

Collaborative Creation with Customers

1 Enhancements to NEXPERIENCE

Hitachi developed NEXPERIENCE to accelerate the development of solutions by collaborative creation, using it to create new services and businesses in partnership with customers. NEXPERIENCE is made up of methods and practices that support this process through each of its steps, from discovering future business opportunities, analyzing the associated issues, coming up with ideas, and evaluating values.

The greater social diversity of recent years together with the digital revolution have made dealing with societal challenges a matter of urgency. Accordingly, Hitachi is making the following methodological enhancements to add precision to business creation in order to develop businesses that address these societal challenges.

- (1) Discovering and analysis of challenges involving the extensive collection and study of information on societal challenges through open collaborative creation
- (2) Support for generating business ideas by drawing on Hitachi's cross-industry knowledge
- (3) Design of ecosystem-based service business models

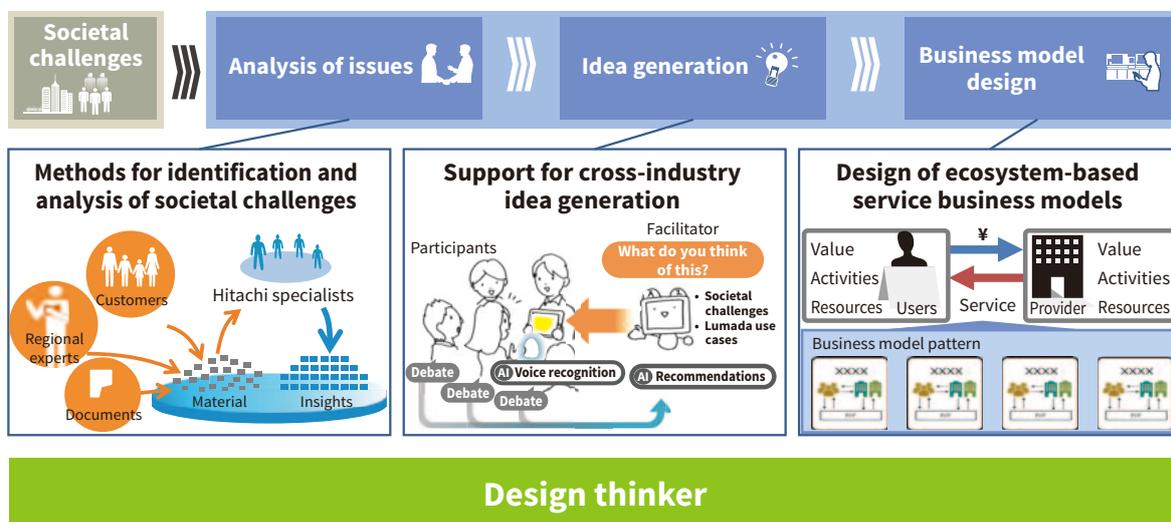
for the resulting business ideas that will gain acceptance from the general public

Along with these methodological enhancements, Hitachi also intends to contribute to the creation of solutions to societal challenges by fostering people with skills in design thinking who can work in collaborative creation with customers to uncover genuine issues and devise innovative solutions.

2 Vision Design

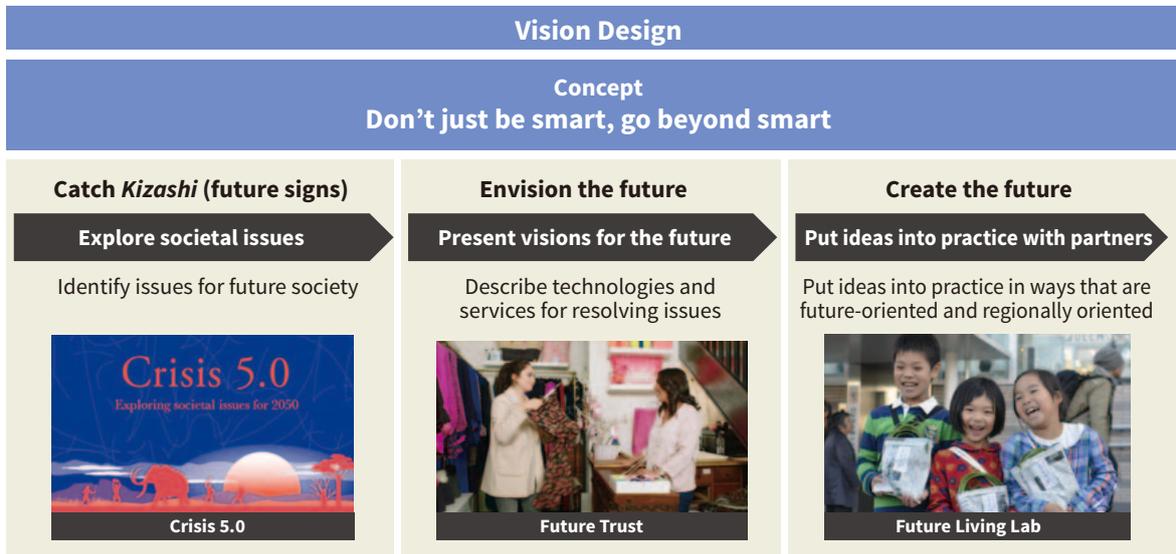
Hitachi engages in vision design for exploring what Society 5.0 might mean in practice by identifying issues that could potentially arise in the society of the future and coming up with technologies and service concepts for overcoming them.

Hitachi is participating with Hitachi Kyoto University Laboratory in the Crisis 5.0 and Imagination 5.0 projects where it is seeking to identify the issues that Japan will face in 2050 while also thinking about how they can be overcome through the creativity of individuals.



AI: artificial intelligence

1 Enhancements to NEXPERIENCE



2 Vision design process

Another project, called “Future Trust,” is investigating the forms of trust in a digital society, coming up with visions for novel technologies that can help forge new links in individuals, community, and urban environments and presenting them on a website and at events.

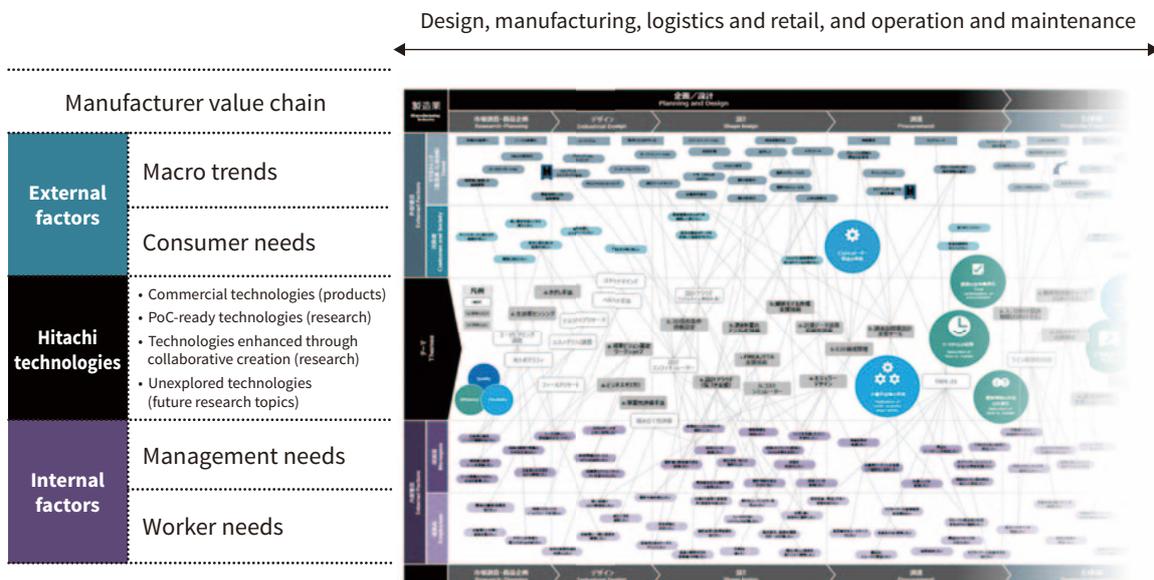
The Future Living Lab, which puts these ideas into practice from a base at the *Kyōsō-no-Mori* collaborative creation facility in Kokubunji City, Tokyo has a focus on regional currency and agriculture and has started work on exploring ways of overcoming the issues of a falling population that are founded on the creativity of the people who live in these communities. Social Impact Design, meanwhile, is taking on the task of developing a new vision of society in partnership with a

wide variety of stakeholders on the basis of an in-depth understanding of urgent societal issues.

In the future, Hitachi will continue to pursue new visions for social infrastructure that can overcome the issues facing communities, and in doing so draw on the inner strengths of the people involved.

3 Full Value Chain Solution for Industry and Distribution

An important part of collaborative creation with customers in the industrial and distribution sectors is to lay out their long-term growth strategies and their roadmaps for achieving them. A useful tool for such



PoC: proof of concept

3 Example of full value chain map

studies is a full value chain map that plots internal and external trends, requirements, and technological issues across all business processes. This provides an overview of the situation and helps ensure project success by clarifying action plans at workshops attended by everyone involved so that they all understand the project objectives.

One example was a collaborative creation with a machinery vendor seeking to improve their manufacturing practices. The challenge was to investigate ways of improving not only productivity but also of simultaneously reforming working practices to address future labor shortages and greater worker diversity. The solution they came up with was to develop a people-friendly production model utilizing a “man, machine, material, and method” (4M) analysis platform that is linked to Lumada, which accelerates the digital innovations that Hitachi has built up over many years. The aim is to use this to achieve a three-fold increase in worker diversity and 30% improvement in productivity.

4 Digital Smartspace that Sheds Light on What People are Doing

Advances in AI and the Internet of Things (IoT) have made possible business and environmental improvements through the collection and analysis of data from a variety of different devices and equipment. The future promises smart spaces that offer greater value to people and are made possible by digitalizing spaces in ways that include the people who use these environments. The research into digital smart spaces being conducted

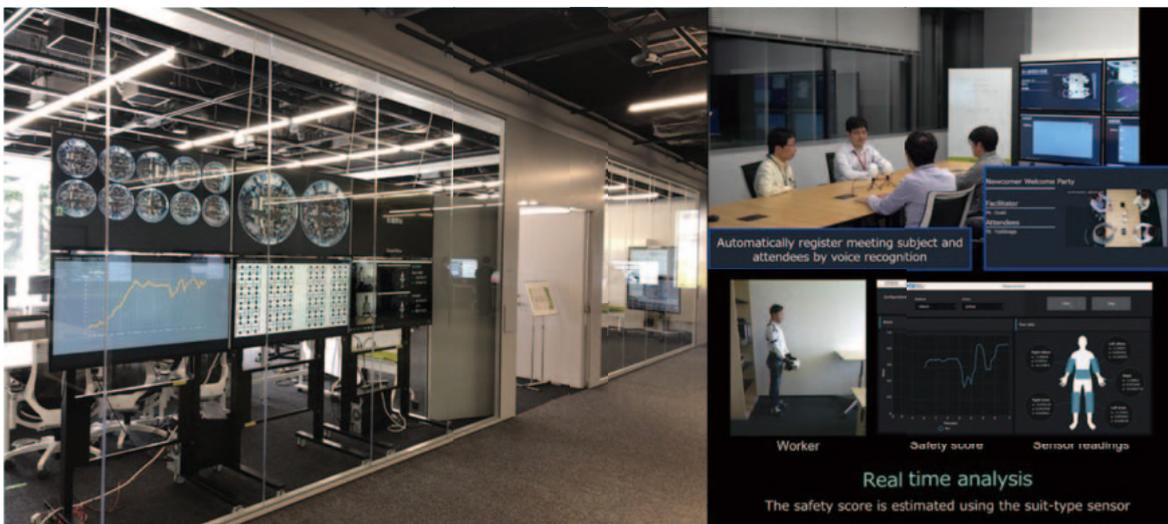
by Hitachi involves developing technologies that shed light on what people are doing in offices, factories, and public spaces, seeing this as a way to address societal challenges such as work style reform, productivity improvement, and the maintenance of public safety and security.

One initiative aimed at enhancing the efficiency of office work improves the quality of meetings by analyzing what the people present are saying and providing a visual presentation of the meeting’s subject matter and level of activity. To improve factory productivity and safety, sensors are used to identify worker actions and highlight places where a high level of bodily stress occurs so that this information can be utilized for things like safety guidance and skills transfer. Technologies for using cameras to detect and track people or large packages help maintain safety and security at railway stations or airports.

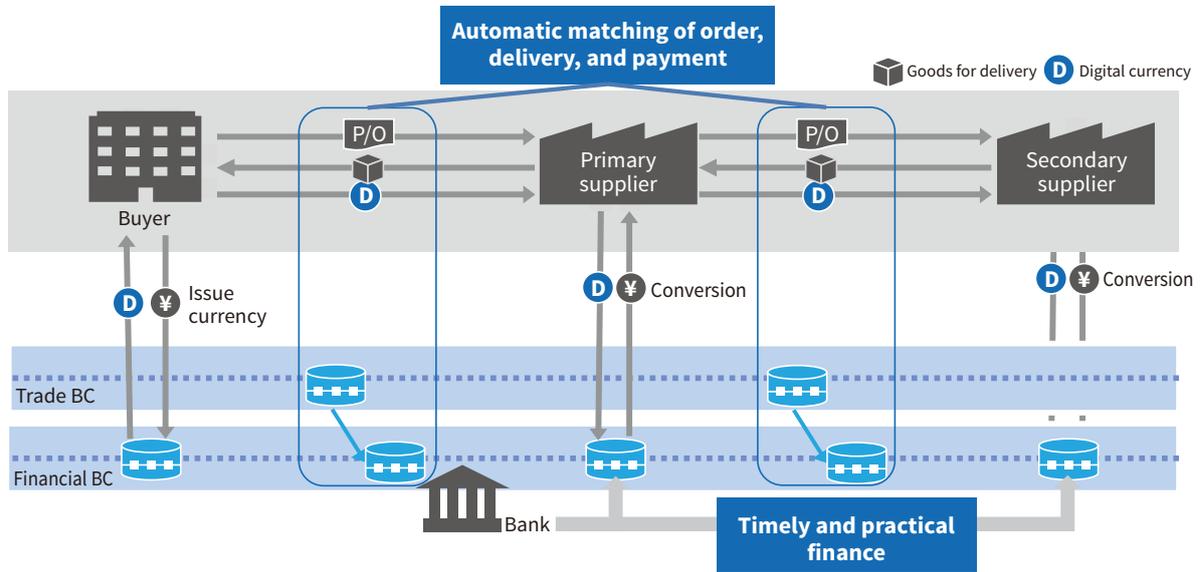
Hitachi is developing these advanced technologies alongside its collaborative creation partners from Japan and elsewhere with the aim of expanding their use in the future.

5 Digital Payment Solution

In current supply chains, the commercial (issuing and receiving orders), logistics (delivery), and financial (payment) aspects of transactions are all handled either manually or by separate systems, with the result that it takes time to match up the large amount of associated paperwork, which includes sale and inward goods



4 Collaborative creation with customers using digital smartspace



BC: blockchain P/O: purchase order

5 Digital payment service

documents. There is also a problem with working capital obstructing the accurate availability of information on sales and deliveries.

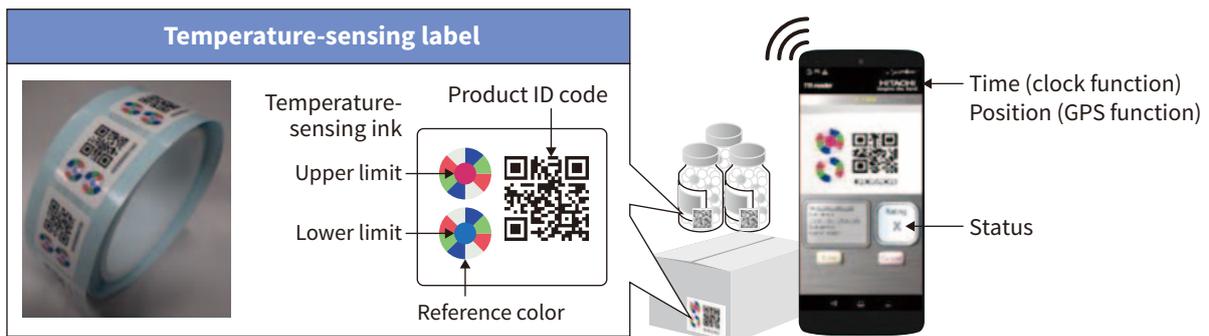
In response, Hitachi has developed a prototype solution for making payments automatically based on order information that works by using a blockchain for the secure sharing of trade and financial information across the supply chain. Hitachi has also engaged in collaborative creation with a bank to enable the issuing of digital currency and its use for payment, and is trialing this in its own supply chains. This transaction information is also being used in the development of a service for the timely and appropriate financing of capital requirements.

Hitachi's objective for the future is to put these services into practical use to create a platform service that helps overcome societal challenges in industry.

6 Logistics Management Solution Using Temperature-sensing Ink

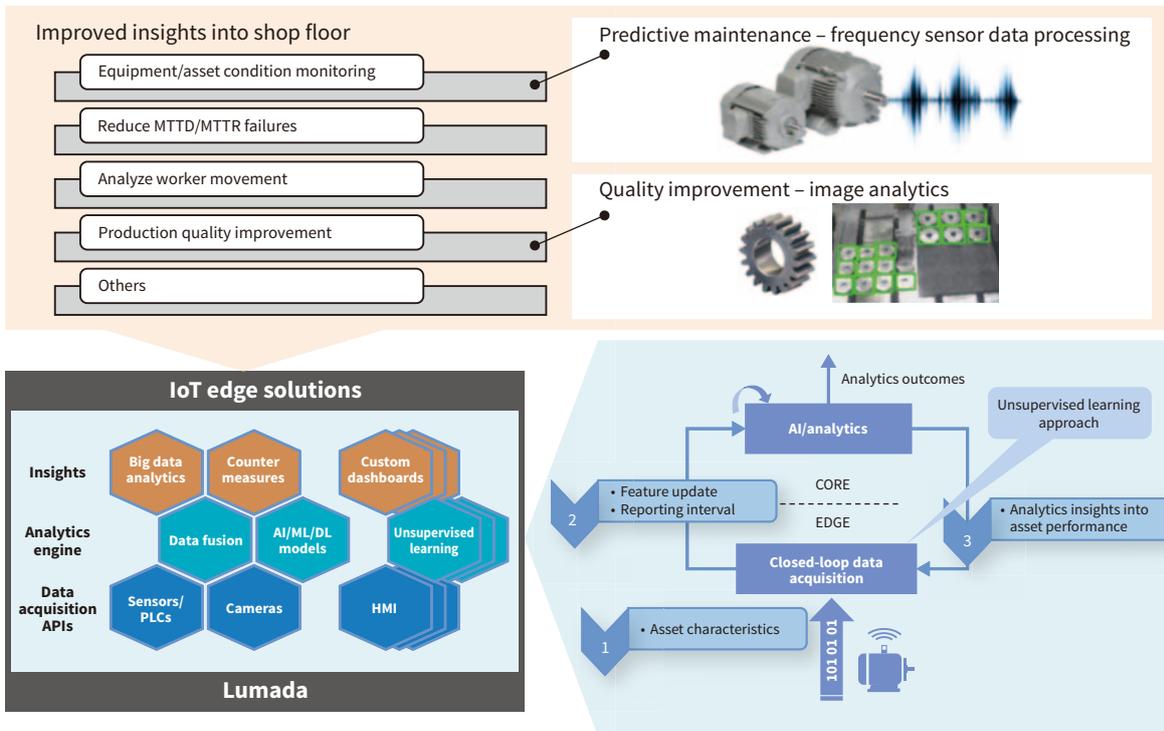
Greater consumer awareness of safety in foods and pharmaceuticals has led many countries to adopt more stringent regulation of cold chains. Hitachi has developed an ink that changes color irreversibly to indicate when the temperature of frozen or chilled goods has gone outside its permitted range, and also a manufacturing process for temperature-sensing labels that combine this ink with a product identification (ID) code.

The region around the temperature-sensing ink on the labels is printed with red, green, and blue reference colors that can be scanned with a smartphone camera to determine how much their color differs from that of the reference color. This design reduces variability in color difference measurement under a variety of different indoor and outdoor lighting conditions. When



GPS: Global Positioning System

6 Quality management solution using temperature-sensing labels



MTDD: mean time to detection MTTR: mean time to recovery ML: machine learning DL: deep learning API: application programming interface
 PLC: programmable logic controller HMI: human machine interface

7 IoT edge solution establishment approach and example solutions for shop floor

a label is scanned, the product status is determined from the temperature history information contained in the ink color and this is forwarded by the smartphone together with the product information embedded in the ID code and the scan time and location directly to a server or customer.

Hitachi is currently trialing the labels with companies in the food and pharmaceutical industries and is working on a commercial cold chain solution with a view to applications such as food freshness management and drug quality management.

co-exist with other solutions as well as a partner/vendor ecosystem. Regarding IoT edge solutions, they must be able to orchestrate analytics anywhere across the complete IoT data chain.

To establish this flexible and pluggable solution architecture, Hitachi has taken a soft-coupling and modular-function approach between data acquisition, edge processing, and cloud analytics. This architecture allows the company to deliver IoT edge solutions to customers very rapidly.
 (Hitachi America, Ltd.)

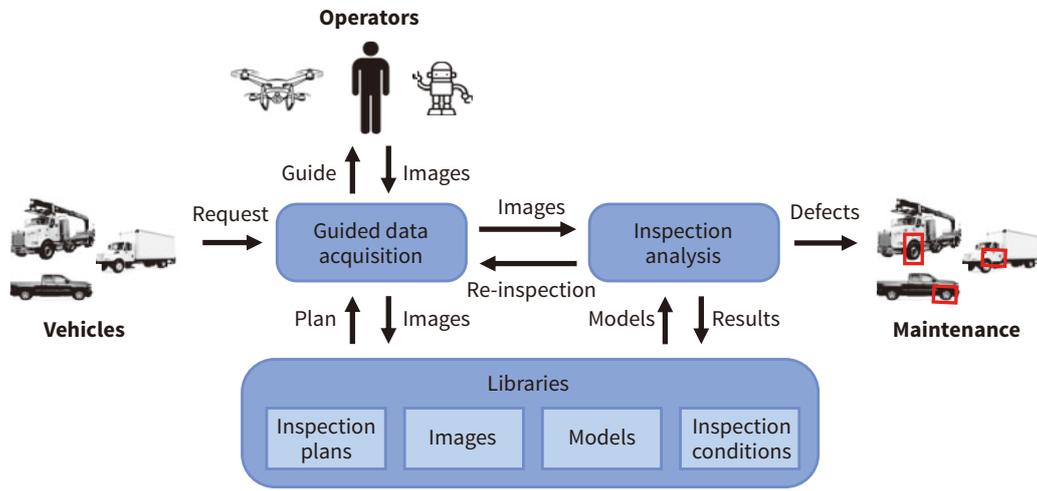
7 IoT Edge Solution for Shop Floor

Hitachi's co-creation approach works with an organization's domain experts to identify and implement IoT projects to generate customer-specific operational insights, which are then analyzed to address the most critical performance challenges and most relevant key performance indicators (KPIs). Because today's factories are composed of multitiered systems that include cloud, edge servers, monitoring devices, and a wide array of heterogeneous equipment, an IoT system should integrate with multiple technologies and

8 Improving Fleet Maintenance with AI-Based Visual Inspection

Trade, economy, and fleets are greatly impacted by asset status and management. Transportation of food, medicines, consumer goods, and industrial products all depend on the effective operation of fleets, which range from automotive vehicles to airplanes and container ships.

Over years of interactions with various customers and associated stakeholders, Hitachi has learned that a critical challenge in the transportation industry is to maintain the fleet assets in good condition to increase



8 Hitachi AI-based visual inspection framework

safety and avoid downtime. As such, it is crucial to proactively identify possible defects and reduce the impact of degradation in assets by an effective maintenance process. Inspection is a key practice to effectively find defects and streamline the maintenance process. Nevertheless, the inspection process requires appropriate data collection and the associated quality of assessment greatly impacts the efficiency of maintenance plans and of repair time and cost. In the current transportation industry, inspection is mostly a manual process where human operators visually inspect and identify defects in assets. Therefore, the current process can be improved by considering the shortage of skilled labor, subjectivity, and inconsistent procedures.

Consequently, Hitachi's Global Center for Social Innovation – North America is developing a visual inspection system in the transportation domain to address these challenges using AI, machine learning, and computer vision. Some of the key technologies powering the system are:

- (1) Inspection planning service: Automatic inspection planning to guide operators based on the type of inspection, type of asset, or detected defect.
- (2) Inspection library: A library of plans to enable consistent, automatic, and scalable inspection execution based on the type of inspection or type of asset.
- (3) Automated inspection: Enabling robots and drones to perform an inspection process based on the plan generated by the planning service.
- (4) Defect analysis: An AI-based analysis system for multi-level defect detection that enhances accuracy and reduces false positives.
- (5) Vehicle defect library: A library of images related to

assets of interest and their defects to enable identification and localization of defects based on AI techniques.

Hitachi is integrating these technologies into an end-to-end visual inspection system for defect detection with high accuracy along with a consistent and repeatable process. The system incorporates new technologies for systematic data collection via robotics, human operators, and fixed instrumented cameras as well as drones; uses AI to analyze and identify defects; and also integrates design thinking to convey the results of the system to decision makers.

Hitachi is working on integrating this system with its other fleet maintenance and repair solutions like an AI-based repair recommendation engine, part inventory, and an enterprise resource planning (ERP) system to develop an end-to-end inspection and repair service system.

(Hitachi America, Ltd.)

9 Developing Tools and Processes for Ethical Technology Design

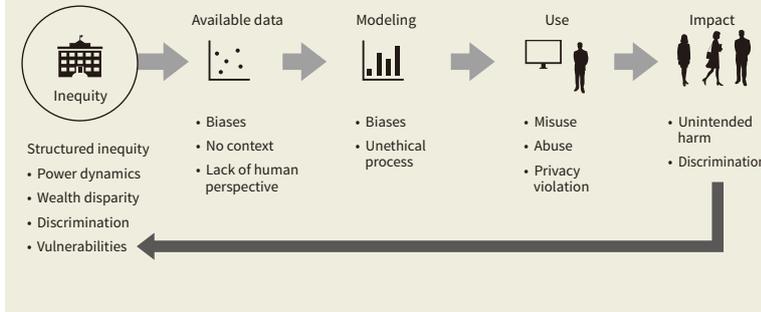
Ethics has gained traction as a critical element of innovation as scholars, policymakers, and the general public are increasingly concerned about the ethical pitfalls of data-based technologies. Understanding ethics in the context of innovation requires understanding of the impact of data beyond immediate operational needs. Customers rarely have complete and perfectly unbiased data; existing data are shaped by operational limits and human subjectivity, some of which are accidental, but others of which are firmly embedded in social

Quantitative data as inspiration for solution development



Letting data define the parameters of a solution can pose ethical risks, since social, human, and operational biases go unquestioned and are potentially replicated in the solution

Considering the entire life and impact of data



Understanding the entire life of data involves everything from knowing what colors data in the first place, all the way to considering possible use and misuse of technologies and harmful impacts

9 Thinking beyond data: considering the entire life and impact of data in the innovation process

structures. Therefore, focusing solely on quantitative data to guide solution development poses the risk of perpetuating or even exacerbating harmful biases. Systematically including the impact of people on data and data on people offers a humanizing perspective that can build ethical solutions.

The Design Laboratory in Hitachi America Research & Development is exploring ways to operationalize ethics in research and development, and is developing tools for ethical innovation. (Hitachi America, Ltd.)

10 Sustainable Finance Platform

It is a top priority for civil society and for public and private organizations to ensure that they are within sustainable development pathways. To achieve this, they need to accelerate finance to increase the deployment of environmentally sustainable activities. However, for the growth in innovative financial instruments such as green loans, green bonds, and sustainability-linked loans, evidence is needed to prove that projects being financed have measurable



10 Illustration of sustainable finance platform

and comparable metrics about their environmental and social contribution.

Hitachi aims to address this need by bringing its experience in the decarbonization of energy and transportation to the field of finance, thereby facilitating the visibility and verification of outcomes. The sustainable finance platform is driven to solve societal issues using multiple digital technologies such as IoT, blockchain, and AI. Moreover, by including functions for highly transparent monitoring, the identification of market opportunities, and data analysis, the aim is to establish an ecosystem that is a win-win for everyone involved in financial markets, also delivering regulatory compliance and data insights.

The key value propositions include efficient reporting, enhanced decision-making, transparency and security, and aggregation of projects.

operations of the machines and create the potential for operational efficiencies, many companies have been collecting and storing these data in the hope that one day they would be able to use such data to revolutionize their operation, improve efficiency, and cut costs.

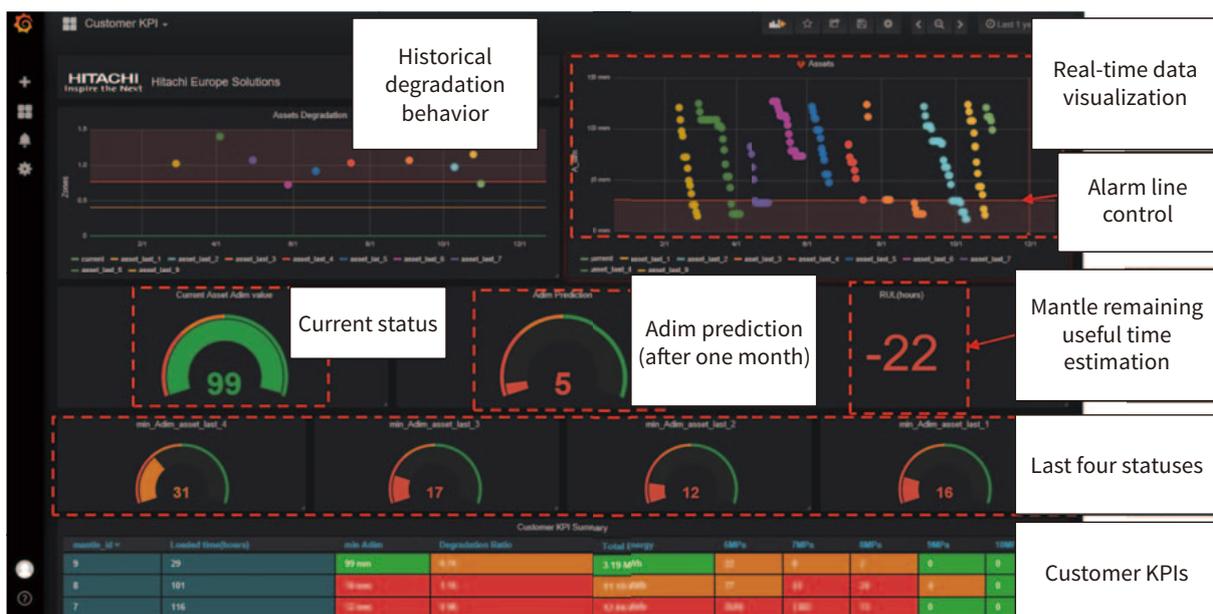
Hitachi is working alongside its customers to harness these data, create useful insights, and recommend actions for efficient operations, leading to cost savings and quality services or products. Over the years, the company has embarked on what it calls data-driven customer co-creation. This involves creating data-driven solutions and services together with its customers as one team by first understanding what the customer needs are using Hitachi's NEXPERINCE tools, understanding the data with the aid of domain experts, building advanced models (using machine learning and AI), and continuously refining these models based on customer feedback.

Currently Hitachi supports customers from various domains, from automotive to marine, from road transportation to rail, from pharmaceuticals to chip makers, and so on. Its co-creation use-cases focus on:

- (1) Predictive maintenance and remaining useful life (RUL) estimation
- (2) Operational efficiency
- (3) Anomaly detection and prediction
- (4) Recommendation engines for efficient and safe operations.

11 Data-driven Co-creation Projects with Customers

It is no longer up for debate that the data generated by machines will surpass that generated by humans in terms of accuracy and quantity. However, a new challenge arises, namely, how to manage and harness the enormous amount of data generated by these (connected) machines. Knowing that data generated by these machines might contain insights into the



11 RUL prediction for cone crushers



12 Signing ceremony for Tsinghua-Hitachi Future-oriented Collaborative Innovation Scheme

12 Collaboration with Universities on Resolving Societal Challenges: Tsinghua-Hitachi Future-oriented Collaborative Innovation Scheme to Create a Super-smart Society in China

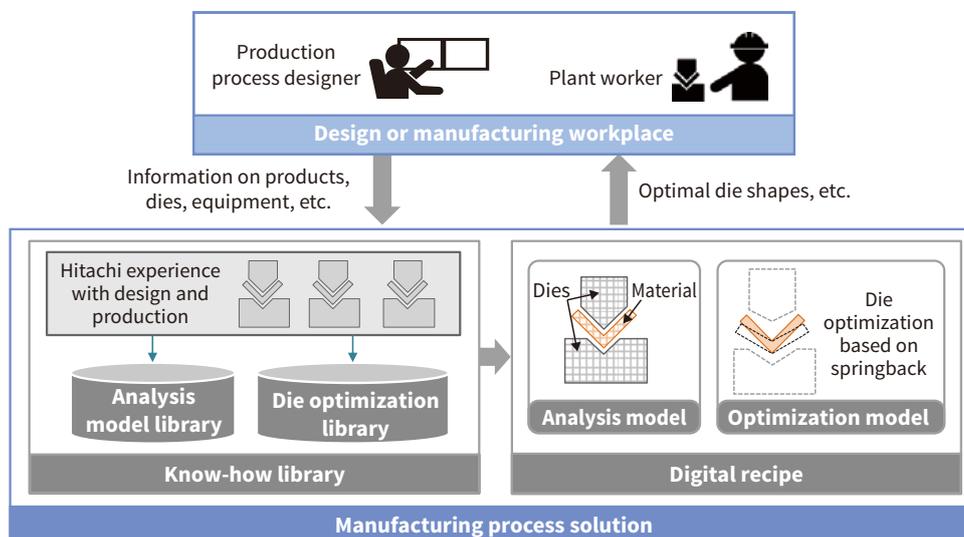
Factors such as the progress of globalization and people's changing values have transformed the knowledge and value creation processes and are bringing rapid change to the nature of the economy and wider society as well as the structure of industry. As this transformation goes on, academic collaborations by Hitachi go beyond joint research into advanced technologies and also encompass acting as an innovation partner on initiatives such as developing visions for the society of the future and using societal challenges as a starting point for value creation.

In November 2018, Hitachi signed a strategic partnership agreement with Tsinghua University of China on a Future-oriented Collaborative Innovation Scheme

to Create a Super-smart Society in China. Work on the plan commenced in April 2019. The collaboration aims to utilize the technologies and resources of the partners in fields such as the digitalization of cities and in healthcare, energy, and mobility, and to work toward achieving practical results by issuing policy proposals based on the vision, developing technology, conducting field trials, and other such initiatives. Hitachi also intends to develop its Social Innovation Business and to contribute to the sustainable development of Chinese society and a better quality of life (QoL) for people.

13 Digital Recipe-based Manufacturing Process Solution for Chinese Market

Hitachi has launched a solution for supporting the production activities of manufacturers using digital recipes that encapsulate know-how in press forming and other fabrication techniques. While customers use



13 Digital recipe-based manufacturing process solution

press forming analysis as part of the process of designing die shapes, being new to the field and having high staff turnover, many companies in China have failed to build up a depth of expertise in analysis and design, resulting in a lack of analytical accuracy and numerous iterations of die shape correction.

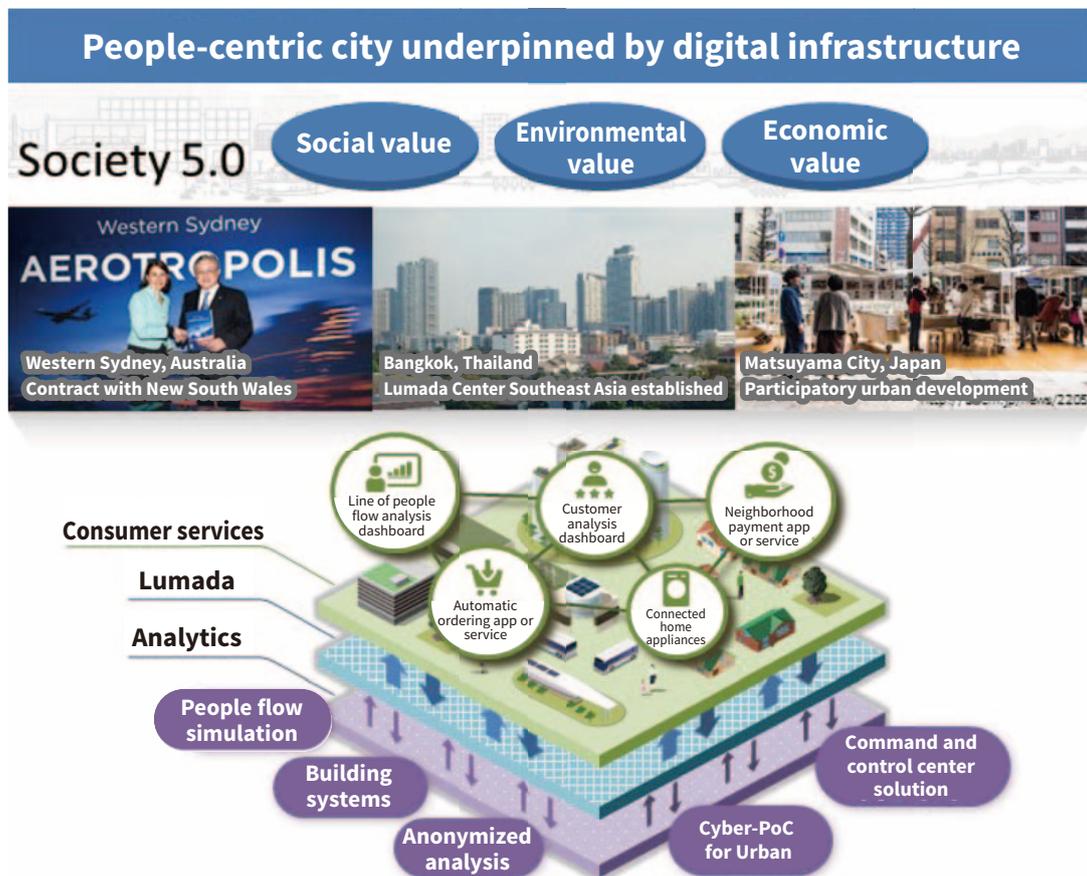
Hitachi has produced a library of expertise by extracting patterns of functions and settings from its past experience with developing analysis and optimization models. By combining these to create suitable models, digital recipes for press forming have been developed in a way that can optimize die shapes by accurately predicting springback, a problematic aspect of die design. By using these digital recipes to provide optimal die shapes based on the customer's products, dies, and equipment information, this creates value for customers by reducing rework (the number of die corrections needed), thereby shortening the lead time for die production.

A trial of the recipes currently being undertaken at a major Chinese car parts supplier is demonstrating their potential for improving analysis accuracy and shortening lead times.

14 Approach toward Creating Digital Smart Cities

Rapid urbanization poses problems for society such as traffic congestion, air pollution, and increased energy consumption. Hitachi, meanwhile, has focused on value for city dwellers as the starting point to consider urban design, and is seeking to create people-centric cities by collecting and analyzing data on cities and their residents, taking a data-driven approach to improve urban planning and operation.

One example is the demonstration project for “data-driven urban planning” taking place in Matsuyama City in Ehime Prefecture. It is part of the work being done by the Habitat Innovation project of the H-UTokyo Laboratory, and is utilizing techniques for measuring people flow. Elsewhere, the Research and Development Center of Hitachi Asia Ltd., with funding from the Singaporean government, has since February 2019 been developing a smart building/digital twin solution. It uses the IoT and AI, and is adapted to building dynamism in the form of spatial functions, user activity, and individual comfort.



14 Concept of a people-centric city

By utilizing data analytics and open collaborative creation with residents to identify changes in their senses of value, and using the latest technologies incorporated into Lumada, Hitachi intends to form a city where people love to live, by continuously providing services to offer new value to people in accordance with the changing times.

15 Digital Payment Analytics Service in India

Digital payment is growing rapidly in India due to the spread of the Internet and smartphones coupled with various government initiatives aimed at realizing an economy that makes less use of cash. Since 2014, the Indian government has been pursuing an open API policy called IndiaStack that allows businesses, start-ups, and developers to utilize digital infrastructure such as electric know your customer (e-KYC)^{*1} and unified payments interface (UPI)^{*2}. This kind of government policy accelerates the adoption by merchants, including small businesses, of digital payment channels, and this is further pushed forward by consistently reducing service charges for the use of digital payment channels by banks.

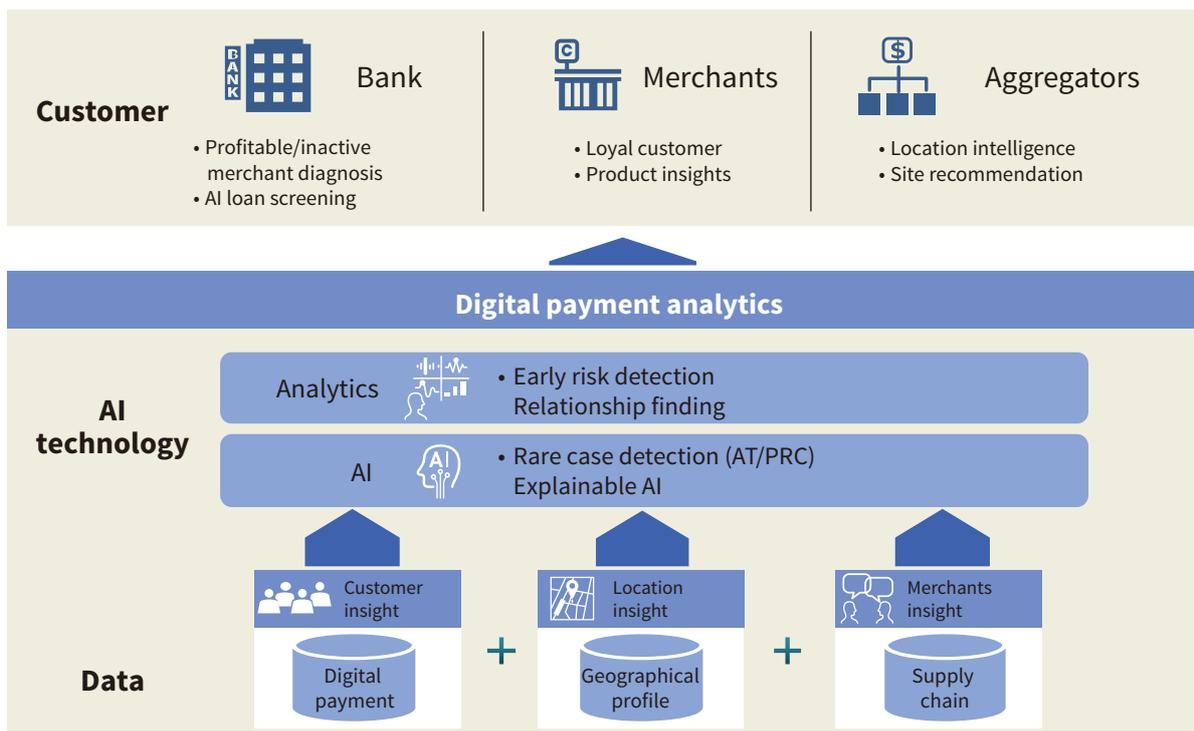
In 2019, Hitachi established a joint venture for merchant acquisition and digital payment with the State

Bank of India (SBI). Through co-creation with SBI, Hitachi is developing a merchant-centric digital payment analytics service that leverages huge amounts of dynamic digital transaction data. From digital transaction data and other associated data sources, this service extracts insights about customer, location, and merchant in real-time and analyzes customer/merchant relationships. It also predicts various risks faced by merchants using Hitachi AI Technology/Prediction of Rare Case (AT/PRC), including giving possible reasons for its predictions. Using this, Hitachi supports the following value-added use cases:

- (1) Bank: Profitable/inactive merchant diagnosis, AI based short-term loan screening
- (2) Merchants: Loyal customer marketing, product insights
- (3) Merchant aggregators: Location intelligence and support for faster merchant network expansion

Hitachi will collaboratively work with SBI to create advanced services to accelerate the adoption of digital payments and facilitate the sustainable growth of the bank and merchants.

*1 Online identity verification needed for opening a bank account or similar
 *2 A next-generation online payment system developed by the National Payments Corporation of India



15 Digital payment analytics service

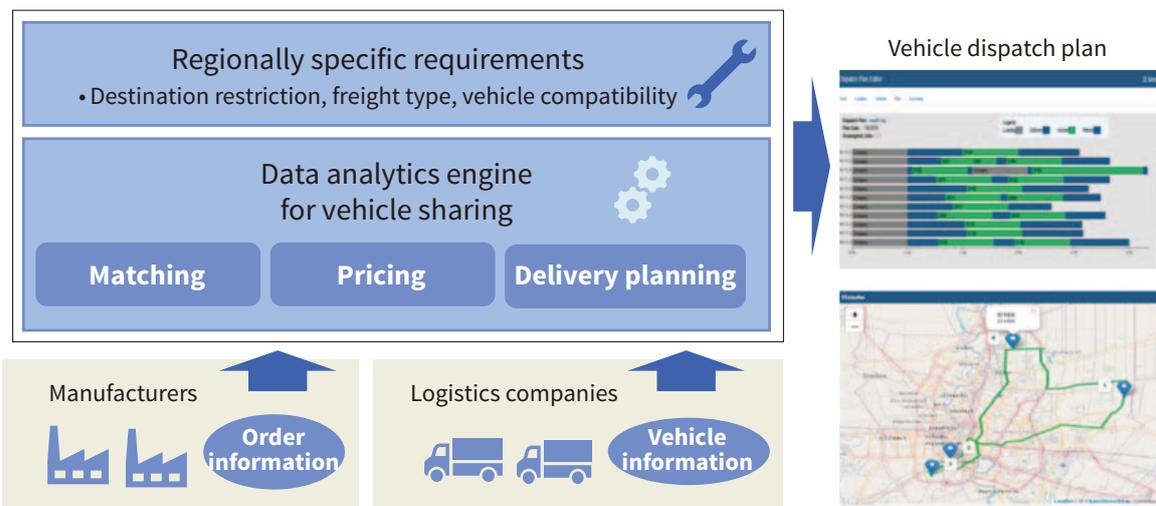
16 Logistics Transport Optimization Solution

The soaring economy of Southeast Asia is driving needs for logistics transportation with on-time delivery and reduced delivery cost. To address these needs, Hitachi Asia, Ltd. is partnering with Hitachi Transport System Vantec (Thailand), Ltd. to offer services for delivery planning optimization and vehicle sharing.

In rolling out these services, a data analytics engine was developed to automatically match the requirements of every delivery order to vehicle attributes. It optimizes

dispatch plans by reducing delivery cost within a minimal amount of planning time. Further, the collaborative effort from the partnership enables the creation of tailor-made functions that cater to regionally specific requirements such as handling vehicle compatibility, destination, and freight constraints. It allows delivery of break bulk or container cargoes by sharing vehicle assets among affiliated logistics companies.

Overall, these services minimize the number of delivery vehicles and optimize delivery routes, thereby reducing fuel consumption and delivery cost while guaranteeing on-time delivery.



16 Illustration of logistics transport optimization solution