Feature 01 JFE Group's Digital Transformation Strategy

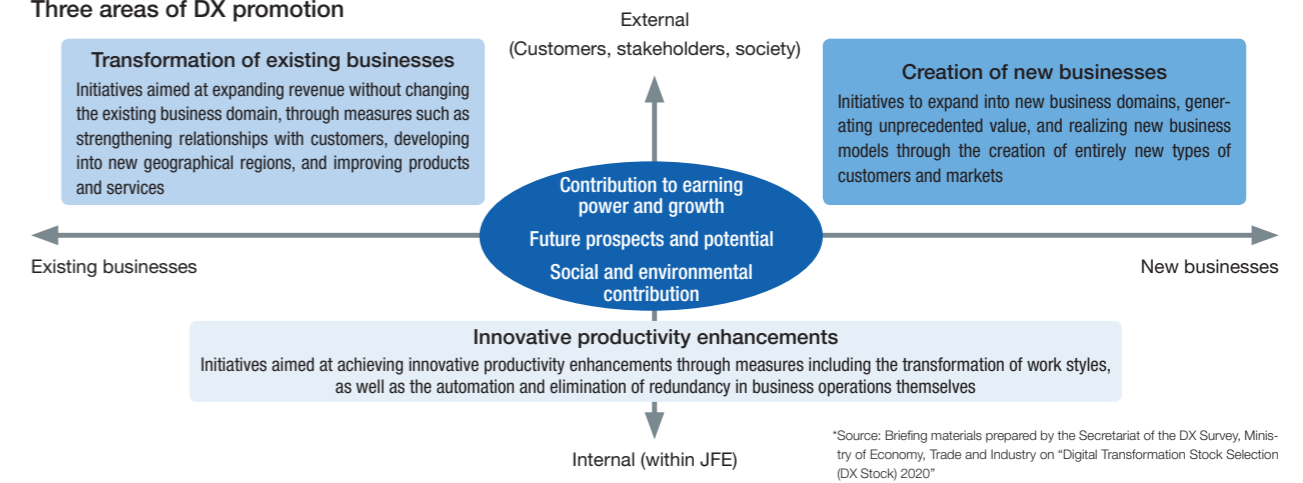**Feature 01**

JFE Group's Digital Transformation Strategy

The global environment has entered a period of great change. Economic development has brought convenience and enriched the lives of many. At the same time however, it has become necessary to resolve increasingly complicated social issues, such as the reduction of greenhouse gas emissions, the mitigation of excess production or losses of food, the suppression of social costs associated with an aging population, and the establishment of a sustainable industry base.

As the world changes drastically, we are also witnessing the emergence of a succession of new technologies that influence the make-up of society, such as the IoT, robotics, artificial intelligence (AI) and big data. Through the adoption of these leading-edge technologies into industry and social life, we must aim to achieve a new society that combines economic development with the resolution of social issues. Based on this perspective, the JFE Group actively promotes the digital transformation (DX) strategy.

Increasing competitive strength dramatically, and establishing a sustainable, stable revenue base through DX

News

Selected as a DX Stock 2020

JFE Holdings is actively promoting strategic IT investment in order to reinforce the competitive strength across the entire Group and improve corporate value over the medium to long term. We have been selected as Competitive IT Strategy Company Stock Selection jointly announced by the Ministry of Economy, Trade and Industry and the Tokyo Stock Exchange for five consecutive years. From this year, the index has been changed to DX Stock Selection with a focus on digital transformation (DX) to realize new growth and enhance competitive strength by fundamentally transforming business models based on digital technology. JFE Holdings was selected as a DX Stock 2020 for its proactive promotion of DX.

DX銘柄2020
Digital Transformation

The JFE Group is confronted with a range of structural changes in the business environment, such as dramatic fluctuations in markets in Japan and overseas, generational change including the retirement of veteran engineers, and the aging of equipment. We have identified Group-wide digital transformation (DX) as an important strategy to enable us to respond flexibly and swiftly to increasingly challenging changes in the business environment. This includes the use of data and digital technology to transform products, services and business models, as well as the transformation of organizations, processes, corporate culture and the nature of business operations themselves.

By actively promoting DX in response to key management issues, we will increase the competitive strength of the entire Group dramatically, establish a stable revenue base, and build a strong and resilient corporate structure that can adapt flexibly to changes in the environment.

The JFE Group has identified information security as an important management issue, and is strengthening information security governance in order to protect information resources that may form the foundation for innovative productivity enhancements, the transformation of existing businesses, and the creation of new businesses.

Based on this approach, we are striving to improve corporate value through the promotion of our unique DX strategy in each of the steel, engineering, and trading businesses.

Three areas of DX promotion

External (Customers, stakeholders, society)

Transformation of existing businesses
Initiatives aimed at expanding revenue without changing the existing business domain, through measures such as strengthening relationships with customers, developing into new geographical regions, and improving products and services

Creation of new businesses
Initiatives to expand into new business domains, generating unprecedented value, and realizing new business models through the creation of entirely new types of customers and markets

Contribution to earning power and growth
Future prospects and potential
Social and environmental contribution

Existing businesses

New businesses

Innovative productivity enhancements
Initiatives aimed at achieving innovative productivity enhancements through measures including the transformation of work styles, as well as the automation and elimination of redundancy in business operations themselves

Internal (within JFE)

*Source: Briefing materials prepared by the Secretariat of the DX Survey, Ministry of Economy, Trade and Industry on "Digital Transformation Stock Selection (DX Stock) 2020"

■ Promotion of DX in the Steel Business

Vision for DX promotion

JFE Steel's DX strategy pivots on technological innovation and the use of data resources, through the proactive introduction of technologies such as the IoT, AI and data science (DS). Compared to steel mills overseas, JFE Steel has accumulated a large amount of know-how and data over many years. These abundant data resources are the source of value creation. By actively utilizing these resources through the latest DS and AI technologies,

we aim to achieve innovative productivity enhancements, quality improvements, and stable operations, to further enhance our competitive strength. In addition, we will promote measures to respond to new work styles in the wake of COVID-19, including remote working initiatives such as the remote monitoring of manufacturing facilities across each region.

JFE Steel's Vision Be a global steel supplier that always creates new value and grows with customers

The three pillars of DX promotion

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

Maximize value

1 Execute IT structural reforms – Upgrade systems at steelworks –
Realize a flexible, change-tolerant IT structure

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 –
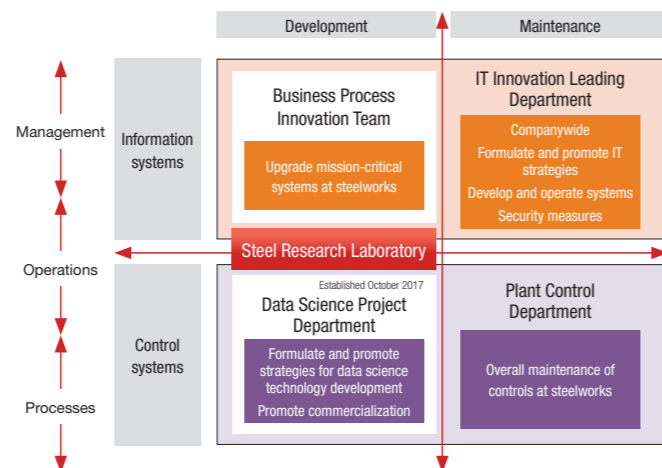Enhance the security environment for IT

Strategies for Value

■ Promotion of DX in the Steel Business

DX promotion structure and transformation

We are building structures to promote the upgrade of legacy systems and the active utilization of the latest IoT, AI and DS, which are key issues for management.
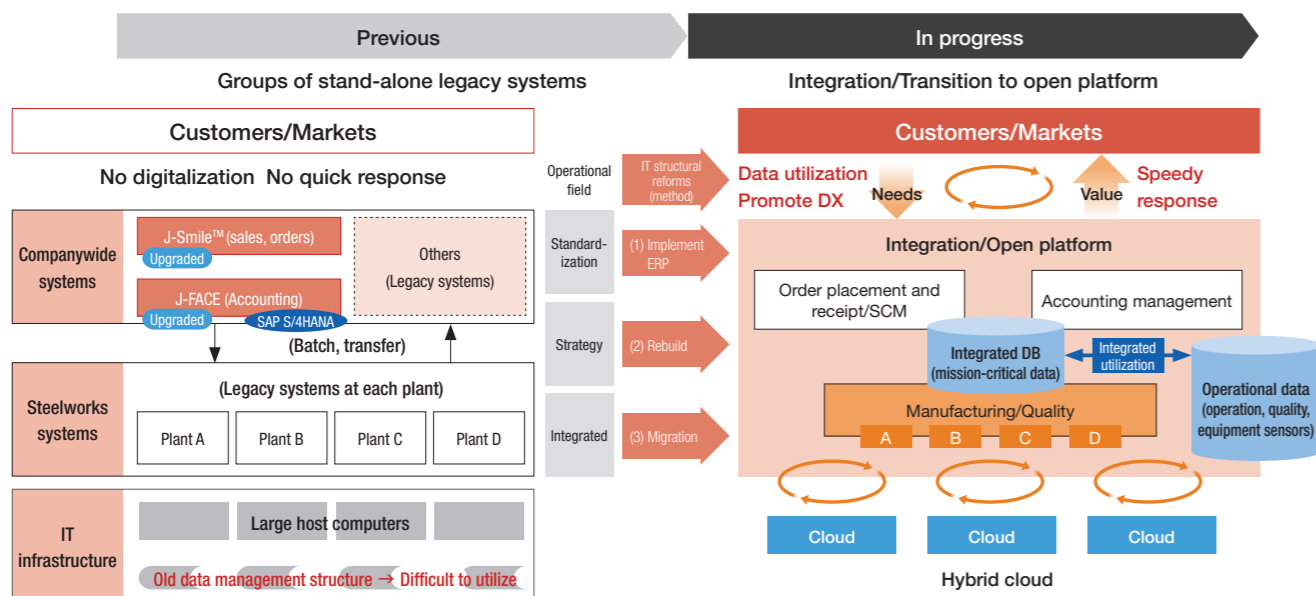
We established the Business Process Innovation Team in January 2015, and continue to steadily promote the upgrading of mission-critical systems at each steelwork and companywide integration.

We went on to establish the Data Science Project Department in October 2017, and the Cyber-Physical System R&D Department in April 2019, promoting the efficient and systematic research and development of the latest IoT, AI and DS technologies from a companywide perspective.

Development / Maintenance

Management — Information systems

Business Process Innovation Team
- Upgrade mission-critical systems at steelworks

IT Innovation Leading Department
- Companywide
- Formulate and promote IT strategies
- Develop and operate systems
- Security measures

Steel Research Laboratory

Operations / Control systems

Established October 2017
Data Science Project Department
- Formulate and promote strategies for data science technology development
- Promote commercialization

Plant Control Department
- Overall maintenance of controls at steelworks

Processes

Enhancement of the information system platform for DX promotion

We are engaged in structural reforms of our IT platform to enable the utilization of our abundant data resources, the core of our DX strategy. We are pushing ahead with the development of structures to respond swiftly and flexibly to changes in the environment, through the integration of groups of legacy systems and the transition to an open platform.

Previous: Groups of stand-alone legacy systems
In progress: Integration/Transition to open platform

Customers/Markets — No digitalization No quick response

Companywide systems: J-Smile™ (sales, orders) Upgraded; J-FACE (Accounting) Upgraded; SAP S/4HANA; Others (Legacy systems)

(Batch, transfer)

Steelworks systems: (Legacy systems at each plant) Plant A, Plant B, Plant C, Plant D

IT infrastructure: Large host computers; Old data management structure → Difficult to utilize

Operational field — IT structural reforms (method)
Standard-ization — (1) Implement ERP
Strategy — (2) Rebuild
Integrated — (3) Migration

Customers/Markets
Data utilization Promote DX Needs Speedy response

Integration/Open platform
Order placement and receipt/SCM; Accounting management
Integrated DB (mission-critical data) ↔ Integrated utilization
Operational data (operation, quality, equipment sensors)
Manufacturing/Quality A B C D
Cloud Cloud Cloud
Hybrid cloud

Initiatives for DX promotion (Raise the level of data use)

J-mAIster™: an equipment maintenance support system utilizing AI technology 01

JFE Steel actively promotes the utilization of its abundant data resources. Based on the companywide integrated maintenance system that began operation in 2015, we introduced the J-mAIster™ system in 2018 utilizing IBM™ Watson to support the recovery from control failures across all manufacturing lines. This new system enables even young maintenance personnel to easily search through extensive failure data accumulated over the past 20 years, and identify countermeasures, achieving a substantial reduction in recovery time.
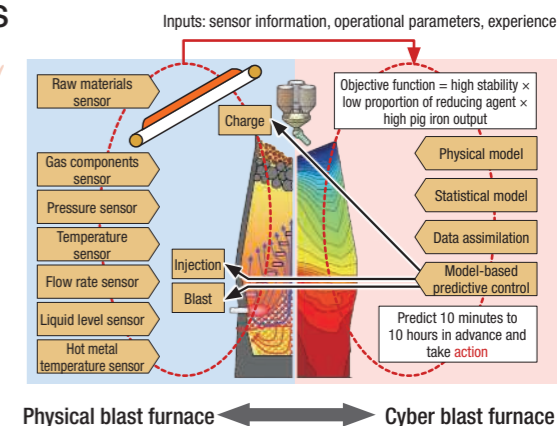

Previous: Separate PDCA cycle/expertise for each plant
Present: Digitalized maintenance

Operations; Regular maintenance; Failure response

Plant A, Plant B, Plant C, Plant D — Individual system — Rules of operation — Equipment
Dependent on the experience and intuition of the maintenance personnel

Standardization; Data integration; AI utilization

Plant A, Plant B, Plant C, Plant D
Integrated maintenance system
J-mAIster AI → Integrated DB
Equipment, Equipment, Equipment, Equipment
AI diagnosis ⇒ Swift recovery

2018 Expanded across the entire company
- Standards/Plans
- Results
- Past failure information
- Equipment manuals (linked to file servers)

Leveraging advanced DS: Transition to CPS (cyber-physical systems)* for blast furnaces 02

We are progressively introducing CPS at all of our operational blast furnaces in Japan. Until now, it was extremely difficult to predict abnormalities in airflow or temperature conditions within the furnace. The introduction of CPS has facilitated the prediction of these factors, contributing to enhanced productivity and safe operation of blast furnaces.
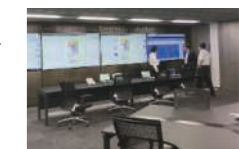
*A system that generates value by feeding vast quantities of data from sensors (big data) concerning physical space (actual equipment and products) into cyber space, and feeding back the result of multiple analysis using various methods to physical space in real time.

Predictive model
- Detect abnormalities in airflow in the furnace from pressure sensors (20 to 30 minutes in advance) ⇒ Avoid gas channeling trouble
- Predict the furnace temperature up to 12 hours in advance ⇒ Take appropriate action to maintain the target temperature

Inputs: sensor information, operational parameters, experience
Raw materials sensor, Gas components sensor, Pressure sensor, Temperature sensor, Flow rate sensor, Liquid level sensor, Hot metal temperature sensor
Charge, Injection, Blast
Objective function = high stability × low proportion of reducing agent × high pig iron output
Physical model; Statistical model; Data assimilation; Model-based predictive control
Predict 10 minutes to 10 hours in advance and take action
Physical blast furnace ⟷ Cyber blast furnace

Establishing the JFE Digital Transformation Center: a base for promoting DX 03

We established the JFE Digital Transformation Center (JDXC®) as a base for promoting DX at the head office. JDXC™ is the first facility in the Japanese steel industry capable of the comprehensive utilization of data from all steelworks and other works, including the coordination of upstream and downstream processes, and data sharing between districts. We will further accelerate technological innovation and the utilization of data resources, which are the pillars of our DX strategy, by expanding CPS to our main manufacturing processes, and promoting measures including training and increasing data scientists centered around JDXC™. This will also enable the remote monitoring of manufacturing facilities across each region, allowing us to respond to new work styles, including remote working initiatives in the wake of COVID-19.

Strategies for Value

■ Promotion of DX in the Engineering Business

Implementing the world's first automated operating system for incinerators through companywide DX promotion framework

At JFE Engineering, we promote DX directly connected to our business by constructing companywide systems to collect and utilize information, such as the Global Remote Center which collects operating data from plants across Japan, as well as platforms to analyze these data.
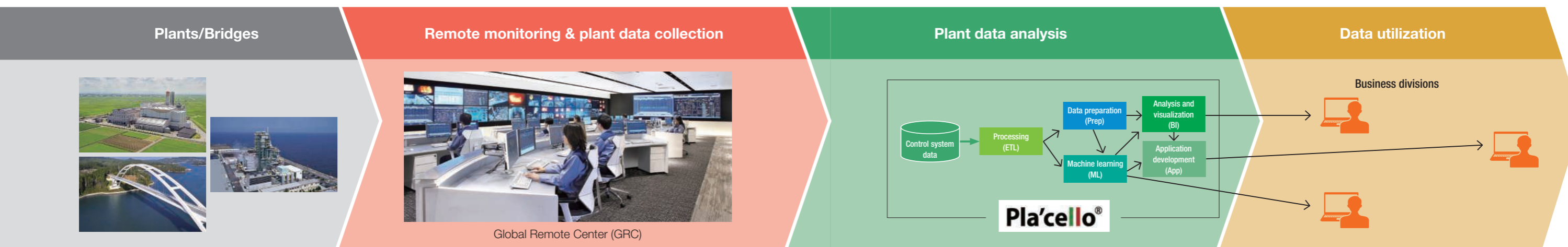
For waste-to-energy plants in particular, we have implemented the world's first automated operating system for waste incinerators through AI image analysis of the combustion status and the systemization of manual operation by veteran operators.

Achieving DX solutions in a range of fields through technology and operation know-how combined with AI developed in-house

We are developing DX solutions to resolve a variety of issues both within and outside the JFE Group. In addition to the automated operation of waste-to-energy plants, these include the automation of bolt work inspection in bridge construction, the optimization of dam operation through water level prediction, and the optimization of electricity supply through the prediction of electricity demand based on customer needs.

We will fuse AI technology developed in-house with original technologies and operation know-how cultivated through manufacturing, using our unique capabilities to achieve unprecedented efficiency in operating services, innovative operational efficiency enhancements, and new business value.

Plants/Bridges	Remote monitoring & plant data collection	Plant data analysis	Data utilization

Global Remote Center (GRC)

Control system data → Processing (ETL) → Data preparation (Prep) → Analysis and visualization (BI); Machine learning (ML) → Application development (App)

Pla'cello®

Business divisions

Initiatives for DX promotion

Global Remote Center (GRC)

The Global Remote Center (GRC), which opened in March 2018, collects customers' plant operation data and provides services including remote monitoring, operational support and maintenance of customers' plants.

It is equipped with an advanced environment for expanding data utilization, consolidating networks that were previously dispersed among different plant types, enhancing the quality of communications lines, and centralizing management of various data from plants on the cloud. For waste-to-energy plants, the company has used the accumulated big data to develop and launch an AI system to determine the combustion status, and an AI system to provide the know-how of veteran operators in a conversational format. The GRC also plans to utilize AI technology in other areas, such as the prevention of operating failures and the swift restoration of normal operations through diagnosis of warning signs, and the maintenance of industrial machinery and pipeline monitoring and control devices, providing diverse and high added-value services.

Message from the Executive Officer in Charge

**Advanced engineering with ICT
Creating and "Ni-na-u"* the foundation for life powered by manufacturing and service capabilities**
* "Ni-na-u" is a Japanese word meaning supporting and remaining responsible.

As privatization of public services is requested, we are actively expanding "Ni-na-u" business in addition to creating social infrastructure. Advanced technologies such as IoT, big data analysis and artificial intelligence (AI) are key drivers for creating and "Ni-na-u" the foundation for life. We make the best use of such advanced technologies for state-of-the- art infrastructure business.
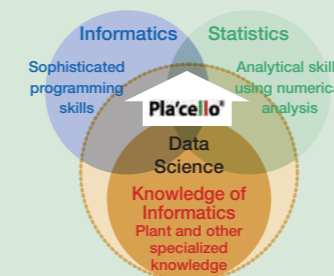
Atsushi Okamoto
Senior Managing Director, JFE Engineering Corporation

Data analysis platform that does not require specialized IT knowledge

The Pla'cello data analysis platform, which allows analysis of a plant's photo and time-series data, was built and started operating in November 2018. In general, the use of AI and big data is said to require knowledge of informatics, statistics and domain knowledge in the particular field. The Pla'cello makes it possible to analyze data to detect abnormalities and predict demand, without advanced knowledge in informatics or statistics.

This permits a reduction of the amount of time required for data analysis by up to 90%.

Using Pla'cello, we plan to increase the number of internal engineers engaged in data analysis to 300 by the end of FY2020.

Informatics
Sophisticated programming skills

Statistics
Analytical skills using numerical analysis

Pla'cello®

Data Science
Knowledge of Informatics
Plant and other specialized knowledge

Automated waste incinerator system for waste-to-energy plants

Because the status of combustion at a waste-to-energy plant changes minute by minute depending on the waste being used as fuel, it was previously necessary for an operator to intervene manually to ensure stable operations. Our BRA-ING, the world's first automated operating system for waste incinerators, which uses AI-based image analysis of the combustion status and the systematization of manual operation by veteran operators, is already at the implementation stage, and planning to introduce to 10 facilities in FY2021.

BRA-ING

Data analysis + AI

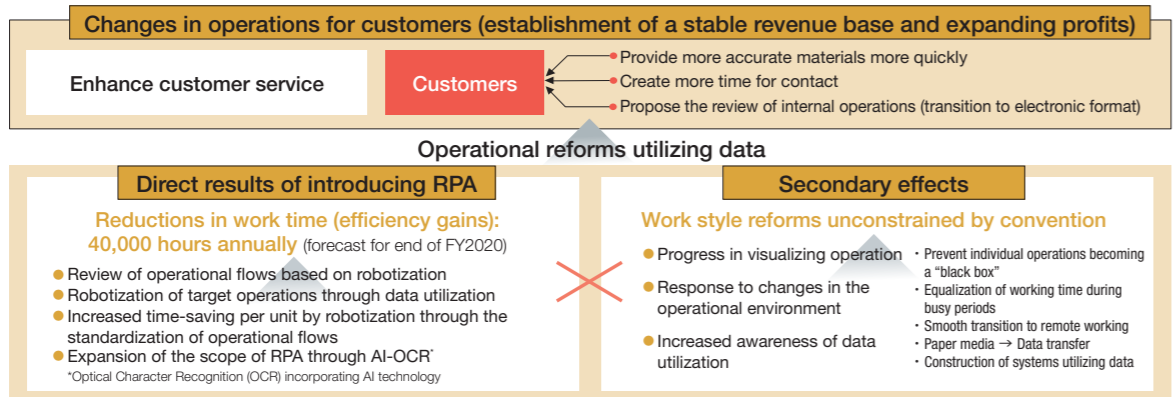# ■ Promotion of DX in the Trading Business

Initiatives for DX promotion

Channeling the internal benefits of introducing RPA to enhanced customer service

In FY2018, we launched a companywide project to introduce RPA. We forecast an effective reduction in working hours of around 40,000 hours annually by the time the project comes to completion at the end of FY2020 (it has been expanded to Group companies from FY2019). Internally, introducing RPA has generated secondary effects such as being able to visualize and standardize operations through the review of operational flows and cross-functional activities, and greater opportunities for data utilization.

There has also been a change in the division of duties since RPA was introduced, including the transfer of some duties from employees in career-track positions to those in clerical positions.

It has also contributed to the faster provision of information and other improvements in customer service at points of contact with customers.

These changes are only the first step for JFE Shoji. We will continue to work to promote DX and further enhance customer service.
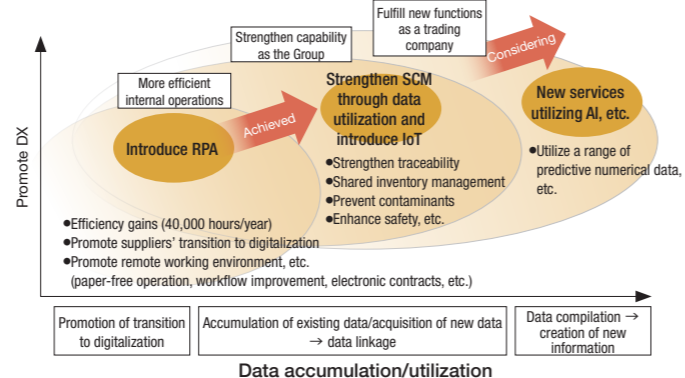
Changes in operations for customers (establishment of a stable revenue base and expanding profits)

Enhance customer service	Customers

- Provide more accurate materials more quickly
- Create more time for contact
- Propose the review of internal operations (transition to electronic format)

Operational reforms utilizing data

Direct results of introducing RPA

Reductions in work time (efficiency gains): 40,000 hours annually (forecast for end of FY2020)
- Review of operational flows based on robotization
- Robotization of target operations through data utilization
- Increased time-saving per unit by robotization through the standardization of operational flows
- Expansion of the scope of RPA through AI-OCR*
  *Optical Character Recognition (OCR) incorporating AI technology

Secondary effects

Work style reforms unconstrained by convention
- Progress in visualizing operation
- Response to changes in the operational environment
- Increased awareness of data utilization

· Prevent individual operations becoming a "black box"
· Equalization of working time during busy periods
· Smooth transition to remote working
· Paper media → Data transfer
· Construction of systems utilizing data

Aiming to further evolved customer service through the promotion of DX

The in-house utilization of data has increased through our activities to expand RPA, while the COVID-19 crisis has spurred the progressive transition of customer communications to digitalization.

In addition, we have begun considering IT systems development utilizing data to strengthen SCM, and the utilization of AI for sales operations. We are also in the process of introducing IoT at our manufacturing Group companies.

We will continue to enhance data accumulation and utilization, with our final goal not only to achieve greater efficiency across JFE Shoji and its subsidiaries but also to provide unique new value to customers.

Promote DX

- More efficient internal operations
- Introduce RPA — Achieved
- Strengthen capability as the Group
- Strengthen SCM through data utilization and introduce IoT — Considering
  - Strengthen traceability
  - Shared inventory management
  - Prevent contaminants
  - Enhance safety, etc.
- Fulfill new functions as a trading company
- New services utilizing AI, etc.
  - Utilize a range of predictive numerical data, etc.

- Efficiency gains (40,000 hours/year)
- Promote suppliers' transition to digitalization
- Promote remote working environment, etc.
  (paper-free operation, workflow improvement, electronic contracts, etc.)

Promotion of transition to digitalization	Accumulation of existing data/acquisition of new data → data linkage	Data compilation → creation of new information

Data accumulation/utilization

Message from the Executive Officer in Charge

JFE Shoji embarked on full-scale DX with the introduction of RPA, focusing mainly on office operations so far. With the adoption of technologies such as the IoT and AI, we are now expanding our sphere of activities outside the company. Specifically, we plan to boost productivity of manufacturing-related Group companies through IoT, and improve various services through data analysis utilizing AI. As the JFE Group's core trading company, we continue to actively adopt digital technology and strive to enhance customer satisfaction.

Tatsuya Sakamoto
Vice President, JFE Shoji

■ Information Security Governance that Underpins DX Strategy (Defensive DX)

JFE Group information security management system

In April 2016, we established the JFE Group Information Security Committee in response to the publication of Cybersecurity Management Guidelines by the Ministry of Economy, Trade and Industry in 2015, with an aim to continuously maintain and reinforce the IT risk management function across the entire Group. Under the direction of the JFE Group Chief Information Security Officer[1], the executives responsible for the IT division in each operating company deliberate on key IT issues principally information security, and determine Group policy. We have also established the JFE-SIRT, made up of General Managers of the IT division in each operating company, and are working to strengthen security measures and governance of operating companies and their group companies, based on the decisions made by the JFE Group Information Security Committee.
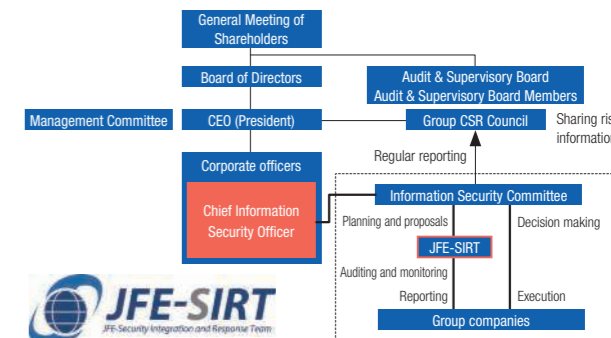
JFE-SIRT (JFE-Security Integration and Response Team) is a CSIRT[2] responsible not only for addressing information security incidents but also for the planning, proposal and promotion of Group-wide measures, auditing group companies, reviewing security policy, etc.

*1 Chief Information Security Officer (CISO). Chief executive ultimately responsible for all information security matters, who is in charge of information management and control within the company and organization.
*2 CSIRT: Computer Security Incident Response Team. A generic name for organizational units that respond to computer security-related incidents within an organization.

Integrated information security monitoring network

Targeted cyber attacks aimed at companies are becoming ever more sophisticated. In many cases, victims remain unaware for a long time that they have even suffered an attack, by which time information resources have already been stolen. An integrated information security monitoring network is necessary to ensure early detection of threats and prevent damage from spreading, by executing multilateral monitoring from individual computers to the network level. By developing a Group-wide SOC[3] we have facilitated constant monitoring across the entire JFE Group. In addition, we have established a system where security incidents at Group companies are promptly reported, dealt with, normal function is restored, and measures are formulated to prevent recurrence, by JFE-SIRT, under the direction of the JFE Group Chief Information Security Officer.
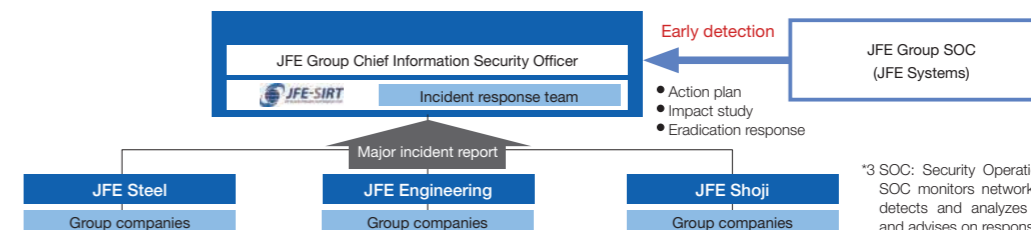
*3 SOC: Security Operation Center. The SOC monitors networks and devices, detects and analyzes cyber attacks, and advises on response measures.

Integrating the Group security platform

We are engaged in the implementation of a shared information security platform, including networks, IT devices, and security-related software, in order to raise the overall level of information security across the JFE Group, and protect the Group's information resources from increasingly sophisticated cyber attacks. In the event of an information security breach, a shared platform will enable us to accurately grasp the threat and respond swiftly.

We have also established a shared data communication platform for the advent of cloud computing. The promotion of safe information sharing within the JFE Group is also contributing to the creation of inter-group DX businesses.