

Cross-ministerial Strategic Innovation Promotion Program (SIP)  
Photonics and Quantum Technology for Society 5.0

Next-Gen Manufacturing Infrastructure Begins to Solidify

Japan: sustainable competitiveness through CPS driven by photonics and quantum tech

The environment surrounding Japanese manufacturing is changing drastically. Business is faced with an existential need to boost industrial competitiveness among new problems, such as creating new value through digital transformation (DX), decarbonization, strengthening the domestic production stance from the viewpoint of economic security. The Photonics and Quantum Technology for Society 5.0 Research and Development Plan defined in the Cross-ministerial Strategic Innovation Promotion Program (below, SIP P&Q) is a national project designed to develop the core technologies essential in strengthening manufacturing competitiveness.

Results of SIP P&Q research entering practical already entering

The SIP P&Q program is engaged in three technical issues needed to construct the Cyber-Physical System (CPS) for smart manufacturing, leveraging Japan's existing strengths in photonic and quantum technologies: laser processing, photonic quantum communication (quantum cryptographic communication), and photonic and electronic information processing (Fig. 1). The 5-year program is now approaching the last fiscal year of in the 2nd period of SIP P&Q. Program Director NISHIDA Naoto comments "We are continuing to advance R&D in close cooperation with domestic industry and overseas research institutes, and some of our research is already being implemented."

Several of the technologies from SIP P&Q have entered practical use, among them the quantum cryptography communication technology commercialized by Toshiba Corp, and the photonic crystal lasers developed by Kyoto University already implemented in light detection and ranging (LiDAR) sensors potentially usable for robots and autonomous vehicles. In addition to the individual technologies, though, SIP P&Q has also begun to sketch out the CPS to unify all three core technologies for practical

implementation: a major step toward developing real solutions.

As global problems including energy, global warming, and economic security continue to intensify, however, it has become increasingly obvious that manufacturing must optimize its role in various social activities. Germany and the rest of the EU are advancing Industrie 4.0, leveraging digital technology to optimize manufacturing, and recently Industrie 5.0 has been discussed to expand optimization targets to include areas peripheral to manufacturing. This movement is catching up to efforts of creating "Society 5.0" in Japan by optimizing social activity using CPS, formulated by the Japanese government in 2016.

As the COVID emergency changed the environment, the value of establishing CPS and its activities to apply digital technology throughout the manufacturing industry was increasingly appreciated. The semiconductor manufacturing industry, which has been in the forefront of digital technology and automation for some time, has attracted considerable attention for the resilience it displayed during the worst of COVID, continuing close-to-usual operations.

Japanese manufacturing is more eager than ever for the long-awaited social implementation of results from SIP P&Q.

Fig.1 The Cyber-Physical System (CPS)

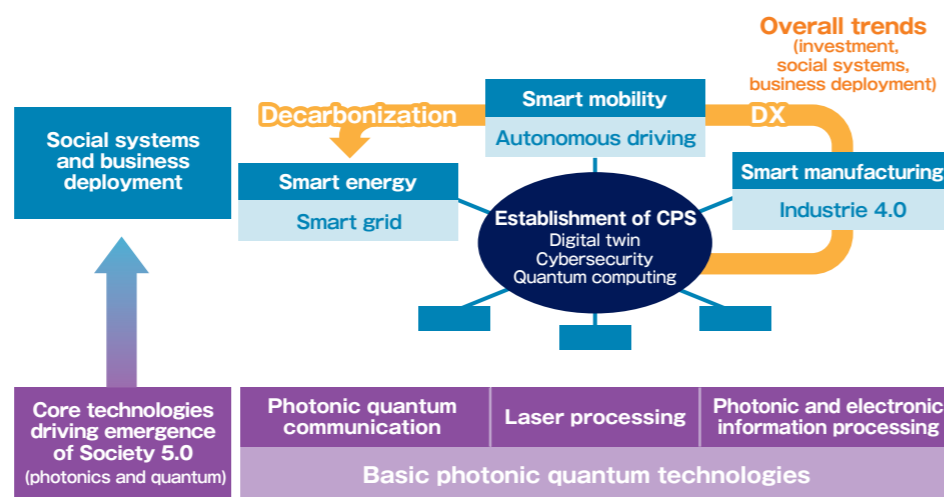
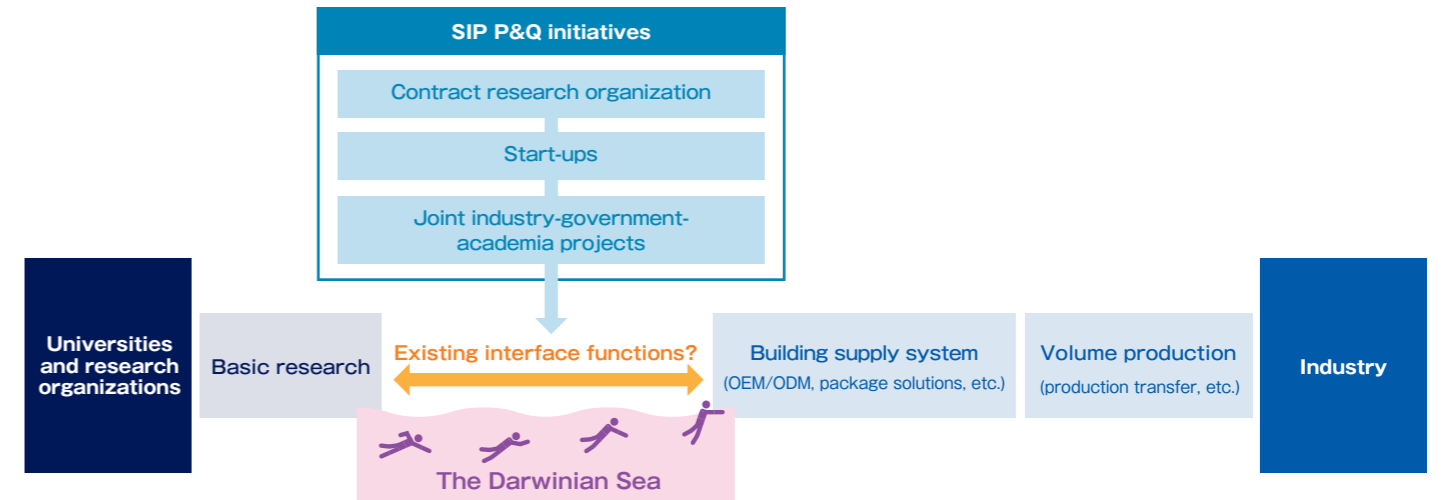


Fig.2 Essential functions to bridge the "Darwinian Sea" and implement research results in society



Bridging the Darwinian Sea and establishing a system to foster competitiveness

Implementing research results in daily society is no simple matter, however. Japanese manufacturing companies boast a considerable variety of developed technologies rich in potential, but in fact many of them have never advanced past the research stage.

The major obstacle to social implementation is that the fields universities and research institutions want to investigate do not match well with the technology fields that industry is interested in developing. SIP P&Q terms this gap the Darwinian Sea (Fig. 2).

Some nations overseas have created agencies to help cross this Darwinian Sea, providing close interaction between industry, academia, and research institutions. Deputy Program Director YASUI Koji explains that companies taking advantage of the service can still book extremely complex business even if they can't handle it with their own technology. Japanese firms can't accept that sort of contract work. He suggests this underlies the competitiveness difference between Japanese and German industry.

There is pressure on SIP P&Q to provide the same sort of interfacing service in Japan, for creating industry-gov-

ernment-academia joint projects and start-ups from university research.

In recognition of the need, the SIP P&Q will help cross the Darwinian Sea, providing a win-win solution for domestic and foreign organizations and universities engaged in a range of research, and industry facing a similarly wide range of problems. As a result, a framework to nurture sustainable competitiveness is emerging.

In recent years it has become increasingly common for creativity in academic research to surge when different fields synergize. At the same time, the amount of capital needed for research has soared. SIP P&Q provides a place for academia and research organizations to work jointly with industry, and a framework returning corporate capital investment into research. Top-level researchers are finally able to enjoy the benefits and significance of bridging the Darwinian Sea, and an increasing number are taking advantage of the opportunity.

A platform to interconnect multiple research centers

Industry, meanwhile, has long wanted an organization that can help find ways to resolve pressing issues and advance corporate plans through CPS. Numerous companies are building and

operating CPS for the first time, and in many cases don't yet know what technologies, knowledge, and skills are needed.

"In addition to relatively obvious technologies such as laser processing and quantum computing, the construction of CPS also demands the realization of a quantum secure cloud to more strongly protect digitized assets," says Deputy Program Director SASAKI Masahide. "It is important to provide a total solution, with all the requisite core technologies." The SIP P&Q goal is a one-stop CPS platform to interconnect multiple research sites, covering everything from corporate technology research to product development.

Program Director NISHIDA comments "The CPS platform will be a success if it can achieve a positive feedback loop between improving research quality and strengthening corporate competitiveness, and reaches the point where industry is investing 120 billion yen, about ten times historical investment into SIP P&Q over a 5-year term, and applying the results."

Recent activity by SIP P&Q is being closely followed both in Japan and internationally.

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