Section 3 Deepening the Relationship Between S&T with Society

1 Recent Trends on the Relationship of S&T with Society

S&T has been contributing to the progress of society by making the lives of citizens more materially rich and creating new employment opportunities in new businesses. In addition, the progress of new IT-based technologies and services, such as the Internet, has made it possible to get the same information as anyone else in the world instantaneously, prompting changes in social systems and social values such as political changes in Tunisia and Egypt.

In recent years, S&T has progressed more significantly, e.g., the spread of the Internet and the advancement of reproductive medicine, and made its relationship with society even closer (Table 1-1-32). For good or bad, the international to neighborhood level/from a global level to areas closer to our lives, S&T has become more intertwined with our daily lives, e.g., occurrences of large-scale earthquakes and global pandemics, global scale issues such as climate change, events threatening the safety of society, food safety, handling of food information. How we manage S&T, such as our attitude toward Ethical, Legal and Social Issues (ELSI) and risks, not only affects our perspective on life, but also how we want our society to be.

As S&T and society become more intertwined, it is important to think about this relationship as we encourage the promotion of S&T.

Table 1-1-32/Recent Events on Relationship between S&T and Society

Year	Trends concerning S&T and society	Trends in Japanese policies concerning science and technology and society
1995	- Great Hanshin-Awaji Earthquake - Sarin gas attack on the Tokyo Subway	- Enactment of the "Science and Technology Basic Law"[1]
1996	- Birth of Dolly, the sheep successfully cloned from an adult cell, in Scotland	
1997		- Enactment of the "Environmental Impact Assessment Law"[2] - Enactment of the "Organ Transplant Law"[3]
1998	- Researchers in the USA successfully grew human ES cells from cell culture	- Enactment of the "Law for Promoting University-Industry Technology Transfer (Technology Licensing Organization (TLO) Law)"[4]
1999	- Internet service became available from mobile phones - The 1st organ transplant conducted under the "Organ Transplant Law" - World Conference on Science (Budapest Conference) - The Tokaimura Nuclear Accident - Millennium bug (Y2K) problem	
2000		- Enactment of the "Act on Regulation of Human Cloning Techniques"[5]
2001	- Confirmation of BSE[1] cases in Japan - September 11 attacks in the USA.	- "Ethical Guidelines for Human Genome/Gene Analysis Research" (MEXT, MHLW, METI)
2002	- Internet penetration rate in Japan crossed 50%	- UN World Summit on Sustainable Development (Johannesburg Summit)
2003	- Spread of Severe Acute Respiratory Syndrome (SARS) - Human Genome Sequencing completed	- Enactment of the "Intellectual Property Basic Act"[6]
2004	- Occurrence of Avian Influenza in Japan - The Inaugural Meeting of the Science and Technology in Society (STS) forum	
2005	- Problem of forged structural calculations on earthquake resistance	- the Conference of the Parties to the United Nations Framework Convention on Climate Change Conference of the Parties, Kyoto Protocol entered into force
2006	- Import of US beef allowed again - Professor Shinya Yamanaka successfully generated iPS cells	- "Code of Conduct for Scientists" (Science Council of Japan)
2007		- Long-term Strategic Guideline "Innovation 25" (government decision)
2008		- Enactment of the "Research and Development Strengthening Act"[7] - Creation of Special Zone for Innovative Technology
2009	- Pandemic (H1N1) 2009	- Implementation of "review of government programs"
2010	- Return of the asteroid explorer "Hayabusa"	-"Promotion of the 'Dialog on Science and Technology with Citizens" (Minister of State for Science and Technology Policy, expert members of Council for Science and Technology) - "2011 2011 Action Plan for the Implementation of Important Science and Technology Policy Measures" (Minister of State for Science and Technology Policy, expert members of Council for Science and Technology)
2011	- Political changes in Tunisia and Egypt (Ruling political powers brought down by large-scale public demonstrations organized through the social media) - Great East Japan Earthquake	

Notes: 1. Science and Technology Basic Law (November 15, 1995, Act No. 130)
2. Environmental Impact Assessment Law (June 13, 1997, Act No. 81)
3. Organ Transplant Law (July 16, 1997, Act No. 104)
4. Law for Promoting University-Industry Technology Transfer (May 6, 1998, Act No. 52)
5. Act on Regulation of Human Cloning Techniques (December 6, 2000, Act No. 146)
6. Intellectual Property Basic Act (December 4, 2002, Act No. 122)
7. Act on Enhancement of Research and Development Capacity and Efficient Promotion, etc. of Research and Development, etc. by Advancement of Research and Development System Reform (June 11, 2008, Act No. 63)

Source: Created by MEXT

1 Bovine Spongiform Encephalopathy

[Column 4] Molecular Biology and the Tale of the Heike

When Dr. Max Delbruck (1906 – 1981), a molecular biologist was told he had won the year's Nobel Prize in Physiology or Medicine in 1969 for his work on uncovering the mechanism of virus reproduction and genetic structure, he distributed the opening passage of the Tale of the Heike to the researchers who had gathered to celebrate with him.

The temple bell echoes
the impermanence of all thing.
The colors of the flowers
teaching the truth that those who flourish must decay.
Pride lasts but a little while.
like a dream in a spring night.
Before long the mighty are cast down
and are as dust before the wind.

Professor emeritus Itaru Watanabe, Keio University, who was one of the researchers present, introduced this episode in his book "End of human – words of a molecular biologist" (1976, Asahi Press): "Dr. Delbruck felt that life is impermanent and even saw 'beauty' in that." On this, Dr. Kazuhiro Sakurada, Sony Computer Science Laboratories, Inc. says, "Dr. Delbruck probably imagined that molecular biology, of which he was a pioneer, could in the future be used to control ageing and death. He did not mention whether he thought that was good or bad, but just wanted to pass that thought on through the image of the beauty of life's impermanence." [1]

The focus of molecular biology research started from the concept of "genetic determinism" which states that biological phenomena can be explained as physical phenomena, and progressed to the stance that the characteristics of life can change due to not only genetic factors but also environmental factors, and now to how genetic information affects body, characteristics, and diseases. In the future, as research in this field progresses, it may be able to explain the various biological phenomena caused by the mechanisms of "pure chance" present in the human body, and it may also possibly deeply affect the life and death of people at an individual level." In Dr. Sakurada's latest book on the developments of epigenomics[2], state-of-the-art research he himself is involved in, he wrote that Dr. Delbruck probably saw beauty in the "pure chance" of life. As modern science gets closer to the source of life, it is posing a challenge to the values and perspectives on life that we have.

2 History of S&T and Society in Europe and America

Building a harmonious relationship between S&T and society is not only an important issue in Japan but also in Europe and America, and many efforts are being carried out toward it.

In the U.K., genetically-modified crop and Bovine Spongiform Encephalopathy (BSE) problems marred public trust in S&T in the 1990s, and prompted many scientists, citizens and politicians to conduct activities to promote mutual understanding among the people. At around the same time, the focus shifted from "Public Understanding of Science," a focus on public enlightenment, to "Public Engagement in Science and Technology," promotion of dialogs between the public and scientists.

More activities concerning "Public Engagement in Science and Technology" have been carried out since the item "Involvement of Science and Society" was included in some reports, such as the "Science and Society" report in 2000, representing a shifting of the focus from lectures by scientists to educate the public, to interactive activities to strengthen mutual understanding between scientists and the public, such as

1 "Science and Technology and Society – transition from 20th century to 21st century" (edited by the Center for Research and Development Strategy, Japan Science and Technology Agency , 2006 Maruzen Planet Co., Ltd)
2 Research on the mechanism in an organism to regulate gene expression through inheritable changes such as DNA methylation.

exchange of ideas with the public and working in joint projects.

Since then, many efforts have been conducted to improve the relationship between science and the public.

Sciencewise - ERC: Sciencewise Expert Resource Centre for Public Dialog in Science and Innovation was established with support from the Department for Business, Innovation and Skills (BIS) in 2007. This center is an organization comprising of specialists who provide various information, advice and guidance to policy makers on the impact of S&T to society. It also supports the promotion of public dialogs for policy makers to understand the perspective and viewpoints of the citizens.

In 2008, efforts to encourage more regional citizens to be involved in S&T were started by universities and local institutions to create a "platform for dialog" and with financial support from the Higher Education Funding Council for England and other organizations.

In 2010, BIS published a report "SCIENCE FOR ALL: Report and action plan from the Science for All Expert Group"[1], which stated that efforts will be made to "improve understanding of the relationship between the public, scientific and policy communities," "develop the potential for engagement through social media" and "establish public compacts on national issues."

In the USA, the American Association for the Advancement of Science (AAAS) was set up in 1948 and is one of the major organizations conducting activities to construct a strong relationship between S&T and the society. In particular, like the U.K., it has also shifted its focus from improving public's understanding of S&T, to increasing more opportunities for engagements with the public on various S&T issues.

One of these activities is the organization of the world's largest conference held annually for approximately 5,000 people including scientists, business people, policy makers, and journalists from the USA, and 50 other countries. The theme was "Bridging Science and Society" in the annual meeting in 2010 and some of the presentation titles were "New Frontiers in Particle Physics," "Geoengineering the Climate," "You earned a Bachelor's Degree in Science, What's Next?" "Science in the Theater," "The Future of Stem Cell Research," "Decoding the Secret Pathologies of Dolphins: Significance for Human and Ocean Health," "Traffic, Crowds and Society" and "Communicating science to the public." All in all, more than 150 presentations on topics ranging from the latest science research, to S&T policies, science education and science communication were held. These issues aim to share information across a wide spectrum of society.

AAAS also acts to connect the US government and scientists. John P. Holdren, Assistant to the US President for Science and Technology and Director of the White House Office of Science and Technology Policy (OSTP) under the current Obama administration, was the President of the AAAS in 2006 and a physics professor at Harvard University before assuming his current role. In the USA brain circulation is established, and many scientists can move to NPOs involved in S&T policies or government agencies, and as a result, this system has made it possible to reflect a wide variety of views in these policies.

3 Ethical, Legal and Social Issues (ELSI) Arising from Contact with S&T

As S&T become more complex and diversified, bioethical issues such as ethical, legal, and social issues (ELSI) also affect people more and more.

1 http://interactive.bis.gov.uk/scienceandsociety/site/all/

(1) Efforts in the Field of Life Sciences

In the Field of Life Sciences, bioethical issues are the main concern among ELSI and cover a wide range of problems such as human genome research and its practical use, clinical research, gene therapy, and tissue engineering.

In Japan, the government constructed the laws and government principles guiding bioethics such as the "Act on Regulation of Human Cloning Techniques"(2000), "Ethical Guidelines for Human Genome/Gene Analysis Research" (MEXT, MHLW and METI, 2001), and "Ethical Guidelines for Epidemiological Research" (MEXT and MHLW, 2002).

In FY 2009, the production of germ cells from human embryonic stem ES cells[1], which are prohibited by these guidelines was approved by the Council for Science and Technology Policy, and based on this MEXT subsequently revised the "Guidelines on the Utilization of Human ES Cells" and "Guidelines on the Derivation and Distribution of Human ES Cells," and established the "Guidelines on Research into Producing Germ Cells from Human Induced Pluripotent Stem Cells[2] or Human Tissue Stem Cells[3]" which it later implemented in May 2010.

In addition, MEXT and MHLW established the "Ethical Guidelines for Research on Assisted Reproductive Technology Treatment Producing Human Fertilized Embryos" on the production and use of fertilized embryos for the purpose of research on assisted reproductive technology treatment in December 2010 and implemented them in April 2011.

In Japan, government agencies usually lead the establishments of guidelines, however, in Europe and America, besides guidelines set by the government, groups formed by academic associations and researchers also actively take part in activities concerning bioethical issues.

One of these activities is the effort to include an ELSI group within a science research project team to evaluate the research's impact on society and this was carried out for the first time in the Human Genome Project. Such groups usually comprise of researchers from life science and medicine, as well as specialists in philosophy and law from the humanities and social science fields.

In terms of ELSI related to iPS cells, organizations such as the Stem Cell Network (founded in Canada, 2001) and The Hinxton Group (founded in the USA, 2004) carry out their activities through establishing international networks.

The Kyoto University's Research Unit for the ELSI of Genomics is an example of an organization tackling ELSI in Japan. This unit was set up in Kyoto University with MEXT's Grants-in-Aid for Scientific Research on Innovative Areas and is part of the "Support for Genome Research – Large-scale information production and advanced information analysis for a comprehensive promotion of genome science" project (2010 – 2014). This unit carries out activities that involve not only researchers but also people from various social backgrounds to think about how to resolve ELSI in genome research. These activities assist the formation of a human network where information on ELSI in genome research is shared.

(2) Efforts in the Field of Nanotechnology

Nanotechnology refers to technology which uses nanomaterials or which manufactures nanosize

1 Human ES (Embryonic Stem) cells are pluripotent, have the ability to replicate, and are derived from an early-stage embryo.
2 Like ES cells, iPS cells are pluripotent, not derived from embryos, and can be replicated from skin.
3 Stem cells which can be found in various tissues in the body

artificial particles, fibers, and membranes, etc. Nanosize materials have more particles and larger surfaces compared to things with similar chemical structures and therefore can be absorbed easier with other materials. The effects are similarly expected to be large, and with ELSI, Environment, Health and Safety (EHS) issues are also expected to become important as people start to worry about the risks of nanotechnology.

In the USA, measures to tackle the risks of nanotechnology were first mentioned in the 2000 National Nanotechnology Initiative (NII), and since then, have been coordinated across the different government agencies. In the EU, programs on safety of nanotechnology and nanotechnology dialogs have started in projects related to the environment, health and safety in the 6th Framework Program (FP6).

In Japan, under the "nanotechnology/materials" field in the "promotion strategies for prioritized areas"[1] in the 3rd Basic Plan, the importance of "R&D for public engagement of nanotechnology" was highlighted. For 3 years from 2007 to 2009, five ministries, MEXT, MHLW, MAFF, METI and MOE co-operated to form the "Policy Group on Infrastructure Development for the Promotion of Nanotechnology R&D and Social Acceptance" to discuss issues related to the development of nanotechnology and a conducive research environment, as well as to conduct research using living things on the impact of nanoparticles on human bodies. In addition, the group collected information on the harmful effects of industrial nanomaterials and in March 2009, MOE published "Guidelines for preventing the environmental impact of manufactured nanomaterials" to reduce environmental risks. In October 2009, the National Institute of Advanced Industrial Science and Technology released its "Risk assessment of manufactured nanomaterials (Interim Report)", and became the first organization in the world to propose permissible exposure levels to carbon nanotubes[2], fullerene[3] and titanium oxide[4] in an industrial environment.

The University of Tokyo's Nanomaterial Center, with the National Institute for Materials Science and the National Institute of Advanced Industrial Science and Technology set up a "development of comprehensive database index for a basis of facilitation of nanotechnology R&D" project team to understand the current situation and problems surrounding nanotechnology, and gather information on how to promote social acceptance.

4 Risk-related Efforts

As awareness of S&T's impact on society and people's concerns about their risks increase, there is a need to evaluate environment safety and safety to the human body based on the logic of high-quality science and whether it is justifiable to society. At the same time there is also a rising awareness within and outside of Japan to share information, and the importance of society to consider measures before risks occur. Several efforts focusing on risks are being carried out.

Such efforts include risk assessment for safety regulations, risk management and risk communication.

Risk assessment refers to assessing risks scientifically and managing the risks based on considerations of the assessment outcomes, technical possibilities, cost performance, and some other factors. What is important in the process is to ensure risk communication takes place smoothly. Risk communication refers

1 http://www8.cao.go.jp/cstp/kihon3/bunyabetu.html
2 Carbon nanotubes are allotropes of carbon with a cylindrical structure with a diameter of about 5-10 atoms, and have a unique property of being either a metal or a semiconductor depending on its structure.
3 A fullerene is a molecule composed of carbon in the form of a sphere made up by more than 60 atoms.
4 Titanium oxide is a metallic oxide which is used in cosmetics, paints and as a photocatalyst.

to an exchange of information and opinions on risks among individuals, organizations and other groups, and involves the sharing of information and exchange of opinions necessary from non-emergency times, and the provision of information for crisis management in emergencies to minimize damage and losses to society. It is important in various fields involving S&T, such as food safety, management of chemical substances, and safety of nuclear power.

In risk communication, it is difficult because there are often gaps between the real risks and the risks perceived by people. It is therefore important to make the scientific evaluation and assessment of risks transparent and share it among the stakeholders.

The government started its efforts to safeguard food safety such as the revisions to the Food Sanitation Act which were carried out in tandem with the enactment of the Food Safety Basic Act in 2003 after the first case of BSE found in 2001. Topics of risk communication include the safety of imported food products and pesticide residue, safety of food preservatives, prevention of food poisoning, safety of functional food.

The Food Safety Commission in the Cabinet Office, MHLW and MAFF mainly promote risk communication activities regarding food safety.

As for management of chemical substances, MOE leads in promoting risk communication activities, in cooperation with other government agencies when necessary. Specifically, it has been organizing the "Round-table Conference on Chemical Substances and the Environment" to produce and provide easy-to-understand information on chemical substances that can adversely affect people and the ecosystem through the environment (hereinafter referred to as "environmental risks"), develop human resources who can answer questions on chemical substances familiar in our lives (chemical substances advisors), and share information and promote mutual understanding among the Japanese public, industries and the administrative offices on environmental risks.

On the safety of nuclear power, the top priority is, of course, to ensure the safety at nuclear power facilities, but carrying out activities to get the public understanding and confidence along the way is also important. The Nuclear Safety Commission of Japan in November 2003, decided on a "Basic Policy" to introduce nuclear safety regulations which utilize risk information, and in September 2007, submitted a report outlining future issues and direction to take[1]. This report highlighted the promotion of risk communication activities as one of the issues, and stated that it was important to actively promote risk communication activities that accurately convey both the positive and negative aspects of relevant information to the stakeholders and promote mutual understanding (Table 1-1-33). Therefore, it is important to organize briefing sessions and symposiums, promote risk communication with the public through the development of neutral risk communicators, raise safety awareness of related personnel working in the fields, and create a culture of safety, and to promote such risk communication activities comprehensively both within and outside the organization. Into the future, the issue of how to communicate in case of accidents still remains, but nevertheless, some lessons can be learned from the recent nuclear power plant accident, i.e., it is necessary to improve risk communication to provide easy-to-understand information that has been verified scientifically to meet the needs of society in both times of emergencies and peace.

1 "Current Activities and Future Issues for Risk Informed Regulation in Japan – for extended use of risk information" (September 2007, approved by The Nuclear Safety Commission of Japan)

In addition to the above, there are also self-governing bodies and regional companies who are taking the lead in promoting risk communication activities actively.

Also, activities carried out by non-profit organizations such as specified non-profit organizations (hereinafter referred to as NPOs)[1] to promote communication between S&T and society span various fields such as life sciences, medicine, and energy, and are expected to promote risk communication as well.

Supporting these efforts is the concept of regulatory science. Regulatory science is science that predicts and evaluates the credibility supporting the results of S&T and their ripple effects, to provide scientific evidence for risks. In addition, it aims to support the social consensus of laws and regulations concerning risk management and is very important for achieving harmony between S&T and society. MAFF started a "Regulatory Science New Technology Development Project" on food safety from FY 2010.

Table 1-1-33/Risk Communication Efforts by Public Institutions

Year	Organizations in Charge	Contents
From 2001	MOE	"Round-table Conference on Chemical Substances and the Environment": held 26 times as of August 2010 to promote information sharing and mutual understanding among citizens, industries and representatives of administrative offices on environmental risks caused by chemical substances.
From 2003	MHLW, Food Safety Commission, MAFF	Organize nationwide opinion exchange meetings on "Risk Communication on Food", to discuss themes such as BSE measures, safety measures for imported food, the positive list[2] system for pesticide residue, and functional food.
From 2003	The Nuclear Safety Commission of Japan	Established a basic policy for "Nuclear Safety Regulations Utilizing Risk Information", and produced a report on future issues and direction to take
From 2004	National Institute of Technology and Evaluation, Chemical Management Center	Provide information regarding chemical substances Introduce examples of domestic risk communication on chemical substances

Source: Created by MEXT

1 Non Profit Organizations are organizations that carry out volunteer activities for the benefit of society on a not-for-profit basis. Specified nonprofit corporations (or Specified NPOs) is a generic term given to corporations who have acquired corporation status to hold rights and responsibilities based on the Act on Promotion of Specified Non-profit Activities.

2 Regulations to be carried out based on the following "In principle, all pesticide residue are prohibited except for those on the permitted list".