS Version 4.0 Refined for Easy-to-Use System

Hitachi pharmaceutical manufacturing execution system (HITPHAMS) is a manufacturing management system for pharmaceutical manufacturers that Hitachi provides to clients. It conforms to the Japanese Good Manufacturing Practice (J-GMP)¹ regulations. Version 4.0 is the latest version. It has been refined for easier installation and use by users. The previous screen design has been replaced with a design that incorporates updated user experience (UX)² expertise.

HITPHAMS installation is done by the conference room pilot (CRP)³ method. Client masters are used while checking actual operation, and the system is installed with minimal customization. This method enables smooth and rapid system installation while placing few demands on the client. The use of this method has also enabled a design that users can operate intuitively and easily. Workflows can be defined for business operations, while displays such as menus, notices, and favorites on the home screen enable intuitive checking of



4 HITPHAMS Version 4.0 installation method and screen illustration

tasks to be done and information of interest. Screens displaying work procedures are shown as flowchart displays, creating a design enabling an intuitive understanding of the tasks to be done.

- *1 Manufacturing management and quality control regulations for Japan's pharmaceutical and "quasi drug" (medicated products) industries.
- *2 A term used in system design to refer to the user's emotions and attitudes about using a particular product, system, or service.
- *3 The work of checking that business operations can be implemented while checking standard functions on the actual equipment.

5 Work Safety Education Cloud Service

Japan's declining birthrate and aging population are expected to shrink the country's working-age population to just one-third of its current size by the 2050s, dropping from around 76 million today to just 25 million. Workplaces are responding by making increased use of foreign and inexperienced workers, but quality and work efficiency are declining. Safety and other issues are also arising as concerns. Examples of workplace problems are listed below.

- (1) Details of work procedures and lessons from accident case studies are not being shared, resulting in the same accidents recurring.
- (2) Work procedures and safety precautions are being communicated to foreign workers when needed, but failure to communicate explanations effectively leads to mistakes.
- (3) The complexity of managing training meeting attendance and records indicating who has viewed work procedures and case reports is resulting in some workers missing required information, and making it impossible to provide education tailored to the needs of each worker.

Hitachi's work safety education cloud service provides conventional headquarters-led safety education while enabling workers to share and accumulate safety skills and expertise in a format based on work site participation and communication. The service can be expected to provide the benefits below for solving the problems above.

- (1) Videos shot at work sites can be viewed on smartphones and tablets just by uploading them. This benefit makes it easy to share work procedures and accident case studies, and to communicate subtle nuances that are difficult to convey verbally.

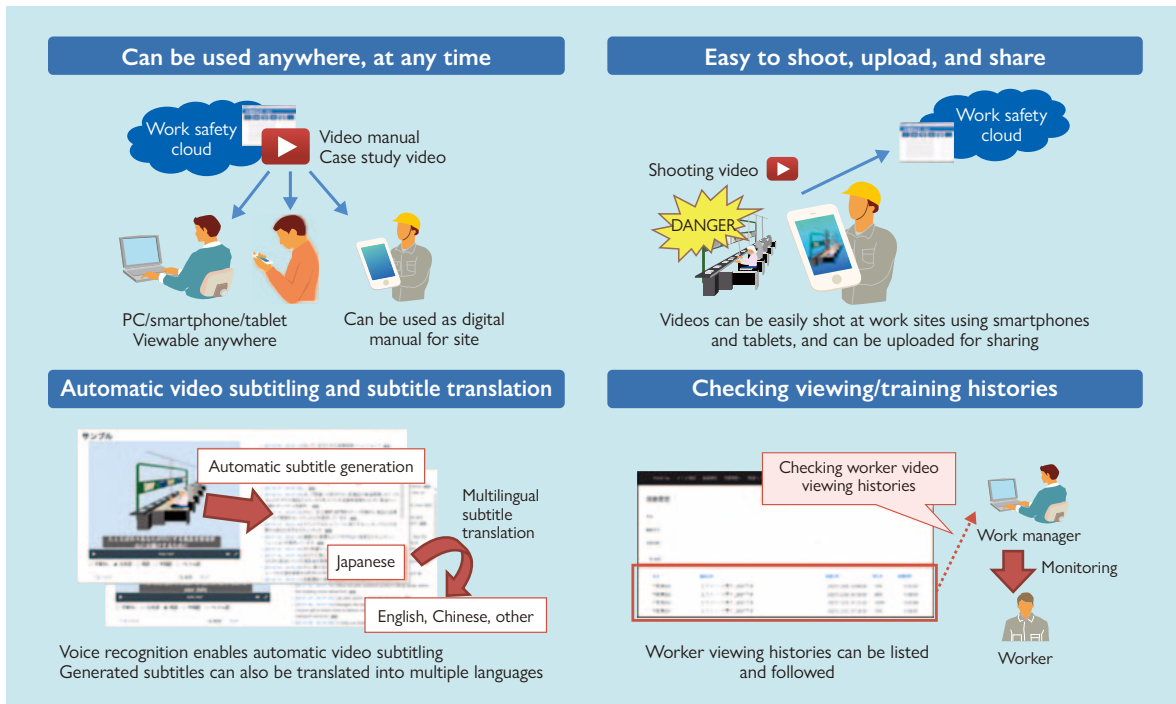
(2) For videos with audio commentaries, multilingual subtitles can be automatically generated and then manually revised. This benefit enables clear communication to foreign workers using videos with subtitles translated into natural language they can easily understand.*

(3) Each worker's video viewing history and training meeting attendance can be managed in a unified manner so that their needs can be accommodated when providing information and creating educational plans.

Hitachi will continue to provide assistance for effective and efficient safety education at a variety of workplaces engaging in operations such as production plant work, logistics warehouse work, and local maintenance/inspection work.

(Hitachi Industry & Control Solutions, Ltd.)

* The multilingual subtitle generation function does not guarantee 100% accuracy. It is an auxiliary function requiring subtitle revision work in each language.



5 Overview of work safety education cloud service

6 High-speed Person Finder/Tracker Solution

The physical security industry in Japan and around the world is experiencing a wave of collaborative public-private sector efforts designed to improve security and anti-terrorism measures at locations open to the general public such as event venues, sports stadiums, railway stations, and airports.

Security systems with surveillance cameras have traditionally been used as a way to improve surveillance, but users are now calling for methods to rapidly spot suspicious behavior or find other persons of interest among massive volumes of captured video data. But conventional technologies such as facial recognition often make it difficult to



(The screens shown were created for illustration purposes during development.)

6 Example personal attribute search result display screens

identify persons of interest in camera footage since the information providing the characteristics needed for personal identification is vague, the person is facing away from the camera, or the image is unclear.

To solve these problems, Hitachi has developed a security solution that uses AI driven by multilayer neural network-based machine learning technology (deep learning technology). The technology can identify suspicious behavior in video images using even vague personal or other characteristics, and supports a large number of cameras using high-speed processing. This solution will help improve the quality and efficiency of surveillance work, making the world more safe and secure.

(Hitachi Industry & Control Solutions, Ltd.)

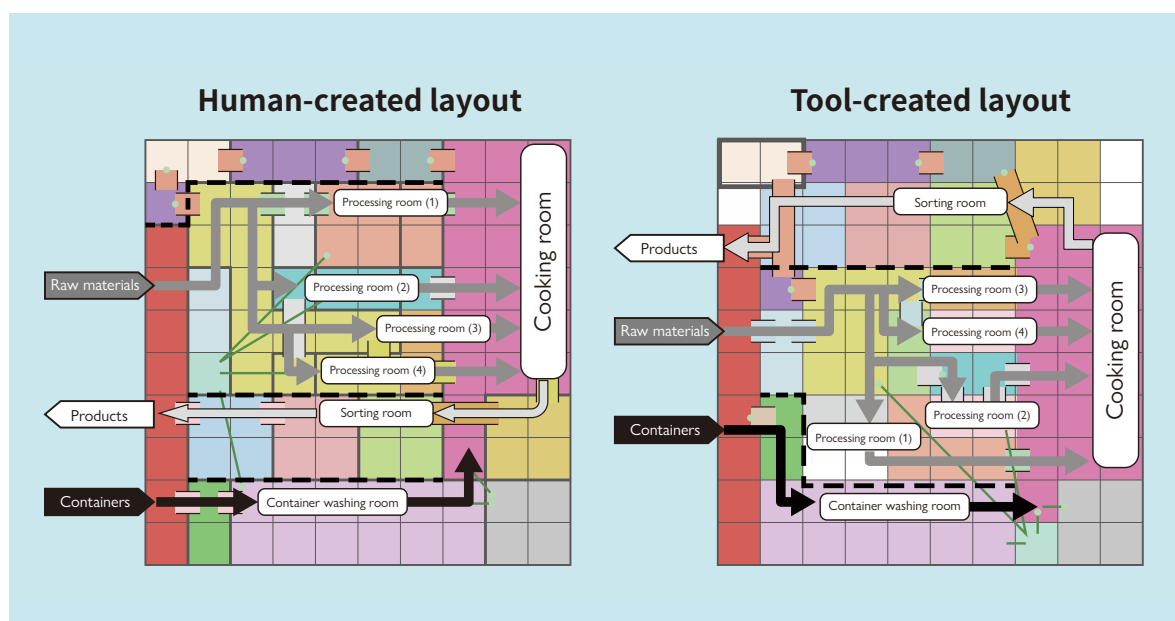
7 AI-driven Engineering Tool for Automatic Creation of Food Processing Plant Layouts

A recent rise in consumer concern over food safety and security is creating an increasing need for optimum methods of determining room placement when designing food processing plant layouts. These methods need to reduce life cycle costs (LCC) and incorporate flow line planning that maintains productivity and quality. They also need to incorporate the hazard analysis and critical control point (HACCP) approach.

But layout design is done by optimal solution search processes among complex and diverse patterns, and has always required a large number of man-hours and reliance on experienced designers. Hitachi Plant Services has attempted to improve this method by developing an engineering tool that automatically creates food processing plant layouts using AI. An improved genetic algorithm (considered a type of AI) is used as a room combination optimization algorithm that standardizes design expertise and forms the tool core.

The tool can rapidly optimize conditions such as sanitary zones and flow lines of items such as products, workers, and waste. It can create multiple layout plans that have each been quantitatively evaluated. The created layouts are nearly equivalent to those of experienced human designers, even in terms of key elements such as flow line intersections. The tool is expected to improve design work efficiency by about 50% (for Hitachi's own design work). It has already been used to create about 10 actual layouts. Hitachi is planning to use it in expanding its total engineering work, a business area that provides a comprehensive range of services encompassing everything from upstream consulting to design, construction, and operation/maintenance services.

(Hitachi Plant Services Co.,Ltd.)



7 Example comparison of human- and tool-created layouts (pre-made food products)

Automatic Marking Robot System for Equipment Installation Work

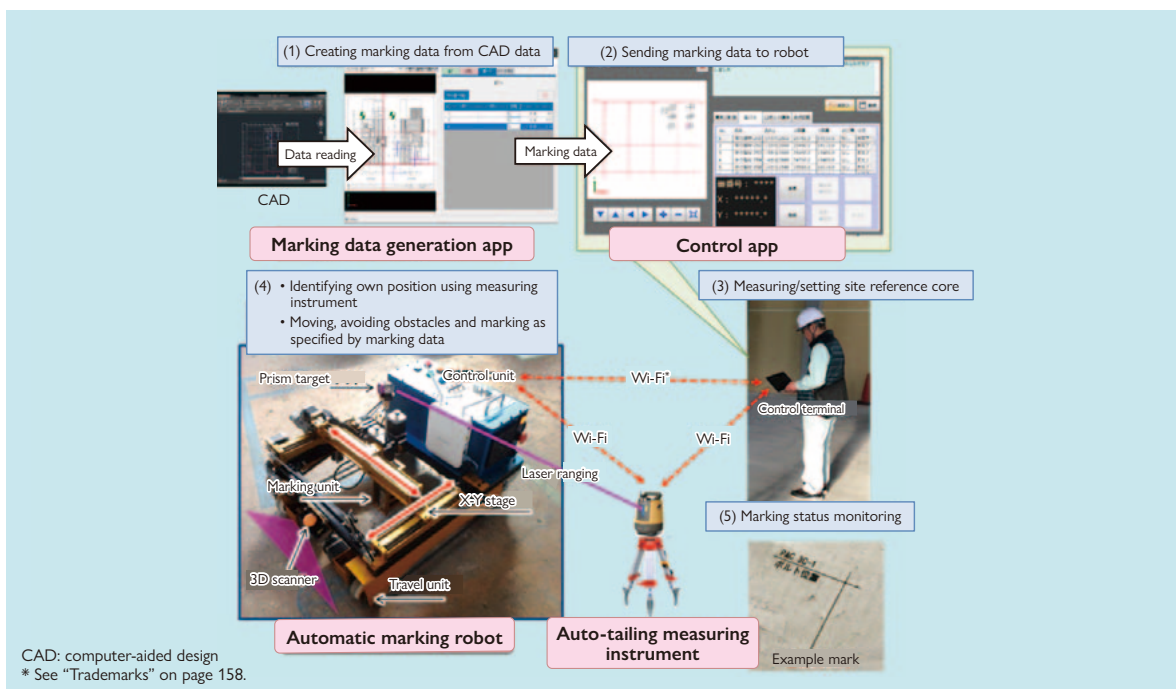
As part of the efforts being done to apply information and communication technology (ICT) to construction work, Hitachi has developed an automatic marking robot system that enables a single operator to handle work that previously took multiple skilled workers.

Equipment installation requires an extensive amount of marking work done to provide floor indications of the positions at which to install devices such as lines, ducts, and ceiling-suspended units. Marking work is done by skilled workers using tools such as measuring instruments and inking devices to repeatedly transfer installation positions shown in drawings onto floor surfaces. Japan's improving economy and aging population have recently been exacerbating the country's skilled worker shortage, creating an urgent need for more efficient work methods that also require less skill.

Hitachi's automatic marking robot system is composed of a self-propelled automatic marking robot, a marking data generation app that extracts and creates marking data from computer-aided design (CAD) drawings, an auto-tailing measuring instrument used to recognize the robot's own position, and a control app. The system was used at five air conditioning equipment installation sites through the first half of 2018, and demonstrated an error of ± 3 mm and marking speed of 3 minutes per point.

Hitachi plans to expand use of the system to sites throughout Japan, while improving its efficiency by using it for simultaneous marking on multiple related work projects and coordinating it with building information modeling (BIM) applications.

(Hitachi Plant Services Co.,Ltd.)



8 Automatic marking robot system configuration

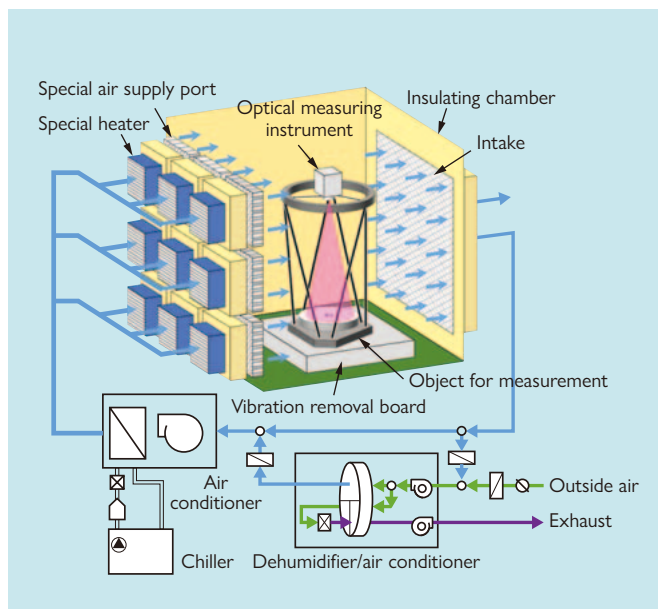
Highly Stable Optical Test Environment Assisting JAXA Space Development

Hitachi has developed a highly stable optical test environment that enables high-precision optical testing at atmospheric pressure, and is designed for optical inspection applications on board earth observation satellites and astronomical satellites. The environment enables major reductions in operation costs and test time relative to conventional vacuum chamber-based testing, and can support next-generation large optical systems. It was developed from a joint research project of the Japan Aerospace Exploration Agency (JAXA)

and Hitachi Plant Services. Hitachi is hoping to use it in future large satellite projects and private-sector space industry applications.

The joint research project with JAXA started in October 2017 with the aim of constructing a highly stable optical test environment. The environment was developed by adding humidity and air-flow control to a platform of proprietary Hitachi Plant Services technology used for precision temperature control and air conditioning. It has temperature stability of within $\pm 0.01^{\circ}\text{C}$ and dew point temperature stability of within $\pm 1^{\circ}\text{C}$. Hitachi conducted simulated optical inspection measurement using a prototype booth created at the Matsudo Works, and demonstrated the equipment's ability to provide measurement accuracy equivalent to a vacuum chamber. Hitachi continued the joint research project in 2018, and is looking into providing support for large test samples.

(Hitachi Plant Services Co., Ltd.)



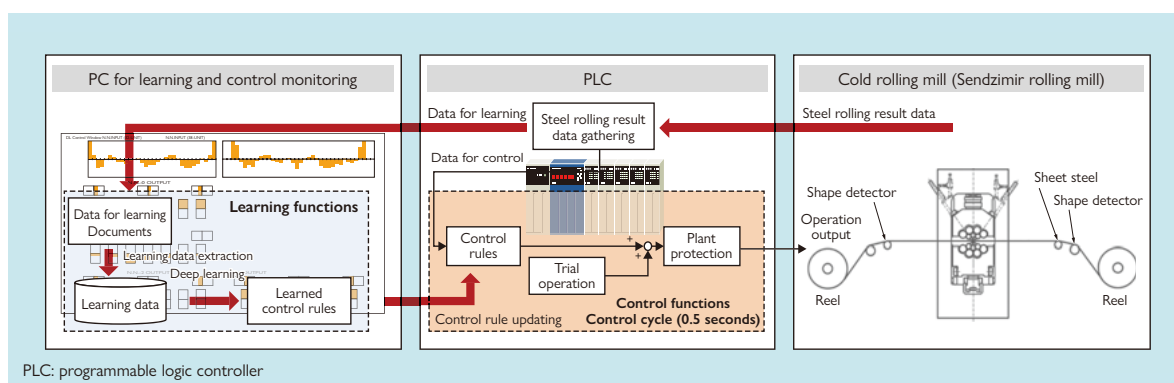
9 Environmental test chamber conceptual diagram

10 Real-time Rolling Mill Shape Control Using Deep Learning

Operator fine-tuning is a vital requirement for correcting complex sheet steel waviness (shape) when manufacturing sheet steel with cold rolling mills. Operator workload and variations in product quality due to differences in skill level are major challenges as a result.

To address these challenges, Hitachi has developed a deep learning-based plant control technology that has been used for shape control on a Sendzimir rolling mill at Shougang Zhixin Qian'an Electromagnetic Material Co., Ltd., a steelworks in China. Data from past operations is used to help the control system automatically learn relationships between equipment operations and work results by itself. This approach enables high-precision control, and gives the system an outstanding ability to self-adjust and gain expertise. The system also has a method of reducing abnormal output, enabling learning to continue while preventing the plant from being adversely affected by control errors. The software has been mounted in a programmable logic controller (PLC) to provide faster control and enable use for applications requiring real-time control.

Hitachi will continue to develop and release systems with higher added value to meet client needs.



10 Overview of deep learning-based real-time rolling mill shape control system

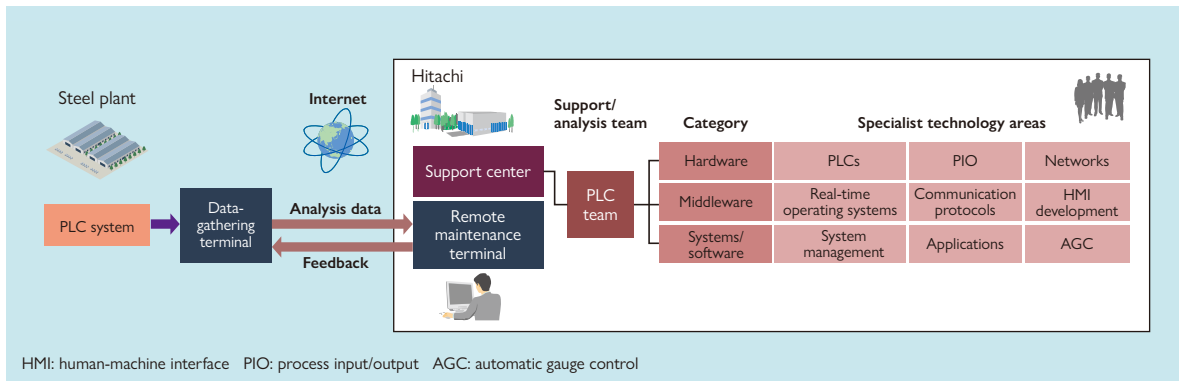
11

Hot Rolling Control System for Outokumpu Stainless in Finland

In December 2017, Hitachi completed an upgrade of the hot rolling control system PLCs of Outokumpu Stainless Oy in Republic of Finland. The PLCs were upgraded to the latest model (HISEC04/R900), and the system is now operating smoothly. The steelmaker's equipment is a large system composed of one Steckel reversible rolling mill (a special-steel hot rolling mill used mainly for stainless steel), one high-pressure rolling rough mill in the pre-stage, and three quality-adjusting rolling tandem mills in the after-stage.

The upgrade involved three months of prior parallel operation testing that allowed Hitachi to upgrade 16 PLCs simultaneously with an equipment shutdown period of just nine days. In addition to upgrading the PLCs, Hitachi also provided a remote maintenance service through July 2018 on a trial basis. The service officially started in October 2018. It enables the system status to be checked from Japan via a remote connection so that optimal assistance can be rapidly provided. It is designed to ensure trouble-free equipment operation and improve work operation quality.

Hitachi will continue to augment the added value of its IT- and operational technology (OT)-based services to help resolve client management issues.



11 Remote service illustration