

Steel Business (JFE Steel Corporation)

JFE Steel is proactively implementing various measures to transform existing businesses, make innovative improvements in productivity, and create new businesses, to establish a competitive advantage that maximizes the wealth of data we have collected over many years.

We have integrated our IT platforms, including steelworks' system upgrades, and have created an environment that makes it possible to make comprehensive use of operational data including our accumulation of mission-critical operational data, images, and sensor data. This enables us to do things like make operations more sophisticated, introduce cyber-physical systems (CPS) for manufacturing processes, and implement remote and automated operations, achieving further improvements in productivity, labor productivity, quality, and safety.

Under the Seventh Medium-term Business Plan, we plan to invest 115.0 billion yen in DX with the aim of a 30.0 billion yen improvement in earnings annually. The approval of investments is on track relative to the plan, and the company will continue to invest in fiscal 2024 to improve earnings through DX.



Akira Nitta
Senior Vice President

DX Strategy

The main pillars of JFE Steel's DX are the introduction of technologies like the Internet of things (IoT), artificial intelligence (AI), and data science (DS) for gaining a competitive advantage by proactively utilizing data (= data-driven). Our accumulated expertise in high-grade steel manufacturing, responses to aging equipment, and data related to predictive management are the sources of our competitiveness, as we make advanced use of data—one of JFE Steel's important strategies. We are pursuing DX with three main areas of emphasis—"raise our level of data use" mentioned above, "execute IT structural reforms," and "reinforce our IT risk management."

JFE Steel's major initiatives under the Seventh Medium-term Business Plan

Use "digital" technologies to strengthen the manufacturing base and execute new growth strategies

JFE Steel's vision for DX promotion

Gain competitive advantage through the proactive utilization of data (= data-driven)

With a long history of manufacturing, JFE is a storehouse of data. Our accumulated expertise in high-grade steel manufacturing, responses to aging equipment, and data related to predictive management are the sources of our competitiveness. Advanced use of data is JFE Steel's strategic theme.

Three pillars of DX promotion

1 Execute IT structural reforms

Upgrade systems at steelworks

Realize a flexible, change-tolerant IT structure

Maximize value

Synergistic effects

2 Raise our level of data use

Promote business reforms and the latest advancements in IT

Actively utilize data science and AI

3 Reinforce our IT risk management

Enhance security and standardized controls

Enhance the security environment for IT

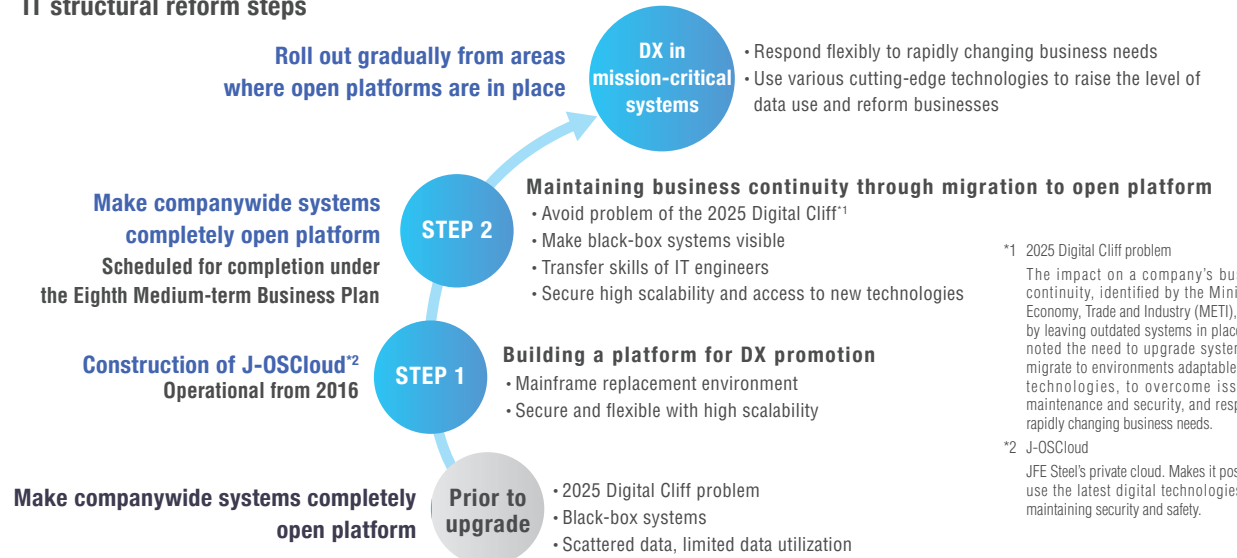
Operational and R&D data assets



Pillars Supporting DX Promotion

Execute IT structural reforms

IT structural reform steps



^{*1} 2025 Digital Cliff problem
The impact on a company's business continuity, identified by the Ministry of Economy, Trade and Industry (METI), caused by leaving outdated systems in place. METI noted the need to upgrade systems and migrate to environments adaptable to new technologies, to overcome issues in maintenance and security, and respond to rapidly changing business needs.

^{*2} J-OSCloud
JFE Steel's private cloud. Makes it possible to use the latest digital technologies while maintaining security and safety.

In May 2023, the Kurashiki district (Kurashiki City, Okayama Prefecture) of the West Japan Works, our core steelworks, migrated to an open platform environment for the shaped steel area of its mission-critical system. This is JFE Steel's first system upgrade to its mainframe system, which is made in Japan by Fujitsu, at its major steelworks, which has three blast furnaces continuously operating 24 hours a day.

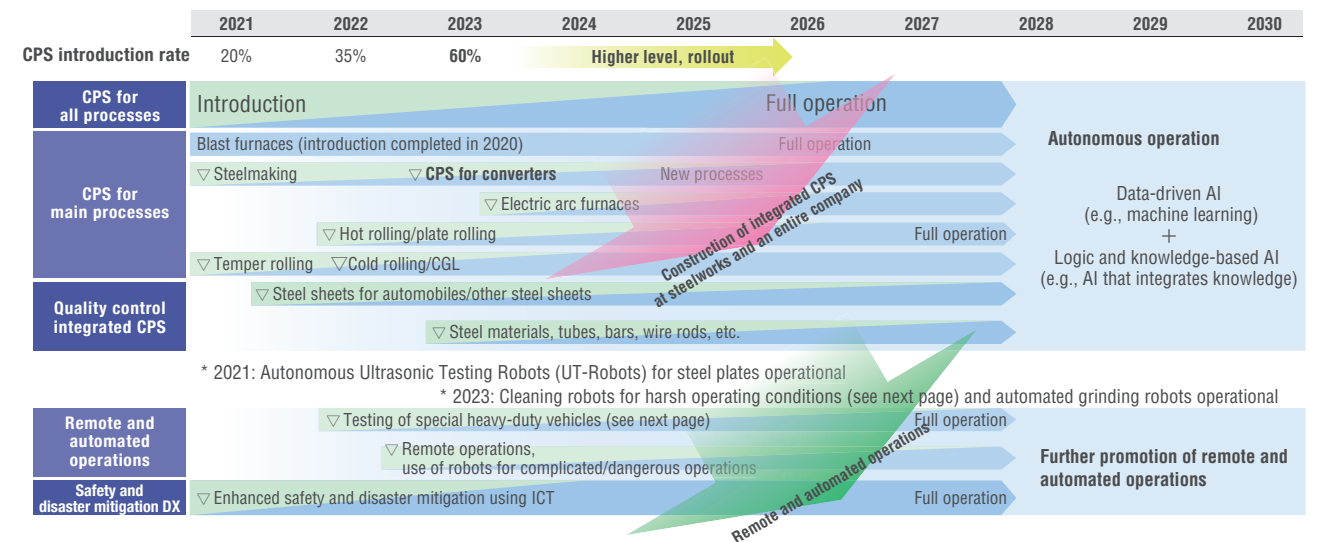
Head office	Steelworks					
	Kurashiki	Fukuyama	Chiba	Keihin	Sendai	Chita
Open platform project Sales, manufacturing, logistics	System updates at steelworks Manufacturing management, operational management					
Marketing : Logistics						
Upgrade completed in FY2021	Upgrades scheduled for completion during period covered by Eighth Medium-term Business Plan					
Open platform project Business management	Open platform project General administration				Upgrade completed in 2022	
Upgrade completed in FY2021	Upgrades scheduled for completion during period covered by Eighth Medium-term Business Plan					

Open structure process : Restructuring and migration : ERP installation

Raising our level of data use

Technological development roadmap and current status (as of the end of FY2023)

- ▶ **CPS introduced for all processes:** Automated operations for some blast furnaces, introduction of CPS for converters, etc. (FY2023 forecast: 86% for development, 60% for district rollout)
- ▶ **Remote and automated operations:** In-house development and use of testing robots and cleaning robots for harsh operating conditions under way



Initiative | 01 **Coke furnace digital twin**

As part of its DX strategy, JFE Steel aims to use a cyber physical system (CPS) for an entire steelworks to become an intelligent steelworks. Digital twins are a core CPS technology that reproduces physical systems and processes from the real world with equivalent properties in a digital model (a twin) in a virtual space to perform accurate simulations of the real world. Even with a small amount of data, conditions within a piece of equipment that are inaccessible in the real world can be visualized, which enables the efficient development and operation of manufacturing processes in equipment for which internal conditions have conventionally been difficult to confirm via sensors or direct observation. This also makes it possible to predict the effects of large-scale changes in operations or equipment.

JFE Steel has recently used this digital twin technology to improve operations at the No. 5, D Group coke furnace (the 5D furnace) in the Fukuyama district of the West Japan Works (Figure 1). An analysis confirmed that a mechanism for partially controlling air supply achieves greater operational efficiency than controlling the entire amount, as had been done in the past, and also made it possible to calculate the amount of supplemental air needed to optimize combustion. Utilizing this partial combustion optimization, the new 5D furnace uses 5% less fuel than in the past and has reduced 6,600 tons of CO₂ emission a year.

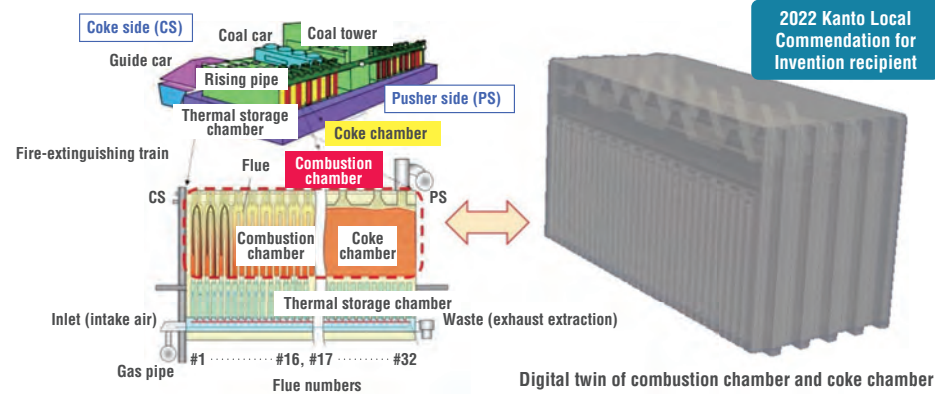


Figure 1. Digital twin model of coke furnace and its architecture

Initiative | 02 **Developments in robotics**

JFE Steel is emphasizing the use of remote operations and automation robots to increase labor productivity at least 20%, as called for in the Medium-term Business Plan. Autonomous Ultrasonic Testing Robots (UT-Robots) were introduced at a steel plate plant, and the company has developed the GAZMASTAR™ (Figure 1) autonomous cleaning robot to operate in harsh conditions involving high temperatures, dust particles, and rough roads.

Some equipment used in steelmaking processes uses materials such as iron ore and coal that create dust particles, and environmental measures including the installation of dust collectors and regular cleaning of dust particles near equipment have been introduced to prevent the dust from being scattered by the wind.

JFE Steel has developed a proprietary internally cooled valve mechanism for robots that can operate in environments with high temperatures, in order to reduce manual cleaning operations, and incorporated this in the GAZMASTAR™.

A LiDAR¹ sensor functions as the “eye” of the GAZMASTAR™ measuring the distances of surroundings and obstacles, and SLAM² is used as the location recognition system (Figure 2). This arrangement enables GAZMASTAR™ to clean while automatically moving along a targeted route within a cleaning area. Verification and durability testing have already been carried out in ironmaking processes. Going forward, the company will develop models for all equipment within steelworks in all the districts, to reduce the operational burden and improve safety and productivity.



Figure 1. GAZMASTAR™ autonomous cleaning robot for harsh operating conditions

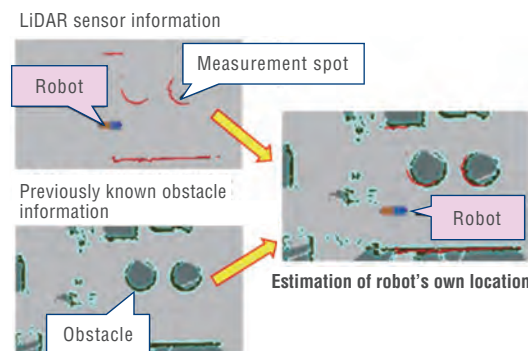


Figure 2. Use of SLAM for robot to determine its own position

¹ Light Detection and Ranging. Near-infrared light and other types are beamed, and the time until the reflection from objects is captured by sensors is used to measure the distance.

² Simultaneous Localization and Mapping. LiDAR sensor information is used to “map” the robot’s location relative to its surroundings and obstacles, while simultaneously “locating” to determine where the robot is and where it should go based on the map.



Demonstration video
<https://www.youtube.com/watch?v=soN1dJRN3Ew>

Initiative | 03 **Self-driving vehicle**

JFE Steel, JFE Logistics, and NICHIGO CORPORATION completed development of the basic functions for automated transport of steel materials within the Kurashiki district of the West Japan Works using special heavy-duty vehicles (Figure 1) equipped with positioning sensors, and began verification testing in 2023.

To address future shortages of drivers and improve working conditions, in 2018, JFE Steel began research and development of technologies to automate the transport of steel materials. Steel materials are transported within a steelworks using trolleys called pallets. Large numbers of steel materials such as rolled steel coils can be loaded onto a pallet, and carrier pallet trucks are special heavy-duty vehicles that can transport these pallets. While a trailer can transport roughly 20 tons of cargo in one load, carrier pallet trucks can efficiently transport up to 160 tons and play an important role within a steelworks for transporting materials between processes and for shipment.

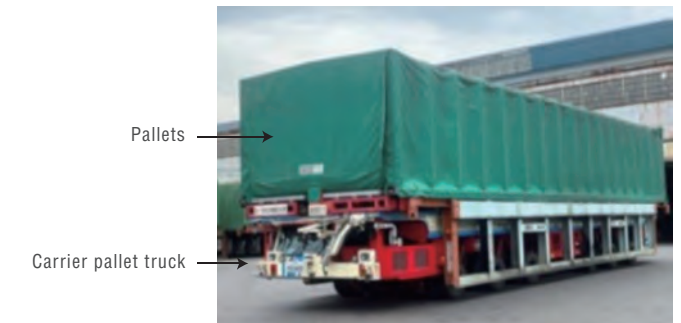


Figure 1. Carrier pallet truck



Figure 2. Rolled steel coils loaded onto pallets



Figure 3. Pallet storage

Cultivating an internal culture for DX

In addition to human resource development (page 5), JFE Steel considers “a culture in which every employee takes ownership of DX and can pursue challenges” important for achieving companywide DX and is working to cultivate that internal culture.

Companywide presentations of dissertations related to data science

Presentations of dissertations have been held since fiscal 2019 to provide successful examples companywide and create a culture that makes greater use of data science, as part of a companywide effort to promote the introduction of data science (DS), the Internet of Things (IoT), and artificial intelligence (AI) in equipment, steelmaking processes, and operations. The eighth presentation event was held in December 2023 at the head office and was also streamed to nine locations including steelworks and manufacturing centers, with more than 700 people including the president and officers participating. Dissertations were presented by various departments at the head office and steelworks, and all employees were able to watch the presentations via Teams, an internal network. Awards were given to recognize particularly excellent dissertations based on criteria including logic, creativity, novelty, immediate effectiveness, and versatility.



The president giving a presentation to show all employees in addition to engineers the importance of personally acquiring DX literacy and cultivating a companywide DX culture



President Yoshihisa Kitano and presenters after the awards ceremony