1.2 How Science and Technology Are for Society

Section 1.1 explained that the key to future progress for mankind lies in the realization of "science and technology for society, and in society." In Section 1.2, the current state of science and technology, and the issues confronting it, are examined from the viewpoint of "science and technology for society."

1.2.1 Contributing to Society through Knowledge Creation and Utilization

Scientific and technological activities refers to the elucidation of unknown phenomena, and to the creation of new knowledge through the discovery of new natural laws and principles, and the new knowledge obtained is then utilized in the real society. The essence of how science and technology contributes to society is the creation of new knowledge, and then utilization of that knowledge to boost the prosperity of human lives, and to solve the various issues facing society.

With the shift to a knowledge-based society well underway in the opening years of the 21st century, the creation of new knowledge is an increasingly important aspect of scientific and technological activities, and the role of science in this knowledge creation is important for the realization of "science and technology for society."

The relationship between science and technology and society, can be described by the example of rain falling on a mountain. Rain that has fallen on a mountain does not immediately wash away downhill. First, it is captured and stored by forests, giving life to trees and other vegetation and creating a verdant landscape. This can be compared to the accumulation of scientific knowledge and the continuing search for truth, obtained through basic research, and perhaps demonstrates that science has intrinsic value in itself. Meanwhile, the rainwater stored in the forest bubbles out from springs and flows downhill in a steadily widening stream. A single stream flow can separate into a large number of sub-flows, and sometimes the flow can go underground into a subterranean network. This situation can be compared to the diversity of research and development that can arise based on scientific knowledge, leading to the planting of various new technological seeds. Eventually, the river reaches farming communities and urban cities, where it is utilized for drinking water and other household purposes, for agricultural or industrial uses, and for various other needs, universally benefiting all aspects of society. This is equivalent to research and development resulting in practical technologies that boost the prosperity of the people's society and lives, and to the utilization of science and technology in response to various issues facing society. If the forest fails to capture a sufficient amount of the falling rain, society will quickly be faced with drought and people will not be able to live. In the same way, realization of societal progress through science and technology requires a sufficient accumulation of scientific knowledge. In other words, science can be considered to be the foundation strength of society. However, this foundation strength is not something that can be acquired in a single day or night, but instead requires a steady, continuous build-up (Figure 1-2-1).

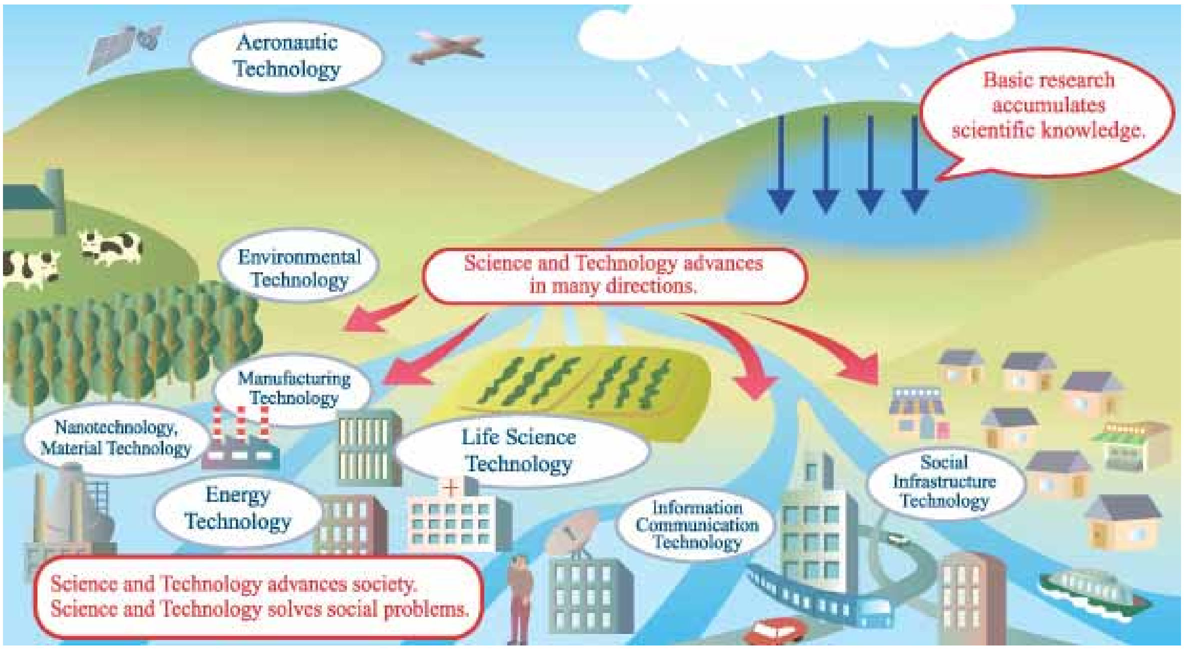


Figure 1-2-1 Relationship between science and technology and society

This section looks at science as the foundation for realizing "science and technology for society," with a focus on the natural sciences.

1.2.1.1 Science's Contribution to Human Civilization

(Societal Significance of Science)

Where technology has developed in close relationship to the convenience and prosperity of human life since before the advent of recorded history, science originated from natural philosophy and was supported by people's intellectual curiosity. The main objective of science has been elucidation of how nature is put together and operates, and it has developed as a separate entity from technology. Of course, while technological progress was backed up by various scientific advances, this does not mean that scientific research was conducted for the purpose of developing new technologies, rather, scientific knowledge was utilized only because it was available. In fact, it was more common for new technologies to be developed in order to pursue scientific research.

After the Industrial Revolution, the separate paths taken by science and technology began to move closer together. Significantly, the concept of linking scientific results to technology for utilization in society became prevalent after around 1850, which is when a chemical industry began to develop based on utilization of knowledge about chemistry, and electrical technologies arose based on knowledge about electromagnetism.

Nevertheless, science has moved away from being the business of the intellectual world, with scientific results now pioneering the frontiers of human activities in terms of both space and time, and expanding the potential of human activities. Science also has become a major influence on people's sense of values, changing the nature of society and becoming the engine driving society's progress from the viewpoint of civilization.

(Scientific Progress Has Changed the Nature of Society, and Its Sense of Values)

While there are probably no end of examples of scientific progress having a major effect on people's sense of values, and changing the nature of society itself, the following is an introduction to just a few of the more famous examples.

The centennial anniversary to one of the most amazing years in history (the "Miracle Year" of 1905) is fast approaching, when Albert Einstein, one of the premier scientists of the 20th century, issued in rapid succession a theory of the photon, a theory of Brownian motion, and the Special Theory of Relativity, all of which served to overthrow the then-prevailing views of physics. Einstein's Theory of Relativity became the foundations for all later physics, contributing greatly to progress in various fields of science. At the same time, it altered people's concepts of space and time, and had a huge effect on philosophy and thought.

In the field of astronomy, Nicolaus Copernicus developed a theory, later bolstered and refined by Johannes Kepler and Galileo Galilei, that had a great effect on the development and reform of society, overthrowing Europe's medieval sense of values and driving it into the modern age. In recent years, however, examples of such society-changing advances have become increasingly common. For example, Edwin Hubble's discovery in 1929 that the universe was expanding led directly to the Big Bang theory of the origin of the universe (1946) by George Gamow and others. In 1965, Arno Penzias and Robert Wilson detected cosmic background radiation pervading the universe, providing powerful evidence for the Big Bang theory. These discoveries gave people a new "sense of the universe." Moreover, advances in space development have greatly expanded the space available for possible human activities, and opened up new frontiers for humanity where people can dream. At the same time, images of Earth taken from space have given people all over the world a new "view of the Earth," vividly revealing its beauty and irreplaceability. Furthermore, the revelation in 1974 by Sherwood Rowland and Mario Molina that chlorofluorocarbon gases were causing depletion of the ozone layer, followed in 1985 by the discovery of an ozone hole, had a huge effect on efforts to protect the global environment.

Alfred Wegener's theory of continental drift, announced in 1915, is widely accepted around the world today as the plate tectonics theory. At the time of its announcement, however, the mechanism for continental drift was unknown, and the theory attracted few supporters. In the 1950s and later, however, advances in sea floor monitoring advanced the field of geophysics, and in the 1960s Frederick Vine and Drummond Mathews found quantitative evidence of continental drift due to a spreading sea floor. This discovery completely altered people's "sense of the Earth."

In the life sciences, meanwhile, as seen by such advances as the Theory of Evolution proposed by Charles Robert Darwin in the 19th century, which greatly changed people's "sense of nature," "sense of humanity," and "sense of society," there are many examples of discoveries going far beyond the world of science to affect the way people think in many sectors of society. The discovery in 1953 of the double helix structure of the DNA molecule by James Watson and Francis Crick gave birth to an entirely new field of molecular biology. The result has been progressive elucidation of the structure of living things at the molecular level and rapid advances in the life sciences, including the establishment of gene recombinant technology by Stanley Cohen and Herbert Boyer in 1973, the birth of a cloned sheep, Dolly, in 1996, and completion in 2003 of the project to sequence the entire human genome, conducted by the International Human Genome Sequencing Consortium, a collaboration of six countries including Japan, and five other North American and European countries. These recent advances in the life sciences have greatly increased understanding of humans and other living things, extending the frontiers of human activity, particularly in the medical field, and greatly affecting people's "sense of life" and "sense of ethics." Furthermore, advances in brain research hint at the possibility of closing in on the human soul, and progress in that area will surely have a large effect on people's sense of values.

The IT revolution of recent years is the culmination of many developments in computer technology, including the concept of the computing machine proposed by Alan Turing, and the invention of the transistor by William Shockley, John Bardeen, and Walter Brattain, as well as the advent of the Internet and other advances in information and communications technology. The IT revolution, however, does not consist merely of the development of new products or improvement of people's convenience, but is also greatly changing people's modes of behavior and lifestyles, through the possibilities it has opened up for the people of the world to use cyberspace for instantaneous exchange of information and opinions. The effects of the IT revolution have changed the nature of society in many dimensions, from the education, medical and welfare, transport, finance, and manufacturing sectors to modes of work and play.

Furthermore, advances in nanotechnology have made possible the elucidation and manipulation of phenomena at the atomic or molecular level, feats that were previously considered impossible, and are now expanding the range of possible human activities. Nanotechnology was launched by a lecture given in 1959 by Richard Feynman, titled “There’s Plenty of Room at the Bottom,” and its progress has been marked by advances in measurement technology, and supported by such scientific discoveries as the discovery of fullerenes in 1984 by Harold Kroto and others.

Elsewhere, the television has become a major factor shaping our modern society, as the communications medium with the greatest influence. This device, as well, is the culmination of various scientific results over the years, beginning with the invention of wireless communication by Guglielmo Marconi in 1895, the invention of the Braun tube in 1897, the invention of the Yagi-Uda antenna in 1925, and Kenjiro Takayanagi’s successful transmission of an electronic image using a Braun tube in 1926.

Table 1-2-2 Footprints of science and technology in the 20th century

Year	Inventions and discoveries related to science and technology	Events in society surrounding science and technology
1901	・First Nobel prize	
	Shibasaburo Kitasato (Japan) was one of the candidates for the prize for his research into the tetanus bacillus	
	・Invention of method for manufacture of adrenaline and procurement of patent (Japan: Jokichi Takamine)	
	・Successful wireless transmission across Atlantic Ocean (Italy: Guglielmo Marconi)	
1902	・Discovery of Z-term for latitude variation (Japan: Hisashi Kimura)	
1903	・Proposal of Saturnian model for the atom (Japan: Hantaro Nagaoka)	
	・First manned flight of powered aircraft (U.S.: Wright brothers)	
1904	・Invention of diode vacuum tube (UK: John Fleming)	・Russo-Japanese War
1905	・Special Theory of Relativity (Switzerland: Albert Einstein)	
1907	・Invention of triode vacuum tube (U.S.: Lee de Forest)	
1908	・Establishment of ammonia synthesis (Germany)	・First sale of Model T Ford (U.S.)
1910	・Discovery of Vitamin B1 (Oryzanin) (Japan: Umetaro Suzuki)	
1911	・Successful cultivation of syphilis pathogen (Japan (Hideyo Noguchi)	
	・Discovery of atomic nucleus (UK: Ernest Rutherford)	
	・Discover of superconductivity phenomenon (Netherlands: HK Onnes)	
1913		・Mass production of Ford automobiles (U.S.)
1914		・World War I (until 1918)
1915	・Artificial inducement of cancer tumor (Japan: Katsusaburo Yamagiwa, Koichi Ichikawa)	
	・General Theory of Relativity (Germany: Albert Einstein)	
	・Theory of continental drift (Germany: Alfred Wegener)	
1917	・Invention of KS steel (Japan: Kotaro Honda)	・Establishment of Institute of Physical and Chemical Research (RIKEN) (Japan)
1920		・World's first radio broadcast (U.S.)
1921	・Discovery of insulin (Canada: Frederick Banting, Charles Best)	
1922	・Proposal of expanding universe model (Russia: Aleksandr Friedmann)	
1925	・Invention of Yagi-Uda antenna (Japan: Hidetsugu Yagi, Shintaro Uda)	
1926	・Proposal of wave equation (Austria: Erwin Schrodinger)	
	・Launch of first liquid-fueled rocket (U.S.: Robert Goddard)	
	・Successful Braun tube reception of electronic signals (Japan: Kenjiro Takayanagi)	
1927	・Proposal of Uncertainty Principle (Germany: Werner Heisenberg)	・Japan's first subway opens for operation
1929	・Discovery of penicillin (UK: Alexander Fleming)	
	・Observation of expanding universe (U.S.: Edwin Hubble)	
1935	・Proposal of mehon theory (Japan: Hideki Yukawa)	
	・Isolation of crystal structure in tobacco mosaic virus (U.S.: Wendell M. Stanley)	
	・Invention of nylon synthetic textile (U.S.: Wallace Carothers)	
1936	・Theoretical computer model (UK: Alan Turing)	
1937	・Development of jet engine (UK: Frank Whittle, Germany: Hans von Ohain)	
1938	・Discovery of uranium fission (Germany: Otto Hahn, Fritz Strassman)	
1939	・Discovery of DDT insecticide (Switzerland: Paul Mueller)	・World War II (until 1945)
		・First flight of jet aircraft (Germany)
1941		・First commercial television broadcasts (U.S.)
1942	・Successful nuclear fission chain reaction (U.S.: Enrico Fermi, et al)	・Manufacture of V-2 rocket (Germany: Werner von Braun)
1944	・Proof of DNA gene structure (U.S.: Oswald Avery)	
	・Discovery of streptomycin (U.S.: Selman Waxman)	
1945		・Manufacture of atomic bomb (U.S.)
		・Bush Report (U.S.: Vannevar Bush)
1946	・Development of ENIAC electronic computer (U.S.: John Mauchly, Presper Eckert)	
	・Big Bang Theory (U.S.: George Gamow)	
	・Development of transistor (U.S.: William Shockley, John Bardeen, Walter Brattain)	
1949	・Hideki Yukawa winner of Nobel Prize for Physics	

Year	Inventions and discoveries related to science and technology	Events in society surrounding science and technology
1951		· First nuclear power generation (U.S.)
1953	·Elucidation of DNA double helix (U.S.: James Watson, UK: Francis Crick)	
1954	·Discovery of interferon (virus inhibition factor) (Japan: Yasuichi Nagano, Yasuhiko Kojima)	
		·World's first kidney transplant (U.S.)
Circa 1955		·Pollution becomes a societal problem (Japan)
1957		·First criticality in Japanese nuclear reactor
		·Launch of Sputnik artificial satellite (USSR)
1959	·Invention of integrated circuit (IC) (U.S.: Jack Kilby)	
1960	·First successful laser firing (U.S.: Ted Maiman)	
1961		·First manned space flight (USSR: Yuri Gagarin)
1963	·Proposal of theory of sea-floor spreading explains magnetic anomalies (UK: Fred Vine, Drummond Mathews)	
1964	·Proposal of Quark Model (U.S.: Murray Gell-Mann, George Zweig)	·Tokai Shinkansen commences operations (Japan)
1965	·Observation of universe background radiation (U.S.: Arno Penzias, Robert Wilson)	
	·Shinichiro Tomonaga wins Nobel prize for physics	
1966		·Commercially based nuclear power generation (Japan)
1967	·Plate Tectonics Theory (UK: Dan McKenzie, U.S.: Jason Morgan)	·Promulgation of Basic Law for Environmental Pollution Control (Japan)
		·First heart transplant operation (South Africa: Christiaan Barnard)
1969	·Superlattice proposal (Japan: Reona Esaki)	·Apollo 11 lands on the Moon (U.S.)
1970		·Launch of Ohsumi, Japan's first artificial satellite
Circa 1973		·Oil shock (Japan)
1973	·Establishment of gene recombinant technology (U.S.: Stanley Cohen, Herbert Boyer)	
	·Reona Esaki wins Nobel prize for physics	
1974	·Indication that chlorofluorocarbon may be depleting ozone layer (U.S.: Sherwood Rowland, Mario Molina)	
1978		·First in vitro insemination infant born (UK)
1979		·Three Mile Island nuclear power plant accident (U.S.)
1981	·Kenichi Fukui wins Nobel prize for chemistry	·First flight of the Space Shuttle (U.S.)
1983	·Discovery of AIDS virus (France: Luc Montagnier, U.S.: Robert Gallo)	
1984	·Discovery of fullerenes (UK: Harold Kroto, et al)	
circa 1985	·Discovery of the ozone hole (Japan, UK, U.S.)	
1986	·Discovery of high-temperature superconductivity (Switzerland)	·Chernobyl nuclear power plant accident (USSR)
		·Space Station Mir commences operations (USSR)
1987	·Susumu Tonegawa wins Nobel prize for physiology and chemistry	
1989		·End of Cold War
1991	·Discovery of carbon nanotubes (Japan: Sumio Iijima)	·Cellular phone service starts (Japan)
1992		·Earth Summit
circa 1993		·Announcement of Information Superhighway concept (U.S.)
		·Explosive growth of Internet
1994	·Confirmation of top quark (U.S.: Fermi National Accelerator Laboratory)	·Launch of H-II rocket (Japan)
1995		·Great Hanshin-Awaji Earthquake (Japan)
		·Passage of the Science and Technology Basic Law (Japan)
1996	·Birth of Dolly the cloned sheep (UK)	
1997		·Promulgation of Organ Transplant Law (Japan)
1998	·Confirmation of mass in neutrino (Japan: Super Kamiokande)	·Assembly of International Space Station commences (Japan, U.S., EU, Canada, Russia)
1999		·World Conference on Science (Budapest)
		·Japan's first organ transplant from brain-dead donor
		·Criticality accident at uranium processing plant (Japan)
2000	·Hideki Shirakawa wins Nobel prize for chemistry	·Passage of Law concerning Regulation relating to Human Cloning Techniques and Other Similar Techniques (Japan)
2001	·Ryoji Noyori wins Nobel prize for chemistry	
2002	·Masatoshi Koshiba wins Nobel prize for physics	·Johannesburg Summit
	·Koichi Tanaka wins Nobel prize for chemistry	
2003	·Sequencing of human genome completed (Japan, U.S., Europe)	

Source: Prepared by MEXT

[Column 1]

Who are we?

“Where do we come from? What are we? Where are we going?” This is the title of a masterpiece by Paul Gauguin, from the Late Impressionist School. Gauguin used this work as a starting point for a whole series of paintings exploring the theme of "the meaning of mankind's existence."

Scientific knowledge has made great strides in the ensuing 100 years, and the answer to Gauguin’s question is beginning to come clear. Advances in the life sciences, for example, have clarified the history of the evolution of life. Based on such researches, the period since the first appearance of life on Earth to the present day can be treated as equivalent to 365 days (a calendar of evolution), for a graphic portrayal of "where we are now." This result offers one viewpoint for considering the relationship between science and technology and society

Calendar of the Evolution of Life

Birth of the Universe (13.7 billion years ago)	—
Birth of the Earth (4.6 billion years ago)	—
Appearance of life on the Earth (3.8 billion years ago)	January 1
Oxygen appears in the atmosphere (2.0 billion years ago)	July 2
Appearance of eukaryotic life (1.8 billion years ago)	July 22
Appearance of multi-celled life (600 million years ago)	November 4
Appearance of dinosaurs (250 million years ago)	December 8
Appearance of mammals (200 million years ago)	December 12
Appearance of primitive humans (1 million years ago)	December 31, 9:40 p.m.
Appearance of civilization (20,000 years ago)	December 31, 11:58 p.m.
The Industrial Revolution (200 years ago)	December 31, 11:59 p.m., 58.4 sec.
Space Age begins (40 years ago)	0.3 seconds before the end of the year

Source: Prepared by Ministry of Education, Culture, Sports, Science and Technology, based on “*Kagaku o Hagukumu*” (Nurture science) by Reiko Kuroda

(Science Supports Modern Civilization)

One more aspect of the contribution that science has made in the establishment of modern civilization has been the steady spread around the world of scientific thought as science has progressed.

Modern science derived originally from certain sciences in one limited region, Western Europe, where a culture of science developed. Yet while debates may exist regarding specific scientific results, the sciences and scientific thought are today widely accepted in many countries around the world. The history of the worldwide spread of modern science has varied sharply by country and region, and was often fraught with dissension or friction. Today, however, Nobel prizes in the natural sciences are being increasingly awarded to researchers from countries outside the core areas of Western nations, and many people in countries outside of Western Europe have accepted the culture of scientific thought and are contributing to the progress of the world’s science (Figures 1-2-3, 1-2-4). It has often been said that “science knows no borders,” a saying that has never been truer than it is today.

With the spread of modern science, of course, it remains important to maintain the diverse cultures and traditions intrinsic to local areas, and achieving harmony between the two will no doubt be an important issue in the future.

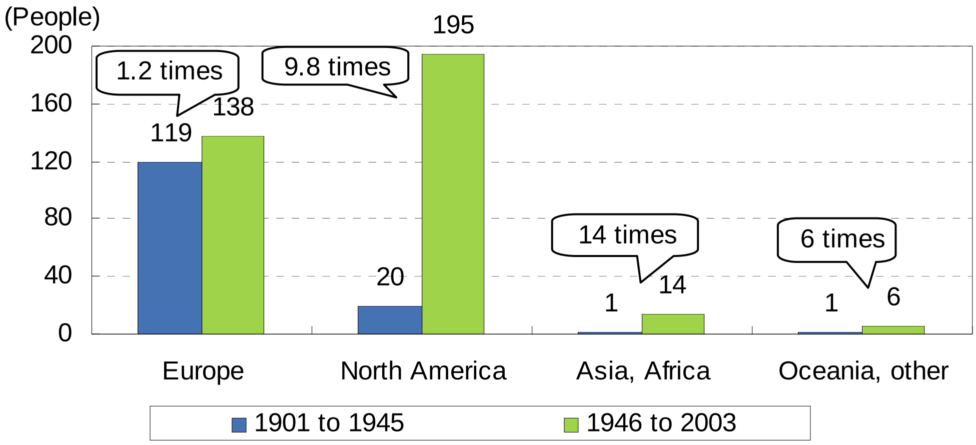


Fig.1-2-3 Trends in Nobel prizewinners (natural sciences) by region

Source: Prepared by MEXT

Table 1-2-4 Nobel prizewinners from Asia (natural sciences)

Sector	Year	Name of prizewinner	Country of origin
Physics prize	1930	C.V. Raman	India
	1949	Hideki Yukawa	Japan
	1957	C.N. Yang, T.D. Lee	China
	1965	Shinichiro Tomonaga	Japan
	1973	Reona Esaki	Japan
	1976	Samuel C.C. Ting	U.S.A. (Note)
	1979	Abdus Salam	Pakistan
	1983	S. Chandrasekhar	India
	1997	Steven Chu	China
	1998	Daniel C. Tsui	China
	2002	Masatoshi Koshiba	Japan
Chemistry prize	1981	Kenichi Fukui	Japan
	1986	Yuan T. Lee	Taiwan
	2000	Hideki Shirakawa	Japan
	2001	Ryoji Noyori	Japan
	2002	Koichi Tanaka	Japan
Physiology or Medicine prize	1968	Har Gobind Khorana	India
	1987	Susumu Tonegawa	Japan

Note: While born in the United States, his parents were Chinese citizens.
Source: Prepared by MEXT

(Promotion of Basic Research from the Viewpoints of Culture and Civilization)

As can be seen from the foregoing, science and technology in modern society is not limited to the technological aspects of a tool for making life more prosperous and convenient. Rather, in its scientific aspect, it forms the foundation for how world's people think and for the nature of society.

In the "Public Opinion Poll on Science and Technology and Society (February 2004)," about 70% of respondents reacted positively to the statement that "scientific research is essential in the sense that it brings new knowledge to humanity," a result that appeared to show that most people in Japan recognize the importance of this scientific aspect of science and technology (Figure 1-2-5).

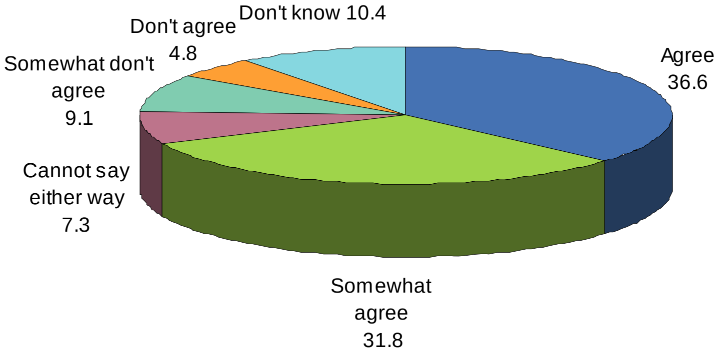


Figure 1-2-5 Scientific research is essential in the sense that it brings new knowledge to Humanity

Note: Response to the question "Do you agree with the opinion that 'scientific research is essential in the sense that it brings new knowledge to humanity'?
Source: Cabinet Office. "Public Opinion Poll on Science and Technology and Society (February 2004)"

In Japan, it is important that basic research for the creation of new scientific knowledge is actively promoted, and emphasis placed on the accumulation and continuation of Japan's knowledge resources, so that the nation can contribute to the advance of international society overall from the viewpoints of culture and civilization.

On the other hand, as was discussed in Section 1.1, it is a fact that various negative effects have appeared in modern society alongside the advances in science, and particularly the natural sciences. It is plain that the natural sciences are not all-powerful. Moreover, the natural sciences alone are probably incapable of explaining the nature of mankind and society. In order to overcome this weak point of the natural sciences, analysis of people's thoughts and behavior, as well as of various social phenomena, is important, as is coordination with thinking in the humanities and social sciences. For the future progress of human civilization, such activity will undoubtedly become increasingly important.

1.2.1.2 Realization of a Prosperous Society through the Utilization of Scientific and Technological Results

(Practical Value of Science)

Scientific results are linked to the development of new products and new technologies, and contribute greatly to economic and medical progress, and to other real social and economic activities. When the question is raised about what science and technology for society really means, one important viewpoint is whether or not scientific results are linked to the development of technologies that can create real, utilizable products and services.

In fact, as shown in Table 1-2-6, the basic research results that were rewarded with the Nobel prize in many cases led, after as many as 10 to 20 years of research and development, to practical application, commercialization, and contribution to economic growth.

Table 1-2-6 Examples of practical applications from Nobel prizewinning results

Practical application	Nobel prize
MRI (Magnetic Resonance Imaging) machine	Felix Bloch, et al (1952 Physics prize) Paul Lauterbur, Peter Mansfield (2003 Physiology or Medicine prize)
Semiconductors (transistors)	William Shockley, John Bardeen, et al (1956 Physics prize)
Insulin	Frederick Sanger (1958 Chemistry prize)
Semiconductors (tunneling effect)	Reona Esaki, et al (1973 Physics prize)
CT (Computerized Tomography) scanner	Alan Cormack, Godfrey Hounsfield, et al (1979 Physiology or Medicine prize)
Monoclonal antibodies	Niels Jerne, Georges Kohler, et al (1984 Physiology or Medicine prize)
Conductive polymers (cell phone screens)	Hideki Shirakawa, et al (2000 Chemistry prize)
Asymmetric synthesis (menthol manufacture)	Ryoji Noyori, et al (2001 Chemistry prize)
Protein analyzer	Koichi Tanaka, et al (2002 Chemistry prize)

Source: Prepared by MEXT

Moreover, science linkage (number of citations of scientific papers per U.S. patent) in major countries in regards to U.S. patents, which are used as an index to show the strength of links between scientific results (scientific papers) and new technologies (patents), is showing a rising trend (Figure 1-2-7). In the past, scientific results obtained through basic research usually followed the so-called linear model, in that it passed through the stages of applied research and commercialization research to reach the product stage. The trend here, however, is an example that appears to show that scientific results are increasingly being converted into products without following the linear model. It would appear that the distance between scientific results and the product stage is becoming narrower.

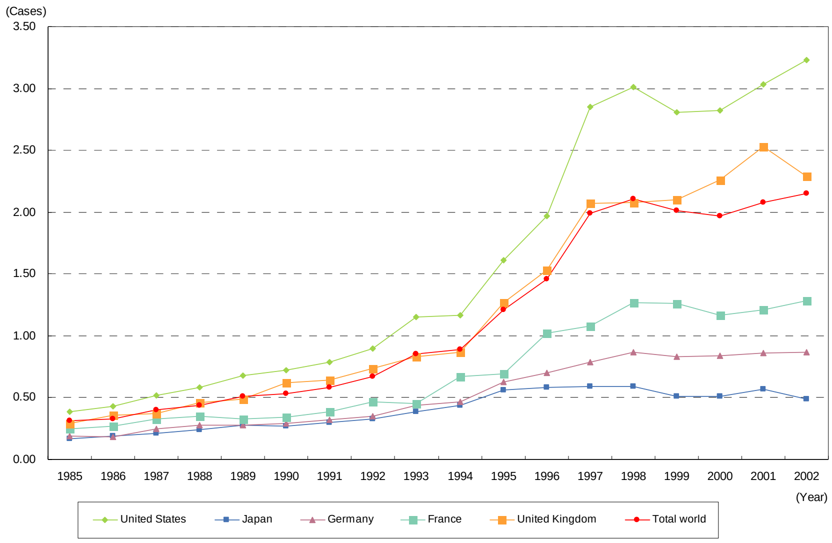


Figure 1–2-7 Trends in science linkage to U.S. patents

Source: Materials by National Institute of Science and Technology Policy

(Japan's Economic Development through the Promotion of Basic Research and Other R&D)

A look at Japan's economy today reveals that, while moderate deflation is continuing, the general outlook is bright, with a continuing recovery in corporate profits and rising investment in plant and equipment. It is important that this bright outlook be linked to firm growth, and revitalization of the economy is one of the most important issues facing Japan.

Economic development in Japan after the Second World War was mainly achieved through the introduction of scientific and technological results from Western nations, the effective conversion of those results into products, and efficient anufacturing.

At present, however, when Japan no longer follows in the footsteps of the Western nations, the nation needs to move beyond the traditional form of follow-up research to obtain the ability to take the lead in the creation of new knowledge ahead of other countries, so as to become one of the world's front-runner nations, and to ensure that Japan can be a survivor in the competition between nations. Moreover, the promotion of basic research for the creation of new knowledge, and of other research and development, is a necessity for Japan's future economic growth. In addition, emphasis is beginning to be placed on the new research and development process, which merges scientific knowledge and technology and then links it to the development of products and solutions to problems.

According to the "Public Opinion Poll on Science and Technology and Society (February 2004)," about 70% of respondents agreed with the statement that "development of science and technology is needed to boost international competitiveness" (Figure 1-2-8). While this question was not necessarily restricted to the economic viewpoint in questioning the importance of science and technology for boosting international competitiveness, it does show people's expectations for Japan's scientific and technological strengths at a time when advancing globalization is heightening the competition between nations.

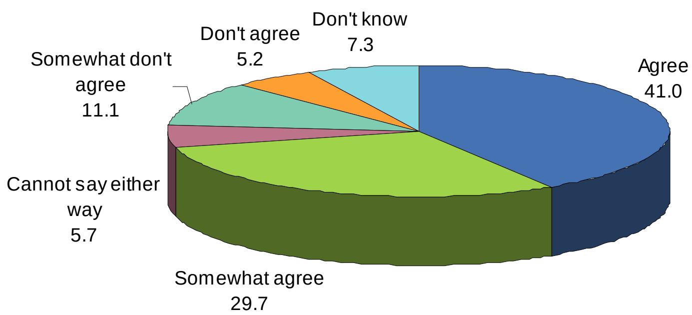


Figure 1-2-8 Development of science and technology is needed to boost international Competitiveness

Note: Response to question "Do you agree with the opinion that 'development of science and technology is needed to boost international competitiveness'?"
Source: Cabinet Office. "Public Opinion Poll on Science and Technology and Society (February 2004)"

(Nurturing Creative Human Resources)

While research expenses and the development of research equipment, facilities, and other aspects of the research environment are important for the promotion of research and development, the most basic requirement is the nurturing of researchers with creative skills.

However, creative skills cannot be learned from others, but rather can only be obtained through hit-and-miss experimentation. In research and development, and particularly in basic research, researchers must be of a character suited to challenging creative topics on their own initiative, and be able to nurture research human resources with creative skills. Promotion of basic research is therefore important from the point of view of human resource development, as well.

(Importance of Cooperation between Industry, Academia, and Government)

Firmly linking new knowledge born from basic research and other R&D to practical applications is also important.

A look at the science linkage of major countries to U.S. patents, shown in Figure 1-2-7, reveals a major gap between Japan on the one side, and the United States and United Kingdom on the other, and a lower rank than France or Germany, as well, leaving the impression that the results of basic research in Japan are not being adequately linked to technology. In order for the results of basic research and other R&D obtained at universities and other public research institutions to be firmly linked to technology and practical applications, efforts to promote cooperation between industry, academia, and government need to be continued. In addition, new knowledge created through basic research and other R&D needs to be given suitable protection, while at the same time positioned so that society can make maximum utilization of it. A firm response to protection of intellectual property is also important.

(Transmission and Development of Japan's Own Technologies and Skills)

As mentioned above, Japan's economic development after the Second World War was mainly achieved through the introduction of scientific and technological results from Western nations, the effective conversion of those results into products, and efficient manufacturing. Japan's traditional strengths lay mainly in effective and efficient conversion to products, and in the improvement of production processes.

Even with the importance for Japan of gaining an ability in the future of taking the lead to create new knowledge ahead of other countries, these traditional strengths should continue to have significance from the standpoint of effectively and efficiently converting the new knowledge created in Japan into practical applications.

It is said that the elements peculiar to Japan serving to support the effective and efficient conversion of products, and the improvement of production processes – the well-springs of Japan's competitiveness – have included the corporate human resource training programs built on the concept of lifetime employment, corporate knowledge transmission through flexible reassignment of employees, and superior product, making technologies that center mainly on small and medium-sized enterprises.

In particular, the superior product making technologies rely heavily on individual skills, such as individual manual technologies and skills of local technicians in the manufacture of lathes and metal molds, and the accumulation of technical and skilled knowledge for the discovery of and response to problems and response to change.

Once lost, the skills of these superior technologists are extremely difficult to restore and, as the foundation supporting Japan's competitiveness, it is important that these technologies and skills be transmitted onward, and that the associated human resources be firmly maintained and nurtured.

A variety of technologies and skills were being created and developed in various locales around Japan even before the age of modernization that began in the Meiji era (1868 to 1912). As evidenced by such examples as *kumihimo* braiding technology, which formed the basis for the development of high-performance textile strengthening compounds, a large number of traditional technologies and skills are being linked to state-of-the-art technologies and stimulating new development. In addition, the development of nano-level structural analysis technologies has resulted in elucidation of the material qualities of Japanese swords, which approach in quality super-steel materials that remain impossible to mass-produce using modern manufacturing technologies. Elucidation of traditional sword manufacturing methods could well open the way toward realization of that mass production.

It is imperative that the superior traditional technologies and skills intrinsic to Japan be re-evaluated and re-utilized for the modern world.

[Column 2]

Science and Technology in the Edo Period

Japan was developing its own distinctive science and technology even before the advent of modernization. In the Edo Period, in particular, the various domains competed with each other in industry and academics, and science and technology rooted in certain regions spread thereafter throughout the country. The rapidity with which Japan achieved modernization in the Meiji Period and later can be traced to the existence of this scientific and technological foundation.

At present, the National Science Museum, with financial backing from the Grants-in-Aid for Scientific Research Program administered by the Ministry of Education, Culture, Sports, Science and Technology, is leading a research project, “Making Things in the Edo Period” (Note 1) to examine what scientific and technological traditions of the Edo Period should be passed on to future generations. This research project is performing surveys and research into creative cultural objects all over Japan manufactured during the Edo Period, such as the “Bow-Shooting Boy” and “Never-Ending Lamp,” both found in the Toyota Collection (Note 2), and the “*Netsuke* Jumping Frog,” and then intends to present to society in easy-to-understand language the scientific and technological traditions and culture of Japan.

Moreover, in cooperation with the “Making Things in the Edo Period” project, the Toyota Foundation is implementing a research assistance program based on the theme of “Rediscovery of Modernization and Living: Finding Our Local History.” This assistance program targets museum art specialists, teachers, university students, housewives, and other residents in local areas, to assist their cooperation with research specialists participating in the “Making Things in the Edo Period” project, and to help ensure that research results are not limited to circulation among research specialists, but are shared widely among the local people.

For example, the “Making Things in the Edo Period” project is engaged in surveys and research focusing on the works of Ikkansai Kunitomo (Note 3), an Edo Period scientist. Alongside that effort, however, the “Rediscovery of Modernization and Living” program is backing an amateur research group restoration of the Kunitomo’s reflecting telescope (the “Ikkansai Experimental Laboratory”) and schoolchildren using that telescope to observe sunspots (the “Ikkansai *Terakoya* Children’s School”). These research links resulted in an international symposium held in the local community of Nagahama-shi, Shiga prefecture in November 2003, through cooperation with the “Making Things in the Edo Period” project, the local board of education, and amateur research groups, to successfully bring research results and reports to a wider audience.

Elsewhere, Japan’s gold, silver, and copper mining operations of the Edo Period, which were some of the most productive in the world, are also being surveyed and researched. For example, the Iwami-Ginzan Silver Mine Ruin is being re-examined with an eye toward eventual registration as a world heritage site, with research results returned to the local area in the form of symposiums with local groups for re-evaluation of the mine as an “industrial heritage” object.

Through such efforts, the traditional science and technology in local areas is being re-evaluated, and raising expectations that the process will lay the foundation toward regeneration of the local economy.

These efforts are promoting surveys and research into the cultural objects of the Edo Period from various vantage points, ranging from scientific and technological aspects to anthropological and sociological aspects, an interdisciplinary approach that is of particular importance. In fact, the “Making Things in the Edo Period” project encompasses more than 400 research participants nationwide, coming from both the scientific and cultural sectors.

Furthermore, these efforts represent a step forward from previous museum and science hall activities, in that the museums and science halls are now actively utilizing the actual objects and materials in their possession in ways that anybody can understand, to build an exchange of scientific and technological research between research specialists and ordinary people, and the museums and science halls are assuming a new role that can serve as a model for promoting the culture of science and technology at the level of the people.

Notes: 1. “Making Things in Edo”
The popular name for the project. The official name is “Surveys and Research Regarding Systematization of Materials at the Dawn of Japan’s Scientific and Technological Age.” The project was launched in 2001 and is planned to continue for five years.

2. Toyota Collection
A collection of documents and materials regarding the progress of Japan’s science and technology purchased by Toyota Motor Corporation in 1999 to prevent their dispersal and contribute to their survey and research, and deposited with the National Science Museum in 2001. The collection centers mainly on items from the mid- to late-Edo Period, sorted into such categories as mechanical puppetry, astronomy and measurement, medical, and living, and numbers more than 1,300 items.

3. Ikkansai Kunitomo
Lived from 1778 to 1840. Expert in gunnery and iron forging in Omi-no-kuni (modern Shiga prefecture). Known for his manufacture of “wind cannons” (air guns) and “divine mirrors” (haunted mirrors), he also made a “telescope mirror” (reflecting telescope) and used it to observe the Moon and sunspots on the Sun.

1.2.2 New Policy Developments Related to Science and Technology for Society

This section examines the development of new policies related to science and technology for society, using the three themes of “scientific and technological progress related to safety and security,” “revival of local areas using science and technology,” and “intra-sector efforts,” to discuss current conditions and topics.

1.2.2.1 Scientific and Technological Progress Related to Safety and Security

(Increased Factors Threatening Safety and Security)

The multiple terror attacks of September 11, 2001 killed several thousand victims in an instant, an attack unparalleled in international society. Again, on March 11, 2004, an explosion on a commuter train in Madrid, Spain left more than 200 dead and more than 1,700 injured. This incident acutely brought home to people in Japan and elsewhere the extent of the threat that terrorism raises.

Turning to Japan, this is a nation that was often beset by natural disasters. As a result of the implementation of disaster prevention policies, losses due to natural disasters have been declining in recent years. Nevertheless, the Great Hanshin-Awaji Earthquake of January 17, 1995 left more than 6,000 people dead, a larger number of disaster victims than the total numbers recorded in any single year since the end of World War II.

In the area of security, a total of 2,853,739 criminal incidents were recorded in FY2002, marking the seventh straight year that a postwar record was registered. Moreover, the arrest and incarceration rate fell to an all-time low, graphically demonstrating a rapid deterioration in security, and the people’s insecurity is increasing (Figure 1-2-9).

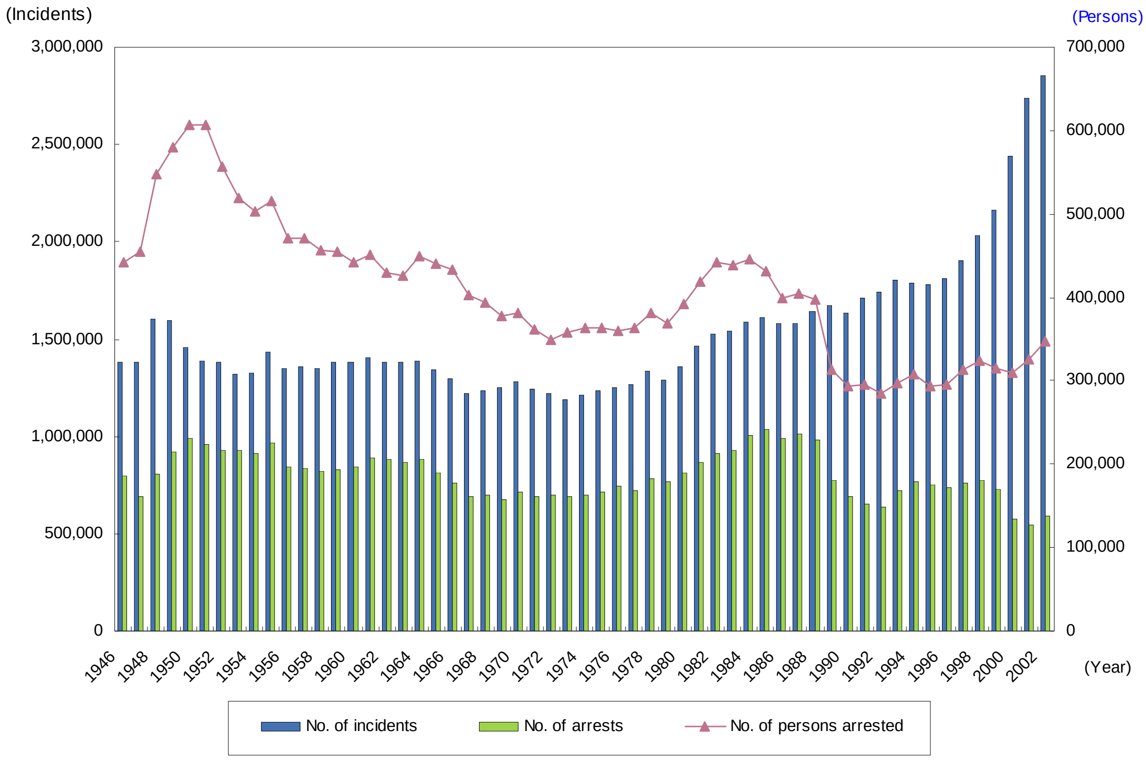


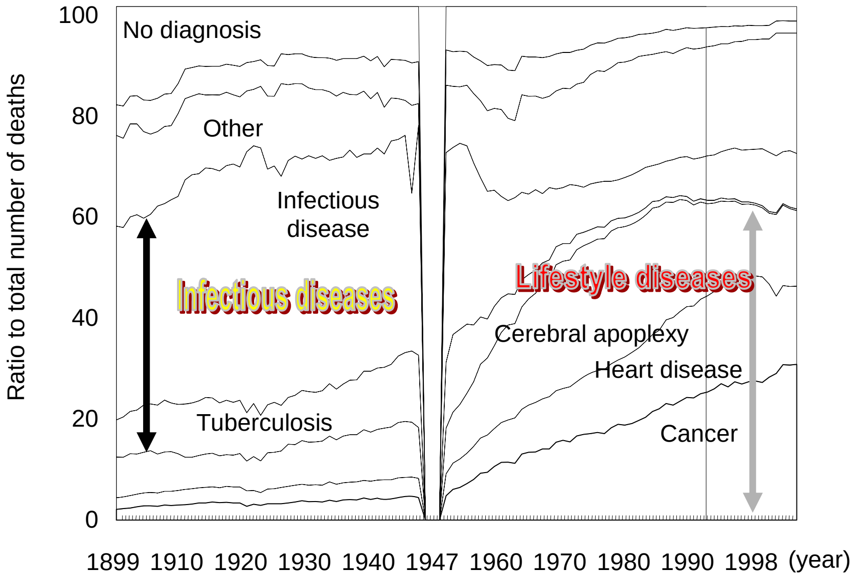
Figure 1-2-9 Trends in crime recognition and arrests

Source: National Police Agency. "White Paper on Police (FY2003)"

For the state of health of the Japanese in terms of ailments, infectious diseases were common before World War II. But the discovery of antibiotics reduced the prevalence of such diseases after the war, and in their place came such lifestyle-related diseases as cerebral apoplexy and heart attacks. In recent years, however, infectious diseases have broken out in various locations around the world. In 2002, there was an outbreak of West Nile Fever in the United States, followed in 2003 by a worldwide outbreak of Severe Acute Respiratory Syndrome (SARS), but concentrated in Asia (Figure 1-2-10). After leaving Japan, Japanese tourists were infected by SARS in foreign countries. It reminded the people of Japan yet again of the real possibility of an outbreak of infectious diseases in the country.

In addition, the highly pathogenic avian influenza ("Bird Flu") broke out in various locations around Asia, and a case was confirmed in Japan, as well, in Yamaguchi prefecture in January 2004, followed by cases in Oita and Kyoto prefectures, events that caused great insecurity and concern throughout Japanese society.

Disease trends in Japan in the 20th century



New infectious diseases in Asia (1996-2004)

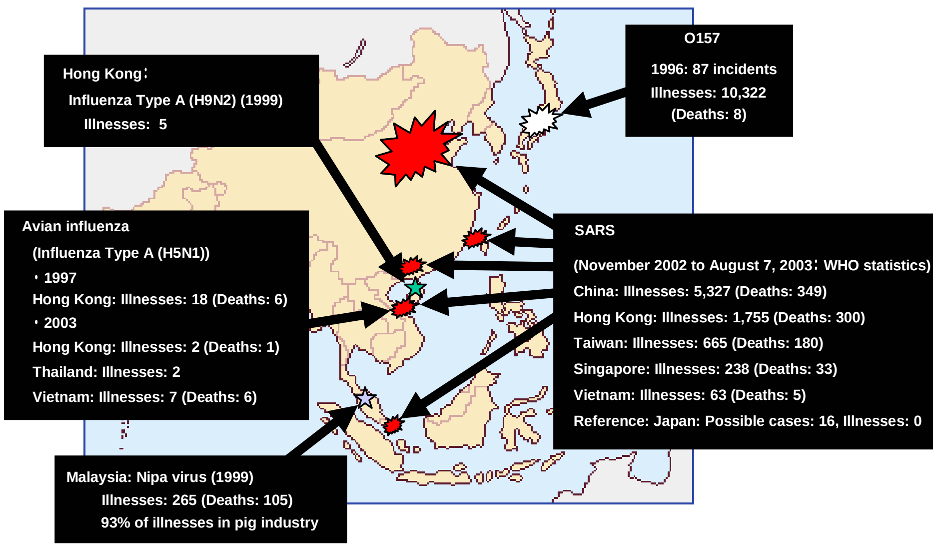


Figure 1-2-10 Disease trends in Japan, and outbreaks of new infectious diseases in Asia

Source: Council for Science and Technology Policy (January 2004) Materials

Once infectious diseases have spread in a society, damage is inflicted both on people's health and on the economy at large. The SARS epidemic had a huge effect on the economies of all the affected countries. According to estimates by the Asian Development Bank, the economic loss due to the SARS epidemic in terms of GDP in Hong Kong was estimated at 4.0% (6.6 billion dollars), while in China it was estimated at 0.5% (5.8 billion dollars), and in Taiwan, 1.9% (5.3 billion dollars) (Figure 1-2-11).

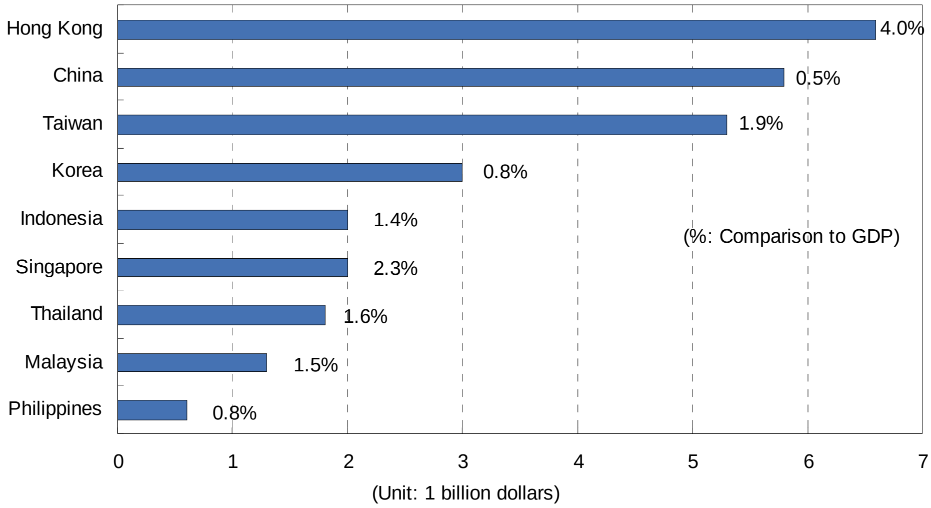


Figure 1-2-11 Tabulation of national or regional economic losses due to SARS

Source: Asian Development Bank (ADB). "SARS: Economic Impacts and Implications, ERD Policy Brief Series, No.15, 2003"

The above changes in society have also brought about changes in people's awareness about safety and security. As shown in Section 1.1.1, the "Public Opinion Survey on Social Awareness (January 2004)" found a large proportion of respondents naming security as an area where the situation in society has been getting worse, and the percentage was higher than in the previous survey of December 2002. In addition, in the "Citizen's Life Preference Survey (FY2002)," in which respondents were asked to rank 60 items related to citizen's lives in order of importance, all of the top 10 survey result items related to safety and security. These results show dramatically the rise in people's interest in safety and security, especially in recent years.

According to the Ministry of Education, Culture, Sports, Science and Technology's "Roundtable Group on Science and Technology Policy for Building a Safe and Secure Society" report (April 2004), a survey result for the question "do you feel that danger has particularly increased in recent years in the area around you?" found about 70% of respondents saying that it had either "increased" or "somewhat increased" (Figure 1-2-12).

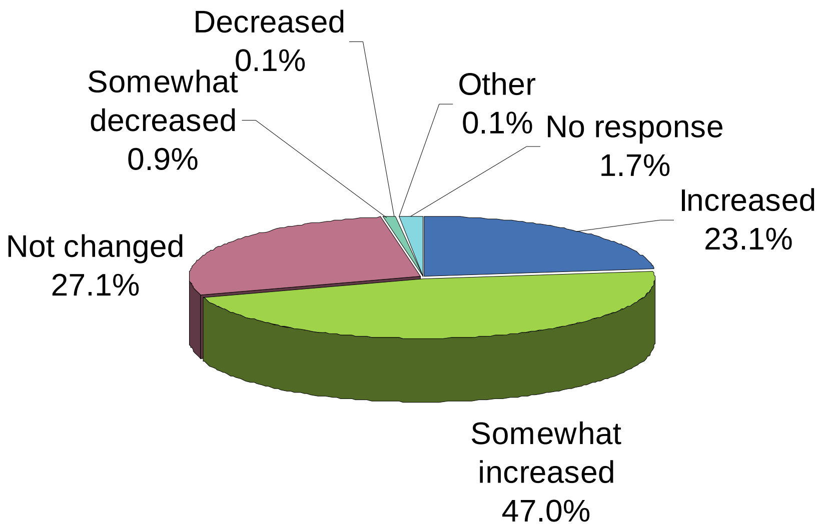


Figure 1-2-12 Have risks to your person increased in recent years?

Note: Results of questionnaire survey sent by mail to 3,600 Japanese residents (number of valid responses: 1,476)
Source: MEXT. "Report of Roundtable Group on Science and Technology Policy for Building a Safe and Secure Society" (April 2004)

The annual meeting of the World Economic Forum (Davos Conference), a gathering of world business, government, and non-government leaders in the Swiss city of Davos, is noted for its discussions on world trends, with a different theme each year. The topic for 2004 was “Security and Economic Prosperity,” and the very selection of security as a topic showed just how much attention the world is paying to security issues.

In concert with the convening of the Davos Conference, an “International Public Opinion Poll on Safety and Economic Prosperity” was conducted. According to these results, when asked “do you think that your country is not as safe when compared to 10 years ago?” 86% of Japanese responded with “not as safe,” far above the world average of 57%. Furthermore, to the question “do you think that the next generation will have to live in a world that is not as safe as now?” 68% of Japanese responded “yes,” far higher than the world average of 48% (Figure 1-2-13).

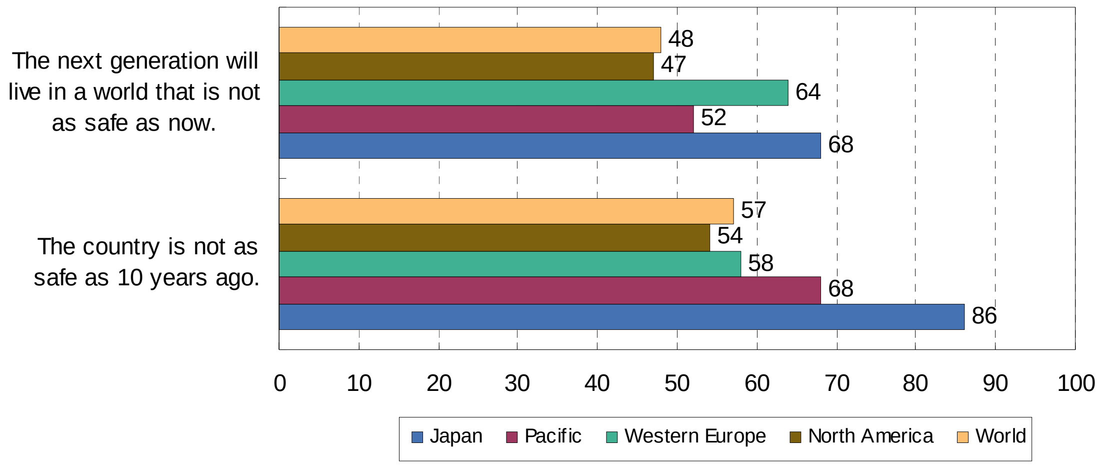


Figure 1-2-13 Public opinion poll by World Economic Forum

Source: World Economic Forum. "International Public Opinion Poll on Safety and Economic Prosperity (January 2004)"

As seen by the revealing comment that “Japanese believe that security and water can be obtained for free,” made by Isaiah Ben-Dasan in his book “The Japanese and the Jews” (1970), the Japanese have long felt that safety and security is Heaven-sent. But as the above survey results show, this awareness has changed abruptly.

Science and technology has the capacity to contribute greatly to realization of safety and security. Realization of sensor systems for detection of dangerous substances or threats, and information security technology for safe utilization of the Internet, are just a few of the many examples of science and technology contributing greatly to resolution of safety or security-related problems. In the “Public Opinion Poll on Science and Technology and Society” conducted by the Cabinet Office, to the assertion that “high scientific and technological standards are needed to ensure security in my life, and the general security of the nation,” about 70% of respondents said “agree” or “somewhat agree.” It appears that the people have great expectations for science and technology in ensuring the safety and security of society (Figure 1-2-14).

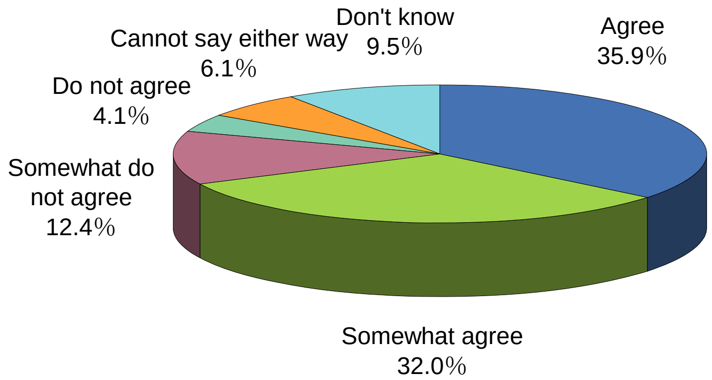


Figure 1-2-14 High scientific and technological standards needed to ensure security

Note: Response to question of whether respondent agrees with the statement "high scientific and technological standards are needed to ensure security in my life, and the general security of the nation."

Source: Cabinet Office. "Public Opinion Poll on Science and Technology and Society (February 2004 Survey)"

(Strengthening Science and Technology for Realization of a Safe and Secure Society)

In order for science and technology to contribute firmly to a safe and secure society, it is important to promote research and development into solutions to safety and security-related problems, and to build a system that will allow swift and flexible responses based on science and technology to the sudden appearance of unknown risks. Furthermore, it is also necessary to foster personnel trained in science and technology related to safety and security.

In addition, efforts to obtain the understanding of society through the use of risk communication[1], based on the smooth promotion of research and development, regarding expected risks, are linked to the realization of a safe and secure society. It should not be forgotten that, without such a linkage, people's participation and cooperation in research and development cannot be obtained.

The use of science and technology to resolve problems related to safety and security also links to increased competitiveness in various industries, and to the creation of new markets and industries.

(1) Promotion of R&D Related to Safety and Security

Regarding research and development topics that require urgent handling for resolution of safety and security issues, project responses are required that laterally and organically link sectors together based on clear goals. In this situation, execution of systematic policies such as the building or altering of related social frameworks alongside implementation of research is also important, which means that participation by the jurisdictional ministries and agencies is essential for societal and systematic responses related to the realization of policy.

For example, the response to new infectious diseases should not be limited to research into pathogens or to the development of medical products, but should also include efforts to integrate individual knowledge and technologies, such as various inspection technologies to prevent the spread of a disease or its intrusion at the water's edge, and implementation of related public sanitation measures.

Moreover, as can be seen by strict customs operations to intercept illegal imports and suspicious items, and by the scientific investigative activities of the police, it is important to promote the development of countermeasure technologies that can satisfy local conditions, and to promote the utilization of results through government procurement or other methods, so that the technologies that have been developed can be effectively utilized to resolve on-site problems where society's safety and security must be preserved.

Under the auspices of the Special Coordination Funds for Promoting Science and Technology, the Ministry of Science, Culture, Sports, Science and Technology instituted the "Important Issue Resolution Research" program in FY2004 to promote research and development into important policy objectives and issues for the Japanese state and society that cannot be handled by individual agencies and ministries, and which require urgent resolution. In FY2004, eight topics are being implemented in the program, under the policy goal of "building a secure, safe, and relaxed society," including such topics as "R&D into new and rejuvenated infectious diseases" and "R&D that contributes to information security."

In addition to these efforts, the creation of policies based on innovative technologies and groundbreaking knowledge that can completely overturn existing policies requires that basic research results at universities and research institutions be linked to the needs of the public institutions and corporations that are striving to ensure safety and security. To achieve this, the needs of these public institutions and corporations, etc., in regards to safety and security should be surveyed and analyzed, and suitable advanced technologies should be unearthed in order to create functions that link the two together in promoting unified research and development on site.

1 Refers to the exchange of information and opinions about risk throughout society, and the sharing of that information.

Also, in order to collect knowledge obtained in individual sectors related to safety and security for utilization in other sectors, it is important that safety and security science and technology knowledge systems be prepared and expanded through the exchange of information and personnel between R&D centers in each sector, and that core R&D centers be formed with the capability of feeding general knowledge back to research centers in each sector.

In the United States, the government responded to the simultaneous terrorist attacks by organizing the Department of Homeland Security (DHS) out of existing departments and agencies in January 2003,encompassing 180,000 personnel scattered across 24 government agencies and bureaus, including the U.S. Coast Guard, Federal Emergency Management Agency, Customs Service, and Immigration Bureau. Included in the DHS is an undersecretary in charge of science and technology, under whose jurisdiction is the newly established Homeland Security Advanced Research Projects Agency (HSARPA), which is patterned after the Defense Advanced Research Projects Agency (DARPA) in the Department of Defense. As with DARPA, HSARPA is in charge of all science and technology related to the preservation of national security, from basic research up through development. The objective is to maintain U.S. superiority in basic science sectors, and to preserve U.S. homeland security through the creation of new technologies derived from that basic technology.

(2) Assurance of Diversified Science and Technology Enabling Flexible Responses to Unknown Risks

With society becoming ever more advanced and complex, prediction of risk has become more difficult in recent years. In particular, as threats posed by man-made organizations increase, the sudden appearance of an unknown risk such as the use of new terrorist methods is becoming an issue. Moreover, with human activity now spreading into untrammeled locations and hitherto unknown regions, chances are high that an unknown risk such as a completely new infectious disease will be encountered.

Developing a countermeasure beforehand for an unknown risk is impossible. Instead, what is desired is research and development of a quick and flexible technology for countering a risk at the moment it becomes apparent. To ensure this kind of responsiveness, a diversity of research sectors needs to be maintained. Diversified research and development activities would build up specialist knowledge and technological seeds in a wide range of sectors, so that when a new risk is discovered, the accumulated knowledge can be utilized to promote research and development into flexible countermeasure technologies. Moreover, in order to quickly implement research in response to new risks, a knowledge network needs to be created that will facilitate understanding of a wide range of science and technology in regard to safety and security, and access to researchers in those areas.

(3) Fostering Scientific and Technological Human Resources in Support of a Safe and Secure Society

To lay the foundations for the creation of science and technology that can achieve a safe, secure society, human resources need to be fostered for scientific and technological sectors related to safety and security.

One example of a sector in strong need of more fostering of human resources is security technologists for the Internet.

In Japan, an estimated 15 million households in FY2003 were utilizing broadband Internet connections through the spread of Digital Service Lines (DSL) or cable Internet, and security problems in the form of computer viruses and theft of personal information are becoming rampant (Figure 1-2-15).

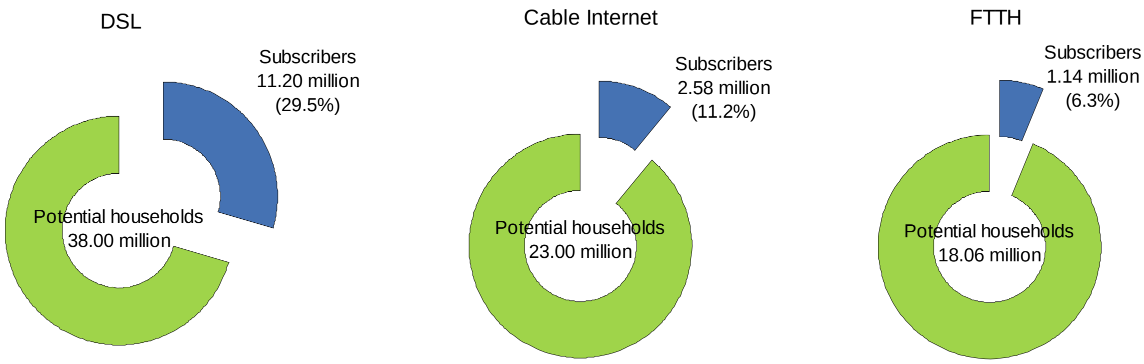


Figure 1-2-15 Ratio of broadband subscribers (actual users) to potential households

Note: Number of potential households as of January 2004 (DSL subscribers as of December 2003). Figure for DSL, cable Internet, and FTTH subscribers as of end of March 2004.
Source: Survey by Ministry of Internal Affairs and Communications

According to an interim report presented by the Information and Communications Software Roundtable's Working Group on Fostering Human Resources, operating under the Ministry of Internal Affairs and Communications, Japan currently has a shortage of 420,000 technologists in the IT sector in Japan, which includes an estimated shortage of 120,000 information security technologists (Figure 1-2-16).

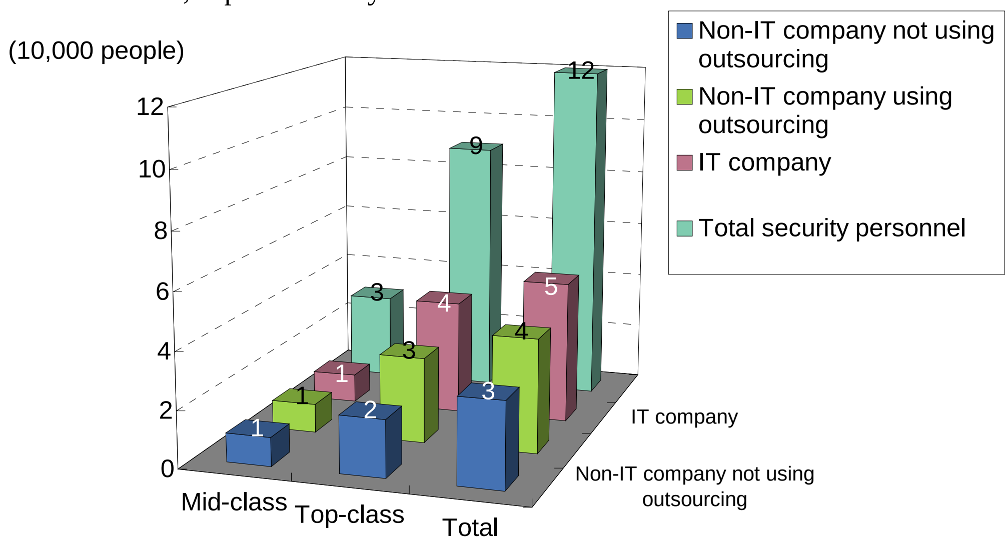


Figure 1-2-16 Shortage of security technologists in IT sector
Source: Ministry of Internal Affairs and Communications. "Interim Report of Roundtable Group on Information Communications Software, Working Group on Fostering Human Resources (FY2003)"

Fostering more information security technologists is therefore an urgent issue. Beginning in 2001, the Ministry of Internal Affairs and Communications added a test in information security to the national qualifications test for electrical telecommunication chief technologists, while in the private sector, as well, a "Network Information Security Manager (NISM)" qualification certification test has been implemented to foster specialists in information security management for placement in enterprises providing information and communications services.

In the Special Coordination Funds for Promoting Science and Technology provided by the Ministry of Science, Culture, Sports, Science and Technology, an information security project was instituted as a "foundation software" sector in the "new sector human resource fostering" program for the purpose of fostering human resources for the personnel-short information security sector (Figure 1-2-17).

Unfortunately, new human resources for the information security sector cannot be fostered overnight, but will instead require a sustained investment of resources. It is expected that sustained investment of resources will be needed to foster the human resources required for any of the sectors related to safety and security, and the national government will need to step forward to invest in the necessary resources.

Table 1-2-17 Information security human resource training project

Name of institution	Name of project	Period
Chuo University	Information Security, Information Guarantee Human Resource Training Center	FY2003-FY2007
Kogakuin University	Secure System Design Technologist Training	FY2003-FY2007
Waseda University	Security Technology Training Center	FY2001-FY2005
Osaka University	Human Resource Training for Construction of Secure Network	FY2001-FY2005

Source: Prepared by MEXT

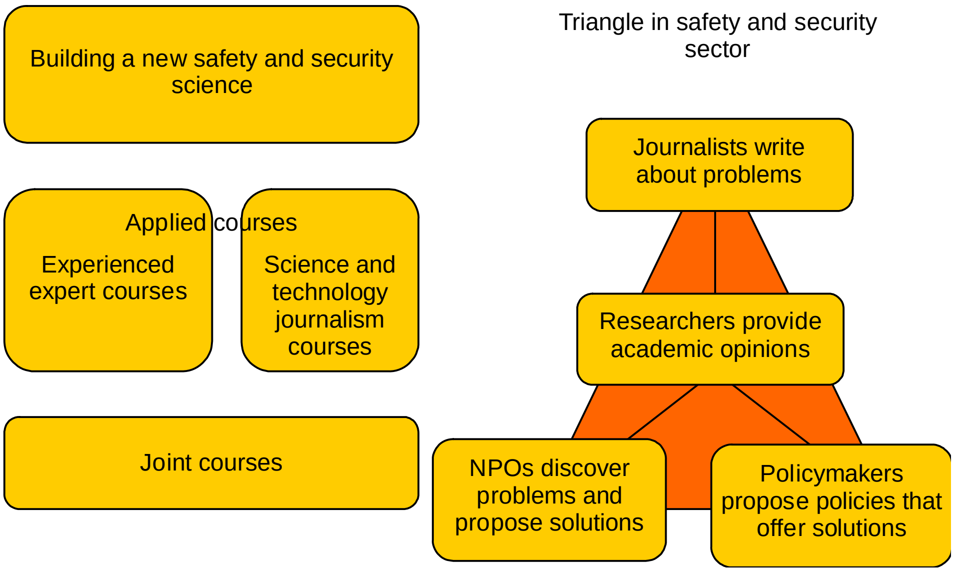
With science and technology becoming ever more advanced and specialized, the people who will be able to forecast the possibility of risks arising from creative knowledge or state-of-the-art technology are the researchers and technologists who will themselves have created that knowledge or technology. If these kinds of risks are to be avoided, the education process for all researchers and technologists, and not just for the personnel specializing in safety and security, will need to incorporate knowledge for the preservation of society's safety and security, and to cultivate skills in predicting risks arising from new knowledge or technologies.

[Column 3]

Project for Fostering Scientific and Technological Human Resources for the Realization of Safety and Security

In FY2003, the Research Center for Advanced Science and Technology of the University of Tokyo created a program that transcends the traditional boundaries of industry, academia, government, residents, and the mass media, and integrates them together in regard to safety and security, and which is centered around a core project, “Fostering Scientific and Technological Human Resources for the Realization of Safety and Security,” designed to train specialist personnel in safety and security.

The eventual goal is to develop a whole new academic field in safety and security that does not lean too far in the direction of either literature or science, and to build and systematize it as “safety and security science.”



(The Importance of Unifying Scientific, Technological, and Societal Responses Related to Safety and Security)

(1) Societal Systems for Safety and Security

With the increase in exchange of electronic documents as the Internet has expanded, the need for assuring document reliability has increased. One response to this changed situation has been the development of technology that displays the creator of electronic contracts and other electronic data, and uses "electronic signatures" to confirm that the data is not corrupted, and the development of certification businesses to certify that electronic signatures correspond to the actual people. This technology is used to confirm that the other party is a specific person, and that the content of a contract has not been altered (Figure 1-2-18).

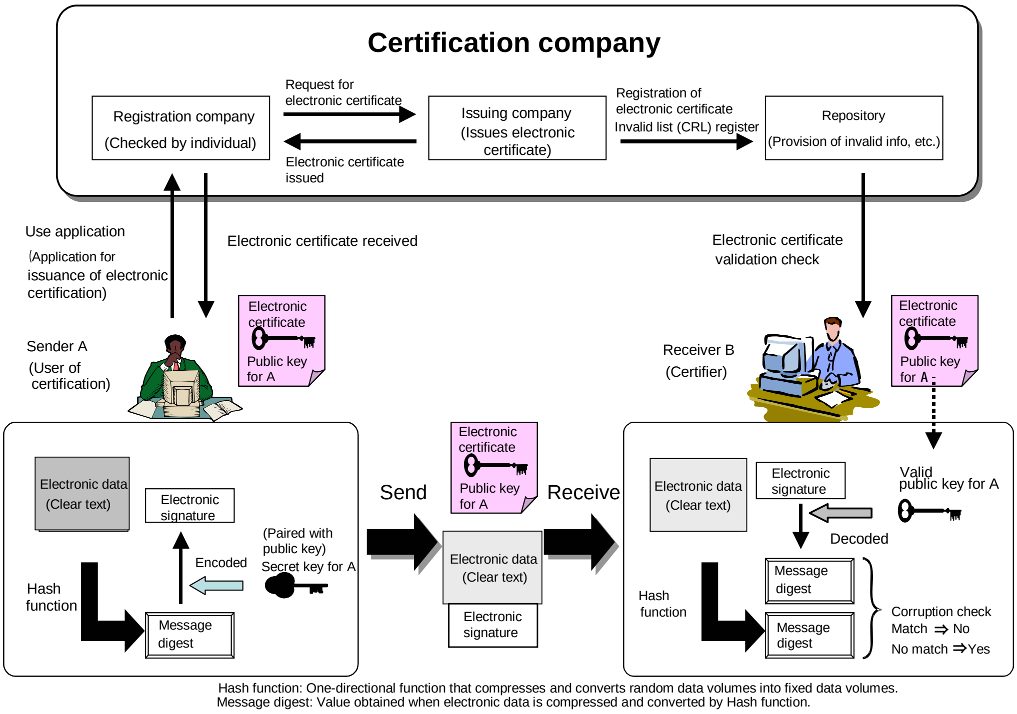


Figure 1-2-18 Electronic signature and certification system

Source: Ministry of Internal Affairs and Communications. "2003 WHITE PAPER Information and Communications in Japan"

When a signature and stamp are found on a contract or other document, it can be assumed that the document was created based on the person's real intent. Ensuring that electronic signatures have the same force as signatures and stamps on paper documents, however, requires legal backing.

According to the Law for Electronic Signature and Certification Business, which came into effect in April 2001, electronic documents with electronic signatures that satisfy certain conditions for the author are now assumed to be created based on the person's intent. In other words, the legal foundation was laid for application of electronic documents equivalent to signed and stamped documents.

This action opened the way for preservation of customer certification and transaction information in Internet banking or Internet securities, etc., and for electronic applications and licensing. The result will be improved convenience, in the form of 24-hour service regardless of whether anyone is manning a service window or not.

This is one example where the societal system responded to progress in science and technology to result in an improvement of convenience. There are also situations, on the other hand, where society has been forced to respond to problems caused by technological advances.

For example, until the year 2000, unauthorized access to a computer's resources was not in itself illegal, with the result that legal sanctions against that unauthorized access could only be applied using other laws. In February 2000, however, the Law for Prohibition of Unauthorized Access Activities, etc., was implemented, and cases involving violation of this law have been increasing (Figure 1-2-19). In this law, unauthorized access activity is defined as using theft of IDs or passwords or an attack on computer security holes to gain access to a computer without access authorization.

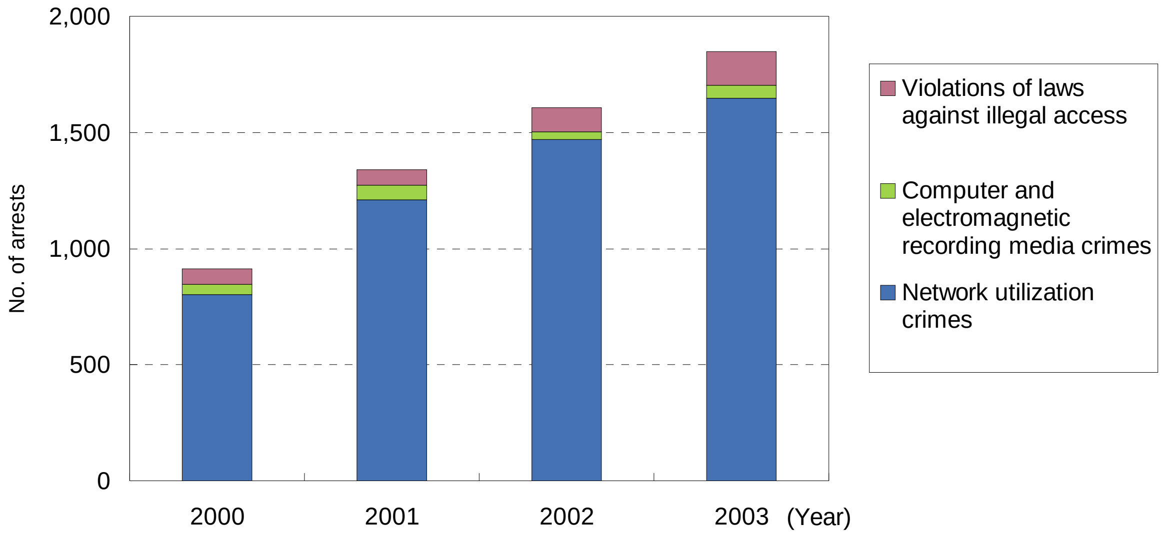


Figure 1-2-19 Trend in the number of high-tech crime arrests

Source: National Police Agency. "Arrests for High-Tech Crimes in 2003, and Receipt of Criminal Complaints"

As can be seen, development of societal systems must also proceed in concert with scientific and technological progress, through the promotion of the use of new technologies, the prohibition of the misuse of technology, etc.

(2)Improvement of Individual Knowledge and Awareness of Safety and Security

The safety of various societal systems is closely related to the behavior of individual users. For this reason, even if society's safety is reasonably protected at the systems level, individual behavior that does not pay any consideration to safety could still easily result in the collapse of societal safety. In addition to the preparation of societal systems, therefore, only when individual users also have a knowledge and awareness of safety, and when their behavior helps to preserve safety, can a safe, secure society be realized.

With the spread of the Internet, for example, losses due to computer virus attacks on personal computers have developed into a major problem. The damage caused by computer viruses can be stopped when the individual owners of personal computers have correct knowledge and awareness of countermeasures to computer viruses, and then take the appropriate action.

Through 1996, about 1,000 cases of computer viruses discovered or computers infected were being reported annually to Japan's Information-Technology Promotion Agency (IPA). Since 1999, however, the number reported has risen sharply (Figure 1-2-20).

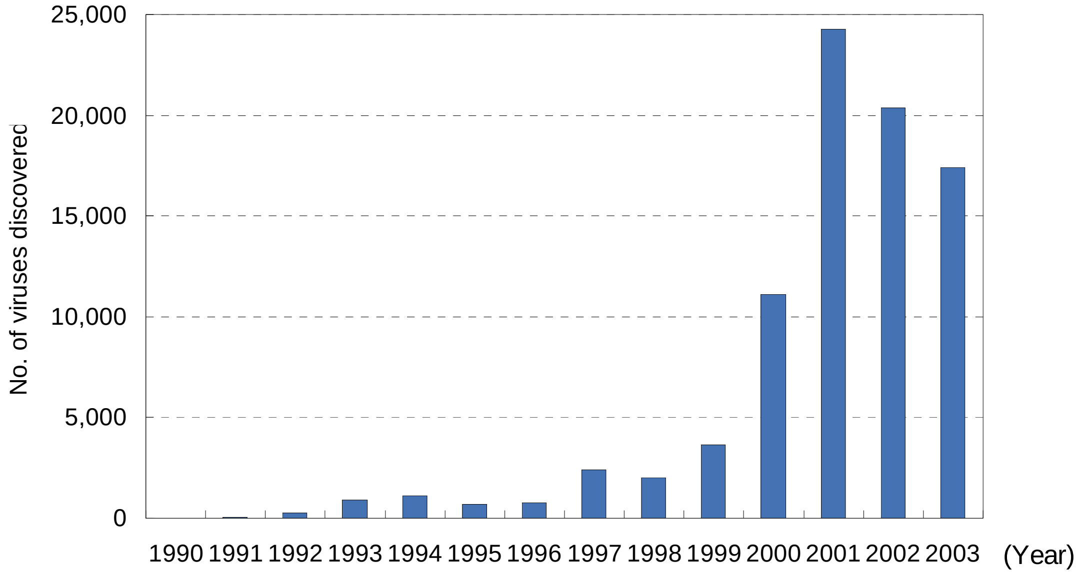


Figure 1-2-20 Trend in number of computer viruses discovered

Source: Information-Technology Promotion Agency, Japan. "Computer Viruses Discovered (Discoveries in 2004 (Detail))"

In 2003, the Blaster worm and other similar creations that attack specific computers on specific dates and times made their appearance, taking advantage of weaknesses in personal computer software to convert victims of computer viruses into unknowing perpetrators of the viruses on other computers.

To avoid being damaged by computer viruses, or to avoid causing damage to other computer users, each individual should take the absolute minimum measures shown in Table 1-2-21.

In an age when the Internet is spreading ever wider, and can be expected to become the foundation for society, computer virus countermeasures will become basic knowledge for each member of society, and spreading the necessary countermeasures is already very important

Table 1-2-21 Countermeasures to prevent infection by computer viruses

1	Install vaccine software, and constantly update the definition file
2	Before opening a file obtained from outside, always run a virus check
3	Set up a suitable software security function
4	Use security patches to cover up security holes
5	Always back up data files, in preparation for the worst-case scenario

Source: Information-Technology Promotion Agency, Japan. “Information Security Manual (February 2002)”.

Today, the amount of knowledge required for a safe and secure life is increasing in volume, and it will probably be necessary for people to engage in broad studies of knowledge related to safety and security from childhood onward as a basic requirement for becoming a member of society.

In the area of disaster prevention, the Ministry of Education, Culture, Sports, Science and Technology has prepared disaster education manuals and distributed them to schools for use in course study, so that students can prepare for earthquakes and other natural disasters and take the appropriate actions to ensure safety.

With this education, people will become better aware of risks, and will incorporate risk-avoidance behavior into their daily activities, so as to improve individual awareness of safety and security.

Furthermore, improvement of knowledge and awareness of safety and security among the people should result in the development of a culture of safety and security in Japan as a whole.

(3) Importance of international cooperation and links in relation to safety and security

The advance of globalization has made it more likely that situations such as SARS will arise in which losses can spread internationally, beyond any single country or district. As a result, efforts to handle safety and security-related problems within Japan alone can no longer be sufficient. Only through international cooperation and linkages to handle international safety and security issues can Japan’s own safety and security be achieved.

[Column 4]

Japan-U.S. Workshop on Science and Technology for a Safe and Secure Society

In the wake of the multiple terror attacks of September 2001, and in response to people's increased expectations for the utilization of science and technology to ensure safety and respond to emergency situations, Japan and the United States recognized the need for increased cooperation in the field of science and technology for a safe and secure society, and in February 2004 convened the First Japan-U.S. Workshop on Science and Technology for a Safe and Secure Society.

The workshop was held in Japan, with participants from the U.S. government bureau director-general level of the State Department, Homeland Security Department, and elsewhere, meeting with officials from the corresponding ministries and agencies in the Japanese government. The meeting began with presentations of the two countries' efforts in regards to the use of science and technology for a safe and secure society, and then proceeded with discussions on the direction of future research cooperation in sectors of interest to the two countries, including infectious diseases, food safety, cyber-security, natural disasters, weaknesses in the social infrastructure, and crime and terrorism. The discussions with the United States are planned to continue in the future on research cooperation in these sectors.

Interest in social safety and security is increasing worldwide, and similar meetings are likely to be convened in the future on both bilateral and multilateral bases regarding scientific and technological cooperation

1.2.2.2 Revival of Local Areas Using Science and Technology

Japan is a country that is blessed with four seasons, and geographic conditions that change greatly from north to south, for a richly diversified natural environment. In this varied natural environment, Japan's regions have each developed their own histories, cultures, industries, and technologies.

At present, Japan's economy and society are in the midst of great structural change, as society moves toward fewer children and more elderly people, and as the economy moves toward globalization. Many local areas are faced with problems that threaten the survival of their economy and society, such as areas where aging is so rapid that the local population is already in decline, or other areas that are seeing their industries get transferred overseas in the face of severe competition and are slowly moving toward stagnation.

On the other hand, however, leaders in some local areas are coming together to rebuild distinctive local industries and technologies toward the creation of new industries that can interact with the world on an equal basis.

In the midst of these major trends in economic and social conditions, some local areas are required to make effective utilization of their distinctive locally developed industries and technologies, and the knowledge and skills obtained from their human resources, natural environment, culture, and history, in order to move ahead with "revival of local areas" through the creation of new industries and employment.

In support of these independent local efforts, the government established a local revival headquarters in the Cabinet in October 2003, based on the concept of "local areas conceive and act on ideas of their own, and the national government supports them," to promote comprehensive efforts toward the revival of local areas.

Next follows an explanation of the role that science and technology should play in the revival of local areas.

(Efforts Toward the Revival of Local Areas, Based on the Promotion of Science and Technology)

For the promotion of science and technology in local areas, Article 4 of the Science and Technology Basic Law implemented in 1995 stipulates that local public organizations have the responsibility to formulate and implement policies for the promotion of science and technology that evoke the characteristics of their particular local area. Under this mandate, the prefectural governments have formulated basic guidelines for the promotion of science and technology, and are in the process of promoting their own independent policies for science and technology promotion.

The Second Science and Technology Basic Plan, which is based on the Science and Technology Basic Law, utilizes local resources and potential skills in research and development to promote the advancement and diversification of Japan's science and technology, and the revitalization of Japan's economy through the creation of innovative technologies and new industries in the local areas, and sees such active promotion as essential. Another goal is the formation of "intellectual clusters" in the local areas. An "intellectual cluster" operates under local guidance around a core of locally distinctive R&D themes and public research organizations with potential, and that invites the participation of businesses both inside and outside the local area to form a technology innovation system. At present, with government support, the universities serving as centers of knowledge creation are at the core of the ongoing effort (the Intellectual Cluster Program) to create concentrations of competitive technology innovation through affiliated research institutions, etc.

In addition, efforts (Industrial Cluster Program) are being made through the construction of wide-area networks of industry, academia, and government, involving universities, businesses, and other entities over a wider regional area, to form "industrial clusters" that link to technology innovation toward the creation of new businesses and new industries.

The Intellectual Cluster Program and Industrial Cluster Program are closely linked to the provision of new technological seeds and to feedback from market needs to reactivate and revive local area economies (Figure 1-2-22).

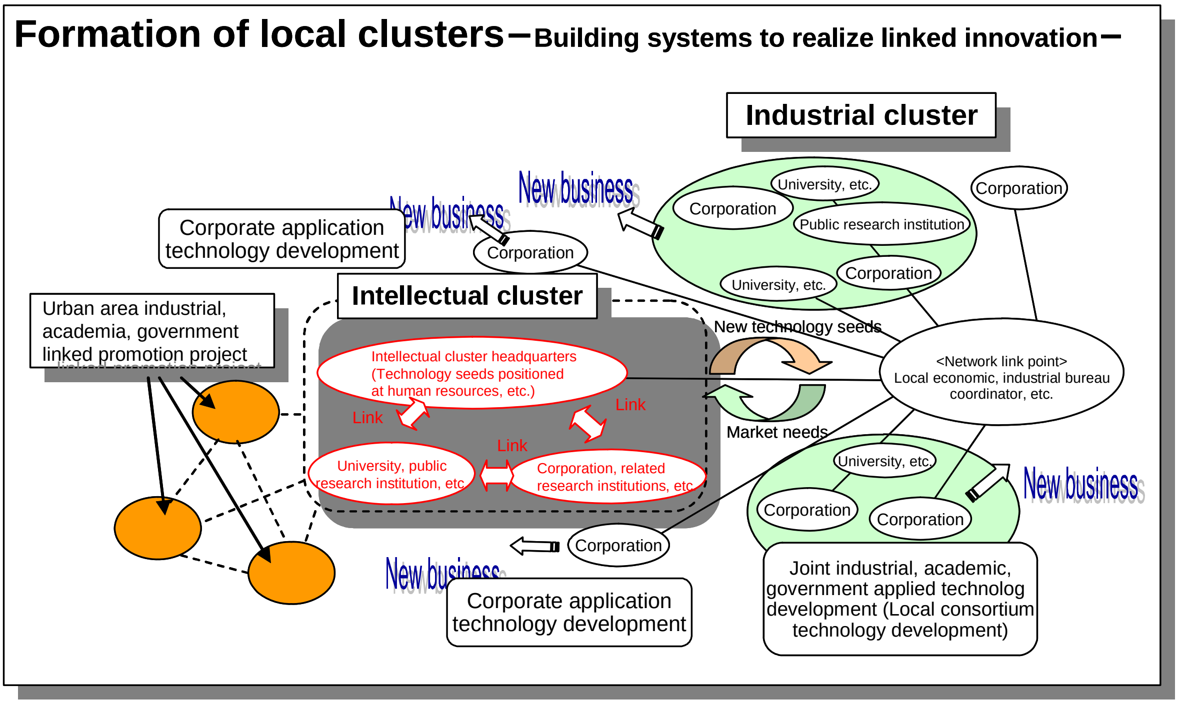


Figure 1-2-22 Formation of local clusters

Source: Prepared by MEXT, based on Cabinet Office materials

Clusters such as these already exist in large numbers in Europe and United States. The National Institute of Science and Technology Policy, operating under the Ministry of Education, Culture, Sports, Science and Technology, examined some progressive examples of these overseas clusters in its “Survey Research into Success Factors and Promotion Policies for Local Innovation (interim report)” (March 2003), and listed 16 items as elements for the successful promotion of the formation of clusters (Table 1-2-23).

Table 1-2-23 Progressive examples of factors promoting cluster formation in Europe and UnitedStates

1. Special regions	1-1	Access to core regions within 30 minutes
	1-2	Risk awareness for local region
2. Special industries	2-1	Selection and concentration in industries that can revitalize local assets
	2-2	Several companies exist as initial core enterprises
3. Research and development	3-1	Core R&D strength is world-class
	3-2	Cooperation and tie-ups between industry, academia, and government
4. Venture businesses	4-1	Vitality of venture businesses
	4-2	Tie-ups between venture businesses, large corporations, universities, etc.
5. Support/tie-ups	5-1	Finance, management, technology, manufacturing, and other support infrastructure exists locally
	5-2	Institution adjusts tie-ups between enterprises, universities, supporters
6. Visionary	6-1	People who can realize a future local vision that attracts researchers
7. Merge with other industries	7-1	Merges with other clusters in other local areas
8. Global development	8-1	Global efforts for market expansion and promotion of innovation
9. IPO	9-1	Use of IPOs (initial public offerings) boosts trust and growth
10. Nationwide recognition	10-1	Improved cluster name recognition
11. Life culture standards	11-1	Attracts human resources from around the world

Source: National Institute of Science and Technology Policy. "Survey Research into Success Factors and Promotion Policies for Local Innovation (interim report) (March 2003)"

[Column 5]

Intellectual Cluster Program
Examples of implementation in local areas

- Ueda, Nagano prefecture

- Summary of effort

Shinshu University, public experimental and research institutions, and Nagano prefecture development-style corporations are participants in a project for R&D into smart devices made from nanocarbon composites, and for R&D into organic nanomaterial devices made from functional nanopolymer materials. To date, the cluster has successfully developed a manufacturing technology for a compound electrolytic powder mixed with equal parts CNF (Carbon Nanofiber) and copper, and an organic LED element technology with strong market competitiveness.

Participating institutions

Shinshu University, Yamagata University, Nagano National College of Technology, Chitose Institute of Science and Technology, Industrial Research Institute of Nagano Prefecture, etc.

-Toyama,Takaoka prefecture

-Summary of effort

With Toyama prefectural governor Yutaka Nakaoki serving as cluster chairman, and the participation of local universities, public experimental and research institutions, and businesses based both in Toyama prefecture and elsewhere, the cluster is engaged in the development of diagnostic and treatment systems for infectious diseases, etc., using human immune functions, and in herbal medicine diagnostic and treatment systems designed for specific patient constitutions. To date, the cluster has successfully developed a high-precision “cell chip” that can extract lymphocyte immune cells one at a time, a world-first, and is expected to actively engage in the development of drugs for treatment of influenza, allergies, and Severe Acute Respiratory Syndrome (SARS), etc.

- Participating institutions

Toyama Medical and Pharmaceutical University, Toyama University, Japan Advanced Institute of Science and Technology, Toyama Prefectural University, Toyama Industrial Technology Center, etc.

Since each local area differs in its economic and social background, these elements will not necessarily apply to the formation of particular clusters. Nevertheless, there are still a number of clusters demonstrating growth by using risk awareness as an opportunity for reviving the local area. In other words, these are examples of a worsening economic situation in a local area being used as an opportunity to plant the seeds of risk awareness across the entire local area, with various local leaders congregating in a group centering on the local administrative institution, and local science and technology being utilized to create new industries that form into a cluster (see Column 6).

As can be seen, the "revival of local areas" utilizing distinctive science and technology created in each local area will become increasingly important in the future as a role that science and technology should play from the viewpoint of "science and technology for society" in the local area. But as can be seen in the overseas clusters, the involvement of local people in the goal of reviving local areas is an essential element.

[Column 6]

Examples of Revived Local Economies Using Science and Technology
(Examples of advanced clusters overseas)

Germany: Dortmund, North Rhine Westfalia

- Background

Dortmund used to be the central city of Germany's steel and coal industries, but its economic situation has steadily worsened as these industries have withdrawn.

- Cluster formation process

Faced with a crisis as the economic and social situation deteriorated, Dortmund city in 1985 established a technology center with an enterprise incubation function in concert with the local university as an unemployment countermeasure, and also invited a public materials applied research institute to participate. Later on, a technology park featuring a concentration of venture businesses was developed next to the university.

- Current situation

Presently about 200 area companies with 8,000 employees are engaged in information technology and software for electronic equipment, and constitute the core of a cluster that encompasses as many as 40,000 employees when the surrounding area is included.

United States: Pittsburgh, Pennsylvania

- Background

Developed since the late 19th century as the representative example of a modern heavy-industry city (steel industry, glass industry). Around 1980 these major industries went into a deep depression, resulting in large numbers of unemployed people and a sudden drop in the area's population. Furthermore, industrial pollution was degrading the living environment.

- Cluster formation process

In 1985, the city of Pittsburgh joined with local universities (University of Pittsburgh and Carnegie Mellon University, etc.) to formulate a plan of urban renewal and industrial rejuvenation (Strategy 21). The city established a support institution to commercialize technologies developed at the local universities, invited in information technology and biotechnology-related companies, offered support programs for businesses, and developed venture capital.

- Current situation

To date, more than 300 venture businesses have been established, and the area is concentrated with medical product, biotechnology, and information technology companies. Pittsburgh's urban renewal program is also well-known all across the United States as a model example.

Sources: National Institute of Science and Technology Policy, "Survey Research into Success Factors and Promotion Policies for Local Innovation (interim report) (March 2003)"
The Japan Research Institute, "Survey into Success Factors for Local Industry, Academia, and Government Cooperation, as Seen in Overseas Examples (March 2002)"

(New Utilization of Science and Technology for Local Society)

In addition to the utilization of science and technology for the revival of local areas through the creation of new industries, etc., it is important in regards to the development of local policies for "science and technology for society" to focus attention on the local residents, who are the main actors in the local area, and to utilize science and technology for them.

In particular, since there is not a great distance between the local universities, research institutions, and corporations that are the main actors in scientific and technological activities, and the local residents who receive their results, it should be easier for these institutions to grasp the needs of local residents in regards to science and technology.

In this case, the university, which is the center for the creation of local "knowledge" and development of human resources, can actively utilize human resources and knowledge for the benefit of the local area, something the local area also demands from the university. In particular, the national universities were all incorporated in April 2004, with each national university moving in its own independent environment to engage in appealing education and research activities in response to the expectations of people and society, and expectations are high that they will be able to respond flexibly to social trends and demands, and at the same time, make contributions to society over a broad range of sectors.

The government has already commenced a project, starting in FY2002, to support university efforts to contribute to the local areas (Special Project for the Promotion of Contributions to Local Areas). This project establishes university-wide organizations for the promotion of university contributions to local society, and also builds permanent liaison and cooperation structures with the local government unit for the purpose of bringing the university and local government unit together.

At Gunma University, for example, a particular characteristic of the local environment is the large number of foreign laborers living as local residents, and the local prefecture's position as having the highest level of passenger vehicle ownership per person in Japan. As a result, efforts are in progress, in cooperation with the Gunma prefectural government and affected municipal governments, for the development and testing of support systems designed to assist with the coexistence of foreign laborers and local residents, and for evaluations of the effects of the automobile society on the lives of prefectural residents (Figure 1-2-24).

In FY2003, 26 universities were selected to participate in the project, with efforts oriented to resolve the particular issues unique to each local area, and expectations are high for the project's future.

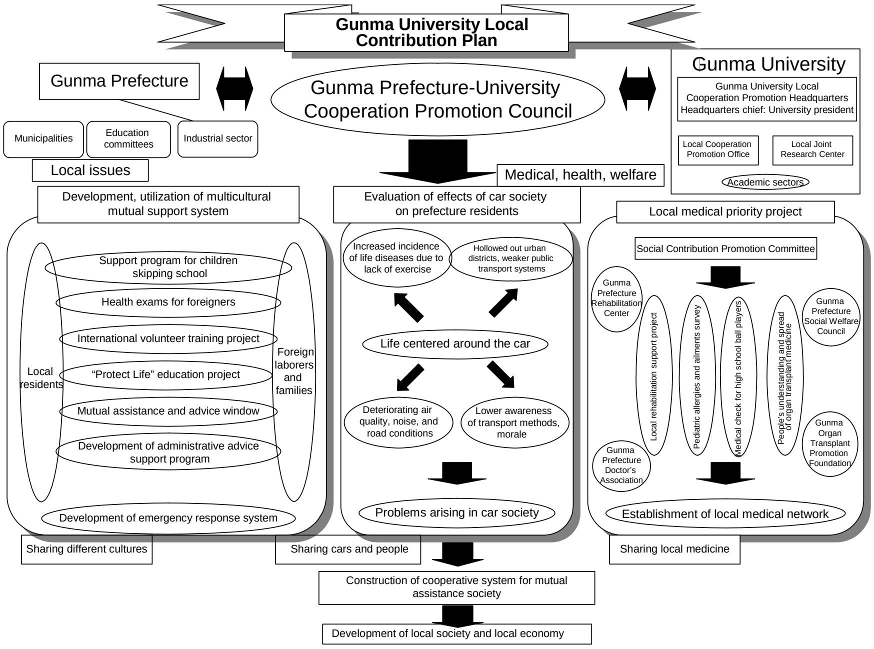


Figure 1-2-24 Example of a university's effort to contribute to its local area (Gunma University)

Source: Prepared by MEXT

(How Science and Technology Will Assist in The Revival of Local Sreas in the Future)

As seen in the results of the public opinion poll, the development of policies from the viewpoint of "science and technology for society," at a time when the people's interest in science and technology is declining, first requires that utilization of science and technology be oriented toward meeting resident needs in local areas and resolving their societal issues.

As mentioned in Section 1.2.1, no one knows when SARS, avian influenza, or some other new infectious disease that constitutes the latest problem threatening the safety and security of society will break out in some local district. For this reason, residents of local areas can be expected to increasingly look toward local science and technology to provide scientific knowledge that they can trust and feel secure about.

In the future, the science and technology created and accumulated in each local area will be linked to the revitalization of long-existent industries, and in a broad sense to revitalization of the local economy and society, as well as to building a new relationship for Japan as a whole between "science and technology and society." In this regard, it will be important for each local area to be actively pressing forward in their efforts.

1.2.2.3 Intra-sector Efforts

Efforts in regards to "scientific and technological progress related to safety and security" and the "revival of local areas using science and technology," discussed above, require comprehensive efforts that go beyond the boundaries between sectors, such as between the natural sciences on one hand and the humanities and social sciences on the other.

This section discusses the importance of efforts that transcend sector boundaries, the current state of such efforts, and the issues facing them.

(Importance of Comprehensive Viewpoints that Transcend Sector Boundaries)

As science and technology has become more closely related to our daily lives, and the range of human activities has expanded, people's sense of values and demands have diversified for more convenience, more ease of use, and more functionality. In addition, as science and technology have progressed, the structure of society has itself undergone great changes, and the various phenomena arising in society have become more complex. In response to these changes in society, a new comprehensive viewpoint is needed in order to build a generally optimum relationship between science and technology and society.

With science and technology becoming more advanced, the various sectors in the natural sciences have become more specialized and detailed. But problems related to the global environment, to the safety and security of society, and many other issues facing society today are complex issues with a large number of causes, and their resolution cannot be achieved using specialized or detailed knowledge alone, but only through the concerted use of all knowledge available.

What is needed today to resolve these kinds of problems is integration of knowledge from various specialized or detailed sectors, and integration of knowledge obtained in such differing sectors as the natural sciences, and humanities and social sciences, or in other words, integration of intra-sector efforts.

(Researcher Awareness of Trans-sector Efforts)

How aware are researchers regarding efforts that transcend sector boundaries?

According to the "Survey of the State of Japan's Research Activities (FY2003)" conducted by the Ministry of Education, Culture, Sports, Science and Technology, about 60% of researchers responded that they are interested in research that transcends sector boundaries (Figure 1-2-25).

In regards to the reasons for their interest, about 80% of researchers responded with "because I think it is essential for promoting research in response to social issues" (Figure 1-2-26), amply demonstrating their recognition of the importance and necessity of trans-sector efforts in their relationship with society.

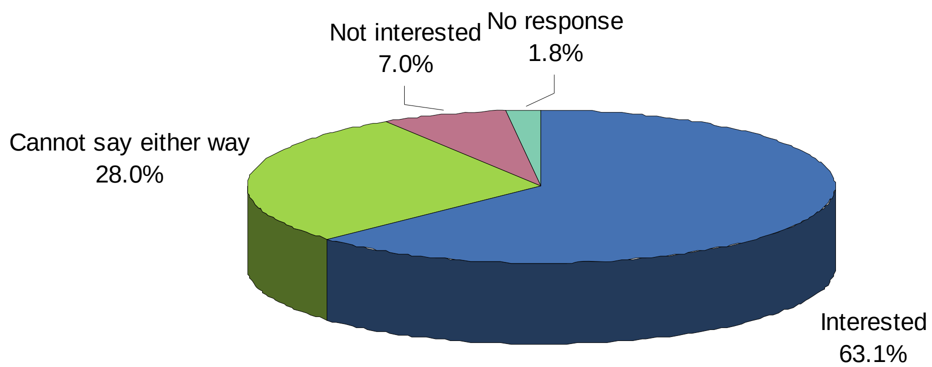


Figure 1-2-25 Interest in trans-sector research

Source: MEXT. "Survey of the State of Japan's Research Activities (FY2003)"

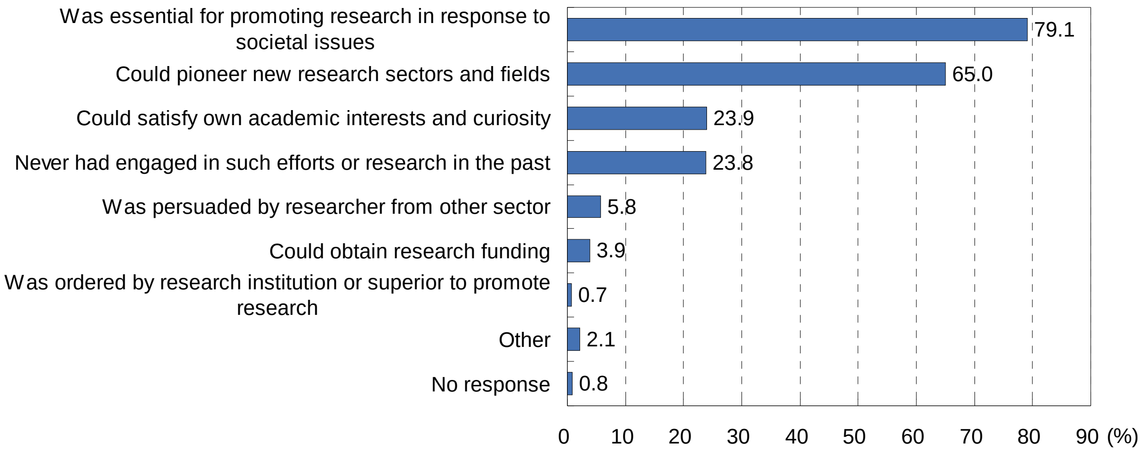


Figure 1-2-26 Reasons for having interest in trans-sector research

Source: MEXT. "Survey of the State of Japan's Research Activities (FY2003)"

(State of Trans-sector Efforts)

Efforts that transcend sector boundaries are slowly increasing in number in response to society demands, and will surely become an important trend in the future. The efforts described below are representative, and further such efforts can be expected as society undergoes further change.

(1) For the Utilization of Knowledge

In the 21st century, already being called the "knowledge century," the accumulation and effective utilization of discoveries and knowledge obtained through science and technology have become important issues.

Intellectual property rights are granted by law to the creators of a broad range of human intellectual activities, and refer to protection for those rights, as well as to the development of an environment in which intellectual property can be actively utilized and its value demonstrated to the maximum extent. In particular, the life sciences, information and communications, and electronics sectors have seen the creation of many results in recent years due to advances in science and technology, while new sectors have appeared that also require protection of rights. The appropriate application of rights protection to these sectors will require efforts that transcend the bounds of the study of law and the natural sciences.

In the United States, protection of intellectual property is supported by the establishment in the 1980s of a federal circuit appeals court for the adjudication of intellectual property disputes, and by the pro-patent policy put forth in the Young Report. In addition, the traditional viewpoint that living organisms cannot be the target of patents has also been overturned, with the establishment of patents for micro-organisms, etc., and the policy has been to steadily expand the range of sectors targeted as intellectual property, while maintaining the highest regard for intellectual property.

In Japan, the Basic Law on Intellectual Property became law in March 2003. In accordance with the law, the Intellectual Property Strategy Headquarters was established, as was the "Plan for Promotion of the Creation, Protection, and Utilization of Intellectual Property." This plan notes the importance of creation, protection, and utilization, as well as fostering excellent human resources in support of those activities, and uses the viewpoint of nationwide social participation to call for maximum implementation of these various efforts, and for their implementation under unified, organic cooperation. In addition, for particularly important policy issues, the law established special research committees ("Special Research Committee on the Method of Patent Protection for Medical-Related Behavior," "Special Research Committee on Content," and "Special Research Committee on Strengthening the Foundation for Rights Protection") for the performance of investigations and holding of discussions.

In regards to the protection of intellectual property, the role of the judiciary is expected to become increasingly important as the utilization of intellectual property progresses. In this regard, the Bill for the Establishment of an Intellectual Property High Court, which is currently being debated in the Diet (as of late-April 2004), stipulates the establishment of a high court for intellectual property disputes, for the expert handling of incidents related to intellectual property in order to strengthen and speed up court responses to intellectual property cases. In addition, in order to foster human resources in the area of intellectual property, education is being promoted in the form of law school and other graduate and technology management school courses that place emphasis on intellectual property.

(2) Toward the Construction of New Social Systems

In order for modern society to resolve the various problems it faces, and to shape a prosperous, safe, and secure society, new systems in society need to be constructed that integrate usable knowledge.

In April 2000, the Science and Technology Agency (now part of the Ministry of Education, Culture, Sports, Science and Technology) established the “Research Committee into Methods for Promoting Research and Development of Social Technologies” (Chairman: Hiroyuki Yoshikawa, president of the Science Council of Japan). The committee issued a report in December 2000 in which it treated as “social technologies” any “technologies for the integration of knowledge from multiple domains in the natural sciences, and in humanities and the social sciences, to build new social systems,” and then made some proposals regarding the importance of this philosophy and its promotion, as well as regarding research systems and research domains, etc. The Japan Science and Technology Agency, which was established based on this report, is now engaged in the promotion of research into social technologies (Table 1-2-27).

Table 1-2-27 Examples of research topics in social technology research (FY2003)

Social Technology Research Forum		Recognizes the essence of social problems and constantly discusses modes of research for achieving their resolution, and performs surveys and research into the systematization and modes of social technologies.
Mission Program		Sets missions deemed to be important for resolution of social problems, organizes research themes necessary for achieving those goals, and implements research.
		I. Construction of knowledge system for solution to safety-related social issues
	Research topics	Construction of knowledge systems for safety, and development of design methods for social technology
		Development of dialogue-type communications technology for creation of mutual understanding and social knowledge
		Construction of methods for reutilization of failed knowledge, and of a society that executes loss avoidance
		Development of social psychological devices that prevent organized violations
		Cross-section analysis and reconstruction of legal systems related to safety protection
		Construction of public risk management concept for safety problems
		Research that incorporates both the technological aspects and social aspects of atomic power safety
		Construction of information system concepts that ensure safety in complex, large technology systems
		Construction of chemical industry information disclosure systems – Is it safe?
		Implementation of quake risk elucidation and loss reduction strategies – Is our community safe?
		Toward a transport system where everyone can truly feel safe
		Systematization of diagnostic information and medical knowledge for medical safety, and application of information system as foundation for diffusion through society
		Consideration of food safety assurance systems/Friction between science and technology, and society, in food terms
		II. Elucidation and resolution of weaknesses in advanced information society
Public Bid-Type Program		Sets research domains needing promotion, based on perspectives deemed important for resolution of social problems, opens research proposals in each domain to public bidding, and implements research.
		Research domain I “Social System/Social Technology Theory”
		Research domain II “Recycling Society”
		Research domain III “Brain Science and Education”

Source: Materials from the Japan Science and Technology Agency.

Since research into social technologies aims for the resolution of societal problems, it is not limited to technological knowledge centered on the natural sciences, but instead involves the promotion of research and development from a broad perspective transcending the bounds of particular sectors, through cooperation between researchers in the natural sciences and in the humanities and social sciences that incorporate knowledge in the humanities and social sciences that target individual and group psychology and behavior.

While such research efforts can be expected to take many forms, one particular example of a research topic now in progress, “construction of a knowledge system for resolution of societal problems related to safety," is being implemented as follows.

First of all, trans-sector cooperation between researchers in engineering, medicine, law, economics, and social psychology promotes research into problems related to safety in each of the sectors, as well as research that cuts across all of the sectors. At the same time, the various research groups engage in mutual studies and opinion exchanges, and then proceed with R&D into technologies that contribute to the resolution of problems in each sector. Then, the results are systematically integrated from an overview perspective. In this way, research and development aimed at the development of technologies that support a general view and grasp of safety problems related to complex and advanced science and technology, and of technologies that support decisions on solutions that should be implemented, is conducted.

In addition to the above, research is being promoted at the present time into the "elucidation and resolution of weaknesses in the advanced information society," "social system/social technology theory," "the recycling society," and "brain science and education."

(3)Healthy Fostering of Intelligence and Sense

Japan is currently faced with a barrage of problems spawned by modern society, including the phenomenon of fewer children and more elderly people, pathological worrying by mothers about child-rearing failures, abuse of children, adolescent crime, school truancy, and refusal to go outdoors. In addition, the human brain is the product of many millions of years of biological evolution, and how to respond to the rapid changes taking place in modern society is a new issue facing humanity.

Regarding issues in the educational sphere, efforts have long concentrated on the utilization of knowledge in children's education science, child psychology, and education science, and on the accumulation of various on-site tests performed at schools. In recent years, these methods have been supplemented by rapid progress in technologies for the measurement of brain functions, which have led to the integration of knowledge from such disparate sectors as brain science, education science, children's education science, psychology, sociology, medical science, and health science, and have opened the way for multifaceted research into the brain functions that give rise to the "soul" and "sense," areas which have not previously been successfully elucidated in scientific ways. These actions have led to expectations for elucidation of the framework for learning throughout a person's life, and for contribution to the resolution of these social problems.

In 1999, the Centre for Education Research and Innovation at the Organization for Economic Co-operation and Development (OECD) launched the "learning science and brain research" project as a place for free discussion by the experts, and research activities based on a research network of experts spanning a wide range of sectors were commenced beginning in 2002. In the United States, the National Institute of Biomedical Imaging and Bioengineering (NIBIB) was established in 2001, as the first engineering-related research center to be associated with the National Institutes of Health (NIH), a collection of national research institutions in the medical and biological sectors, and is focusing efforts on promoting research into non-invasive measurement of brain functions that will enable research into "brain science and education."

In Japan, the Ministry of Education, Culture, Sports, Science and Technology established a study committee in FY2001 for investigating research into "brain science and education," and studying research plans, etc., and specific research has already begun at the Japan Science and Technology Agency.

(4)Contribution to an Intellectually Prosperous Society

Science and technology has to date contributed to prosperous lives and societal activities. On the other hand, however, the prosperity that people demand is shifting in emphasis away from material prosperity and toward spiritual prosperity, and future science and technology will need to be able to contribute to spiritual prosperity as well (Figures 1-2-28, 1-2-29).

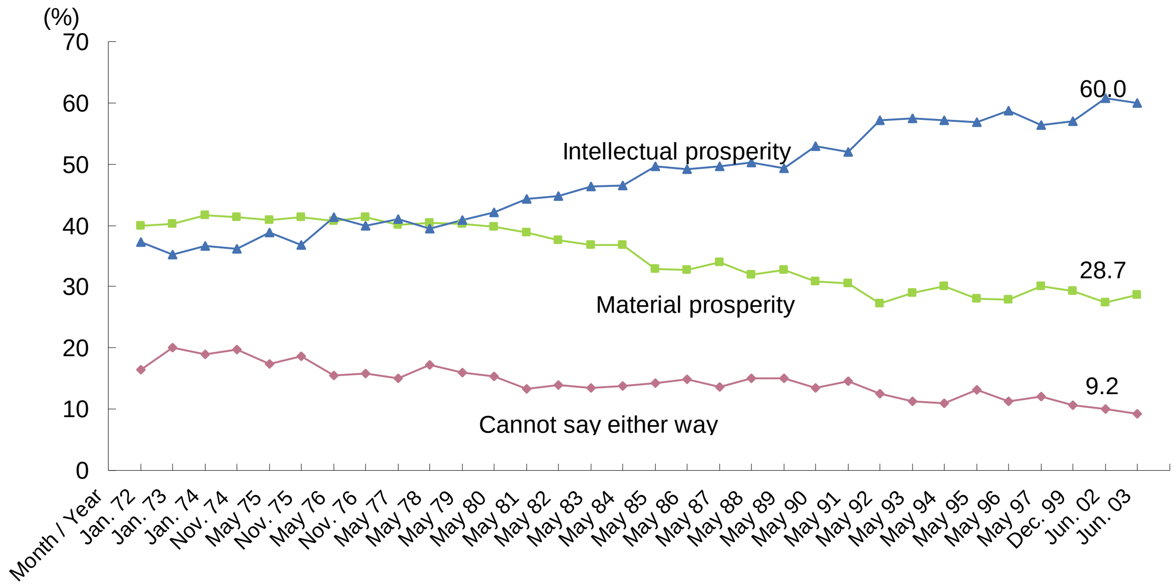


Figure 1-2-28 Trend in type of prosperity sought by the people

Note: Intellectual prosperity: "Since I have reached a reasonable level of material prosperity, I would now like to place more emphasis on intellectual prosperity and relaxation in my life."
Material prosperity: "I still need to place emphasis on making life more materially prosperous."
Source: Cabinet Office. "Public Opinion Poll on the People's Lives"

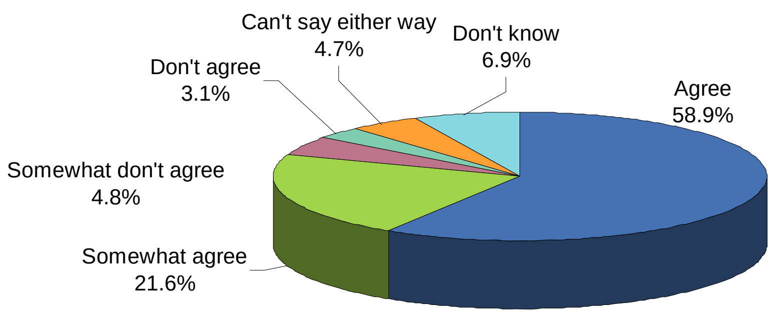


Figure 1-2-29 Progress in Science and Technology should also be able to realize intellectual prosperity

Note: Response to a question asserting that "I think that future progress in science and technology should not be for realization of material prosperity only, but should also be for intellectual prosperity as well."
Source: Cabinet Office. "Public Opinion Poll on Science and Technology and Society (February 2004)"

In December 2001, the Basic Law for Promotion of Culture and Arts was passed into law, to promote culture and arts at the national government level. Based on this law, a basic policy for the promotion of culture and arts was adopted in December 2002. In this basic policy, culture and arts is not limited to artists or cultural arts groups, or even to certain lovers of the arts, rather it is defined as being essential to the realization of a spiritually prosperous society in which all citizens can experience true relaxation and leisure. In this sense, culture and arts is a social asset belonging to all of the people.

At the same time, culture and the arts are resources for the realization of high-quality economic activities. The market for digital content of culture and art is estimated to exceed 2 trillion yen, marking the sector's importance as a national industry for Japan. Internationally, however, Japan is a huge net importer of movies and similar media, and while Japan is internationally competitive in a few sectors such as animations, the country has in recent years lagged behind the United States and its huge reservoir of advanced production technology. Moreover, with Asian countries such as China and Korea having advanced technology combined with low personnel expenses, Japan is in danger of being left behind in the international arena.

In this situation, the Intellectual Property Strategy Headquarters is currently engaged in studies into the promotion of arts content as a top priority intellectual property that Japan should aim for in the future. At the same time, the Diet is currently considering (as of late-April 2004) the Bill for Promotion of the Creation, Protection, and Utilization of Content. Furthermore, the Japan Federation of Economic Organizations (Keidanren) recently issued a memorandum entitled "Toward Promotion of an Entertainment Content Industry," indicating the importance placed on the topic.

In the promotion of culture and arts for the realization of spiritual prosperity, science and technology can play a major role. From this perspective, the Science and Technology Council's Resource Survey Division released a report in February 2004 on the role of science and technology in relation to the future of culture and art, calling for the "Promotion of Science and Technology in Support of Preservation, Utilization, and Creation of Cultural Resources." Based on these proposals, specific policy efforts will be needed for the promotion of science and technology for the creation of media arts and other cultural resources supported by technology, investigation and scientific analysis for the preservation and utilization of cultural assets, the promotion of technology for preservation and display using virtual reality, and the re-evaluation of the social value of contributions of science and technology to culture.

[Column 7]

Scientific Analysis of Arts and Crafts

Nanostructural analysis of Imari ware

The blue patterned pottery ("*sometsuke*" (underglaze cobalt blue)) representative of Imari ware was a popular export product of the Edo Period. The patterns were created using a pigment called *gosu (*huiqing), whose main component was cobalt oxide, topped by a glaze (smear), and then baked until the glaze became a glass freshly highlighting the underlying blues.

The blue seeping into the glazed layer was altered by the effects of transitory metallic components in the *gosu*, by the amount of glaze used, and by oven temperature and other conditions. Moreover, the *gosu* varied in composition and manufacturing method by location and over time, making it possible for experts to discern the place and time of production based on the coloring and composition of the tterns. Furthermore, it was difficult to analyze using traditional methods, but the latest modern technology has made it possible to perform structural analyses of Imari ware at the nanolevel, which should allow further refinements to the classification of these masterworks in place and time.

Examination of the nanostructure of the colored area of a piece of Imari ware clearly reveals the existence of cobalt (Co) globules floating in the glass layer.

Geometric analysis of Edo *komon* patterns

The fabric pattern known as Edo *komon* was popular from the Muromachi Period (late 16^{th} century) on through the Edo Period (1600 to 1868), and several thousand types of patterns are known.

Research into the classification of these patterns utilizes knowledge based on systematized crystallography. The result has been a successful sorting of *komon* patterns into a number of grid types.

In the famous *Same* (shark-pattern) *komon*, the quasi-regularity of the apparently random points can be understood as an amorphous structure. Further rigorous analysis could reveal that the pattern's beauty lies in its subtle shift from perfect pattern regularity.

Such scientific pattern analysis could lead to new pattern proposals being designed on computers.

Source: Science and Technology Council's Resource Survey Division Report (February 2004), "Promotion of Science and Technology in Support of Preservation, Utilization, and Creation of Cultural Resources"

(5) Fostering Human Resources with Specialist Knowledge in Both Technology and Management

For the revitalization of Japan's economy and society, the creation of sustainable innovation is important. Therefore, human resources are required who possess advanced scientific and technological knowledge, and who have the experience and knowledge to handle patents and other intellectual property, and to commercialize and manage the results. Meanwhile, in response to the recent economic situation, corporations are outsourcing their education (training) departments, or are looking for specialist personnel who have real skills from the moment they enter the company, and their expectations for education performed in universities have risen extremely high.

Management of Technology (MOT) is management in corporations and organizations that place technology at the core of their business and that continuously create business for the next generation; it focuses on creative and strategic innovation for sustainable development. In order to foster human resources that are capable of handling these MOT activities (MOT personnel), the development of MOT programs that aim for understanding of both technology and management is now in progress. To ensure that a practical MOT program suited to the conditions of Japan's economy and society is developed, it is important that the "industry" related to operations be actively brought together with the "academy" related to education.

Meanwhile, with the recognition that MOT personnel and other management personnel are lacking both in terms of quality and numbers (Figure 1-2-30), future assurance and fostering of human resources, as well as improvement in the quality of human resources, will require further promotion of policies, and further development is expected in all institutions.

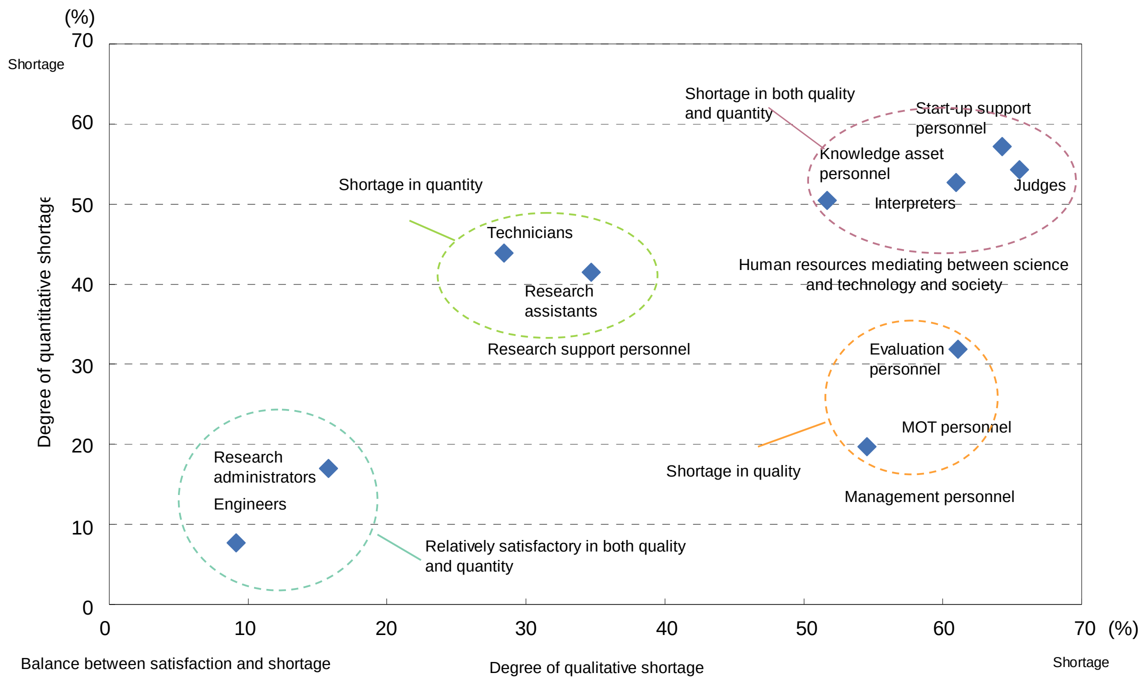


Figure 1-2-30 Shortages of science and technology human resources seen by researchers

Note: Each index figure represents a valid response value subtracting shortage response from satisfactory responses.
Source: MEXT. "Survey of the State of Japan's Research Activities (FY2002)"

(Promotion of Trans-sector Efforts)

As can be seen from the above, efforts transcending sector boundaries for the resolution of social issues are occurring in various circumstances throughout society. In order for science and technology to contribute to society, these kinds of efforts will become increasingly important in the future.

Moreover, to boost Japan's international competitiveness still more, it is important that distinctive new sectors be created. Many of these new sectors will undoubtedly be formed through a fusion of existing sectors, cooperation between the natural sciences and the humanities and social sciences through a fusion of science and technology with culture and arts, or other aesthetic sectors, or some other efforts that transcend sector boundaries.

While the cooperation of experts in various sectors is needed, of course, for the smooth promotion of trans-sector efforts, it is becoming increasingly important to foster personnel who are capable of taking a broad viewpoint to combine various forms of knowledge, or who can take a bird's-eye view of events. Such development of human resources can take the form of a stronger educational perspective in, for example, graduate school Ph.D. courses that foster researchers with advanced specialization on broad foundations of knowledge, guidance provided at the university level by multiple professors, introduction of double major programs (efforts to systematically take courses in sectors outside of the main course major program), or support for all these efforts.

In addition, the humanities and social sciences are expected to play important interdisciplinary roles in reflecting on human management and various social phenomena. In Japan, however, it has been pointed out that research in the humanities and social sciences has not always been sufficient in tackling issues related to science and technology, and to society. If trans-sector efforts are to be effectively used for appropriate responses to social issues, it will be necessary to promote the humanities and social science sectors, as well as the natural science sectors.

1.2.3 Application of New Technologies to Society

1.2.3.1 Two Sides of the Influence of Science and Technology

In most cases, science and technology inventions and discoveries have been profitable for society. At present, science and technology outcomes are utilized in a diverse variety of forms, and bring much profit to society, while at the same time their application has also led to unforeseen issues for society.

As explained in Section 1.2, science and technology can contribute to industrial development, to improvement in life's conveniences for people, and to realization of material prosperity. On the other hand, it also leads to all kinds of environmental problems including destruction of the natural environment and other problems. Utilization of new science and technology alone is not enough to attempt resolution of environmental problems; a societal response is also needed, through such means as development of programs such as the Basic Environment Law and the Air Pollution Prevention Law, and through promotion of changes in people's modes of living toward lifestyles that take the environment more into consideration.

As can be seen, the process of applying science and technology to society requires investment in social infrastructure and the development of programs designed to promote such applications, as well as responses to newly appearing social issues. In fact, according to results from the "Public Opinion Poll on Social Awareness," people's favorable awareness of science and technology is declining year by year, revealing the complex feelings people have toward progress in science and technology (Figure 1-2-31).

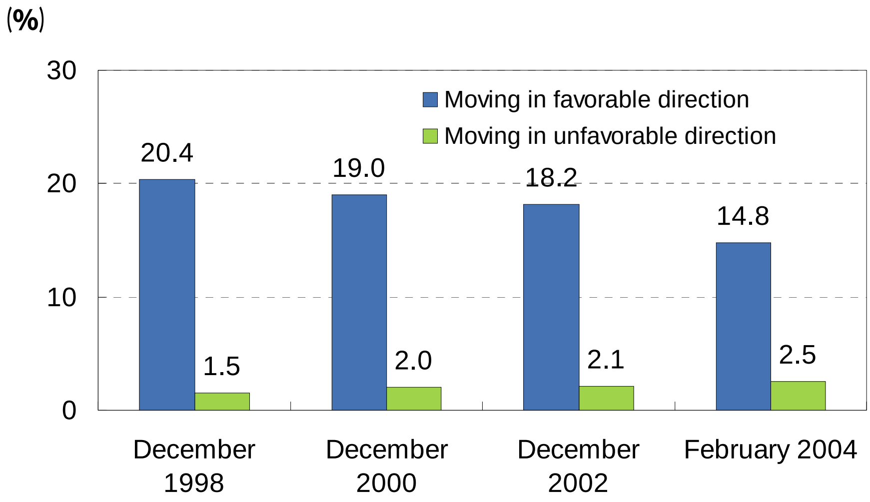


Figure 1-2-31 Changes in people's awareness of the direction of science and technology

Source: Cabinet Office. "Public Opinion Poll on Social Awareness"

On the other hand, as the "Survey on the Awareness about Science and Technology (2001)" found, most people believe that progress in science and technology has made life more comfortable, and expectations are high for the future role of science and technology in promoting socioeconomic growth and boosting people's living standards (Figure 1-2-32). For this reason, it is important in the application of science and technology in society that the benefits and issues include a study of the social aspects alongside a restudy of the technological aspects, to ensure that progress in science and technology and the benefit to society are not canceling each other out.

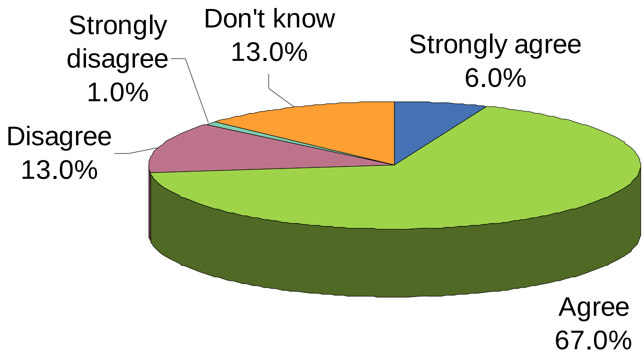


Figure 1-2-32 Awareness of opinions regarding science and technology making life more comfortable

Note: Response to the assertion that "Science and technology has made life more healthy, simple, and comfortable."
Source: National Institute of Science and Technology Policy. "Survey on the Awareness about Science and Technology (2001)"

1.2.3.2 Dealing with Ethical, Legal, and Social Implications of Science and Technology

As can be seen by the bioethics issue, in the application of new technology in society, investigation into its social aspects should not be limited to effects on the natural environment or on people's health, but should also extend to consideration of the effect on ethics and on the legal order, and of various other social effects.

To put a general name on the ethical, legal, and social issues that are generated in society alongside progress in science and technology, this discussion will hereafter use the acronym ELSI (Ethical, Legal, and Social Implications). In recent years, a number of foreign countries have been promoting efforts into the study of ELSI, for promotion of science and technology and clarification of the accompanying social effects and the responses required.

Because ELSI is strongly linked to the social systems prevailing in each country, and to people's cultural background and sense of values, examples from individual countries may not always be directly applicable to Japan. For this reason, Japan needs to actively pursue its own efforts in regards to ELSI.

(International Trends)

In the United States, when the Human Genome Project (HGP) was first implemented, there were high expectations for the contribution that analysis of the human genome would make toward promotion of the health of humanity, but also fears from the very beginning of the project's concept stage about how individual gene data would be handled and other social issues. As a result, studies were commenced into ELSI in regards to human genome research, and the following ELSI efforts were listed as necessary in the first report, issued in 1990:

- address and anticipate the implications for individuals and society of mapping and sequencing the human genome;
- examine the ethical, legal and social ramifications of mapping and sequencing the human genome;
- stimulate public discussion of these issues;
- develop policy options to assure that the information is used for the benefit of the individual and society.

In response to this report, the National Human Genome Research Institute (NHGRI), operating under the National Institute of Health (NIH), and the Department of Energy (DOE) commenced specific investigations of ELSI. The NIH and DOE committed 3-5% of their Human Genome Project budgets to ELSI-related efforts.

In the United States, measures are also being taken in the relationship of society to the nanotechnology sector. As noted in Section 1-1, the "21st Century Nanotechnology Research and Development Act" of December 2003 establishes research programs for consideration of the implications for society of the ethical, legal, and environmental aspects of nanotechnology, thus incorporating into official regulations specific investigations of ELSI.

In Europe, the EU's Sixth Framework Program (2002 to 2006) established the Science and Society program from the perspective of encouraging dialogue between the scientific community and the people of Europe, and the program has promoted research into the ethical aspects of science and technology.

As can be seen, in Western nations specific efforts are being promoted for research into ethical, legal, and social implications, including positioning of public programs and investment of funding, which, based on the recognition that science and technology are the foundations supporting the future of society, ensure that science and technology and society, do not drift too far apart.

(Study and Response into the Social Implications of Science and Technology —Centering on the Bioethics Issue)

Scientific and technological advances in the life sciences have been remarkable, contributing to huge developments in medicine, and to resolution of food and environmental issues, and raising expectations of the development of wholly new industries. On the other hand, because these sciences target humanity and because they open the door to the artificial creation of functions and characteristics that do not exist in nature, and for other similar reasons, consideration for bioethics and the assurance of safety is needed. Here in Japan, as well, discussion between experts and people are now in progress on multiple fronts in bioethics and safety issues.

While the specific problems and issues requiring attention may vary depending on the research content and state of implementation, some of the concerns that have been raised include the problem of respect for people, the problems of the right to self-determination and invasion of privacy in research that targets human subjects, and the risks to human health and life, and also go beyond these issues to include concern about the effects on the environment. Moreover, with the heightened societal interest in the subject in recent years, there is a need for promotion of greater understanding in society and particular groups.

In response to this situation, the Biotechnology (BT) Strategy Council prepared a BT strategy outline in 2002, in which it called for the "promotion of ethical, legal, and social issues in regards to BT."

Here follows some examples of research, looking at their significance and social implications, and the responses made (Table 1-2-33).

(1) Cloning Technology

The birth of the cloned sheep Dolly in the United Kingdom in July 1996 attracted the attention of the world with the successful application of a cloning technology using the nuclei of mammalian cells, which had previously been considered to be impossible. Cloning technology is widely expected to contribute to the stable supply of livestock food sources, to the manufacture of pharmaceutical products, to the protection and reproduction of rare animals, and to mass production of test animals. On the other hand, the suddenly approaching possibility of production of human cloned individuals carries with it ethical and social issues from the perspective of raising the possibility of infringing on respect for human life. Other issues focus on safety, such as the appearance of gene abnormalities in animal testing.

In Japan, as well, in September 1997 the (then-called) Council for Science and Technology established the Bioethics Committee to engage in studies into the issue, including hearings for gathering public comment from the people. The result was the enactment and promulgation of the "Law Concerning Regulation Relating to Human Cloning Techniques and Other Similar Techniques." in December 2000. This law bans the transfer of human cloned embryos, etc., into human or animal wombs for the purpose of producing human cloned individuals, and stipulates severe penalties for violators. In addition, in regard to the creation of human cloned embryos, the law calls for the Council for Science and Technology Policy to engage in discussions about the future handling of fertilized human embryos, while banning the practice for the time being, in accordance with guidelines established under the law.

Meanwhile, in response to the moves of a few scientists after the birth of Dolly to attempt production of a human clone, Germany and France joined in 2001 to propose the start of negotiations at the United Nations for the adoption of an international treaty banning the production of cloned humans, and discussions began toward the adoption of such a treaty. At present, while the shape of an agreement regarding prohibition of the production of human cloned individuals is in sight, there is disagreement between countries insisting that the creation and utilization of human cloned embryos for research purposes should be banned in the treaty, and countries insisting that the handling of human clone embryos should be regulated by each country in accordance with domestic conditions, and should therefore not be targeted by the treaty. As a result, the United Nations General Assembly voted in November 2003 to extend the discussion period regarding adoption of the treaty by one extra year.

(2) Human ES Cells

Because human ES (Embryonic Stem) cells have the potential to differentiate into every type of cell in the human body, they are often called "master cells." Cells that are lost to disease or accident, and which cannot regenerate on their own, for example, could be created from human ES cells and then transferred into the body, opening up new treatments of ailments that were previously considered to be difficult to cure. But human ES cells are created (established) through the destruction of a human embryo, giving rise to ethical issues, because a human embryo that could have developed into a fetus if it had been transferred into a human womb is being used for a purpose other than the birth of a human life.

As a result, the Bioethics Committee Subcommittee on Human Embryo Research was established in 1999 under the Council for Science and Technology (which was renamed the Council for Science and Technology Policy in January 2001), to engage in studies into the utilization of human embryos for research purposes, followed in September 2001 by the "Guidelines for the Establishment and Utilization of Human ES Cells" being adopted by the Ministry of Education, Culture, Sports, Science and Technology. These guidelines require that careful ethical and societal consideration be taken in regards to the handling of human embryos.

In other countries, as well, ethical discussions in regards to human ES cells are recognized as necessary, and the preparation of frameworks in regards to ethical issues is in progress. Moreover, a number of countries have drawn up rigorous laws and public ordinances in regards to the handling of these cells.

(3) Human Genome and Gene Analysis Research

The human genome is the blueprint for human life, and human genome and gene analysis research has led to the development of new treatment methods through the explication of affected genes, and to clarification of people's tendencies to catch disease based on their genetic characteristics, which is leading to expectations of medical treatment suited to specific individuals (the so-called "tailor-made medical treatment"), and other major contributions to progress in the life sciences and health treatment science. On the other hand, information obtained in the process of human genome and gene analysis research will enable the identification of genetic factors in the providers of specific samples and all their blood relatives, which could lead to various ethical, legal, and social problems. In addition, while information regarding the analysis of gene structure or function could be utilized in tests, diagnoses, and medical treatment, utilization of such information to determine the gender of unborn children, to discriminate in employment, or to influence the content of insurance contracts, for example, will require consideration of serious societal issues.

Faced with these issues, in Japan, the Council for Science and Technology's Bioethics Committee laid down basic principles in June 2000 in regards to human genome research. Based on these principles, the Ministry of Education, Culture, Sports, Science and Technology joined with the Ministry of Health, Labour and Welfare and the Ministry of Economy, Trade and Industry in March 2001 to establish the joint "Ethical Guidelines for Human Genome and Gene Analysis Research." The guidelines stipulate an emphasis on respect for people, securing individuals' consent (informed consent), protection of individual information, appropriate return of research results to society, and procedures for ethical investigations in research institutions.

(4) Gene Recombinant Tests

Gene recombinant technology, which is already in technical use in society, is well-suited to elucidation of the framework of living things, to the efficient manufacture of medical and pharmaceutical products, and to the improvement of agricultural crops, etc., and expectations are high for its technological applications. On the other hand, one social concern is the fear of the adverse effect it may have on biodiversity and on sustainable utilization.

In addition, the handling of living things using gene recombinant technology has developed into an international issue. In 2000, the "Cartagena Protocol on Biosafety to the Convention on Biological Diversity" was adopted under the auspices of the Convention on Biological Diversity, for the purpose of adopting measures in line with the safe transport, handling, and utilization of gene recombinant lifeforms that could adversely affect the protection of biological diversity and their sustainable utilization, with particular focus on the appropriate control of movement that crosses international borders. In Japan, the "Law for Preservation of Biological Diversity Through Regulation of the Use, etc., of Gene Recombinant Lifeforms, etc.," stipulating the domestic measures required to conform with the protocol, was passed in June 2003.

Table 1-2-33 Life sciences in Japan, the ethical issues, and responses

Life science research issues	Expected societal benefits	Presumed societal issues	Japan's response to date
Cloning technology	Stable supply of livestock, etc., manufacture of pharmaceuticals, protection and restoration of rare animals, large-scale supply of test animals, regeneration medicine, etc.	Production of cloned humans (violation of respect for people, risks to the human bloodline and human body), etc.	Law Concerning Regulation Relating to Human Cloning Techniques and Other Similar Techniques (issued in December 2000)
Human ES cell research	Regeneration medicine, etc.	Destruction of human embryos, "the germination of human life"	Guidelines for the Establishment and Utilization of Human ES Cells (announced in September 2001)
Human genome and gene analysis research	Development of medicines suited to individuals (tailor-made medicines), etc.	Misuse of individuals' genetic information, effects on social evaluation, etc.	Ethical Guidelines for Human Genome and Gene Analysis Research (announced in March 2001)
Gene recombinant testing	Elucidation of lifeform frameworks, efficient manufacture of pharmaceuticals, etc., improvement and stable supply of farm products, etc.	Adverse effects on biodiversity and sustainable use, etc.	Recombinant DNA test guidelines (announced in 1974, abolished in February 2004) Law for Preservation of Biological Diversity Through Regulation of the Use, etc., of Gene Recombinant Lifeforms, etc. (issued in June 2003)

Source: Prepared by MEXT

1.2.3.3 Toward the Utilization of New Technologies

(Basic Recognition)

As can be seen in the United States, where efforts for ELSI are stipulated in the law for research in the nanotechnology sector, investigation into ELSI is probably needed in Japan, as well, and not only in the life sciences, but also in any sectors where the people feel insecurities about the circumstances, and even in sectors where it is impossible to predict what kind of effects may occur.

For example, the Internet has vastly broadened communications and brought people closer together, but is also recognized as generating serious social problems, such as the appearance of on-line dating sites that can encourage criminal activity, the spread of sites that encourage slander against other people, and intrusions into people's rights through leaks of personal information.

So while various sciences and technologies have become familiar in people's lives in recent years, there are still many issues that stimulate discussion of social issues. For this reason, as well, efforts for ELSI will likely be needed for a wide spectrum of sectors in the future.

(Perspective on Efforts Relating to Ethical, Legal, and Social Implications)

In cases where scientific and technological progress has ethical implications, and in which efforts due to legal and other social measures have not kept up, some people feel that the research itself should not be attempted, even if it can be beneficial to society.

But as was discussed in Section 1.2.1, results of science and technology are not linked only to social benefits, since their effects can spread outward to give rise to new science and technology that link to benefits for future generations. Moreover, activities that pursue the truth, or lead to research that results in creativity, are related to academic freedom, and are therefore deserving of respect, because they constitute a universal right for satisfying humanity’s intellectual curiosity, which is essential for the development of society as a whole, and not just for scientists and technologists.

In ELSI investigations, the focus tends to settle on the negative aspects of science and technology, and the discussion is based on what needs to be restricted. But an important point that needs restating here is that ELSI efforts should proceed under the assumption that the research results are valid and important for society. Discussions should never be limited to the negative aspects for society, and the contributive aspects to society must not be overlooked.

(Consideration for International Society)

While international cooperation in science and technology has become increasingly active in recent years, it is easy to imagine that science and technology with no social implications for Japan could have major social implications in some other country, and that the science and technology in that country could have social implications in Japan.

For this reason, when engaged in research cooperation with other countries, care must be taken to ensure harmony with international society, and efforts in ELSI that take into consideration international trends or conditions in the partner country for exchanges are required.

(Scientists Awareness of Ethical, Legal, and Social Implications)

According to the “Survey of the State of Japan’s Research Activities (FY2003),” a questionnaire survey directed at researchers, the vast majority of researchers recognize the importance of efforts in ELSI, which clarifies the social benefits and issues from science and technology, and which also hints at the response needed (Figure 1-2-34).

Moreover, a large proportion of those researchers who recognized the importance of efforts in ELSI also recognized the need for reforming awareness among researchers and the research community (Figure 1-2-35).

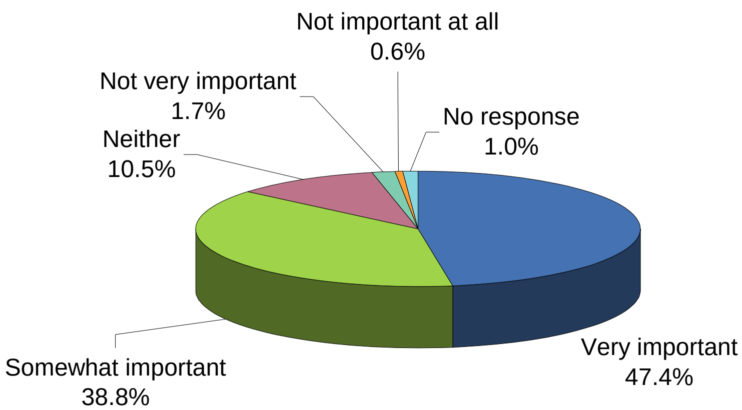


Figure 1-2-34 Researcher awareness of research into ethical, legal, and social issues

Source: MEXT. "Survey of the State of Japan's Research Activities (FY2003)"

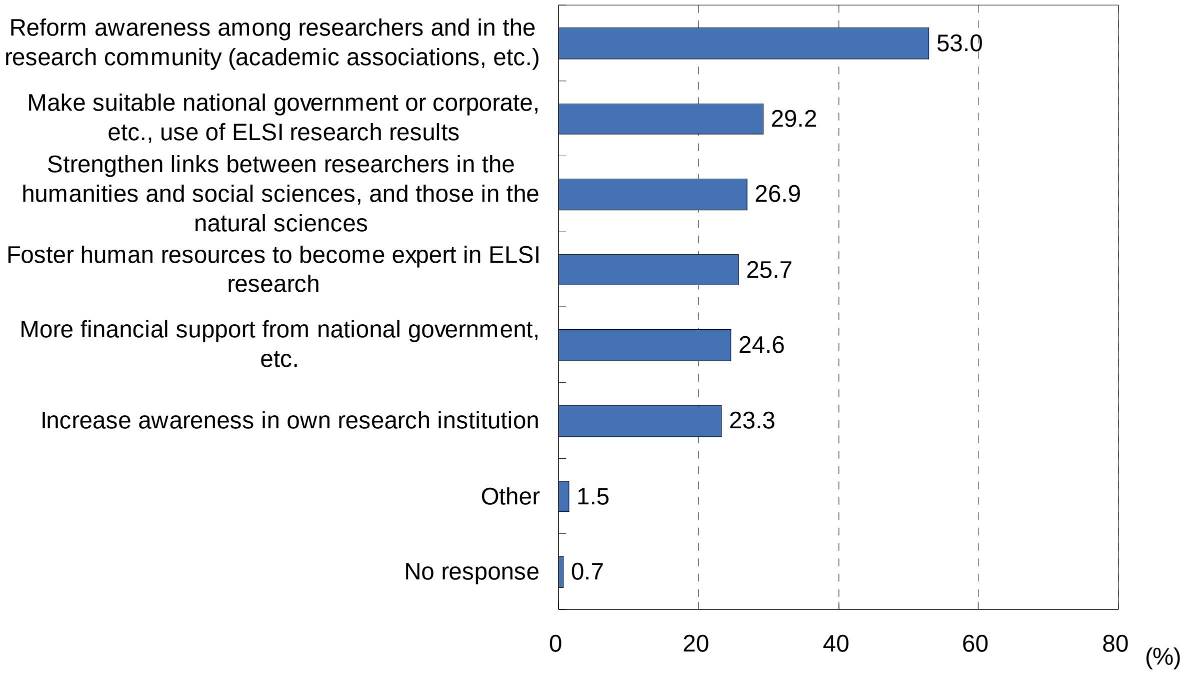


Figure 1-2-35 Efforts required for promotion of future research into ethical, legal, and social implications

Source: MEXT. "Survey of the State of Japan's Research Activities (FY2003)"

It follows that the promotion of ELSI efforts requires that researchers, academic associations, and other members of the research community recognize the importance of efforts for ELSI. But with the present situation, where already the vast majority of researchers recognize the importance of efforts for ELSI, it is probably the community where the fostering of consciousness of ELSI is most needed in the future.

At the same time, it is also important for the countries, corporations, and others actually utilizing the results of science and technology to put discernment obtained through investigation of ELSI to practical use. In addition, it is important that participation in studies of the various issues that arise at the point of contact between science and technology and society, using the relationships between various social models, not be restricted to experts in the natural sciences, but also be extended to experts in as broad a spectrum of sectors as possible, such as researchers in the humanities and social sciences, including experts in ethics and law, as well as policymakers, and that discussions reach beyond sector boundaries.

For this purpose, in regards to practical support for the establishment of ELSI efforts, and for the development of a suitable environment, as well as for such issues as fostering human resources, sharing information, and transmitting that information to society, comprehensive efforts extending to the nation overall, including research institutions, corporations, and governments, rather than to individual researchers alone, are important for ensuring that science and technology can truly be accepted and utilized as being for society.

1.2.4 Japan's international contributions

(Contribution as a Leader in Science and Technology)

Japan has historically introduced and developed many sciences and technologies from overseas, and in that sense can be considered to be the recipient of many benefits from international society. At present, Japan is a major economic power that is ranked No.2 in the world in terms of GDP, and is now aiming to become a world leader in science and technology, and as can be seen by studies now in progress at the Council for Science and Technology Policy, the Advisory Council on Economic and Fiscal Policy, and elsewhere, based on the state policy of an Advanced Science- and Technology-Oriented Nation, the promotion of science and technology is a top priority issue for the state.

Japan's advanced competence for science and technology has created excellent results in automobiles, electrical equipment, and compact equipment, etc., and these have gone out to the world, contributing to the improvement of societal convenience in countries everywhere. According to the "Public Opinion Poll on Science and Technology and Society (February 2004)," many people in Japan recognize that Japan's science and technology is more advanced than that of most foreign countries (Figure 1-2-36). At the same time, a public opinion poll of attitudes toward Japan in Western nations found that even residents of advanced nations hold high expectations for Japan's international contribution in the area of science and technology (Figure 1-2-37).

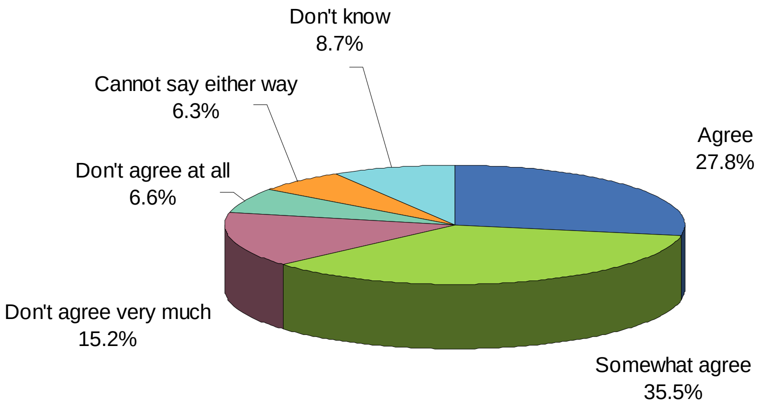


Figure 1-2-36 Awareness that Japan's science and technology is more advanced than most foreign countries

Note: Response to question about the assertion that "Japan's science and technology is more advanced than most foreign countries."

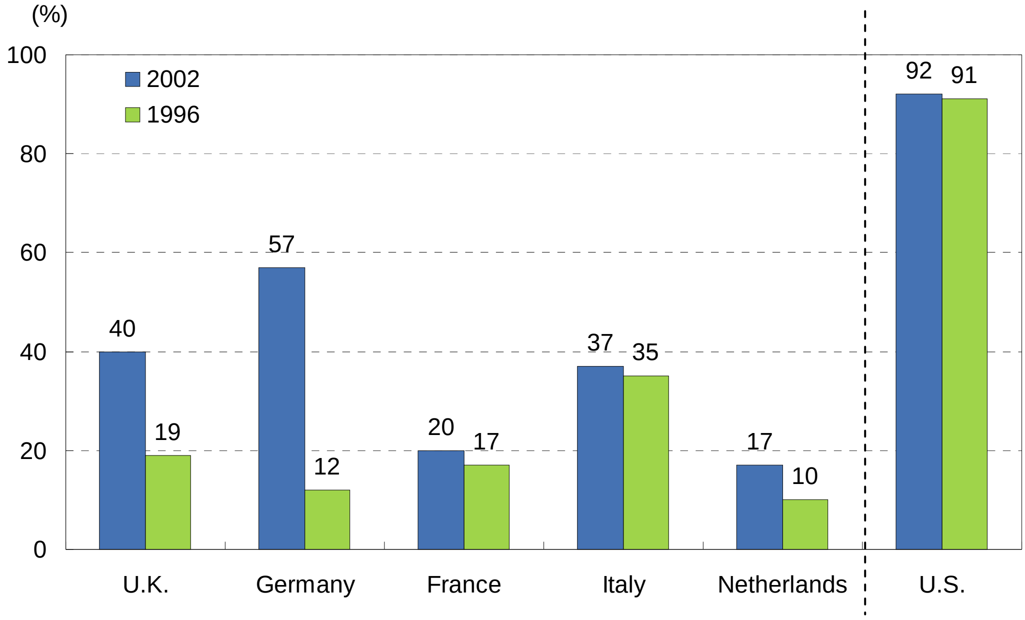


Figure 1-2-37 Proportion of respondents in foreign countries selecting science and technology when asked where Japan should make a greater international contribution

Note: For the United States, the result shows the proportion of respondents who selected the "science and technology sector" in response to the question "in what sector should Japan play an important international role."

Source: UK, Germany, France, Italy, Netherlands: Ministry of Foreign Affairs of Japan. "Public Opinion Poll on Attitudes Toward Japan in Five EU (European Union) Countries (April 2003)" United States: Ministry of Foreign Affairs of Japan. "Public Opinion Poll on Attitudes Toward Japan in the United States (among the general public) June 2002)"

As can be seen, many people today believe that Japan will make an international contribution in science and technology. But while science and technology has helped to improve the living standards of mankind in general, it may also be promoting a widening divide between nations. The Digital Divide, for example, describes a new divide that has arisen between the countries that are able to catch up with the progress of leading-edge science and technology, and those countries that are not capable of such responses, and it could well be widening the economic gap between the two.

In addition, any attempt to promote in all regions everywhere the mass production, mass consumption, and mass waste that has been the hallmark of economic development in the advanced nations would clearly be impossible in a physically limited Earth, because resources would quickly be exhausted and the environment destroyed. As a result, the role played by science and technology will be increasingly important in promoting "sustainable development," which aims to leave a nice living environment for future generations, and to maintain and develop the living standards of our own generation.

In response to the 2002 Johannesburg Summit, Japan is making specific efforts to support the formation and implementation of environmental policies, through cooperation in fostering human resources, as well as through Earth observation and other activities related to S&T. At the Evian Summit of G8 advanced nations in 2003, Japan announced to international society that science and technology is the key to upholding both world economic growth and the preservation of the global environment, after which the “Science and Technology G8 Action Plan for Sustainable Development” was adopted. Following the summit, Japan hosted the Earth Observation Summit II in Tokyo in April 2004. In this meeting, recognizing that Earth observation holds the key for understanding the Earth, for strengthening the safety and welfare of people’s lives, and for ensuring sustainable growth for our society, several goals for socioeconomic benefits were clarified, including to “reduce human and property losses due to natural disasters,” “respond to climate change,” and “improve water resource management.” Moreover, based on a review of past Earth observation activities, Japan has actively played a role in the establishment of a framework for an Earth observation implementation program over the next 10 years, to construct a new Earth observation system with the cooperation of the member countries and related institutions.

Other specific contributions related to science and technology include efforts to develop technology for humanitarian reasons for the detection and removal of antipersonnel mines, now being promoted by the Japan Science and Technology Agency, and the project is expected to be an international and visible contribution of Japan’s advanced science and technology.

In recent years, Japan has utilized science and technology to contribute to improvements in the quality of life, and has felt the need to take the initiative in dealing with societal issues shared by all of humanity in such areas as global environmental and bioethics issues for which solutions by single countries cannot be successful. Moreover, science and technology is now so closely connected to the economy and society that scientists must join with all levels of the people in dealing with these problems.

To this end, Japan called for the convening of a Science and Technology in Society Forum of scientists, policymakers, economists, journalists, and others to discuss such international issues as the global environment and bioethics, in relation to the future of mankind. With an enthusiastic international response to the idea, the forum was held in November 2004, with an agenda that included discussion of how to achieve harmonious progress between science and technology and society.

With demand rising for a science and technology strategy from the international perspective, the leading role that Japan plays in the utilization of science and technology for ensuring society’s safety and security, discussed in Section 1.2.2, as well as in various other efforts related to science and technology for society, and to science and technology in society, should be considered extremely important, as one of Japan’s contributions to international society, and as one of its policies for demonstrating an international presence.

(Contributions to the Asia Region)

In the late 19th century, Japan aimed for industrial development toward the goal of formation of a modern state, and then in the mid-20th century for economic growth toward the goal of recovery from World War II, in both cases harnessing science and technology as a national policy for the modernization and industrialization of the state. Meanwhile, the science and technology that was so deeply rooted in the culture of the nations of the West penetrated deeply into Japan’s society, completely overturning it and leading in some cases to the discarding of older traditions and customs. Japan, after a period of worry about how to maintain traditional culture in the face of science and technology, is now universally recognized as being at the forefront of science and technology. Japan’s experience and history as a nation that introduced science and technology while coming from a different cultural background than the nations of the West offers rich hints for the development of science and technology in the nations of the developing world, and particularly for the nations of Asia.

In a public opinion poll targeting Asian nations (the member nations of ASEAN) on attitudes toward Japan, people in Asian nations, while showing some differences from one country to the next, tended to exhibit a high degree of interest in Japan’s science and technology (Figure 1-2-38). While the results probably need to be treated with some care, because the survey targeted the literate classes, they do show the importance for Asian countries, with their similarity to Japan in being culturally distinct from the nations of the West, in engaging in various research exchanges and drawing on the current conditions and experiences of Japan’s science and technology.

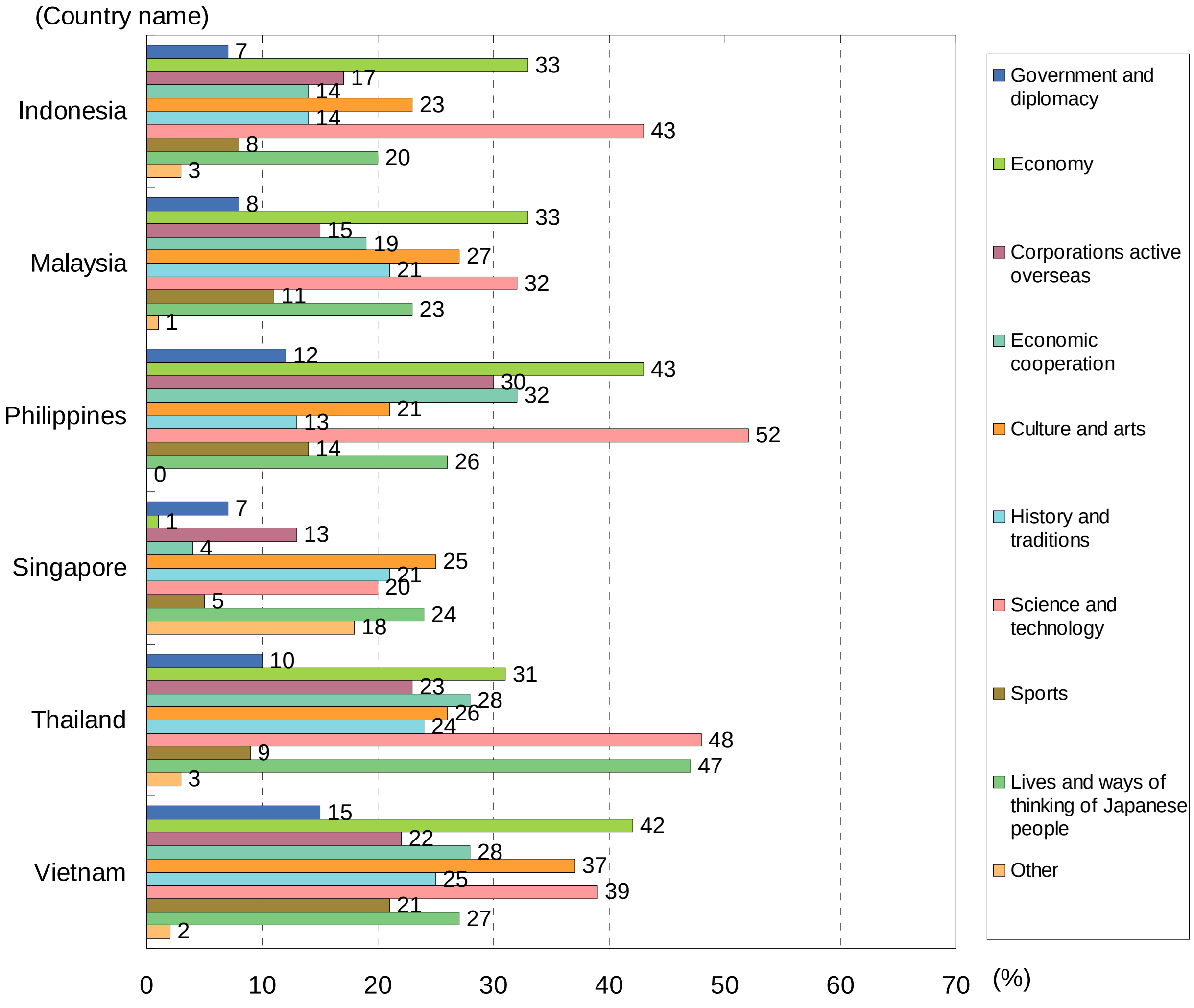


Figure 1-2-38 Sectors in which people in ASEAN countries would like to know more about Japan

Source: Ministry of Foreign Affairs. "Public Opinion Poll on Attitudes Toward Japan in ASEAN Countries (November 2002)"

To date, the Asian countries and Japan have engaged in a variety of joint activities in science and technology. For the purpose of promoting cooperation in scientific sectors in the Asia region, and of encouraging mutual understanding, the Science Council of Japan called for the establishment of a Science Council of Asia for the exchange of opinions in scientific sectors by representatives of 10 Asian countries. In response to this suggestion, annual meetings of the council have been held since 2001, contributing to the promotion of international scientific activities in Asian countries (Table 1-2-39).

Table 1-2-39 Countries and organizations participating in the Science Council of Asia

Country name	Organization
Japan	Science Council of Japan (SCJ)
China	Chinese Academy of Space Technology (CAST)
India	Indian Council of Social Science Research (ICSSR)
Indonesia	Indonesian Institute of Sciences (LIPI)
	Department of National Education
Korea	National Academy of Science (NAS)
	Korean Academy of Science and Technology (KAST)
Malaysia	Academy of Sciences Malaysia (ASM)
	Ministry of Science, Technology and the Environment (MOSTE)
	Institute for Environment and Development
Philippines	National Research Council of the Philippines (NRCP)
	Philippine Social Science Council (PSSC)
	Marine Sciences Institute
Singapore	Agency for Science, Technology and Research (A*STAR)
Thailand	Thailand Academy of Science and Technology
	The Science Society of Thailand (SST)
Vietnam	Ministry of Science and Technology (MOST)
	Ministry of Health (MOH)

Source: Prepared by MEXT, based on materials from the Science Council of Japan.

If the countries of Asia are to take their places alongside the United States and the countries of Europe in the fields of science and technology in the future, Japan needs to build a partnership with them as the nucleus for a long-term perspective in the fields of science and technology.

In such an effort, it is important to foster and ensure human resources able to support various science and technology activities, and in this regard Japan will need to strengthen programs to invite excellent young researchers to Japan for the purpose of fostering front-line class researchers in Asian countries, while at the same time sending Japanese researchers to Asian countries. In regard to efforts toward global-scale issues, it is important to develop activities centering on the Asia region. Furthermore, Japan can, as a member of the Asia region, act in concert with Asian countries to promote cooperation and exchanges with Western nations in science and technology, a process that will require dialogue with Asian nations at the bilateral policy level, as well as the formation, strengthening, and utilization of an Asian network linking researchers and research institutions in Asian countries.

In implementing these efforts, Japan will need to make available technologies in sectors where it has demonstrated particular excellence, and to demonstrate its leadership as an advanced scientific and technological country within Asia, so as to contribute greatly to the vitality of Asia as a whole.

One specific example of such efforts is at the Japan Society for the Promotion of Science, which has systematically implemented a university exchange program for exchanges of researchers on a bilateral or multilateral basis to participate in international joint research, and has contributed to the formation of a network in Asia. Moreover, some problems facing Asian countries include floods, earthquakes, and other natural disasters, and also parasites and infectious diseases. In all these cases Japan has shared similar experiences, and has developed advanced technologies for preventing or reducing the effects of natural disasters, and for responding to infectious diseases. In regard to the technologies in these sectors, Japan has demonstrated international leadership among Asian countries, and is actively engaged in hosting international forums and in performing the accompanying international surveys and research, as well as in dispatching people to developing countries to train people in skills for the prevention of earthquake disasters. Through these activities, Japan contributes to the Asian countries.