

Overview

Hitachi's R&D Strategy

Tsukasa Ariyoshi

R&D AS A DRIVER OF THE SOCIAL INNOVATION BUSINESS

UNDER its Mid-term Management Plan that runs until FY2015, Hitachi has been strengthening its Social Innovation Business throughout the world. This business involves working with customers to achieve social innovation by jointly identifying challenges and then mobilizing the commercial resources of Hitachi, which include technologies, products, services, and expertise, to supply solutions to those challenges. Research and development (R&D) is one of the drivers of this business, and its role goes beyond just producing technology and other knowledge to also include enhancing capacity for innovation by utilizing these to find ways of creating new value that will provide business opportunities. To achieve this, Hitachi is pursuing the following three strategies.

The first is to expand collaborative creation with customers. The challenges being faced by customers and other parts of society are becoming more complex, encompassing problems such as energy and the environment, food and water, transportation systems, and security. Hitachi works alongside customers on these problems and is stepping up its activities aimed at the joint development of solutions. To achieve this, it is establishing a customer-oriented R&D organization that includes its recently expanded overseas R&D facilities. Measures also include accelerating business expansion by establishing common platforms for collaborative creation with customers.

The second strategy is the development of innovative technologies that meet market needs. With the aim of delivering innovative products and services that are competitive in global markets, Hitachi is strengthening the solid base of technologies it has built up across a wide range of businesses. As creating new solutions through the optimal combination of technologies is also important to progress on social innovation, this strategy includes the fusion of different technologies.

The final strategy is to work on challenges for the future. Hitachi believes that fundamental research

based on a distinctive vision that the public and customers have yet to recognize is essential to its own sustainable growth and that of society and customers. This means undertaking R&D in new fields with a long-term perspective that anticipates upcoming social change. Also essential to realizing its vision is to forge a variety of partnerships and relationships. Hitachi intends to actively pursue open innovation both with customers and with countries, regions, and other technology partners.

The following sections provide an overview of the R&D organization at Hitachi and describe the actions being taken to implement this strategy and achieve future growth.

R&D ORGANIZATION AT HITACHI

The main business units within Hitachi at the current point in time include the Power & Infrastructure Systems Group, Information & Telecommunication Systems Group, Construction Machinery Group, High Functional Materials & Components Group, Automotive Systems Group, and Healthcare Group, which operate in the information & telecommunication systems, power systems, social infrastructure & industrial systems, electronic systems & equipment, construction machinery, high functional materials & components, automotive systems, smart life & ecofriendly systems, and financial services markets. For example, the Power & Infrastructure Systems Group deals with such markets (and associated customers) as electric power, manufacturing, public works, urban infrastructure, and transportation, while the Information & Telecommunication Systems Group mainly deals with finance, public works, industry, logistics, and telecommunications. Similarly, the Healthcare Group seeks to help the population live long and healthy lives by using information and medical technology to satisfy increasingly diverse needs throughout the care cycle that extends from prevention and examination to testing and diagnosis, treatment, and recuperation.

Hitachi's annual investment in R&D totals about 340 billion yen, the majority of which is targeted directly at R&D projects identified by the business groups as matching the requirements of their respective markets and customers in the short and medium term. In parallel, Hitachi also operates an R&D organization that is independent of these business groups.

Hitachi's very first research organization was the "research section" it established in 1918, just eight years after the company's formation. Since then, based on its Mission of "contributing to society through the development of superior, original technology and products," Hitachi has continued to set up new laboratories and restructure its organization in step with expansions and shifts in its business portfolio, including the establishment of the Hitachi Research Laboratory in 1934 and the Central Research Laboratory in 1942. By 2014, this had grown into an organizational structure that comprised four divisions in Japan (the Central Research Laboratory, Hitachi Research Laboratory, Yokohama Research Laboratory, and Design Division) and six overseas R&D centers (in the USA, Europe, China, Asia, India, and Brazil) under the name of the Research & Development Group.

The Research & Development Group has three core roles, described below.

Development of Technologies that Individual Business Groups Find Difficult to Tackle on Their Own

Because it specializes in R&D, the Research & Development Group can maintain the tangible and intangible resources that this work requires. Similarly, the many years it has spent working with a wide range of markets and technologies that cross the boundaries between different businesses have left the group with a collection of methodologies that represent research best practices, and platform technologies with broad applications. The group is also able to be selective and focused, assigning research resources flexibly based on the urgency and importance of the topic concerned. It is able to utilize these resources to tackle high-level problems based on the requirements of markets and the various business groups.

Development of Technologies that Span Multiple Business Groups

Because its business groups are organized along market lines, as described above, Hitachi needs to take care to avoid duplicating the development of common technologies. It is also not uncommon for

a technology developed by one business group to be applicable to another, either as is or with only small modifications. Similarly, there is a need for R&D aimed at establishing business fundamentals such as reforming cost structures. Beyond considerations of commercial efficiency, there are also numerous instances of technologies that can be enhanced through the centralized development and accumulation of technologies from a variety of different market segments. In addition to serving as an important future resource for the R&D organization, this also provides the driving force behind the pioneering of new markets, as described below.

R&D Aimed at Entering Markets not Served by Existing Businesses or Creating Future Markets

Based on the following strategies, Hitachi is working on R&D that deals with this most crucial factor in the sustainable development of society, customers, and Hitachi.

- (1) Keep up to date with information on markets to which Hitachi has access thanks to its involvement in a wide range of businesses.
- (2) Keep up to date with the latest scientific developments by taking advantage of its involvement in R&D in the wide range of technical fields that underpin these businesses.
- (3) Conduct research into methodologies, including those from the human and system sciences, for utilizing this information to identify signs of social change.

The factor that is crucial to all of these strategies is open innovation.

The Research & Development Group is formulating and implementing a long-term technology plan for these strategies under the direction of the Technology Strategy Office.

R&D Organization Facilitating Greater Innovation

As a further boost to social innovation, Hitachi has reorganized the Research & Development Group's three Japanese laboratories, Design Division, and its overseas R&D centers into the Global Center for Social Innovation, Center for Technology Innovation, and Center for Exploratory Research, to establish a customer-oriented R&D organization (see Fig. 1).

The Global Center for Social Innovation is a customer-facing organization that works with customers to develop solutions. It operates four

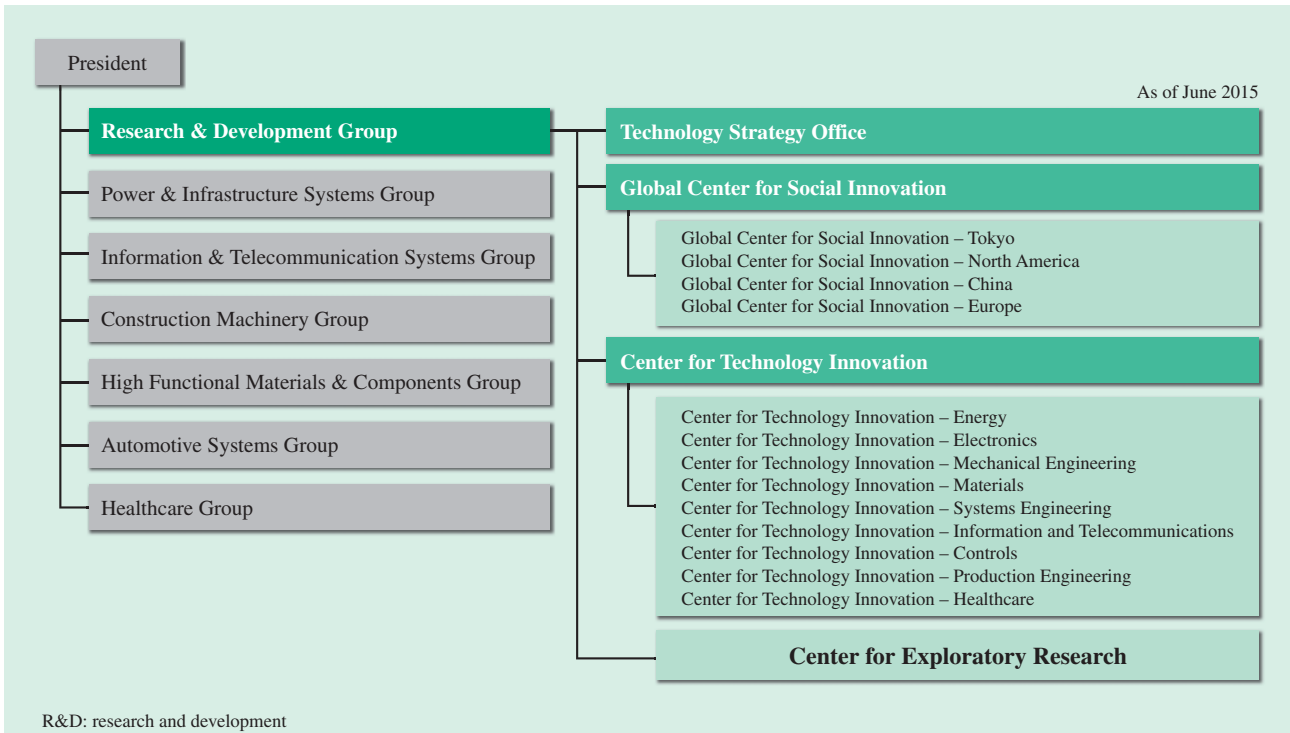


Fig. 1—Hitachi’s Main Business Groups and R&D Organization.

The activities of the Research & Development Group include the development of common platform technologies and research into methodologies for creating new markets from a perspective that transcends the boundaries between business groups. In order to conduct customer-oriented R&D on a global basis, the group has also been restructured into three divisions (“centers”).

centers, in Tokyo (Asia-Pacific region), North America, China, and Europe (see Fig. 2), that work closely with their respective regions on formulating

and investigating ways of overcoming challenges, and that utilize the technology platforms and other innovative products of the Center for Technology

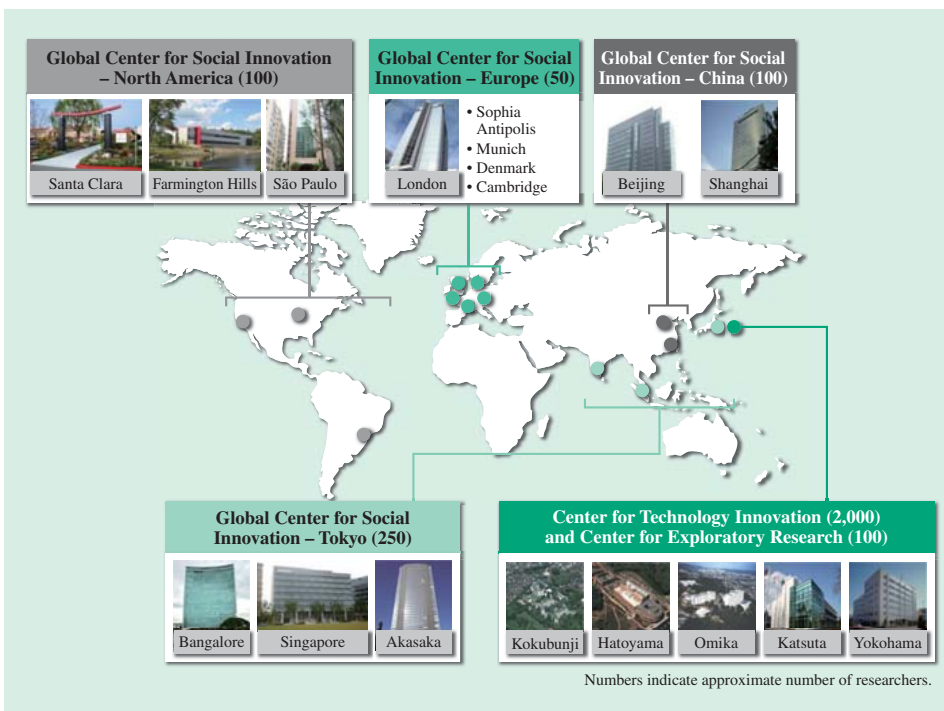


Fig. 2—Global R&D Facilities. Hitachi is strengthening its Social Innovation Business around the world by establishing R&D facilities close to customers.

Innovation (described below) to provide leadership that extends from developing prototype solutions to conducting on-site testing.

The Center for Technology Innovation operates nine centers that deal with Energy, Electronics, Mechanical Engineering, Materials, Systems Engineering, Information and Telecommunications, Controls, Production Engineering, and Healthcare respectively. Its role is to support the development of new solutions through the optimal combination of a wide range of technical fields while also strengthening the technology platforms for these nine fields through the creation of innovative products.

The Center for Exploratory Research conducts leading-edge R&D from a long-term perspective on ways of resolving the challenges that society will face in the future, and also operates as a global open laboratory to open up new opportunities for Hitachi's Social Innovation Business through collaborations with a variety of other research institutions.

The following sections describe the R&D strategies of these organizations.

HITACHI'S R&D STRATEGIES

Customer-oriented Approach to Research

The Global Center for Social Innovation acts as a customer-facing organization so that R&D can drive the "customer-orientation" that is a key feature of the Social Innovation Business, establishing and enhancing collaborative creation processes that extend from sharing a common vision with customers to the formulation of new concepts, prototype development, and demonstrations and site testing.

To provide methods for working with customers to identify challenges and to formulate and investigate visions and solutions, Hitachi has already established NEXPERIENCE / Ethnography^(a), the experience-oriented approach^(b), and the NEXPERIENCE / Opportunity Finding^(c) as proprietary service design techniques and set about expanding their scope of application⁽¹⁾. NEXPERIENCE / Ethnography, for example, is a technique for identifying a customer's latent needs and underlying issues by having researchers observe work in progress. It has been

(a) Ethnography

Originally used in fields such as anthropology and sociology, ethnography is a methodology for conducting field work to survey and record the behavior patterns of a society or other group. The term is also used for the survey documentation. It has been increasingly used by corporations in recent years to study consumers. Unlike statistical or quantitative analyses such as questionnaires, it is characterized by qualitative analysis using techniques such as interviews or observation.

used for applications such as coming up with ways of improving workplace productivity at a rolling stock maintenance depot in the UK, and in a variety of different workplaces, including data centers and the construction site for a proton beam therapy system in the USA, construction machinery maintenance in places like Australia and South Africa, and software development in China. In Kashiwanoha Smart City, it has been used to demonstrate the value of energy visualization and present specific usage scenarios from a user's perspective, facilitating the introduction of an area energy management system (AEMS) for optimizing the use of energy in the community. In addition to formalizing methods developed in the past, Hitachi is speeding up the collaborative creation process by implementing these methods in the form of information technology (IT) tools so they can be deployed as best practices throughout the world. In particular, NEXPERIENCE / Cyber-Proof of Concept (Cyber-PoC), a system that combines a variety of simulation tools to display in cyberspace the value provided by services and solutions, is helping build a common vision and sense of shared values.

NEXPERIENCE / Space that utilizes these tools are or will be operating in Tokyo (June 2015) and Santa Clara, USA (scheduled for November 2015).

Strengthening Technology Platforms to Assist Creation of Innovative Products

Hitachi is strengthening a wide range of technology platforms through the creation of the innovative products, software, and services needed for social innovation.

In the healthcare business, Hitachi is boosting development of particle beam cancer therapy systems and superconducting magnetic resonance imaging (MRI) systems that use strong magnetic fields. In the former case, work by Hitachi has included joint research with Graduate School of Medicine, Hokkaido University through the Japanese Cabinet Office's Funding Program for World-Leading Innovative R&D on Science and

(b) Experience-oriented approach

A new system development technique proprietary to Hitachi for working together with the customers who use IT to generate "experiences" (human experience values such as delight, impressions, or intellectual gratification) and share "impressions" during the progress of a project.

(c) NEXPERIENCE / Opportunity Finding

A method for identifying new businesses by predicting social trends based on future changes in the values held by consumers. It is used to envisage the future by conducting desktop research based around looking at printed or web-based material from the perspectives of a nation's politics, economics, society, and technology, and considering how these will interact as they change over time.

Technology (FIRST Program), and approval has been obtained for the manufacture and sale (as a medical device under the Pharmaceutical Affairs Act) of a new proton beam therapy system that combines realtime tumor-tracking^(d) and spot scanning^(e), two advanced radiotherapy techniques⁽²⁾. Elsewhere, the Research & Development Group has strengthened its capabilities in fields such as virtualization for high-capacity storage systems, which are used by the information and telecommunication systems business, and in large-scale analysis techniques for the development of crashworthy structures for high-speed rolling stock, which are used in the railway systems business. It has also developed an active vibration control system to be used in the world's fastest elevator (as of June 2015) for the infrastructure systems business, and a double-sided cooling technique for building smaller inverters for the automotive systems business.

It is also working on innovations that combine these technology platforms to provide new forms of added value. In a demonstration project being undertaken in partnership with the Bonneville Power Administration of the U.S. Department of Energy, Hitachi is developing a grid stabilization system for preventing major power outages by combining power system analysis techniques with IT.

R&D from a Long-term Perspective

The most important mission of R&D is to lead the way toward long-term growth. To achieve this, the Research & Development Group seeks to anticipate future challenges and engage in creative leading-edge research that can provide new forms of social innovation or other paradigm shifts. These activities are focused in particular on the physical, life, and information sciences. In the physical sciences, this includes advanced techniques for simulating physical phenomena and atomic-resolution electron microscopes for developing innovative materials, and theoretical developments aimed at creating these technologies. In the life sciences, research topics include regenerative medicine and single cell genome analysis. In information science, Hitachi is working

(d) Realtime tumor-tracking

A synchronized radiotherapy technique whereby metal markers are implanted near a tumor and two X-ray fluoroscopes used to detect their locations and calculate them in three dimensions so that a particle beam can be applied at those instants when the markers are within a few millimeters of the intended location.

(e) Spot scanning

A technique for pinpoint irradiation in which the particle beam is scanned over the target area and applied one spot at a time. This allows the particle beam to be targeted with high accuracy to match the complex shape of the tumor.

on research into new computing concepts for the high-speed solution of combinatorial optimization problems, and on the analysis of things like brain activity and human behavior. In response to societal challenges such as population growth, and energy and food problems, work is also proceeding in new fields based on a vision of creating a sustainable society.

To develop innovations that can overcome the diverse challenges faced by customers and other parts of society, it is essential to work with customers and other technology partners, and with government agencies in Japan and elsewhere. Hitachi seeks to act as a hub for open innovation and to drive the development of future social innovations.

EXAMPLES OF INNOVATIVE R&D

This issue of *Hitachi Review* is dedicated to innovative R&D. It includes a total of 11 articles that present examples of this work, grouped under the categories of collaborative creation with customers, technology innovation, and exploratory research. The Category Overview provides summaries of each of these articles.

The first two articles present examples of collaborative creation in the form of an imaging solution and a solution for improving the efficiency of hospital management. The next seven articles deal with technology innovations, describing products for the home appliance, security, industrial, healthcare, and automotive equipment markets and the innovative technologies that make them possible. The final two articles look at exploratory research. These describe wearable sensors that can measure “organizational activity,” a parameter that correlates with levels of happiness in an organization, and a new computing concept for the efficient solution of combinatorial optimization problems.

This issue also includes a “Special Article” on the atomic-resolution holography electron microscope that achieved world-record resolution.

TOWARD FUTURE GROWTH

Hitachi has a track record of creating solutions that provide more advanced social infrastructure for energy, water, resources, urban development, and logistics by combining the latest IT with the infrastructure businesses it has built up over many years. For the ongoing growth of its Social Innovation Business, Hitachi recognizes the importance of establishing common platforms that can provide

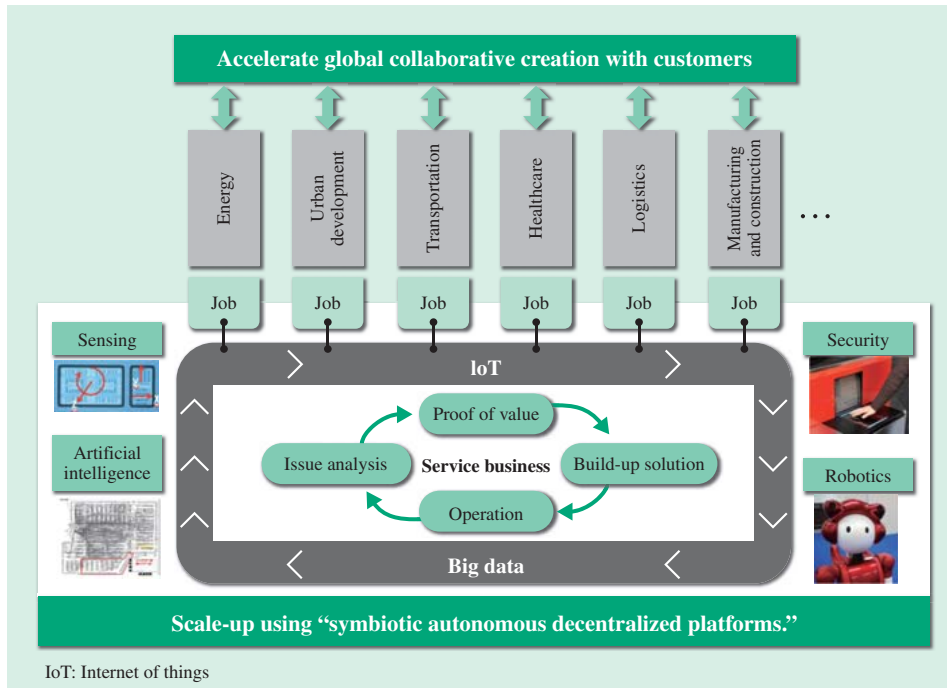


Fig. 3—Common Platforms for Expediting Social Innovation. Hitachi is accelerating the pace of collaborative creation with customers throughout the world using common “symbiotic autonomous decentralized platforms” that link value chains together across different industries and activities.

innovation as a service. New services will be provided by using the “symbiotic autonomous decentralized platform,” a common platform based on the IoT^(f), to analyze customer challenges, verify benefits, and build and operate solutions (see Fig. 3). The term “symbiotic autonomous decentralized system” refers to the system-of-systems concept whereby individual autonomous decentralized systems that have been optimized on a standalone basis are linked together via the IoT so that their collective operation can be optimized through “symbiosis” using artificial intelligence techniques. This enables solutions to be expanded from a scope that only encompasses a particular industry or activity into large systems that connect across different industries and all the way along the value chain. Artificial intelligence that can analyze indicators of system-wide efficiency will play an important role in achieving such “symbiotic autonomous decentralized” systems, as will sensing techniques for big data collection, security for information exchanged between systems, and techniques from robotics for interfacing with the real world. Hitachi intends to expand its Social Innovation Business and drive growth by working on the research and development of these technology platforms and by building platforms in collaboration with customers.

(f) IoT
Abbreviation of “Internet of things.” By providing network connections for the exchange of information among a wide variety of devices that have not been connected in the past, the IoT enables things like automatic recognition or interdependent control.

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ABOUT THE AUTHOR



Tsukasa Ariyoshi
Technology Strategy Office, Research & Development Group, Hitachi, Ltd. After joining Hitachi, Ltd. in 1983, worked in the Design Laboratory, Hitachi Design Centre Europe, and Rail Systems Division, and as General Manager of the Design Division prior to his current appointment as head of the Technology Strategy Office in the Research & Development Group.