Category Overview

Product Innovation Achieved through Technology Innovation —Center for Technology Innovation—

ROLE OF CENTER FOR TECHNOLOGY INNOVATION

FORMED from parts of the Hitachi Research Laboratory, Yokohama Research Laboratory, and Central Research Laboratory, Hitachi's nine Centers for Technology Innovation respectively work in the fields of Energy, Electronics, Mechanical Engineering, Materials, Systems Engineering, Information and Telecommunications, Controls, Production Engineering, and Healthcare. In addition to developing Hitachi's technology portfolios further in these nine sectors through the creation of innovative products, the centers will also support the development of new solutions through the optimal combination of a wide range of technologies.

STRENGTHENING OF TECHNOLOGY PLATFORM

In parallel with Hitachi's more than 100-year history of product development, its Research & Development Group has been developing and accumulating element technologies that underpin fundamental product features such as performance and reliability. In the future, Hitachi plans to develop these technologies further and organize them into technology platforms so they can be utilized in the development of innovative products and services that will ensure ongoing growth.

A technology platform collates together a variety of element technologies. These cover all of the processes from basic research to product development, including

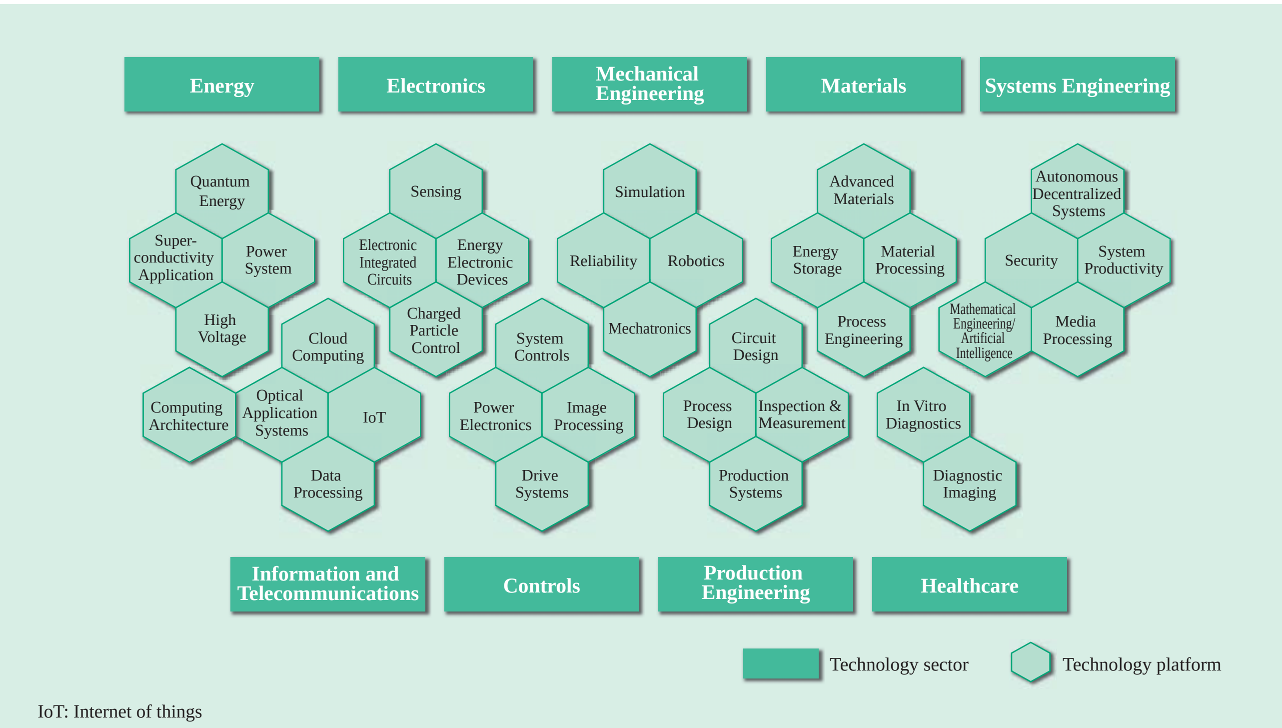

Fig. 1—Technology Sectors and Technology Platforms.
Hitachi has brought together existing element technologies and combined them into 36 technology platforms (represented by the honeycomb cells in the figure) covering nine technology sectors, including Energy and Electronics.

core technologies developed in-house, technologies adopted from external sources, and experimental research technologies for testing the limits of theory. Hitachi has already established numerous technology platforms through its ongoing work on element technology development, product applications, and enhancements.

This resource is currently organized into 36 technology platforms spread across nine technology sectors (see Fig. 1). Along with coordinating its technology platforms with product development and deepening their scope, Hitachi is also expanding them in step with international technology trends.

USE OF TECHNOLOGY PLATFORMS TO CREATE INNOVATIVE PRODUCTS

This section groups the establishment of technology platforms and the development of innovative products into four categories and describes example developments.

Technology Innovation Coordinated with Product Development

Hitachi develops new technologies as it seeks to obtain "ultimate performance" from products. The critical dimension scanning electron microscope (CD-SEM) provides a typical example (see Fig. 2). Since commencing research in 1982, Hitachi has continued to improve resolution to keep pace with advances in semiconductor device miniaturization. Along with higher resolution, Hitachi has also developed new measurement techniques that go beyond the limit of optical wavelength resolution. In the case of electron beam sources (electron guns), which are an important determinant of measurement performance, Hitachi has been working first on field emission electron guns and subsequently on the Schottky electron gun, which provides more stable emission of electrons, and has commercialized these by utilizing electromagnetic field analysis techniques for electron beam manipulation. The achievement of highly stable electron emission and high resolution has improved resolution from 15 nm initially to 1.8 nm. Thanks to these ongoing technology innovations, Hitachi now has the largest share of the global market for CD-SEMs*1.

Fig. 2—CD-SEM for Use in Semiconductor Production.
This is a photograph of the CG5000 high-resolution field emission beam critical dimension scanning electron microscope (FEB CD-SEM) (Hitachi High-Technologies Corporation). The CG5000 is used for the dimensional measurement of the patterns formed on semiconductor or other wafers.

Finger vein authentication provides another example. With the aim of obtaining "ultimate performance" from security techniques that use biometric information, Hitachi has developed a biometric identification technique capable of high-speed recognition of finger vein patterns regardless of how the finger is presented (position and orientation, etc.). The technology is currently being deployed for walkthrough-style personal verification.

This issue of *Hitachi Review* includes an article about energy-efficient room air conditioners that offer yet another example. These have achieved an Annual Performance Factor (APF) of 7.3 thanks to the use of analysis techniques to make ongoing improvements to the efficiency of system components, leading to the air conditioner winning the FY2014 METI Minister's Prize for Excellence in Energy Efficiency and Conservation.

Creation of Innovative Products by Combining Different Technologies

Work is ongoing to achieve innovation in numerous products through the combination of different technologies, elevators being one recent example. This has included developments in fields that have been a subject of research at Hitachi since 1920, including drive and control techniques for electric motors with high output intended for high-speed transportation, and heat-resistant materials for brakes that can perform an emergency stop when excessive speed is

*1 As of April 2015, based on research by Hitachi, Ltd.

*Fig. 3—Hitachi High-speed Data Access Platform*3.*
Centered around the ultrafast database engine, the platform contributes to the use of big data by enabling ultra-high-speed data searches.

Fig. 4—Shipment of Class 800 Rolling Stock for the UK. Department for Transport Intercity Express Programme (IEP).
Hitachi successfully complied with European standards by taking analysis techniques and material technologies built up through product development in a variety of fields and applying them to rolling stock safety design.

detected. Along with faster speeds there is also a need for comfort. Hitachi has developed the world's fastest elevator*2 with a speed of 1,200 m/min by combining the above technologies for high-speed operation with active damping techniques that can detect tiny distortions in guide rails or lateral vibration caused by wind and reduce the associated vibrations, and techniques for controlling the air pressure in elevators cars to minimize ear blockages.

Other examples are hybrid analyzers for clinical chemistry and immunoassay. These are capable of performing a wide range of biochemical and immunological blood tests at high speed thanks to the combination of optical measurement techniques designed for high sensitivity with techniques for the precise separation of samples, including micro-sampling methods and sample handling techniques.

As an example of this sort of technology, this issue of *Hitachi Review* includes an article about amorphous motors. Through a combination of motor design techniques and machining techniques for amorphous metals, which are characterized by low energy losses, the motors have achieved the highest possible International Efficiency (IE) rating of IE5.

Technology Innovations Achieved through Infusion of Open Innovation

There are also cases of product innovations that resulted from the adoption of new technologies through collaboration with external institutions and their combination with Hitachi technologies.

One example is the ultrafast database engine*3, which serves as the core of information systems. Major improvements in processing performance have been achieved by combining database implementations that Hitachi has built up through the mainframe era with the principle of out-of-order execution devised by Professor Masaru Kitsuregawa and Associate Professor Kazuo Goda of The University of Tokyo. The increasing speed of data processing makes it possible to optimize the use of hardware performance. This also significantly reduces the execution time for

*2 As of June 2015, based on research by Hitachi, Ltd.
*3 Utilizes the results of "Development of the Fastest Database Engine for the Era of Very Large Database and Experiment and Evaluation of Strategic Social Services Enabled by the Database Engine" (Principal Investigator: Prof. Masaru Kitsuregawa, The University of Tokyo/Director General, National Institute of Informatics), which was supported by the Japanese Cabinet Office's FIRST Program (Funding Program for World-Leading Innovative R&D on Science and Technology).

big data analytics (see Fig. 3).

The proton beam therapy system for cancer treatment described in an article in this issue of *Hitachi Review* combines Hitachi's spot scanning technique with the tumor tracking technique developed at Hokkaido University[*4]. This is able to target the proton beam accurately even at tumors that move due to the patient's breathing, for example.

Cross-disciplinary Creation of Innovative Products

Hitachi is taking technologies built up through product development in one sector and utilizing them in different sectors, not only to create innovative products, but also to expand and strengthen its technology platforms.

An example of this is the safety design of the Class 800 series high-speed rolling stock for the UK's Intercity Express Programme (IEP). This involved the application to high-speed rail safety design of analysis techniques and material and other technologies developed for fields such as industrial machinery, and nuclear and thermal power generation. The rolling stock achieved compliance with the numerous European safety standards through measures that included the design of crashworthy structures and the simulation of collisions involving an entire train, something that is difficult to test experimentally. The first train was shipped to the UK from Kasado Works, Hitachi, Ltd. in March 2015. Operation is scheduled to commence in 2017 (see Fig. 4).

Other examples include the big drum washer-dryer, which includes a "wind iron" technique for blowing air through clothing to remove wrinkles and that was developed using a blower design that re-purposed techniques from fluid dynamics developed for the design of the Shinkansen, and a power module with double-sided cooling that puts technology developed for small automotive inverters to use in uninterruptible power supplies.

CONCLUSIONS

Unlike the individual element technologies, technology platforms are not something that can be assembled overnight. Along with the further development of its technology platforms, the Research & Development Group intends to continue working on innovations in the technologies and products that use these platforms.

*4 Utilizes the results of "Advanced Radiation Therapy Project: Real-time Tumor-tracking with Molecular Imaging Technique" program (Principal Investigator: Professor Hiroki Shirato of the Graduate School of Medicine, Hokkaido University) that ran from March 2010 to March 2014 under the Japanese Cabinet Office's FIRST Program.

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