Report

The Future Society Envisioned by the Science Community

January 25, 2007

Committee for the Investigation of Innovation Promotion,

Science Council of Japan

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Summary

1. Background

In its publications “The Japan Perspective” in 2002 and “Japan Vision 2050: Principles of Strategic Science and Technology Policy Toward 2020” in 2005, the Science Council of Japan (SCJ) has presented its vision on how Japan and the rest of the world should move forward in future. In May 2006, the SCJ created its Subcommittee on Enhancement of Innovation Capability in Science and Technology, and has been carrying out studies on innovation from the viewpoint of science and technology since then.

The Japanese government, meanwhile, has started to work on “Innovation 25”, a long-term strategy initiative targeting the year 2025, for the creation of innovations that will revitalize Japanese society and contribute to its further growth.

Following a request from Ms Sanae Takaichi, Minister of State for Innovation, the SCJ has created a Committee for the Investigation of Innovation Promotion to support the formulation of “Innovation 25” by the government, based on the visions proposed by the SCJ hitherto. The Committee has conducted studies on innovations needed for the future, as well as ways to promote these innovations from the comprehensive viewpoint of various academic fields, as an organization that represents the science community. This Report represents the outcome of these efforts by the Committee.

2. Current status and problems

In its “Japan Vision 2050”, the SCJ points to “global environmental degradation”, “population growth” and “the widening North-South divide” as major global problems of the 21st century that seriously threaten the sustainability of human society. As a way of solving these global problems, the SCJ proposes that steps should be taken to achieve a “balance between environment and economy”.

In recent years, the creation of innovations has been attracting interest in many countries. This is due to the expectation that breakthroughs forged by science, technology and innovation could solve these major global problems of the 21st century, and could achieve sustainability for humankind.

3. Contents of the proposals

(1) Innovation and academic research

"Innovation" means to produce new value and bring about a major transformation in society. Academic research is a source of new value, and is therefore indispensable to innovation. At the same time, it must be borne in mind that academic research in specific fields alone is unlikely to bring about changes in society, and that the results of academic research should not be confined within the academic sector.

(2) The ideal society of the future and the innovations to be promoted

The ideal society envisioned in the year 2025 will be a society in which people can live in health and safety, a society in which highly advanced information technology (IT) systems are widely used, a society in which Nature has been restored and local communities revitalized, a society in which efforts are made to solve the problems of the global environment and energy, and a society in which a suitable response has been found for the problems of water and food supply. This Report highlights innovations that should be promoted with a view to realizing this vision.

(3) Conditions, environments and systems for creating innovations

This Report specifically highlights efforts to develop systems of human resource training, science and technology environments and R&D systems, as well as designing a social system that will assist in creating innovations.

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1. Foreword

Based on studies that envisioned Japan and the rest of the world as they would be in 30 to 50 years from now, the Science Council of Japan (SCJ) published "The Japan Perspective"[1] in 2002 and "Japan Vision 2050: Principles of Strategic Science and Technology Policy in Japan toward 2020"[2] (hereinafter "Japan Vision 2050") in 2005. In this way, the SCJ presented its vision of how Japan and the world should move forward in future. The SCJ also created a Subcommittee on Enhancement of Innovation Capability in Science and Technology in May 2006, and has been carrying out studies on innovation from the viewpoint of science and technology since then.

Meanwhile, the Council for Science and Technology Policy formulated its "Comprehensive Strategy for Creating Innovation" in June 2006, as part of the Third Science and Technology Basic Plan (promulgated by the Cabinet on March 28, 2006). This was based on the recognition that it will be essential for Japan to promote innovation in order to maintain energy for further growth as well as contributing to the sustainable development of Japan and the rest of the world.

In addition to these, the government has established an "Innovation 25 Strategy Council" within the Cabinet Office with a view to formulating "Innovation 25". This is a long-term strategy initiative targeting the year 2025 for the creation of innovations that will revitalize Japanese society and contribute to its further growth. The Council is to present, by the end of February 2007, ways in which the quality of life in Japan will be improved through various innovations by the year 2025, including aspects of safety and convenience. The Council will also summarize innovations that are to be promoted in order to achieve these goals, and will work out a Road Map for strategic policies based on these outcomes, integrating all of these in "Innovation 25".

Following a request from Ms Sanae Takaichi, Minister of State for Innovation, the SCJ has created a Committee for the Investigation of Innovation Promotion to support the government's formulation of "Innovation 25", based on the visions proposed by the SCJ hitherto. The Committee has conducted studies on innovations needed for the future, as well as ways for the SCJ to promote these innovations from the comprehensive viewpoint of

[1] "The Japan Perspective" summarizes proposals for visions of how Japan should move forward in future, the roles of academia and the scientific community in the broader global community, and so on.
(URL http://www.scj.go.jp/en/scj/perspective.pdf)

[2] "Japan Vision 2050: Principles of Strategic Science and Technology Policy Toward 2020", an extension of "The Japan Perspective", presents basic ideas and fundamental principles that must be taken into account when formulating the Third Science and Technology Basic Plan.
(URL http://www.scj.go.jp/en/scj/vision2050.pdf)

various academic fields, as an organization that represents the science community. This Report represents the outcome of these efforts by the Committee.

Since the SCJ was to be fully involved in studying these matters, proposals for innovation were sought from SCJ Members, Associate Members and the Associate Society of SCJ, and these proposals have been incorporated in this Report.

2. What is innovation?

The word “innovation” is derived from the Latin “*innovare*”, where “*in*” means “inside” and “*novare*” means “to make new”. It refers to the incorporation of something new into something old, leading to the creation of new wealth or new value. In historical terms, the word can be traced back to the middle of the 16th century, when the Copernican system was first presented. In its studies for Innovation 25, the government has stated that “the word ‘innovation’ means to introduce completely new technology and ways of thinking to existing products or systems, thereby producing new value and giving rise to a major transformation in society.”

3. Innovation and academic research

“Innovation” means to produce new value and bring about a major transformation in society. Academic research is a source of new value, and is therefore indispensable to innovation. At the same time, it must be borne in mind that academic research in specific fields alone is unlikely to bring about changes in society, and that the results of academic research should not be confined within the academic sector.

(1) Academic research as the source of innovation

Academic research is an activity whereby existing knowledge creates new knowledge. As such, it functions as a foundation for “the creation of knowledge”, which is the source of innovation. In order to create and promote innovation, therefore, it is absolutely vital that we promote academic research.

Academic research, which creates new knowledge as the source of innovation, is promoted by enhancing research systems that respect researchers’ independence and motivation to research. To bring about innovation, moreover, it is vital that we promote not only research that bears short-term fruit or has policy-oriented goals, but also basic and fundamental research that is slowly accumulated over the long term. For this reason, the Third Science and Technology Basic Plan asserts that “The first requirement for building a

nation that can create human wisdom and contribute to the world is to build substantial and diverse intellectual stock that will continue to produce breakthrough knowledge". Meanwhile, the Comprehensive Strategy for the Creation of Innovation (issued by the Council for Science and Technology Policy on June 14, 2006) extols the need to "ensure diversity and continuity in basic research as the source of innovation". Innovations that contribute to society can only be created by using the results of such academic research activities. Furthermore, as stated in "Proposals Regarding Important Issues in the Science and Technology Basic Plan" (issued on February 17, 2005 by the Science and Technology Basic Plan Review Committee attached to the Advisory Panel for the Operation of the SCJ), basic research also entails a cultural aspect, in that acquiring new knowledge appeals to the human mind, as well as an educational aspect that leads to the development of human resources. These are also important elements that form the germs of innovation.

(2) Conditions for academic research to promote innovation

In recent years, appropriate action has been required to address ever deepening and broadening social demands on a number of issues – for example, increasingly violent international disputes, an aging society with fewer children, and the global issue of balancing the consumption of food, natural resources and energy associated with economic growth and the protection of the global environment. The reason why the creation of innovation is attracting so much interest in various countries seems to revolve around the expectation that science, technology and innovation can break through ever-intensifying economic competition accompanying the advance of globalization, as well as constraints associated with the limited availability of natural resources and global environments, thereby leading to a new frontier of sustainable human life.

Given this situation, academic research must not simply pursue the creation of knowledge but must also have a clear link with innovations that represent a transformation in society. Namely, as envisioned in the "Worldwide Declaration on Science and the Use of Scientific Knowledge" adopted on July 1, 1999, by the World Science Conference in Budapest, jointly held by UNESCO and the International Council for Science (ICSU), the concept of "Science in Society and Science for Society" is one of the most important responsibilities of academic research.

In view of the above, the following three requirements would appear to obtain for academic research to contribute to innovation:

Firstly, interaction among various disciplines is required. To address issues that are gaining in complexity, research needs to be pursued from diverse angles; our inquiry should not remain within the confines of a single scientific domain, but should survey the whole picture, encompassing diverse academic disciplines. Especially when applying science and technology to society, we need to adopt an awareness of cooperation among humanities,

social and natural sciences, something which is generally thought to have been lacking thus far.

Secondly, we need to take into account the fact that innovation is not consummated by academic research alone. Academic research must contribute to achieving the goal of innovation, i.e. a transformation in society. As such, we need to provide schemes for tackling innovation, without isolating academic research but with cooperation among industry, academia and government sectors, while aiming at a fusion of ideas between academic research and society at large.

Thirdly, the process of academic research should not be geared simply to satisfying intellectual curiosity but should take account of the impact that the obtained knowledge will have on society. Along with a search for truth, it should also be seen as an important element in academic research to assume both the advantages and the disadvantages that such a search may bring to society.

4. The ideal society of the future and the innovations to be promoted

In its “Japan Vision 2050”, the SCJ points to “global environmental degradation”, “population growth” and “the widening North-South divide” as major global problems of the 21st century that seriously threaten the sustainability of human society. As a way of solving these global problems, the SCJ proposes that steps should be taken to achieve a “balance between environment and economy”.

In this Chapter, the ideal society in the year 2025 will be envisioned by referring to the “Japan Vision 2050”, together with proposals made by SCJ Members and Associate Members. That society will be one in which people can live in health and safety, a society in which highly advanced IT systems are widely used, a society in which Nature has been restored and local communities revitalized, a society in which efforts are made to solve the problems of the global environment and energy, and a society in which a suitable response has been found for the problems of water and food supply. After this, specific innovations that should be promoted with a view to realizing such a society will be highlighted.

(1) Social infrastructure for healthy life

It is natural for human beings to seek a good quality of life (QOL). To achieve a society in which everybody can live in good health by the year 2025, society will need to be given the means to address the problems of declining birthrates, aging and population shrinkage. Biotechnology, information technology, and others must be integrated with a view to creating innovations that offer sufficient levels of medical and health care. If the innovations such as those envisioned below can be realized, they could be expected to contribute to the

enrichment of life not only for people in Japan, but for people all over the world as well.

1. By integrating information technology with medical science, we will be able to provide permanent health care in daily life, making it easy to prevent diseases and health hazards; even in old age, people will be able to live vigorous and active lives.
2. The use of telemedicine based on new information technologies will enable us to provide specific information regarding major diseases in real time; high-level medical care will be equally available in underpopulated regions. Moreover, such services will be available regardless of national borders.
3. Thanks to technical innovations in materials science, robot engineering, drug manufacturing technology and other fields, state-of-the-art artificial organs (including hybrid types) and medical/welfare apparatus (such as safe wheelchairs and ultra-compact hearing aids) will have been developed, leading to a further rise in the healthy age limit and an improvement in QOL.
4. With the invention of new medicinal drugs that prevent cell aging, progress in regenerative medicine including cell therapy, and other advances, it will be possible to treat formerly incurable diseases.
5. There will be advances in robot technology, which will endow robots with high-level intelligence and an excellent capacity to interface with humans. Robots will become widespread in various social services such as domestic safety, nursing care, welfare and spiritual healing.

(2) Safety and reassurance in people's lives

Safety technology for preventing natural disasters and traffic accidents, based on a core of information technology, robot engineering and materials technology (fields in which Japan excels), will be harnessed to create a society in which people's everyday safety and peace of mind can be firmly guaranteed. People will be able to make proper judgments on the risks that could be brought by new technologies, based on scientific knowledge. For example:

1. New materials with a high capacity for self-purification and durability will be developed. Houses will be designed for resistance to earthquakes, typhoons and other disasters, as well as longer periods of habitation.
2. The number of traffic accidents will decrease dramatically due to progress in prognostic safety technology for accident prevention (including analysis of vehicle structure, mechanisms and performance, analysis of human psychology, understanding of biological information, and analysis of accident statistics), the upgrading of information network systems for major highways, and the use of high-performance driving support

systems and car navigation systems mounted on vehicles.

3. Regulatory sciences will be widely accepted by the nation at large. These sciences will, upon requests made by risk administrators, provide the relevant scientific basis required when deciding regulation to mitigate the risks associated with a wide range of foods (including genetically modified foods), medicines and industrial products.
4. Risk communication networks will be established for risk administrators, risk assessors, consumers, businesses, researchers and other stakeholders to study the potential for new science and technology to be accepted by society and the directions for regulation to reduce risks, while gaining a better understanding of each other by exchanging information and opinions. This will substantially enhance their scientific understanding of safety and reinforce their capacity to make accurate judgments, as a result of which consensus will be reached.
5. Technology will be developed to allow a proper overview of various spatio-temporal information that is produced in bulk, making it possible to reach appropriate decisions or simulate social change. This kind of technology will be used to establish a system providing speedy and effective support for international action on global problems, such as regions afflicted by international disputes, disasters and widespread epidemics.

(3) Culture and lifestyles

In 2025, globalization will have advanced, but at the same time the importance of indigenous cultures of countries or regions will be recognized, while individual values and lifestyles will become further diversified. Innovations in science, technology and industry will be created by people's pursuit of changes in culture or lifestyle. However, innovations will emerge not only in science, technology and industry but also in the areas of culture and lifestyle. These will be engulfed in a major transformation that will usher in a futuristic social system, including the ubiquitous network society and the post-materialist, recycling-based society. Examples include:

1. The heritage of Japan's culture and civilization (including its classical literature, traditional performing arts, architecture, image culture in the form of movies, animation, etc., academic books, and so on) will have been transferred to digital information in multi-language format. In this way, information on Japanese culture will be spread strategically. Similarly, the Buddhist and *kanji* culture of Asia, as well as the heritage of world culture and civilization, will be archived in digital format, helping to promote mutual understanding amongst people all over the world.
2. Portable automatic translation devices will have been developed, enabling people from all over the world to communicate more easily with each other. This will greatly promote

a better understanding of different cultures.

3. The notion that responsibility for childcare lies not only in parents but also in society at large will be widespread, creating an environment in which it will be easier to produce and raise children. Meanwhile, children will develop broader points of view, show limitless motivation and live life with vitality, thanks to their experiences of contact with nature and different cultures with the aid of various technologies.
4. Life sciences and information technology will be integrated to create a system for providing dietary recipes matched to individual physical requirements.
5. It will be easier to access frontier areas such as outer space, the Earth's interior and deep seas, and the range of human activities will become broader.

(4) Information technology

By 2025, it will be possible to obtain any information we need from anywhere in the world instantaneously, thanks to an enhanced global network of IT infrastructure, and IT systems will play a crucial role in all aspects of life throughout the world. Also, by respecting the diversity of people's lifestyles and building a set of values on a common platform for all people, IT will allow people all over the world to understand each other better. To bring all of this to fruition, Japan will create a next-generation IT society by integrating various technologies in which it excels, such as ultrahigh-capacity storage and micro-display technology, as well as safe and secure IT systems. Typical examples include:

1. By combining displays that can be folded or rolled like a sheet of paper with the technologies of holography and communication, an environment in which workers will share a virtual common workspace with their communication partners (the telework system) will be developed.
2. Software engineering, system technology and computer language processing, all of which are core elements of information technology, will have evolved further still. Japan's information technology will have been enhanced, and all of these will support innovation in each field.
3. Technologies that allow the secure utilization of useful information technologies will have been developed, creating a safe IT society within the ubiquitous society of the future.

(5) Creation of new manufacturing and basic science & technology

Manufacturing is an area in which Japan excels, producing many different kinds of industrial products thus far. In twenty years from now, new ways of manufacturing will have

appeared – for example, a method based on the structures or mechanisms of living organisms. For innovations that will change the whole concept of manufacturing, we will need to create a new basis of science and technology that is not bounded by any conventional discipline. Moreover, such new methods are expected to achieve a higher quality of ecology, safety and economy. For example:

1. By understanding the extremely fine structures, functions and formations of living beings, none of which are seen in artificial products, a new field of bioinformatics (a method of analyzing life phenomena by combining information analysis with life sciences and information engineering) and new manufacturing methods based on nano-science will have been created.
2. "Uncrashable" aircraft will be built, and, due to progress in noise prevention technology, flight departures and landings will be possible 24 hours a day even at domestic airports.
3. Linear-motor bullet trains with a speed of 500 km/h will be adopted all over the world.
4. By sustainably preserving conventional manufacturing and maintenance technology for artificial systems, the foundation required for the further development of industry and society will be established.

(6) Revival of national infrastructure, nature and local regions

Science and technology should be able to contribute to many aspects in the revival of national infrastructure, nature and local regions. With the help of technologies based on civil engineering, urban engineering, and others, a landscape that is in harmony with nature and a society in which humans and nature coexist amicably will be created. Cyclical processes will be introduced to agricultural communities, taking advantage of information technology, robot engineering, etc., and this will lead to the creation of a sustainable society.

Also, in order to revitalize regions affected by problems such as depopulation or a rise in the rate of population aging, industries that draw on the characteristics and strengths of local regions will be promoted, and local communities that attract human resources and businesses from all over the country and the rest of the world will be materialized. Examples include the following:

1. With the help of new civil engineering developed in Japan, urban development that offers beautiful landscapes while preserving old cultural heritage will be promoted. It will be possible to develop pleasant urban spaces with plentiful greenery, in which surrounding woodland and hills will be revived so that urban life can coexist harmoniously with nature and wildlife.
2. It will be possible to develop pleasant urban spaces with abundant greenery, making use

of highly water-permeable concrete and other materials that allow plants to grow. In urban areas, meanwhile, it will be possible to achieve long-lasting, spacious and pleasant residential environments in which room layouts can be changed to suit the life stages of their occupants.

3. The integration of robot engineering and information technology will establish a process for recycling the products and waste produced by agricultural communities.
4. The characteristics of individual regions (their administrative mechanisms, culture, history, resources, natural landscapes, etc.) will be highly prized, and regional revitalization programs drawing on those characteristics will be developed in each region. Based on such programs, local communities, including their businesses and research and educational institutions, will invite experts from all over the country and even from overseas to establish centers of excellence (COEs) as cores for their respective fields, and their regions will be revitalized.

(7) Measures to cope with problems of the global environment and energy

As a country that has scant natural resources but is advanced in terms of energy conservation, resource conservation and environmental technology, Japan can make a great contribution to the world. On the energy problem, the global supply of oil and other resources is forecast to be at crisis point in the year 2025. By then, Japan will have achieved a level of technology whereby renewable energies will account for a large portion of the domestic energy supply, with a view to addressing the burgeoning energy demands of developing countries and at the same time preventing the further degradation of the global environment. In this way, Japan will take the lead in the world's future energy technologies. Typical examples are:

1. By integrating the development of artificial rainfall technology, desalination plants powered by solar batteries, water-retentive gel technology, and others, it will be possible to prevent desertification and create green areas in deserts.
2. Taking advantage of Japan's advanced environmental technologies such as energy conservation, environmental cleanup and carbon dioxide mitigation, Japan will contribute to solving problems of the global environment.
3. The cost and energy required for manufacture will have been reduced, and high-efficiency solar batteries will have been developed and be widely used in ordinary households.
4. Eco-friendly systems for supplying energy (including energy sources such as solar energy, hydro power, wind power, geothermal power, ocean energy and biomass) will have been established, while high-efficiency energy conversion technology for fossil

fuels and Asian-type standardized nuclear reactors will have been developed. Based on these and other developments, the use of an efficient and well-balanced energy supply (energy mix) will spread throughout Asia and the world.

5. Reversal factories, which convert unwanted and used products into raw materials, will be built on a large scale and a well-balanced system of material recycling will be established.

(8) Measures to cope with problems of water and food supply

The world of today faces a number of serious problems including water shortages and water pollution, attributed to social development and rapid global population growth (particularly in developing countries), the impact of global warming, and other factors. Amid global initiatives aimed at solving these problems, Japan will play an important role in realizing a water-recycling society by further developing its technologies for prevention and repair of environmental destruction, accumulated through its own experience of overcoming such problems. Meanwhile, Japan today is confronted by a rapid decline in petty farming and the population engaged in agriculture and fisheries, in addition to a low level of food self-sufficiency with a large dependence on imported foods. To address this situation, Japan will fulfill a long-term commitment to expanding the application of biotechnology and information technology, thereby mitigating the problems of agriculture and food in Japan and helping to solve food problems around the world.

1. Japanese technology will help to solve problems with the water supply in Asia, where rapid urbanization and population concentration are taking place. A water resource and water environment management system suited to regional climates, customs, society and economy will be designed by integrating Japan’s engineering technology, economics, geographical studies, and others.
2. Water purification technology based on molecular biology and materials science will have been developed, and as a result both highly developed regions and underdeveloped regions will enjoy access to clean water.
3. Due to the fusion of biotechnology with information technology, the consumption rate of water, agricultural chemicals and synthetic fertilizers will have been reduced significantly. This will make it possible to achieve sustainable increases in food production taking account of the environment and resources. This technology will also be used in developing countries, and will contribute to solving worldwide food problems.
4. By using robot tractors and information technology, large-scale forestry production systems that can accurately reflect all variations in terrain and changes in climate will

have been commercialized.

5. Efforts will be made to further enhance food stockpiling technology (especially for rice, vegetables and animal protein sources), creating a society that can cope with every conceivable kind of food supply situation.

(9) Realizing dreams by breaking through limitations

The many limitations in the society of today mean that it is considered impossible to realize many of our dreams by the year 2025. However, dreams will never come true if we believe those limitations to be insurmountable. Rather, we consider these to be problems that can be overcome by innovation. Below, we present examples of a world view in which our dreams will be realized.

1. By launching satellites that can convert solar energy into microwaves and transmitting those microwaves to Earth, photovoltaic power will be generated in outer space and the power used on Earth as a clean and efficient form of energy.
2. Routes for manned interplanetary navigation will be developed by constructing space ports and docks as transfer ports, and developing a round-trip transportation system that will be fully reusable for travel between Earth and the other planets.
3. A voice-recognition portable automatic translation device will be developed to assist smooth communication between people from different parts of the world, greatly enhancing cross-cultural understanding.
4. Due to progress in brain research, artificial limbs that move in accordance with the brain’s thoughts will have been developed, and disabled people will be able to lead a much more comfortable daily life.

5. Conditions, environments and systems for creating innovations

This Chapter will outline the conditions, environment and social systems needed to create innovations that will realize the society described in the previous Chapter.

(1) Systems of human resource training to create innovation

Principles:

1. To foster multidimensional human resources that can perceive a variety of values.
2. To foster human resources that can interact positively with people from different cultural backgrounds and learn from each other to develop their own skills.

3. To foster human resources that will energetically tackle new challenges.

More specifically,

1. It is imperative that we establish graduate schools that will attract human resources from all over the world.
   - Excellent researchers should be invited in large numbers under attractive conditions that are internationally competitive.
   - The president of each graduate school should have the authority to decide the terms offered to invited researchers.
   - The graduate school system should allow students to move easily between schools, and a system of multiple research supervisors should be introduced.
   - A system should be established whereby Ph.D. holders are socially appreciated and can make full use of their competence.

2. It is imperative that we enhance the undergraduate education system and make it more open.
   - For example, the number of universities that are attended by foreign students or whose lectures in specialized courses are given in English could be increased to enhance interaction among students.
   - Each university should introduce and implement a principle of competition, in the positive sense, by removing barriers caused by attaching too much priority to their own graduates (“inbreeding”).

3. Academic levels at elementary and secondary schools must be improved.
   - A large number of science teachers with research experience should be trained and assigned to elementary schools and high schools.
   - Teachers’ ability to pass down the pleasure and fun of learning to their students should be fostered.
   - Education in science literacy should be enhanced, museums and science museums upgraded and expanded, and human resources fostered to support the development of future science and technology.
   - The curricula of elementary and secondary schools should be revised periodically to meet contemporary needs, and tuition should be offered on contemporary subjects such as information technology and life sciences.

(2) Developing environments and R&D systems to create innovation

1 Establishing world-class universities as centers of excellence

- Many universities should be made into world centers of excellence at the highest level in terms of education and research, and large numbers of outstanding researchers and students from all over the world should be invited there. Also, collaboration between academia and industry should involve businesses not only from Japan but also from the rest of the world.

2 Establishing unique COEs at regional universities

- Regional universities should be made into COEs by inviting researchers in their specific domain of excellence from all over the world. These COEs should function as cores for their regions by establishing close ties with industry in their respective regions.

3 Enhancing public support to stimulate research activity

- New domains should be explored by encouraging interdisciplinary alliances.
- Young researchers and female researchers should be supported so that they can fully demonstrate their capabilities.

4 Developing programs to improve the mobility of human resources

- Customary employment practices, seniority-based remuneration, retirement benefits, pension schemes and other practices should be reformed to promote the mobility of human resources among education and research institutions, among businesses, and between these two sectors.

5 Enhancing the business environment for fostering venture businesses

- Procurement of services and materials from venture businesses should be encouraged without prejudice against their past delivery record or financial status.
- Expert support service programs should be enhanced in areas such as financial affairs, accounting, legal affairs and tax matters for venture businesses.

6 Establishing alliances between industry and academia to promote innovation

- Deregulation in various areas should be promoted and basic rules governing conflicts of interest established.
- The tax system should be reformed to encourage businesses and others to donate funds to educational institutions.

7 Academic societies and associations should be reformed to promote innovation.

- By reforming the tax system to promote financial donations, the basis of academic societies and associations should be consolidated to make them function as platforms for promoting innovation.

8 Enhancing the intellectual property system

- To protect and utilize the intellectual property owned by educational and research institutions, human resources who are familiar with intellectual property systems in Japan, the United States and Europe and who have experience in pioneering research activities should be fostered.
- Measures to combat imitations and pirated material should be reinforced.
- While securing freedom of academic research as a source of innovation, the intellectual property system should be improved to provide incentives and thus encourage the use of such research by industry.

(3) Designing social systems to create innovation

1 Restructuring the human mindset and values

- A plan for restructuring values that are important for the development of society should be drawn up by researching the diverse values that exist in society, as well as their mutual interaction and historical changes.
- A plan for building intelligent infrastructure should be drawn up with a view to developing a sustainable socio-economy, by designing a system for appropriately balancing out remuneration terms within the same generation as well as between generations.
- Steps should be taken to form a shared knowledge base on proper behavior and rules, by researching social etiquette with a view to constructing a society in which people with different personalities (and different places of birth and nationalities) can coexist peacefully.

2 Designing institutions that are consistent with the evolution of social systems

- A new institutional system compatible with the pursuit of sustainable evolution (improvement) should be designed by consciously designing social systems as a combination of values and technology.
- The many latent abilities of the individual should be developed and innovative challenges by individuals who research business models and support systems in which spiritual and cultural activities can grow as socioeconomic activities should be

encouraged. To this end, a support system should be established (in terms of re-education opportunities, investment and financing schemes, the tax system, etc.) to give failed challengers the chance to make a fresh start.

- Voluntary activities for collaboration between individuals in society should be encouraged, and social organizations and networks should be built to balance the self-fulfillment of individuals and the fulfillment of public needs through those voluntary activities.

3 Deepening our understanding of science and technology, investigating "social technology" and the nature of systems that allow science and technology to fully demonstrate their social character

- By comprehensively examining the possibilities and risks involved in science and technology, an integrated, self-referencing study should be carried out to eliminate or avoid those risks and appropriately orient the development of science and technology. Also, in order to heighten the awareness and adaptability of society, means of communication between the general public and experts should be developed.
- A self-governing, self-aware organization of scientists and researchers should be promoted, and a community of scientists who are open to the rest of the world should be formed, its common goal being the progress of science, the dissemination of scientific knowledge and the acceptance of social responsibility by scientists.
- The science community should take responsibility for continuously reviewing the development of science and technology and periodically reporting on "the present and future of science and technology" to society at large.
- Based on studies regarding human behavior in the event of disasters or crises, social technology for risk management that provides means of appropriate risk management should be developed and a contribution made to international risk management.

4 The science of innovation policy

- Research on innovation policy, as a specialized branch of policy science that is actively pursued in Europe and the United States, should be promoted, and a system established whereby comprehensive and consistent innovation policies can be proposed and implemented.

6. Conclusion

This Report brings together the wisdom of the Science Council of Japan (SCJ), and should

play a useful role in the formulation of “Innovation 25”.

The SCJ has conducted continuous research on Japan’s future vision, publishing the results in “Japan Vision 2050: Principles of Strategic Science and Technology Policy Toward 2020” and “The Japan Perspective – the Role of Scientific Information in Society”. It is thanks to these achievements that this Report was completed in a relatively short time between October 2006 and January 2007.

Innovation is not intended to be a short-term concern, but should be studied and implemented continuously. The Science Council of Japan will continue studying innovation through its various organs, including the Subcommittee on Enhancement of Innovation Capability in Science and Technology, a combined subcommittee of the Council’s General Engineering and Mechanical Engineering Committees.

(The original report (Japanese) has an appendix of 247 ideas about innovations and how to promote them, proposed by 2,200 Members of the SCJ.)