R&D Vision and Strategies for Supporting Industrial Infrastructure of Sustainable Society

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As a key supplier of products and solutions supporting the industrial and social infrastructure, we create our R&D visions and strategies based on a long-term perspective and our core competencies of measurement, control and information. The Corporate R&D Headquarters defines three cross-functional technology areas, namely Field-ubiquitous Computing, Micro-technology, and Photonics Technology, as the key strategic technology domains, and focuses on research to help create the industrial infrastructure for a sustainable society.

INTRODUCTION

In the 21st century, globalization in society and the economy is advancing even faster. Globalization of our business is also rapidly advancing, and so we must differentiate our products from others in order to compete globally. The globalization of social issues such as global warming, depletion of energy and resources, and the digital divide are also advancing. We believe that creating advanced technologies to address these global-scale issues is the best way to maximize the value to customers and to win in the competitive marketplace.

This paper introduces the approach of the Corporate R&D Headquarters on research and technology in line with our visions.

FUNDAMENTAL POLICY ON RESEARCH AND TECHNOLOGY

As indicated in our corporate philosophy, "As a group, our goal is to contribute to society through broad-ranging activities in the areas of measurement, control and information," Yokogawa focuses on supplying sophisticated products and solutions for industry and social infrastructure. We started out by providing mother tools and leading-edge infrastructure necessary for manufacturing, and in recent years, our business has expanded broadly to encompass the fields of information communications, medicine, and life sciences, which are all part of the social infrastructure. In all areas, our core competencies remain the measurement and control technologies that we have cultivated for many years in the manufacturing sector, and information technologies that support those technologies.

Since Yokogawa focuses on infrastructure for industry and society which involves a heavy responsibility, our products and solutions must deliver long-term higher reliability and stability than in other fields. Our products and solutions inherit functions from each generation of products, and continue to embody more advanced technologies. As a key supplier of infrastructure, we must also be able to supply long-lasting stable components and maintenance services for a long time.

With this background, our R&D activities, which started out with the basics such as sensor development, have led to many long-selling products. We understand that a medium- to long-term perspective is important without being affected by short-term economic fluctuations and temporary trends when deciding our direction in technology. We predict what Yokogawa should be about 10 years into the future while analyzing macro trends in the market and society, decide R&D strategies, and then work on developing the core technologies. We also choose the most important areas based on a medium- to long-term perspective and invest continuously in R&D with strong support from top management.

TRENDS IN SOCIETY AND MARKETS

In the manufacturing industry, the worldwide production network and value chain reflect social and economic globalization in the 21st century. Through this global network,

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suppliers, producers, and customers in different locations exchange goods and information beyond national borders. As a result, many countries, not only developed countries but also those which supply resources and the fast-industrializing countries, are enjoying the benefits of the global value chain. This is a major difference from the globalization in the last century, in which only some developed industrial countries reaped the benefits.

Meanwhile, social issues are also spreading worldwide in line with global economic growth. Global warming, depletion of energy and resources, and the digital divide are common challenges for all of humankind.

As reported by the Intergovernmental Panel on Climate (IPCC), global warming is a world-wide threat to human prosperity, and has been intensively discussed by the international community. [(1)] Regulations are needed to prevent problems, as well as drastic social change to create a low-carbon sustainable society that balances environmental protection with economic growth. Further technological innovation is essential for solving the issues and building a sustainable society. Japan, which has developed technologies for saving energy and protecting the environment since the oil shocks, is expected to develop new forms of energy and a social system for conserving resources and energy. [(2)]

The promoters of globalization extend from the national and enterprise level, through to the individual level. This is another characteristic of globalization in the 21st century. [(3)] The dramatic progress and integration of various information and communication technologies, such as the Internet, allow individuals to collaborate directly in various activities. As global economic development has brought individual affluence, diversity in products and services is essential to meet individuals' preferences and demands. Individuals are thus playing a leading part in this flat world.

THE R&D VISION

The primary role of the Corporate R&D Headquarters is to decide the technical direction that the Yokogawa Group should take, and through R&D, to provide leading-edge technologies that will spawn new businesses. By analyzing societal and market trends, we have defined the following two medium- to long-term R&D visions to be achieved by 2020:

1) The development of technologies for a low-carbon society with sustainable growth
2) The creation of technologies for a social structural revolution in products and services emphasizing the individual

To counter the depletion of resources and global warming, new energies and environmental conservation systems are being developed. Through its plant instrumentation, Yokogawa has accumulated technologies for environmental preservation, energy conservation and optimizing plant operation. We also have a wealth of experience in the energy industry both inside and outside of Japan. In line with the "green IT" concept, technologies for energy conservation and resource saving using IT will be applied to various social systems other than industry in the future. Thus, Yokogawa will help to build a low-carbon society through its industrial measurement and control technologies.

In the era of globalization where the individual plays a leading part, products and services must be customized to individuals' needs in the manufacturing industry and social services, in addition to the current system of mass production/mass consumption. Products and services for individuals will be produced by a different system to the conventional mass production, and new technology will be required.

The two key visions of establishing a low-carbon society and promoting products and services for individuals, are inconsistent requirements under the conventional economic principle of a rapid-growing industrial society. However, in the upcoming sustainable industrial society, a balance among economic growth, environmental conservation and individual affluence is required. The key for technological innovation is to respond appropriately to these challenges, thus creating even greater value. For Yokogawa, with its core competencies of measurement and control, this is an outstanding opportunity. Responding appropriately to these challenges will provide the driving force for ensuring competitive leadership in our business as well as contributing to the global society.

THE FUNCTIONS OF CORPORATE R&D HEADQUARTERS AND ITS TECHNOLOGICAL DEVELOPMENT STRATEGIES

Functions of Corporate R&D Headquarters

Corporate R&D Headquarters has three functions as shown in Figure 1. We are contributing to business by providing company-wide support for product development and R&D for future business.

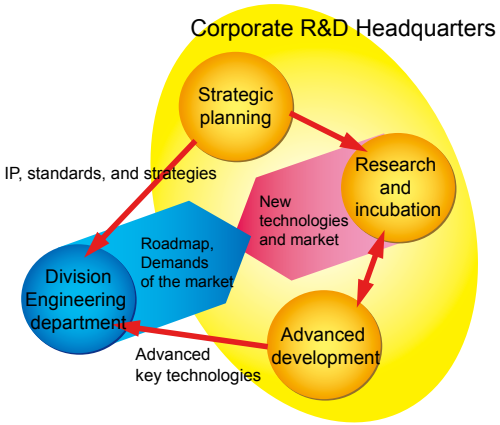

Figure 1 The functions of Corporate R&D Headquarters

1) Research and incubation function
   Discover technologies for future business in the medium- to long-term, and develop them into key technologies.
2) Advanced development function
   Develop leading-edge technologies for the division's next-generation products prior to product development.

3) Technological strategies function
Strategically operate intellectual property and international standardization activities by planning and implementing the technological strategies of the entire Yokogawa Group.

Focused R&D strategy

To realize our R&D vision by 2020, we have defined core R&D domains for strategic technologies. The fusion of technological fields beyond borders and the strategic utilization of those fields are essential to create higher value-added products and solutions based on our core competencies of measurement, control and information. We have selected three fields, "Field-ubiquitous Computing," "Micro-technology" and "Photonics technology" as indicated in Figure 2, on condition that they have broad-ranging potential to take advantage of Yokogawa's strengths. The following sections describe each domain.

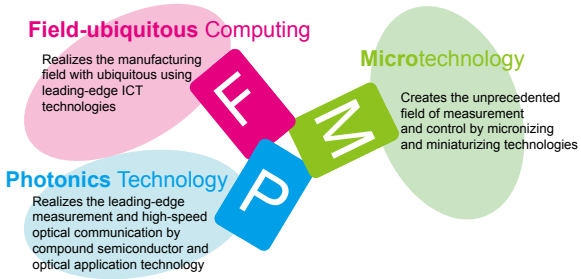

Figure 2 Three domains for strategic technologies

International standardization strategy

When planning the technological strategy, we emphasize international standardization while considering the strategic acquisition and use of intellectual property. [4] We believe that open technology will significantly increase value for customers, so we have been focusing on standardizing technology and ensuring its interoperability. In strategic fields, we strive to ensure that the values delivered by the new international standards we propose will increase our own global competitiveness. Examples of standardized technologies in which Yokogawa has led the industry include industrial field communication "FOUNDATION Fieldbus ™" and IPv6, a basic Internet technology.

An essential element of international standardization is to set up a framework for collaboration with forward-thinking customers. We propose what Yokogawa should be in the future from a technological point of view, the way to realize it, and the value for customers at an early stage. Thus we are aiming to achieve standardization in collaboration with customers.

Open innovation strategy

In fields where products need to be supplied stably for a long time, such as industrial systems, correct judgments of the technology and market for technology development are essential from the medium- to long-term point of view. However, technical innovation is progressing ever faster, and for companies that adhere to their own technologies alone, it is impossible to win the development race. Therefore, "open innovation," which means collaboration with a partner for seeking synergies among superior knowledge and technologies, is becoming increasingly important.

Yokogawa has been undertaking joint research with public research organizations through national projects, and also with universities, seeking leading-edge technologies in new fields. We will intensify collaborative R&D with external organizations in various ways, such as collaboration with companies in different industries to complement our non-core areas, and collaboration with forward-thinking customers to develop technologies from the users' standpoint. We will always encourage the globalization of R&D since there are no borders between our partners and us.

THREE DOMAINS FOR STRATEGIC TECHNOLOGIES

The three strategic technology fields are described in this section. The details are given in each paper on each field in this Yokogawa Technical Report.

Field-ubiquitous Computing

Ubiquitous computing, which means that the benefit of information technology can be obtained "at anytime, anywhere, by anybody," is now rapidly spreading in offices and homes. However, closed systems have been the norm in industry for so long in order to guarantee reliability and robustness; ubiquitous computing has been considered valuable only in an open environment. Yet in recent years, there has been rapid technical progress with open technologies, and open technologies such as the Internet have been introduced into industrial systems one after another. Now, the environment for penetration of ubiquitous computing has been created in the industrial fields as well.

The ultimate form of ubiquitous computing in the industrial automation field is where all devices and equipment on the plant floor are highly intelligent and function autonomously. Originally, the main purpose of using computers was to "make people intelligent." But now, ubiquitous computing means that the environment itself is becoming intelligent.

A "ubiquitous" plant floor realized by field-ubiquitous computing technology is expected not only to improve the network environment but also to create new values for users. For example, a group of autonomous devices and equipment will be able to respond accurately to all the demands of all individuals related to production, through the operators, process engineers, and maintenance engineers, to production control engineers.

Micro-technology

The increasing sophistication of functions requires further miniaturization and integration of elements and devices. Yokogawa, in order to create differentiating products, has started developing its own semiconductor components

which have been at the heart of products since the early 1980s. In the measurement sector, we have developed key devices such as the high-speed high-resolution A/D converter for electronic measuring instruments and those for semiconductor testers. Also, in the control sector, we have developed a silicon resonant differential pressure sensor making full use of Micro Electro Mechanical Systems (MEMS) technology to satisfy the demand for highly reliable and accurate pressure measurement.

This trend toward miniaturization and integration of electronic and mechanical technologies is becoming widespread even in the chemical industry. Recently, micro-plant technology, which means making a chemical plant compact enough to fit onto a chip like an IC chip, has emerged. Since this technology simplifies the theoretical handling of chemical reactions, it is expected to create reaction fields that were hard to achieve.

Micro-plant technology is an important key technology for on-site and on-demand production systems where the necessary amount of the required products is produced in the desired location. The on-site and on-demand process can achieve the paradigm of satisfying the demands of individuals not possible through mass production. This is an expansion of the ubiquitous concept to production, and could be called "ubiquitous production," Ubiquitous production is appropriate for sustainable society, because it has the potential to prevent unnecessary production and wasted energy while responding to the demands of individuals.

We are now broadening the scope of application of micro-plant technology to encompass the medical and life science fields. By integrating complex chemical analysis processes in a compact space, inspection of biological substances such as genes and diagnosis of diseases can be done on-site without requiring special skills.

Photonics technology

Optical devices have been widely used for displaying and communicating information for a long time. After the discovery of the laser, the field of optics expanded to high-accuracy spectral analysis with laser spectrometry and high-speed, large-capacity optical communication. In future, it will expand to optical information processing.

Yokogawa has been working on photonics technology integrated with classical optical and electronics technologies, in which R&D initially focused on optical measurement. We started researching compound semiconductors in the early 1980s, and have been supplying optical devices as key components for optical measuring instruments and semiconductor testers since the 1990s. In the 2000s, we developed a 40-Gbps optical communication module, aiming to apply compound semiconductors to optical communication infrastructure.

In April 2006, the Photonics Business Headquarters was established based on the optical component technologies described above, and entered the high-speed optical communication sector. Optical communication and information transmission reduces the power consumption, offering remarkable energy savings, and so is expected to help create a sustainable society.

We have also been researching photonics technologies in the measurement field. Through integration with mechatronics technology, we have created various optical measuring instruments such as laser confocal scanners, optical power meters and optical spectrum analyzers.

To use photonics technologies in more advanced applications, we are now studying optical application measurement, such as a high-resolution spectroscopic analyzer using high-density photodiode arrays, and are working on using such photonics devices as a key component of genetic diagnosis systems.

CONCLUSION

Corporate researchers in future require not only technical skills but also a global awareness of business, as well as a willingness to adopt Open Innovation. Companies need to encourage such researchers with a challenging spirit.

We will continue to share our R&D vision and focus on creating innovations to enable Yokogawa to grow.

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