

## Overview

# Exploratory Research Targeted at Overcoming Societal Challenges

## Efforts of the Center for Exploratory Research of Hitachi

Shinji Nishimura, Ph.D.

### 1. The Mission of the Center for Exploratory Research

Advances in information and communication technology (ICT) and the progress of globalization are pushing the world into an era of major transformation in which the nature of the economy and society and the structure of industry are undergoing rapid change. The period up until now has been one of technology-centric innovation in which the technologies arising out of the pursuit of efficiency and convenience have provided the driving force behind the progress of society. However, a greater emphasis has also come to be placed globally on the value of solving the societal challenges raised by the Sustainable Development Goals (SDGs)<sup>(1)</sup> and Society 5.0<sup>(2)</sup>. In considering what approach to take to ongoing growth, Hitachi for its part seeks to delve deeply into the challenges faced by people and society and to generate new value across all of its activities in ways that encompass environmental and social as well as economic value. We can be said to be entering an era of human-centric innovation in which new value is generated by thinking about how the economy and society function in

a way that focuses on people and by making rapid changes that extend even to the structure of industry.

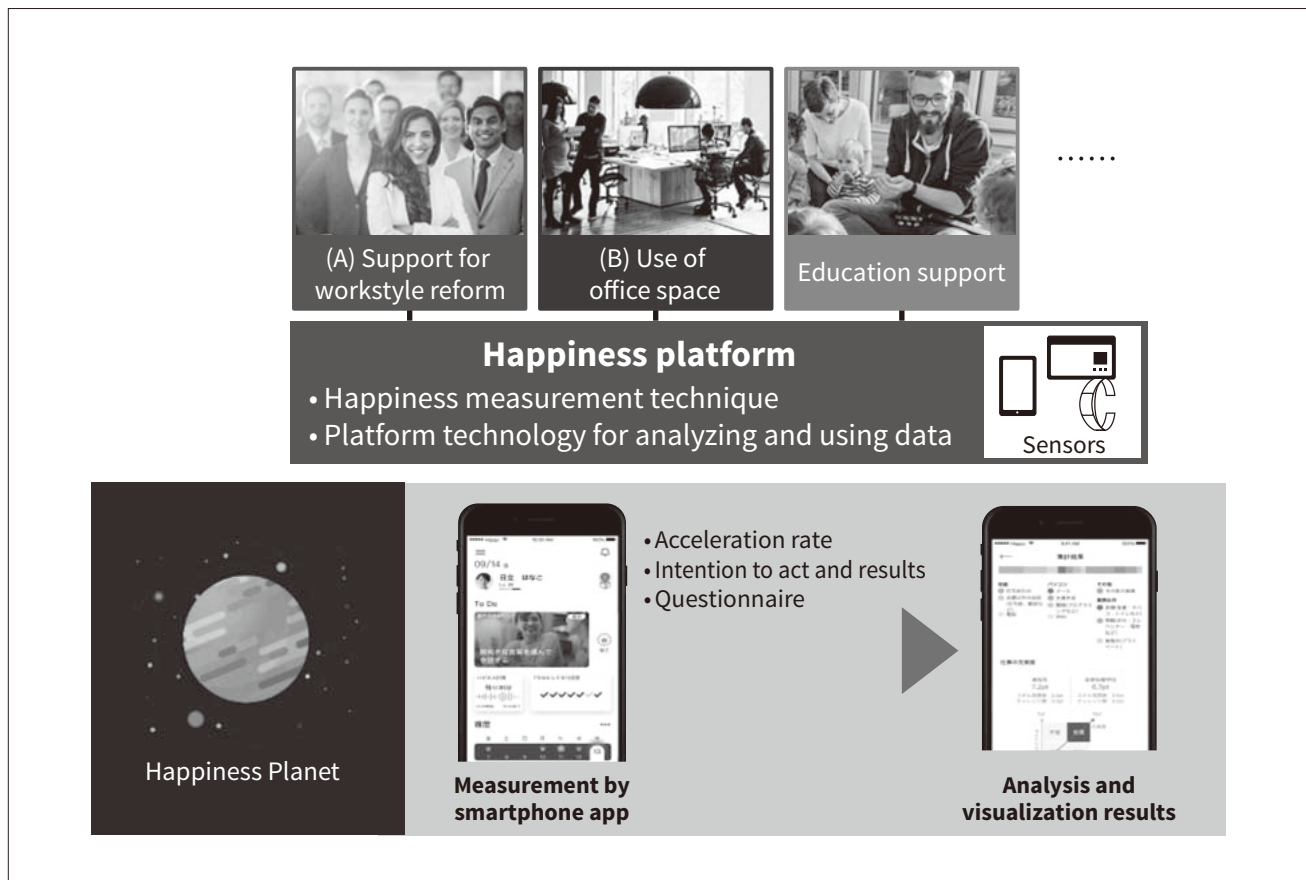
With its mission of “Creating human-centric value and promoting such concepts through research into the challenges we face,” the Center for Exploratory Research is accelerating its development of disruptive technologies through visionary open innovation that leads the way to Society 5.0. The center is also promoting a vision of where the world is going and is engaged in world-leading and vision-driven exploratory research aimed at establishing a new set of values with people at its center that is in harmony with society and the environment.

### 2. Resolution of Societal Challenges and Generation of Human-centric Value

The Center for Exploratory Research defines a disruptive technology as an innovation that disrupts existing market structures and is recognized globally as being a major step forward in resolving societal challenges. On this basis, the center is engaged in the following open innovation activities that seek to generate human-centric value by putting these technologies into practice.

**Figure 1 — Happiness Initiative**

The aim is to deliver economic reforms through a happiness platform that uses data on happiness.



**2. 1**

**Happiness**

In seeking to achieve public wellbeing, Hitachi is aiming to develop new businesses based around “happiness,” which it sees as a key performance indicator (KPI) when it comes to creating a society that delivers both economic growth and wellbeing for its people. By engaging in global demonstration projects that utilize happiness measurements in social activities such as workstyle reform and education, Hitachi is working to promulgate and standardize global happiness levels (see **Figure 1**).

In FY2018, Hitachi developed a platform for utilizing data on happiness. A large social experiment using a smartphone application with a happiness movement function in which 3,792 people participated from 83 companies (the “Workstyle Festival”) succeeded in demonstrating meaningful benefits<sup>(3)</sup>. The number of participating partner companies is also rising and Hitachi is taking steps to strengthen the theoretical underpinnings and core technology with the aim of

developing new businesses around use of the platform to determine happiness levels.

As part of this, Hitachi is also planning another large proof-of-concept (PoC) project for FY2019. To further enhance the happiness platform that serves as the basis of this work, Hitachi is working on basic research into quantitative measurement techniques for human behavior, environmental assessment techniques, and an artificial intelligence (AI) that interprets the measurement results. Meanwhile, further effort is going into maximizing happiness through the use of technologies such as interfaces that present results to people and facilitate interaction between people and the AI.

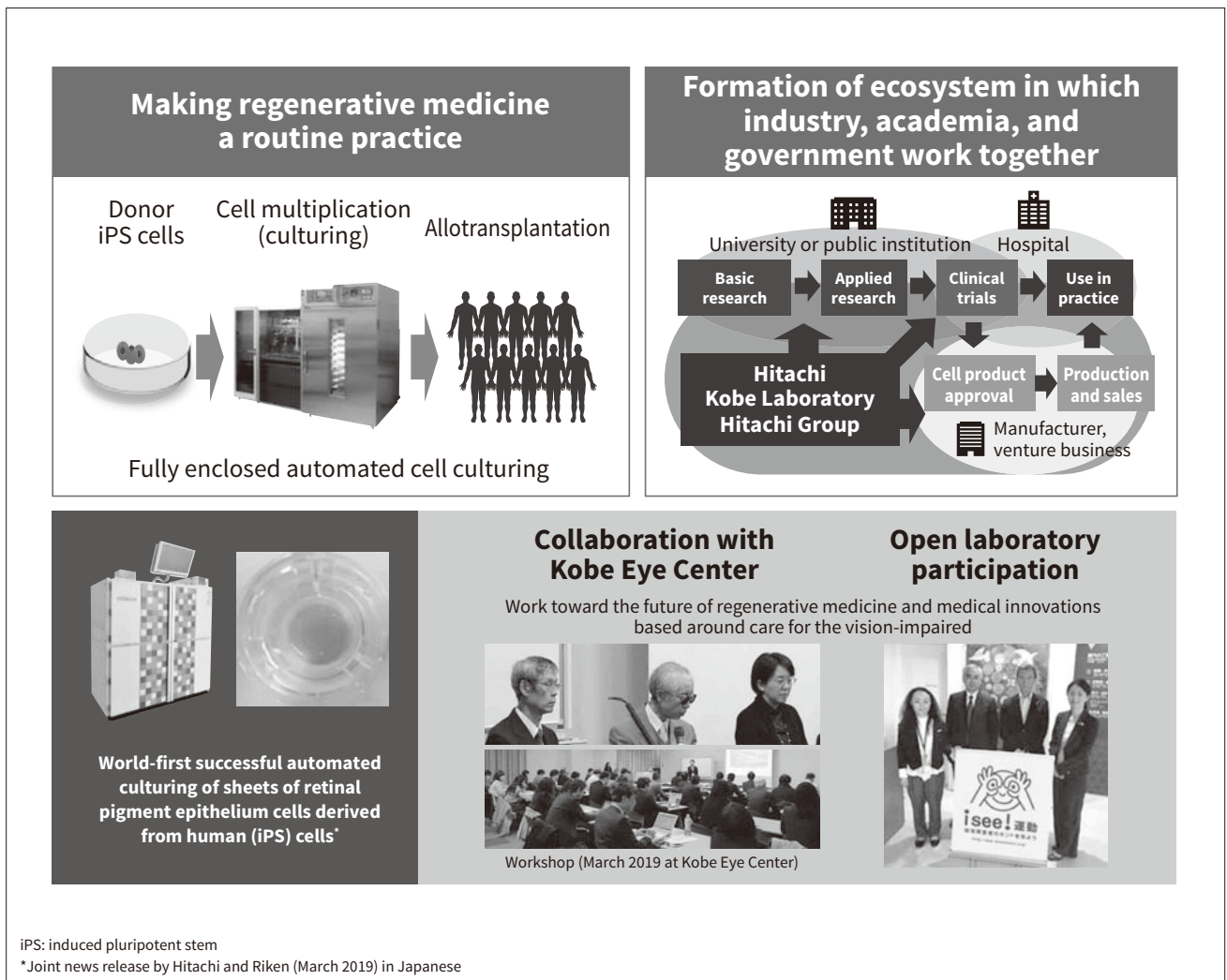
**2. 2**

**Regenerative Medicine (Hitachi Kobe Laboratory)**

Regenerative medicine is recognized for its potential as a revolutionary new form of treatment that is able to cure difficult diseases that have lacked an effective

Figure 2—Work on Regenerative Medicine<sup>(3)</sup>

The aim is to create a society in which people enjoy long healthy lives by using regenerative medicine to treat previously untreatable diseases.



treatment in the past. Hitachi is working toward its commercialization and routine use in healthcare as part of efforts aimed at creating an environment in which people can live vibrant lives and participate in society. To this end, the Hitachi Kobe Laboratory was opened in April 2017 in the Kobe Biomedical Innovation Cluster (KBIC), a site of intensive activity in the field of regenerative medicine. Hitachi’s aim is to have regenerative medicine (using donor cells) become widely adopted by enabling reliable cell production and by rationalizing costs by a factor of one hundred, with its proprietary fully enclosed automated cell culturing playing a core role. Accordingly, Hitachi is working with academia and industry partners on testing to demonstrate the utility of its fully enclosed automated cell culturing systems that feature excellent sterility (see Figure 2).

Using this system, the automated culturing of sheets of retinal pigment epithelium cells derived from human induced pluripotent stem (iPS) cells was successfully achieved in FY2018. Having also achieved experimental verification that the quality was on the same level as cells cultured manually by an experienced technician, Hitachi will press ahead with establishing intelligent automated cell culturing that monitors the cell culturing process and uses automatic control to keep it on track. Hitachi is also working on processing techniques for patients’ own stem cells (autologous stem cells) to develop the core technologies for achieving the ultimate in personalized medicine.

Another new initiative aimed at creating a society in which everyone can participate and enjoy a long healthy life is a workshop on care for the

vision-impaired being launched in collaboration with the Kobe Eye Center (an experiment to assess the adoption in healthcare of reforms to how people are helped to become active again in society, rehabilitation devices, and to promote wider public understanding of people with impaired vision).

## 2.3

### Quantum Information Processing

To help provide the information processing infrastructure for the society of the future, recent years have seen considerable activity in America, China, Europe, and elsewhere directed at the development of new computing technologies that can outperform the capabilities of classical computers, quantum computers being one such example.

The Hitachi Cambridge Laboratory has been engaged in basic research using quantum physics for many years. In FY2018, as part of a European collaboration that included the University of Cambridge, University of London, and Laboratoire d'électronique des technologies de l'information (CEA-Leti) (a research institution for electronic and information technology of the French Alternative Energies and Atomic Energy Commission), the laboratory successfully demonstrated a technique for reading information from quantum bits (qubits) with maximum sensitivity at extremely low temperatures using silicon complementary metal-oxide-semiconductor (CMOS) qubits<sup>(3)</sup>. The Center for Exploratory Research in Japan, meanwhile, has been working on a scalable bit structure that uses the quantum state of electron spin with a view to practical applications. Through broad coordination of work taking place in Europe and Japan, Hitachi is pushing ahead with a new generation of computing techniques such as quantum computing in ways that include architectures and applications.

## 2.4

### Pioneering New Science for High-performance Electron Microscopes

The Center for Exploratory Research has a number of holography electron microscopes, including the world's only ultra-high-voltage (1.2 MV and 1 MV) holography electron microscope. Since 2015, the center has been seeking to expand its research network

for exploring new sciences and to create new value by working with world-leading researchers from the Institute of Physical and Chemical Research (Riken) and elsewhere.

The center is engaged in basic research with potential for technological innovations that range from fundamental principles through to applications,<sup>(3)</sup> with one example being a collaboration with Riken and Osaka Prefecture University that successfully proposed and demonstrated a new way of performing the double-slit experiment that seeks to study the wave and particle nature of electrons. Other successes include measurement of magnetic fields with sub-nanometer resolution and the world's brightest electron beam for use in electron microscopy. The intention is to use the implementation of measurement and analytical techniques that lead to partner solutions like these as a launch pad for accelerating innovation.

The center is also considering the adoption of practices that bring in outside partners on the work it is doing to establish a network for pushing the bounds of measurement. Other activities include work aimed at the development and use of new physical measurement techniques based on electromagnetic radiation in collaboration with the large synchrotron radiation facility, SPring-8, and the other large-scale research facilities of the High Energy Accelerator Research Organization. The center also successfully developed a new technique for the non-destructive measurement of the internal temperature of objects in FY2018. By accelerating this sort of vision-driven exploratory research that leads to innovation in the natural sciences, the center is working toward applications of quantum physics and the development of innovative new materials that can overcome the challenges facing people and society.

## 3. Telling the World about Concepts

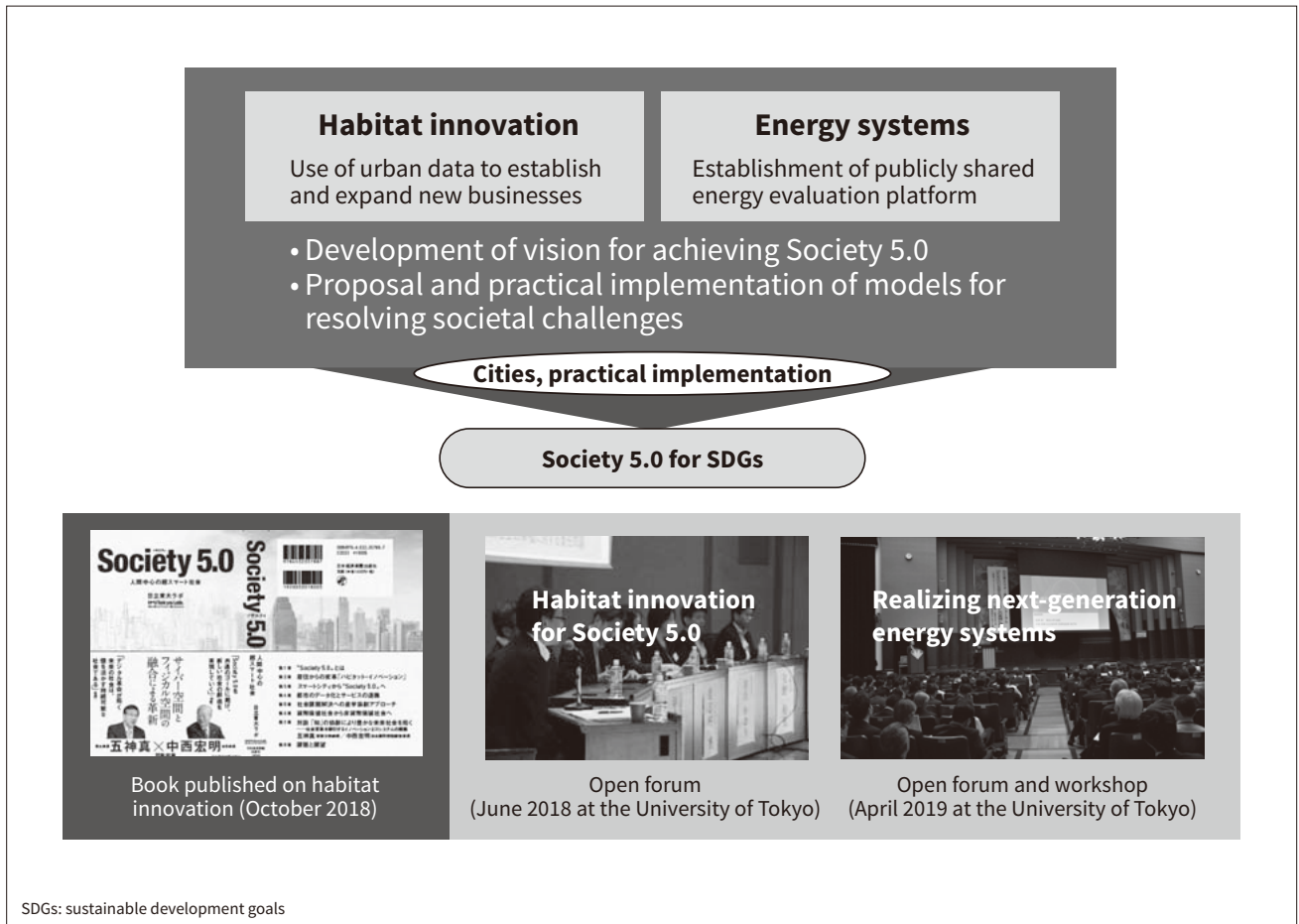
### 3.1

#### Realizing Society 5.0 (Hitachi-UTokyo Laboratory)

Hitachi-UTokyo Laboratory is seeking to realize Society 5.0 and contribute to the SDGs by developing a vision for the society of the future and implementing models for resolving societal challenges. It is currently

**Figure 3 — Activities at Hitachi-UTokyo Laboratory**

The laboratory is currently working on two projects: the habitat innovation project that deals with urban development and the energy systems project that supports the data-driven society.



working on two projects: one titled habitat innovation that deals with urban development and another titled energy systems that supports the data-driven society (see **Figure 3**).

Looking at new business development aimed both at making urban infrastructure more efficient and improving quality of life (QoL), the habitat innovation project is structured in a way that brings Hitachi and the University of Tokyo together, being made up of five working groups that respectively address the issues of data integration platforms, social infrastructure systems, lifetime health support, data-driven urban development, and overall integration. Drawing on the extensive expertise of the University of Tokyo that spans both the sciences and humanities, the project is working with Matsuyama City and a number of other local governments on community demonstration projects. Along with collating its vision for the future and presenting it at public forums during FY2018,

the project also published a book titled “Society 5.0: Human-centric Super Smart Society.”<sup>(4)</sup> The concepts were also presented at the Davos Meeting of the World Economic Forum (WEF) and the project has plans to collaborate with the WEF’s Centre for the Fourth Industrial Revolution (C4IR).

The energy systems project has identified the future technical and regulatory challenges facing the energy systems that will underpin Society 5.0, and along with producing proposal documents on this topic<sup>(5)</sup> is also holding public forums. It is working on an evaluation platform for electricity networks with the aim of reaching a consensus on the problems with stakeholders.

### 3.2 Policy Proposal AI for Achieving a Sustainable Future (Hitachi Kyoto University Laboratory)

Located in Kyoto, with all its culture and its long history, the Hitachi Kyoto University Laboratory

has embarked on an exploration of future challenges based on a deep understanding of people and culture as well as on fundamentals and theory. With the aim of overcoming the future challenge of Crisis 5.0<sup>(6)</sup> in 2050 that was issued in 2017 in partnership with Kyoto University, Hitachi is engaged in implementing public policy proposals that will contribute to improving the sustainability of society using a new policy proposal AI produced jointly by the laboratory and university, and also publicizing these to a wider audience.

This use of AI to generate policy proposals involved building a cause-and-effect model of a large number of societal indicators that embody knowledge of sociology and economics, and then using the AI to generate more than 20,000 future scenarios running to 2052. An analysis of these scenarios shed light on when important measures should be adopted and how necessary they will be. Along with presenting the policy proposal AI technique publicly, Hitachi is also working with local governments and other government agencies with a view to future policy development.

Other work includes the implementation of new IT systems that help society function, not only by using the past approach of analyzing social systems in order to understand them, but also by diagnosing what is going on with these and adopting measures (interventions) that take account of the prognosis and predictions. To this end, activities include investigating technologies such as those for assessing decision-making using data on people's behavior, with reference to knowledge of philosophy and psychology (as they relate to societal norms and ethics), and also system technologies for the regional economic cycle that take account of people's values and culture.

### 3.3

#### **Development of New Public Service Platforms for Regions at the Forefront of Facing Coming Challenges (Hitachi Hokkaido University Laboratory)**

The primary focus of the Hitachi Hokkaido University Laboratory is on solutions for regions at the forefront of facing coming challenges. Accordingly, it has since its establishment been utilizing demonstration

projects and other exploratory activities involving local government to work on resolving societal challenges in Hokkaido such as population loss, aging, and regional development.

The laboratory has been collaborating with the Center of Innovation (COI) site at Hokkaido University, Innovative Food and Healthcare Master on surveying the health of mothers and children and elucidating environmental factors, this being part of a technique for the analysis and prediction of human data that uncovers relationships between QoL and the problem of falling populations. In particular, it has commenced work in Iwamizawa City on collating a long-term health database unlike any such databases elsewhere in the world with the aim of establishing a community to support residents so that they can take the initiative to manage their own health.

Possible future activities involve linking the COI site at Hokkaido University, private-sector companies, base hospitals such as Hokkaido University Hospital, city health centers, welfare commissioners, and about 80,000 residents of Iwamizawa City to strengthen the base of public and private data integration, build a self-healthcare platform for use in a wide variety of service businesses, and implement and publicize this work.

## 4. Conclusions

This article has described how the Center for Exploratory Research uses research on overcoming the challenges facing society to create human-centric value, and what it is doing to communicate such concepts to the world.

In the future, Hitachi intends to pursue work on presenting a human-centric original vision that leads to the resolution of societal challenges, something that is ever increasing in importance as a global issue, and also to engage in open innovation with partners in Japan and elsewhere on vision-driven exploratory research for achieving this.

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## Author



### **Shinji Nishimura, Ph.D.**

General Manager of the Center for Exploratory Research, Research & Development Group, Hitachi, Ltd. *Society memberships:* Senior member of IEEE and the Institute of Electronics, Information and Communication Engineers (IEICE).