Creating, protecting and utilizing intellectual property

In order to boost innovation, it is essential to stimulate the intellectual creative activity cycle and ensure that the resulting intellectual property is properly protected and utilized.

(i) Transferring the research results from universities to society

With the implementation of the University Intellectual Property Centers Program in FY2003, there has been progress on the establishment of intellectual property headquarters at universities. In addition, as a result of the incorporation of the national universities in FY2004 each university took over the rights and responsibilities related to intellectual property, and have developed systems to utilize intellectual property according to their own judgment.

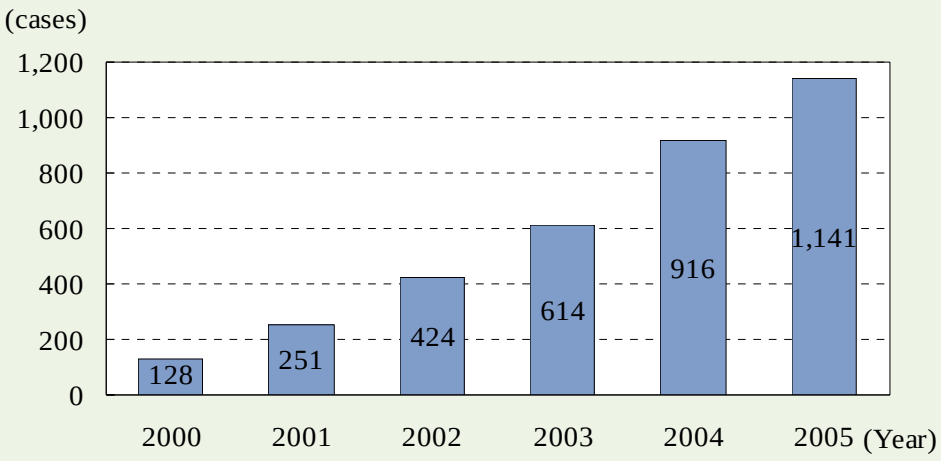
(ii) Promoting intellectual property activities

It is important to utilize outstanding R&D results that become the source of global competitiveness by effectively obtaining the rights, particularly as basic patents in Japan and abroad. For businesses it is important to shift from a quantity-based patent strategy to a quality-based strategy, and work on obtaining high-quality basic patents. For universities, it is important to actively obtain the appropriate rights for their intellectual property, regardless of whether it is within Japan or abroad. It is also necessary for the country to support the strategic measures of the universities, etc.

Promoting entrepreneurial activities of R&D ventures

Research and development-based venture businesses, such as university start-ups, quickly return ground-breaking research results from universities to society, and play an important role as a driving force of innovation. In recent years universities are not just generating the seeds that are the source of knowledge, but are also actively setting up university start-ups to develop new goods and services utilizing their own research results (Figure 19).

Figure 19 ▶ Number of university-based venture start-ups



Note: Survey subjects: National, municipal and private universities, technical colleges, and inter-university research institutes throughout the country (786 sites), as well as government research facilities (47 sites)
Source: Ministry of Education, Culture, Sports, Science and Technology "2005 University-Based Venture Start-up Survey"

Building regional innovation systems and creating vital regions

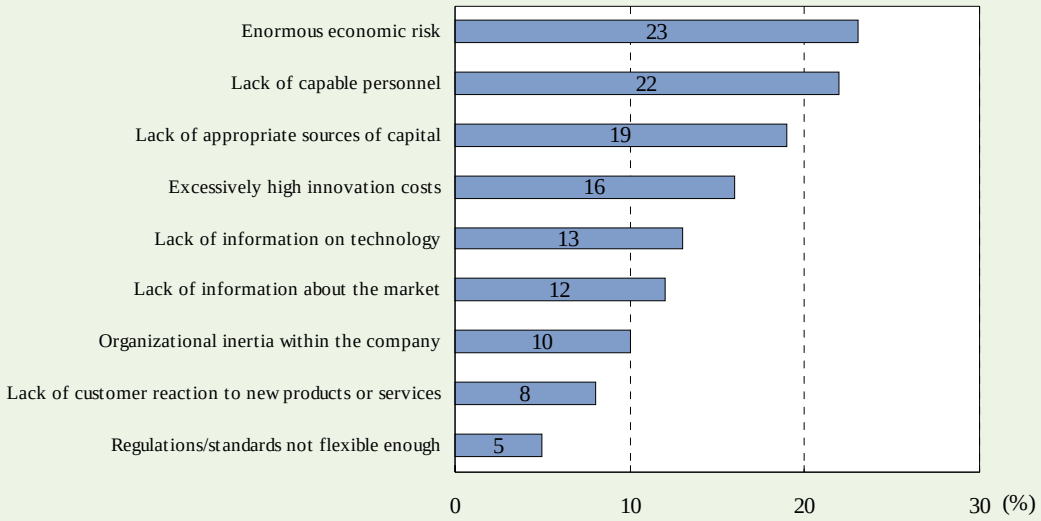
A cluster is a concentration of the necessary business and industry functions needed for innovation. In order to promote innovation throughout Japan it is important to build competitive local innovation systems by developing local clusters with international competitive ability.

Japan has implemented the "Knowledge Cluster Initiative" and the "Industrial Cluster Project." A liaison committee of agencies associated with regional science and technology has been formed and there are efforts to achieve cooperation and coordination among agencies and ministries.

Innovation activities by private enterprises

According to the December 2004 "Statistics on Innovation in Japan" 29% of all businesses conduct innovation activities, and 22% have achieved innovation. The main obstructions reported by the companies that have achieved innovation are "enormous economic risk," "lack of capable personnel," "lack of appropriate sources of capital," and "excessively high innovation costs." (Figure 20)

Figure 20 ▶ Innovation obstructions to innovating companies

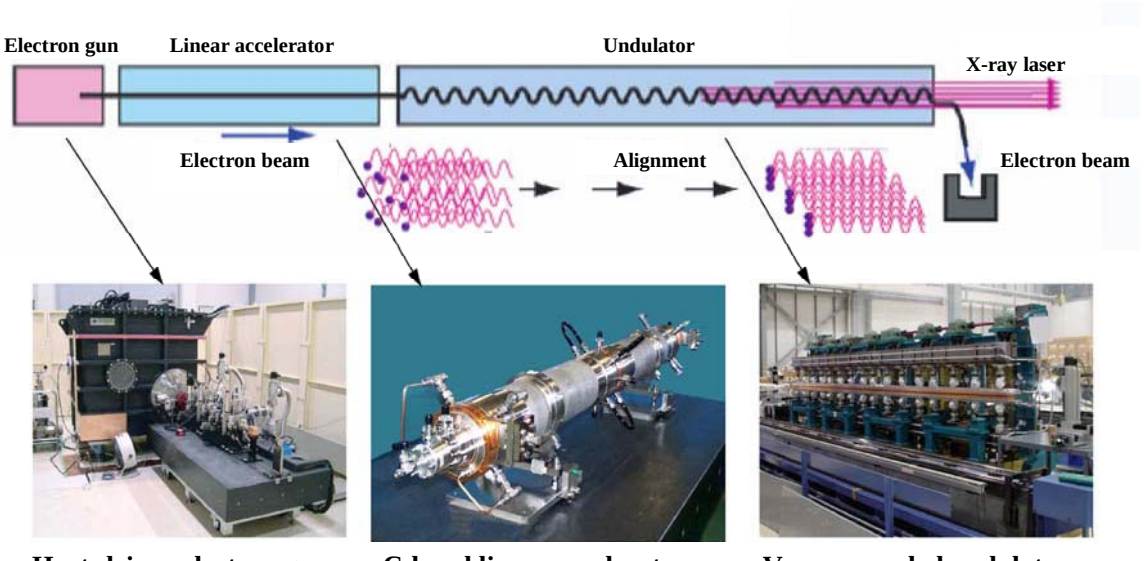


Note: Among the companies that have achieved innovation and responded, the percentage of companies indicating a high level of importance (strong impact) for the obstructions experienced during the time innovation activities were being conducted (1999-2001).
Source: Ministry of Education, Culture, Sports, Science and Technology, National Institute of Science and Technology Policy "Statistics on Innovation in Japan" (FY2004)

3 To Build Innovation Systems

As society continues to age and the number of children declines it is crucial for the country to have continuous innovation in order to maintain economic vitality and international competitiveness. In the future it will be necessary for industry, academia and the government to work together and strengthen the innovation systems so that the latent abilities of the nation are utilized to the fullest extent in order to continuously and effectively achieve innovation for the ground-breaking research and development results including the basic research results from universities and public research agencies. As a nation it is necessary to prepare a variety of research funding systems to correspond to the various stages of R&D development, and to build the mechanisms to develop promising research results from the basic research stage through the creation of useful products.

Research facilities that drive the development of the nation
X-ray FEL (free-electron laser)



Heat-driven electron gun: **Generates a sharper electron beam**

C-band linear accelerator: **Accelerates to high energy in a short distance through an acceleration gradient**

Vacuum-sealed undulator: **Oscillation of short wavelength, high interference, high intensity x-ray laser**

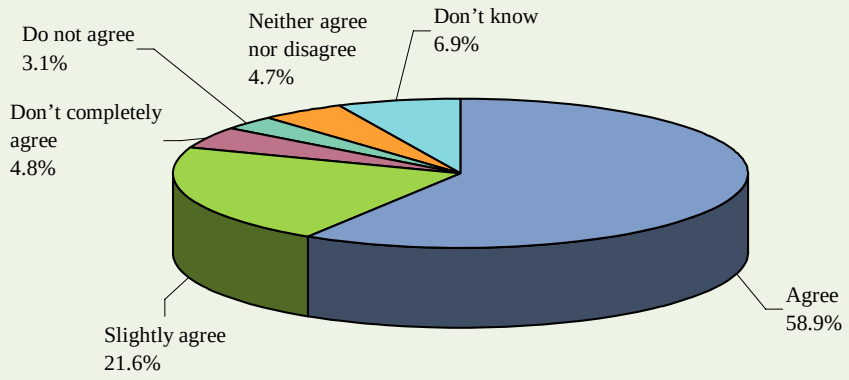
Source: RIKEN

Section 3 Science and Technology Contributing to Building a Spiritually Wealthy Society

1 Science and Technology Contributing to Achieving Spiritual Wealth

In an aging society with fewer children the average lifespan is increasing, if it is possible to extend the healthy lifespan (period of time of healthy independence, in terms of the quality of daily life and health of both mind and body) through science and technology, this is expected to lead to a society in which people can live a long life of health and abundance. Over 80% of people feel that the progress of science and technology in the future should contribute not only for material wealth, but also for achieving spiritual wealth (Figure 21).

Figure 21 ▶ Science and technology development should focus on spiritual wealth



Note: Responses to the statement "The progress of science and technology in the future should not only be for material wealth, but also directed at achieving spiritual wealth"
Source: Cabinet Office "Public Opinion Poll on Science & Technology and Society" (2004)

2 Science and Technology to Contribute to Preservation/ Utilization of Cultural Heritage and Creation of Arts

Science and technology contributions to preservation and restoration of tangible cultural heritage

For the preservation and restoration of tangible cultural heritage, preservation and restoration techniques are being developed using the latest science and technology.

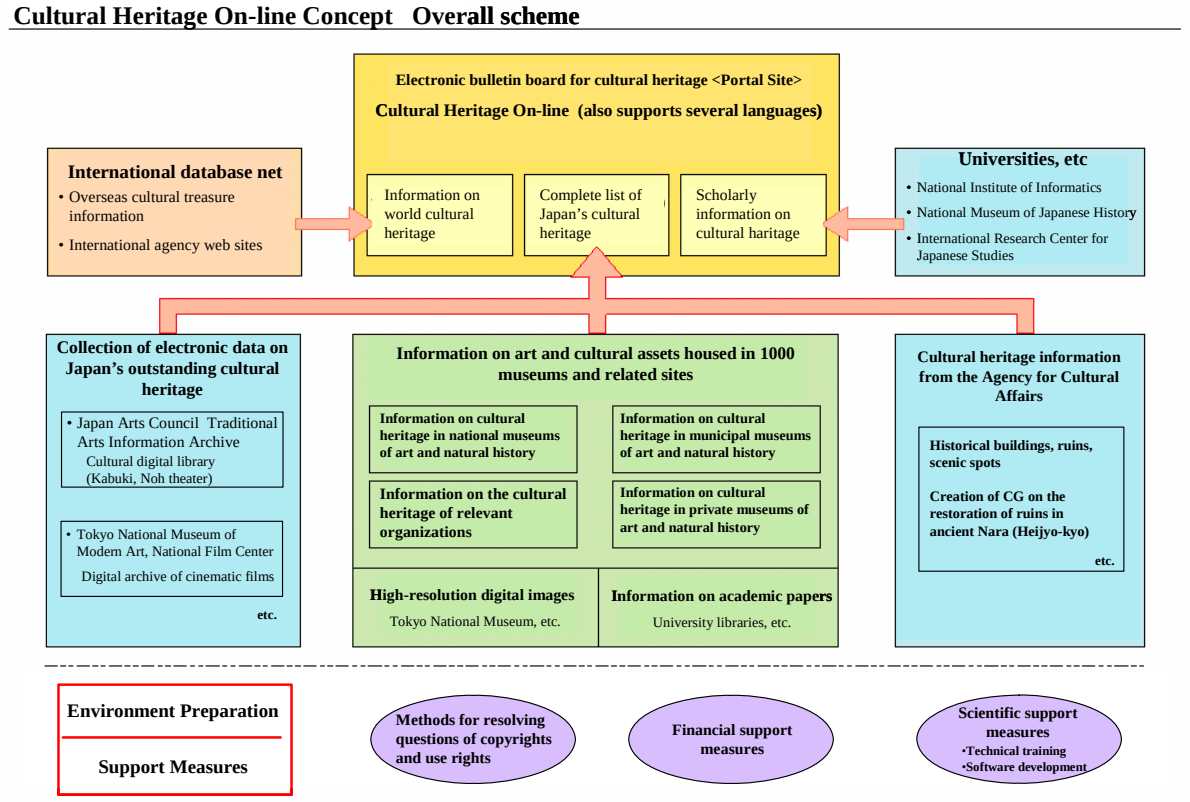
Science and technology contributions to preservation and restoration of intangible cultural heritage

Science and technology makes a large contribution to the preservation and passing down of skills that have historical and artistic value, such as the movements of the human body, as in the traditional techniques of pottery artists, etc.

Recent advancements in 3-D imaging technology have made it possible to make detailed recordings of movements.

Cultural heritage on-line

The Agency for Cultural Affairs and the Ministry of Internal Affairs and Communications are working on the "Cultural Heritage On-line Concept" to actively disseminate information on tangible and intangible cultural heritage of local regions and the nation using broadband technology. Under this plan it will become possible for citizens to easily obtain information on cultural heritage and traditional arts even from great distances.



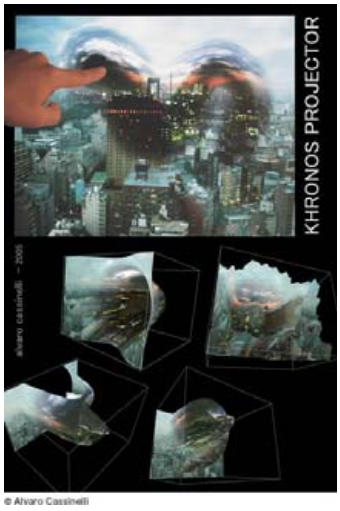
Source: Agency for Cultural Affairs "Cultural Administration for the Nation" (2005)

Science and technology contributing to the creation, transmission and use of arts and crafts culture

There has been remarkable progress on IT/telecommunications technology in Japan and a widespread use of computers and broadband connections. It is now an era in which anybody can view the information they want at almost any time. In the midst of this a new field of art has been created, known as media arts, including movies, animation, CG (Computer Graphic) art and game software using the multifunctionality and flexibility of the latest digital technology.

At the FY2005 Media Arts Festival, a symposium on the fusion of art and technology was held, and the latest technologies were introduced (leading edge technology showcase), drawing a high level of interest.

FY2005 Media Arts Festival,
Agency for Cultural Affairs
Grand prize winner in the art division



Title: Khronos Projector

Symposium “Fusion of art and technology”
-It’s future

A new look at the drawings from the “Genji Monogatari” (Tales of Genji)

Photo 1:
Takekawa (Bamboo River) chapter scroll,
Image of the wife section, Original image

Photo 2:
Takekawa (Bamboo River) chapter scroll,
Original image, Magnified section

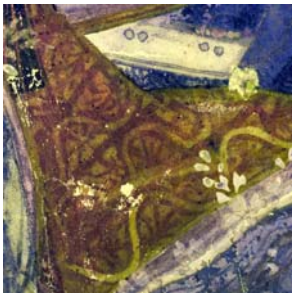


Photo 3:
Takekawa (Bamboo River) chapter scroll,
Patterns visible using fluorescent imaging technology

Sports to provide “spiritual wealth”

Sports are not simply a spectator form of entertainment; sports also offer a great deal of enjoyment to those who participate. Science and technology makes a large contribution to the analysis of the basic principles of sports in order to improve records, as well as to the advancement of the equipment and materials. As science and technology advance, the materials in the equipment changes, and more people can enjoy involvement in sports.

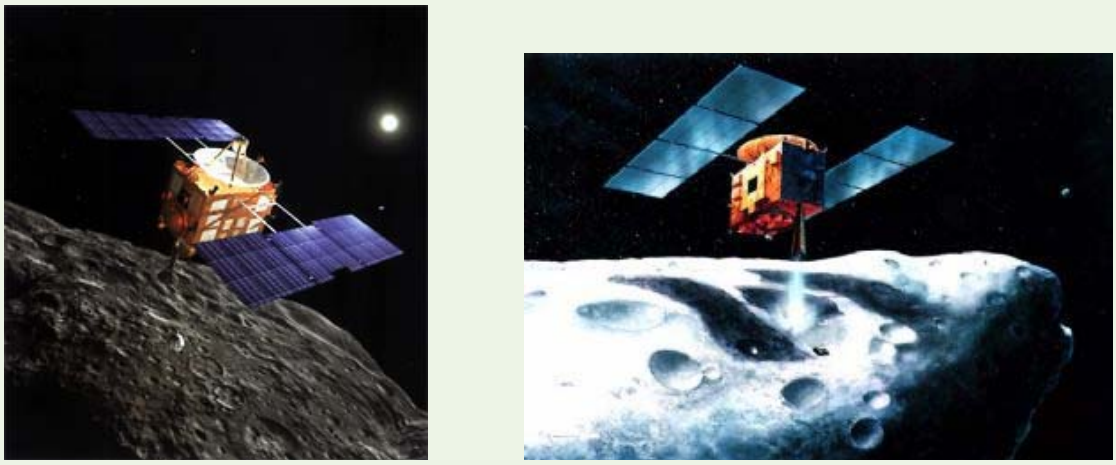
3 Science and Technology Creating Intellectual Value and Answering Intellectual Curiosity

The new understanding and discovery arising from the investigation of human frontiers of space, the earth and life contribute to the shared intellectual assets of mankind and answer the intellectual curiosity of people throughout the world who desire to know the truth.

Unraveling the mysteries of space *Hayabusa*

Hayabusa, the asteroid explorer launched in 2003, landed on the asteroid Itokawa in November 2005, approximately 300 million kilometers from earth. If the technology to bring back the samples obtained from the asteroid can be implemented, it is expected that this will provide clues about the solar system galaxy in which the asteroid was born (Figure 22).

Figure 22 ▶ Asteroid explorer *Hayabusa*



Source: Japan Aerospace Exploration Agency

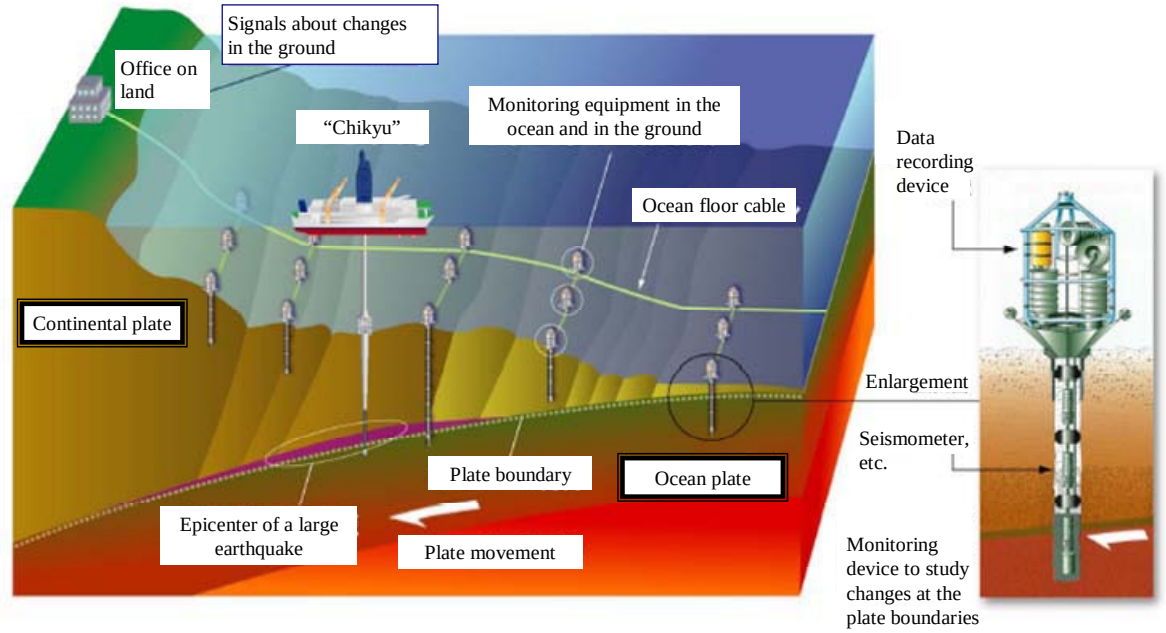
Deep Sea Drilling Vessel *Chikyu*

The deep sea drilling vessel, *Chikyu*, developed by Japan is expected to reach the mantle of the earth and investigate the massive earthquake zones in the ocean trenches. In addition, earthquake measurement equipment will be buried in the holes dug by *Chikyu* to help build an earthquake measurement network system to quickly relay information at the moment an earthquake occurs. This is expected to make a large contribution to future earthquake prediction, and disaster preparedness in urban areas (Figure 23, Figure 24).

Figure 23 ▶ *Chikyu*

Source: Japan Agency for Marine-Earth Science and Technology

Figure 24 ▶ *Chikyu* and plate boundaries



Source: Japan Agency for Marine-Earth Science and Technology

Investigation of ancient Egyptian ruins using satellite information

Science and technology is used to understand ancient civilizations. Data about the surface of the earth obtained from earth-observation satellites orbiting in space several hundred kilometers in space is being analyzed to look for characteristics similar to pyramid sites that have already been excavated, in order to identify promising locations to discover other as yet unknown pyramid sites.

Section 4 Science and Technology for the People and the Human Resources to Support Them

1 Science and technology for the sake of the people

(1) Understanding and interest of individuals toward science and technology

Necessity of Understanding and interest in Science and Technology

Science and technology continues to become more closely related with our daily lives, but in recent years there is a decline in interest in science and technology among the people in Japan, particularly among the young (Figure 25).

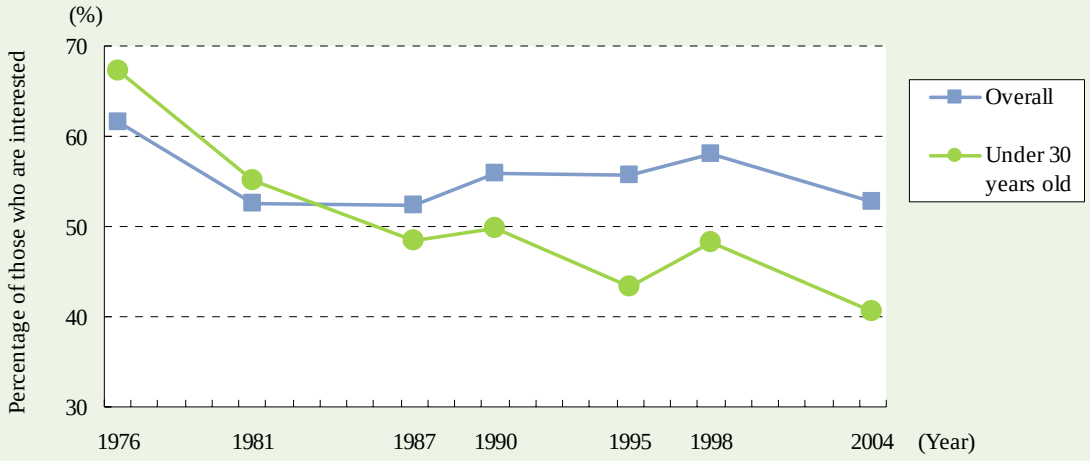
However, in the midst of a global shift to knowledge-based society, it is crucial for people to have an understanding of and interest in science and technology in order to actively cope with an aging society with fewer children through the creation of intellectual and cultural value, and the resolution of social and economic problems with science and technology, as shown in the previous section.

Improving science and technology literacy

It is important for individual citizens to have a basic understanding and ability in science and technology (science and technology literacy) for sufficiently enjoying the results of science and technology, considering desirable implementations of science and technology in society with interest, and forming their own opinions.

Methods likely to be effective in improving the science and technology literacy of citizens include presenting easy-to-understand, specific information on knowledge, skills and viewpoints on the science and technology that should be familiar to adults. The Third Science and Technology Basic Plan sets forth that such ideal science and technology literacy should be defined and widely disseminated.

Figure 25 ▶ Interest in science and technology news and topics



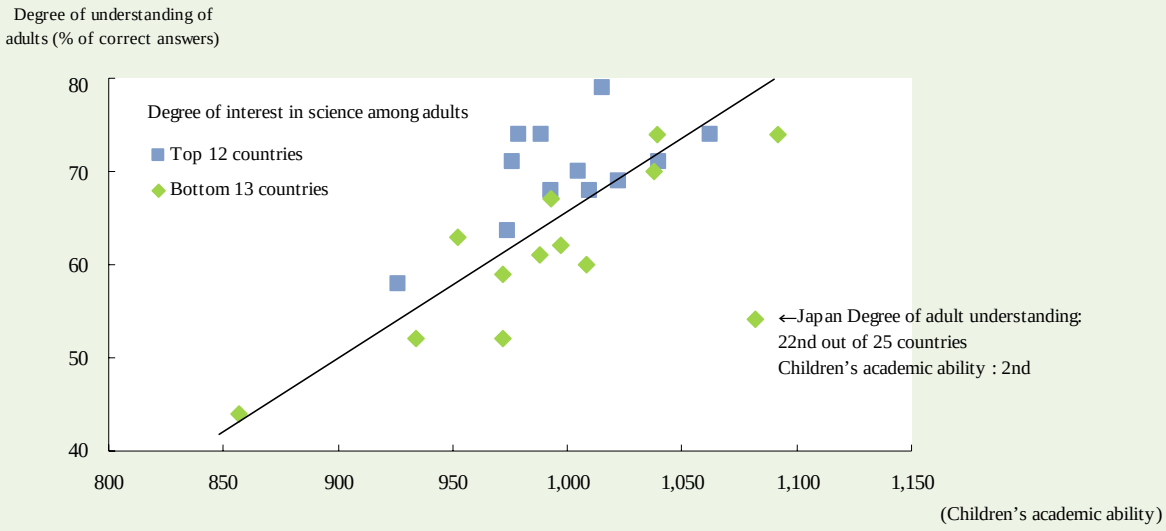
Note: Percentage of people who responded either “Interested” or “Somewhat interested”
Source: Cabinet Office “Public Opinion Poll on Science and Technology and Society”

Status of science and technology literacy and interest in Japan

It is important that citizens have an appropriate level of science and technology literacy in order to move forward into a new society through science and technology. At present, however, the understanding of adults in Japan regarding the basic concepts of science and technology is low in comparison to international levels (Figure 26).

Analyzing the degree of understanding by adults in Japan and various countries in Europe and America regarding the basic concepts of science and technology, along with the academic ability of children in science and math (Figure 26), shows that in general, countries in which the science and math abilities of the children are high also have a high level of understanding among adults, while low math and science abilities in children are associated with low levels of adult understanding. In Japan, however, situation is quite unique, as the academic abilities of the children are at the highest international levels, while the degree of understanding of science and technology among adults is in the bottom level.

Figure 26 ▶ Degree of understanding of science and technology among adults and academic ability of children (25 countries, including Japan)

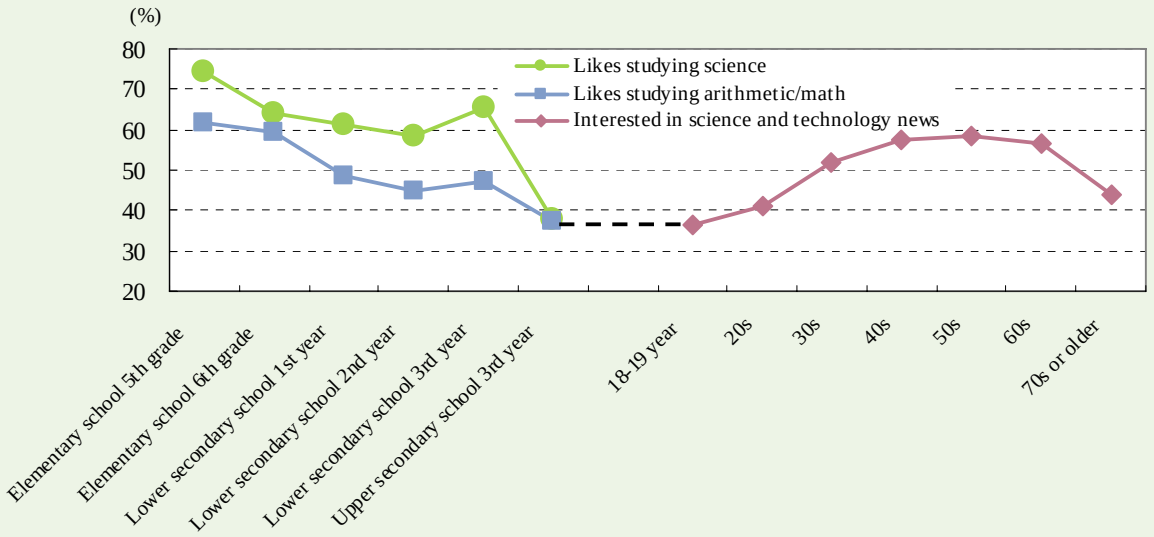


Notes: 1. The degree of understanding of basic concepts of science and technology among adults is indicated by the average percentage of correct answers to the same 13 questions in each country.
2. The academic ability of children is the combined average score on science literacy and math literacy form PISA 2003 surveys by OECD.
3. The degree of interest in science among adults is the percentage of those who responded that they were "very interested" or "fairly interested" in news reports on new scientific discoveries.

Source: National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology "Survey on the awareness about science and technology" (NISTEP REPORT No. 72, March 2001)
US National Science Foundation (NSF) "Science and Engineering Indicators 2002"
European Commission "Special Eurobarometer – Europeans, Science and Technology"

In Japan, the academic ability of children in science and math is at the highest levels internationally. In comparison, the interest in science and technology (study of math and science) drops as they progress to higher academic levels. This does not change after reaching adulthood (Figure 27), and the degree of understanding of science and technology among adults is far below international levels.

Figure 27 ▶ Interest in science and technology by grade level and age



Note: For the 5th grade of elementary school through the 3rd year of upper secondary school, percentage of students responding “yes” or “I guess so” when asked if they like studying each subject. For those 18 years and older, the percentage of those responding “interested” or “somewhat interested” regarding their reaction to topics and news about science and technology.

Source: National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology “2003 Research on Curriculum for Primary and Lower Secondary Schools,” and “2002 Research on Curriculum for High Schools”
Cabinet Office “Public Opinion Poll on Science & Technology and Society” (February 2004)

Propagation of indifference

A child’s like or dislike of science is greatly affected by the adults around the children.

In Japan, it seems likely that there is a self-perpetuating cycle of disinterest, as children with low interest become adults with low interest, and the low-interest adults influence the next generation of children to have low interest. In such a situation it is likely that the awareness and understanding of science and technology among adults would also be low.

Science café


Tokyo/Akihabara


Nagasaki

(2) Building empathy and confidence in science and technology

Mechanisms to vitalize communications to connect science and technology and society

It is necessary to decrease the number of children and adults with no interest in science and technology, increase science and technology literacy, and invigorate two-way communications between science and technology and society.

There should be outreach programs through which researchers and engineers explain their research to the public in easy-to-understand ways, as well as hear the desires and anxieties of the public and reflect them in their activities. In addition, there is a need to increase the opportunities for people to touch, experience and learn about science and technology at museums and science exhibition centers, and foster and ensure specialized personnel to be the workers responsible for these activities, volunteers, and science and technology journalists.

Furthermore, there must be efforts to train and improve the quality of good teachers, and coordinate among schools, local universities, public research institutes, businesses and museums so that they can convey to children the importance and pleasure of learning science and math by providing more opportunities to speak directly with researchers and meet them face-to-face, and to understand empirical and problem-solving science and technology through observation, experimentation and training.

Researcher/engineer ethics

In February 2006 the Council for Science and Technology Policy decided the “Handling Misconducts in Research” to provide its opinions to the relevant ministries. It stated that there was a need to quickly deal with problems of misconducts in research, and requested that the researcher community, relevant ministries, as well as universities and research institutes take measures according to their respective positions based on the autonomy of those involved in research.

At present, the “Special Committee on Misconducts in Research Activities” is established in the Council for Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology, conducting studies to deal with the improper behavior in research activity that is performed with public competitive funds. In addition, the Science Council of Japan conducts investigations on presenting a charter or a code of conduct of scientists in order to maintain and strengthen the autonomy and ethics of the scientific community from the standpoint of representing the community of scientists.

Figure 28 ▶ Handling in various nations for misconduct in research (Cases)

Country	Measures (cases)
USA	・Office of Science and Technology Policy (OSTP) adopted federal regulations on misconduct. ・Office of Research Integrity (ORI) and National Science Foundation (NSF) came to require research institutes to establish procedures for investigating and judging misconduct and a code of conduct as a qualification for research grants. ・For researchers found to have engaged in misconduct, measures are taken, such as loss of the qualification to apply for grants for several years, publication of details of misconduct and dismissal from associated research institutes. ・National academies implement education and awareness-raising activities, such as publication of pamphlets on ethics aimed at young researchers.
Germany	・The committee on "Professional Self Regulation in Science (Selbstkontrolle in der Wissenschaft)" established by the German Research Foundation (Deutsche Forschungsgemeinschaft; DFG) issued recommendations on 16 items, including the establishment of procedures to investigate and judge misconduct and a code of conduct at research institutes. ・At several universities, procedures to deal with misconduct and a code of conduct were established in accordance with these recommendations.
France	・The National Institute of Health and Medical Research (Institut national de la sante et de la recherché medicale; INSERM) established a code of conduct and procedures to deal with misconduct.
United Kingdom	・Each research council, including the Medical Research Council (MRC), established guidelines on code of conduct, and guidelines on procedures to investigate and judge misconduct. ・Many universities have codified the same kind of rules and procedures as those of the MRC.
Northern Europe	・In Denmark and Norway there are national level agencies to handle cases of suspected misconduct.
China	・The Chinese Academy of Sciences has established a Science Morality Construction Committee and enacted a rule on autonomous ethics for members of the Chinese Science Institute Academy. ・The National Natural Science Foundation of China enacted the "Measures against misconducts in providing the Science Foundation grants (tentative)"

Source: Created by the Ministry of Education, Culture, Sports, Science and Technology based on the [Current Status and Countermeasures to Misconduct in Science (Science and Society Standing Committee report)] of the Science Council of Japan

2 Human Resources to Support Science and Technology

(1) Science and technology-related personnel acting in a wide range of jobs, and personnel development

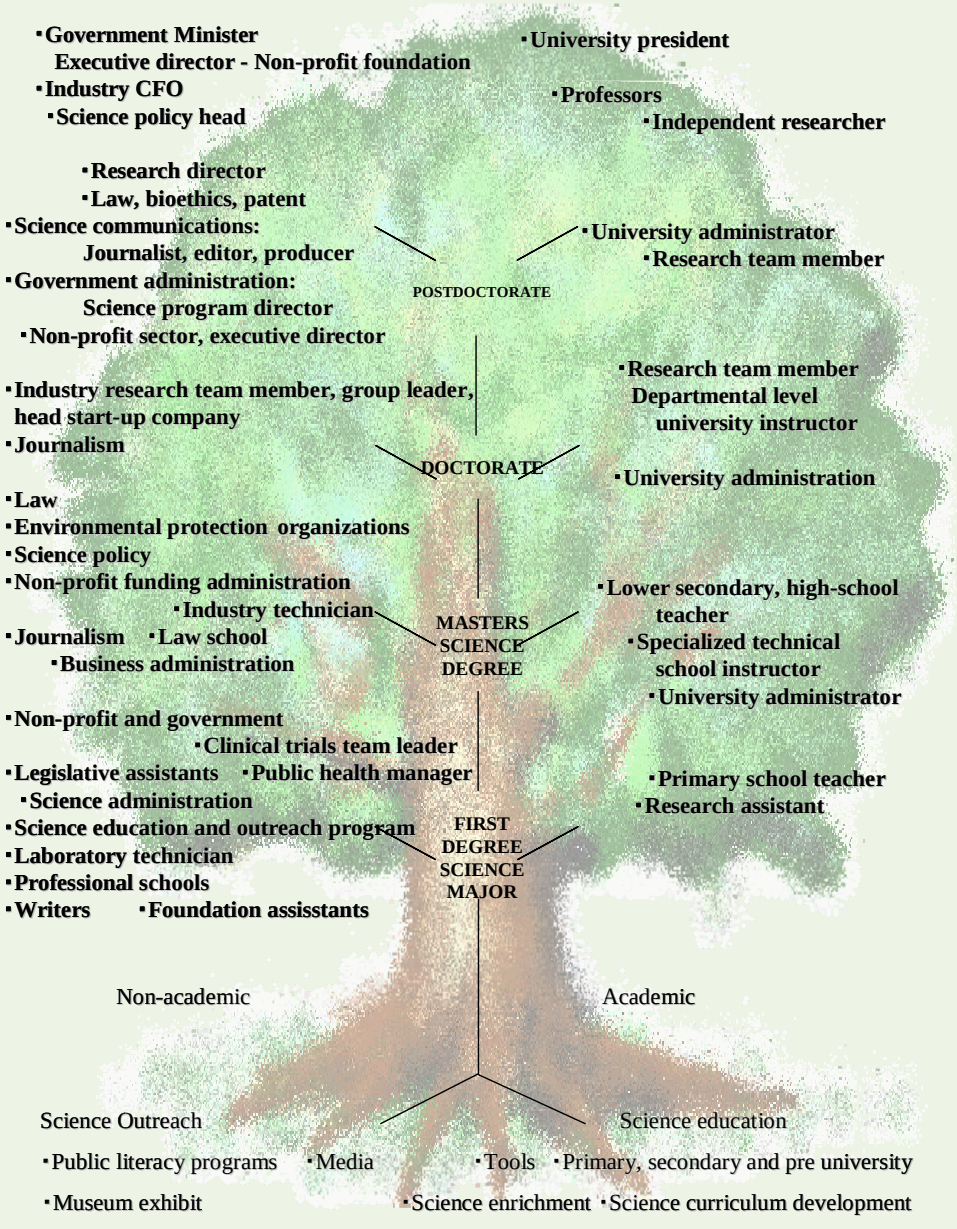
● Science and technology-related personnel acting in a wide range of jobs and anxiety about a lack of personnel

If various problems arise with the changing of the population composition of we Japanese

citizens, it is also we that must overcome these problems and open the way to a new society. The realization of a new social system through the creation and use of science and technology will be achieved only by the activities of those among us who are associated with science and technology.

There is no need to belabor the importance of the researchers who create new knowledge, but in addition, various science and technology-related personnel will come to play important roles in a more diverse range of sites and scenes in the future society where science and technology will be used even more actively (Figure 29).

Figure 29 ▶ Diverse career paths for science and technology workers

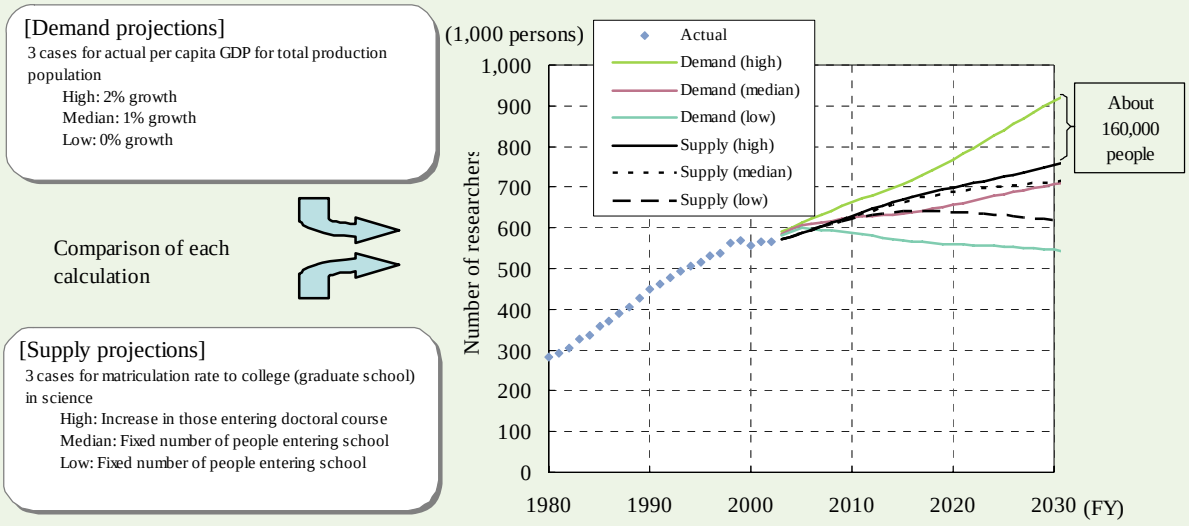


Source: "Conference on International Training and Support of Young Researchers in Natural Science" November 2001, Strasbourg France

It is estimated that, depending on the changes in the economic growth rate and industrial structure, in 2030 there could be a shortage of about 160,000 researchers and 1,090,000 engineers (Figure 30).

With an aging population with fewer children, it is predicted that the labor population will decline. This means it is necessary to ensure the quantity and quality of a wide range of personnel, and to create the environments in which every person working in science and technology can exercise their abilities to the fullest.

Figure 30 ▶ Projected future supply and demand of research personnel



Source: Ministry of Education, Culture, Sports, Science and Technology "Report on Research Personnel Future Supply and Demand" (March 2005)

Personnel development efforts of universities/graduate schools to meet the needs of society

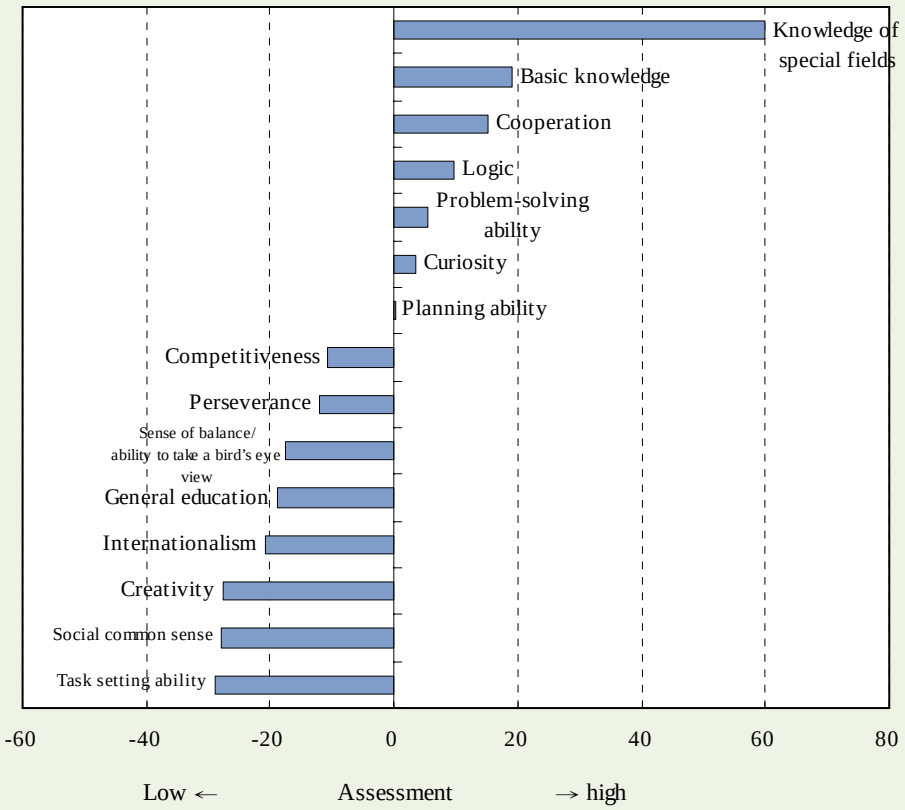
To work toward fostering and securing science and technology personnel, it is necessary for universities and graduate schools to continue to develop the human resources to meet the diverse demands of society, making full use of their role as a direct provider of science and technology personnel to society.

The evaluation of young researchers by currently-active researchers indicates high marks for knowledge of special fields, basic knowledge and cooperation, but low assessments for task setting abilities, social common sense and creativity (Figure 31). From the industrial world as well, there have been requests to the universities and graduate schools that supply the personnel, including "Teach them to think rather than giving them knowledge," "Switch from entrance exams that asses the quantity of knowledge to a format that assesses multiple facets, like the ability to think, interest, and aptitudes."(Note)

Based on this, it is necessary for universities and graduate schools to improve educational content and methods. In particular, for graduate schools, it is necessary to clarify the purpose of the curricula, incorporating the needs of society, and to create systematic educational programs and thoroughly manage the degree-conferment process.

(Note) Ministry of Education, Culture, Sports, Science and Technology "Survey on Private Sector Research Activities" (FY2004)

Figure 31 ▶ Evaluation of young researchers



Notes: 1. Results of a questionnaire survey of researchers in industry, academia and government
2. For each item, the percentage (%) of those responding "very high" was multiplied by 2, the percentage of those responding "high" was multiplied by 1, the percentage of those responding "low" was multiplied by -1, and the percentage of those responding "very low" was multiplied by -2, and the values were added together.

Source: Ministry of Education, Culture, Sports, Science and Technology "Survey of the State of Japan's Research Activities" (2005)

● Promotion of provision of opportunities for re-education

From the perspective of effectively utilizing a limited number of workers in an aging society with fewer children, even for people who have completed a university degree and entered into society, it is desirable for them to return to school to learn the latest theories and technologies in their specialty, to learn about new, related fields, as required, and to acquire new abilities in addition to those already acquired through their career. In recent years, while the number of working adults studying at universities and graduate schools has been increasing, it is desirable for universities and graduate schools to more actively provide opportunities for re-education to meet the needs of society.

(2) Preparing an environment in which it is possible for a diverse range of personnel to be fully active

● Necessity to prepare the environment to fully utilize all personnel

In promoting an assured supply of science and technology-related personnel amid the predicted decline in population and continuing aging of society with fewer children, it is

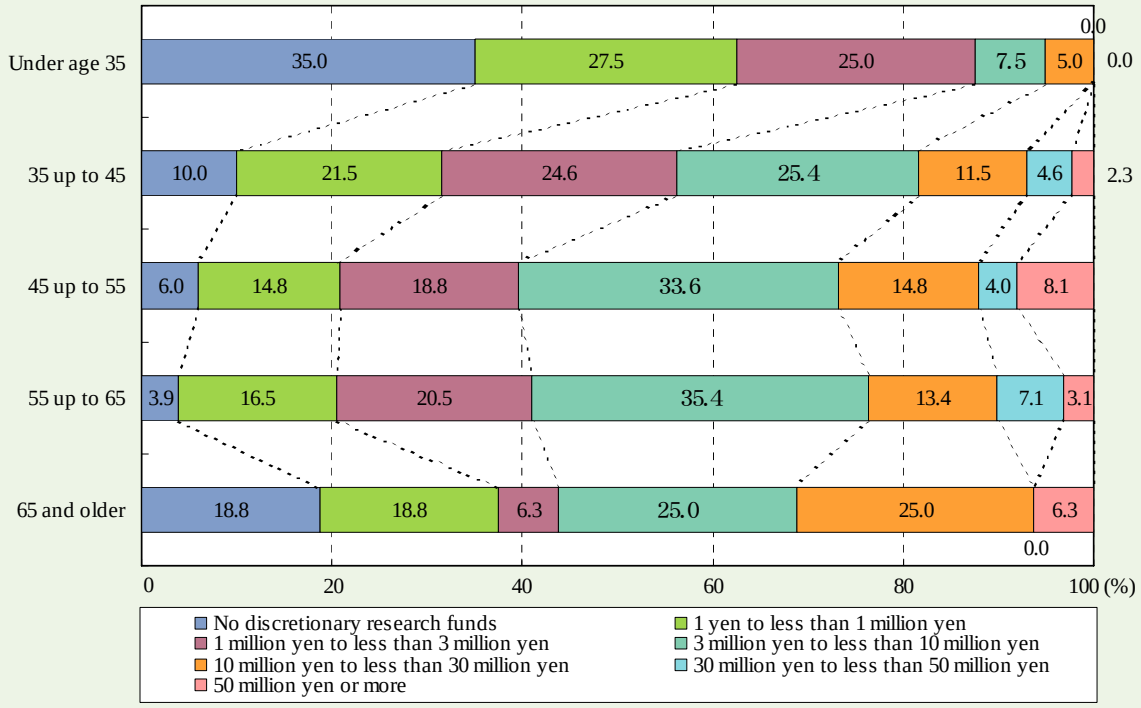
necessary to prepare the environment to enable the talented existing personnel to fully utilize their skills and talents.

Young researchers

There is increasing concern about the supply of personnel, particularly young researchers, from a quantitative perspective as the number of children in society declines. It is more important than ever to promote the activity of talented, highly-creative young researchers. To achieve this, it is necessary to develop the environment, such as tenure track systems, and to provide the opportunities to allow young researchers to conduct autonomous research activities and make full use of their talents.

In addition, with regard to securing research funds, the Ministry of Education, Culture, Sports, Science and Technology conducted a survey of researchers on the annual total of research funds that could be allocated at their own discretion. The results indicated that it is currently difficult for young researchers to obtain the research funding needed to conduct their own research (Figure 32).

Figure 32 ▶ Annual total research funds that can be used and/or allocated at your discretion (by age)



Note: Results of a survey of researchers at universities and public research institutes
Source: Ministry of Education, Culture, Sports, Science and Technology "Survey of the State of Japan's Research Activities" (FY2004)

Elderly researchers

Providing opportunities for talented people to be active, regardless of age, is important for society, also from the viewpoint of using the potential science and technology-related human resources in the higher age groups that are expected to increase in the future. There is a need for universities to make it possible for talented researchers to continue their research in some form, through the use of external funding, etc., as in the USA.

In positions other than researcher as well, it is desirable to increase the opportunities for elderly personnel with a wealth of accumulated knowledge and experience to be active and productive in order to promote science and technology.

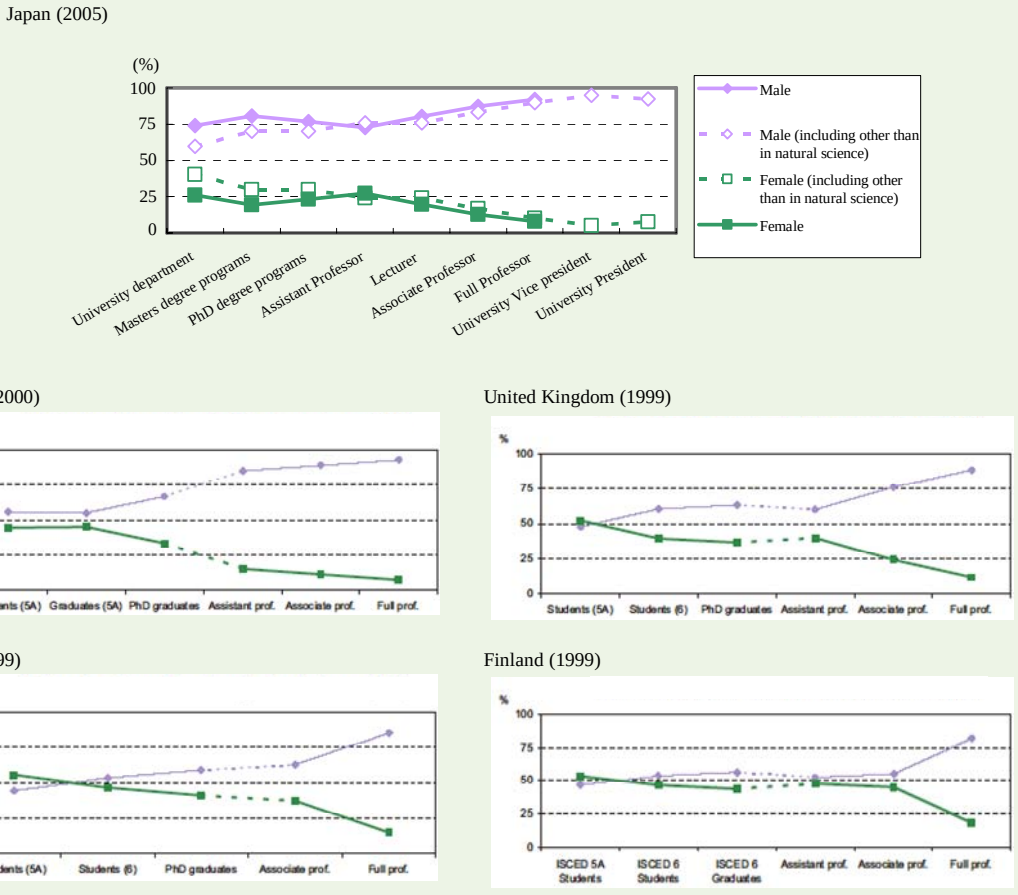
Female researchers

With regard to females, the percentage of researchers in Japan who are female is the lowest level internationally, so there is room for them to conduct more activity. It is an urgent task to take advantage of the talents of female researchers and engineers, in order to promote gender-equality as well as to expand the pool to secure quality science and technology personnel in the future.

At present, looking at the career path in a university teaching staff, from the time of entry into a university department, through the progression to graduate school, promotion to assistant professor, associate professor, and to full professor, the percentage of women drops at each stage of the career path. More than in Europe, in the career overall, there are few women employed or promoted, and even at the time of entrance to the university level there is a big drop in the percentage of women in comparison to men. In addition to measures to promote the active employment and promotion of female researchers, this suggests that it is also necessary to implement some measures at the stage the females graduate from upper secondary school (Figure 33).

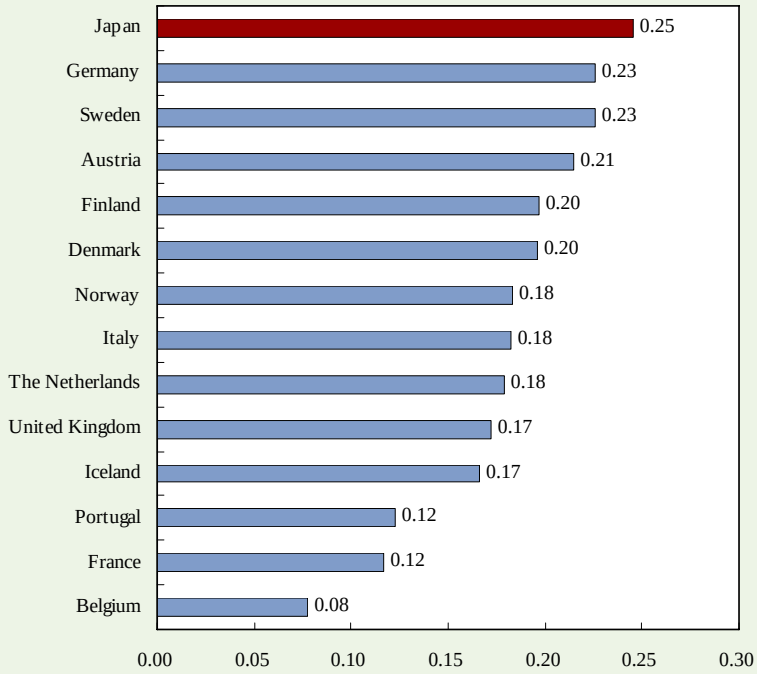
Additionally, the differences between men and women in specialized fields are larger in Japan than in other countries in Europe (Figure 34).

Figure 33 ▶ Percentages of males and females among students and faculty in natural science fields at universities (International comparison)



Source: Data for Japan, Ministry of Education, Culture, Sports, Science and Technology “School Basic Survey 2005”
Other countries, European Commission “National Policies on Women and Science in Europe”

Figure 34 ▶ Difference between males and females in specialty fields (international comparison)



Note: Calculated using the following formula using the number of researchers in the higher education sector in each country
Dissimilarity Index = $0.5 * \Sigma | (Fi/F) - (Mi/M) |$
i: Field (physics, engineering, agriculture, health, social science, humanities, and others)
Fi: number of female researchers in field i, F: Total number of female researchers in all fields
Mi: number of male researchers in field i, M: Total number of male researchers in all fields
Source: For Japan, Statistics Bureau "2005 Science and Technology Research Survey"
For other countries, European Commission "She Figures 2003"

As a result, a variety of measures will be implemented to promote the activity of female researchers. With regard to the granting of competitive funding, there should be expansion of measures that consider the balancing of conducting research and childbirth/child-rearing, etc., such as allowing for term extensions and interruptions for fixed periods for the purpose of childbirth and child-rearing. In addition, since there is already a large drop in the percentage of females that continue their education at the university level, there will also be efforts to increase interest and curiosity in young female students and children.

Foreign researchers

In the midst of promotion of the active participation of a diverse range of personnel, it is important to prepare the environment that allows talented researchers from other countries to live and work in Japan, from the perspective of not only securing personnel, but also improving the level and internationalization of research activity in Japan.

Since there is fierce international competition for intellectual talent, in order to encourage universities and public research institutes to invite and recruit talented foreign researchers, the government of Japan will support the establishment of preparedness to accept them, that not only pays attention to the quality of research environments, but also to housing and schools for their children. Additionally, the government will further promote necessary reviews and operational improvements of the immigration control system and visa systems.