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HITACHI
Inspire the Next

Expansion of Service Business through Collaborative Creation with Customers

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Hitachi Review
Volume 65 Number 2 March 2016

From the Editor

Has there ever been a time when the business environment was subject to such severe change? Advances in information and other technologies lead to the creation of new businesses, and these businesses in their turn give rise to new requirements for technology. The accelerated change brought about by this spiral is a feature of the current business environment.

If companies are to survive in such an environment, they need to adapt their businesses to its requirements. Adapting their businesses does not mean changing the products they sell or changing who they sell to. Rather it means rebuilding their fields of business and their alliances, while also dealing with ever-changing business value and new technology.

Hitachi's goal is to be the best partner for businesses that want to evolve. Hitachi intends to work with customers to open up new areas of business through a suitable combination of its new technologies. Through this partnership with customers, Hitachi's vision is to create a safe and secure society with advanced IT. We call this our Social Innovation Business.

In April 2015, Hitachi reorganized its Research & Development Group, which had been focusing on technology up until then, in order to accelerate the pace of Social Innovation. This reorganization included establishing a new division (the Global Center for Social Innovation) within our research laboratories to take responsibility for utilizing advanced technology to develop service businesses through collaborative creation with customers.

This issue of *Hitachi Review* presents articles about service collaborative creation at Hitachi, focusing on the activities of this new organization. What is distinctive about the organization is that it brings designers and research engineers together in the same division, an initiative with few parallels anywhere else in the world.

Designers are traditionally good at coming up with ideas that are inspired by users rather than by technology. They are also skilled at presenting intangible value and services in visual form. These capabilities come to the fore in reaching consensus with customers. Research engineers then find ways to implement these based on their knowledge of advanced technology.

The first part of this issue presents tools and methods for service collaborative creation that are based on design thinking. In these articles, I hope you will find a new Hitachi that differs from the traditional ways of doing things.

The latter part of this issue presents examples of collaborative creation with customers from both Japan and overseas. The Japanese examples deal with urban development, telecommunications, and logistics, while those from overseas describe work in China and North America.

I hope that this issue will be a chance to learn more about how Hitachi goes about collaborative creation in its role as the best partner for our customers.

Editorial Coordinator,
"Expansion of Service Business through Collaborative Creation with Customers"

Norihiro Suzuki
General Manager (as of March, 2016)
Global Center for Social Innovation
Research & Development Group, Hitachi, Ltd.

Expansion of Service Business through Collaborative Creation with Customers

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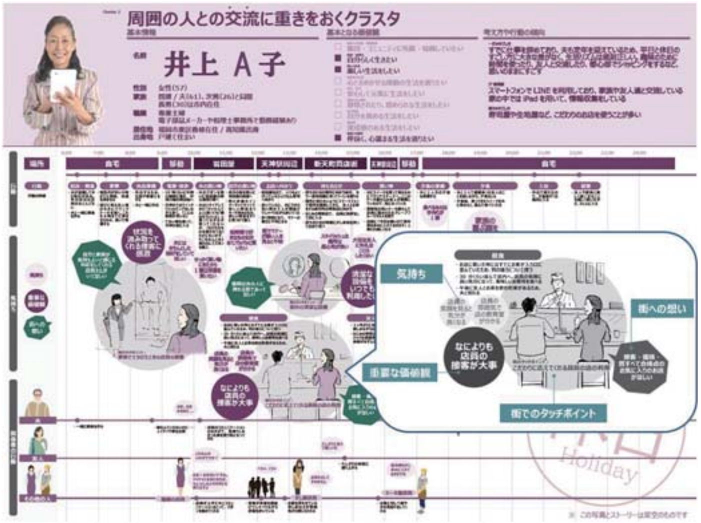
Collaborative Creation Space opened in Akasaka (in Minato-ku, Tokyo)
(photograph: Masaya Yoshimura)

Expansion of Service Business through Collaborative Creation with Customers

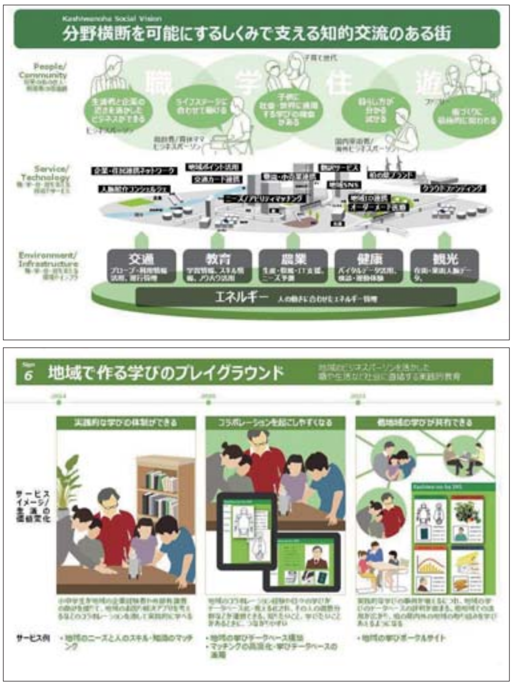
Numerous technological innovations such as artificial intelligence are being created against a backdrop of a rising global population, urbanization in emerging nations, and aging in the developed world.
Collaborative creation with customers and various other business partners is the key to the accurate interpretation of these global megatrends so that companies can rebuild their business ecosystems to achieve steady growth and overcome societal challenges.
Hitachi has reorganized its research and development organization with the aim of using collaborative creation to strengthen its Social Innovation Business.
Hitachi is seeking to create new value that can help overcome the challenges of global society, with the newly created Global Center for Social Innovation having a central role in formalizing tools and other methods for collaborative creation, and making the most of the extensive technology platforms available within Hitachi.

Example screen of NEXPERIENCE / Cyber-Proof of Concept, a tool for simulating business value



Example use of the customer journey map, part of the service design method

Human big data: ID card type wearable sensor for collecting data



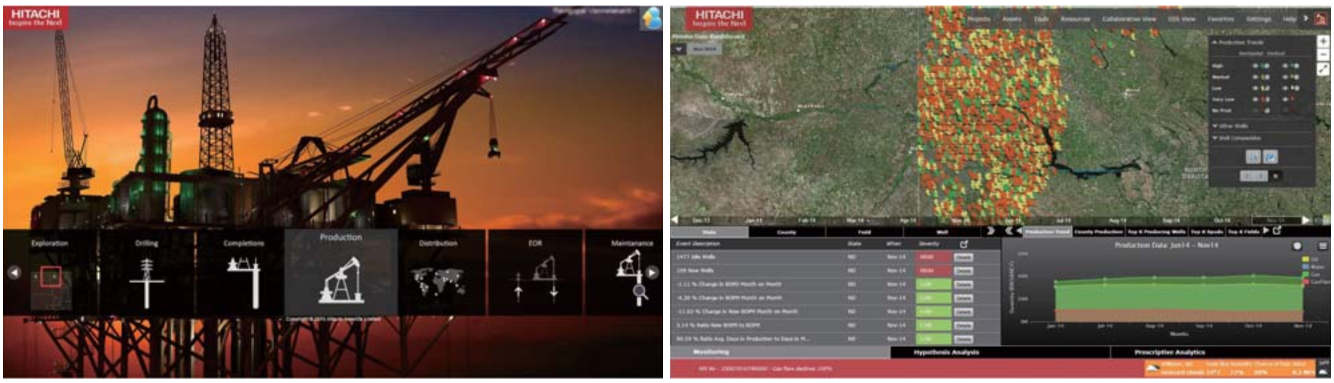
Example investigation of the ideal image of a city in the future using service design and vision design

Proposed “universal design city” in which everyone can live an active life (designer’s illustration)

Use of template-based public biometric infrastructure in campus information system

Ethnographic research and workshop conducted for improving operations at a logistics warehouse

Smart branch solution for Chinese banks (image included)



Screens from the production features assessment application, part of an oil and gas analytics solution for North America

Expert Insights

Achieving Co-creation of Value

Tamio Arai, Dr. Eng.

Professor, Center for Promotion of Educational Innovation,
Shibaura Institute of Technology

Graduated Department of Precision Machinery Engineering, The University of Tokyo in 1970 and was awarded a doctorate in engineering from the same university in 1977. Worked as a researcher at the Department of Artificial Intelligence at The University of Edinburgh in 1979.
Appointed Professor, School of Engineering, Department of Precision Engineering, The University of Tokyo in 1987. Appointed Professor, College of Engineering, Shibaura Institute of Technology and Professor Emeritus, The University of Tokyo in 2012.
He is currently President of the Society for Serviceology and Vice President of International Research Institute for Nuclear Decommissioning. Past appointments include President of The Japan Society for Precision Engineering.
He is engaged in making advances in the fields of service science and service engineering. His research interests include automatic assembly, the coordination of mobile robots, and artifact engineering. His awards include a best article award from The Japan Society for Precision Engineering and several IMS awards.

The understanding of customer (service user) behavior is frustrated these days by the fact that customers hold such diverse values. This makes it important to have users participate in the provision of services so that value can be generated through cooperation between providers and users. This process is called the “co-creation of value.” This issue of *Hitachi Review* uses the term “collaborative creation,” however the term “co-creation” is used by most researchers in the field of service science, so that term will be used in this article.

If you look up “co-creation of value,” you will find a number of similar but different definitions. In “Service-Dominant Logic” by Vargo and Lusch, it is thought of as creating value by having users activate proposals from providers. Prahalad and Ramaswamy, meanwhile, bring up the concept of “co-creation value.” I model services as an interaction between providers and users, with both parties having dual roles as “prosumers,” to use the term coined by Alvin Toffler. In this case, the co-creation of value comes about from the different values of each party.

This raises the question of what form this value takes. While there is a strong case for a win-win relationship between stakeholders falling into the category of value co-creation, my view is to treat co-creation as a form of emergence defined in a complex system, with a tendency to look for situations in which characteristics that exceed the simple sum of the characteristics of each part emerge from the relationships between them.

Accordingly, while the concept of value co-creation does not necessarily have an accepted definition, it is possible to see how the concept has become important.

Having accepted the importance of value co-creation, how do we go about achieving it? I believe that there are two requirements for establishing the process of value co-creation: (1) Very frequent interaction between providers and users, and (2) Having users assess the services provided and add new elements. The process of value co-creation can also be expedited by, (3) Collecting the experiences of both providers and users and then utilizing them when subsequent opportunities arise. Here, providers and users are considered both individually and in multiple combinations.

In this way, service providers can improve customer satisfaction by understanding the behavior of users and coming up with effective new ideas. Users, meanwhile, can gain greater value from services, resulting in the creation of a win-win relationship. In some cases, it is possible to discover value from new perspectives.

In practice, however, users are unable themselves to say how satisfied they are with what is provided or to provide clear explanations of their reasons, with users frequently unaware of how to explain the background factors (context). Accordingly, user participation is encouraged, increasing user awareness through frequent interactions. Common practices for understanding user behavior include the use of ethnographic methods on small numbers of users and the use of big data analytics on large numbers of users. Both are ways of making discoveries, and while the knowledge gained is important, a key topic of study at universities is the discovery of common ways of thinking.

This issue of *Hitachi Review* covers the technologies of value co-creation in actual businesses, including examples. The uncovering of practical knowledge by companies and its formalization into theories by universities is another form of co-creation we have to look forward to.

Technotalk

Enhancing Service Businesses by Design

Masanao Takeyama, Ph.D. Professor, Faculty of Economics, Keio University
Masahiko Hasegawa General Manager, Service Business Incubation Division, Social Innovation Business Promotion Division, Hitachi, Ltd.
Kaori Kashimura General Manager, Global Center for Social Innovation – Tokyo, Research & Development Group, Hitachi, Ltd.

The challenges facing both companies and wider society are becoming more complex, encompassing rapid changes in the structure of society, globalization, and the problems of resources and the environment. Along with the need to move away from past growth scenarios, Hitachi is strengthening its Social Innovation Business through collaborative creation, meaning the sharing of challenges with its customers and other partners and working with them to develop solutions. Utilizing its portfolio of technologies built up through past experience, Hitachi intends to help overcome the challenges facing companies and societies by developing innovative solutions as well as by using its own service design methods to create and expand service businesses.

Fusion of Design and Business

Takeyama: My research field of service design is a new area of study that has been attracting attention in Japan recently. As society matures, the bulk of value generated by economic activity is shifting away from goods and toward the services that accompany the provision of goods. This creates a need for service systems that generate new value in the relationships between goods and people. Service design emerged, primarily in Europe, as a way of achieving this.

In recent times, the scope of service design has expanded beyond service interactions to include the nature of the business itself and the organization, extending as far as the organizational culture. One likely background factor to all this is that a growing uncertainty about the future direction of the global economy and other aspects of society has led to greater recognition of the potential for design techniques that seek answers through a repeated process of prototyping. This expanding scope of service design is bringing with it major changes in the roles played in business by design and designers. Rather than jumping straight to a conclusion, it has become more common to work creatively with users or to help users create their own designs.

At Hitachi, meanwhile, "collaborative creation" has been a key concept behind your Social Innovation Business, and I understand you are seeking to build up your service businesses. How are you dealing with the major changes taking place in business and design?

Kashimura: While design at Hitachi used to focus on product design for such things as home appliances and digital signage. Then, we naturally expanded our focus to human-centered design, experience design, and now to service design. As you mentioned, the role of corporate designers has changed. They are now expected to have facilitation skills and knowledge of technologies and business models. With this background, Hitachi reorganized its research and development group in April, 2015. We established a new organization called the Global Center for Social Innovation, where the designers and the IT researchers are working together to create innovative solutions on the front line of collaborative creation with customers.

Hasegawa: We are also aware of major changes in the business workplace. In the past, along with systems and other products, we have also supplied customers with services, the form of which was decided in advance. In our Social Innovation Business, however, which creates new value through collaborative creation with customers, we work with customers from the design stage, both for services themselves and the value able to be provided by these services. There are also examples from within Hitachi itself in which service operation and design staff work together from the business design stage, such as an energy management service for a block of office buildings in which experience design techniques were adopted for the development of information services that make it easy for the people who work in or visit the buildings to see how they use energy.

Takeyama: Internationally, too, putting the capabilities of design to use in service businesses is emerging as a rising trend. In fact, my teaching at the Faculty of Economics is also service design. The fusion of design and service businesses will likely expand further in the future. It is worthy of note that Hitachi has preemptively reorganized itself for just this reason.

Clarification of Issues

Takeyama: The service design process is primarily made up of: (1) Clarification of issues through consultation with users or the identification of their latent challenges and other needs, (2) Use of the potential for new value as a basis for devising ideas and a business model, (3) Testing of prototypes, and (4) Launching the commercial business. While the focus in design tends to be on how to put things together, I believe that ideas for innovation are to be found prior to that step in the process of determining the true nature of the challenges faced by the users. In the issues, in other words. However, when you set out to investigate new problems in actual collaborative creation with customers, do you find things like defining and sharing the issues to be difficult?
Kashimura: They surely are difficult. The management problems are not necessarily clear to the customers themselves. The important thing is to reveal these problems through dialogues with customers. A designer's approach would be helpful here. For example, we have a design method for envisioning future images as well as business opportunities. It is done by identifying changes in people's values and social trends. We have been applying this method to various countries and areas. Our intention is to discover new issues by disrupting the customer's ideas of future service, which often are developed as extensions of the existing systems, with our future images.
Hasegawa: Looked at in business terms, it is also important to consider how much the management challenges faced by one particular customer have in common with those of other customers. Being a business, we need to think about things like cost and profitability, and this makes it essential that we seek to leverage our solutions. I believe that both customization and standardization will be key considerations in the future expansion of service businesses.

Service Platforms Based on Symbiotic Autonomous Decentralized Systems Concept

Takeyama: Going from identification of the issues to idea creation is the phase that calls for creativity. Hitachi has led the world in devising unique methods for generating ideas such as your customer journey map and other service design techniques.
Kashimura: Hitachi's unique tool related to the customer journey map came out of the idea that a service can be designed by visualizing the interactions among stakeholders and the way their emotions change on a timeline. The customer journey map has become a common tool today. However, our tool has been developed through a process of trial and error from a time when such a map was not available. Moreover, our tool was developed through actual applications rather than from a theoretical concept. So we are confident about our excellent capability in conducting and applying this tool.
Takeyama: Advances in technology often serve as a trigger for coming up with new ideas. In relation to service design, it is recognized that genuine progress is being made on the true integration of products and services that deliver these services on an as-required basis, using technologies such as the Internet of things (IoT) to keep track of users in realtime. How do you view this development?
Hasegawa: With a portfolio that includes both control technologies for operating equipment and information and telecommunication technologies, Hitachi can be seen as having the wherewithal for implementing the

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IoT. Given this strength, a key consideration for service business enhancement is the symbiotic autonomous decentralized systems concept. A further development of the autonomous decentralized systems concept used by Hitachi as the basis for the implementation of a railway traffic management system for the Tokyo metropolitan area, the symbiotic autonomous decentralized systems technology concept involves creating an environment that facilitates system-wide optimization by having systems of different types interoperate in a symbiotic manner while still operating autonomously.

The value provided by service businesses and the types of service they deliver change in the course of their operation. Rather than being built once and never modified, the systems and other platforms that underpin these services need to be designed on the assumption of ongoing change, growth, and expansion. Platforms that incorporate the symbiotic autonomous decentralized systems concept are intended to serve as common platforms, providing an environment that facilitates the implementation and mashup of services by customers.

Takeyama: We are entering a world in which various services are tied together by IoT, and in which it is no longer possible to know at the development stage what form products or services will ultimately take. This is a world where I see great potential for the symbiotic autonomous decentralized systems concept, which is based on growing as an ecosystem.

Hasegawa: In that regard, I believe that, even at the level of companies and other organizations, creating a world based on the symbiotic autonomous decentralized systems concept will lead to the fusion of social systems that include goods and information technology (IT).

Use of Simulation for Trials

Takeyama: The idea of prototyping upcoming processes is a concept unique to the field of design. Unfortunately, with service design it is frequently difficult to measure the success of trials quantitatively, with the prototyping of something on such a large scale as social infrastructure being likewise difficult. How do you cope with this?

Kashimura: Hitachi has been developing many simulation technologies in various industries. We are also working on the development of interactive tools by combining those technologies to simulate the impact of services, which are provided with Hitachi's systems. Our aim is to be able to use simulations to obtain a certain assessment before actual application in projects for which it is difficult to investigate a scheme for the highest return on investment (ROI), for instance, building new rail lines in emerging markets.

Takeyama: So far we have gone over the process of service design, but once it is up and running what is important is the organization. Even when we consider how attractive we can make the user's experience, unless the organization and systems needed to implement the concept in practice are put in place, this takes us no further than painting a picture. In other words, we can speak of organizational design as being at the core of service design.

Hasegawa: This is an issue that we too have come up against. We identify the elements required by service businesses established through collaborative creation at an early stage and make an effort to build an organization that fosters people while building up know-how.

Expectations for Use of Data Science

Takeyama: When thinking about design, the human factor cannot be ignored. Energy efficiency or healthcare services, for example, where there is a need for user behavior to shift in directions desired by society without coercion, call for an approach to service design that

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Joined Hitachi, Ltd. in 1987. Prior to being appointed to his current position in 2015, his previous appointments include Department Manager, Department 1, Financial Information Systems Sales Management Division and Deputy General Manager, Kyushu Area Operation.

Kaori Kashimura

General Manager, Global Center for Social Innovation – Tokyo, Research & Development Group, Hitachi, Ltd.

She is currently engaged in the use of user research for studying product and service usability and experience improvement. Prior to being appointed to her current position in 2015, her previous appointments include General Manager, Design Division.
Ms. Kashimura is a member of The Japanese Psychological Association, the Japanese Cognitive Science Society, and the Japanese Society for Cognitive Psychology.

encourages changes to people's behavior. In this context, the fusion of behavioral science and service design has attracted attention in recent times. To create a sustainable society, I believe we need service design capabilities that are accompanied by an understanding of people and knowledge of psychology.

Kashimura: That's right. Just as the fusion of cognitive psychology and design has contributed to improving usability in digital devices, innovative design technologies based on a deep understanding of human behaviors are required in social infrastructure, where a large number of people are involved in various activities. We are taking on the topic of service design as it is an important part of our business.

Hasegawa: The use of data science is another key to service businesses for social infrastructure. Hitachi already has experience with the use of big data, including systems for things like remote monitoring and predictive maintenance that collect large quantities of data from the industrial machinery that supports social infrastructure. Hitachi was also among the first to make use of human big data, including systems that utilize the measurement and analysis of people's movements for such applications as marketing and city operations, or systems that measure people's behavior at an organization and use it to improve results. Our aim is to contribute to Social Innovation by expanding the scope of new service businesses that utilize this big data.

Takeyama: Data science is clearly set to become an important technology for future service design. I also see potential for the creation of services or the development of service design techniques that use actual data as evidence and are based on new understandings of people's behavior.

Kashimura: Hitachi is accelerating the development of artificial intelligence and its applications in the business domain. We will apply qualified design to Social Innovation while utilizing such advanced technology to be a leader in driving innovation. Thank you for your time today.

Overview

Service Businesses Based on Collaborative Creation

Chiaki Hirai, Ph.D.
Jun Furuya

REBUILDING BUSINESS ECOSYSTEMS

COMPETITION between companies in the information technology (IT) industry over recent years now extends beyond simply competing on value delivered, shifting instead toward companies competing to redefine the ecosystems in which their businesses operate(1). The companies that succeed globally are those that rebuild their business ecosystem through new businesses that extend beyond areas where they have been active in the past, securing themselves a position in these sectors from which they can maintain steady growth. The value they deliver in doing so takes the form not of the products themselves, but of the platforms that serve as the core of the business ecosystem and the services that are based on them. These developments provide the background against which manufacturing is becoming increasingly service-oriented(2), (3).

These changes can be thought of as a consequence of industry boundaries becoming less well defined due to rapid advances in IT, with the rebuilding of ecosystems arising from places that would not have been considered in the past. For example, nobody in the past could have imagined a retailer becoming a major player in the field of cloud computer services. Companies that only consider their current areas of business and traditional competitors are at risk of being left out in the cold by a rearrangement of their ecosystem arising unexpectedly.

The keys to corporate survival in such an environment lie in deciding who to collaborate with on collaborative creation of new businesses and whether to build a business ecosystem. What is needed are collaborative creation partners with dependable practical technologies with whom the business can share challenges and a vision for the future.

The aim of Social Innovation as pursued by Hitachi is to be the best collaborative creation partner in this sense of the term. Hitachi brings together its technologies in suitable combinations to supply solutions and grow in tandem with customers.

One such initiative aimed at accelerating Social Innovation was the reorganization by Hitachi of its research and development division in April 2015(4).

Its three research laboratories and Design Division in Japan, and its overseas research and development (R&D) centers, were restructured into three new organizations: the Global Center for Social Innovation, the Center for Technology Innovation, and the Center for Exploratory Research.

The purpose of the new Global Center for Social Innovation(5) is to increase contact between Hitachi and its corporate customers, and to work alongside customers to share information about the challenges they face and devise solutions.

This issue of *Hitachi Review* focuses on the activities of the Global Center for Social Innovation and profiles Hitachi's involvement in new businesses and services being undertaken through collaborative creation with its customers.

ORGANIZATIONAL STRUCTURE OF GLOBAL CENTER FOR SOCIAL INNOVATION

Adopting a global perspective is an essential part of Hitachi's Social Innovation Business. More than a few customer challenges and solutions transcend geographic boundaries. Furthermore, because the reorganization of business ecosystems is not limited to a single country or region, it is essential to pay attention to competitors around the world. Moreover, local operations are needed when entering overseas markets alongside customers.

With reference to these background factors, the Global Center for Social Innovation operates at four sites in different parts of the world: The Global Center for Social Innovation – Tokyo (which covers Japan and the Asia-Pacific region), Global Center for Social Innovation – North America, Global Center for Social Innovation – China, and Global Center for Social Innovation – Europe (which covers Europe, the

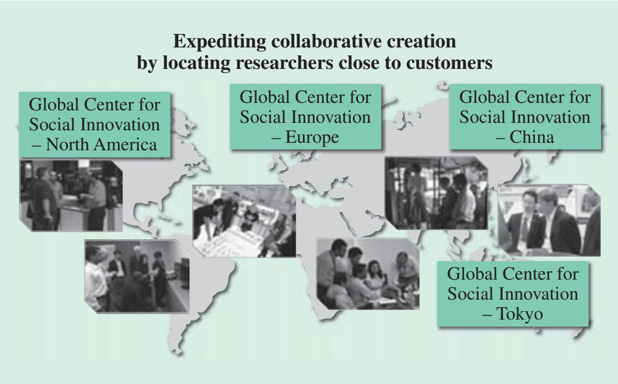

Fig. 1—Global Center for Social Innovation.
The Global Center for Social Innovation operates at four sites: The Global Center for Social Innovation – Tokyo (which covers Japan and the Asia-Pacific region), Global Center for Social Innovation – North America, Global Center for Social Innovation – China, and Global Center for Social Innovation – Europe (which covers Europe, the Middle East, and Africa). It employs approximately 500 research staff.

Middle East, and Africa). It employs approximately 500 research staff (see Fig. 1).

The following chapter details the Global Center for Social Innovation – Tokyo based in Tokyo, which has a unique organization that includes designers and IT engineers.

The other centers outside Japan, meanwhile, treat customers as a starting point for implementing their respective regional strategies.

The Global Center for Social Innovation – North America already has experience with the development of platforms for big data analytics, with its Big Data Lab established in 2013 playing a central role. In 2015, it went on to acquire Pentaho Corporation, a leading company in the data analytics field. In addition to using Pentaho's technology to augment its big data analytics platforms, it added more than 1,200 customer channels spread across more than 180 countries. It aims to expand its operation into new fields, such as network analysis solutions for the communications industry or production optimization solutions for the oil and gas industry.

The Global Center for Social Innovation – China engages in business development using as a foothold successful Hitachi products that have gained a presence in the Chinese market. One example is the deployment of the smart cash stream solution[a] to automated teller machines (ATMs). This solution improves the efficiency and rigor of cash handling. It is also developing urban and building solutions ("New Town" policy) based on its escalator and elevator business by working with the National Development and Reform Commission (NDRC) and engaging in collaborative creation with developers, city authorities, and others.

The Global Center for Social Innovation – Europe works on overcoming the challenges facing mature societies. It is engaged in the collaborative creation of the super hospital concept for making a 25% improvement in the efficiency of hospital administration in an aging population, smart energy systems that help achieve the environmental targets of the European Union (EU), and solutions for railway maintenance systems that deal with aging infrastructure.

ROLE OF GLOBAL CENTER FOR SOCIAL INNOVATION – TOKYO

This is not the first time Hitachi has engaged in collaborative creation with customers. In the IT sector, Hitachi has made changes to the value it delivers. The first time the term "computer" appeared in *Hitachi Hyoron* (the Japanese language edition of *Hitachi Review*) was in 1961[6], with "system" first appearing in 1971[7], and "solution" in 1998[8]. These key terms have been appearing frequently in articles ever since.

As noted above, recent changes in the business environment have led to Hitachi to also target Social Innovations delivered with a view to rearranging business ecosystems rather than solutions that set out to overcome individual challenges.

The tools for achieving this include not only technology in the traditional sense of the word, but also techniques for social insights, marketing, business strategy, and business development processes. Furthermore, recognizing the challenge of how to provide ways of looking at intangible services from the design stage, as opposed to tangible products, Hitachi has been reevaluating the role of designers since the early 2000s[9].

With regard to this, Hitachi has been developing and utilizing techniques for identifying changes in society, considering issues from a human-centric perspective[10], and setting up businesses[11]. These techniques are called social science design methods, with designers having played a central role to date.

The Global Center for Social Innovation – Tokyo consists of these designers brought together with researchers.

(a) Smart cash stream solution
A solution developed by Hitachi for smarter operation of ATMs. Key features include money demand prediction for the efficient handling of the cash used to fill ATMs and route optimization for efficient filling of ATMs.

Fig. 2—Process of Collaborative Creation with Customers.
The Global Center for Social Innovation – Tokyo seeks to work through this process rapidly by utilizing the Collaborative Creation Space, methodologies, and information technology.

On the subject of having researchers involved in new business ventures, while it may seem odd, among the new business development practices that have attracted attention in recent years are those that adopt the sort of approaches used by researchers. The lean startup method(12) is a typical example. The approach it adopts, which involves a repeated process of establishing a hypothesis, conducting quantitative testing, and then reformulating the hypothesis, is identical to that used in research, an area where researchers have expertise.

This research approach is also utilized for new business development, not technology development. That is, rather than haphazardly developing technology, this approach utilizes commercial knowledge when deciding which fields to enter, and designs the value and business to produce a profit forecast (hypothesis) before embarking on system design. This is then followed by a repeated process of subjecting the hypothesis to quantitative testing and reformulating the hypothesis. However, this cycle needs to be worked through at a speed that defies comparison with past practice.

Rather than simple technology development, the Global Center for Social Innovation – Tokyo engages in business collaborative creation. Fig. 2 shows the collaborative creation process. The stages of the process are as follows.

(1) Utilize business knowledge to choose which fields to enter by working with operational divisions that are familiar with business domains (establish a go-to-market strategy).
(2) Identify customer challenges from the social changes that serve as the background to business ecosystems, and develop a shared vision with the customer.
(3) Design new service and business model concepts and use prototypes, simulation, and other techniques to make estimates of profitability.
(4) Identify extensive Hitachi technologies and other commercial resources through "One Hitachi," then implement solutions and verify their effectiveness.

In this collaborative creation process, the Global Center for Social Innovation – Tokyo aims to take on the role of bringing together customers and Hitachi's operational divisions and other research centers (Center for Technology Innovation and Center for Exploratory Research) to lead practical business development.

Furthermore, to create the tools for achieving this, Hitachi is providing venues for discussions with customers and making agreements, together with the use of service and business model design methodologies, the adoption of IT in workshops, and simulation for business evaluation to establish mechanisms for working through the collaborative creation process at high speed by the repeated formulation and testing of hypotheses (see Fig. 3).

Fig. 3—Collaborative Creation Space Provided by Global Center for Social Innovation – Tokyo.
The Global Center for Social Innovation – Tokyo has a facility for holding discussions and reaching agreements with customers. It is used to hold workshops with customers to discuss, design, and simulate service and business models to evaluate them prior to implementation.

TABLE 1. Articles in This Issue
This issue splits Hitachi's work on creating service businesses that emerge out of collaborative creation with customers into three categories.

Category	Subject	Article
Methods and tools for collaborative creation	Facilities	Interior Design for Collaborative Creation Space: Creating a Collaborative Environment Based on Color/ Material/Finish
	Methods and tools	Collaborative Creation with Customers: Establishment of NEXPERIENCE
		Development of Methods for Visualizing Customer Value in Terms of People and Management
	Big data analytics	Use of Human Big Data to Help Improve Productivity in Service Businesses
Examples from Japan	Urban development	Application of Service Design and Vision Design by Collaborative Creation in Urban Development Business
		Initiatives Aimed at Creating a Universal Design City for 2020
	Information systems	PKI Platform for Campus Information Systems Using Cloud-based Finger Vein Authentication and PBI
	Logistics	Framework for Collaborative Creation with Customers to Improve Warehouse Logistics
Examples from overseas	China	Collaborative Creation with Customers of Smart Branch Solution for Banks
	North America	Winning in Oil and Gas with Big Data Analytics

PKI: public key infrastructure PBI: public biometric infrastructure

HOW ARTICLES IN THIS ISSUE RELATE TO HITACHI'S PLANS

The above chapters have described what Hitachi is doing to create service businesses that emerge out of collaborative creation with customers. This chapter goes on to explain how the articles in this issue fit into this scheme.

The articles fall into three broad categories. The first describes methods and tools for achieving collaborative creation. The second presents examples of collaborative creation in Japan. The third deals with Hitachi's regional strategy in global markets. These are described below (see Table 1).

(1) Methods and tools for achieving collaborative creation

"Interior Design for Collaborative Creation Space: Creating a Collaborative Environment Based on Color/ Material/Finish," describes the Collaborative Creation Space opened in Akasaka (in Minato-ku, Tokyo). This facility aims to provide not only the features needed for collaborative creation but also a fresh and comfortable space that encourages unrestricted imagination, designed with consideration for welcoming visitors. The article explains the design intentions and process.

"Collaborative Creation with Customers: Establishment of NEXPERIENCE" describes the NEXPERIENCE methodology for collaborative creation with customers provided by Hitachi. NEXPERIENCE covers a series of phases, from methods for discovering business opportunities to business model design methods. It is made up of techniques and IT tools for the creation of attractive service businesses, with consideration for the profitability and viability of a large number of stakeholders.

"Development of Methods for Visualizing Customer Value in Terms of People and Management" describes a method for identifying business challenges that can visualize management issues and their impact, and another for establishing and visualizing the structure of end-user needs.

"Use of Human Big Data to Help Improve Productivity in Service Businesses" describes techniques that use quantitative analysis to support the management of service and knowledge workers. It presents a method for identifying action characteristics that uses wearable sensors that measure activity and an artificial intelligence (AI). It also describes how the techniques were put into practice to identify and quantify the action characteristics that increase organizational activity levels.

(2) Examples of collaborative creation in Japan

The articles in this category present examples of urban development, information systems, and logistics.

"Application of Service Design and Vision Design by Collaborative Creation in Urban Development Business" describes urban development. As the problems and challenges facing cities become more severe and diverse, Hitachi aims to provide a more comfortable way of life and create societies and cities that are conscious of the environment. This article presents the involvement of Mitsui Fudosan Co., Ltd. in establishing the Kashiwa-no-ha Smart City as an example of working with a customer on activities that extend from the creation of a vision for the future to service delivery.

"Initiatives Aimed at Creating a Universal Design City for 2020" describes an example of collaborative creation for urban development. The "UD city" is a vision for overcoming challenges such as the extreme aging of the population that is confronting Japan. It was put forward in the "Implementation of Advanced Infrastructure Systems from Japan in 2020—Realizing a Dream that Originates from Japan," an FY2014 project of the Council on Competitiveness-Nippon (COCN) with participation by 17 companies. The article describes the respective approaches of Kajima Corporation and Hitachi, Ltd. to urban development based on the concept of universal design, together with the outlook for the future.

"PKI[b] Platform for Campus Information Systems Using Cloud-based Finger Vein Authentication and PBI[c]" presents examples of collaborative creation with a university of safe, secure, and convenient academic systems, and social infrastructure. It describes a joint demonstration project that combined cloud-based finger vein authentication with existing campus information systems on site in order to identify the problems associated with installation and operation and prepare for wider deployment.

"Framework for Collaborative Creation with Customers to Improve Warehouse Logistics" presents a case study of improving logistics and operational efficiency at customer warehouses. It uses this example to present a framework for collaborative creation with customers to analyze and improve working practices at distribution warehouses. The framework provides two different approaches for supporting appropriate warehouse operations: the holding of workshop discussions with warehouse staff to identify and overcome problems, and the analysis of data collected from a variety of sensors.

(3) Hitachi's regional strategy in global markets

"Collaborative Creation with Customers of Smart Branch Solution for Banks" presents a case study from the banking sector in China. The smart branch solution for banks was developed through joint innovation with local partners and customer banks. The solution provides self-service tools, security plans, and precision marketing plans to improve the bank's brand image, the efficiency of branch (outlet) operation, and marketing.

"Winning in Oil and Gas with Big Data Analytics" describes work on big data analytics in the North American oil and gas industry. Hitachi has developed a data analytics platform in response to demand for the timely implementation of data analytics solutions through collaborative creation with customers. It can be used for the rapid configuration of systems for collecting a wide range of operational data, such as oil and gas production volumes, from diverse sources and presenting it to the operator in terms of various different KPIs[d]. The system brings together analytics techniques built up by the Big Data Lab.

COLLABORATIVE CREATION IN THE FUTURE

Hitachi's new initiative in collaborative creation with customers began with the reorganization of the Research & Development Group.

To make a success of this, Hitachi intends to focus on human resource skill definition and training that can adapt to new business environments, accumulating experience in service businesses, formulating policies for an intellectual property strategy for collaborative creation, and developing mechanisms for identifying the best technologies and commercial resources for collaborative creation.

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(b) PKI
An abbreviation of "public key infrastructure," meaning an information security platform that provides functions for electronic authentication, electronic signatures, and encryption. It works by having a trusted third party issue certificates to users (public key certificates) in order to verify their identity. Public key encryption uses a key pair (a public and a private key) for encryption and decryption. As information encrypted using the public key can only be decrypted using the private key, the security of the information is assured so long as the private key is kept safe.

(c) PBI
An abbreviation of (template-based) "public biometric infrastructure." It performs authentication in the same way as PKI, except that finger vein or other biometric information is used as the private key. This use of biometric information provides a convenient, secure, and reliable means of identity verification.

(d) KPI
An abbreviation of "key performance indicator," meaning a quantitative measurement of the extent to which an organization has achieved a target. KPIs are the particularly important indicators among those used for monitoring the progress of business processes.

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Featured Articles

Interior Design for Collaborative Creation Space

Creating a Collaborative Environment Based on Color/Material/Finish

Kenta Kumagai
Haruna Tako
Keisuke Ichinose
Hiroaki Takatsuki

OVERVIEW: The Global Center for Social Innovation – Tokyo was established in Akasaka with a collaborative facility that fuses tools and space to accelerate Hitachi's Social Innovation Business. This facility not only satisfies the required functions for collaborative creation, but also delivers hospitality to visitors with a fresh and pleasant environment that is capable of encouraging free ideation. At the same time, the interior design was shaped by aspects of inspiration from a unique collaborative creation environment. This article introduces the purpose and process of this interior design with visual images.

INTRODUCTION

THE Global Center for Social Innovation (CSI) is positioning itself to conduct collaborative creation with customers as a means to accelerate Hitachi's Social Innovation Business.

The process of collaborative creation with customers is first to extract the problems that are faced by customers and society, and then to share these problems among stakeholders who explore solutions with their data, technologies, and wisdom to bring new values that are difficult for one entity to produce. CSI-Tokyo has been developing technologies for collaborative creation and integrating them with information technology (IT). Consequently, a space that is away from the ordinary workplace and that fosters free ideation and active discussion among stakeholders while utilizing advanced collaborative creation technologies and tools is an inevitable requirement. At the same time, it is imperative to provide comfort for guests by offering hospitality and the uniqueness and aspects of inspiration so as to present an active environment.

Under these requirements, CSI-Tokyo collaborated with an external creator and completed the interior design of the collaborative creation facility in Tokyo, Japan in June 2015.

SPACE AND FUNCTIONAL REQUIREMENTS

Before beginning the detailed interior design, the activities to be conducted in this facility were listed and their functional requirements were determined.

The collaborative creation activities were specified by benchmarking the existing facilities of competitors, and repeating the discussions with the members who have been developing the tools for collaborative creation. As a result, the required space for fostering collaborative creation with Hitachi's uniqueness and its functional requirements are defined as follows.

Presentation Space

This space is for attracting customers and for conducting presentations that will accelerate and advance the decision-making for collaborative creation.

The maximum capacity of this room is about 30 persons. There is a large display of eighteen 55-inch high-definition screens. This room is called D1.

Collaborative Creation Space

This space is for allowing stakeholders to concentrate on collaborative creation to innovate values.

As a platform for deepening discussions while using the IT tools of Hitachi's unique collaborative creation technologies, there is a custom-made touchscreen table and a large display with three 70-inch monitors.

Two rooms with different sizes: each room capacity is about 10–15 persons. These two rooms are called D2 and D3.

Lounge Space

This space is primarily for taking breaks during meetings or to use as a meeting point for greeting stakeholders. It also can host a casual party after work.

As a relaxing space, its furnishings must be able to trigger informal dialogues. The room is called the Lounge.

Meeting Space

This space is for conducting regular meetings apart from collaborative creation activities.

With the combined function of a reception space, there are two rooms with different sizes: one room has a capacity of 10 persons and the other a capacity of 5 persons. The ambiance of the rooms should offer maximal openness for visitors. These rooms are called B1 and B2.

FLOOR PLANNING

Based on these determined functional requirements, the details of floor planning were carried out. After this floor planning, the construction management and interior design was conducted by CSI-Tokyo and ITOKI Corporation as a collaborative project.

With the limited space, each layout was investigated repeatedly like playing with a jigsaw puzzle. The tasks included placing the storage units for the devices that will be used for collaborative creation while anticipating the behaviors and movements of visitors. After trial and error, the final floor plan included a distinctive pathway for visitors to shift their feelings and emotions once they walk into this facility. The design of this pathway purposely divides the facility from the ordinary outside world to logically escort visitors to each Collaborative Creation Space. This pathway is called the Corridor (see Fig. 1).

CONSTRUCTING A DESIGN CONCEPT TO EXPRESS THE SPACE

While the layout was designed based on the required functionalities, the research and discussions for expressing the space to highlight the facility were conducted intensively at the same time.

The facility based on the determined floor plan consists of three areas: the Corridor to divide the spaces, rooms D1 to D3 for conducting effective collaborative creation, the Lounge for relieving tension, and rooms B1 and B2 for deepening the

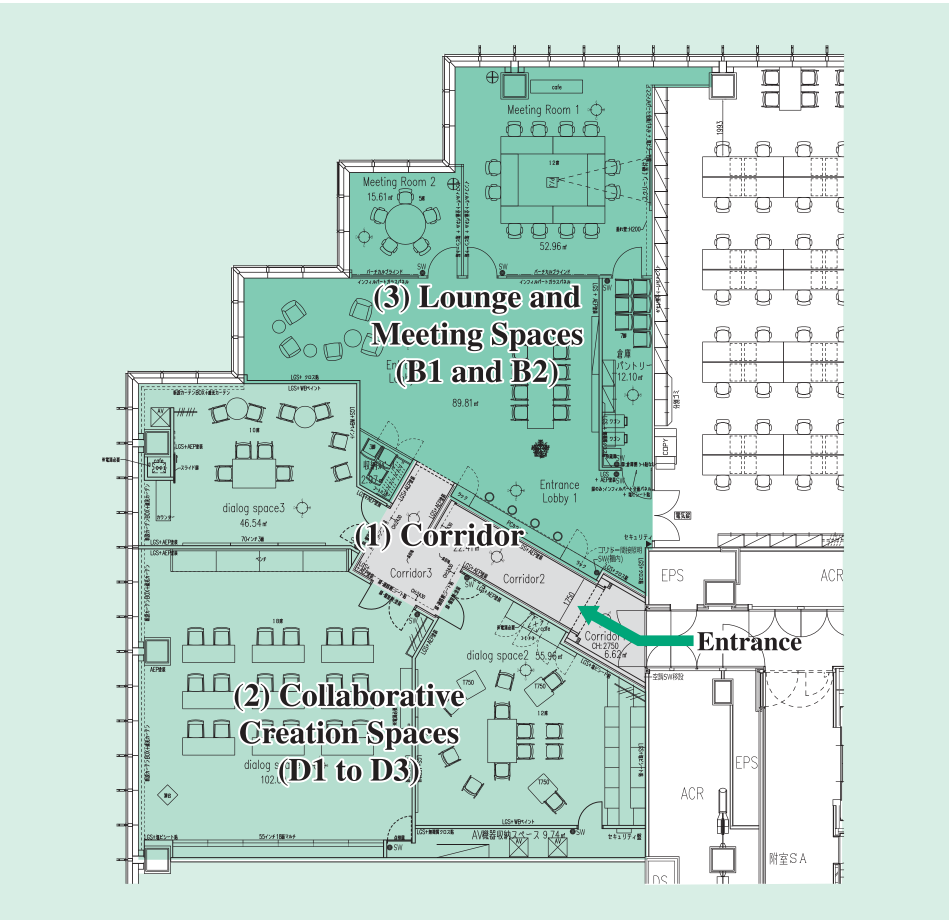

Fig. 1—Floor Plan of the Collaborative Creation Space.
The focus of this layout is the Corridor (1), which runs at an angle from the entrance door, and expresses the characteristics of each space by contrasting the Collaborative Creation Spaces (2) with the Lounge and Meeting Spaces (3). The Collaborative Creation Spaces satisfy the required functions in the limited space available and offer closed spaces allowing users to concentrate better on any collaborative creation activities. The Lounge and meeting spaces provide openness for relaxation and discussion.

dialogue. To emphasize the uniqueness of Hitachi's Collaborative Creation Space, it is necessary to offer an attractive experience that allows visitors to imagine themselves engaging in collaborative creation activities in order to stir their interests in collaborative creation.

The CMF dominant design that was applied in Hitachi's product design was selected to create a unique design concept throughout the whole facility. CMF stands for "color, material, and finish," which is a design concept for focusing on the impressions created by objects. Non-professionals find it easier to recognize and distinguish the design differences with the CMF dominant design concept than with the conventional shape design concept. CMF dominant design has been cultivated through Hitachi's product design over many years. Its concept is to prioritize CMF over shape for expressing and constructing the target subjects. Utilizing CMF is effective for creating an attractive yet unique experience throughout a space due to its expression elements, which are intuitively and physically recognized, even with limited flexibility in floor planning due to space restraints.

By using CMF dominant design, the design of each space was explored based on the functionalities of these three areas. In the end, themes were established for each area: light, which is the base of all colors, is for the Corridor, a composition of multiple large colored surfaces is for rooms D1 to D3, and a harmony of different materials is for the Lounge and rooms B1 and B2. By applying the design concept using multiple colors and materials to weave out all the spaces in this facility, the overall consistency can be maintained while creating their uniqueness and attractiveness. Furthermore, the CMF-focused design can bring the features of "generating new and unprecedented value through collaborative creation that fuses different ideas and opinions" and "creating a rich and beautiful world in more than one color by harmonizing multiple colors out of each color, which is originally strong in declaring its own attractiveness."

FEATURES OF EACH DEVELOPED ROOM

Each space was designed in accordance with visitors' experiences. Here the features of each room are explained according to the sequence followed by visitors once they walk into the facility.

Corridor

Walking through the public hallway by opening the door of the collaborative creation facility leads to a space with slowly changing lighting that draws visitors into the room. This is purposely developed to shift the emotions of visitors by establishing a space to separate the unique Hitachi collaborative creation from the ordinary world.

Fig. 2—Corridor.
The Corridor offers an extraordinary atmosphere for visitors to transform their mindsets toward the upcoming collaborative creation activities.

The installation of lighting was redesigned using red, green, and blue (RGB) color components that were sampled from morning and dusk. This development was a collaboration with Tsutomu Muto, an external creator who works on and researches lighting design (see Fig. 2).

D1

After walking through the Corridor and opening the door indicating room D1, multi-screens covering the whole wall appear in front of visitors in the presentation room.

To present the screens clearly, the color scheme is set to coordinate multiple gray colors. An aqua-blue-colored curtain that blocks light and red-purple-colored

Photograph: Masaya Yoshimura

Photograph: Masaya Yoshimura

Fig. 3—D1.
This room directs users to focus on the large multi-screens while motivating them by rich coloring in order to enhance the effectiveness of presentation.

Photograph: Masaya Yoshimura

Photograph: Masaya Yoshimura

Fig. 4—D2.
This room offers the impression of brightness and activeness and is equipped with Hitachi-designed tools allowing users to engage in effective discussions during collaborative creation activities.

back wall allow the colors to distinguish each other in order to offer the impression of a sophisticated theater. This can enhance the effectiveness of presentations. The normal room capacity is 20 persons, but this can be increased to 28 persons by rearranging desks and chairs.

The design and development of effective lighting for optimizing each activity, and a lighting design that is capable of highlighting colors and materials, was achieved through collaborative work with Sawada Lighting Design & Analysis Inc. (see Fig. 3).

D2

On opening the door, visitors see a bright and active space that is woven with the colors of cherry blossom and blue with a base of dark and light grays. The purpose of this interior design is to trigger friendly and peaceful dialogue in collaborative creation activities.

There are three connected monitor screens on the wall and a custom-made table with an embedded touchscreen. The maximum capacity for collaboration is 18 persons and the capacity for an audience is 10 persons with seating in the form of stairs at the back of the room. This room is a closed space without any windows, but the room's irregular pentagon shape and the large colored-surface walls reduce the sense of closeness.

The wall next to the screen is furnished with a whiteboard that has a metal substrate. During the collaborative creation activities, this wall can be used for illustrating ideas and graphs, pasting notes and memos, and posting posters using magnets. Workshops can be conducted using a combination of digital and analog methods (see Fig. 4).

D3

After opening the door of room D3, there is equipment installed that is similar to room D2. The space is smaller and more enjoyable. The windows are covered with gray curtains to intensify concentration on collaborative creation activities.

A vivid yellow color is used to oppose the gray in order to avoid making visitors feel that they are in a limited space. The design aims to trigger active discussions with a maximum room capacity of 10 persons.

Fig. 5—D3.
This room is wrapped with a cheerful color scheme to distract users' awareness from its small size and to encourage active collaborative creation.

Fig. 6—Lounge.
The combination of a sensation of openness from outside views and an ambiance of multiple textures from the different materials in the space presents an environment for users to spend a slow and calm time.

This space also has a wall furnished with a whiteboard that has a metal substrate (see Fig. 5).

Lounge

The end of the Corridor is a space full of openness.

Opposite to rooms D1 to D3 where the spaces are closed, the Lounge is designed to connect to the outside world as much as possible. The open views surrounding the space are capable of offering visitors a chance to relax. Compared to the large colored surfaces and abstract expression of rooms D1 to D3, the design of the Lounge focuses specifically on the materials in each part.

The interior design includes a grayish wooden pattern and a high-quality dark brown carpet, an artificial marble high-counter, and several other exclusive decorative items. All the materials echo each other to offer an impression of calmness in order to trigger informal and open dialogue (see Fig. 6).

B1 and B2

There are two different-sized meeting rooms next to the Lounge. These two rooms are furnished with large glasses to reduce the sense of closeness.

The maximum room capacities of B1 and B2 are 12 and 5 persons respectively. Both rooms are equipped with darker wooden furniture and bluish gray carpet so that the total design harmonizes with the dark blue of the wall. The overall design seeks to offer a high-quality and calm impression.

The views from these two rooms are open for several hundred meters above the ground, which provides a remarkable highlight to their distinctive position and endless openness (see Fig. 7).

THOUGHTFUL CONSIDERATIONS FOR HOSPITALITY

The most important features for creating an environment to make visitors feel welcomed has been applied to the design of this facility. To realize this notion, the designers have poured their sentiments into every item in the facility.

For example, the photos in the Lounge are digital composite images of the four hours before and after the dawn of April 1, 2015, the day that CSI was

Fig. 7—B1 and B2.
These two rooms are adequately surrounded allowing users to feel secure while openly facing the Lounge. With the outside views, these spaces encourage comfortable discussions.

Fig. 8—Photograph Displayed in Lounge.
Produced from photographs taken of the dawn sky on April 1, 2015, the work represents the launch of the new Global Center for Social Innovation (CSI).

Fig. 9—Flower Arrangements Placed around the Facility.
The flower arrangements have been created specially to coordinate with the color schemes of the spaces in which they are placed.

established. These photos were shot by someone on the staff who is good at photography (see Fig. 8). Also, the decorative flower arrangements are specially ordered to match the CMF of each space (see Fig. 9).

CONCLUSIONS

The collaborative creation facility of CSI-Tokyo has been completed. Much of Hitachi's Social Innovation Business will be created by utilizing this facility effectively and using the unique tools that are installed in the facility for rapidly processing discussions.

This space design project has combined knowledge and design sense from both inside and outside the company. This facility has achieved its goal of providing a space for creating innovations by fulfilling all the requirements because of all the talented people who joined this project and worked in close collaboration with each other. Our great appreciation goes to all the people who were involved in this project.

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Featured Articles

Collaborative Creation with Customers Establishment of NEXPERIENCE

Tomomu Ishikawa
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Kiyoshi Kumagai
Yoshitaka Shibata
Yukiko Morimoto, Ph. D
Masaaki Tanizaki

OVERVIEW: The transformation of manufacturing into a service industry is growing. In its Social Innovation Business, Hitachi is required to create acceptable service businesses by analyzing and evaluating the profitability and feasibility of multiple stakeholders. However, a holistic investigation of complex issues is difficult with conventional methodologies and tools. Therefore, NEXPERIENCE has been systematized to conduct collaborative creation for service businesses while visualizing ideas in multiple perspectives based on knowledge from customers and partners. NEXPERIENCE covers a wide range of phases from discovering business opportunities and designing business models, to simulating business value in order to satisfy customers' goals. Through methodologies and tools that promote a series of collaborative creations, it is capable of accelerating the Social Innovation Business and increasing the ratio of promising service businesses by carrying out intensive and high-quality discussions in a short period of time.

INTRODUCTION

THE transformation of manufacturing into a service industry is growing. Many industrial products have involved low-price competition in which services that increase customer satisfaction have become opportunities for manufacturing to shift its source of profit[(1)]. Innovations in information technology (IT) and sensors, and the advancement of how services are provided have accelerated the shift to services.

To conduct planning for service businesses requires careful consideration of acceptability, profitability, and achievability. The Social Innovation Business involves multiple stakeholders, and this means its business planning must satisfy each stakeholder's expectations for profitability and achievability. However, the numerous challenges include the following.

(1) It is necessary to investigate intensively and holistically.

(2) It is possible that there are business fields in which Hitachi does not have deep knowledge.

The Global Center for Social Innovation has been accumulating achievements in the shift to services, with in-depth research into collaborative creation methodologies by utilizing both design thinking and service engineering[(2)]. Currently, the work has shifted to systematizing Hitachi's collaborative creation, NEXPERIENCE, to accelerate the Social Innovation Business. The purpose of NEXPERIENCE is to conduct collaborative creation while visualizing ideas from multiple perspectives based on knowledge from customers and partners.

NEXPERIENCE covers a wide range of phases for satisfying customers' goals (see Fig. 1). The phases are "NEXPERIENCE / Opportunity Discovering" for sharing visions with customers to discover business opportunities, "NEXPERIENCE / Ethnography" for uncovering on-site issues and "NEXPERIENCE / Business Analysis" for analyzing management challenges, "NEXPERIENCE / Service Ideation" for creating service ideas, "NEXPERIENCE / Business Model Designing" for designing business models and simulating business value for validating developed business models. Through the methodologies and tools that promote a series of collaborative creations, it is possible to accelerate the Social Innovation Business and increase the ratio of promising service businesses by carrying out intensive and high-quality discussions in a short period of time.

Among those phases, ethnography is used as a method for discovering business opportunities[(3)]. Furthermore, the article on "Development of Methods

Fig. 1—A Flowchart of Collaborative Creation and Systematized NEXPERIENCE.
The methodology covers a range of phases based on the customer's objectives, from discovering business opportunities to designing business models and simulating business values. Hitachi has established a Collaborative Creation Space to support the practical implementation of NEXPERIENCE.

for Visualizing Customer Value in Terms of People and Management" in this issue describes the analysis of management challenges. This article will give an overview of the tools and impacts of the methodologies of "NEXPERIENCE / Opportunity Discovering," "NEXPERIENCE / Service Ideation," "NEXPERIENCE / Business Model Designing," "NEXPERIENCE / Cyber-Proof of Concept (Cyber-PoC)," and introduce the Collaborative Creation Space that is supporting the activities of NEXPERIENCE.

DISCOVERING BUSINESS OPPORTUNITIES

Hitachi has been conducting an extensive number of studies into social trends through the perspectives of politics, economy, society, and technology (P.E.S.T.) to generate qualitatively anticipated content on the value perception of people in the future[4]. This content includes the value perceptions of people in the future and the background social trends.

The approach to discovering business opportunities is to conduct workshops with customers using this content. Based on this content, the fields of business opportunity in the future will be organized through repeated discussions about business challenges in the future and the direction of business planning.

Expansion of Content on Social Trends

In the workshops, the content is first shared with participants. The content is a booklet that describes content as stories. Due to the limitations of paper and concerns about readability, not all the social trends for those stories are included in the booklet. This requires the researcher who composed the content to attend the workshop and provide details of those social trends to participants in order to fully engage in discussions and, at the same time, to prevent any differences in interpretation among participants.

To solve the problem, the social trends that serve as background to the content are presented as the cause and effect of each social phenomenon by using causal loop diagrams (CLDs)[5] (see Fig. 2). This has two impacts.

(1) People other than the researcher who composed the content can properly explain the social trends.

(2) People other than the researcher who composed the content can thoroughly discuss the social trends.

In addition, the quantitative information from the social trends can be examined in discussions persuasively. In particular, an interactive graph of statistical data with a timeline is used to indicate the social trends that are described in each node of the CLD (such as the "number of environmentally conscious products" in Fig. 2). Furthermore, the result of predictive analysis based on correlations and causal relations can also be indicated.

Future Development

NEXPERIENCE / Opportunity Discovering Tool, an IT tool, has been developed for the purpose of exploring content that has been extended using CLDs and graphic presentations. The tool integrates

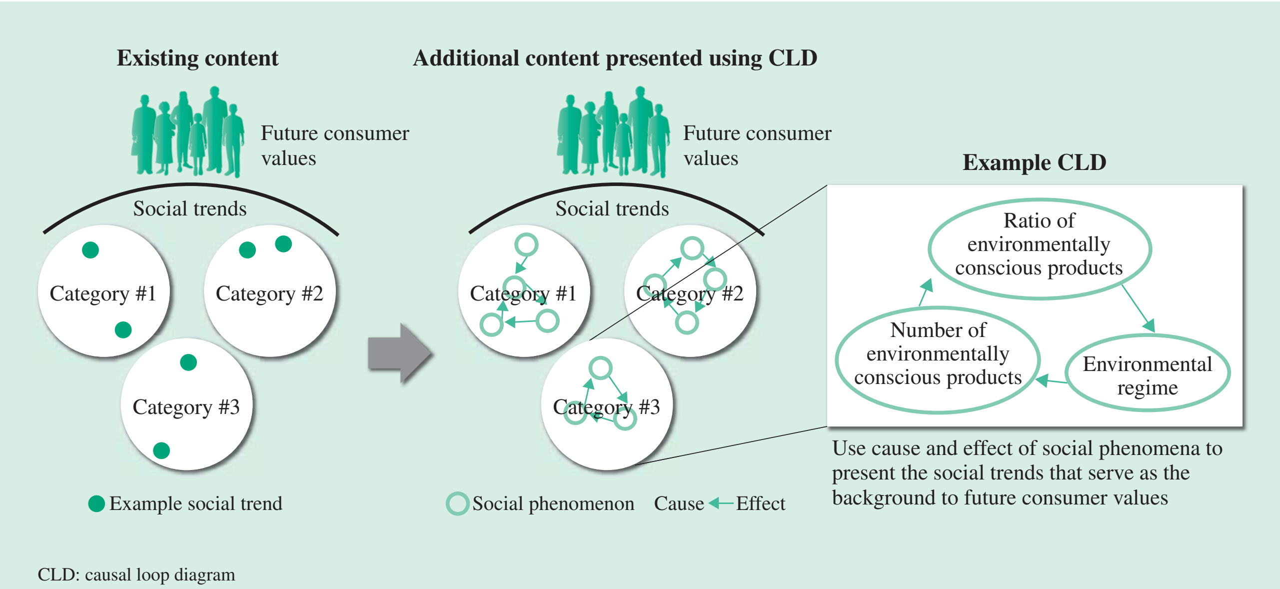

Fig. 2—An Example Use of CLD to Represent Social Trends.
By expressing the causes and effects of social phenomena in terms of cause and effect relationships (including examples of social trends that could not be included in the booklet), the background social trends can be presented accurately, even by presenters other than the person who produced the content, and comprehensive discussion can take place.

conventional memo-style discussions with IT creating a function for automatic digital memo categorization. This has shortened the time taken for workshops and made it easy to repeat the discussions (see Fig. 3).

The next step is to refine the methodologies and the tool further, and apply the developed tool to various business fields and accumulate more detailed content according to each field at the same time.

CREATING SERVICE IDEAS

Framework of Service Idea Creation

To expand service businesses, it is necessary to create innovative service ideas to provide customers with new values. The important task is to create “knowledge fusion” ideas that involve collaboration with experts from various fields such as targeted business know-how and advanced technology while accurately capturing business opportunities in the future, and current operational issues(6).

Hitachi has developed a framework of service idea creation with this concept of “knowledge fusion” to accelerate innovation (see Fig. 4). This framework is used in workshops where customers and partners participate with Hitachi’s experts. The method of this framework for accelerating service idea creation is to use service knowledge from multiple fields of industry to identify suitable products and IT technology from Hitachi’s wide range of products and IT technologies in addition to clarifying customers’ values and operational issues from customers’ expertise in their business fields.

Fig. 3—A Workshop in Progress.
Tablets are used to post opinions on things like business challenges or measures for the future, with reference to statistical data on social trends expressed as CLDs and the social phenomena indicated on CLD nodes.

Idea Creation by Framework

The procedure and perspectives that are indicated in each space in the framework are provided based on the following three approaches. They enable idea creation according to the identified purposes of the project.

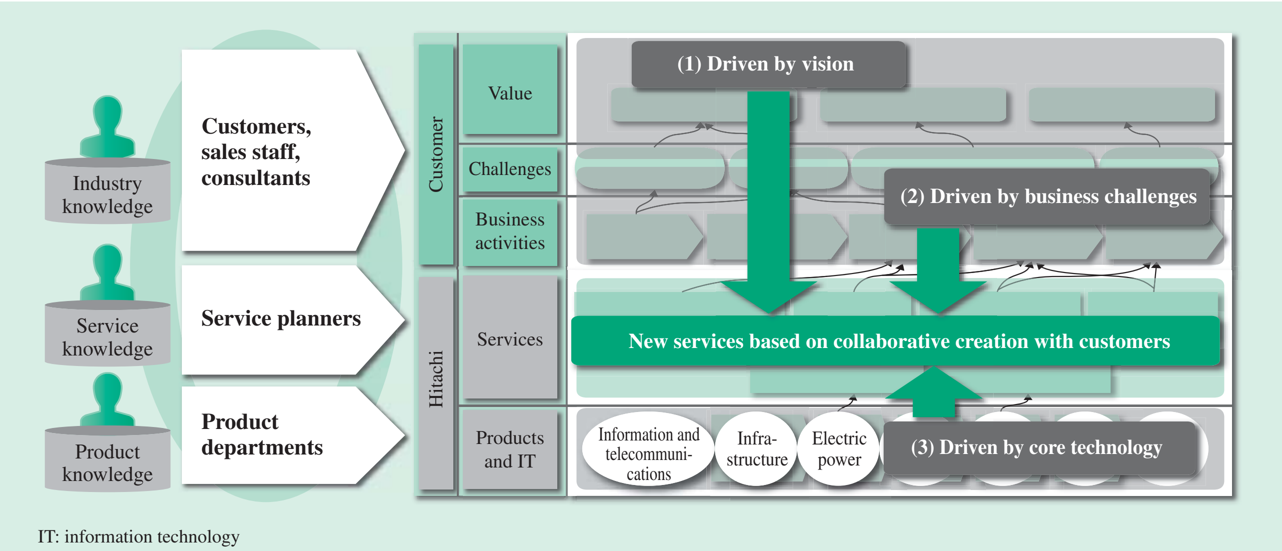

Fig. 4—A Framework for Generating Service Ideas.
This framework is used in workshops attended by customers and other partners as well as experts from Hitachi to encourage every stakeholder to come up with service ideas by providing an overview of: (1) the ideal values for customers, (2) the business challenges faced by customers, and (3) the associated IT and other products.

(1) Driving vision in order to realize ideal images in the future.
(2) Driving operational challenges in order to solve current issues.
(3) Driving core technologies in order to foster the utilization of unique technologies.

For example, there are four typical processes and perspectives for idea creation to realize the ideal images in the future described in approach (1).
(1) Clarifying values that will be demanded by customers' businesses in the future through the use of NEXPERIENCE / Opportunity Discovering, described above.
(2) Listing operations that achieve customers' values and their issues in detail.
(3) Determining effective products and IT technologies for solving challenges.
(4) Creating service ideas to solve challenges by combining products and IT technologies.

This framework is capable of promoting the creation of service ideas to examine every detail with a focus on services. One example is the creation of service ideas through collaboration by multiple operations. Furthermore, it is possible to create service ideas by utilizing resources strategically, such as transforming operations by integrating core technology.

Future Development

Currently, there are many projects that are utilizing this framework in different industries. The framework will be refined along with accumulating case studies of services. Also, the NEXPERIENCE / Service Ideation Tool, an IT tool, was developed to perform knowledge construction through the collection of service case studies in a database. At the same time, a recommendation function is being developed for related case studies in various industries using knowledge. This is aimed at utilizing "cross-industry analogies" to create ideas from case studies in different industries by applying Hitachi's superiority in many business domains(7).

Mechanisms for accelerating service idea creation and creating innovative service ideas will continue to be developed.

DESIGNING BUSINESS MODELS

After obtaining an innovative service idea, the business model is explored in detail. Hitachi developed NEXPERIENCE / Business Model Designing Tool, an IT tool, for designing business models with workshops in which Hitachi staff from multiple backgrounds can participate(8).

Business Model

There is no exact definition of a business model, but here the definition is a set of concepts that indicate an approach for increasing profits continuously in a service that consists of multiple stakeholders. This set of concepts is identified as the following four perspectives on the features of services.

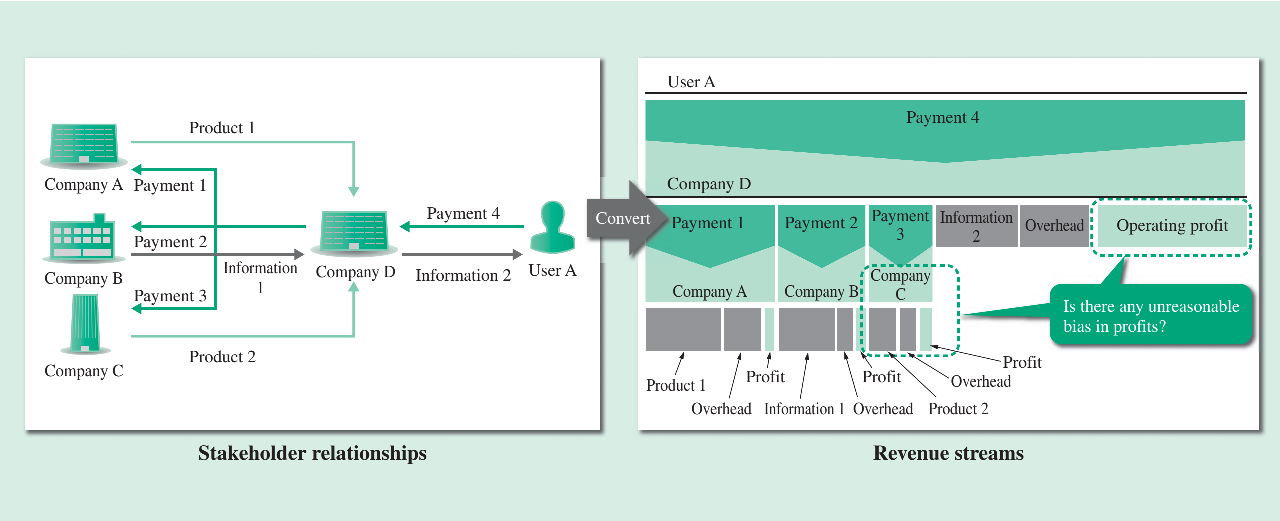

Fig. 5—The Conversion of Stakeholder Relationships into Revenue Streams.
This shows how the flow of money is identified from the stakeholder map (left), which uses arrows to represent the interactions between stakeholders. The contents of this flow are converted into revenue streams (right). The revenue streams are used to study the monetary amounts for each item and ensure the profitability of each stakeholder (such as identifying any unreasonable bias in how benefits are shared).

(1) "Stakeholders' correlations" as an overall design blueprint of the service.
(2) "Individual business strategy" to indicate a structure for businesses that participate in the service to create profits continuously.
(3) "Service user stories" to indicate the details of planning for service users so they will recognize the need for the service and use it continuously.
(4) "Revenue stream" to confirm the profitability of each stakeholder from the money flow and amount of money in the service.

By investigating service ideas from these perspectives, business models can be designed with a consideration for balancing the maximized value for both users and providers.

Conventional Approach and Challenge

Several frameworks have been developed for investigating the features of services from the four perspectives described above. The purpose was to enhance the effectiveness of investigating business models in a workshop. These developed frameworks have been applied to several projects. They include a stakeholder map[9] for investigating "stakeholders' correlations" and a template for co-creating customer journey[10] for investigating service users' "service user stories." In addition, an investigative tool for "individual business strategy" with the business model canvas[11], which was proposed by Alexander Osterwalder, and a new visualization tool for investigating "revenue stream" were developed. These have all been applied to workshops in order to design business models.

The advantage of utilizing these frameworks from those four perspectives is that the investigation can be accurate without missing any point by clearly identifying all items that should be discussed and their correlations. On the other hand, each framework has been discussed independently because the large number of frameworks makes it time consuming to cover all of them.

Framework Collaboration Tool

Extending the advantage described above, IT was integrated with the frameworks to overcome the challenges. Content studied under one framework can also be translated into other frameworks. Due to the ease of switching between frameworks during a workshop, it is easy to notice whether the "revenue stream" is acceptable and appropriate during the discussion process instead of the conventional focus on investigating "stakeholders' correlations" (see Fig. 5). This shortens the time required for switching frameworks. By repeatedly switching back and forth between frameworks during the discussion, a win-win service business can be created with multiple stakeholders.

In the future, business model design will be enhanced from a holistic perspective, such as by applying strategies from competitors.

SIMULATING BUSINESS VALUES

It is important to share an overview and value of a business with customers at the very earliest phase of the system implementation investigation to promote the Social Innovation Business that is illustrated by Hitachi's collaborative creation methodology. NEXPERIENCE / Cyber-Proof of Concept is a simulation tool for assessing business value. It is capable of verifying the return on investment (ROI) of the developed system while changing parameters interactively.

Features and Application of NEXPERIENCE / Cyber-Proof of Concept

NEXPERIENCE / Cyber-Proof of Concept presents a simulation of the degree to which the issues facing society and customers could be solved by inputting a system for solving those issues and its specifications. At the same time, it also can simulate management key performance indicators (KPIs) such as initial cost, operating cost, and ROI. The simulation can be conducted with different conditions by interactively changing things such as the system to be implemented and the attributes that will be the key drivers of KPI (see Fig. 6).

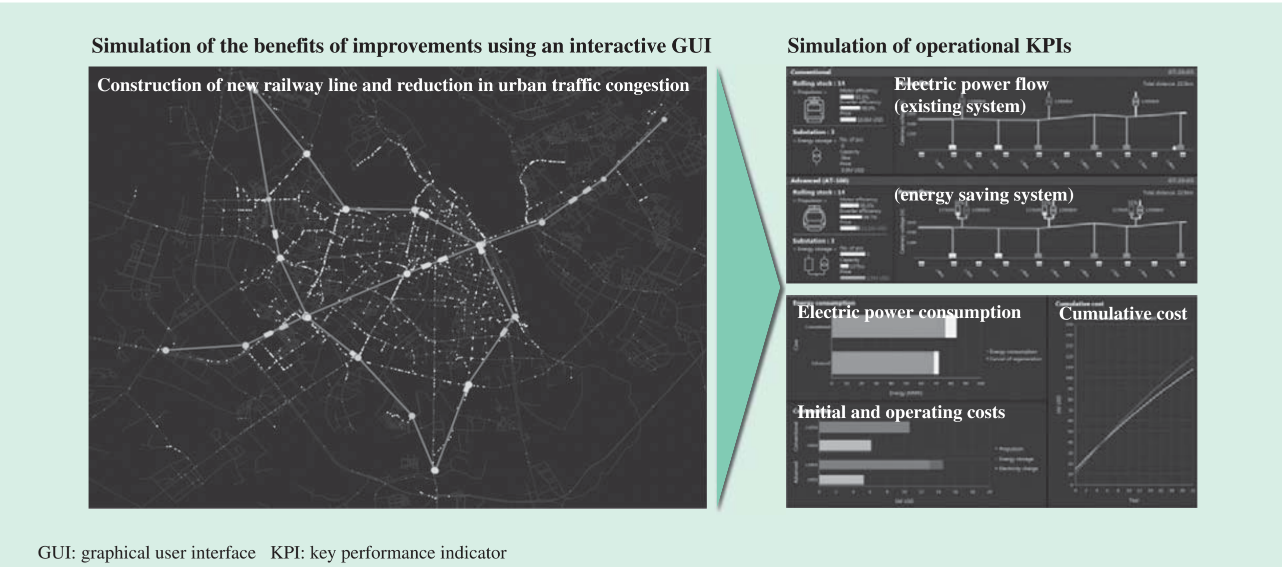

Fig. 6—The Screens Displayed by NEXPERIENCE / Cyber-Proof of Concept (Cyber-PoC) for Railway and Transportation Solutions.
The screen on the left shows a visualization of the extent to which the construction of new railway lines will reduce urban traffic congestion. The top half of the screen on the right shows the results of a simulation of electric power supply planning for the railway line from the screen on the left. The bottom half of the screen on the right shows the results of a simulation of the corresponding electric power use, initial cost, operating costs, and cumulative cost. Different conditions can be simulated by interactively making changes to the railway line on the left.

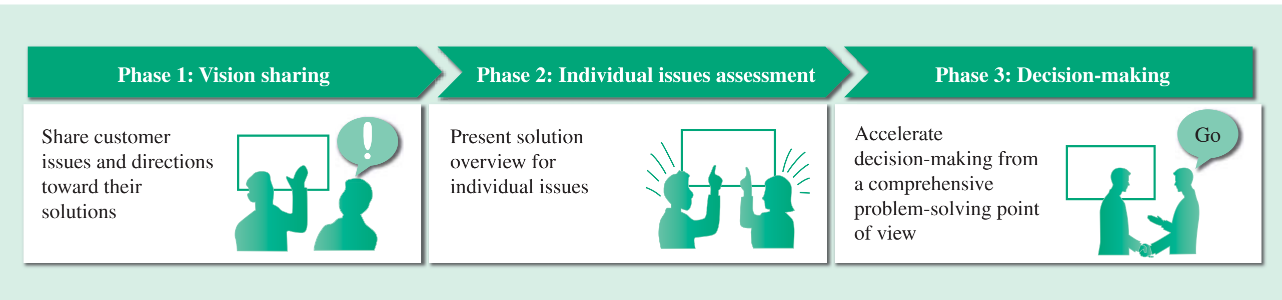

Fig. 7—The Cyber-PoC Phases.
The phase of sharing a vision with the customer involves Hitachi presenting the customer with a simulation based on available data to enable an in-depth discussion of the issues. The phase of considering the individual issues uses detailed data from across the customer's organization to look at an overview of the issues. The final phase is to perform a comprehensive simulation of the issues facing each customer department to facilitate decision-making.

Fig. 8—A Collaborative Creation Space that Facilitates Use of IT Tools.
To enable multi-faceted discussion, Hitachi has built a facility where people can focus on collaborative creation, creating opportunities for collaborative creation and presenting the results of such collaborations.

From these features, Hitachi's proposed system and business values can be accepted by the customer in the vision sharing with customers phase, investigating individual issues facing customers phase, and decision making phase to accelerate the final investment decision by corporate executives (see Fig. 7).

Future Expansion

Currently, Hitachi is developing NEXPERIENCE / Cyber-Proof of Concept for the fields of railways, transportation, and electric power by integrating its analysis technologies accumulated from a vast number of research achievements in many fields. Extending NEXPERIENCE / Cyber-Proof of Concept to the fields of urban development and healthcare will be undertaken by working with business divisions.

COLLABORATIVE CREATION SPACE

The collaborative creation methodology[2] that has been building up effectiveness through actual application uses multiple individual tools for investigation, with holistic discussion using multiple tools at one time. For example, if one developed service is discovered to have difficulty in its profitability, the investigation can be conducted again for an alternative service.

In this situation, NEXPERIENCE / Space (see Fig. 8) was established to facilitate the use of IT tools that can provide holistic investigation to support NEXPERIENCE applications.

CONCLUSIONS

This article has given an overview of NEXPERIENCE, including its methodologies and tools and their impacts, and described the Collaborative Creation Space that supports NEXPERIENCE activities.

To expand the Social Innovation Business, it is essential to understand NEXPERIENCE methodologies and tools, increase the number of people able to use them, and apply them on actual business projects. Training programs and cooperative practices with related business divisions are an on-going process. Furthermore, expanding NEXPERIENCE to locations outside Japan has been planned to foster the Social Innovation Business globally.

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Featured Articles

Development of Methods for Visualizing Customer Value in Terms of People and Management

Haruko Nagaoka
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OVERVIEW: The era of the IoT will make it possible to collect data from a wide variety of devices at a level of granularity that was inconceivable in the past, and many companies see this as an opportunity for improving their business and creating new business opportunities. In this current period of transition, however, not only are there few business workplaces from which sufficient data can be collected and stored to enable its use for management and business analysis, workplace analysis is also impeded by human factors, such as people's values and emotions, which are not available as electronic data. This article describes a method for identifying business challenges that can provide accurate visualization from limited data and a method for analyzing the structure of user requests that can express user needs based on people's values. This paper also presents a case study of the use of these methods in an urban development project for the Tenjin district of Fukuoka City.

INTRODUCTION

AS the Internet of things (IoT) becomes a well-established part of our world, it has become possible to collect data from devices in the business workplace at a level of granularity that was inconceivable in the past. This has prompted many companies to see this as a means for improving their business and creating new business opportunities. According to a survey of 1,125 Japanese companies conducted by the Japan Users Association of Information Systems (JUAS), more than 40% of respondents said they would use, or consider using, big data in some form over the coming three years. On the other hand, major challenges of achieving this include clarifying objectives, establishing systems and practices, and mastering and choosing the associated technologies(1).

Although data on things, money, and information is used in business to make sense of management and operations, at this point in time it is rare for such data to be collected and stored in sufficient quantity for it to be of immediate use, including cases where data is unavailable because it is the property of some other organization. Workplace analysis is also made more difficult by human factors, such as people's values and emotions, which are not available as electronic data, a main factor behind the challenges listed above.

To deal with this, General Electric Company (GE) has devised a way of collecting data needed for analysis. This involves analyzing data from hundreds of sensors in an aircraft engine and providing it to an airline(2). The airline provides the data to GE because of the accompanying benefits, which include fuel savings that stem from changes in aircraft handling based on this data. GE's immediate customer is the aircraft manufacturer and its end-customer is the airline, hence GE is also able to build a relationship with the end-customer by supplying valuable services.

Meanwhile, Google provides an interesting example of how to obtain information about people. Google announced its Brillo operating system (OS) for IoT devices in May 2015. It includes a development environment for device control that is suitable even for such energy-efficient products as light bulbs. While the convenience of using Brillo to control indoor devices will likely lead to rapid adoption of the OS, there have also been media reports about its potential, once implemented, for using device status data to track people's movements in detail(3).

To obtain information about the workplace or marketplace, it is important to create an environment in which customers and other users can see the benefits, as in the examples above, and to establish a means for collecting data. While Hitachi already offers a workplace analysis service[(4)] and management impact assessment service[(5)], since the required data is often collected by using methods such as workplace surveys or workshops, one of the challenges is the time it takes to collect this data in the case of customers with whom Hitachi has yet to build a sufficiently close relationship, or in the case of business-to-consumer (B-to-C) services that target a diverse range of people. This article describes a precise method for identifying business challenges from even limited data and a new method for analyzing people's values, together with results from their use in practice.

BENEFITS AND DIFFICULTIES OF LINKING WORKPLACE ANALYSIS AND MANAGEMENT IMPACT ASSESSMENT

Hitachi has developed the NEXPERIENCE / Ethnography[(4)] and experience-oriented approach[(4)] methods for observing business workplaces and identifying problems that might otherwise be overlooked, and the NEXPERIENCE / Business Analysis (BA)[(5)] method for visualizing organization-wide challenges and their impact on management. Past work has included linking these methods with statistical techniques to identify things like market needs and workplace issues, their implications for management objectives, and what degree of impact they have on the business. This can bridge the gap that tends to arise between management and frontline staff, and has prompted feedback from customers who say they have discovered the reason for their past inability to reconcile actual results with calculations made from operational data, or that their management teams are finally able to understand the point of view of their frontline staff.

However, the use of these methods with customers has raised the following two issues (see Fig. 1).

(1) The limited amount of information that can be obtained from customers with whom Hitachi has yet to build a sufficiently close relationship makes it difficult to highlight things like challenges or the benefits of improvements in a short timeframe.

(2) As people's values change due to factors such as location and timing, there is a limit to how well the needs of end-customers can be determined using past analysis methods based on static demographic data such as gender and age.

In response, Hitachi has developed methods for overcoming these problems and has verified their practicality in actual use.

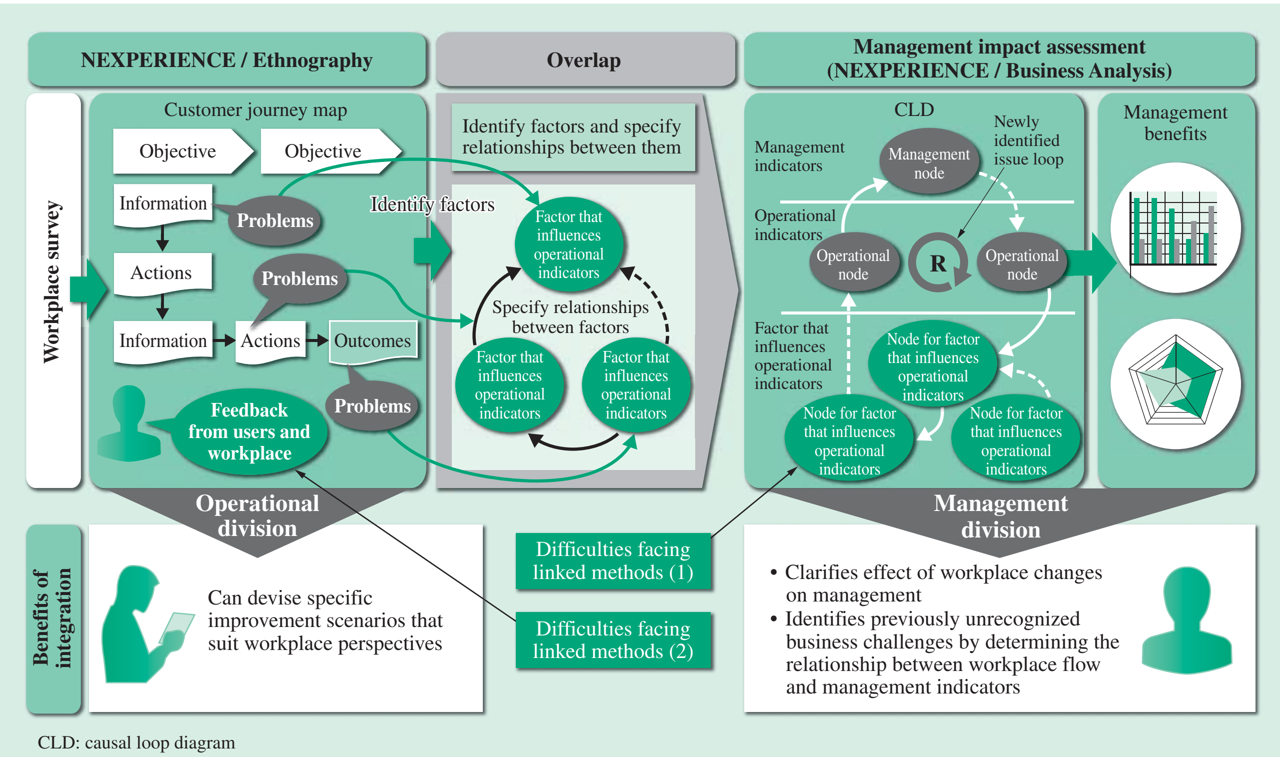

Fig. 1—Benefits and Difficulties of Linking Workplace Analysis and Management Impact Assessment Methods.
While the use of linked methods bridges the gap between workplace and management views, collecting the information required for situation assessment can prove difficult in some cases.

DEVELOPMENT OF NEW METHODS FOR COLLABORATIVE CREATION WITH CUSTOMERS

This section describes two methods for overcoming the challenges described above: (1) identifying business challenges, and (2) user request structure analysis.

Identifying Business Challenges

This method is able to correctly identify business challenges from even a limited amount of information. The process facilitated by the NEXPERIENCE / BA method referred to above involves obtaining management and operational data from the customer, representing it using a modeling technique called a causal loop diagram (CLD), and identifying the challenges through consensus with the customer. The CLD of the business structure takes the form of a directed graph network, with the management indicators, operational indicators, and the factors that influence them represented by nodes, and the cause-and-effect relationships between these nodes are represented by links. Unfortunately, because the items that appear in a CLD range from those considered important by the customer to trivial items that arise in routine operations, the number of nodes can be high and the CLD is often difficult to understand or interpret at first glance. In response, Hitachi has made the following two improvements (see Fig. 2).

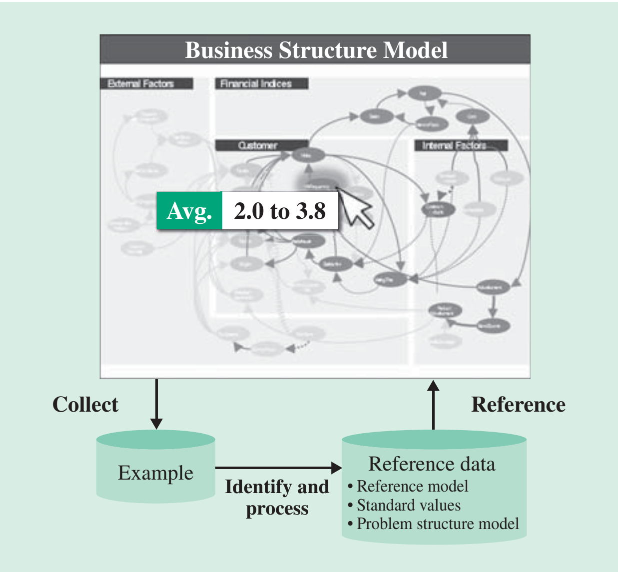

Fig. 2—Overview of Modeling Tool Functions and Example Screen.
The screen displays customization suggestions and reference information based on past examples.

(1) Reference function for industry-specific benchmarks and case studies

The method provides pre-defined reference CLDs for specific industries that are customized for the customer to enable analysis. To support this customization, Hitachi developed a function that searches past case studies to provide reference information, such as nodes that are likely to have cause-and-effect relationships that match the cause-and-effect relationships of existing nodes in the CLD, and mean values for the industry.

Presenting a list of possible nodes augments the customer's thought process and facilitates the customization of the model. The function also presents mean values and trends for commonly used indicators in each industry, such as daily in-process inventory turnover in the case of manufacturing, to facilitate the consulting process of assessing the customer's situation.

(2) Function for highlighting sub-graphs of specific structures

This function is used to show sub-graphs from the CLD that represent specific structures that are likely to cause problems. By allowing importance and other attributes to be specified for each node in the CLD (for instance, whether they are controllable or what business function they belong to), the function can highlight sub-graphs that contain specific nodes. This helps identify discussion points and makes the model easier for the customer to understand by highlighting specific parts as needed to clarify presentation.

By facilitating the addition of extra information and, providing the ability to use a benchmark CLD as a starting point and customize it for the customer using even a limited amount of information, these functions enable the analysis of business challenges in a customer-specific CLD and the visualization of management impact.

The benefits for the customer are that analysis results are available quickly and that they can make discoveries and generate new knowledge through a consulting process that they do not find burdensome. The more the method is used in practice, the greater the portfolio of reference data becomes, thus Hitachi intends to build up its experience with this method so that it can better respond to customer concerns.

User Request Structure Analysis

The method uses questionnaires to obtain an in-depth understanding of what people want, and helps generate ideas for services based on those needs. Developed by Hitachi, the method divides users into clusters

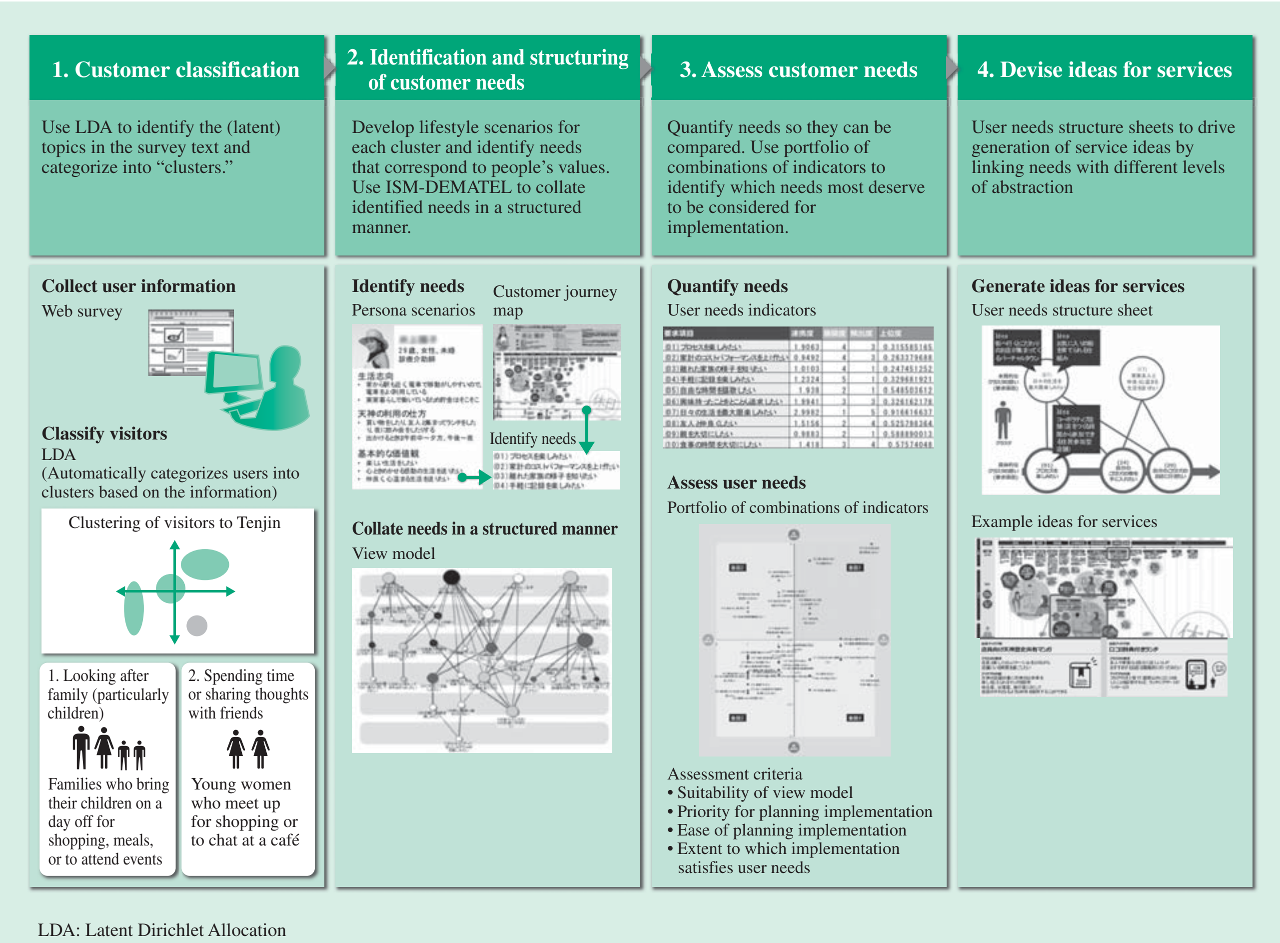

Fig. 3—User Request Structure Analysis.
The method collates user needs in a structured manner and performs an analysis to come up with ideas for services that match the identified values and deliver a high level of satisfaction.

depending on their values and then identifies and categorizes their needs in terms of lifestyle scenarios for each cluster. The scenarios that correspond to customers’ underlying needs are then determined, and user needs structure sheets are then used to drive the generation of ideas for services (see Fig. 3).

This method of analysis has two important features. The first is the use of Latent Dirichlet Allocation (LDA)[6] to characterize users. LDA has gained attention in recent years as a mechanistic technique for classifying natural language text. It uses a topic model to identify the latent subject matter of the text being analyzed with a high level of accuracy.

Along with the statistical analysis of demographic data, other well-known methods used in the past to characterize users include the use of “personas”[7]. Because these depend so heavily on the skills and subjectivity of the designer, however, the tendency is to come up with stereotyped personas that are influenced by the prejudices of the designer.

In contrast, LDA can generate user profiles mechanically from free-form natural language text written by the user. This provides objective user classification and profiling with minimal influence from the analyst’s subjectivity, and can result in the identification of new clusters that were not previously considered (see Fig. 4).

The second feature of the user request structure analysis is the quantification of user needs so that their importance can be determined. Ways of identifying user needs include conducting surveys or holding consultations. In many cases, however, these methods only provide simplistic opinions or requests, with information having insufficient detail for use in considering services.
If a survey elicits an opinion that a neighborhood has too few benches, for example, without knowing the background it is not possible to decide whether the best course of action is simply to provide more benches or to add additional facilities that allow people to take

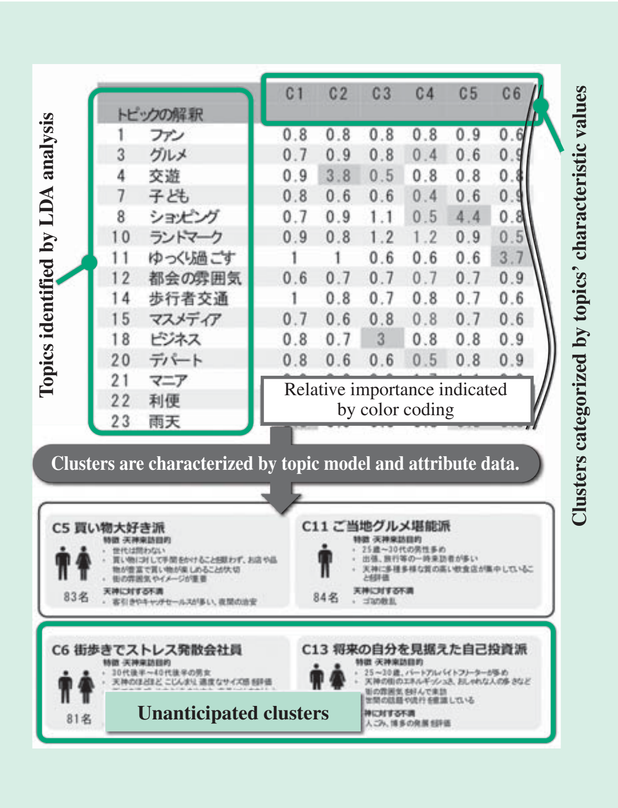

Fig. 4—Use of LDA Analysis to Categorize into Clusters.
LDA is used to identify the topics in free-form questionnaire responses. These are categorized into clusters based on the topics' characteristic values and the clusters formed by linking in attribute data.

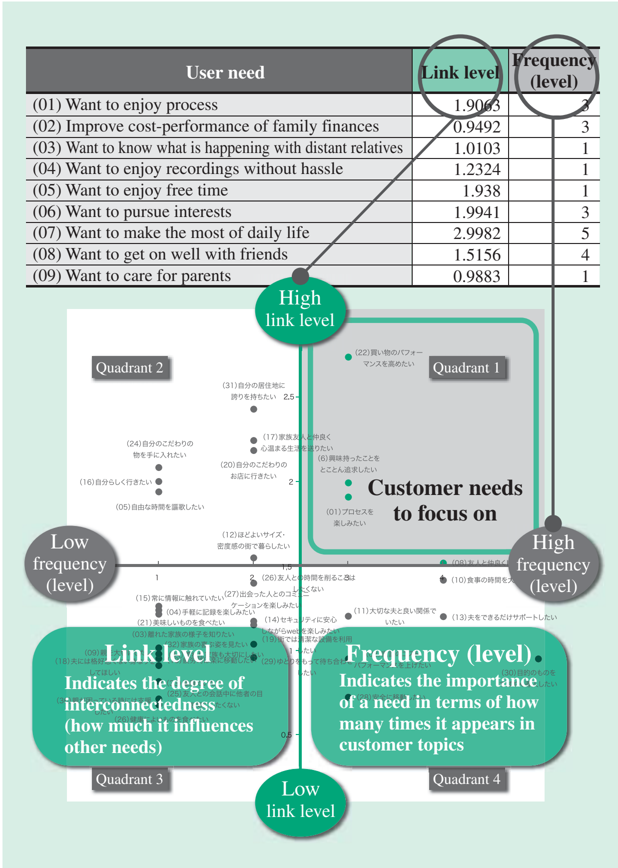

Fig. 5—Quantification and Assessment of Customer Needs.
To identify what users really want, user needs are quantified to determine which customer needs to focus on.

their time looking around. In other words, there is no way of knowing how important the opinion is to users.

To overcome this, the method quantifies each need's "link level" (the degree to which the user need influences other needs) and "frequency (level)" (how frequently the need appears in scenarios), and designates needs that have high values for both of these indicators as having high importance. In this way, the method can identify the needs that are characteristic of each user, and determine which of these needs matter most (see Fig. 5).

EXAMPLE CUSTOMER COLLABORATIVE CREATION PROJECT USING THESE METHODS

This section describes an example project that uses the methods described above for collaborative creation with customers.

Hitachi participated in a service collaborative creation project with We Love Tenjin (WLT), an organization involved in urban development for the Tenjin district of Fukuoka City. The project used the methods described in section above with the aims of boosting visitor numbers to the district and improving satisfaction levels.

This included producing scenarios for how users used and thought about the district based on information obtained through analysis, and holding discussions with WLT on people's motivations for visiting the district, the likelihood of their making purchases, and which user needs have a strong potential for influencing neighborhood vitality (see Fig. 6).

It also included using user needs structure sheets produced with reference to these discussions to generate ideas for services. One example was using residents' desire to take pride in their neighborhood to come up with the basic idea of finding ways to foster an attractive neighborhood, and to combine this with specific user needs to drive the generation of ideas such as a cooperative store (a store that residents can participate in from its initial establishment) or having residents perform maintenance as they walk around the neighborhood (see Fig. 7).

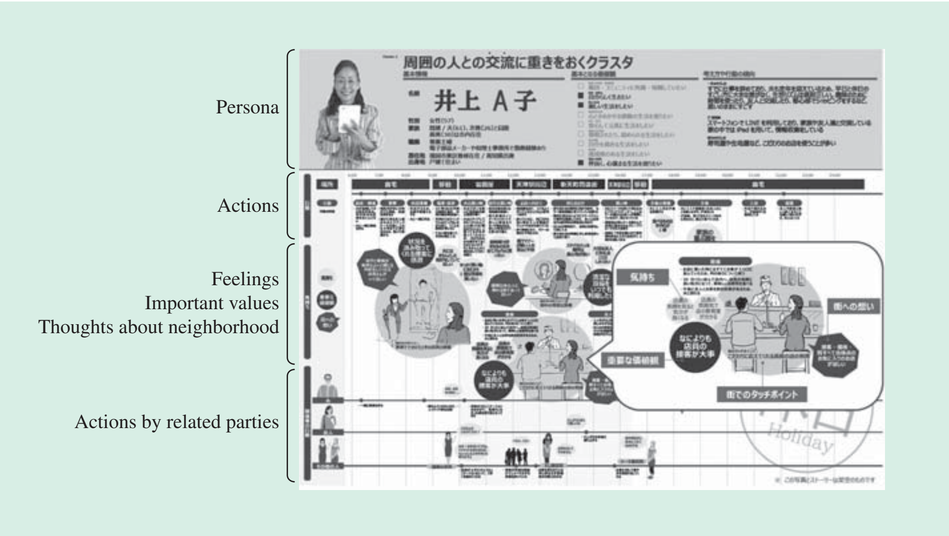

Fig. 6—Customer Journey Map.
The "actions and touch points," "values," and "thoughts" about the neighborhood of visitors to Tenjin are expressed as a story of their day.

Commenting on their reaction to these ideas, WLT said, "Using values to come up with ideas for services was interesting. It makes us want to use methods like this to come up with services for ourselves."

In the future, Hitachi intends to continue using the methods described above to visualize the impact on the district of implementing the ideas for new services from the perspectives, not only of the people involved in urban development, but also of numerous other stakeholders including residents and retailers.

CONCLUSIONS

While there are high hopes for using data to create new businesses or other improvements, information that cannot be fully represented in electronic form often complicates decision-making. Hitachi intends to make further enhancements to its methods of identifying what is wanted by management as well as people's values, and to establish practices for collaborative creation with customers by generating service ideas and solutions that customers will find compelling.

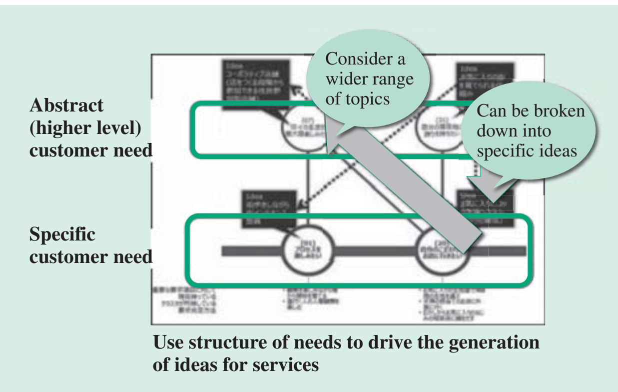

Fig. 7—User Needs Structure Sheet.
The sheet is a way to forcibly expand the scope of idea generation or break down an idea in terms of the structure of customer needs.

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Featured Articles

Use of Human Big Data to Help Improve Productivity in Service Businesses

Satomi Tsuji
Hisanaga Omori
Kenji Samejima
Kazuo Yano, Dr. Eng.

OVERVIEW: While initiatives that use big data to improve productivity have become commonplace in the industrial sector, the quantitative assessment of the relationship between worker actions and organizational results and its use to make improvements has proved difficult in service businesses and knowledge work. Hitachi has devised a technique that uses wearable sensors and AI to identify action characteristics that influence organizational KPIs. This article describes a demonstration project at The Bank of Tokyo-Mitsubishi UFJ, Ltd. that involved a comprehensive study of the relationship between organizational KPIs and action characteristics to identify those action characteristics that were effective at improving KPIs for each attribute and situation. This succeeded in identifying the people and actions that contribute to the organization. Hitachi intends to use this technique to build management support systems that enable teams to perform to their full potential.

INTRODUCTION

WHILE tertiary industry accounts for approximately 70% of both gross domestic product (GDP) and employment in Japan, the labor productivity growth rate has been a poor 0.8% (from 1995 to 2003), placing Japan 19th out of the 27 members of the Organisation for Economic Co-operation and Development (OECD)[1]. Because services generate value through interactions between people rather than in the form of physical goods, productivity improvement requires the analysis of people and the acquisition of knowledge.

Use of big data has attracted attention in recent years, and while productivity improvements are being made in the industrial sector, the quantification of worker actions and organizational results in the service sector has proved difficult. This is because value is created through people with different roles working together as teams, meaning that improvements in individual productivity do not necessarily lead to improvements in overall productivity as they would with a machine. As a result, managers need to make management decisions without any means for determining which actions by which people are contributing to the overall organization.

This article describes how Hitachi set about quantitatively evaluating the relationships between worker actions and organizational results with the aim of building systems that will present management guidelines on how to get teams to perform to their full potential. This involved the study of a management support system that makes comprehensive use of three methods in the form of human big data. These methods are: identification (ID) card type wearable sensors that Hitachi developed previously, an indicator of the level of activity at an organization (“happiness”), and Hitachi Artificial Intelligence (AI) Technology/H. A demonstration project was conducted at The Bank of Tokyo-Mitsubishi UFJ, Ltd. to evaluate the viability of this system by identifying action characteristics for each worker attribute and situation.

MANAGEMENT SUPPORT SYSTEM

Overall Concept

The aim is to build a system that can analyze data on business processes and provide managerial staff with management guidelines. Specifically, Hitachi is seeking to provide quantitative criteria for deciding what each staff member should be focusing on, taking account of external factors such as the weather and events. This is to be achieved by establishing a sustainable cycle that provides daily and attribute-specific management guidelines by using wearable sensors to measure worker activity and AI to generate stochastic models (see Fig. 1).

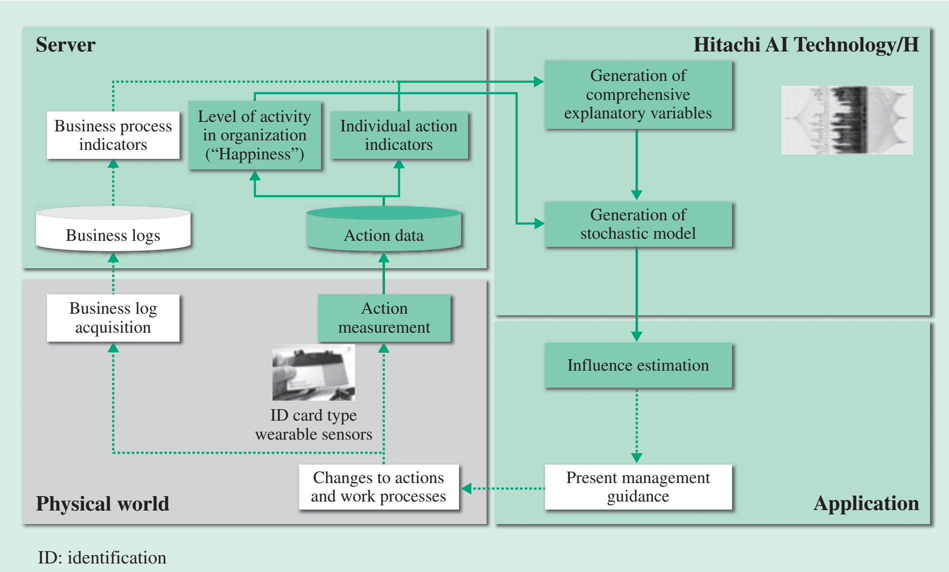


Fig. 1—Conceptual Diagram of a Management Support System.
Hitachi has built a system that uses AI to analyze human behavior data and business logs collected from the physical world and to identify the best action plans for improving the organization's overall KPIs with respect to individual attributes and situations. The parts indicated by dotted lines are outside the scope of the demonstration project described in this article.

Measurement of Actions by Individuals —ID Card Type Wearable Sensors—

ID card type wearable sensors are used to measure worker actions. These devices use a built-in infrared sensor to detect communication between people and an accelerometer to detect physical movements. This information is used to obtain work characteristics indicators, such as the quantity and quality of office worker communication (whether it is one-way or two-way) and the length of time spent on uninterrupted desk work (see Fig. 2)[2].

Measuring the State of the Organization —Level of Organization Activity (“Happiness”)—

The level of activity in an organization is a quantitative indicator of the “happiness” at that organization obtained from the pattern of people's physical movements. It is calculated from the variability in the duration of periods of continuous activity, using the accelerometer contained in the ID card type wearable sensor to determine whether a person is active or sedentary. It has been demonstrated that the level of

Category	Indicator	Definition
Duration of interaction (min)	Total time	Time during which interaction with at least one other person is detected
	Two-way	Time during which two-way conversation is in progress
	Pitcher	Time during which subject is speaking
	Catcher	Time during which subject is listening
Number of interactions (number of instances of each category of interaction duration)	(a) Continuing for < 5 min	Number of short conversations (greetings or passing on a message)
	(b) Continuing for 5 < 15 min	
	(c) Continuing for 15 < 30 min	Number of long conversations (such as meetings)
	(d) Continuing for ≥ 30 min	
Duration of desk work (min)	Total duration of desk work	Time during which subject does not interact with others and has minimal physical movement
	Maximum duration of continuous desk work	Longest period of uninterrupted desk work during the day
Number of instances of desk work (number of instances of each duration category)	(a) Continuing for < 5 min	Number of times desk work is interrupted (by being spoken to, going for a walk, etc.)
	(b) Continuing for 5 < 15 min	
	(c) Continuing for 15 < 30 min	Number of times desk work continues for a long period with few interruptions
	(d) Continuing for ≥ 30 min	
Length of time sensor is worn (min)	Length of time sensor is worn	Time measured by ID card type sensor (in the case of office work, this is the office's working hours)

Fig. 2—List of Action Indicators for Office Workers.
Hitachi has defined indicators for interactive communication and desk work.

activity in an organization is correlated with daily productivity, and it has been suggested for use as a daily key performance indicator (KPI), even in services that find it difficult to quantify the state of the organization[3]. With reference to this, this article uses the level of activity in an organization as a KPI for that organization.

Uncovering Relationships between Individuals and the Organization—Hitachi AI Technology/H—

The system uses Hitachi AI Technology/H to analyze quantitative data. Hitachi AI Technology/H generates explanatory variables of various types by exhaustively combining action indicators and other information (attributes, events, and so on), and then determines which of these indicators are relevant to the target variable. When the target variable has macro data granularity (organization-wide indicators, for example) and the explanatory variables have micro granularity (indicators that relate to individuals), a stochastic model is used to determine which actions by an individual influence the organizational indicators.

In this way, when organizational KPIs are set as target variables, Hitachi AI Technology/H can perform an exhaustive search to identify which individual action indicators are relevant to the KPIs[4].

DEMONSTRATION PROJECT AT THE BANK OF TOKYO-MITSUBISHI UFJ

The first demonstration project was conducted at Hitachi's partner, The Bank of Tokyo-Mitsubishi UFJ, Ltd., to verify the viability of implementing the concept described in the chapter above.

Purpose of Demonstration Project

The demonstration project sought to verify the following.

(1) Whether the system can identify which individual action indicators explain organizational KPIs, and then order them by priority.

(2) Whether the system can obtain action indicators that take account of external factors (such as weather and events) that are outside the control of the people in the workplace.

Project Overview

Data was collected from the ID card type wearable sensors as follows:

Department: Headquarters planning department (office work)

Measurement period: Three weeks

Subjects: Approximately 40 people (three groups, each with 10 people or more)

Method of Analysis

The analysis was conducted using the following procedure.

(1) Action indicators for office workers

The office worker action indicators listed in Fig. 2 were used. The nature of one-to-one communication was categorized as "two-way," "pitcher," or "catcher" based on the extent of physical movement by the two parties, and utilized the number of interactions categorized according to duration, which reflect the type of conversation (greeting, passing on a message, long discussion, and so on). The maximum duration of uninterrupted desk work and the number of each duration of uninterrupted desk work were calculated by treating as interruptions those instances in which interaction was detected or the degree of physical movement became large.

(2) Calculate level of activity in the organization

The level of activity in the organization was calculated for each day and group.

(3) Identify indicators

Taking the level of activity in the organization on each day and for each group as target variables, analysis determined which individual action characteristics were associated with variations in the daily value. To generate the indicators, the action indicators (continuous values) were classified into two categories depending on whether they were above or below the median. These indicators were then used to generate compound indicators made up of all possible combinations of "attributes and action indicators" and "external factors and action indicators," and a t-test with a significance criterion of $p < 0.05$ was used to identify those action indicators that made a significant difference to the level of activity in the organization.

DEMONSTRATION PROJECT RESULTS

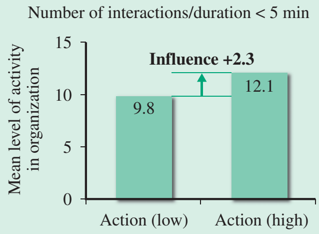
Simple Analysis

Before conducting the analysis using the compound indicators, the relationship between the individual action indicators and the level of activity in the organization were analyzed [see Fig. 3 (a)]*. This analysis satisfied $p < 0.05$ for the department being studied and found

* The experimental data shown in this article (Fig. 3 to 6) is a mock up for presentation purposes. However, the knowledge obtained is the same as that achieved in practice.

Action indicators		Mean level of activity in organization: Action (low)	Mean level of activity in organization: Action (high)	Influence (difference in mean values)	Significance (p value)
Duration of interaction	Total time	10.4	11.6	1.2	0.88
	Two-way	9.3	11.8	2.5	0.11
	Pitcher	11.6	11.4	−0.2	0.11
	Catcher	10.6	12.0	1.4	0.85
Number of interactions	Continuing for < 5 min	9.8	12.1	2.3	**0.02**
	Continuing for 5 < 15 min	11.4	11.4	0.0	0.62
	Continuing for 15 < 30 min	9.5	12.4	2.9	0.35
	Continuing for ≥ 30 min	12.0	10.8	−1.2	0.58
Duration of desk work	Total time	11.5	10.4	−1.1	0.07
	Maximum duration of continuous work	11.0	11.5	0.5	0.78
Number of instances of desk work	Continuing for < 5 min	10.7	10.8	0.1	0.41
	Continuing for 5 < 15 min	11.8	10.8	−1.0	0.32
	Continuing for 15 < 30 min	10.6	11.4	0.7	0.40
	Continuing for ≥ 30 min	11.0	10.6	−0.4	0.86
Length of time sensor is worn		10.1	11.5	1.4	0.32

(a) Relationship between magnitude of all action indicators and the mean level of activity in organization



(b) Difference in levels of activity in the organization on days when the number of short interactions (less than five continuous minutes) was high and low

Fig. 3—Mean Value of Level of Activity in the Organization for Each Category of Action Indicator Values.
The level of activity in the organization was higher on days with a large number of short interactions (greetings or passing on a message) than on days with a low number (with a significance of $p < 0.05$). The "influence" means the expected change in the level of activity in the organization when actions are changed.

a relationship with the "number of interactions lasting less than five minutes" action indicator. The mean level of activity in the organization was 12.1 on days with a large number of short interactions (greetings, passing on a message, and so on) and 9.8 on days when the number of such interactions was low. This difference of +2.3 is called the "influence." The "influence" is the change in the level of activity in the organization that is expected to result from a change in action, such that the larger its absolute value the more a change in action is expected to influence the level of activity in the organization [see Fig. 3 (b)]*.

Action characteristic		Duration of interaction: Total time	Duration of interaction: Two-way	Duration of interaction: Pitcher	Duration of interaction: Catcher	Number of interactions: Continuing for < 5 min	Number of interactions: Continuing for 5 < 15 min	Number of interactions: Continuing for 15 < 30 min	Number of interactions: Continuing for ≥ 30 min	Desk work: Total time	Desk work: Maximum duration of continuous desk work	Number of instances of desk work: Continuing for < 5 min	Number of instances of desk work: Continuing for 5 < 15 min	Number of instances of desk work: Continuing for 15 < 30 min	Number of instances of desk work: Continuing for ≥ 30 min	Length of time sensor is worn
Status	Management A	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-
	Management B	-	1.5	-	-	-	-	-	1.1	-	-	-	-	-	-	-
	Staff member	0.9	-	-	-	1.6	2.2	-	-	-	1.8	-	-	-	-	-
Age	20s	-	-	1.3	-	-	-	-	2.1	-	-	-	-	-	−0.7	-
	30s	1.6	1.8	-	1.5	$\boxed{2.8}$	-	-	-	-	-	-	-	-	-	0.8
	40s or older	-	2.0	-	-	1.9	-	-	-	−1.8	-	-	-	-	-	0.3
Gender	Male	-	1.7	-	-	1.2	-	-	-	-	-	−1.5	-	-	-	-
	Female	1.1	2.1	-	-	1.8	-	-	-	-	-	-	-	-	-	-
Job	Job A	2.1	-	-	-	1.2	-	-	-	−1.0	-	-	-	-	-	-
	Job B	2.0	-	-	-	1.7	-	-	-	-	-	-	-	-	-	-
	Job C	-	-	-	-	-	-	-	-	-	-	-	0.3	-	1.7	-
No. of years at department	Low (< 3.5)	-	0.7	-	-	1.4	-	-	-	-	-	-	0.3	-	$\boxed{2.5}$	-
	High (≥ 3.5)	-	-	-	0.6	0.8	-	-	-	−1.7	-	-	-	-	−1.6	-

Fig. 4—Results of Action Characteristics Analysis for Different Attributes.
The table shows the results for all combinations of attributes and action indicators. Influence values are only shown for attributes in the case of indicators for which there is a significant ($p < 0.05$) difference in the level of activity in the organization between days with a high number of actions and days with a low number. A positive influence value means that a high number of actions for that attribute is associated with a high level of activity in the organization, whereas a negative value means the opposite. The larger the absolute value of the influence, the higher the priority. Action indicators with an absolute influence value of 2.5 or more are highlighted in bold frames.

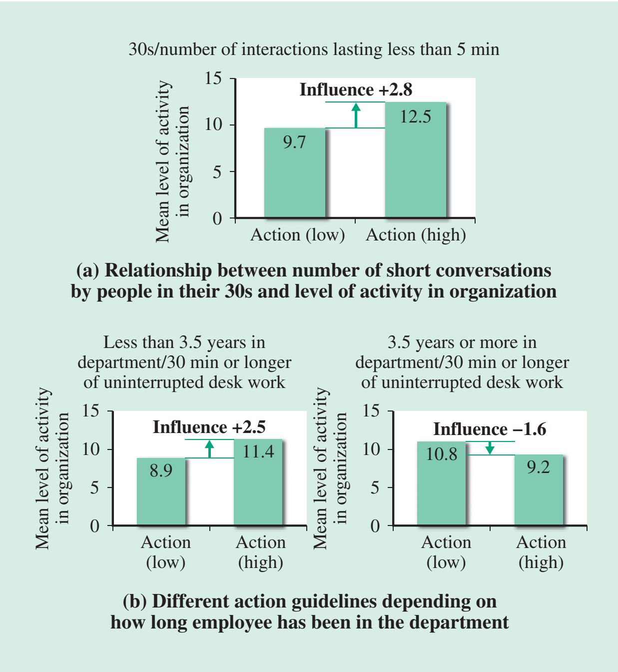


Fig. 5—Example of Action Characteristics Analysis for Different Attributes.
(a) The level of activity in the organization is higher by 2.8 on days on which people in their 30s had frequent short conversations such as greetings or passing on a message.
(b) Opposite guidelines were obtained for uninterrupted desk work time depending on how long the employee has been in the department.

Analysis of Action Characteristics by Attribute

A t-test of the compound indicators formed from the combination of "attributes and action characteristics" found influence values for indicators with $p < 0.05$ similar to those described above (see Fig. 4)*. This can be used to identify relationships (with a significance of $p < 0.05$) between variations in the level of activity in the organization and the magnitude of actions with specific attributes, and to list these actions in order of priority based on the absolute value of their "influence."

The overall trend was that indicators that relate to the duration of interactions, particularly the number of short interactions (greetings, passing on a message, and so on), has a positive correlation with numerous attributes, which is to say that the level of activity in the organization was higher for higher values of the indicator. On the other hand, the total time spent on desk work was found to have a negative correlation, meaning that the level of activity in the organization was higher for shorter desk work times.

An individual finding with a high level of influence was that the level of activity across the entire organization was high when people in their 30s had short and frequent conversations. A difference in action indicators was also found between new recruits who had been in the department for up to 3.5 years and long-term employees who had been there for 3.5 years or more, where it was better for the former to have long desk work durations (30 minutes or longer), and for the organization as a whole, it was desirable if the situation for the latter group included desk work that was split up into periods of less than 30 minutes due to interruptions such as being consulted by other staff (see Fig. 5)*.

Analysis of Action Characteristics by Situation

The demonstration project chose whether or not a social gathering was to be held after work as an example of an external factor outside the control of the people in the workplace. An analysis of the relationship between the level of activity in the organization and the compound indicators formed from the combinations of "social gathering (day of gathering, day after gathering, normal day) and action indicators" found that the level of activity in the organization could be increased on days with a social gathering if two-way conversations were longer, the frequency of short conversations was higher, and the frequency of long conversations was lower. On the

External factor	Two-way conversation time	Number of short conversations (greetings or passing on a message)	Number of long conversations (meetings)
Day of social gathering	Higher	Higher	Lower
Day after social gathering	Lower	Lower	Higher
Normal day (other than above)	Higher	Higher	(No correlation)

Fig. 6—Results of Action Characteristics Analysis for Different Situations (Sample).
The results show that the measures for increasing the level of activity in the organization are different depending on external factors (day of gathering, day after gathering, normal day).

other hand, the opposite result was found for the day after a social gathering. That is, the level of activity in the organization was higher if two-way conversations were shorter, the number of short conversations was lower, and the number of long conversations was higher (see Fig. 6)*. The interpretation of this finding is that, because people are still tired on the day after a social gathering, productivity is higher when discussions are held over an extended period of time rather than working in short time intervals. Hitachi also concluded that, if data covering a long period of time was available, it would be possible to adopt a more detailed classification of external factors and determine action guidelines for individual factors, such as the weather, timing, and whether important customers are visiting or not.

CONCLUSIONS

The demonstration project described above succeeded in identifying action indicators for specific attributes and situations that are associated with the level of activity in the organization. This included the discovery, described above, of action characteristics for staff members who contribute indirectly to the organization, even though this is detrimental to their own productivity, as indicated by the finding that interruptions to the work of experienced staff raised the productivity of the organization as a whole. This suggests that it is practical to build management support systems that take account of indirect contributions that have not been assessed in the past. Hitachi intends to undertake further trials and testing as it works to implement such systems.

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Featured Articles

Application of Service Design and Vision Design by Collaborative Creation in Urban Development Business

Takeshi Minemoto
Asako Miyamoto
Mariko Doi
Atsuko Bando
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Yutaka Sano
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OVERVIEW: The problems and challenges in cities, such as supplying renewable and fossil-fuel energy, shrinking populations and aging, and the increasing concentration of industries and talents, are becoming intensified and diversified. Hitachi has been engaging in a vast number of projects to provide a comfortable lifestyle, society, and city with consideration of the environment. As part of the Kashiwa-no-ha Smart City project of Mitsui Fudosan Co., Ltd., Hitachi has supported the system development by applying service design to the visualization of energy in the city. The image of services in the future was studied at Hitachi by utilizing vision design, which anticipates overall city planning for future extension. The tasks included conducting collaborative creation with customers from creating a vision in anticipation of future events to providing services; creating value for each city, the surrounding areas, residents, visitors, and business entities; and studying optimized technology implementation. The purpose is to contribute to cities in order to accelerate the Social Innovation Business.

INTRODUCTION

THE problems and challenges in cities, such as supplying renewable and fossil-fuel energy, shrinking populations and aging, and the increasing concentration of industries and talents, are becoming intensified and diversified. Hitachi has engaged in a vast number of projects to provide a comfortable lifestyle, society, and city with consideration of the environment.

The Kashiwa-no-ha Smart City project has attracted much attention from both inside and outside of Japan. Mitsui Fudosan Co., Ltd. and Hitachi developed and deployed the Kashiwa-no-ha area energy management system (AEMS) to realize an environmental-symbiotic city[1]. Further discussion and study with stakeholders will be required for the planned development of streets and facilities in the future.

This article explains how service design was applied to visualizing energy in the city, how vision design was employed for future community services, and the significance of collaborative creation in studies.

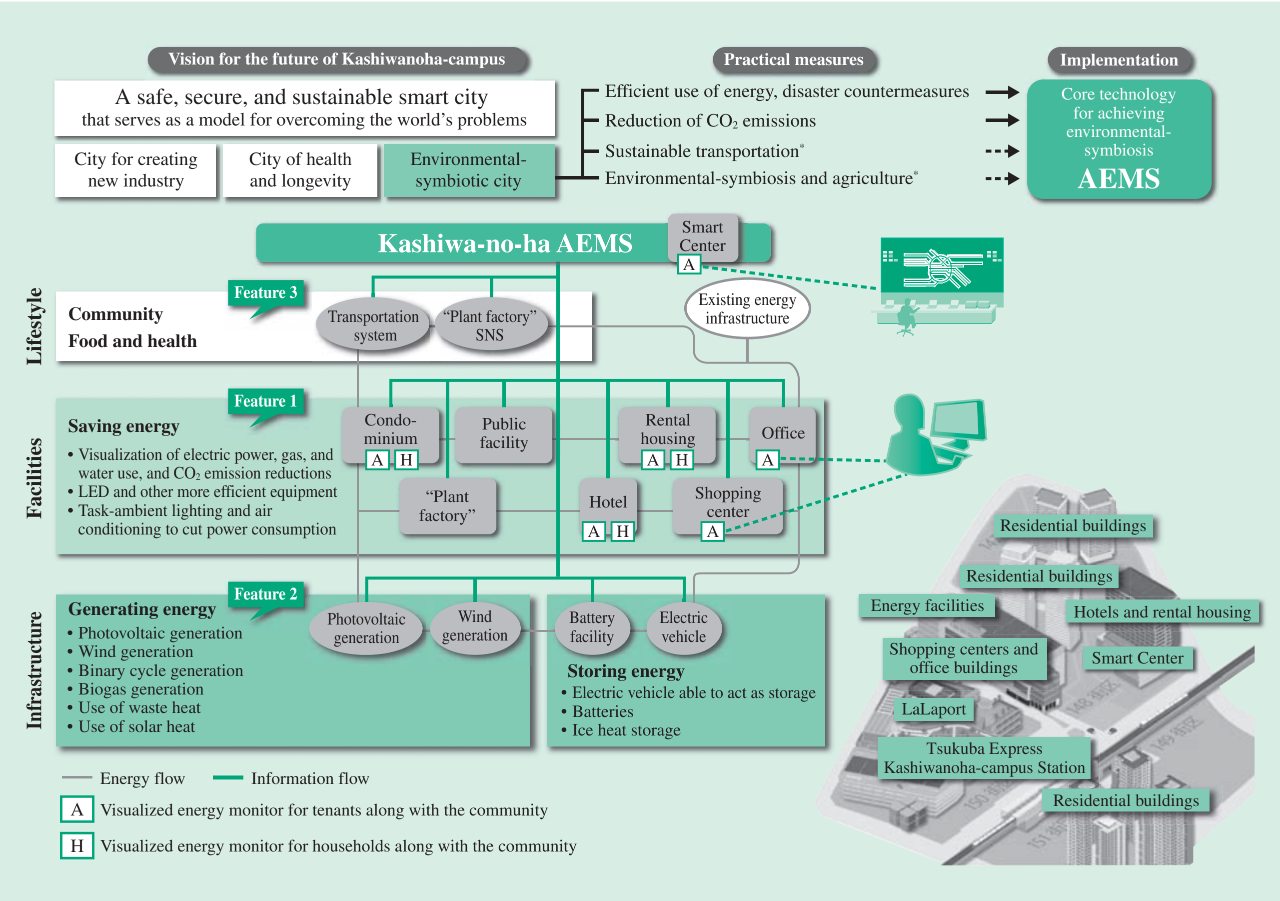
SERVICE DESIGN IN SMART CITY IN THE NEAR FUTURE

Hitachi's Research & Development Group is supporting technology development by applying service design from the conceptual phase of the urban development business. The most important activity is to maximize the value of a city from the perspectives of both users, such as residents and visitors, and businesses, such as workers and operators. Hitachi has been involved in this solution development since the concept proposal phase in 2011.

Concepts behind Kashiwa-no-ha Smart City

The Kashiwa-no-ha Smart City project is based on three concepts: an environmental-symbiotic city, a city for creating new industry, and a city of health and longevity. This safe, secure, and sustainable city was achieved through a partnership between the public sector (government organizations), private sector (businesses), and academia (universities).

The aim of an environmental-symbiotic city is to realize a city in which both people and the environment can co-exist by solving several issues related to the environment and energy. Hitachi conducted collaborative creation with customers to achieve optimization of energy use and area-shift through the construction of an AEMS as a core technology for realizing the environmental-symbiotic aim as well as generating energy, saving energy, and storing energy. The factors of "community" and "health" were also captured as part of the "energy"



CO_2: carbon dioxide AEMS: area energy management system SNS: social networking service LED: light-emitting diode
* Integration with AEMS is part of the future plan.

Fig. 1—The Role of Kashiwa-no-ha AEMS as Practical Means for Implementing Future Objective of Transforming Kashiwa-no-ha Smart City/Kashiwanoha-campus into an "Environmental-symbiotic City."
The AEMS consolidates collection and management of data on energy use in the area to predict community-wide demand. Overnight power is utilized along with photovoltaic and wind power generation to charge batteries, and this power is then supplied to the community. The AEMS also minimizes peaks in demand for electric power and ensures that full use is made of renewable energy sources despite the weather-dependence of their output. It provides a means of visualizing energy for the city.

for management. As a result, everyone in the city will care about an environment that encourages them to do something about it. Kashiwa-no-ha has become a center for connecting people and facilities in the city with the aim of "growing and developing a smart city" (see Fig. 1).

Study Process for Energy Visualization Display

To engage in an unprecedented project for managing city energy, service design was applied to the study of capturing a method of visualizing energy from the organization of values of multiple users. An effortless and sustainable scheme is required for people to act voluntarily through the Kashiwa-no-ha AEMS without feeling any burden from participating in energy saving activities. Thus, the contact point between users and the Kashiwa-no-ha AEMS and the connection with energy was organized, and the information to be communicated and how to present it was studied. The activities are summarized by six steps.

(1) Organizing value

Methods of presenting visualizations with an effective appeal to users by organizing the values of stakeholders such as residents and business entities was studied.

(2) Visualizing value

Ideas were studied using visualization methods from a technology perspective to realize the values of targeted stakeholders.

(3) Applying technology

The functions of the AEMS were organized and studied from the specifications based on the display design that was created in the study of ideas.

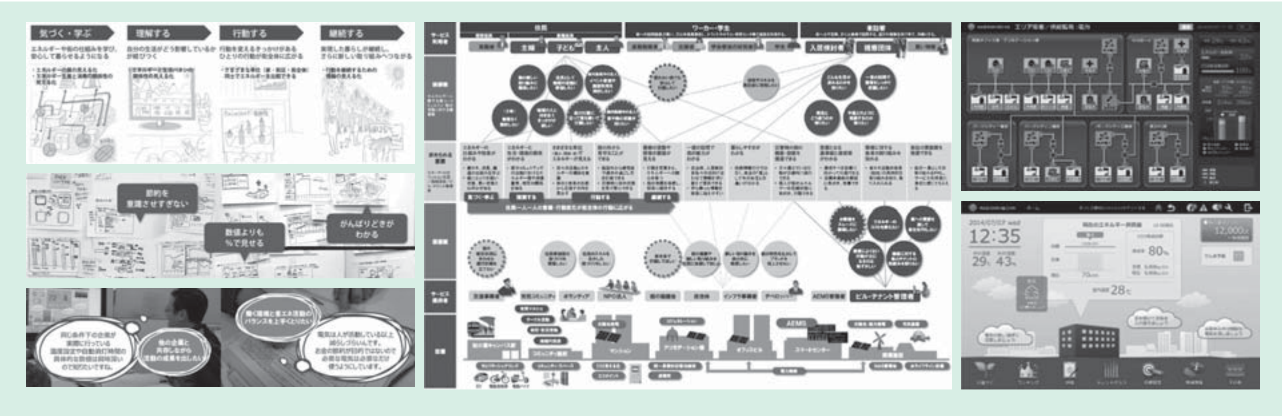


Fig. 2—The Process for Designing the Displays of the Energy System with Visualized Energy Use to Explore the Values Examined in Residences for Developing the Actual System, Applying Technology, Conducting Surveys with Stakeholders, and Advancing Values.
A study into energy visualization was conducted based on the collation of things like changes in activities and attitudes at Kashiwa-no-ha, communication, and the roles played in the community by housing residents, visitors, building users, and others. In the work on identifying value, in particular, what was helpful for studying the displays was the use of a stakeholder map to define the relationships between people, goods, and the environment and the identification of values for everyone involved with the community.

(4) Understanding relationships

Direct observation of the environment and the use of energy facilities was conducted in the station center area of the Kashiwanoha-campus.

(5) Bringing out values

The required features were reorganized based on the information about users' needs and the local environment that were obtained from observation. This time the detailed planning of "Kashiwa-no-ha AEMS as a center of connection for a growing and developing city" was concluded, including specifications based on future concepts such as information displays for transportation that were not part of the project.

(6) Brushing up visualization display

The final proposal regarding the details of the display design was completed through all the activities. At the same time, guidelines for making designs that are compatible with home energy management systems (HEMS) was generated by collaborating with other companies. The aim is to make the residents and workers recognize activities related to energy in Kashiwa-no-ha (see Fig. 2).

Features of Energy Visualization and Display Design

The development of the display design for the Kashiwa-no-ha AEMS as a system was conducted for "visualizing the city's energy."

(1) For smart center energy managers

The energy manager will monitor and manage the entire city's energy and disaster prevention functions, which is an unprecedented new role. The display configuration is for professional use with dynamic representations that respond to energy changes. Through this design, the status of the city's energy can be seen early enough for visitors to understand the activities that are going on in Kashiwa-no-ha.

(2) For office users and business tenants

The workers in the area can access energy-use information for the city and for tenants from their workplaces and homes. By engaging in energy saving activities while working, the effort of each person will produce results for the whole city. The display combines the city's status and energy information for tenants, and was designed to be intuitively understandable. This makes everyone feel that they are part of the Kashiwa-no-ha community and that it is part of their daily lives and work. This leads to continued use of the system.

Evaluation of Service Design Activities

The display of the Kashiwa-no-ha AEMS that was studied through these activities has been exhibited in the Kashiwa-no-ha Smart City Museum, which opened in May 2013 in front of Kashiwanoha-campus Station, per customers' requests. This exhibition started before the system construction. The technologies, facilities, and structure of this near-future city, and its lifestyle, can be experienced by companies, local government stakeholders, and citizens. This project has become well known to many people.

Furthermore, Mitsui Fudosan and Hitachi jointly received a 2013 Good Design Award in the urban development category. A large exhibition panel, a display for demonstration, and documents that explained the relationship between urban development and energy through the two companies' collaborative activities were prepared for the screening. The comments from the jury included "this makes it possible to share energy information that is difficult to visualize and I expect it will become a guideline for future urban development."

Operation of the Kashiwa-no-ha AEMS officially started in April, 2014. In July of the same year, Gate Square in the center streets area and the Smart Center facility of the Kashiwa-no-ha AEMS were opened. The smart city has begun its journey.

VISION DESIGN FOR A FUTURE SMART CITY

Hitachi has been conducting demonstration projects in healthcare independently of the energy industry. However, when a study involves the near future, the project technology can easily be expected to involve advanced expertise in technology. On the other hand, the second stage of the Kashiwa-no-ha Smart City project is planned to expand urban development to the north of the area. In this situation, an overall study is required. Thus, the vision design methodology for Kashiwa-no-ha was applied to studying the ideal urban image as it is anticipated to be 10 years from now.

Utilizing Methodology in Kashiwa-no-ha Smart City Project

Hitachi's Research & Development Group utilizes vision design to study the ideal image of the future. It generates content that qualitatively infers people's values in the future by intensive research into social trends from a politics, economy, society, and technology (PEST) perspective[2]. This time, the project is required to illustrate a future image and a service outline in a determined area. The methodology for the project[3] is combined with service design to study "Kashiwa-no-ha Smart City Vision." A feature of this combined methodology is that it enables the development of a future image with an understanding of the area and the distinctive service outline by sharing the research information with all stakeholders. This has allowed the project to study its directions without concerning itself about an unpredictable future.

Study Methodology Process for Ideal Image of an Area in the Future

There are four steps in this project methodology, which conducts two workshops with the stakeholders to analyze information and create the vision and service outline.

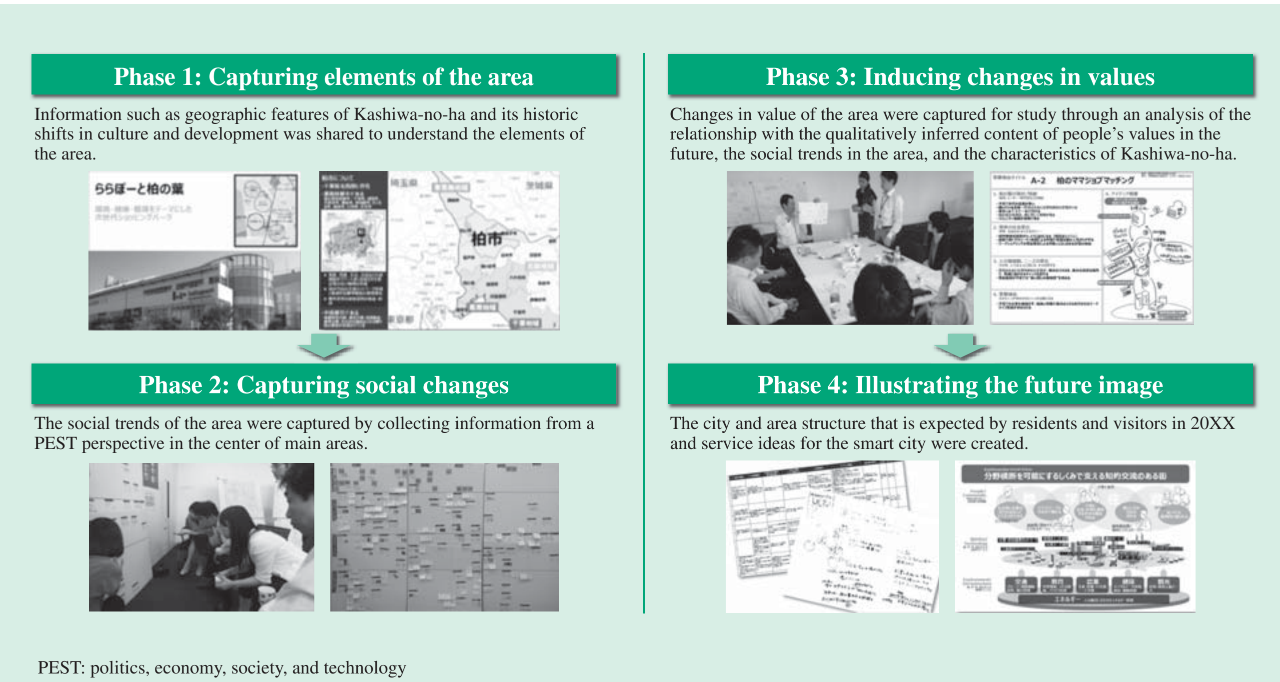


Fig. 3—The Study Process Using Techniques for Considering Future Vision for Community.
A "service image" that conforms with the vision and changes in community values can be created through a study with stakeholders that starts with preliminary preparations and extends over four phases, and collating the work done at the workshops.

(1) Capturing elements of the area

Information such as geographic features of Kashiwa-no-ha and its historic shifts in culture and development was shared to understand the elements of the area. Document research, direct area observations, and interviews with local residents were conducted to analyze the current conditions. After obtaining the appropriate data, workshops were conducted to share information with all the stakeholders to extract the issues.

(2) Capturing social changes

The social trends of the area were captured by collecting information from a PEST perspective in the center of Kashiwa-no-ha and other main areas. Many PEST cards were produced. The change keywords were extracted from those PEST cards with a timeline in workshops.

(3) Inducing changes in values

Changes in value and the distinctive features of the area were captured for study through an analysis of the relationship with the qualitatively inferred content of people's values in the future, the social trends in the area, and the characteristics of Kashiwa-no-ha.

(4) Illustrating the future image

The city and area structure that is expected by residents and visitors in 20XX and service ideas for the smart city were created. The detailed image of people's values in the future for an anticipated time was formulated using content based on qualitative inferred (see Fig. 3).

Future Image of Kashiwa-no-ha

The study produced eight current conditions, future value changes, a vision, and service images.

The value changes and ideal image of the city from the perspective of Kashiwa-no-ha residents and users 10 years in the future were illustrated as a lifestyle design. The conceptual proposal was composed as a basis for discussion and collaborative creation (see Fig. 4).

With regard to the characteristics of users, an image of the technologies, services, environment, and infrastructure that support working, studying, living, and recreation in the area was produced by capturing the values of future residents and users, who may include families or visitors from outside Japan. In particular, the captured visions for transportation, education, agriculture, health, and travel have become features of the Kashiwa-no-ha AEMS as

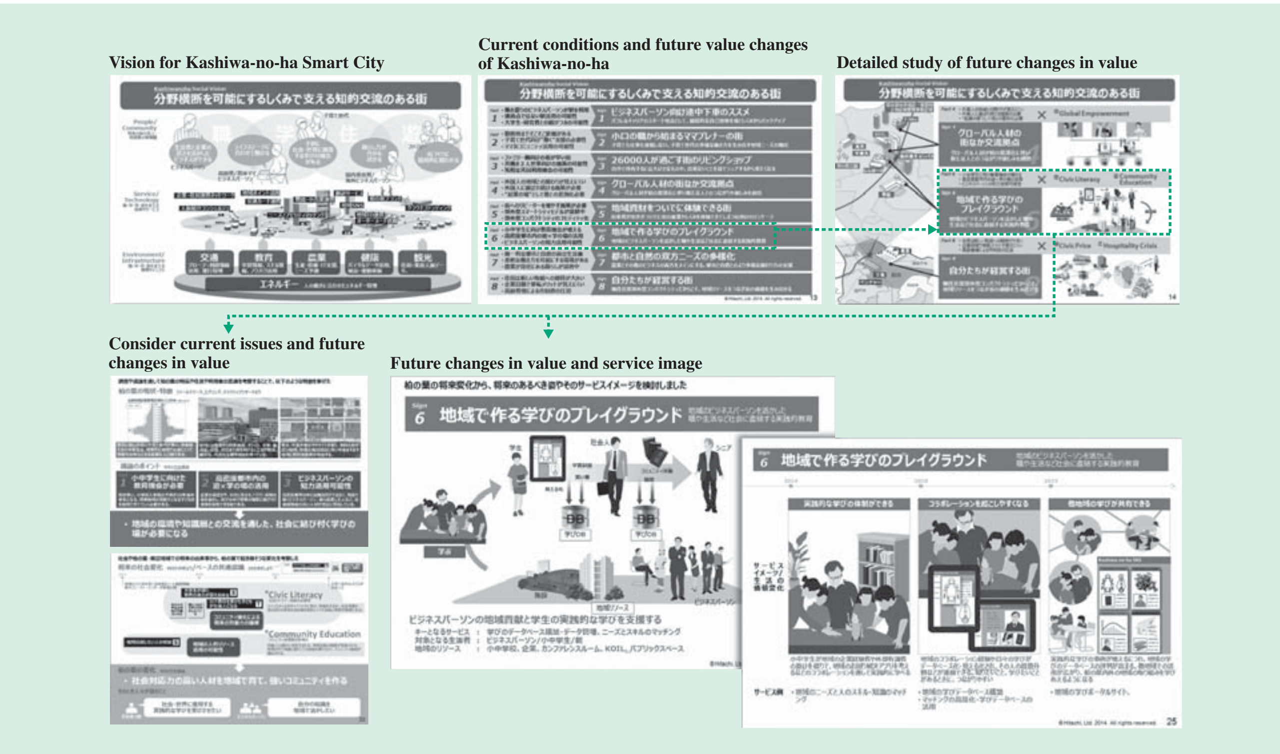


Fig. 4—The Smart City Vision and Service Image for Kashiwa-no-ha.
It is possible to identify how values will change based on a consideration of current issues and future changes in values, and to present a detailed service image that also expresses interrelationships. Collated in conceptual proposal, this material can then be used in future studies.

well as the platform for energy management that includes people's movement. From this study, the direction can be determined in detail by illustrating the service image based on the created future vision. The importance of this activity was that its scheme was understood by Hitachi staff and that it expanded their understanding with regard to study for the future.

Evaluation of Future Image Study and Future Application

In July 2014, Hitachi established "Hitachi Collaboration Square Kashiwa-no-ha" as a strategic business location along with the opening of Gate Square in the center of Kashiwa-no-ha. This presentation has also used the methodology to accelerate collaborative creation by sharing the perspectives and needs of the city and residents in the future. Its press release announced that its aim is to create a global Social Innovation Business from Kashiwa-no-ha Smart City[(5)].

In October of the same year, the generated vision for Kashiwa-no-ha Smart City was presented to Mitsui Fudosan and received several comments. The overall activity was well received with particular interest in the study conducted through a field survey to understand the area intensively and the generation of a vision by capturing changes in the future. After that, workshops were held for joint projects between Mitsui Fudosan and Hitachi based on the documents from this study.

CONCLUSIONS

Mitsui Fudosan Co., Ltd. and Hitachi have been treating Kashiwa-no-ha Smart City as a showcase for urban and infrastructure development in the future through the development of an energy network in a smart city centered on the Kashiwa-no-ha AEMS and through collaborative promotion in other business demonstration projects. Through the application of service design and vision design, the project has demonstrated the importance of utilizing core technology by illustrating images that form a platform for communities in cities and by connecting energy management systems to the future from the near future.

The high-density environment and technological applications required for urban concentration and compact cities brings possibilities for urban development both globally and in Japan. However, also inevitable is problem solving for disappearing cities in Japan due to the reduction of the population and increase in the number of elderly people, which are a popular subject in Japan.

The activity of collaborative creation with customers will be conducted by creating a vision in anticipation of the future for providing services as well as creating values for residents, visitors, and business entities in each city and their surrounding areas to study the application of optimized technologies. The aim of this is to make contributions to the city through an acceleration of Social Innovation Business.

We deeply appreciate the people at Mitsui Fudosan who provided valuable feedback on the sites when we were developing the Kashiwa-no-ha AEMS and studying the vision for this smart city.

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Featured Articles

Initiatives Aimed at Creating a Universal Design City for 2020

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OVERVIEW: "Implementation of Advanced Infrastructure Systems from Japan in 2020—Realizing a Dream that Originates from Japan," an FY2014 project of the Council on Competitiveness-Nippon with participation by 17 companies, put forward the UD city as a Japanese vision for overcoming such challenges as the extreme aging of the population and the increasing number of overseas visitors to Japan in the lead up to international sports events that are to be hosted by Tokyo(1). The proposal included each company describing on its own behalf the challenges in the energy, mobility, security, and communication technology sectors that are best tackled through public-private collaboration. This article describes the "UD city," the particular approach to urban development that is based on the UD concept and is being undertaken by Kajima Corporation and Hitachi, and the outlook for the future.

INTRODUCTION

IN the lead up to an international sporting event to be hosted by Tokyo in 2020, preparations are being made for numerous redevelopment projects, upgrades to city infrastructure, and technology trials for advanced infrastructure systems such as automated transportation. Meanwhile, universal design (UD) is growing in importance as a core function of cities, including increasing the number of overseas visitors to Japan to 20 million (target for 2020), and dealing with the extreme aging of the population and with those most vulnerable to disasters.

Through the efforts of relevant government agencies and private companies, steady progress has been made on making public spaces and transportation barrier-free and incorporating UD into different products, areas in which Japan is well-advanced by international standards. From the viewpoint of users, however, progress remains patchy and unevenly distributed. This is believed to be due to its limited and transient nature because work on UD for infrastructure, products, and services has been undertaken in a piecemeal way and has had to be established in a standalone manner in terms of the business model it follows. Other inadequacies include lack of public understanding of the elderly or disabled, and poor awareness of the mutual and cooperative assistance by city residents needed to fill the gaps in infrastructure and other technology.

The 2020 sporting event is an excellent opportunity to overcome the challenge of making progress on UD from the user's perspective because of growing interest by the public as large numbers of stakeholders work together to achieve their shared objective of making the 2020 event a success.

While the concept encompasses all aspects of people's lives in cities, the proposal focuses on mobility, a subject that is deeply intertwined with the quality of life of the elderly and the disabled.

FROM THE BEGINNINGS OF BARRIER-FREE ACCESS TO THE ORIGIN OF THE UD CITY

An international sporting event hosted by Tokyo in 1964 was one of the starting points in Japan for thinking about autonomy and barrier-free access for the disabled. The same event, which is to be hosted by Tokyo again in 2020, presents a business opportunity for marketing advanced Japanese infrastructure systems to the world, in the form of a vision for mature cities in which the extreme aging of the population has become well-established.

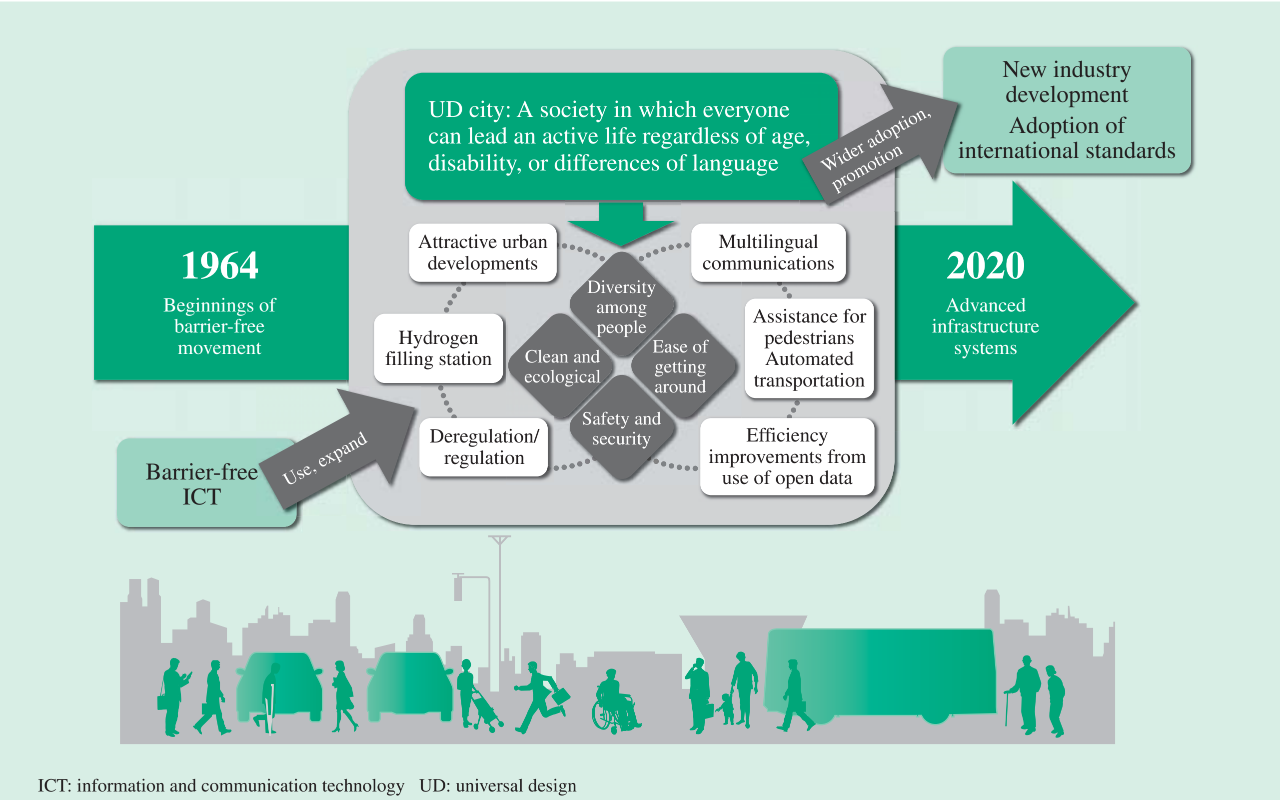

Fig. 1—Creation of UD City by Building Advanced Infrastructure Systems.
Demonstration project for trialing advanced systems for infrastructure such as energy, mobility, security, and communications are planned in the lead up to 2020. The UD city aims to tie these together from the user's perspective.

What is a UD City?

The concept behind a "UD city" is that it is a place in which everyone can live an active life regardless of age, disability, or differences of language. While the UD city represents a new vision for the cities of the future, much like an eco-city or smart city, it differs in envisaging the infrastructure, products, and services that make up a city in terms of user needs. The vision of everyone being able to appreciate the benefits of innovation to the greatest extent possible carries with it the potential for the creation of new industries (see Fig. 1).

Extreme Aging Populations and UD Cities

As Japan leads the world in the trend toward the extreme aging of the population, creating a society in which it is easy for the elderly to live is a pressing concern. For the elderly, being able to walk around, for example, is not only a means of getting from place to place, it is also a basic requirement for maintaining their quality of life. This means that reducing barriers and making places easily accessible by pedestrians, and expanding the scope of activity through measures such as physical assistance or personal mobility, are effective policies for making the elderly more active and extending their healthy life while also revitalizing the local economy.

ICT Platforms Needed for UD Cities

For example, pictograms (graphic symbols indicating things like toilet facilities or event venues) were used during the sporting event referred to earlier that was hosted in 1964 to make Japan an easier place to get around for overseas visitors of many different nationalities. Similarly, plans for the lead up to 2020 include providing advanced information and communication technology (ICT) such as multilingual digital signage as part of the city's tourism infrastructure. However, because it is impractical to serve the diverse needs of visitors with a single service, it is essential that these be coordinated and augmented based on the preferences and other characteristics of users. Providing seamless coordination of services from a user's perspective requires ICT platforms for the joint management and use of shared information. Examples include coordination of transportation information across different mobility services and joint management of personal information by businesses and users.

OVERVIEW OF UD CITY CONCEPT —FOCUSING ON MOBILITY—

This section considers how to deal with mobility, something that is recognized as both effective and of the utmost importance for such people as society's elderly and overseas visitors to Japan, and makes the following proposals.

Creating an Environment in which Everyone Can Move Around Freely and Will Want to Do So

(1) Mobility support technology and social practices that integrate goods and infrastructure

Easy and stress-free mobility not only helps individuals become more active and improves their quality of life in terms of health and other factors, it also promotes local economic activity and brings neighborhoods to life. What is needed are attractive urban developments in which everyone, including the elderly, disabled, and foreigners, can choose the means of getting around that best suit their physical capacities and other needs, and that encourage people to be mobile.

(2) Expansion of UD-related industry ("Silver New Deal")

The extreme aging of the population calls for infrastructure systems that enable everyone, including the elderly, disabled, and foreigners, to live active lives and make full use of their capabilities. This involves incorporating advanced Japanese technologies into these infrastructure systems and having them evolve with well-balanced assistance from hardware and software—including their integration into the environment and services, rather than just machinery on its own—and with the involvement of people. As the market for products and services that suit the lifestyle needs of such users is extremely large, an expansion in UD-related industries is anticipated(2).

Challenges

To achieve the objectives described above, the following two challenges need to be overcome.

(1) Treating products, services, and infrastructure as a combined package

Rather than deploying products, services, and infrastructure individually, they need to be provided as

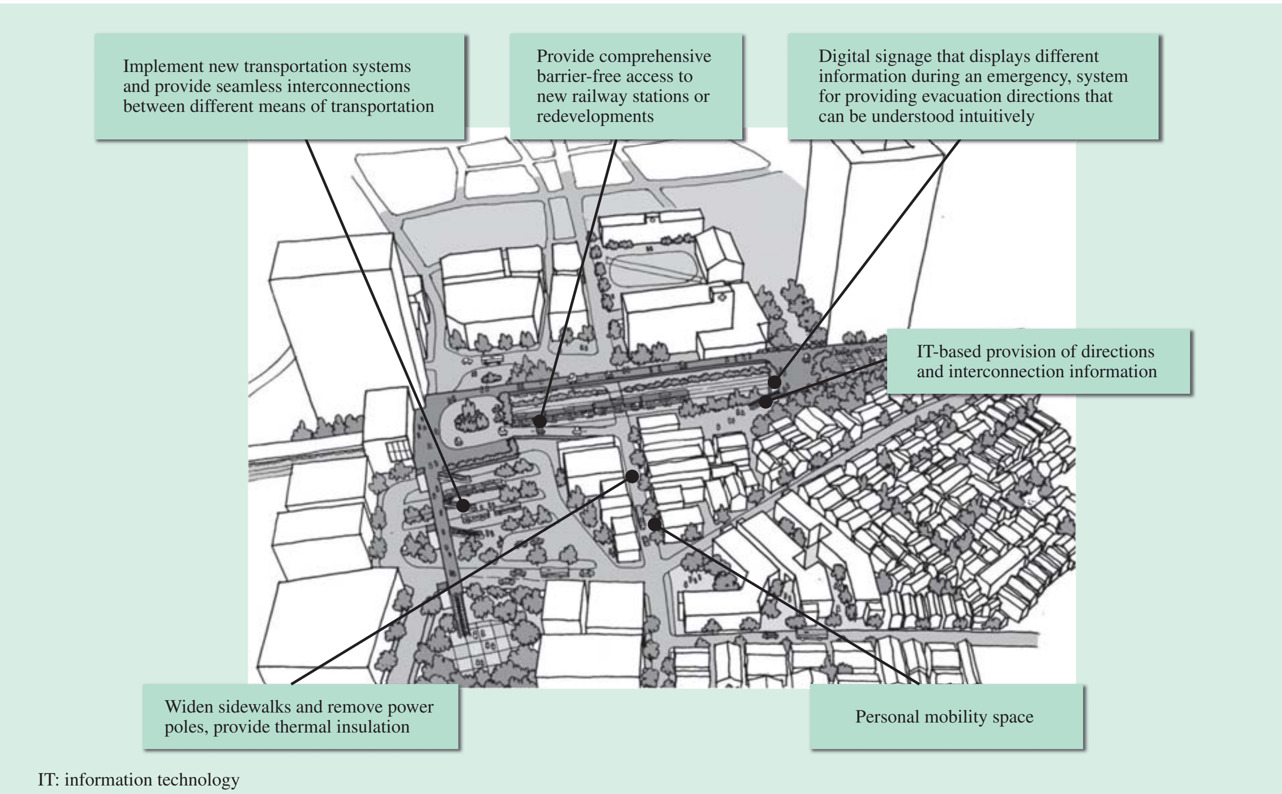

Fig. 2—Unified Execution of UD Implementation Projects for Urban Development.
UD technologies are first combined into packages through demonstration projects that include implementing new transportation systems or providing barrier-free access to sports venues, major transportation routes, and new railway stations, then deployed throughout the city.

a package in order to take advantage of synergies and make them more efficient. Personal forms of mobility with designs that encourage use, transportation and disaster information customized for individuals, and thoroughfares that can be shared by pedestrians, bicycles, electric mobility scooters, and other vehicles are examples of packages that support various different forms of mobility. Furthermore, making neighborhoods more attractive (such as being more lively and convenient) is an essential prerequisite for encouraging this sort of mobility.

(2) Pressing ahead with UD cities as a form of Social Innovation

There is a need for measures that cover numerous stakeholders in order to provide services that appear seamless to users, with a prerequisite being that Social Innovations include the development of new business models through collaborative creation.

Five Policies to Facilitate Implementation

The following five policies have been proposed for making the UD city a reality in the lead up to 2020.

Execution and Packaging of Public-Private UD Implementation Projects in Key Parts of the City

UD implementation projects that include the provision of major transportation routes and venues for large sporting events, new railway stations, and redevelopment involve new transportation systems as well as pressing ahead with the comprehensive provision of barrier-free access. Effective technology packages initially established through demonstration projects will subsequently be adopted throughout the city (see Fig. 2).

Creation of Attractive Pedestrian-oriented Thoroughfares that Invite Use of Diverse Forms of Mobility

To provide places where people can get around easily, whether it be on foot or using an electric mobility scooter or other vehicle, thoroughfares will be created that include infrastructure such as thermal insulation and are also free of obstacles such as power poles. The previously unused measure of selectively raising up parts of the road will be adopted for differences in level between roads and sidewalks. Places will be created where bicycles and personal mobility vehicles

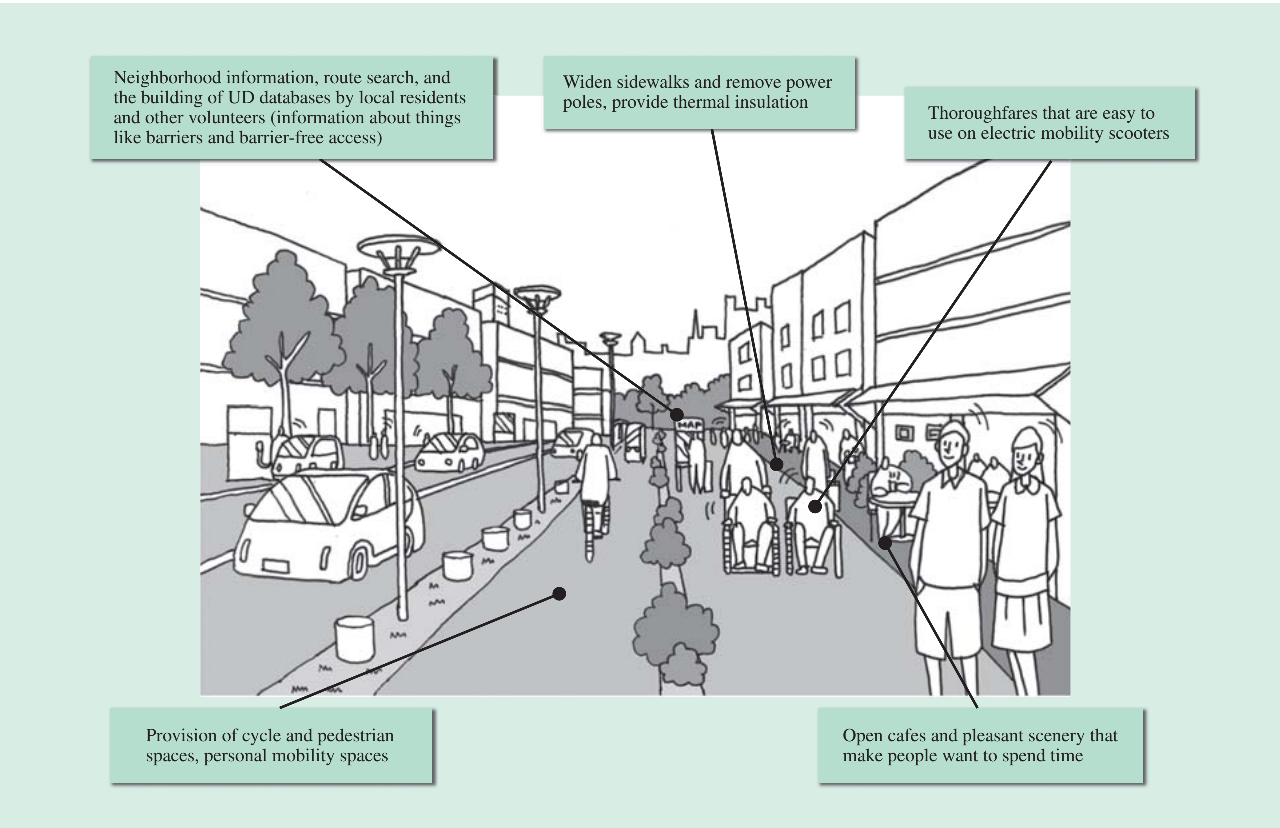

Fig. 3—Attractive Pedestrian-oriented Thoroughfares Suitable for Use by Diverse Forms of Mobility.
The provision of thoroughfares where people can get around on foot or can share with electric mobility scooters, bicycles, and other vehicles is an important aspect of the UD city. As well as being functional, these need to be attractive enough to encourage people to get out and about.

can be ridden safely, together with infrastructure for enabling seamless interconnections between different forms of transportation (such as bus stops or the plazas outside railway stations) (see Fig. 3).

Industry-Government-Academia Partnerships for Creating Market-Responsive Goods and Services to Achieve World-leading UD

This involves improving convenience and encouraging wider adoption by using such advanced technologies as artificial intelligence (AI) and robotics, and by producing attractive designs that utilize ways of creating market-responsive goods and services that allow for public participation.

Products and solutions suitable for the wider world will be made possible through collaborative creation with numerous stakeholders using techniques such as design thinking and inclusive design.

Achieving Viability for Construction and Operation of Transportation, Event, and Disaster Information Systems that Satisfy Diverse User Needs

This means enabling the provision of extensive information to the elderly, disabled, and foreigners to help them move around by having local residents and other volunteers create resident databases (DBs) of information about things like barriers and barrier-free access for small communities, and then combining these DBs. The information to be included in these DBs will be updated not only with detailed figures and photographs, but also information that is closely associated with daily life, such as three-dimensional information, frequency of use, and recommendations, and it will have interfaces that allow it to be accessed in a variety of different ways, including multilingual support.

Composition of Government-led "Centralizing Functions" that Execute UD-derived Projects in an Integrated Manner

The creation of a UD city is a complex policy challenge that covers a variety of sectors, and it requires the government to coordinate beyond its own specialist areas and proceed in a comprehensive and unified manner. Achieving this demands one-stop "centralizing functions" for formulating and implementing comprehensive policies. These functions integrate and standardize knowledge about UD, and are also needed when extending activities nationwide or overseas.

INITIATIVES AIMED AT IMPLEMENTATION

Putting the above proposals into practice will require collaborative creation through collaboration between the public and private sectors.

Integrated Supply of Infrastructure, Products, and Services by Combining UD Technologies from Different Companies

To date, the UD of infrastructure and products has been undertaken by individual companies working alone. Experience with UD at Kajima Corporation, for example, includes firefighting equipment (water screens) that enable the safe evacuation of people from a building during a fire regardless of their age or physical capabilities, and spatial designs for lighting, sound, and the appearance of floor coverings that appeal to the senses. The company has also adopted techniques for using simulation to evaluate these prior to use[3].

Hitachi also has experience using UD for products such as home appliances, elevators, and rolling stock, and it has utilized the experience design methodology for optimizing designs in terms of how user experiences vary over the course of service delivery[4], [5].

Various other companies have applied UD to a wide range of products, including vehicles, ICT equipment, and home appliances.

The UD city proposal represents an approach that maximizes urban values from the user's perspective by consolidating the UD practices of these companies to supply infrastructure, products, and services as an integrated package.

UD Trends

A wide range of policies are under consideration as potential UD initiatives. These include the "Basic Plan on Transport Policy" being coordinated by the Ministry of Land, Infrastructure, Transport and Tourism, Automated Driving System that helps the elderly and others get around (the Cabinet Office's Cross-ministerial Strategic Innovation Promotion Program), the "Study into How to Provide Information and Barrier-free Access for Evacuation Routes, etc. for Disasters and Emergencies" of the Ministry of Land, Infrastructure, Transport and Tourism, and the provision of infrastructure for overseas visitors and others (payment by credit card: Ministry of Economy, Trade and Industry, multilingual translation system: Ministry of Internal Affairs and Communications). In Tokyo, meanwhile, numerous local bodies have formulated policies for providing things like barrier-free access and UD (with a plan for welfare urban development as one example), including a committee to study comprehensive transportation policies for Tokyo.

A recent development has been an increase in UD-related activities in anticipation of the international sporting events to be hosted by Tokyo, including the Tokyo Universal Design Showcase(6) announced in May 2015 by the Industrial Competitiveness Council, and an economics conference on the Olympic and Paralympic Games and other events held by the Japan Business Federation (Keidanren).

Achieving Collaborative Creation with a View to the Long Term

Creating a UD city requires ongoing activities that go beyond the bounds of "welfare" and are based on an awareness of how it relates to things like improving social vitality and industrial competitiveness. However, benefits are slow to appear in the short term and only come about through ongoing work. What is needed is for companies to act on their own initiative in cognizance of these long-term benefits and in step with the national and local government developments described above, and, against this background, to establish a virtuous circle in which the adoption of more active policies by the public sector creates an environment that encourages action by the private sector (see Fig. 4).

A feature of the proposal by the Council on Competitiveness-Nippon (COCN) is that it involves companies themselves engaging in ongoing activities aimed at achieving the objective. The proposal also involved the establishment of a UD city steering committee in October 2015 by a number of companies to look at how to realize the concepts described in this article. This was a spin-off activity of the FY2014 project. It is anticipated that activities like this will help make the UD city a reality by coordinating with other initiatives such as public-private technology trials or policies for raising awareness among city residents.

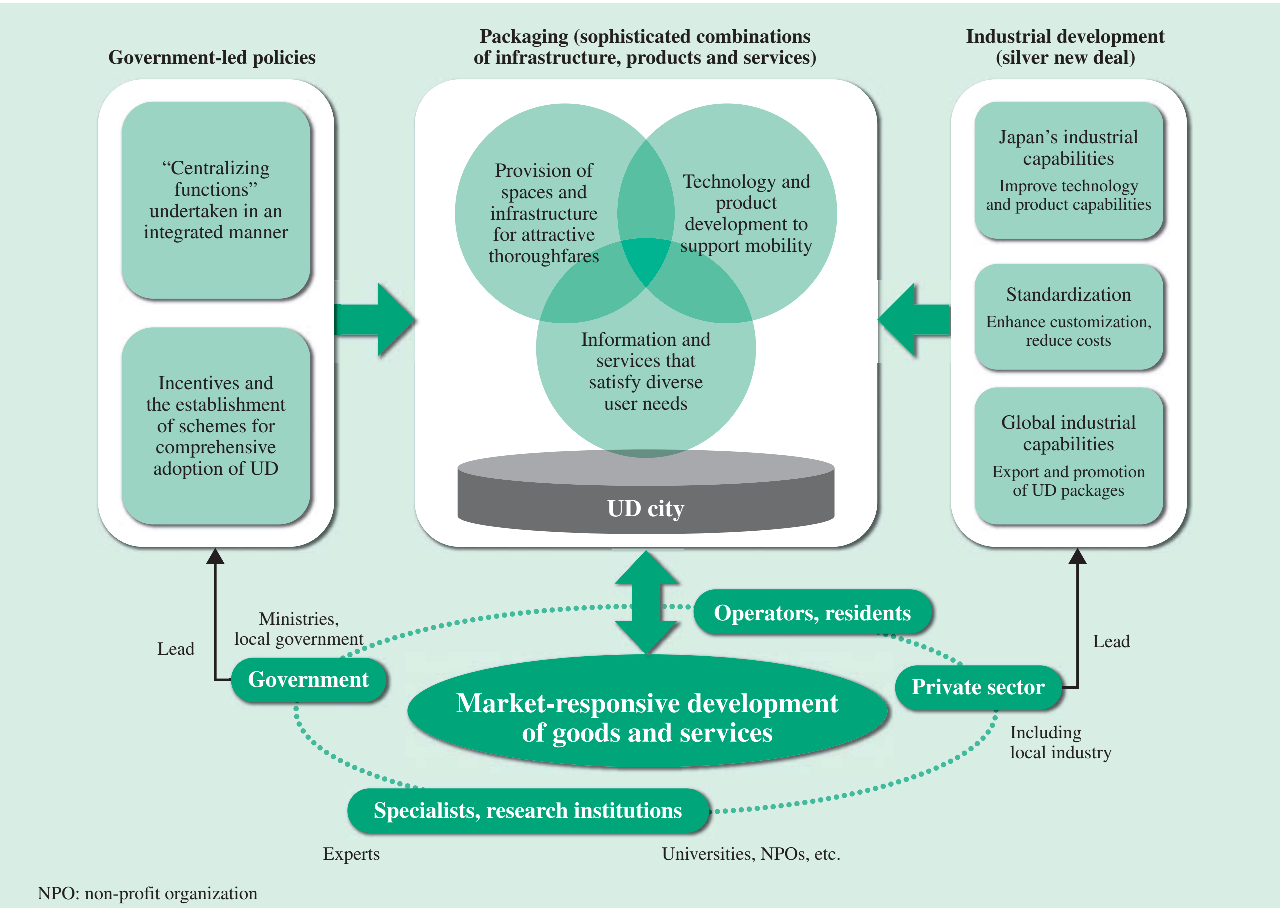

Fig. 4—Overview of Activities Aimed at Creating UD Cities.
What is needed is for companies to act on their own initiative in step with national and local government developments, and, against this background, to establish a virtuous circle in which the adoption of more active policies by the public sector makes it easier for the private sector to take up new challenges. By adopting an approach based on user participation, opinions are incorporated from the early stages.

CONCLUSIONS

Considered in terms of the technologies used to achieve it, the UD city is not significantly different from the existing idea of a smart city. Nevertheless, it represents a new approach in that it involves user-inspired urban and product development whereby services and infrastructure are optimized in terms of the perspectives and needs of users, while also raising awareness of UD among city residents. Achieving this is recognized as a major challenge targeting the market-responsive production of goods and services through collaborative creation with the many stakeholders and participation by those involved, and thereby fosters a sense of complementarity and mutual assistance among city residents.

Just as the international sporting event held in Tokyo in 1964 was one of the factors in kicking off the barrier-free movement in Japan, letting the world know that holding the same event again in 2020 will be the starting point for creating UD cities should lead both to a renewal of understanding among the Japanese population, and to the international promotion of a vision for cities where the aging of the population is well-advanced by the country that will be the first to experience such a situation, namely Japan.

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Numerous people from relevant government departments, universities, and other organizations contributed ideas to the preparation of the Council on Competitiveness-Nippon (COCN) proposal that forms the basis of this article. The authors would also like to take this opportunity to thank the companies that were part of the project and participated in discussions, and the members of the COCN executive committee who provided advice.

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Featured Articles

PKI Platform for Campus Information Systems Using Cloud-based Finger Vein Authentication and PBI

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Satoshi Saito
Masaki Konno

OVERVIEW: Incidents involving leaks of personal information from universities, companies, and other organizations resulting from such attacks as unauthorized login are on the rise, creating a major problem for society. Unfortunately, the on-premises adoption of biometric authentication is made difficult by high costs, including the installation and operation of dedicated servers and modification of existing systems. Hitachi teamed up with Kyoto Sangyo University to run a demonstration project that combined cloud-based finger vein authentication with existing campus information systems on site in order to identify the problems associated with installation and operation and to prepare for wider deployment. The results will enable the implementation of safe, secure, and convenient academic systems and social infrastructure.

INTRODUCTION

THERE is an active program of collaborations and partnerships between industry and academia in Japan, including Hitachi, Ltd. Recently, there has been a call for initiatives aimed at commercialization that will enable the generation of sustainable innovation by combining the work of universities and other research institutions with the needs of corporations.

To energetically promote collaboration between industry and academia, the Japan Science and Technology Agency and the New Energy and Industrial Technology Development Organization have hosted Innovation Japan, the country's largest forum for matching up industry and academia. Hitachi has offered cloud-based finger vein authentication for safe, secure, and convenient personal identification to Associate Professor Toyokazu Akiyama of Kyoto Sangyo University, which exhibited at Innovation Japan 2013. The spread of Internet services has led to a rapid increase in the threat of unauthorized logins using techniques such as password list attacks. The recognition by Associate Professor Akiyama of the need to ensure stronger user authentication in the future in university information systems as well as elsewhere led to his agreeing to joint research aimed at overcoming the problem with the intention of using the work to create a business.

This article describes the joint demonstration project for incorporating public key infrastructure (PKI) into campus information systems using cloud-based finger vein authentication and a new technology for template-based public biometric infrastructure (PBI).

INTEGRATION OF CAMPUS INFORMATION SYSTEMS

Background and Objectives

The spread of Internet services has been accompanied by a rapid increase in the use of password list and other techniques for attacks on user authentication data, such that protecting this data is one of the major challenges facing providers of Internet services.

For university information systems, the challenges include providing stronger user authentication to support the handling of personal information. However, the adoption of more secure techniques such as biometric authentication is associated with high costs, including the installation and operation of dedicated servers and modification of existing systems.

In response, Kyoto Sangyo University and Hitachi undertook a joint demonstration project to identify the challenges associated with the installation and operation of cloud-based finger vein authentication. The joint research used a prototype cloud-based finger vein authentication system and a prototype system developed by Kyoto Sangyo University that provides a way to simplify use of PKI to study the potential for using a new biometric technique to provide more secure authentication at universities.

Research Objectives

The research involves assessing the efficiency, convenience, and issues associated with integrating Hitachi's cloud-based finger vein authentication into campus information systems at Kyoto Sangyo University.

In practice, this consisted of integrating the prototype cloud-based finger vein authentication system made up of a single sign-on (SSO) cloud-type authentication management service and a finger vein authentication product into an authentication server developed by Kyoto Sangyo University using the Shibboleth[*1] middleware, which has been adopted as a standard by the Academic Access Management Federation in Japan (GakuNin[*2]), thereby establishing an upward migration path for authentication from a GakuNin Shibboleth environment to Hitachi's cloud-based finger vein authentication.

The project also sought to reduce the amount of work required for installation at the university by identifying the changes that need to be made to GakuNin Shibboleth and setting it up as a model. The user experience was also surveyed with the aim of highlighting issues of concern or needing investigation in relation to installation and user operation.

Research Results

The research produced the following three conclusions:

(1) Cloud-type authentication management service and Shibboleth were successfully integrated using Security Assertion Markup Language (SAML) 2.0, and the settings required to achieve this were identified.

(2) It was confirmed that the identity provider (IdP) authentication server can be configured by adding additional settings to the defaults provided by Shibboleth.

(3) Integration of the Shibboleth and cloud-type authentication management service IdPs can be achieved by storing the uniform resource locator (URL) for Shibboleth IdP remote user authentication in the Shibboleth service provider (SP) module, and integrating the Shibboleth SP module and cloud-type authentication management service IdP.

From these conclusions, the changes that need to be made to GakuNin Shibboleth were identified and set up as a model. It was further concluded that this research can be utilized when universities that belong to GakuNin adopt Hitachi's cloud-based finger vein authentication to reduce the amount of work associated with making changes to their server settings.

The research also found that the authentication system was suitable for practical use, being just as good as the identification (ID) and password authentication in current use with respect to perceived speed, usability, and accuracy of identification. This implies that it is worthwhile to adopt the system as a way of reducing the security risks (including interception and spoofing) associated with the keyboard entry of an ID and password.

On the other hand, it was anticipated that eliminating all user resistance to the introduction of the new system would prove difficult. Instead, rather than adopting cloud-based finger vein authentication for all users at once, including students, it was deemed desirable to foster an environment in which the use of biometric authentication would gradually spread through the university by introducing it progressively, starting with a limited user base, such as academic staff engaged in specific work.

PKI PLATFORM INCORPORATING PBI

Background and Objectives

With web browsers having become widely used as an interface for Internet access, along with strengthening interoperation with local devices as in Web Real-Time Communications (WebRTC), there is a growing need for new forms of communication such as peer to peer (P2P) that are unlike those of the past.

With the spread of WebSSO technology, meanwhile, the environment is being put in place to allow end users to demonstrate their authenticity via SSO servers. Unfortunately, SSO only provides a way for end users to verify with applications that they are who they claim to be. It offers no direct mechanism for end users to verify the identity of other users.

Research Objectives

The research was intended to make GakuNin more useful by extending the scope of SSO to encompass those areas required for P2P communications and content signatures.

Kyoto Sangyo University studied how to combine WebSSO and PKI to provide a way for end users to verify each other directly from a web browser, and conducted research and development to identify the associated security issues.

The joint research project has the potential to make it possible to implement more secure simple

*1 Shibboleth is a registered trademark of Internet2.
*2 "GakuNin" is a registered trademark of the National Institute of Informatics, Research Organization of Information and Systems.

PKI authentication for web applications by combining cloud-based finger vein authentication with research and development by Kyoto Sangyo University.

Research Overview

On the assumption that end users can be authenticated using WebSSO, Kyoto Sangyo University set out to create a simple PKI environment that allows the request, issue, and use of certificates online from a web browser. In doing so, it took note of the following considerations.

(1) Achieving security with respect to malicious websites
(2) Avoiding any need for complex key management by users
(3) Using it with WebRTC and other new applications

Progress is being made on standardizing the Web Cryptography Application Programming Interface (API) and implementing it in different browsers to provide a JavaScript*3 API for encryption processing in a browser. While the standardization documentation makes reference to key management being separate to JavaScript, at the time the study was being conducted no such functions were available in browsers. While providing encryption functions in all web browsers is impractical, a test environment was needed to allow the above work to proceed without waiting for the Web Cryptography API to be ready.

Accordingly, an encryption function was implemented externally to the browser and a framework established for function testing (see Fig. 1).

A key management server coded as Node.js*4 was installed on the local personal computer (PC) and Socket.IO was used to issue operation requests from JavaScript running in the web browser. These operations included the generation of key pairs, transmission and reception of certificate signing requests (CSRs), and Public Key Cryptography Standard #12 (PKCS#12) storage. Unauthorized manipulation of keys from JavaScript can be prevented by having the key management server API not allow access to keys.

A prototype mechanism for simplifying key management through automatic mapping of web applications and keys had already been implemented using the above framework.

The research project included an investigation into extending the existing functions of the key management service and using them for PBI. PBI includes encryption and decryption using biometric

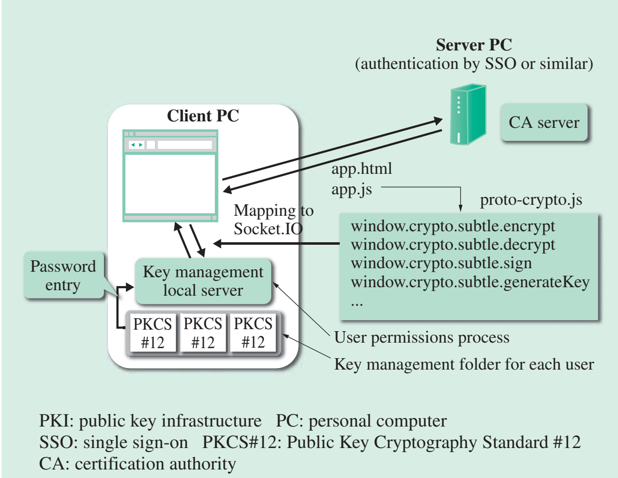

Fig. 1—Framework for Simple PKI Function Verification.
Hitachi has developed a prototype for Kyoto Sangyo University that simplifies PKI key management by implementing encryption externally to the browser on a client PC.

information as the private key and an electronic signature function. As the key management server used in the research stores keys in encrypted form (PKCS#12 format) using a pass phrase, the pass phrase must be entered when the key is used.

This provides PKI-based user (client) authentication that is both "empty-handed" (does not require a card or similar) and does not use a password by storing the pass phrase encrypted by PKCS#12 encryption using the PBI function for encryption and decryption with biometric information as the private key, and by using the biometric information again to decrypt it when needed for authentication. Fig. 2 shows a model of interaction between the PBI library and the web browser key management mechanism.

Fig. 3 shows the testing framework for PBI that extends the key management server based on the interaction model in Fig. 2.

As the keys encrypted using PKCS#12 in the test environment are software tokens, they can be used for functional testing of finger vein authentication even though it does not affect the ease of falsification in practice. However, during system development it became apparent that the use of tokens was outside the scope of the Web Cryptography API specification and that use of tokens in the API was explicitly prohibited.

In practice, when using tokens that are difficult to falsify, as is the case with PBI, a higher level of assurance (LoA) is assumed, and it is likely there will be cases where it will be desirable to enforce applications having an explicit requirement for the use of tokens with a difficulty of falsification above

*3 JavaScript is a registered trademark of Oracle and/or its affiliates.
*4 Node.js is a trademark of Joyent, Inc.

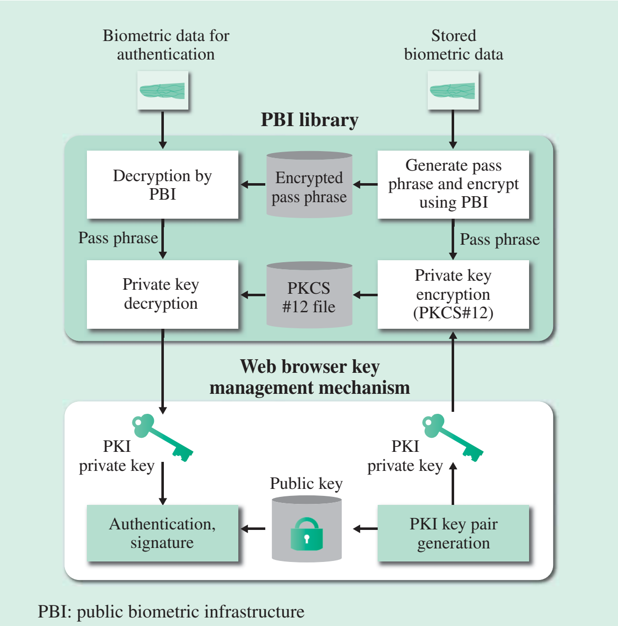

Fig. 2—PBI Interaction Model and Web Browser Key Management Mechanism.
By using PBI encryption and decryption functions, client authentication can be achieved without needing to enter a pass phrase.

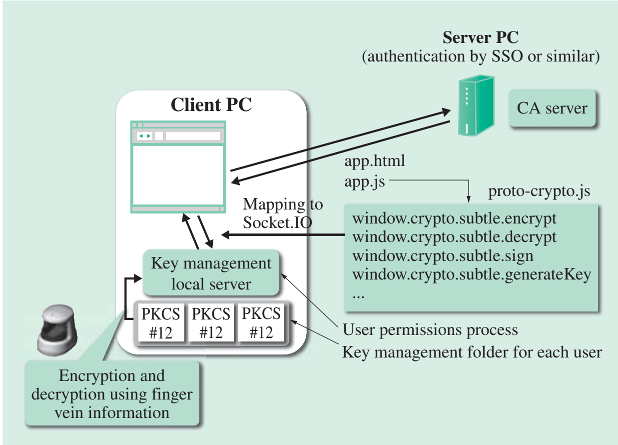

Fig. 3—Testing of PBI Interaction Model on Framework for Testing Simple PKI.
The need to enter a pass phrase is eliminated by extending the key management server and using the finger vein authentication scanner.

a certain level. For example, it is believed that the ability to specify such tokens will be desirable in situations such as when specifying a guarantee level with software like Shibboleth 3 and Authentication Engine developed by Kanazawa University. Further investigation is needed with a view to extending the Web Cryptography API.

Research Results

The research produced the following three conclusions.
(1) While implementation of the encryption processing provider is outside the Web Cryptography API specification (is left up to the vendor), with regard to selecting an authentication method with security in accordance with the guarantee level, a mechanism is needed to pass web application requests to the browser to select an appropriate provider.
(2) The framework used for this research was implemented on the basis of using software tokens, with an option to use either a password or finger veins for authentication when using the tokens, and it is anticipated that the addition of an API for specifying the authentication method on the provider will be needed.
(3) The research and development work included investigation of a model for interaction between the PBI library and the web browser key management mechanism, with application on a simple PKI testing framework. Specifically, the work demonstrated that it is possible to provide PKI-based user (client) authentication that is both “empty-handed” and does not use a password by storing a pass phrase encrypted by PKCS#12 encryption, and using the biometric data again to perform decryption during authentication.

Based on the above, as actual web application development using the PKI testing framework is currently incomplete, there is a need to develop applications and conduct operational testing to determine the issues once progress has been made on Web Cryptography API standardization and the specifications have been clarified. In the case of the hardware tokens used by the Web Cryptography API, while this has been discussed at the World Wide Web Consortium (W3C) Workshop on Authentication, Hardware Tokens and Beyond, it is anticipated that it will still take some time, including for things like coordination between hardware vendors. Until then, the intention is to continue with pre-emptive testing using the framework that has been developed.

CONCLUSIONS

This article has described research and development at Kyoto Sangyo University, Hitachi’s cloud-based finger vein authentication, and work on establishing an authentication platform that incorporates PBI technology.

It was found that practical and innovative solutions can be built by sharing information with the customer in the workplace and combining research by both parties.

In the future, Hitachi intends to continue working with Kyoto Sangyo University to implement applications in GakuNin and supply social infrastructure services that can be used in such fields as electronic payments, courier delivery, government agencies, and leisure industries.

ACKNOWLEDGMENTS

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Featured Articles

Framework for Collaborative Creation with Customers to Improve Warehouse Logistics

Junichi Kimura, Dr. Eng.
Eizaburo Takegami
Takashi Watanabe
Yoshihiro Wakisaka
Miho Kobayashi
Hiroaki Nasu
Akihisa Okada

OVERVIEW: Hitachi has developed a framework for collaborative creation with customers to analyze and improve operations at their distribution warehouses to achieve better logistics and operational efficiency. The framework is made up of three steps: (1) review current warehouse performance and identify problems, (2) conduct analyses and formulate improvement measures, and (3) assess the benefits. A notable feature of the second step is that it involves conducting the review on site while building consensus with the customer, adopting two different approaches for this purpose, namely workshops that focus of human factors and analyses that utilize data. Conducting the review on site enables improvement measures to be trialed at an early stage to support appropriate warehouse operation that responds to rapidly changing markets. This article describes the framework along with supporting case studies.

INTRODUCTION

FACTORS such as more intense competition in the distribution industry and the rapid spread of online shopping are raising the importance of logistics. Competitiveness in the distribution industry is maintained by measures such as shortening the time taken from product purchase to delivery (in the case of online shopping) and minimizing inventory at retail stores to improve profitability. Logistics support, especially improvements to working practices at distribution warehouses, has an important part to play in these measures. The requirements for achieving this include shortening the time taken for “picking” (retrieving the product from inventory) and shipment when an order is received from a retailer or individual, and the reliable execution of working practices to ensure that various deadlines are met.

Growing use is being made of 3rd-party logistics (3PL) services that draw on sophisticated know-how and expertise to handle complex warehouse operation on the customer’s behalf.

This article describes a framework for collaborative creation with customers that seeks to improve their warehouse logistics through collaboration between the Research & Development Group of Hitachi, Ltd. and the 3PL service of Hitachi Transport System, Ltd. (see Fig. 1).

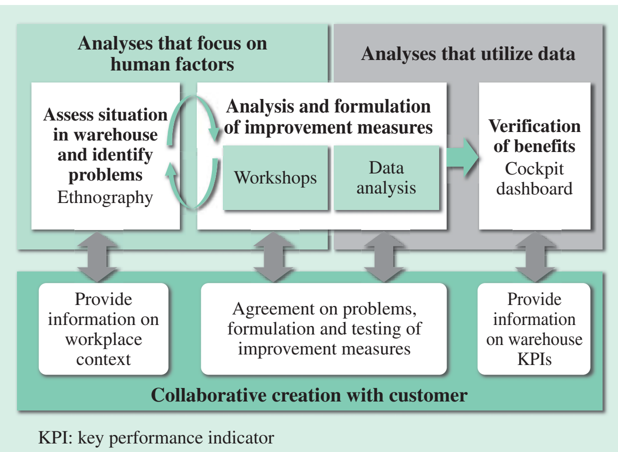

Fig. 1—Overview of Framework for Collaborative Creation with Customers to Improve Warehouse Logistics.
The framework extends from building consensus with the customer to the formulation of improvement measures and the verification of the benefits, with repeated hypothesis testing based on two approaches to dealing with the identified problems involving, respectively, analyses that focus on human factors and analyses that utilize data.

UNDERSTANDING OF WORKING CONTEXT AND IDENTIFICATION OF WORKPLACE ISSUES

This section describes the methodology of ethnographic research conducted to understand the context of working practices for warehouse logistics and identify workplace issues, and presents examples of its use at Japanese warehouses.

Ethnographic research is a technique used in fields such as anthropology and sociology. It involves living alongside the people being studied and using techniques such as interviews and observation to determine the culture and other living practices of the group (ethnic group or society). It has attracted attention in recent years as a way of identifying factors to consider in regard to operational improvements or product planning, and Hitachi has been fostering and utilizing ethnography for these purposes since 2003.

If interviews alone are used to assess working practices, the collected information tends to focus on those explicit aspects of which the workers being studied are consciously aware. In contrast, because ethnographic research conducts extensive observation of the actual behaviors of those involved, it can shed light on the overall mechanisms associated with workplace problems.

Hitachi Transport System, Ltd. has been engaged in a wide range of activities that deal with workplace efficiency improvement at distribution warehouses, including ethnographic studies of workers. Fig. 2 shows such work in progress along with the outcomes it has achieved.

Activity	Issues	Scope	Cause and effect
(1) Receiving (of goods)	Not covered by study		
(2) Restocking	Regular restocking is too slow.	Addition	Cause
(3) Picking	No products available for picking	Initial	Effect
(4) Inspection and packing	Backlog of buckets awaiting inspection		
(5) Shipment (of goods)	Not covered by study		

Fig. 2—Warehouse Ethnographic Research and Outcomes.
The photograph shows a researcher observing "picking" work (retrieving products from inventory to fill an order) and the table lists the types of activity studied, the main issues identified, and the scope of the study.

The sequence of operations from receiving (of goods) to shipment (of goods) at the warehouse being studied can be broken down into the following five steps.
(1) Receiving (of goods) (inward goods from the factory are stored in the warehouse's backyard)
(2) Restocking (transfer of products from warehouse backyard to picking area)
(3) Picking (retrieval of products to fill retailer order)
(4) Inspection and packing (inspection and packing of retrieved products)
(5) Shipment (of goods) (dispatch of packed products)

Based on consultation with the warehouse manager at the start of the study, the two steps selected for observation were picking and inspection and packing, both of which were believed to pose a challenge for productivity improvement. During the study, however, both were found to be reasonably efficient, with no evidence being found of underlying causes of lower productivity.

Accordingly, the study was extended to include the previous step (restocking). This found that the underlying causes of lower productivity lay in the restocking step. The study also identified the conditions under which these manifested and the extent of their impact. The response from the warehouse manager when these results were reported was the study had uncovered problems spanning multiple steps that would have been difficult to identify through routine improvement activities alone. The manager also expressed an intention of utilizing the improvement suggestions to look into the problems immediately. This represents a classic example of how extensive observation of workplace activities identified the mechanisms through which problems manifest (underlying causes, relationships between specific causes, scope of effects, and so on) and highlighted the problems to be addressed.

USE OF WORKSHOPS FOR CONSENSUS-BUILDING AND FORMULATING IMPROVEMENT MEASURES

A workshop in which the people involved can all meet under one roof is an example of a human-based initiative for encouraging consensus on the problems to be addressed and how to address them. Compared to assigning investigation work to individuals, the advantage of this approach is that it enables a high quality of discussion, bringing together the people

Fig. 3—Workshop to Study Problems to be Addressed and How to Address Them.
The workshop aims to build consensus by presenting the results of ethnographic research as a process flowchart and bringing together the people with the necessary knowledge and authority to make improvements.

with the necessary knowledge and authority, so that subsequent improvement activities can be undertaken on the basis of their being supported by key staff.

Workshops that have the benefit of the ethnographic research described above can be attended by the staff responsible for each step as well as by the warehouse manager, with meticulous planning of the framework for presenting improvement proposals and material for sharing information about workplace issues (see Fig. 3). The workshops take about half a day and involve the following four steps.

(1) Presentation of current situation assessment and improvements
(2) Consideration of ideas
(3) Definition of issues, assessment of practicality
(4) Assessment of improvement benefits and matters of concern

This enables those involved to collate and agree on improvements, such as reviewing task allocations or making changes to restocking timings and working practices, and prepares the ground for subsequent improvement work.

USING DATA ANALYSIS FOR CONSENSUS-BUILDING AND FORMULATING IMPROVEMENT MEASURES

Analyses conducted using customer data provide another approach to building consensus about problems and associated improvement measures. This involves reaching agreement with the customer on the problems to address and how to address them by conducting quantitative measurement and analysis of the movement of people and goods at the warehouse.

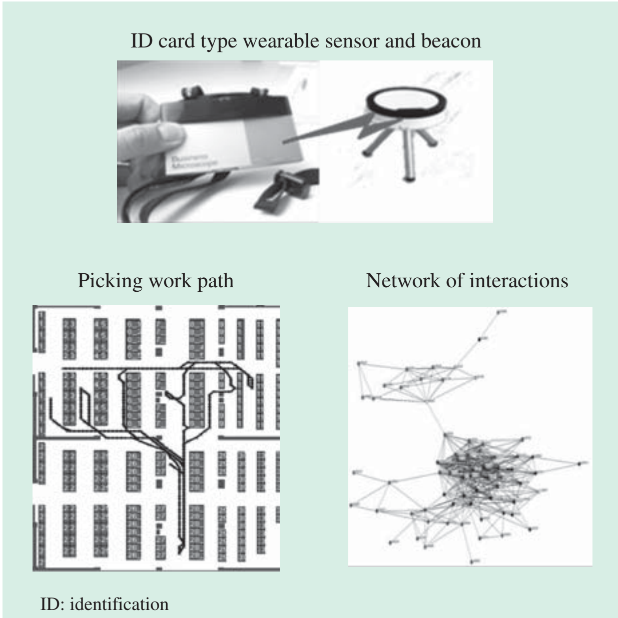

Fig. 4—ID Card Type Wearable Sensor and Example Applications.
ID card type wearable sensors with infra-red sensors identify and analyze interactions between workers and between supervisors and workers, and to detect where they are in the warehouse.

The key to analysis is understanding the worker behaviors that make up the bulk of activity at a warehouse. One method for achieving this is the identification (ID) card type wearable sensors worn by staff detect the presence of other staff or beacons installed around the workplace[1]. As each beacon transmits a unique ID, the system can record where staff are at each point in time (see Fig. 4).

Table 1 lists analyses performed using the wearable sensor data and warehouse operations data recorded in the warehouse management system (WMS) logs, and also examples of improvement measures undertaken in response to the analysis results. The work confirmed the increased efficiency of picking and other warehouse activities achieved by implementing the various improvement measures.

VISUALIZATION OF WAREHOUSE INFORMATION FOR VERIFICATION OF BENEFITS OF IMPROVEMENT MEASURES

To ensure that the improvement measures introduced using the various approaches described above deliver genuine ongoing benefits, a “cockpit dashboard” is used to help the warehouse manager gain an accurate assessment of these benefits and the situation in the workplace. The cockpit dashboard collates a wide range of logistics data from work logs to organization-

Table 1. Example Warehouse Efficiency Improvements based on Data Analysis
The table lists analyses performed using ID card type wearable sensor data and log data from the WMS, and examples of improvement measures undertaken based on the analysis results.

Objective	Analysis tool	Analyses and example improvement measures
Instruction of shortest items gathering path	Layout analysis	Comparison of actual and optimal path followed by workers analyzed using ID card type wearable sensor data Example improvement measure: Use handheld device to follow optimal path
Optimization of order allocation	Work efficiency analysis	Comparison of actual work time obtained from WMS data with estimated work time for a worker handling a number of orders at one time determined from the speed of movement, picking work time, and other parameters identified from ID card type wearable sensor data Example improvement measure: Optimize order combination
Optimization of item arrangement in shelves	Work order analysis	Determine optimal product locations from shipping frequency analysis and records and item restocking analysis in WMS data Example improvement measure: Generate suggestions for how to change current layout
Optimization of worker assignment	Worker path analysis	Calculate where workers are in the warehouse at each point in time, and their direction and speed of movement Example improvement measure: Make changes to inefficiencies in warehouse layout. Optimize worker assignment.
Strengthen the effect of foreman	Face-to-face communication analysis	Calculate change in productivity of worker after face-to-face communication with supervisor Example improvement measure: Conduct efficient work-site observations

WMS: warehouse management system

wide management and presents it in the form of key performance indicators (KPIs) appropriate to each user's role.

The following describes an example where the cockpit dashboard was used to provide a progress management function to field managers and a daily profit management function to the warehouse manager (see Fig. 5).

The progress management function (shown in the top half of Fig. 5) shows the progress of tasks such as picking or inspection and packing for each shipment time (or other criterion) based on realtime data from the WMS on instructions for the shipment (of goods) due to be dispatched the same day. Field managers refer to this screen as they go about maintaining efficient warehouse operation, which may include reallocating staff, rearranging work schedules, or predicting the workload as it is progressively added to through the day. The function can also be used to determine the benefits of improvement measures from warehouse operations information, such as comparisons with similar days in the past, productivity assessments for individual tasks or workers, or information on equipment operation.

The daily profit management function (shown in the bottom half of Fig. 5) assesses the benefits of improvement measures from a management perspective by collecting quantity and other operational data from sources such as the WMS and attendance management system, and calculating sales and costs to determine whether or not daily performance targets have been achieved. It can also identify the causes of poor profitability by analyzing parameters such as the

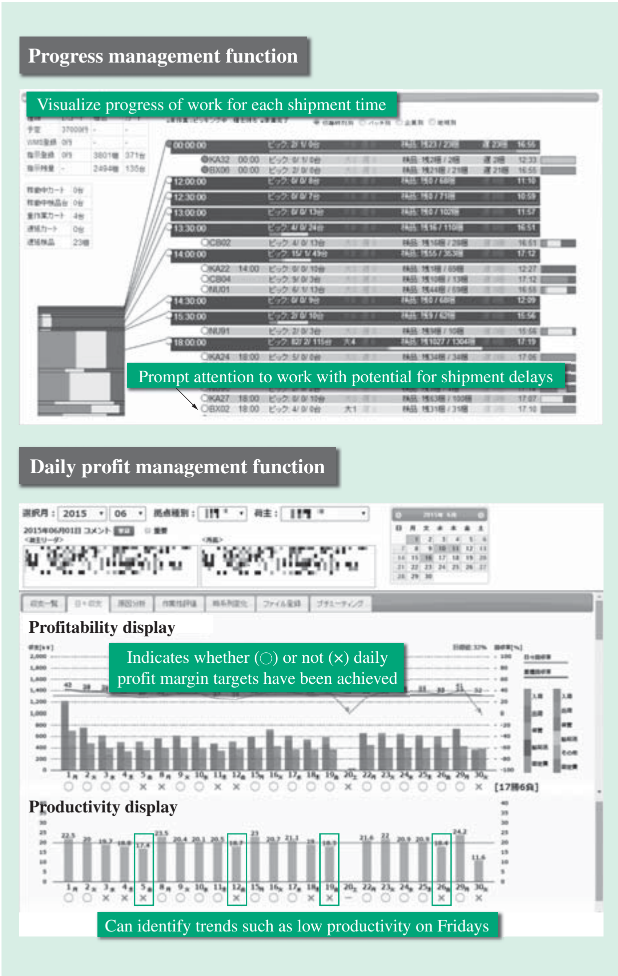

Fig. 5—Cockpit Dashboard System Functions.
The progress management function prevents delays in shipment (of goods) by showing their progress. The daily profit management function presents information on daily profitability and productivity to help manage decision-making and assess the benefits of improvement measures.

difference between planned and actual values for work quantities and man-hours, actual data on the lending and borrowing of workers between departments, whether this is appropriate, amount of overtime, and the productivity of individual processes.

The sharing of this information provided by the cockpit dashboard with the customer has potential for collaborative creation of more sophisticated logistics strategies.

CONCLUSIONS

This article has described a framework for the collaborative creation with customers of warehouse logistics improvements that is made up of three steps: the review of current warehouse performance and identification of problems, analysis and the formulation of improvement measures through consensus with the customer, and assessment of the benefits.

Warehouse operations are expected to become increasingly complex and sophisticated in the future. By using the framework described here, it is possible to maintain appropriate warehouse operations through the analysis from numerous different angles of changes in the external environment, including the workforce.

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Featured Articles

Collaborative Creation with Customers of Smart Branch Solution for Banks

Ke Jiang
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Ting He

OVERVIEW: Along with the growth of "Internet finance," the banking industry is under pressure from the increasing pace at which the industry is opening up and interest rates are being deregulated. Banks have come to place an emphasis on using business innovation to improve customer service and profitability. Working with partners in the finance sector in China, Hitachi has developed a smart branch solution for banks through joint innovation with its customers in the industry. The solution utilizes branch design and an IT solution to provide self-service tools, security plans, and precision marketing plans. In addition to improving the bank's brand image, the efficiency of branch (outlet) operation, and marketing, these features also increase customer satisfaction.

INTRODUCTION

THERE has been rapid growth in Internet finance in recent years, with competition among private-sector banks in the traditional Chinese banking sector becoming more intense. The gathering pace of reforms to financial supervision and growing links to the outside world are forcing banks and other financial institutions to enter into partnerships. Banks are being forced to revise their past business model of providing branches and instead take the initiative in seeking to gain market share in the form of "peddler" services. They have also come to emphasize the use of business innovation to improve customer service and profitability.

Working with partners in the finance sector in China, Hitachi has developed a smart branch solution for banks through joint innovation with its customers in the industry. The solution utilizes branch design and an IT solution to provide self-service facilities, security plans, and precision marketing plans. These increase customer satisfaction by making branches function more efficiently and improving marketing. Hitachi is supplying the solution to its customers in the Chinese banking industry and working on further development of new functions to satisfy customer needs through collaborative creation (see Fig. 1).

This sections below look first at the issues facing the Chinese banking industry, then at the use of collaborative creation with customers to overcome them and an analysis of core technology. The final section considers plans for the future.

CHALLENGES FACING BRANCHES

Bank branches are currently subject to major business pressures, with the biggest difference from the traditional branch model being that new branches place a greater emphasis on improving customer satisfaction and are being called on to switch from a "transaction-type" model to one of self-directed marketing. The main challenges to achieving this are described below.

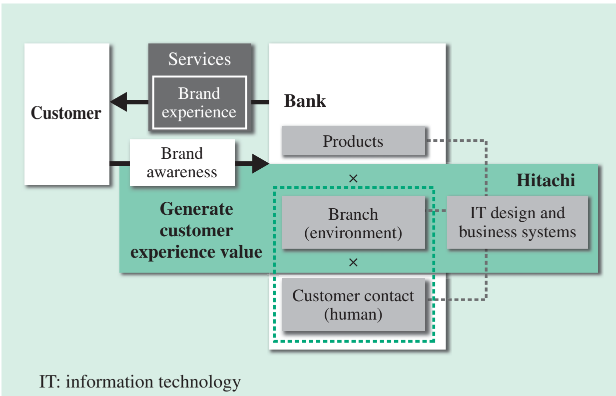

Fig. 1—Concept behind Smart Branch Solution for Banks.
The solution improves the customer experience and creates new value by combining branch design and an IT solution to build new smart branches.

Business Transformation for Better Marketing

Most traditional bank branches are passive and functional, and along with the spread of practices such as mobile and Internet banking, the functional aspects of branch operation are being incrementally replaced. Accordingly, self-directed marketing of the financial products offered by banks is one of the major features of this branch transformation.

Eliminating Branch Efficiency Bottlenecks

The way most traditional bank branches operate is to have the bulk of transactions take place over the counter, creating a bottleneck due to problems that include complex forms to be filled out and long waiting times for customers at branches in busy business areas. While attempts to improve the situation have included management practices or new equipment, these have failed to satisfy the need for things like encouraging marketing or making efficiency improvements.

Extending Branch Coverage

User behavior is changing along with the emergence of new Internet models such as electronic commerce (EC) and online-to-offline (O2O). The inability of traditional branches to satisfy various user needs due to their only providing counter services for eight hours a day means that they need also to provide self-service with longer opening hours. In spatial terms, it is not possible to satisfy customer needs simply by building branches and waiting for the customers to come. To overcome this, the "peddler" model (of improving marketing by having customer managers cover a wide area of the community) needs to become a major policy.

HOW TO GO ABOUT COLLABORATIVE CREATION WITH CUSTOMERS

To overcome the business pressures on the banking industry, Hitachi uses collaborative creation with customers to deliver innovations through close cooperation with its customers and other partners (see Fig. 2).

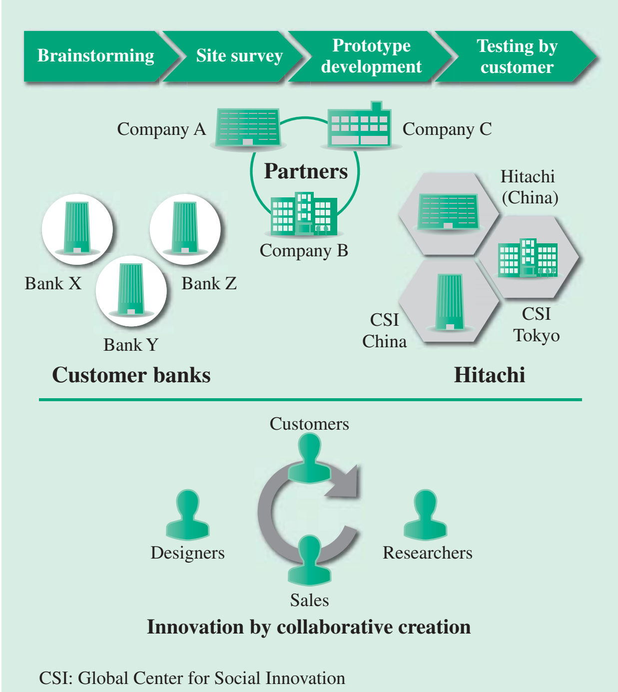

Fig. 2—Innovation through Collaborative Creation with Customers.
Researchers work with designers, sales staff, and customers to uncover needs, then develop a prototype and trial it at the customer site.

Winning Customers

Hitachi has established close collaborative relationships with Chinese partners in finance and IT based on its automated teller machine (ATM) business platform. A joint in-depth investigation into customer needs in collaboration with local operations was undertaken in the early stages of solution development. This started with financial equipment and identified what it is that customers want from smart branches. To respond promptly to customer needs, Hitachi sees financial solutions as a new direction for customer collaborative creation and it has established the infrastructure for its solution business through internal collaboration.

Proposal-based Joint Innovations Involving Different Perspectives and Roles

Solution development by Hitachi has involved engaging in a series of joint innovations with its customers in the banking industry (customer collaborative creation).

(1) Brainstorming with experts

Teams made up of designers, technical support staff, researchers, and business managers from Hitachi have undertaken frequent brainstorming sessions with customer banks, including presenting depictions of future designs, and determining the overall goals that customers have for the construction of smart branches in order to offer opinions and proposals.

(2) Multifaceted site surveys

The site surveys included not only visits to branches and observation of existing business processes, but also visits to other banks and similar service facilities. They reviewed things like current operational bottlenecks and customary user behavior and proposed ideas for how best to go about branch and IT design.

(3) Early prototype development

This involved combining the best aspects of the technologies they had built up based on customer feedback and business needs. The plan concepts were clarified by utilizing visual effects, such as the design of branch functional diagrams and equipment layout plans, and the early development of models for the customer queuing assistant system, precision marketing support system, and so on.

(4) Trials at customer sites

The prototype systems were deployed at a number of branches so that users could trial the IT systems and provide feedback. Three-dimensional simulation was used for branch designs to give customers a sense of how the changes to branches would work.

(5) Solution development and deployment

The development group developed a solution in accordance with the customer needs based on the post-testing prototype and technology, and system deployment and handover were completed with assistance from local partners. The aim is to supply the solution to a large number of banks. Hitachi currently supplies the smart branch solution to banks, including large banks in China.

Summary of Work on Collaborative Creation with Customers

In going about collaborative creation with customers, Hitachi invariably contributes in a variety of roles and takes the initiative in considering matters from a variety of perspectives to uncover the latent needs of the customer as it develops the prototype system and core technology. The initial concept and model system are revised based on customer trials, finally producing and deploying a systematic solution. Along with supporting problem solving by the customer, Hitachi gains their trust by understanding the needs of Chinese customers in regard to schedules and the future direction of the project, and seeking actively to align concept and rhythm.

OVERVIEW OF SMART BRANCH SOLUTION

Hitachi's smart branch solution for banks has its origins in the experience of the customer and reforms to banking practices, and it has earned a good reputation for both societal and economic benefits, transforming branches from a "transaction-type" model to one of self-directed marketing through innovation and optimization of services, marketing, branch design, and IT (see Fig. 3).

Branch Design

Having built up experience in branch design at banks in Japan, Hitachi focused on the specific needs of Chinese customers to conduct surveys of bank branches, including those of large Chinese banks, and of past smart branch projects, coming up with the idea of smart branches being places that maximize the value of customer experiences. It also established its core concepts for branch design (see Fig. 4).

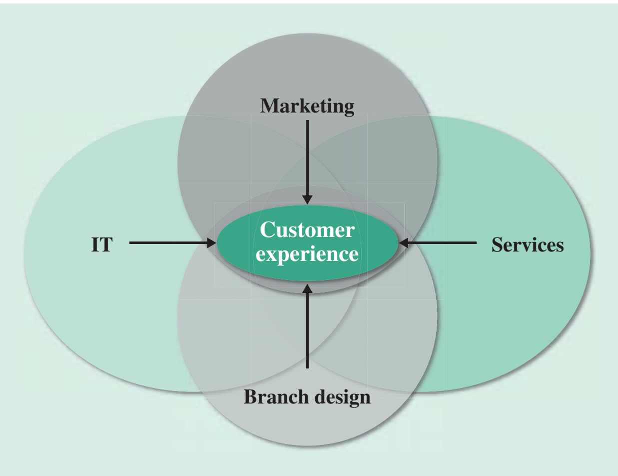

Fig. 3—Aspects of Smart Branch Solution.
The solution combines branch design, IT, services, and marketing to improve customer experiences as far as possible.

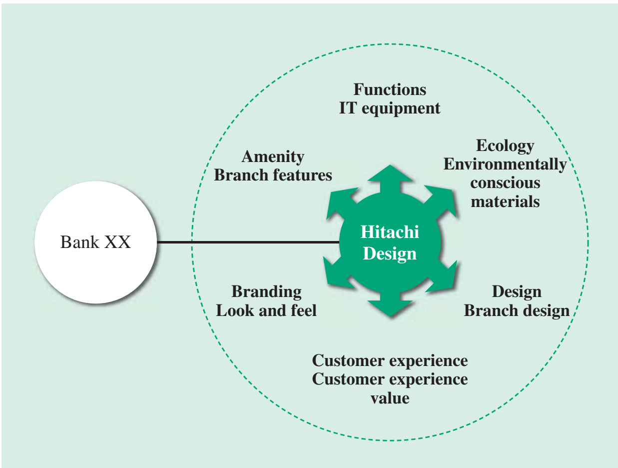

Fig. 4—Core Concepts of Branch Design.
Hitachi's design concept considers a variety of elements, including a branch features, brand image, customer experience, design environment, and functions.

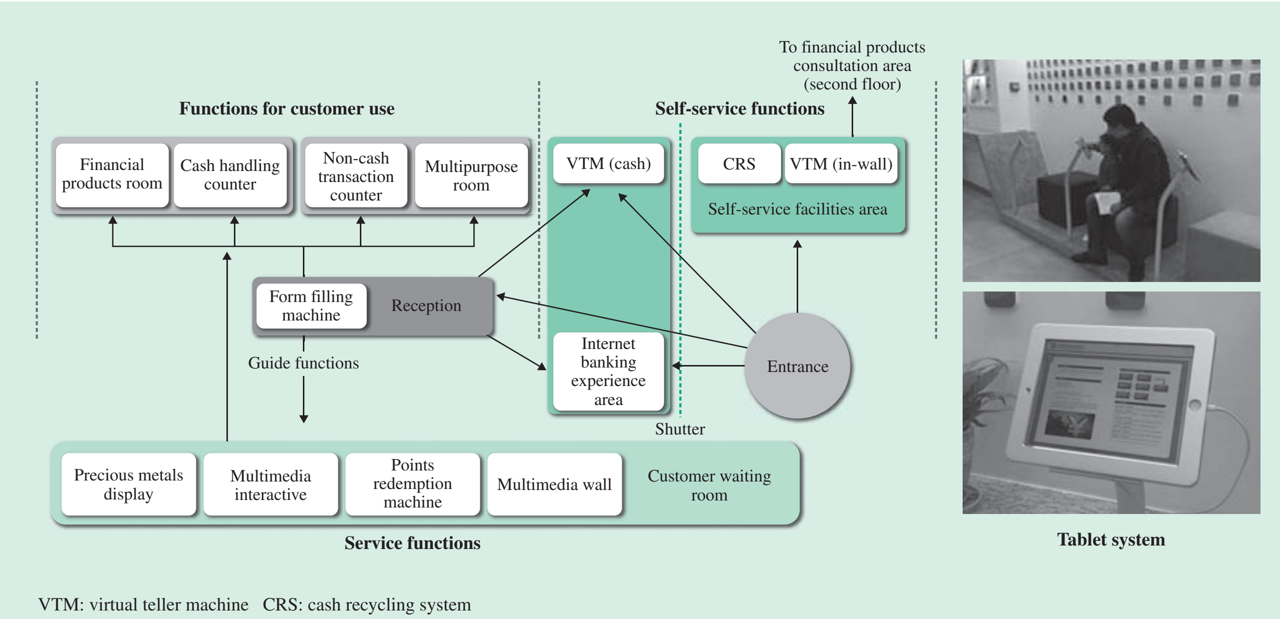

Fig. 5—IT Solution Concept and Benefits of Installation.
The solution improves operational efficiency and the customer experience by adopting the right IT equipment and solutions for the function.

These core concepts are expressed by the following measures.
(1) Establish brand image as a service industry
(a) Strengthen image differentiation between bank and other companies.
(b) Make greater use of a distinctive brand color and represent financial services as part of a specific design.
(c) Customize services in accordance with the specific needs of users and tailor marketing to users.
(2) Treat services for users as the basis for compartmentalizing space and designing traffic flow
(a) Focus on the current situation in the branch and design traffic flows that make sense to both users and staff so that branches are easy to navigate
(b) Improve ease of use through the rational compartmentalization of space and highly efficient business processes
(c) Provide protection for privacy in accordance with user needs
(d) Encourage customers to visit by improving visual transparency. Make branches places that people feel comfortable entering and visiting
(3) Satisfy customer needs through a range of routes
(a) Combine design elements and IT with convenient information transmission
(b) Introduce new equipment and satisfy customer needs in various different ways by establishing a range of routes

IT Solution

The design concept established for the IT solution involves being based on the new features and operational needs of smart branches, being secure and controlled, offering highly efficient self-service, being self-directed and accurate, and covering a wide range of times and places (see Fig. 5).
(1) Highly efficient self-service

This means installing a number of facilities for self-service banking to reduce the over-the-counter workload. The current design calls for installing Hitachi ATMs, cash recycling systems (CRSs), and virtual teller machines (VTMs) with banknote recognition modules to significantly increase banking efficiency and free up staff for self-directed marketing by automating 90% or more of over-the-counter cash handling.
(2) Secure design

To improve the security of staff work areas, financial product (investment product) areas, and cash handling areas, the smart branch solution uses Hitachi finger vein authentication technology to identify individuals.
(3) Precision marketing system

The smart branch solution also includes a data mining platform to improve marketing effectiveness and the ability of staff to identify customers by themselves. By linking this platform with the queuing system and customer relationship management (CRM) system, this can calculate customer preferences for financial products through the comprehensive analysis of data such as their purchase histories. This can improve marketing at the branch by notifying the lobby manager at an appropriate time so that products can be recommended to customers that match their preferences.

(4) Mobile solution

To improve branch coverage and the coordination of work at the branch, the smart branch solution provides smart tablets and a suite of applications. The tablets enable the lobby manager and customer managers to be kept informed of the latent needs of customers, and can provide functions such as for branch management or for guiding them through procedures or products. The actual functions provided are as follows (see Table 1).

(a) Financial product inquiry system

This provides advice on financial products based on the customer's circumstances.

(b) Product information

This helps give customers a broad understanding of bank products.

(c) Procedure information

This uses video to explain procedures to customers

(d) Call up waiting customers

Provides realtime information on the place of customers in the queue.

Customer managers can use the tablet to provide a traveling banking service to the community to expand branch coverage and improve the efficiency of banking.

PRECISION MARKETING TECHNOLOGY

Against a background of branches designed for marketing, this involves utilizing the highly efficient integration of data banks to dig deeply into the latent needs of customers to build up information based on things like their core attributes and life stages, demographics, and activity histories (see Fig. 6).

Using data mining and quantitative models, this technology is used to support precision and cross marketing by customer managers by identifying customer needs and the type of tailored financial products that they will be interested in and can be sold. Through system implementation, it encourages the effective use of data mining to support precision marketing while also making the collection of customer information more efficient and convenient.

The implementation of the smart branch precision marketing system by Hitachi is based on the principle of moving ahead simultaneously on advanced capabilities, openness, high efficiency, and security, with adequate study having been undertaken from considerations of overall technology configuration and middleware selection.

Table 1. Applications for Branch Tablets

Applications are available for a variety of functions for the lobby manager, financial products sales staff, and customers.

	Lobby manager's tablet	Financial products manager's tablet	Customer tablet
Precision marketing	○	○	
Financial product inquiry	○	○	○
Information on products	○	○	○
Information on procedures	○	○	○
Call up waiting customers	○	○	○
Card procedures			○
Fill out forms in advance			○
Branch management	○		

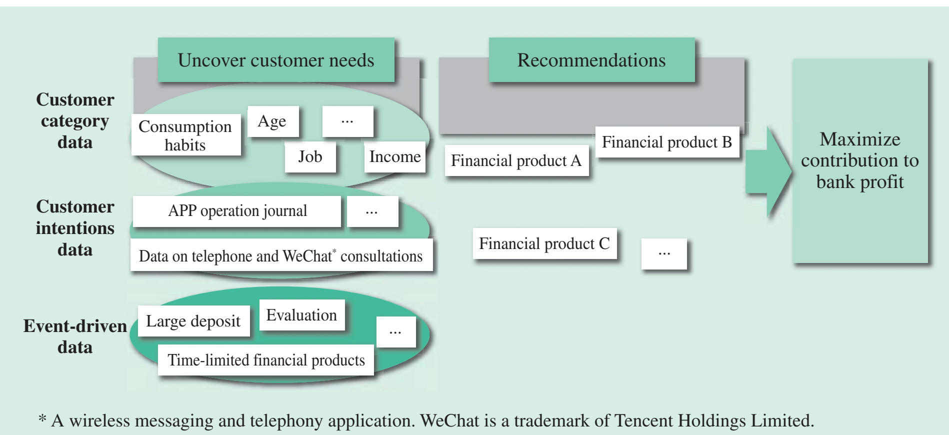

Fig. 6—Data Resources for Precision Marketing System.
Information such as basic customer attributes and activity records is analyzed to recommend financial products to customers. This helps improve bank profitability as well as marketing success rate.

Precision Marketing Calculation Techniques for Bank Branches

Hitachi has adopted a mixed model for the mining techniques to use at smart branches (event-driven model and user profile model).

(1) Event-driven model

This uses existing CRM data as a basis and specifies different rules for each event in response to user event data. Examples include recommending financial products to users at appropriate timings such as when they make a high-value deposit, have an existing financial product mature, or have their rating upgraded.

(2) User profile model

A user profile model is built by combining existing CRM data (customer attributes and account transactions) with operation intention data for various customer devices (such as APP). The user profile is utilized for joint filtering recommendations and to make recommendations by performing a coupled analysis across images and products.

The system incorporates a variety of recommendation parameters into a range of models and then performs a weighting calculation to obtain the final weighting for a recommendation. In this way, marketing can better satisfy banks' expectations for work.

CONCLUSIONS

Hitachi has utilized collaborative creation with customers to develop a smart branch solution that suits the needs of Chinese customers. The solution delivers the following main benefits.

(1) Enhanced brand image and better marketing through precision marketing

(2) More efficient branch operation through the rational compartmentalization of areas by function and the provision of self-service facilities

(3) Use of tablet and other smart applications to expand the coverage area of a branch

The solution draws on strengths in design, development, software, and hardware to demonstrate Hitachi's core technologies for data processing. Hitachi believes that this comprehensive solution that is in tune with trends in the mobile Internet will serve as a template for future smart branches.

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Featured Articles

Winning in Oil and Gas with Big Data Analytics

Ravigopal Vennelakanti
Anshuman Sahu, Ph.D.
Umeshwar Dayal, Ph.D.

OVERVIEW: Disruptive innovation in an unconventional oil and gas industry such as the shale industry offers a promise to change the world's economies. Advances in technologies such as horizontal directional drilling and hydraulic fracturing have fueled growth in the industry. However, oil and gas industry operators are facing tough business challenges. Shale sub-surface geology poses challenges in terms of proper characterization. Operators want to maximize production output from their acreage through assembly-scale operations. The orthodox approach of modeling the shale upstream operations have proven inadequate. Big data technologies can augment traditional methods in developing a deep understanding of the shale oil and gas operations to address the challenges faced by operators in a holistic way. Hitachi prioritizes the requirements by understanding such customer challenges through voice-of-customer surveys. Collaboratively creating solutions with customers, and collaboratively evolving the lifecycle of the solution with the customer as the focus has been championed by Hitachi's oil and gas analytics technology. Hitachi consolidates and builds analytics on data from multiple upstream processes which gives the customer multiple, rich contextual views.

INTRODUCTION

THE oil and gas industry can be broadly categorized into upstream, midstream and downstream processes organized along the direction of the stream. The upstream process comprises the following phases, in order: exploration, drilling, completions, and production. Advances in upstream shale oil and gas processes such as horizontal directional drilling coupled with completions through hydraulic fracturing technologies have increased the potential for recovering more resources. However, they have also added to the complexity of upstream processes. Shale sub-surface geology poses challenges in terms of appropriate characterization for the above processes. Operators want to maximize production output from their acreage through assembly-scale operations. Understanding the factors affecting the steep decline curve will help operators build the right strategies from these assets. Nonproductive time, especially in drilling adds to the total cost to the tune of approximately 30%. In sum, operators have to take difficult operational and top-side facilities planning decisions[(1)].

Understanding such customer challenges through voice-of-customer surveys, building a collaborative solution with the customer, and collaboratively evolving the lifecycle of the solution with the customer has been put into practice in developing Hitachi's oil and gas analytics solution. Hitachi's oil and gas analytics solution allows customers to ingest data from a variety of data sources collected through the lifecycle of the oil and gas assets, and discover deep insights from these cross-process dependent data sets. Hitachi's oil and gas analytics solution also allows the user to build custom hypotheses and evaluate them with a rich data set context.

In this article, the authors discuss at length the efforts involved in building the solution. Hitachi consolidates and builds analytics on data from multiple upstream processes which gives the customer multiple, rich contextual views. Hitachi is developing an agile platform that rapidly integrates data in varied formats from different sources, and enables analytical solutions to be built on top of it. The plan is to supply the solution to customers through multiple mechanisms, including software-as-a-service (SaaS). Finally, the analytics use cases are fine-tuned based on periodic feedback from customers.

DEVELOPMENT OF LANDSCAPE FOR DATA-DRIVEN SOLUTIONS IN OIL AND GAS INDUSTRY

As part of Hitachi's Global Center for Social Innovation – North America (CSI), Big Data Lab has pursued cutting-edge projects at the intersection of operation technology (OT) and information technology (IT) technologies. Hitachi's oil and gas analytics solution is the flagship project in the oil and gas industry that has followed the CSI philosophy of "collaborative innovation with customers," both in letter and spirit. As shown in Fig. 1, this entails the four-pronged step of engaging with the customer very early in the process to identify the problems; building, testing, and validating an initial solution prototype; scaling the solution to multiple customers; and finally rolling out a commercial solution. As the first step toward systematically understanding the requirements and challenges of our customers in the industry, Hitachi conducted a voice-of-customer exercise. This involved surveying 58 companies and interviewing a total of 22 people with operational decision making capabilities at large-cap, mid-cap, small-cap, and private companies as well as service providers about their current practices. The input from this broad spectrum of companies validated our notion about how traditionally oil and gas operators have looked at data across each individual process, and therefore, face challenges in terms of analyzing the data holistically to address cross-dependencies across processes. With the ability to handle multiple data from different contexts, rich domain centric attributes, superior analytical tools, and user-friendly visualization, Hitachi's oil and gas analytics solution is well-poised to address the challenges and provide value-added benefits as acknowledged by the customers.

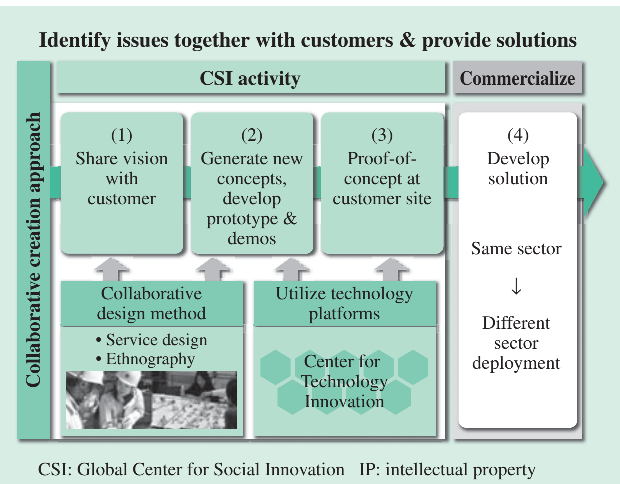

Fig. 1—CSI Methodology for Collaboratively Creating Innovative Solutions with Customers.
The methodology involves developing an industry landscape, developing competencies and core IP, validating the concepts through proof-of-concept projects at the customer's site, and commercialization of the technology (including addressing scale up and scale out requirements).

SOLUTION SCOPING AND DEVELOPMENT OF HITACHI'S OIL AND GAS ANALYTICS PLATFORM

Digital Oil Fields and Remote Operation Centers

With the advent of digital oil fields initiatives in the oil and gas industry, the expectation is that the digital oil field encompassing both instrumentation tools and the processes surrounding measurements, and data acquisition across the entire suite of upstream processes, will allow operators to capture more contextual data, with greater frequency, from all parts of the oil and gas value chain and analyze it in real or near-real time to discover cross dependencies in these data sets. Managers of the assets can hence better understand and address a wide range of topics including design decisions and improving process operational efficiencies, developing drilling strategies, optimizing reservoirs, well mechanics, and top-side facility planning and performance. The deployment scheme is shown in Fig. 2. Digital oil field initiatives combined with big data analytics can address the challenges while maximizing oil field recovery, significantly reduce non-productive time, and enable value chain integration through integrated operations and workflows. Digital oil field workflows combine business process operations and management with advanced information technology and engineering practices performed by cross-functional teams. Augmenting the digital oil field solutions with big data solutions will help realize the full potential of the digital oil field solutions. New-age big data analytics technologies promise to bridge the gap between domain experts, process managers, data scientists, and IT systems users.

Hitachi's Oil and Gas Analytics Solution Architecture

Hitachi's oil and gas analytics solution is unique and state-of-the-art in terms of its design and implementation. To address the challenges faced by

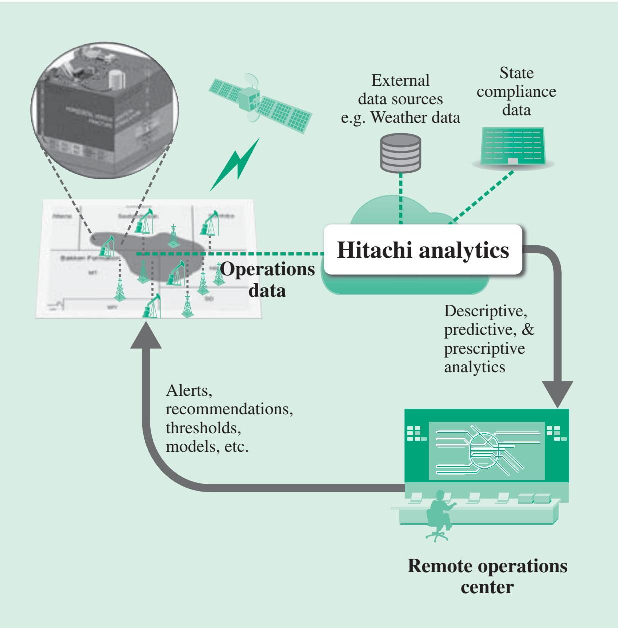

Fig. 2—Deployment Scheme for Hitachi's Oil and Gas Analytics Solution.
Digital oil field initiatives combined with big data analytics can address the challenges associated with maximizing oil field recovery and significantly reduce non-productive time.

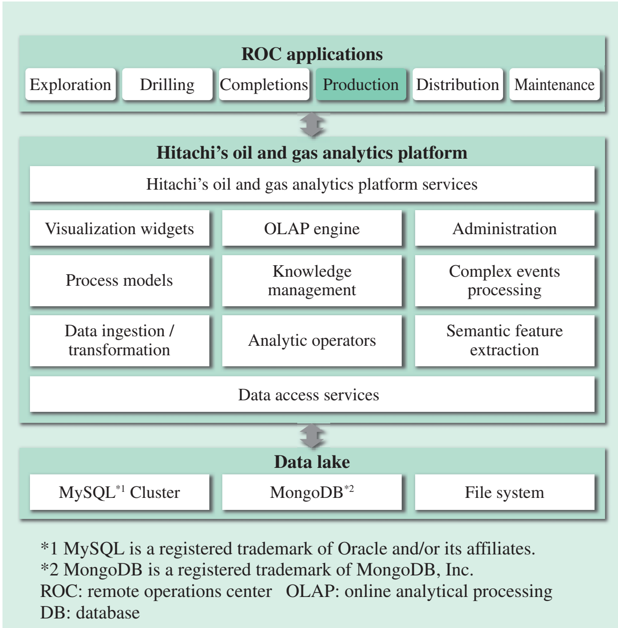

Fig. 3—Reference Architecture for Hitachi's Oil and Gas Analytics Solution.
Hitachi's oil and gas analytics solution framework is based on service-oriented architecture principles and enables rapid development of analytics-enabled oil and gas applications.

customers, Hitachi's oil and gas analytics solution framework allows for analytics-enabled applications. Hitachi's oil and gas analytics solution framework shown in Fig. 3 was developed based on service-oriented architecture principles comprising the following key services: a) data ingestion operators with the ability to ingest data in multiple formats (flat files, databases, streaming, and unstructured well logs), and persist the data in a data lake, b) data transformation operators that check for the consistency and integrity of the data and apply complex transformations to the data sets, c) a feature extractor to extract relevant *features* from the data, and d) analytics operators to develop custom hypotheses. The architecture boasts an integrated service-oriented interface to support both build-to-order and subscription-based business models.

The core Hitachi oil and gas analytics solution system integrates complex analytics and machine learning techniques seamlessly with the above-discussed key services. This capability provides the ability to ingest data from the entire oil and gas asset lifecycle offering a 360-degree view of the asset and its process models.

The system enables users to discover cross dependencies between data sets. The insights are designed to be learned both automatically by the system as well as allowing users to learn them through exploratory analysis. Example applications include learning the behavior of newer wells from older wells. Intent-based exploratory analysis in Hitachi's oil and gas analytics solution is provisioned by enabling management and execution of user-defined hypotheses, in which the user can visualize the results in line while constructing complex hypotheses. For this, Hitachi's oil and gas analytics solution provides a catalog of domain-level functionalities for the user to choose from. Each functionality is able to provide descriptive, predictive, and prescriptive views. Hitachi's oil and gas analytics solution also provides search capabilities over structured and unstructured data sets. The users can also define particular behaviors for the wells they are interested in and monitor this behavior across space and time. The system provides the capability to compare and contrast behavior of different wells by computing performance envelopes.

In a production environment, Hitachi's oil and gas analytics solution can be deployed using a core and edge model where the system-wide learning is done at the core and this learning is pushed to the edge to enable closer and faster monitoring of on-site wells. The system is offered in both stand-alone customized mode as well as in a secure SaaS mode.

Production Characterization Application for Digital Oil Fields Solution

To demonstrate the capability of the Hitachi's oil and gas analytics solution system, Hitachi developed a well production characterization application that analyzes data from over 30,000 wells in the state of North Dakota. Fig. 4 represents the digital wall depicting the dashboard developed for several application functionalities for a remote operations center. These include allowing oil and gas operators to monitor their assets through several key performance indicators (KPIs), including oil production, gas production, and gas flaring as well as water cut. These KPIs are calculated spatially as well as temporally via a decision cube. The future trends for such KPIs are built using statistical forecasting techniques. Further characterization of the production profile of wells is carried out using several features from different stages of the lifecycle of wells. These features include rock property description, perforation length, orientation of well trajectory, and density of well heads from drilling, and total water volume and chemical composition from completion. The features from underlying sub-surface geology are extracted from unstructured hand-written files and correlated with production behavior using regression techniques[2]. Total perforation length, and water volume used during completions have a statistically significant correlation based on Spearman's rank correlation procedure. Wells with similar behavior across all these features are identified using a composite similarity matrix.

Spatial characterization of wells is computed by clustering well heads using Gaussian mixture models to identify regions of high density. Neighborhood behavior is analyzed using the concept of "interference," where the distance between wells is computed not just between the well heads but also between the overall trajectory including the perforation stages. The impact of such distance on the initial production behavior of wells is analyzed.

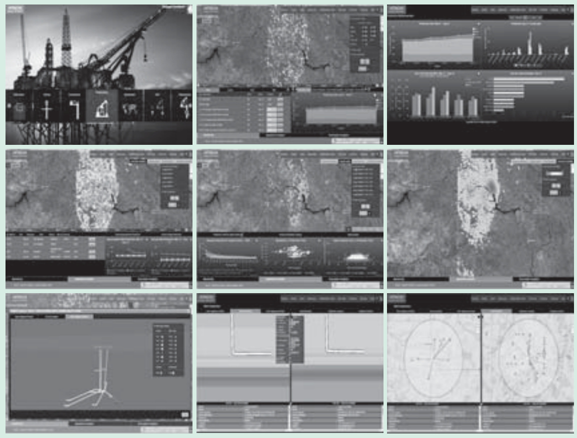

Fig. 4—Production Characterization Application for Hitachi's Oil and Gas Analytics Solution.
The dashboard illustrates several application functionalities integral to a remote operations center solution allowing operators to monitor and improve their asset operations through better knowledge and insights by applying big data analytics technologies.

CONCLUSIONS

Hitachi's oil and gas analytics solution is uniquely positioned to address customer challenges in terms of its ability to bring in data from multiple processes and provide a full suite of descriptive, predictive and prescriptive analytics to its customers. The robust architecture allows scalable solutions to be deployed securely. Working closely with Hitachi's partners and business units, Big Data Lab is rapidly furthering the development of Hitachi's oil and gas analytics solution as well as engaging multiple customers to enhance the solution.

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