1.3 Future of Japan and Science and Technology

In the 21st century, the environment surrounding Japan and the world is expected to change considerably, and expectations are likely to rise for science and technology to resolve various problems that emerge as that happens. This chapter discusses the problems that Japan will face in the future, the expected roles of science and technology, and the direction in which science and technology should be promoted.

1.3.1 Challenges for Future Japan

In Japan, there is a concern that the working population will decrease in the future due to the declining birthrate and aging of the population. In addition, Japan is expected to face various difficult problems including measures against intensification of competition, such as the rise of Asian countries like China, and achievement of coexistence between environmental protection and economic development. This section focuses on the changing social conditions and the problems that Japan will face in the future.

1.3.1.1 Coexistence Between Environmental Protection and Economic Development

With development of science and technology, people have expanded their scopes of activities, and their social lives have become extremely affluent. On the other hand, the industrial society that uses a lot of underground resources, built by mankind in the 20th century, created the society of mass production, mass consumption, and mass disposal. However, resources on the Earth and the amount of waste that natural environment can dispose of are limited, so environmental pollution gradually came to have a strong impact on people's lives and surfaced as an environmental problem. Specific examples are global environmental issues, such as global warming, acid rain, depletion of the ozone layer, destruction of the rainforests, and desertification, and pollution issues, such as air and water pollution. Although the details of environmental problems are wide-ranging, they have all been caused by the spread or intensification of human activity pertaining to the development of science and technology.

(Environmental protection and sustainable development)

"Sustainable development," which was adopted by the World Commission on Environment and Development (Chair: Gro Harlem Brundtland, then Prime Minister of Norway) as the central concept of its report "Our Common Future" released in 1987, is the concept of viewing the environment and development not as contrary, but as able to coexist. It places importance on controlled development that "satisfies the needs of the present generation without compromising the chance for future generations to satisfy theirs" and gives consideration to environmental protection. It serves as the basic idea underlying current measures for global environmental problems.

(International efforts for sustainable development)

The International Panel on Climate Change proposes in its report that, in order to resolve climate change issues, a drastic reduction in use of greenhouse gases is necessary, and the amount of greenhouse gases used must be reduced to less than half of the current level in the future. Since the amount of greenhouse gas emissions is predicted to increase dramatically in line with the economic development of the world, particularly China and other parts of Asia, it will not be easy to achieve a coexistence between global warming prevention and economic development, and this issue is expected to become an increasingly important political and economic issue at global level as well as at private and regional levels. Under such circumstances, the Kyoto Protocol (Table 1-3-1), which has a legal binding force on the reduction of CO_2 emissions and greenhouse gases, entered into force in February 2005 to address a world-level environmental problem—global warming. This was important as the first step of the measures against global warming, but there still remain problems with respect to its effectiveness; for example, the United States has withdrawn from the protocol, and developing countries including China are outside the framework for specific emissions reduction.

Under the Kyoto Protocol, Japan is required to reduce its greenhouse gas emissions by 6% from the 1990 level by the 2008-2012 period. However, Japan's total greenhouse gas emissions in fiscal 2002 was 7.6% higher than the 1990 level, indic-

ating that achieving the targets of the Kyoto Protocol is not easy. Therefore, further reinforcement of global warming countermeasures will be required.

Table 1-3-1 Outline of the Kyoto Protocol

(Key points) Adopted in 1997 and entered into force in February 2005
○ Legally binding numerical targets on the amount of greenhouse gas emissions are set for the respective developed countries.
○ Schemes are introduced in order to achieve the targets through international cooperation (emissions trading, clean development mechanism, and joint implementation)
○ No new obligations such as numerical targets are imposed on developing countries.
○ Numerical targets
Gases covered: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6)
Offset of emissions: greenhouse gas emissions can be offset by sink activities such as afforestation
Base year: 1990 (base year may be 1995 for HFCs, PFCs, and SF_6)
Target period: 2008 to 2012
Target: separate target for each country → e.g., Japan: -6%; United States: -7%; EU: -8%
Achieving at least 5% reduction in overall developed countries

Source: Ministry of the Environment, “Outline of the Kyoto Protocol”

1.3.1.2 Intensification of International Competition

(Progress of globalization)

The end of the Cold War structure, the development of larger and faster international transporttation means, development of information and communications technology, and establishment of communications networks caused activity of human, cultural, and economic exchanges beyond the border on all levels of society, such as individuals, regions, and states. Because of this, mutual understanding has been promoted and the closer relationships between countries and regions, mainly in the economic aspect, have intensified competition on a global scale. On the other hand, international coordination and cooperation has become indispensable for adderssing problems that can no longer be tackled by a single country, such as dealing with international criminal organizations and emerging/reemerging infectious diseases.

(Rise of Asian Countries including China and South Korea, and Multipolarizing World)

In the medium to long-term, Japan’s population is expected to decrease, but the world population is predicted to surge from the current figure of approximately 6.3 billion (2003) to about 8.9 billion by 2050.

Under such circumstances, the United States is likely to continue to have the most influence in all areas, namely, politics, military, and economics, and the EU is likely to increase its political uniformity and come to represent Europe in conducting diplomacy and security policy. Moreover, in addition to South Korea, which has maintained competitiveness mainly in the IT industry, China, India, and Brazil have also achieved high economic development in recent years (Figure 1-3-2). If China continues to significantly increase its international influence in line with economic development, Russia grows as an energy exporting country, and India and Brazil make further economic growth, the BRICs[6] and Asian countries will increase their influence in the international community, and while they maintain high growth rates, the world is expected to become multipolarized.

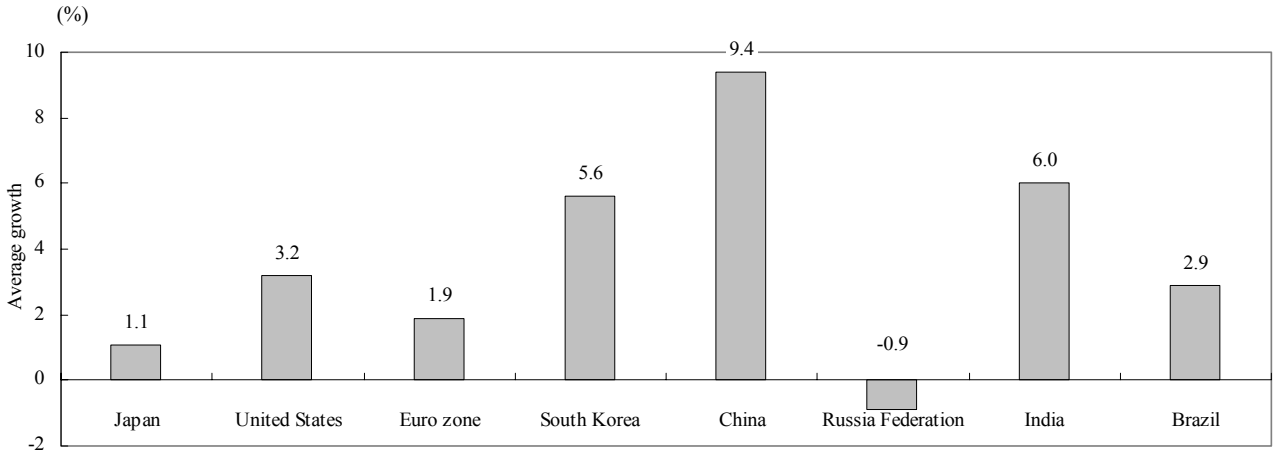


Figure 1-3-2 Average GDP Growth from 1993 to 2002

Note: "Euro zone" refers to the following 12 countries: Germany, France, Italy, Netherlands, Belgium, Luxemburg, Spain, Portugal, Greece, Ireland, Austria, and Finland.
Source: Cabinet Office, "World Economic Trend, Autumn 2004" (November 2004)

1.3.1.3 Decrease in Population Due to Aging Society with Fewer Children

Declining birthrates and aging populations are a worldwide trend, which faces developed countries and which will also face the neighboring countries in Asia in not-so-distant future. Japan's population is predicted to peak in 2006, start decreasing in 2007, and fall to about 100.59 million persons by 2050. This means going back to the 1967 level when the total population exceeded 100 million for the first time. During this process, the decline in birthrate and aging of the population will advance rapidly, and the proportion of young population aged 14 or under to the total population will decrease from the 14.6% in 2000 to 10.8% in 2050, while the population aged 65 or over will constitute about 30% of the whole population and three out of ten people will be elderly persons by the 2020s (Figure 1-3-3).

In line with this, the working population, which was about 67 million in fiscal 2003, is predicted to start declining after peaking in 2005, and become about 63 million by 2025, while the labor force of 60 or over will increase. In this manner, the aging of the working population is predicted to advance (Figure 1-3-4).

There is a concern that such changes in the social structure will invite contraction in GDP caused by a decrease in the working population and an increase in social security expenditures, and will reduce the vitality of society.

6 BRICs: The term is made up of the first letters of Brazil, Russia, India, and China. They draw attention as countries in which economic growth can be expected in the future.

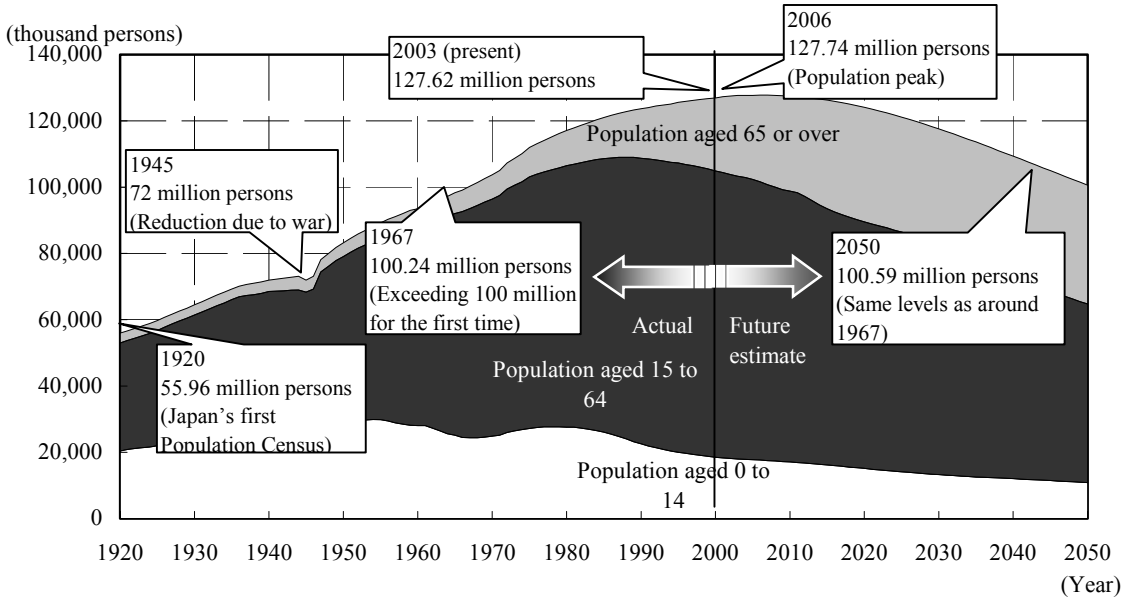


Figure 1-3-3 Japan's Population Structure

Sources: Values for 2003 and before: Statistics Bureau, MIC, "Population Census"
Values for 2004 and after: National Institute of Population and Social Security Research, "Population Projections for Japan, January 2002"
Note: Values from 1941 to 1943 were interpolated from the values for the three major age groups in 1940 and 1944.
Values from 1946 to 1971 do not include those of Okinawa Prefecture.
In "Population Census," the values for persons of uncertain age are proportionally distributed.
Source: Cabinet Office, "White Paper on Society with Declining Birthrate 2004" (December 2004)

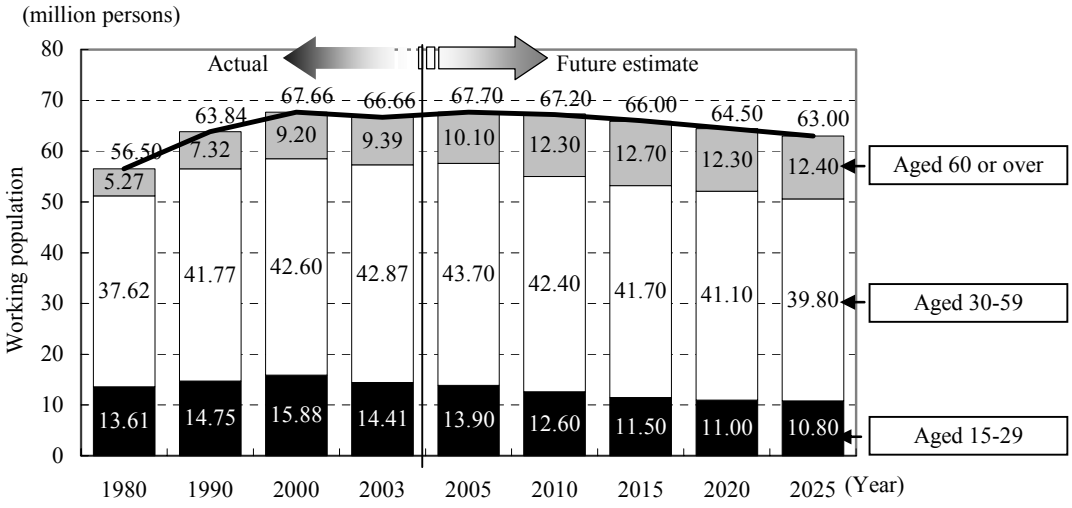


Figure 1-3-4 Transition and Prospects of Working Population

Sources: Values for 2003 and before: Statistics Bureau, MIC, "Population Census"
Values for 2005 and after: Estimated by Employment Security Bureau, Ministry of Health, Labour, and Welfare (July 2002)
Note: Values are rounded off, so they may not add up to the total.
Source: Cabinet Office, "White Paper on Society with Declining Birthrate 2004" (December 2004)

1.3.1.4 Sophistication and Diversification of People's Needs

As society matures, individuals and individual characters are expected to become even more respected, and people's lifestyles and values will become even more diversified. In addition, due to the advancement in globalization, depletion of food and energy, and increased intricacy of social systems, the science and technology is likely to become increasingly sophisticated and diversified, including areas such as establishment of a safe and secure society.

(Spiritual wealth)

Science and technology has deeply penetrated people's lives and material wealth has come to be attained recently, so people have begun to place more weight on seeking spiritual wealth (Figure 1-3-5). Since people's leisure time is expected to increase with the maturity of society and the coming of an aging society, the desire for spiritual wealth and comfortable lifestyles is likely to increase even more in the future along with diversification of lifestyles and values.

(Health)

Because the average life expectancy will prolong and individuals' lifestyles will become diversified with advancement in the aging of the population, mental and physical "health" will become an ever important concern for many people in planning their lives. While aging of the working population, swelling of social security expenditures, and an increase in adult disease patients are expected in the future, the challenge for addressing these problems would be to extend healthy longevity (the period during which a person is physically and mentally healthy and self-reliant while giving consideration to the quality of life and health) so that the elderly may live healthy lives. In addition, it is hoped that medical science for prevention and treatment will develop so as to allow young people and middle-aged people to stay healthy both physically and mentally.

(Safety and security)

In recent years, Japan has come to face various new threats, such as the spread of terrorism worldwide after the terrorist attacks in the United States on September 11, 2001, large-scale natural disasters, occurrence of infectious diseases on a global scale, worsening of international organized/heinous crimes, and a rapid increase in computer crimes that attack the weak points of the advanced information and communications network society. Thus, there is a need to reinforce the crisis management frameworks for combating these diverse threats and to build a safe and secure society.

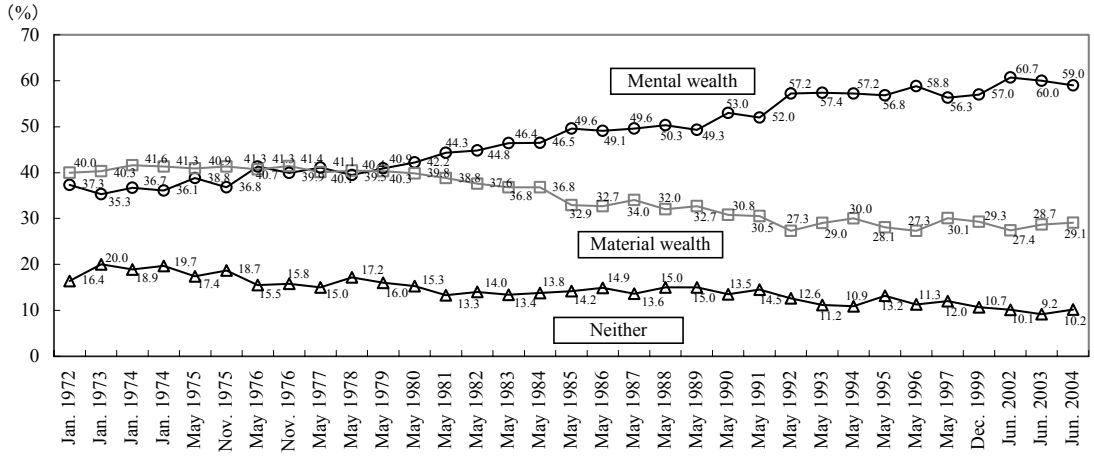


Figure 1-3-5 Changes in Type of Wealth Sought by People

Note: Mental wealth: "I have gained material wealth to a certain extent, so I want to focus on mental wealth and comfortable life from now on."
Material wealth: "I want to focus on further increasing material wealth in my life."
Source: Cabinet Office, "Public Opinion Survey on National Lifestyle" (June 2004)

1.3.2 Roles Expected from Science and Technology

As discussed above, science and technology has contributed greatly to creating intellectual/cultural values, economic values, and social/public values over a long period of history. Science and technology is expected to play a significant role in addressing problems for the whole society, such as the declining birthrate and aging of the population, a decline in productivity, and global environmental problems, as well as addressing individuals' desire for "wealth," which is becoming more diverse and sophisticated. In order for Japan to precisely deal with these changes and achieve sustainable development in the 21st century, when the society will become more complex and diverse, science and technology must fully play this expected role.

1.3.2.1 Creation of New Values (Creation of Intellectual/Cultural Values)

Science and technology creates intellectual/cultural values and has had a great deal of impact on the formation of our values, including our views on the universe, matter, and life. Intellectual curiosity is a desire common to mankind, and will continue to bring new knowledge to us.

The knowledge acquired through science and technology will be used for creating new goods and services as well as for solving various problems, and become intellectual assets (stock) for creating yet other important new knowledge. These intellectual assets must be used as common assets for mankind, and at the same time, they will become the source for sustainable creation of knowledge.

Basic research, which aims at discovering new principles, establishing creative theories, and predicting/discovering unknown phenomena, such as elucidation of the origin of matter, various phenolmena in space, and life phenomena, serves as the basis for creating knowledge, so it should continue to be actively promoted in the future.

1.3.2.2 Economic Development and International Competitiveness (Creation of Economic Values)

As discussed in 1.3.1, the situation surrounding Japan is expected to become extremely severe in the future due to such constraining factors as the global environmental issues and depletion of resources as well as a decrease in the working population due to the declining birthrate and aging of population.

Looking at the world, Japan's neighboring countries—China and South Korea—are rising as Japan's competitors amidst major changes including the advancement of globalization and growth of the BRICs. In these countries, new industries based on achievements of cutting-edge science and technology, such as the information and communications industry and the biotechnology industry, are emphasized as the key to economic growth and creation of employment. They are already implementing active measures to promote science and technology by regarding science and technology as the driving force for economic development, in this way.

It would require extraordinary efforts for Japan to maintain and reinforce its international competitiveness under such circumstances. Apparently, for resources-poor Japan, innovation will serve as the driving force for securing international competitiveness. Therefore, innovation using science and technology, such as adding high value to products and further strengthening Japan's superior technical fields, will be indispensable.

There is a concept called "Soft Power." It is used as an antonym to "Hard Power," which refers to military power and the like. It is the ability to attain the desired result not by force or for reward, but based on the appeal of knowledge or culture. Since information technology has greatly advanced, it is extremely important for Japan to disseminate its appeal to overseas at present and in the future. Japan has abundant "Soft Power" to be proud of, such as popular culture including animations and video games, as well as Japanese culture including traditional art and crafts. Japan, which has a high level of science and technology, would be able to acquire strong "Soft Power" by creating knowledge—the world's common property—through using science and technology and achieving economic development by making continuous innovation.

[Column 19]

Japan's Future Prospects and Technologies Indicated in the "Japan's 21st Century Vision"

On April 19, 2005, the special board of inquiry for examining "Japan's 21st Century Vision" (Council of Economic and Fiscal Policy) published a report on their examination.

In "Japan's 21st Century Vision," the year 2030 is assessed as the beginning of "a new era of dynamism." The report illustrates the future direction Japan should strive to take in the quarter of a century from now. It also shows the specific courses that Japan should take to work with the trends of the times, including the declining population, progressing aging of the population, globalization, and the advanced information-oriented world.

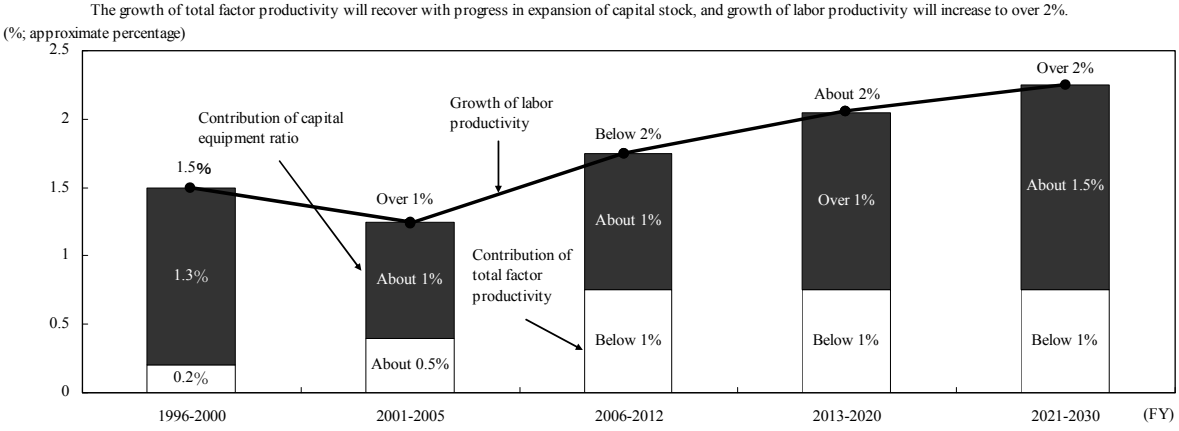
If Japan neglects to carry out reforms and fails to swim with the major currents of the times, according to "Japan's 21st Century Vision," the economy will stagnate, an increasing number of people will lose hope, and society will become unstable. In that case, Japan will follow a gradual but steady pathway to decline. If Japan can successfully work with the trends of the time, on the other hand, it will be able to see a new era of dynamism. To ensure a bright future, Japan should take the following actions: (1) creating a virtuous cycle of rising labor productivity and growing income; (2) taking maximum advantage of globalization; and (3) creating systems to provide public values as selected by the public.

Considering the economic situation in Japan in 2030 as results of the reforms, the rise of labor productivity is essential to the continuous development of Japan's economy, in spite of the decrease in population and the progressing aging of the population. It is highly expected that technological innovation can promote labor productivity.

"Japan's 21st Century Vision" indicates that there is a possibility of a more than 2% increase in labor productivity by the expansion of capital stock (the rise of capital equipment ratio) with the progress of mechanization, as well as the improvement of total efficiency (the rise of total factor productivity) with technological innovation. Based on this estimation, rising labor productivity will sustain the real GDP growth rate at somewhere about 1.5%, which is enough to maintain a high standard of living.

Prospects for Labor Productivity

The growth of total factor productivity will recover with progress in expansion of capital stock, and growth of labor productivity will increase to over 2%.



Note: 1. Labor productivity rises through the expansion of capital stock (with the progress of mechanization) plus the improvement of total efficiency (the rise of total factor productivity) with technological innovation. That is:

(Growth of labor productivity)

= (Growth of total factor productivity) + (Capital relative share) x (Growth of capital equipment ratio)

Contribution of capital equipment ratio

2. Note that the estimation is based on various assumptions with many uncertain factors, as it is a long-term projection.

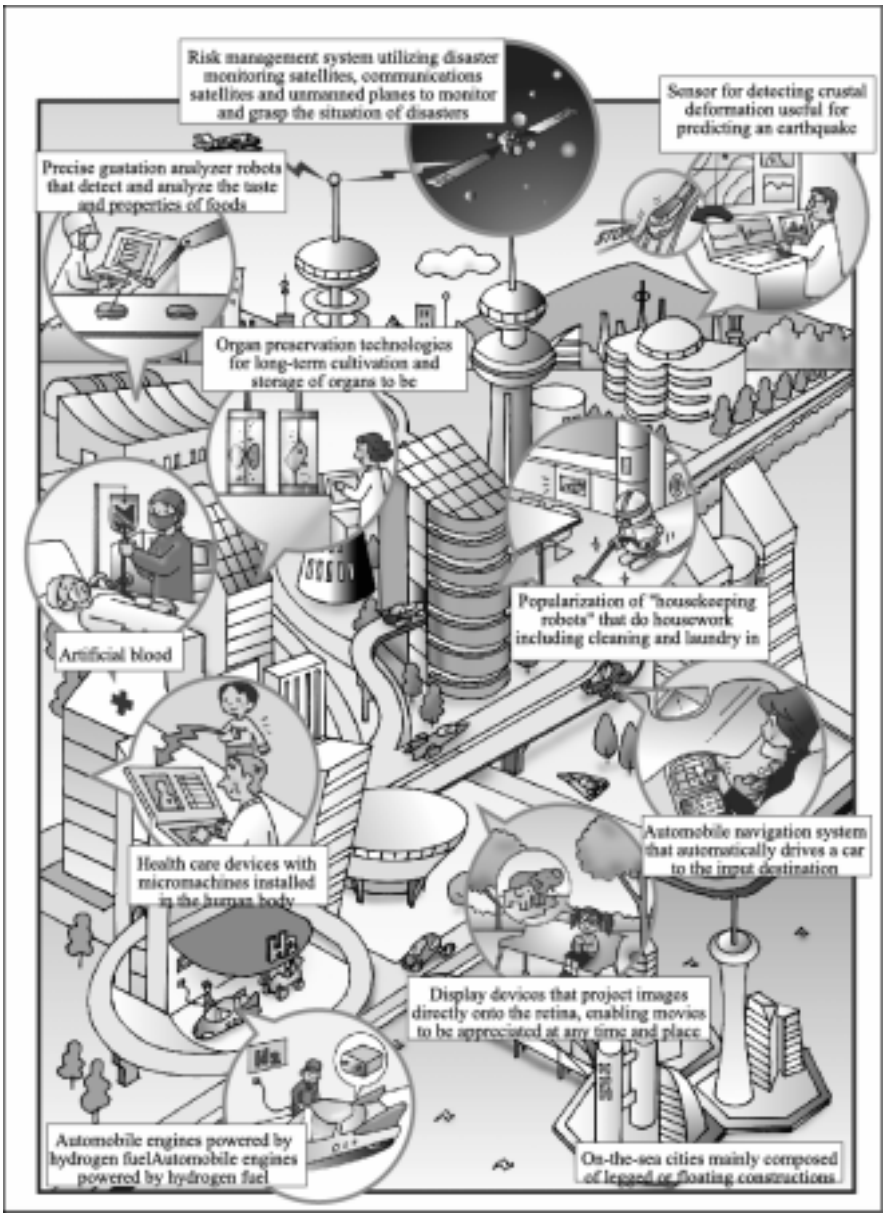
Source: Publication by the special board of inquiry for examining "Japan's 21st Century Vision"

[Column 20]

Our Society and Lives in 2025

In May 2005, the National Institute of Science and Technology Policy (NISTEP) made a report on the Science and Technology Foresight Survey Delphi, sending out questionnaires to over 2,000 specialists in various fields.

The NISTEP report concludes that the following technologies will be utilized in our society in 20 years, in about 2025. It is expected that our lives will change drastically with the introduction of those technologies 20 years from now.



Source: Illustration created by the Ministry of Education, Culture, Sports, Science and Technology, based on the "Eighth Science and Technology Foresight Survey Delphi" (NISTEP Report No.97)

1.3.2.3 Sustainable Development of Human Society (Realizing Social and Public Values)

(Dealing with diversified/more sophisticated social needs)

As society matures, individuals and individualities are expected to become respected even more, and people's lifestyles and values will become even more diversified. At the same time, people's needs for material affluence as well as spiritual affluence are expected to become more diverse and sophisticated. Science and technology is able to make contributions to culture, art, and entertainment, so it should be used to meet such diverse demands of the people.

One of the challenges that Japan will definitely face and must tackle in the near future is to address the "aged society." In order to form a vigorous society, not a mere extension of life, but prolongation of healthy longevity that considers the quality of life would become an important task. Therefore, Japan needs to steadily promote R&D on extending healthy longevity including prevention and treatment of lifestyle-related diseases.

Meanwhile, as society becomes more and more intricate, there has been strong demand for building a safe and secure society due to the increased factors that destabilize society such as terrorism, natural disasters, and a decline in public safety. As represented by the spread of infectious diseases due to advancement of globalization and computer crimes pertaining to progress in information technology, new threats have been emerging due to the increased complexity of society. Therefore, there are high expectations for science and technology to make further contributions in this field.

(Coexistence between environmental protection and economic development)

In the 21st century, it is no longer possible to think about the environment and economic development separately. In order for mankind to achieve sustainable development, coexistence between the environment and economy is indispensable, such as developing the economy while protecting/conserveing the environment or making economic advances that lead to improvement of the environment.

Because environmental problems such as global warming and air pollution are extremely wide-ranging, and due to the fact that each individual has an influence on the environment, multi-tiered measures throughout the social and economic systems will be required based on proactive participation of individuals and all sectors in order to achieve coexistence between the environment and the economy. These measures should encompass those on the "mind-set" level of individuals as well as fostering of markets that actively evaluate environmental values and building a recycling-oriented society. Of these measures, energy-saving and new-energy measures that actively adopt science and technology, as well as various environmental conservation technologies will be essential.

Japan has the world's most advanced technologies as follows in these fields.

Home electrical appliances that achieve the world's highest-level resource and energy saving performance

Low-emission vehicles including hybrid cars that adopt the world's most advanced technologies

Photovoltaic power generation systems that are introduced in the largest number in the world

R&D of innovative technologies that are essential for a recycling-oriented society, such as recycling technologies and use of hydrogen energy

Japan should fully use its scientific and technological potential and contribute to the world to help achieve coexistence between environmental protection and economic development, which is the common challenge for mankind.

(Strategic promotion of international activities based on science and technology)

While globalization of society and economy advances, Japan has been competing with other countries of the world over human resources, technologies, and knowledge, but at the same time, it faces problems that need to be resolved under international cooperation, such as global environmental problems. Today when international competition and cooperation are concurrently required, the role that should be played by science and technology is increasing.

In recent years, notably the rising China, South Korea, and ASEAN countries, which are seeking to develop as newly industrialized countries, are rapidly gaining strengths not only in the economic field, but also in the science and technology field. Japan

needs to lead in the establishment of a science and technology community in the Asian region through addressing the problems common to the region, such as dealing with environmental problems and emerging/reemerging infectious diseases, and exchanging/accumulating knowledge through building a network of Asian researchers and increasing mobility of researchers within the region with these countries, which are also geographically close. If Japan plays an active role in these fields, it will contribute to raising the status of the Asian region in the world, while it will also allow Japan to take the leadership in the Asian region and attract talented Asian R&D human resources, which are flowing out to western countries, to Japan.

At the Science and Technology in Society Forum held in Kyoto in November 2004, active debates were conducted on ideal science and technology in society with the participation of overseas ministers of science and technology and famous experts from industry, academia, and government. Meanwhile, at the United Nations World Conference on Disaster Reduction held in Kobe City, Hyogo Prefecture in January 2005, the "Hyogo Framework for Action," which will serve as the guidelines on disaster prevention for the next 10 years, was adopted, and the importance of research, observation, and prediction of disasters for reinforcing the disaster prevention capacity was indicated. Furthermore, Japan called on establishing regional tsunami early warning systems in the Indian Ocean in light of the Indian Ocean Earthquake in December 2004.

Japan's effort to actively conduct scientific and technological activities in the international community and contribute to creating knowledge, which is the common asset for mankind, will receive trust and respect from other countries, and Japan will be able to gain important ground in the international community.

[Column 21]

Science and Technology in Society Forum (STS Forum)

From November 14 to 16, 2004, the first Science and Technology in Society Forum (STS Forum) was held at the Kyoto International Conference Hall. The forum is considered to be the Davos Conference (World Economic Forum Annual Meeting) of the scientific field. Approximately 500 participants from 50 countries throughout the world, including government ministers (e.g. the Minister of State for Science and Technology), eminent scientists and business executives, attended the three-day forum to discuss the theme of "Science and Its Social Aspects: Lights and Shadows." The most distinctive feature of the STS Forum is that every participant attends the event as an individual, not representing a specific country or organization.

Japanese Prime Minister Junichiro Koizumi delivered the keynote address at the STS Forum. Since the hall was the site where the Kyoto Protocol had been agreed, he introduced the efforts of the Japanese government for prevention of global warming, including replacing existing official vehicles with low emission vehicles (LEV). Prime Minister Koizumi mentioned that science and technology could make environmental protection and economic development mutually achievable. On the other hand, he also indicated the disadvantages of the development of science and technology, giving the example that the invention of steam engine was so beneficial to us, but it increased the consumption of fossil fuels that cause global warming. He claimed that we should combine the best wisdom in the world to solve the problems that have occurred in line with the development of science and technology.

Subcommittees were set up at the STS Forum to discuss various subjects including bioethics, information technologies, technical experts, infectious diseases, safety and peace, nanotechnology, and the role of science and technology in governmental strategies. Based on the discussion, the following opinions were agreed: (1) science and technology should be used for solving the problem of global warming, which is a major problem for the human race; (2) it is necessary that developed countries support developing countries in improving their technological competence; and (3) science and technology should be used for the safety and peace of the human race.

The STS Forum is to be held annually in September. The second session is scheduled for September 11-13, 2005.

[Column 22]

World Conference on Disaster Reduction (WCDR) and Early Tsunami Warning System

From January 18 to 22, 2005, the United Nations World Conference on Disaster Reduction (WCDR) was held in Kobe, Hyogo Prefecture, Japan. In commemoration of the tenth year from the Great Hanshin earthquake, the disaster-stricken Kobe was chosen as the site of WCDR, which was established based on the "World Conference on Natural Disaster Reduction" in 1994.

At the intergovernmental and thematic meetings of the WCDR, more than 4,000 delegates were present, from 168 member states of the United Nations, 78 international organizations including U.N. agencies, and 161 nongovernmental organizations. Attendance at the symposiums and exhibitions totaled over 40,000, including the general public.

Recently, the approximate number of disaster victims throughout the world has reached 200 million per year, with 60,000 of them fatalities, and the total amount of damage approximately 37 billion dollars per year. At the WCDR, it was pointed out that disasters were a major obstacle to the accomplishment of sustainable development and eradication of world poverty, as they destroyed the results of development investment in just a short period. It was indicated that one of the biggest tasks for the international society was taking countermeasures against disasters, to reduce such damage.

On the last day of the WCDR, the "Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities" was formulated. It is a guideline for disaster prevention in the next ten years, aiming for the substantial decrease of the human, social, economic, and environmental damage caused by disasters. The measures in relation to science and technology include the promotion of technologies for research, observation, and prediction of disasters, and the establishment of a system for disaster reduction. Along with the framework for action, the "Hyogo Declaration" was also adopted at the WCDR. It is the promise by the participating nations to make efforts for disaster reduction.

Additionally, at the WCDR, the "Common Statement of the Special Session on the Indian Ocean Disaster" was adopted. The statement corresponds to the disaster in December 2004 when an earthquake and accompanying tsunami in December 2004 left over 200,000 people dead or missing. It appealed to participants to establish an early warning system for tsunami in the area, under the coordination by the United Nations. The Japanese government participated in the project, joining with the countries and organizations concerned. The early warning system for tsunami in the Indian Ocean will be established based on the know-how of the current tsunami warning system in the Pacific Ocean. Utilizing its advanced knowledge and experience in disaster prevention, Japan is required to make a wide range of efforts to reduce the damages caused by tsunami in the Indian Ocean, in a global cooperative setting.

1.3.3 Toward Promotion of Science and Technology in Japan

Section 1.3.2 discussed the roles that are expected of and should be played by science and technology in the severe conditions surrounding Japan.

In order for Japan to overcome various constraining factors and maintain sustainable development in the 21st century, it must exert an increasing effort to promote science and technology, which is hoped to make greater contributions in these fields.

(Promotion of basic research and important science and technology)

Basic research is the source of scientific development and innovation. Scientific development leads to creation of intellectual/cultural values and innovation leads to creation of economic/social values. In the international community, which will become more diverse and complex in the future, Japan needs to compete with other countries with its intellectual assets. Therefore, in order to secure diverse and solid intellectual assets that will continue to produce new knowledge, it is necessary to place even more weight on basic research and promote it extensively, steadily, and in a sustained manner. In addition, it is necessary to steadily promote facility improvements, and the development of infrastructure, such as information infrastructure and intellectual infrastructure.

Basic research, which is based on intellectual curiosity, forms the foundation for science and technology from the viewpoint of intellectual assets. Therefore, Japan, as a nation, should take responsibility for carefully selecting and promoting important fields of science and technology, which are necessary as infrastructure for the sustainable development of the nation and which the related ministries and agencies should work on in collaboration as a nation by clarifying the goals under a long-term national strategy. Specifically, Japan must examine and promote the fields of science and technology for which Japan has a comparative advantage and which will serve as the basis for strengthening its international competitiveness, the fields of science and technology in which Japan can maintain leadership in the international community, and based on which it can strongly advertise itself as being an advanced science-and technology-oriented nation in Japan and overseas, and the fields of science and technology which have spillover effects on extensive fields, which are promoted by the nation as a whole, and which contribute to the development of society. If Japan, which suffers many natural disasters like earthquakes and will become a super-aging society ahead of the world, contribute to "resolving the common problems for mankind" by effectively using its scientific and technological capabilities and actively engaging in science and technology, it will symbolize Japan's national power and serve as a source of soft power. Accordingly, such efforts would be essential for establishing Japan's presence in the world.

(Returning achievements to society)

It is extremely important to return scientific and technological achievements to society in a usable form. R&D achievements lead to industrial development and improve people's lives in the form of goods and services. At the same time, dissemination of the achievements to society in the form of scientific papers leads to accumulation of knowledge, which become seeds and develop into yet new science and technology. In order to develop an environment in which such creation and return of achievements take place continuously, Japan needs to further strengthen its current measures to reinforce coordination between industry, academia and government and protect/use intellectual property.

(Communication with society)

Science and technology has permeated throughout our lives and has a considerable impact on the whole society. It is indispensable to always look at the relationship between science and technology and society from the viewpoint of "science and technology in society for the sake of society." Scientists as well as the universities and scientific communities where they mainly conduct their activities are demanded to realize their social role and responsibilities, as well as fulfill their accountability and actively offer information, that is, actively conduct "outreach activities." At the same time, society must make efforts to maintain interest in and understand science and technology. The role of "science communicators," who explain details that are hard to understand for the general public and the significance of cutting-edge science and technology in an easy-to-understand manner, and the role of the

mass media are also important. Two-way communication between science and technology and society will be indispensable for establishing and maintaining a good relationship.

(Developing and securing diverse human resources)

Meanwhile, due to the decline in the absolute number of human resources, which is attributable to the decline in the birthrate and aging of the population, it has become an extremely important challenge to develop and secure excellent human resources who will support science and technology. In addition, the results of two international surveys on academic abilities, which were released in December 2004, revealed that academic achievements of elementary school students and lower secondary school students in mathematics and science partially declined, and there were problems in their willingness to study and their studying habits.

Lack of human resources that will lead science and technology will have a considerable effect on future Japan. It is important how we can convey the "importance and the interesting aspects of science and technology" to the generation that will play a lead role in the future of science and technology. So, in addition to improving school education, multidimensional measures will be required, such as improving science museums. In addition, from the viewpoint of securing many excellent scientific and technological human resources, an environment should be established in which female researchers and non-Japanese researchers, and competent elderly researchers can fully demonstrate their abilities.

Conclusion

As discussed above, we are so closely involved with science and technology that it is not too much to say that we live in science and technology.

This year is the tenth year from the enactment of the Science and Technology Basic Law. In this time, the environment surrounding Japan's science and technology has been considerably improved, such as through an increase in the government investment in R&D, reform in the technological and scientific system, and promotion of coordination between industry, academia and government. Also, looking at the aspect of "scientific and technological capabilities," Japan has definitely accumulated its capabilities while scientific and technological activities have become more profound.

However, as we have entered an era of worldwide knowledge megacompetition, all countries have become fully aware that science and technology is the foundation of national strength. They all position promotion of science and technology as well as human resources development as an important policy and strengthen government investment. Also, China and South Korea are catching up quickly. When we look to the future of the 21st century, which is called the era of the "knowledge society," and consider the severe situation in which we are likely to be put, because of issues such as a decrease in population, a super-aging society, and energy restrictions, we realize that we have come to a time when people in all industries and all segments must seriously think about what kind of country we should aim at and how we should treat science and technology.

Nevertheless, Japan has an accumulation of culture, tradition, and technical capabilities of which it can be proud in the world, and a high academic standard on average among developed countries. The greatest resource for Japan, which is a resources-poor country, may be human resources. Japan needs to make efforts to overcome its "weaknesses" in the future throughout the whole society, weaknesses such as lack of human mobility, the follow-the-leader mentality, and the weak external dissemination capabilities. At the same time, Japan should not merely imitate or introduce western scientific and technological systems as they are, but it should integrate and develop them with Japan's original "strengths" and establish the most suitable and effective systems for Japan.

At present, discussions toward formulating the Third Science and Technology Basic Plan are in progress lead by the Council for Science and Technology Policy. This is an effort to decide the basic direction of Japan's scientific and technological policy for the next five years by taking an overall view of about 10 years. Investment in science and technology takes a long accumulation time of 20 to 30 years and requires participation and contribution of various entities in order to achieve results. In addition, in order to develop researchers and engineers who will promote scientific and technological activities, comprehensive and continuous measures should be taken from elementary and secondary educational levels. In light of these circumstances, it will be necessary to take a long-term perspective also for science and technology policies.

Furthermore, in order for science and technology to be accepted by society and the people and to gain their trust and support, administration, research institutes, and researchers must make efforts to promote interactive communications with society and the people.

Japan, which aims to become an "advanced science-and technology-oriented nation" through the promotion of science and technology, should use scientific and technological capabilities—power in intangible areas—to the full and build an affluent and vigorous society, as well as contribute to creating new knowledge and resolving common challenges for mankind, and aim at becoming a reliable country with large presence.

To this end, Japan must further promote science and technology and achieve an "education-and human-resources-oriented nation" as its basis, as cross-generation "investment for the future," and it needs to form a national consensus on this matter.