Looking Toward the Future in 2040: Chapter 2 A Future Society Expanded by Science and Technology (Society 5.0)

This chapter introduces you to the Science and Technology (S&T) Foresight Survey, a foresight initiative by the National Institute of Science and Technology Policy (NISTEP), which was established under the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as an institution for research on science and technology and academic policy.

The S&T Foresight Survey has been conducted about every five years since 1971 to foresee the future of science and technology and its relationship with society, and to contribute to the formulation of the Science and Technology Basic Plan.

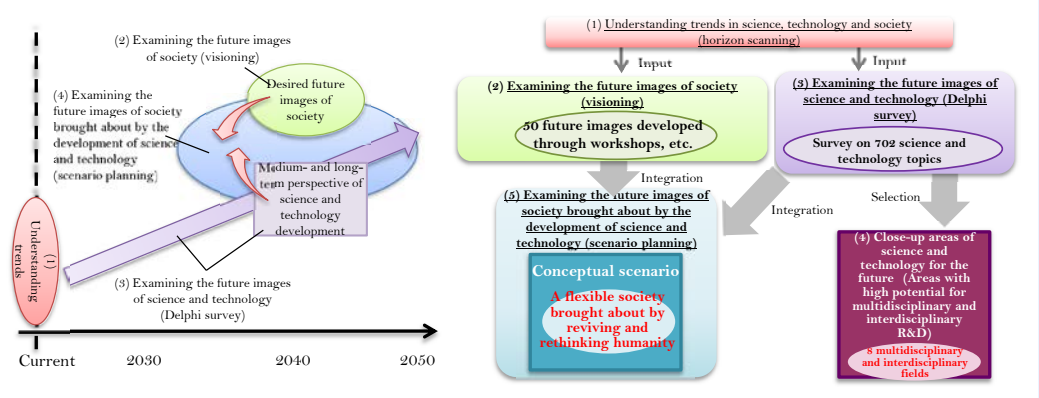
The report on the 11th Survey published in November 2019 discussed the future images of society (the desired future images) and the future images of science and technology (the medium- and long-term perspective of science and technology development). Combining these two, the report presents "a flexible society brought about by reviving and rethinking humanity" as the "vision of the future of society brought about by the development of science and technology." In addition, it also identified eight "close-up areas of science and technology" as areas with high potential for multidisciplinary and interdisciplinary R&D.

Section 1 About the S&T Foresight Survey

1 Background and Overall Structure of the Survey

The S&T Foresight Survey is a survey to depict future images of society brought about by the development of science and technology. Over its 50-year history from 1971, the focus of the survey has first shifted from science and technology to society (such as social needs and solutions to social issues), and then to the creation of scenarios that integrate these two. The 11th Survey was conducted by combining the following four methods: (1) understanding trends in science, technology and society (scanning method), (2) examining the future images of society (visioning method), (3) examining the future images of science and technology (Delphi method), and (4) examining the future images of society brought about by the development of science and technology (scenario planning).

■Figure 1-2-1/Structure and timeline of the Survey



Source: NISTEP, MEXT

2 Details of the Survey

(1) Understanding Trends in Science, Technology and Society (scanning method)

Based on information collected by literature survey, database and websites search, and interviews with experts and intellectuals, the latest trends in science and technology and society were identified and then used in discussions on the future images of society (visioning method) and the future images of science and technology (Delphi method).

■Table 1-2-2/Collected information

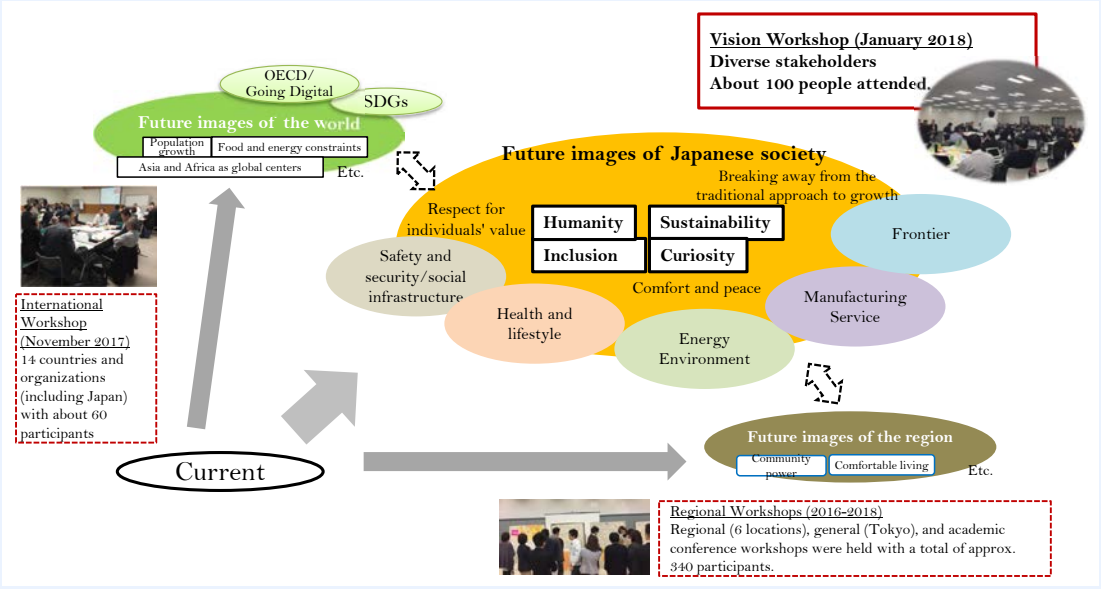
Category	Description	Source
Science and technology trends	Research trends	Existing literature
	Topics for the Grant-in-Aid for Scientific Research (KAKENHI)	KAKEN (Grant-in-Aid for Scientific Research database)
	Latest research findings	Research institutes' press releases
	Changes in competitive funding	Online information
	Agendas of governmental councils and other organizations	Online information
	Signs of scientific and technological progress	Experts and intellectuals
Social trends	Prospects of future society	Existing literature
	Social goals	Strategies, plans, etc.
	Signs of social change	Experts and intellectuals

Source: NISTEP, MEXT

(2) Examining the Future Images of Society (Visioning Method)

As shown in Figure 1-2-3, the survey team drew on the future images of the world and of the region as it envisioned the future images of Japanese society.

■Figure 1-2-3/Method of examining the future images of society



Source: NISTEP, MEXT

Based on the results of the workshops, 50 future images were proposed, from which the following four values were extracted.

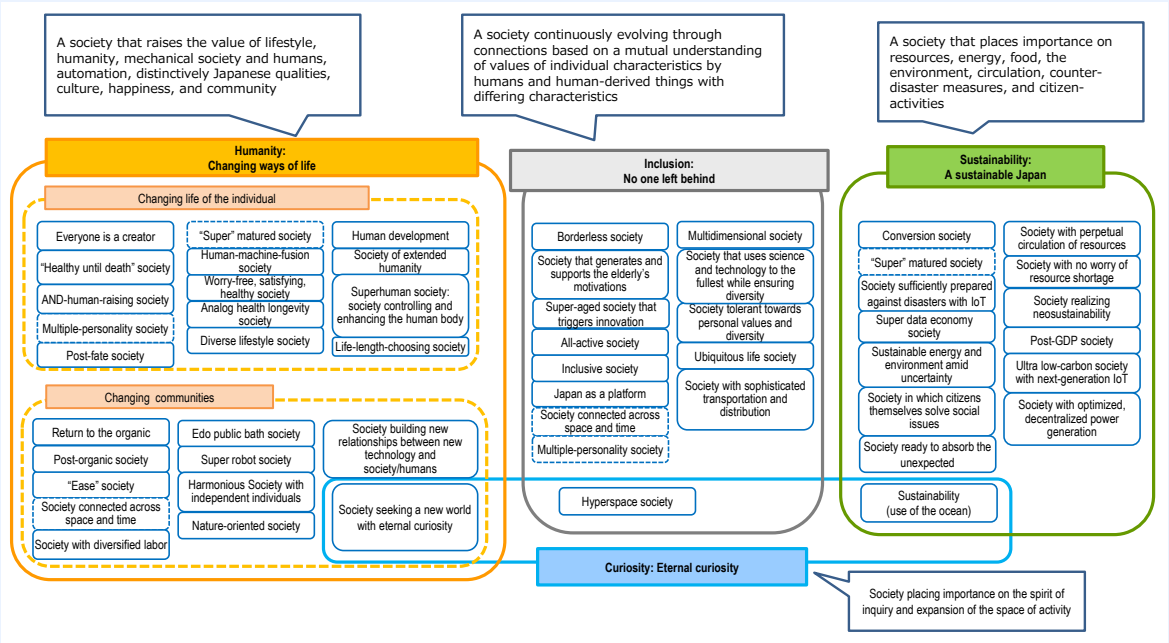
(1) Humanity: "Changing ways of life"

(2) Inclusion: "No one left behind"

(3) Sustainability: "Sustainable Japan"

(4) Curiosity: "Eternal curiosity"

■Figure 1-2-4/Four values and 50 future images



Source: NISTEP, MEXT

(3) Examining the Future Images of Science and Technology (Delphi Method)

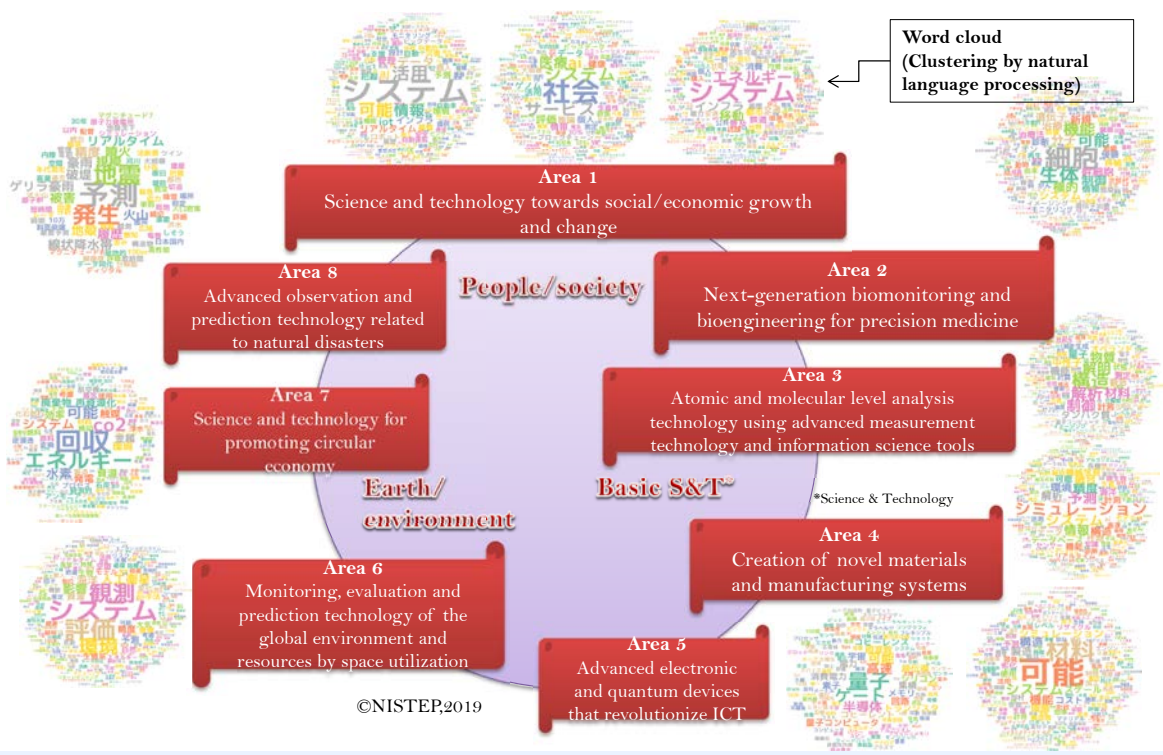
In the study of the future images of science and technology, 702 topics were first examined by the S&T Foresight Committee (chaired by HAMAGUCHI Michinari, President of Japan Science and Technology Agency (JST)) and subcommittees in different fields (a total of 74 members in seven fields). Next, the survey team solicited a wide range of expert participants from industry, academia and government through a network of about 2,000 experts, researchmap (a researcher database run by the JST), academic societies, economic organizations, etc. The team conducted web-based questionnaires from February to June 2019 using the Delphi method (a method of repeating the same questions to the same respondents in order to converge the answers). As a result, answers were obtained from 6,697 experts for the first round and 5,352 experts for the second round (69% from universities and other academic institutions, 17% from public institutions, 10% from companies, and 4% from others) in response to the questions about the importance of different topics and prospects for their realization.

7 fields: Health, medicine, and life sciences; agriculture, forestry, fisheries, food, and biotechnology; environment, resources, and energy; ICT, analytics, and services; materials, devices, and processes; cities, architecture, civil engineering, and transportation; and space, ocean, earth, and science foundations.

(4) Close-up Areas of Science and Technology for the Future (Areas with High Potential for Multidisciplinary and Interdisciplinary R&D)

In order to explore the direction of development in areas with high potential for multidisciplinary and interdisciplinary R&D, the survey team examined R&D areas that should be further promoted beyond the borders of various fields into the future. After clustering the 702 topics using AI technologies, discussions with experts were held and eight multidisciplinary topics were identified as "close-up areas of science and technology for the future" (Figure 1-2-5).

■Figure 1-2-5/Eight close-up areas of science and technology for the future



Source: NISTEP, MEXT

(5) Examining the Future Images of Society Brought About by the Development of Science and Technology (Scenario Planning)

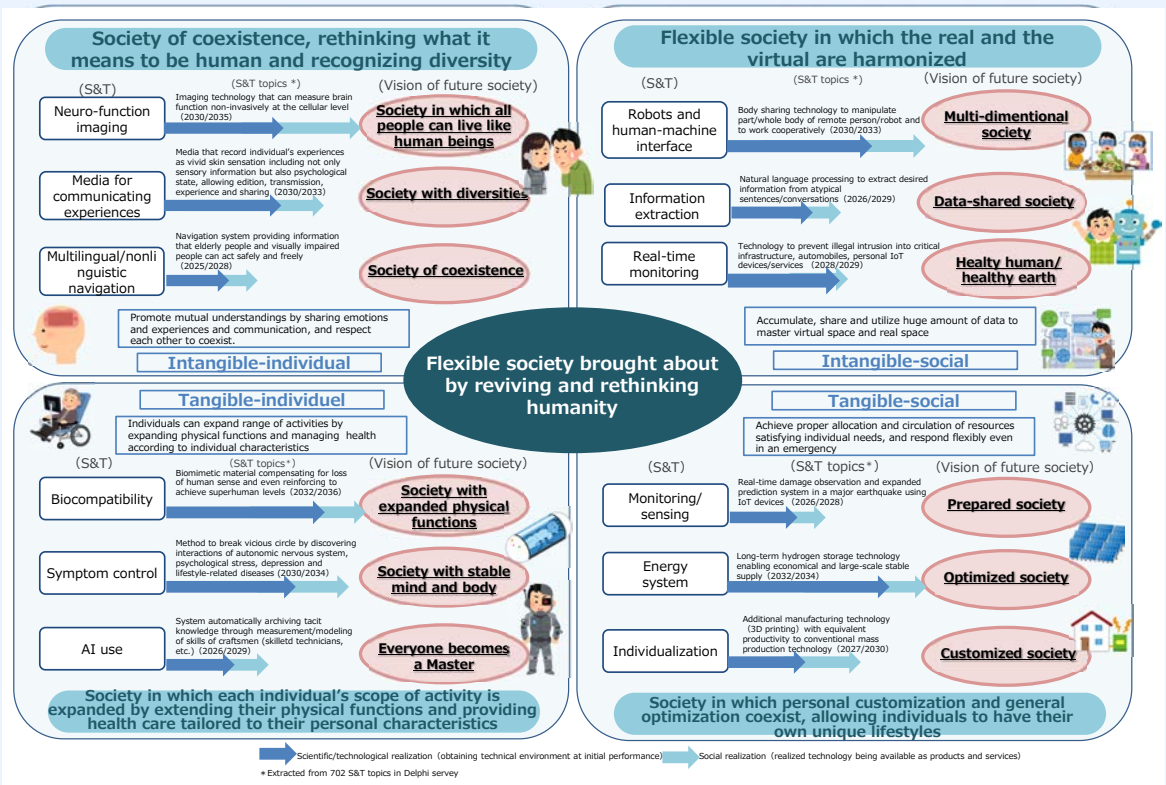
A workshop was held with about 20 experts and intellectuals who were involved in the previous steps of the Survey. The participants formulated a "Conceptual Scenario" that describes a future society brought about by the development of science and technology, based on the "50 future images of society" obtained in the step of examining the future images of society and the "702 science and technology topics" identified in the step of examining the future images of science and technology. Specifically, the 702 science and technology topics were linked to the 50 future images of society, which are related to the four values of (1) humanity, (2) inclusion, (3) sustainability, and (4) curiosity. Then, the survey team examined future images of society in 2040 brought about by the development of science and technology. After further deliberation by the experts, "a flexible society brought about by reviving and rethinking humanity" was proposed as the vision for 2040. The year 2040 is expected to bring further progress in Society 5.0, which will lead to

major changes in the nature of tangible things such as bodies and objects and intangible things such as the mind and data. From this perspective, the experts identified science and technology topics that fall under four categories defined as combinations of "tangible/intangible" and "individual/society" (Figure 1-2-6).

Through this discussion, the society that Japan should aim for in 2040 was summarized as "a flexible society brought about by reviving and rethinking humanity." In this society, human beings live by their own values and society provides an environment that allows diverse people to be loosely connected with each other and live together. Science and technology are to help and support various activities of people and society.

Although the 11th Survey was conducted before the spread of COVID-19, science and technology related to infectious diseases was also among the topics selected by the experts. Related science and technology, such as telemedicine, education, and workplaces, are expected to come to play a major role (see the next section, "Image of Society in 2040" for specific examples). According to the preliminary report of the Opinion Poll on Science and Technology (Opinions on COVID-19 and Other Infectious Diseases), in response to the new question asking what science and technology measures the respondents think the government should take in order to predict and counter COVID-19 and other infectious diseases, the percentage of respondents who chose "promotion of research and development" and those who chose "information disclosure in an easy-to-understand manner for the public" exceeded 60% for the first time in the history of the poll, increasing from the previous poll in March 2019. There is a need for Japan to bring about a society that meets this kind of public awareness through the development of science and technology. (See also Part 2, Chapter 3 for the Opinion Poll on Science and Technology.)

■Figure 1-2-6/Future images of society



Source: NISTEP, MEXT

Section 2 Image of Society in 2040

The previous section introduced how the 11th S&T Forecasting Survey integrated the future images of society and those of science and technology, and portrayed the society in 2040 brought about by the development of science and technology as a "flexible society brought about by reviving and rethinking humanity" (Figure 1-2-6).

This section presents illustrations of these future images of society in 2040, along with specific examples of science and technology topics for each of the four groups defined as combinations of tangible/intangible and individual/social (intangible-individual, intangible-social, tangible-individual, and tangible-social) (see the Appendix for an overall picture integrating these illustrations). If there is more than one science and technology topic that corresponds to the illustration, the earliest timing of scientific/technological realization and the latest timing of social realization are listed.

Individual-intangible
Society of coexistence, rethinking what it means to be human and recognizing diversity (1)

By being able to share experiences and emotions on the spot regardless of various restrictions that each individual has, the way people are connected with each other will become more diverse. This will also enable people for whom it is physically hard to communicate with others in language by using a communication device. This will enhance mutual understanding and allow diverse people to live together in harmony, while respecting humanity and embracing one's self-worth.

No.	Description	S&T topic	Forecasted time of scientific/technological realization[1]	Forecasted time of social realization[2]	Major related SDGs
A1	A palm-sized, ultra-lightweight sensor that can be carried anywhere, including in airplanes, and can quickly detect and determine whether or not a person is infected with an infectious disease.	Ultralight sensors that can be used in the contaminated areas, such as aircrafts, that can quickly detect the infection with specific pathogens, the infectivity to other person, and the susceptibility of uninfected people	2029	2031	

1 "Scientific/technological realization" means the establishment of a technological environment, such as achieving the desired performance.
2 "Social realization" means that the technology realized becomes available as a product or service.

A2	Media for communicating experiences, which record and share individuals' psychological state, senses, and taste.	Media that record individual's experiences as vivid skin sensation including not only sensory information but also psychological state, allowing edition, transmission, experience and sharing	2030	2033	
A3	A portable conversational device that enables people and animals who are unable to speak to understand verbal expressions and express their intentions in language.	A portable conversation device that enables people and animals who cannot speak to understand linguistic expressions and express their intention in language	2031	2034	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.

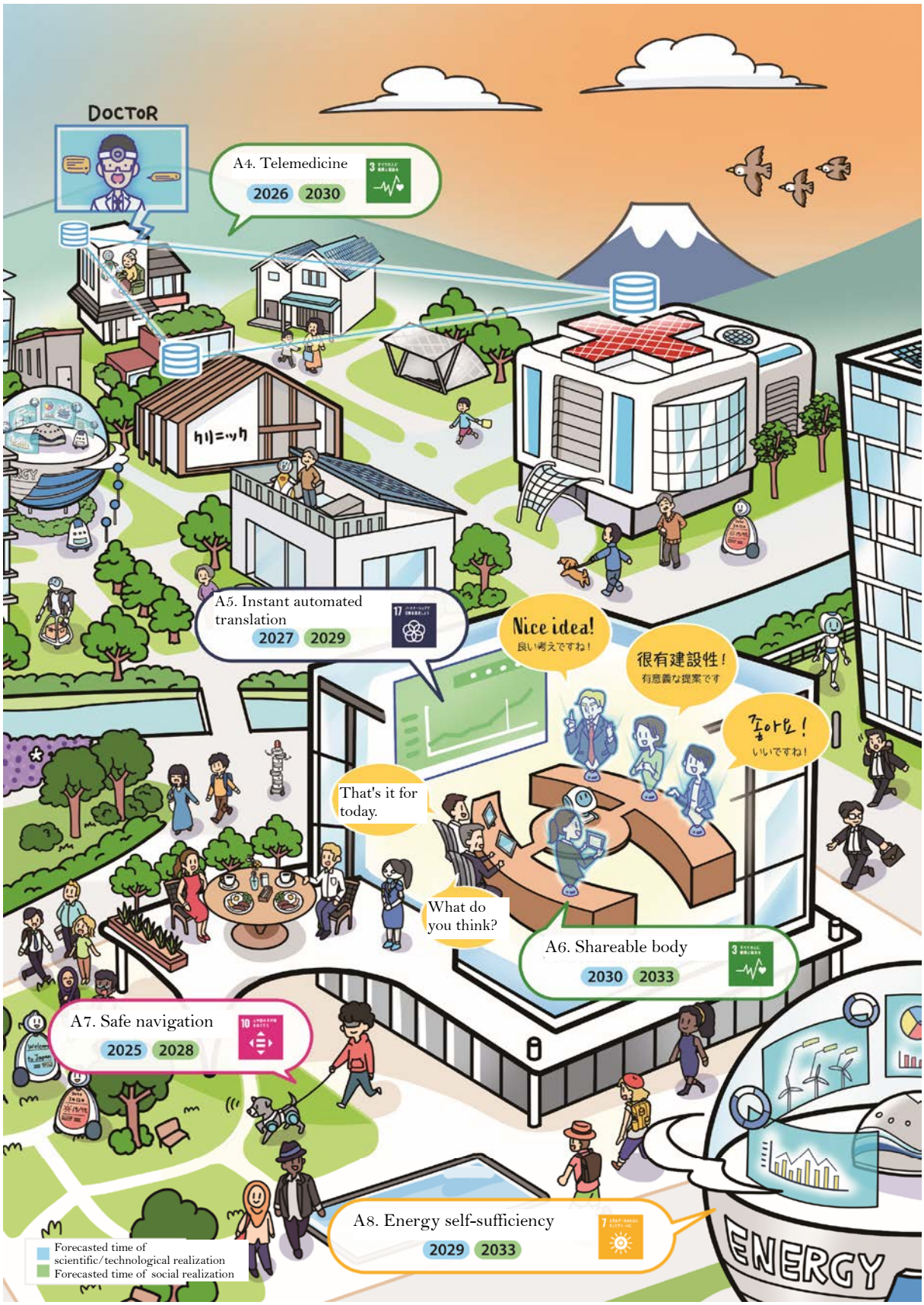

SHARE!
SHARE!
A1. Ultra-lightweight infectious disease sensor
2029 2031
A2. Sharing experiences
2030 2033
A3. Communication device
2031 2034
Forecasted time of scientific/technological realization
Forecasted time of social realization

Individual-intangible
Society of coexistence, rethinking what it means to be human and recognizing diversity (2)

Infrastructure for regional energy management, telemedicine, etc. will be in place which allows diverse people to work and live safely and without barriers, wherever they want. In addition, information gaps and communication challenges will be solved by instantaneous and automated translation technology and navigation systems, enabling people from different countries to live harmoniously without any hindrance.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
A4	A super-distributed hospital system that enables remote treatment and care for dementia and other conditions	Compactification and Artificial intelligence (AI)-introduction of non-invasive diagnostic equipment (imaging, etc.) that enables rapid identification and early detection of lesions	2026	2028	
		Ultradispersed hospital system (regional network of home, clinic, and hub hospital) that enables treatment and care of dementia etc. remotely	2028	2030	
A5	System for real-time translation and interpretation of any language	Real-time automated translation of movie speech, integrating image recognition and speech recognition	2027	2029	
A6	Body sharing technology that enables the remote manipulation of people and robots	Body sharing technology to manipulate part/whole body of remote person/robot and to work cooperatively	2030	2033	
A7	A navigation system that provides information to allow visually impaired and elderly people to move around freely and with confidence	Navigation system providing information that elderly people and visually impaired people can act safely and freely e	2025	2028	
A8	Energy control in autonomous cities	A smart grid control system that realizes small cities (less than 100,000 populations) by 100% renewable energy supply	2029	2033	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.


DOCTOR
A4. Telemedicine
2026 2030
A5. Instant automated translation
2027 2029
Nice idea!
良い考えですね！
很有建設性！
有意義な提案です
좋아요！
いいですね！
That's it for today.
What do you think?
A6. Shareable body
2030 2033
A7. Safe navigation
2025 2028
A8. Energy self-sufficiency
2029 2033
ENERGY
Forecasted time of scientific/technological realization
Forecasted time of social realization

Social-intangible
Flexible society in which the real and the virtual are harmonized (1)

People's lives and health will be protected by the power of data and AI, through risk management based on observations, predictions, simulations, etc., and health advice based on physical and mental data. In addition, digitization will expand educational opportunities, and the use of data will dramatically improve labor efficiency.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
B1	Real-time disaster risk assessment system using satellites	System for real-time high spatial and high temporal resolution meteorological prediction and disaster risk assessment, utilizing satellite and/or meteorological observation data	2028	2030	
		Technology for quantitatively determining real-time changes in land, large structures and deformation during disasters using the positioning data from quasi-zenith satellites	2028	2029	
B2	A digital environment that allows anyone to learn anything according to their abilities and interests at anytime, anywhere.	Realization of an inclusive society where everyone can enjoy the benefits of digitization, by all citizens acquiring IT literacy and elimination of the shortage of IT talent	2028	2032	
		AI/ block chain is introduced into education, establishing a learning style beyond the boundaries of schools, achieving a society with lifelong skill improvement	2028	2032	
		All books become electronic books (extinction of paper books)	2028	2032	
B3	An AI system that can automatically convert spoken words into organized, written sentences based on their context	Natural language processing to extract desired information from atypical sentences/conversations	2026	2029	
B4	An ultra-small device that analyzes a person's physical and mental condition and gives immediate advice	Ultra-small human-machine interface (HMI) device with integrated sensing, information processing, and actuation functions to accelerate and support various abilities in the human mind and body, such as exercise, memory, information processing, and natural healing	2029	2032	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.


B1. Immediate disaster forecasting
2028 2030
DOCTOR
B2. Digitization of education
2028 2032
FOOD FACTORY
SCHOOL
Would you like to change the cooking time from 5 minutes to 3 minutes?
B3. AI that can summarize and understand a story
2026 2029
UNIVERSITY
ポリエステルの構造式
RECOMMEND ROUTE
B4. Mental and physical support
2029 2032
Forecasted time of scientific/technological realization
Forecasted time of social realization

Social-intangible
Flexible society in which the real and the virtual are harmonized (2)

New ways of working and playing will be created, such as robots that can be made to behave as if the user were at a given location, and augmented reality sports using such robots. In addition, the harmony between humans and robots will be advanced, and unmanned precision agriculture and safe, automated driving will become part of people's daily lives.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
B5	Promotion of precision agriculture using IoT	Spread of unmanned agriculture using driverless tractors and other such equipment, spread of precision agriculture using IoT, and an environmental control system based on environmental data, etc., acquired through these technologies	2026	2027	
B6	Highly safe automated driving system based on quantum information and communication technology	With the development of quantum information communication technology, the basis of ICT system safety will be a new safety framework based on quantum technology, etc., replacing the existing cryptographic technology	2031	2035	
B7	Technology to prevent unauthorized access to computer systems	Technology to prevent illegal intrusion into critical infrastructure, automobiles, personal IoT devices/services (technology to reduce the probability of fraudulent communication to an almost negligible level)	2028	2029	
B8	Self-driving systems that can be operated anywhere	Level 5 automatic operation (system operates every aspect without being limited by location)	2030	2034	
		Autonomously navigable unmanned merchant vessels	2027	2031	
B9	Body sharing technology that enables the remote manipulation of people and robots (re-listed)	Body sharing technology to manipulate part/whole body of remote person/robot and to work cooperatively	2030	2033	
B10	Augmented reality sports that allow users to compete against past selves, famous people, remote people, video game characters and more	AR sports using natural information display in real space that enables the player to compete with their past self, great sporting figures, remote people, video game characters, etc.	2028	2030	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.

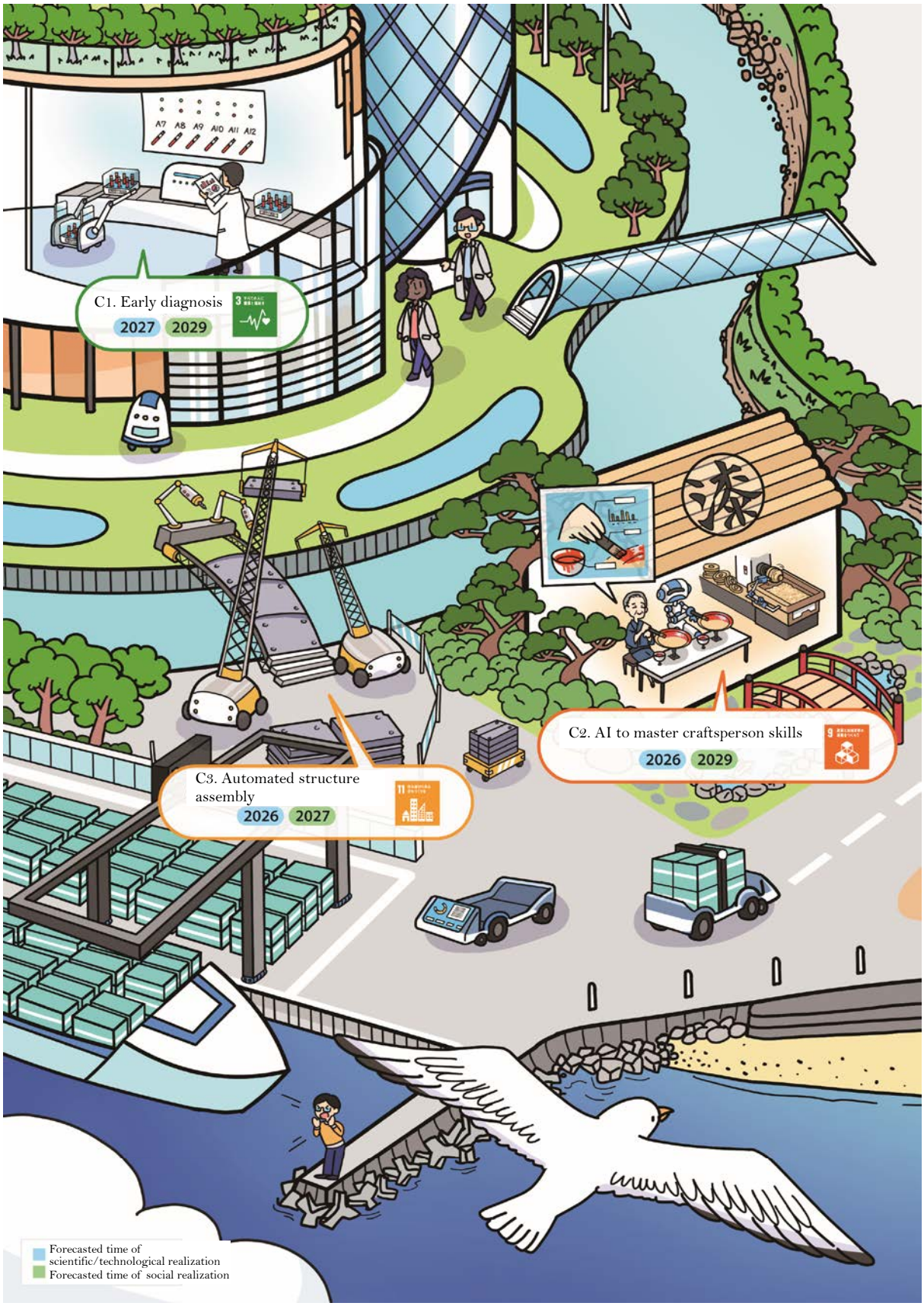

B5. Unmanned precision agriculture
2026 2027
B7. System intrusion prevention technology
2028 2029
B8. Automatic driving everywhere
2027 2034
B6. Highly secure cryptography
2031 2035
SPORTS CENTER
B9. Shareable body (re-listed)
2030 2033
B10. AR sports
2028 2030
Forecasted time of scientific/technological realization
Forecasted time of social realization

Individual-tangible
Society in which each individual's scope of activity is expanded by extending their physical functions and providing health care tailored to their personal characteristics (1)

With the digitization of specialized skills and the support of robots and other technologies, everyone will be able to acquire a high level of expertise. At the same time, robots existing in harmony with humans will also be learning human skills and be capable of assembling structures in place of humans and replicating craftsperson skills.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
C1	Early diagnosis of cancer and dementia through blood analysis	Early diagnosis and pathology monitoring of cancer and dementia by using blood	2027	2029	
C2	An AI system that allows users to acquire the skills and experience of craftspersons through measurement and modeling of craftsperson skills	A system that automatically archives tacit knowledge through measurement and modeling of the skills of a craftsperson (skilled experts, etc.)	2026	2029	
C3	Unmanned assembly of concrete structures such as bridges and other constructions (dangerous work by unitization)	Automation of on-site assembly by unitization of concrete structures such as bridges	2026	2027	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.

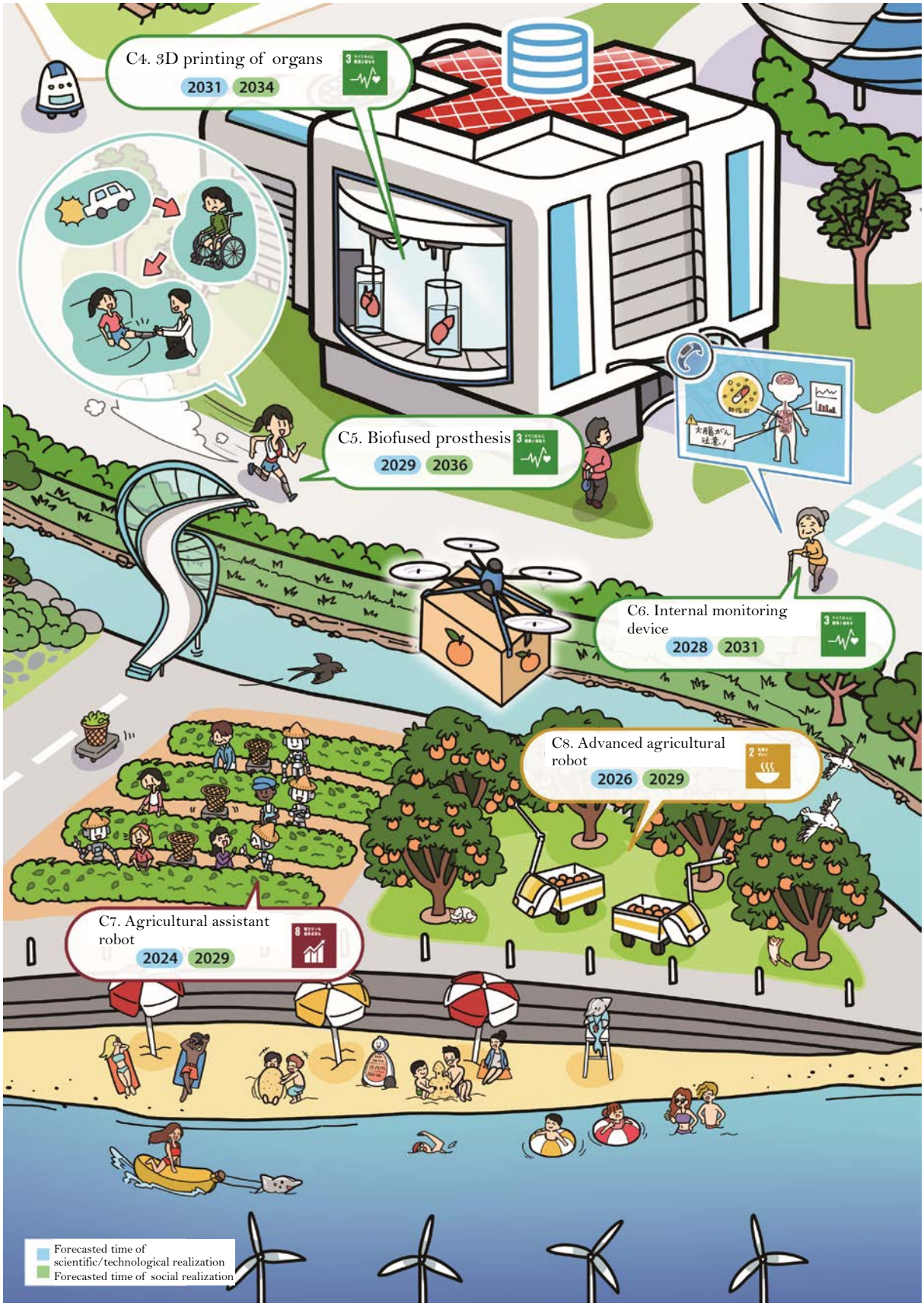

A7 A8 A9 A10 A11 A12
C1. Early diagnosis
2027 2029
C2. AI to master craftsperson skills
2026 2029
C3. Automated structure assembly
2026 2027
Forecasted time of scientific/technological realization
Forecasted time of social realization

Individual-tangible
Society in which each individual's scope of activity is expanded by extending their physical functions and providing health care tailored to their personal characteristics (2)

Body information monitoring devices will allow for proper health care at all times. Should any abnormality be detected, biocompatible materials and organ manufacturing can be used to restore bodily functions. Combined with robotic support, the possibilities for individuals are greatly expanded.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
C4	3D printing of transplantable organs	Production of regenerated tissues and organs using 3D printing technology (biofabrication)	2031	2034	
C5	A prosthetic body that is completely integrated with the body and can be used in life without any inconvenience	Prosthetic limb with a function to feedback all skin sensations to the brain	2032	2036	
		Advanced biocompatible materials that enable high function implant devices and drug delivery system (DDS) technology based on refinement of biological-artificial interface control using nanotechnology	2029	2032	
C6	Wearable device for monitoring pharmacokinetics, cancer markers, infection and blood composition	A wearable device that monitors in vivo information	2028	2031	
C7	Agricultural robots to teach archived craftsperson skills	A system that automatically archives tacit knowledge through measurement and modeling of the skills of a craftsperson (skilled experts, etc.)	2026	2029	
		Spread of a machine learning utilization base capable of being used be beginners	2024	2025	
C8	Autonomous agricultural robots that can undertake physically demanding, advanced growing and harvesting techniques on behalf of human beings	Agricultural robots to replace humans	2026	2029	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.

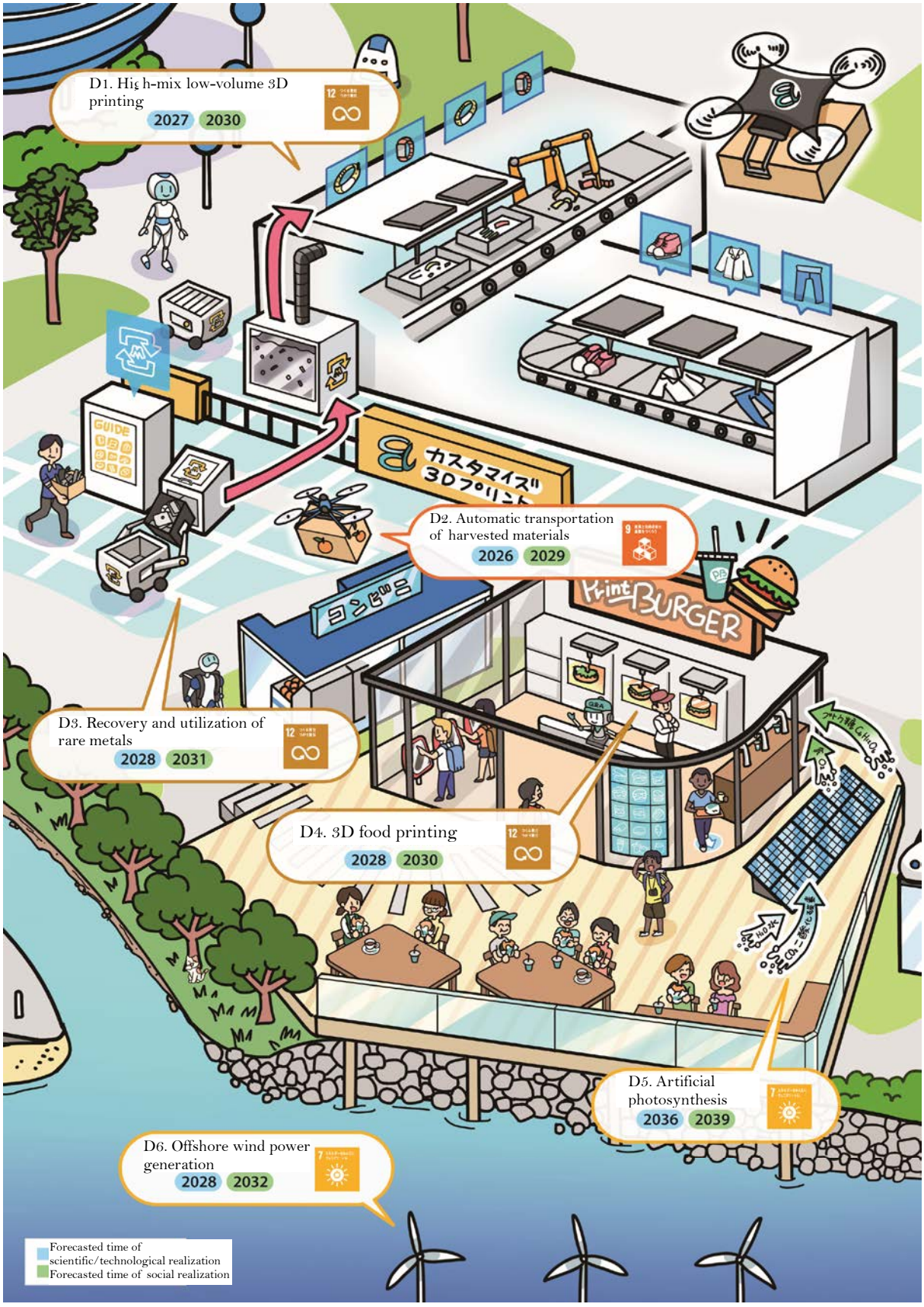

C4. 3D printing of organs
2031 2034
C5. Biofused prosthesis
2029 2036
C6. Internal monitoring device
2028 2031
C8. Advanced agricultural robot
2026 2029
C7. Agricultural assistant robot
2024 2029
Forecasted time of scientific/technological realization
Forecasted time of social realization

Social-tangible
Society in which personal customization and general optimization coexist, allowing individuals have unique lifestyles (1)

Efficient individual production through 3D printing of a wide variety of products in small quantities, resource recycling through rare metal recovery, renewable energy and 3D food printing will become widespread, building a sustainable system according to the needs of individuals.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
D1	3D printing for customized products at a cost similar to mass production	Additional manufacturing technology (3D printing) with equivalent productivity to conventional mass production technology	2027	2030	
D2	A system that automatically transports harvested crops to collection points by drone	Achievement of unmanned factories, unmanned shops, unmanned logistics warehouses, unmanned home deliveries by extensive spread of work robots to the three-product (food, cosmetics and pharmaceuticals) industry, service industry and logistics industry	2026	2029	
D3	Technology to recover and utilize rare metals from small electronic devices and waste	Technology to reasonably collect and use rare metals from small electronic devices, waste and sewage sludge from incineration fly ash	2028	2031	
D4	Made-to-order 3D food printing using artificial ingredients	3D food printing technology for manufacturing (forming) made-to-order food based on artificial foods such as artificial meat	2028	2030	
D5	Artificial photosynthesis technology with energy efficiency of more than 20%	Photoreduction catalyst or artificial photosynthesis with an energy efficiency of 20% or more in CO_2 recycling (synthesis of fuel or chemical raw materials)	2036	2039	
D6	Offshore floating wind power generation capable of generating large amounts of electricity	50MW class offshore floating wind power generation	2028	2032	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.


D1. High-mix low-volume 3D printing
2027 2030
D2. Automatic transportation of harvested materials
2026 2029
D3. Recovery and utilization of rare metals
2028 2031
D4. 3D food printing
2028 2030
D5. Artificial photosynthesis
2036 2039
D6. Offshore wind power generation
2028 2032
カスタマイズ 3Dプリント
コンビニ
Hrint BURGER
GUIDE
Forecasted time of scientific/technological realization
Forecasted time of social realization

Social-tangible
Society in which personal customization and general optimization coexist, allowing individuals have unique lifestyles (2)

Weather observation and disaster prediction, renewable energy to address energy challenges such as hydrogen production and long-life secondary batteries, structures that can self-repair damage due to deterioration and other reasons, and new means of urban transportation using drones, all contribute to a sustainable society that is able to respond to both peacetime and disaster situations.

No.	Description	S&T topic	Forecasted time of scientific/technological realization	Forecasted time of social realization	Major related SDGs
D7	Structural materials that can self-repair damage due to aging, deterioration and other reasons	Structural materials with self-repairing functions preventing deterioration and damage over time which can maintain the function of structures such as buildings	2033	2035	
D8	Long-term hydrogen storage technology that allows for economical and stable supply on a large scale	Long-term hydrogen storage technology enabling economical and large-scale stable supply	2032	2034	
D9	Hydrogen production using surplus electricity from solar and wind power	Hydrogen production using surplus power from solar and wind power generation	2027	2031	
D10	Long-life, low-cost secondary batteries that require no replacement	Long-life and low-cost secondary batteries that do not require replacement for electric cars	2029	2032	
D11	Drones that can transport people in urban areas	"Flying cars and drones" able to carry people in urban areas	2029	2033	
D12	Technology for predicting the timing of natural disasters such as heavy rainfall, active volcanoes, and earthquakes, as well as the damage they may cause	Real-time prediction of damage related to slope failure and earth structure based on highly accurate predictions of localized torrential rainfall over a short time	2027	2029	
		Real-time damage observation and expanded prediction system in a major earthquake using IoT device	2026	2028	
		Evaluation of the urgency of identifying the next volcano likely to erupt or unlikely to erupt, from all active volcanoes in Japan	2031	2033	
		Technology to predict the location, scale, timing (within 30 years), and damage of inland earthquakes with magnitude 7 or higher	2037	2036	

Source: Prepared by MEXT based on the 11th S&T Foresight Survey by NISTEP.
*The time of scientific/technological and social realization may be reversed due to the nature of the Survey.


D7. Self-repairing materials
2033 2035
D8. Stable hydrogen storage
2032 2034
D9. Eco-friendly hydrogen production
2027 2031
D10. Long-life, low-cost batteries
2029 2032
D11. Urban manned drone
2029 2033
D12. Natural disaster prediction technology
2026 2036
RENT
Forecasted time of scientific/technological realization
Forecasted time of social realization

Column 1-5 The Future as Envisioned by the Past S&T Foresight Surveys

The NISTEP, MEXT has continuously conducted the S&T Foresight Survey, an expert questionnaire (Delphi survey) on science and technology expected to be realized within 30 years. In December 2009, a review was conducted on approximately 4,300 science and technology topics (hereinafter referred to as "topics") that were covered in the five surveys from 1971 to 1992. As a result, it was found that approximately 70% of the topics were realized (including partial realization). Examples of the realized topics include planetary probes, wall mounted TVs, mobile phones, human genome sequencing, and digital cameras.

Examples of realized topics

Survey year	Topic
1971	Unmanned vehicles will be used to explore the vicinity of Uranus, Neptune and Pluto. (1999: Probes approached nearest to Uranus in 1986, Neptune in 1989, and Pluto in 2015.)
1977	The thickness of 20-inch TVs will be less than 10 cm and wall-mounted TVs will be widely used. (1993: The first wall-mounted liquid crystal television appeared in the affordable price range around 2000.)
1982	Pocket phones that can communicate from anywhere will be commercialized. (1992: An ultra-compact mobile phone appeared around 1990.)
1987	The entire DNA of the human chromosome will be sequenced. (2003: Declaration of the completion of the human genome sequencing in 2003)
1992	As electronic cameras replace silver chloride film and photographic paper, the demand for silver for photography will drop dramatically. (2003: The introduction of affordable digital cameras in the mid-1990s.)

*Figures in parentheses represent the projected year of realization at the time of the survey and the actual status of realization.

For those topics that did not come to fruition, the factors that contributed to their failure are analyzed and discussed below. It shows the importance of considering the direction of R&D from a long-term perspective while assuming social changes and the potential of science and technology, as well as of having the flexibility to respond to rapid changes.

Examples of topics that have not been realized for different reasons

Survey year	Topic	Reason	Forecasted time of realization at the time of the survey
1977	Technology to prevent cancer cell metastasis will be put to practical use.	Technical problems (no established technology to reliably block cancer cell metastasis)	1993
1992	Investigation of mineral resources (manganese, hydrothermal ores, cobalt, crust, etc.) in the deep seafloor will be advanced, and technology to extract these resources economically will be put to practical use.	Cost and other problems (high cost compared to land extraction)	2006
1992	Automobile navigation devices using fiber-optic gyros will be widely used.	Emergence of an alternative technology (liberating the use of GPS).	2004
1987	Electronic newspapers (scrambled system for subscribers only) via satellite or terrestrial broadcasting will become popular.	Small needs (spread of the Internet)	2001