[Column 4]

A Creature that Supports Studies on Aging

It takes a long time for aging research by using a creature with a long life span. Nematode C. elegans, which is approximately 1 mm in length and lives its short life underground by eating bacteria, is a model organism convenient to experiment with. It has a basic system as an animal, including muscles, a digestive tube, neural system, and skin, and shows a variety of behaviors in spite of its simple neural system. At 20 degrees C, a nematode develops from a fertilized egg to the adult stage in three days. This is easy to observe due to its transparent body. The process of which cell divides into which cell and which cell dies (Note) is predetermined precisely, and the number of cells of adult nematodes is 1,031 for males and 959 for hermaphrodites.

For several days after being an adult, a nematode actively moves around to eat and lay eggs, but from around 10 days after its birth, the movement gradually becomes slow. The transparent body gets brown granules, orderly muscles become disorderly, and dead cells get blisters. Unlike the process of becoming an adult, this aging process varies depending on individuals, organs, and cells. In their natural settings, aged nematodes die from around the 10th day, and the maximum length of life is about 25 days.

By using this C. elegans, various research on the genetic factors of life span have been conducted. Bringing about mutations by agent and checking the average length of their lives, many mutants with several times the average and maximum length of life of the wild strain have been obtained. Under ordinary conditions, some mutants do not show much difference from the wild strain in terms of their activity and reproductive performance when they are at the young adult stage. By checking the mutated genes of these mutants, what kind of protein those genes make and where and how they work, the mutual relationship of gene groups that influence the length of life has become clearer.

Concerning the molecules that have been identified in experiments using nematodes to make up the signal transduction mechanism to control the length of life, homologous ones exist in human beings. It was also confirmed that mutated homologues in mice extended their life expectancy. It is expected that the aging mechanism of human beings will be elucidated by promoting, in the future, research with nematodes on the mechanism to control aging, and to decide life expectancy, and by researching on commonality with higher animals including human beings.

For the achievement of introducing C. elegans as a model organism, the Nobel Prize for Physiology and Medicine in 2002 was given to Dr. Sydney Brenner (present President, Okinawa Institute of Science and Technology).

Note: The programmed cell death that is caused by a cell itself is called apotosis.

●Development of lifelong learning and vocational skills

In modern society, with the pace of knowledge change increasing, its foundation on information, and in which people are connected by communications technology, it is of increasing importance to continue learning and to maintain and improve vocational skills throughout life. There is thought to be a growing demand for distance education that provides education programs that meet the needs of many people and can be conducted at times and locations that are convenient for individuals. To meet this kind of demand measures are being implemented, such as the operation of an engineer's web learning system (http://weblearningplaza.jst.go.jp/) by the Japan Science and Technology Agency in order to support the reeducation and continuing skills development of engineers.

The development of learning and vocational skills using communications technology will support the return to the work force of those who took childcare leave, as well as the re-employment of people who have retired from another job. Furthermore, it is of great importance in an aging society with fewer children, because it is an effective method for older people to further improve their quality of life, pursue study after reaching retirement and work to obtain an academic degree.

●Telecommunications systems to support more flexibility in styles of working

According to the "2004 White Paper Information and Communications in Japan," about 15% of companies in Japan, and 69% of companies in the USA are using telework for employees to work at locations other than the office using telecommunications networks. The importance of telework will probably grow as a style of working in an aging society with a declining birthrate, because it allows people to work while also raising children, and reduces the physical burden of commuting to an office. The Second Basic Plan for Gender Equality (determined in a cabinet meeting in December 2005) presents a numerical goal to increase the percentage of telecommuting workers in the working population to 20% by 2010.

There is also development of video monitoring at nursery schools and day care, services to check on the whereabouts of children and the elderly outside the home using a home computer, systems to detect and report on intruders or disasters like fire to the place where one has gone, as well as systems that enable people to remotely check on the operation and status of home devices, such as air-conditioning systems, laundry and cooking equipment.

To achieve widespread use of telecommuting and intelligent home appliances, security countermeasures to protect company secrets and the personal information of individuals are important. Therefore, it is necessary to implement a variety of management and operation measures, including technology measures such as violation detection technology.

1.2.1.4 Science and Technology to Contribute to the Effective Utilization of Social Capital

Social capital stock, such as the roads, airports and sea ports under the jurisdiction of the Ministry of Land, Infrastructure and Transportation has been steadily accumulating. In the near future a large amount of this stock accumulated during the periods of high economic growth will begin to require updating or renewal, and it is expected that there will be a large increase in the demand for funding for maintenance, operation and renewal of this social capital stock in the future (Figure 1-2-11). In 2004 a public opinion poll on the development of social capital stock was conducted by the Cabinet Office. Subjects throughout the nation aged 20 and older were asked what kind of results should be emphasized in developing social facilities. The most popular response at 48% was "deal with aging society with a declining birthrate," and many voiced the opinion that there should be special consideration of use by the elderly and disabled.

In Japan, one of the reasons thought to be a factor in the low number of children, particularly in metropolitan areas, is the small size of the houses. In comparison to the west, where it is common to renovate and update houses and use them for several generations, the average service life for a residence in Japan is very short, lasting only about 30 years. This is considered to be one of the reasons for the poor quality living environment despite the cost. In an aging society with fewer children, it is, of course, necessary to develop facilities that are easy for the elderly and disabled to use, but it is also necessary to prepare social capital and housing that can be used comfortably for a long time and can withstand disasters in the harsh natural conditions of the nation, including earthquakes, typhoons, and the hot, humid climate. There should be an emphasis on maintenance management and effective use of resources, so that this housing and social capital can be used with care for a long time.

Therefore, in addition to steps and elevators, there should be progress on creating barrier-free public facilities and transportation, such as making it possible to access public transportation without buying tickets, using just a single smart card. It is also necessary to continue with the development of technology for the planning, construction and maintenance, and development of structural materials with a long lifespan and suitable for recycling, so that social capital can be utilized efficiently for a long time.

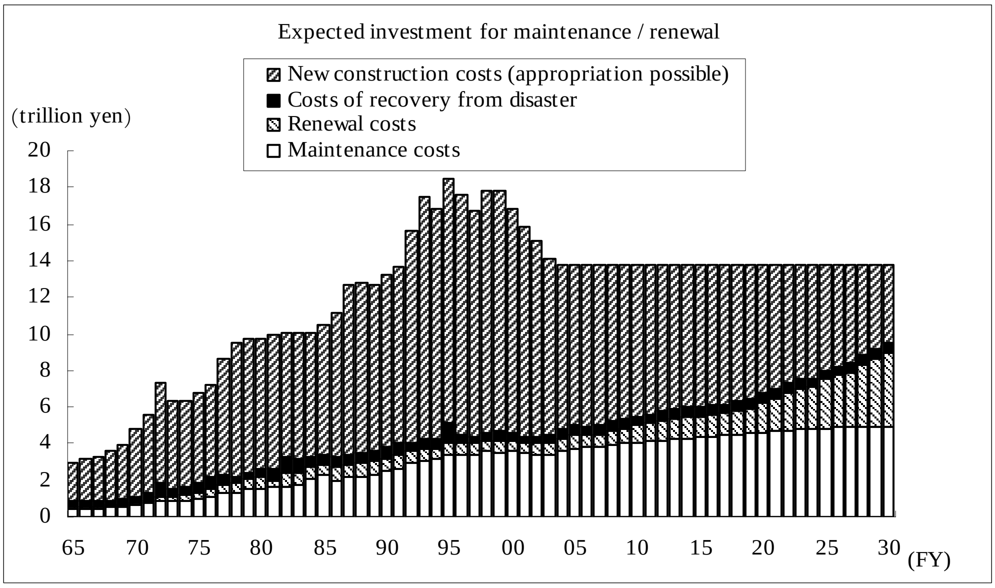


Figure 1-2-11 Estimates of demand for funding for maintenance and replacement investment

Note: The expansion of total possible investment is shown for the case assuming ±0% relative to the previous year in and after 2005.
The total amount for maintenance and renewal costs as a percentage of the total possible investment increases from about 31% to 65%; while the amount available for new construction as a percentage of the total possible investment decreases from 65% to about 31%
Source: Ministry of Land, Infrastructure and Transportation

●New construction materials

In order to extend the service life of social capital, there is development underway on high-strength materials with a long useful life, having superior recycling characteristics and resistance to weather. (Figure 1-2-12) In addition, there is development underway on risk management methods and detection/measurement/assessment of damage and deterioration of materials and structures in order to effectively develop and maintain a variety of public buildings, as well as development of technology for planning, construction, repair, maintenance, corrosion prevention, etc. in order to reduce maintenance costs and improve the durability of concrete structures like roads and bridges.

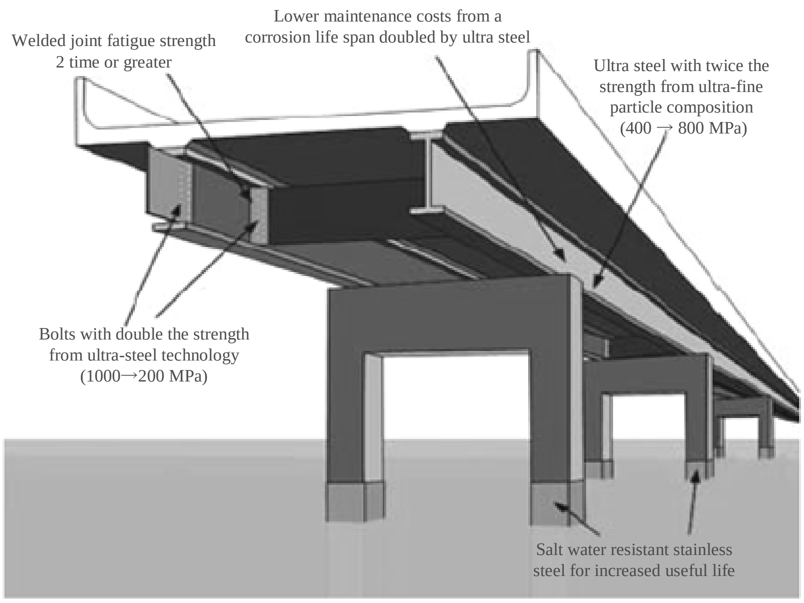


Figure 1-2-12 High-strength, long-life construction materials

Source: National Institute for Materials Science

1.2.1.5 Science and Technology for Safe and Secure Society and Sustainable Society

Most of our daily activities in modern society depend on social systems that are supported by advanced science and technology, such as telecommunications, transportation for distribution of goods, and energy supply. These social systems are expected to contribute to a sense of security and ensure the stability of the activities of everyday life. The tragic railroad accident and the scandal over buildings based on fabricated structural calculation sheets in 2005 demonstrated how the safety in our daily lives depends on the social systems, and how confidence in the social systems is vital for feeling a sense of security. Safety and security in society is even more important for vulnerable members of community, such as children and the elderly, who are likely to be unable to flee from disaster or killers targeting young children.

In 2005 the USA was struck hard by hurricane Katrina, while Japan saw an increase in typhoons and record-breaking high temperatures; and unusual weather phenomena seem to occur more frequently in recent years. The direct and indirect effects of changes in climate, including desertification due to changes in rainfall patterns, decreases in food production, and increases in tropical infectious disease due to global warming, along with an increasing impact on the environment from human activity accompanying a growing world population and rising standards of living, may destabilize world society, including refugees and conflicts arising from threats to the stable supply of food and energy, and threaten the foundations of the existence of mankind. This places Japan, a nation long dependent on importing energy, food and other resources, in an especially vulnerable position regarding this kind of supply instability. Furthermore, as globalization progresses, there is even greater danger of unexpected movement of pathogens and international terrorism.

In the “Special Public Opinion Poll on Science and Technology” conducted by the Cabinet Office in May 2005, there was the most support for “preservation of the environment” and “achieving a safe society (prevention of disaster and crime, food safety, etc.)” as the important focal points for support for science and technology (Figure 1-2-13), and nearly 70% of citizens agreed that "a high level of science and technology is required to ensure safety" (Figure 1-2-14). It is clear that there are high expectations from the citizens regarding the contributions of science and technology on these problems.

There is a need to address the demand of the people to provide a safe and secure society, along with achieving both environmental conservation and sustainable development through the strategic advancement of science and technology research and development. It is also necessary to secure the foundations for safely conducting social and economic activities, building close reciprocal relationships with many nations by using this science and technology to help solve global problems.

To handle large-scale disaster and terrorism, it is necessary to improve security standards, by establishing the possible scenarios, and devising measures to first prevent damage, and then minimize the expected damage. On top of this, there must be measures implemented for initial response and disaster recovery to handle incidents if they do occur. It is also important to develop an environment where the risks can be objectively assessed and appropriately handled, and build relationships of confidence through the accurate provision of reliable information, while keeping in mind the necessary information control to ensure safety in order to build a safe society.

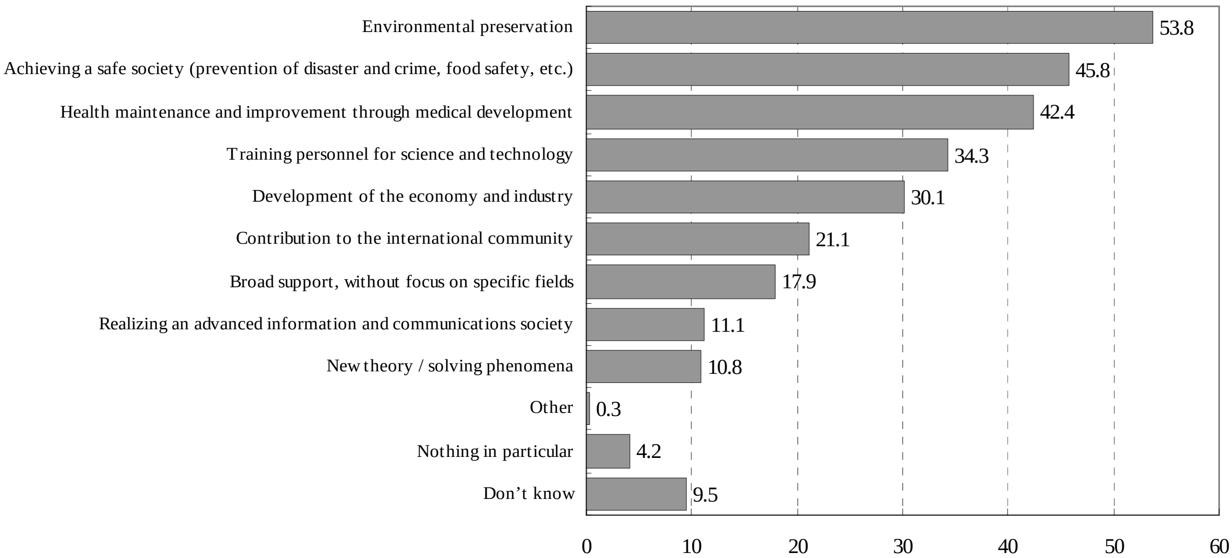


Figure 1-2-13 Points that should be the focus of support for science and technology (multiple answers)

Source: Cabinet Office "Special Public Opinion Poll on Science and Technology" (June 2005)

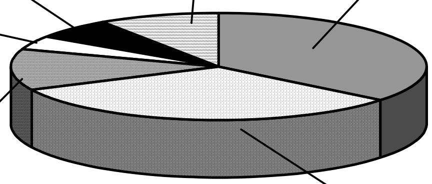


Figure 1-2-14 High levels of science and technology required to ensure safety for familiar activities and the overall security of the nation

Source: Cabinet Office “Public Opinion Poll on Science & Technology and Society” (February 2004)

●Global environmental change and largescale natural disasters

We are now facing global-scale environmental problems, such as global warming, desertification, deforestation, water source problems, acid rain, loss of bio-diversity, damage to the ozone layer, and marine pollution. These problems are affected by human behavior and activity, and there is a high risk that if these problems progress, there may be a point of not return, from which recovery is not possible.

Last year, there was a record-breaking water shortage in the Amazon river, a river that accounts for nearly 20% of the river water in the world. For the Fourth report of the Intergovernmental Panel on Climate Change (IPCC), forecasts were made using Japan’s high-performance supercomputer “Earth Simulator” (Figure 1-2-15). The results of the forecast suggest that there is a possibility that rainfall in the Amazon river basin will decrease in the future, and that tropical rainforests will be lost. Abnormal weather indicating the effects of global warming has been seen in various countries in recent years. In Japan also, there have been frequent unusually-high temperatures and record rainfall (Figure 1-2-16). In 2003 there were 35,000 deaths, primarily among the elderly, during a heat wave in Europe. In 2005 1,300 people in the USA were victims of a series of enormous, record-breaking hurricanes.

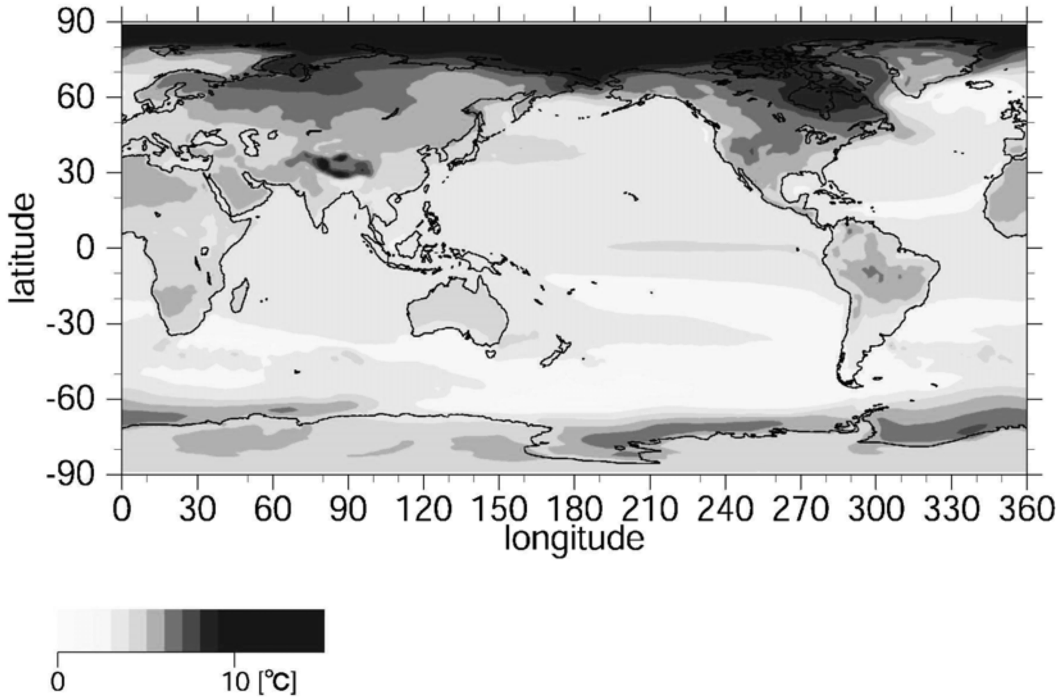


Figure 1-2-15 The projected Geographical distribution of annual mean surface air temperature increases

Shows the difference between the average air temperature between 1971 through 2000 and the predicted average air temperature between 2071-2100 in the future scenario created by the IPCC, assuming the world continues internationalization focused on economic gain

Source: Joint research team of University of Tokyo Center for Climate System Research (CCSR), National Institute for Environmental Studies (NIES), and the Japan Agency for Marine-Earth Science and Technology, Frontier Research Center for Global Change (FRCGC)

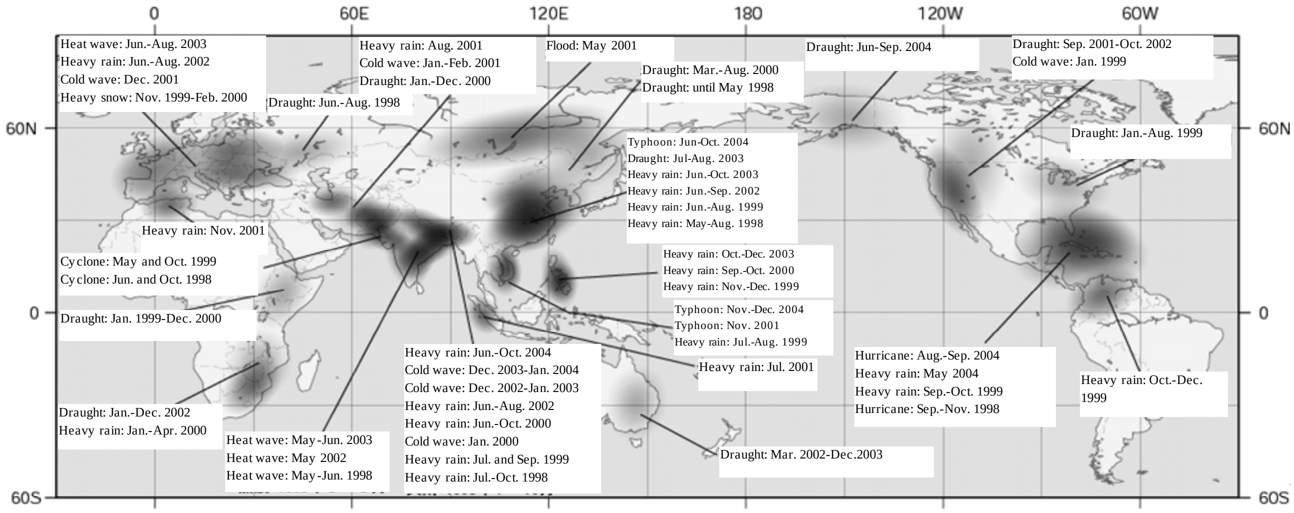


Figure 1-2-16 Distribution of main climate disasters in the world (1998–2004)

Note: Areas reporting heavy rain, typhoon / hurricane, drought / forest fires, heat waves and cold waves are colored in green, yellow ocher, red and blue, respectively.

Source: Japan Meteorological Agency “Extreme Weather Report 2005” (October 2005)

There is a connection between the conditions in the ocean and the weather in widely separated regions, such as the El Nino currents causing cool summers and warm winters in Japan. Unusual weather is not only a direct threat to the daily activities of humans, but could also attack the foundations of human existence, through desertification, deforestation and a decline in food production.

Japan is a country prone to earthquakes, and the Japanese word “tsunami” is used throughout the world, illustrating that disasters caused by movements of the earth crust have had considerable damage and impact on Japanese society. Following the experience of the Hanshin-Awaji earthquake, research and development of earthquake disaster prevention and earthquake investigation technology should help lessen the damage from future earthquakes and tsunami that are likely to occur in the future, including a strong earthquake beneath Tokyo, Tonankai and Nankai earthquake. It is also necessary for the latest science and technology to be applied for disasters abroad, such as the large earthquake and tsunami in Indonesia and Sumatra at the end of 2004.

There is increasing awareness of the importance of establishing integrated global Earth observation systems. Upon the proposal of Prime Minister Junichiro Koizumi at the 2003 Evian G8 Summit, a series of Earth Observation Summits was held and at the Third Earth Observation Summit held in February 2005, the “Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan” (Figure 1-2-17) was endorsed. Japan is now working to promote observation and monitoring systems which integrate satellite, terrestrial and ocean observation in order to contribute to the response to natural disasters such as earthquakes and tsunamis, as well as global warming. The deep-sea Earth drilling project aims to promote R&D to bring to light global environmental changes, the earth’s interior structure, and deep-subsurface ecology by providing the Integrated Ocean Drilling Program (IODP) with the “CHIKYU” deep sea drilling vessel which was developed to reach the earth’s as-yet-unexplored mantle. There are also efforts under way to create and publish earthquake forecasting maps, conduct focused study of areas with a high probability of experiencing a strong earthquake, research to greatly reduce the material damage and injury that would occur if a major earthquake occurs within a large metropolitan area, prediction of volcanic activity, floods, landslides and damage from snow and ice, and development of systems to accurately and rapidly provide information on flooding and evacuation warnings.

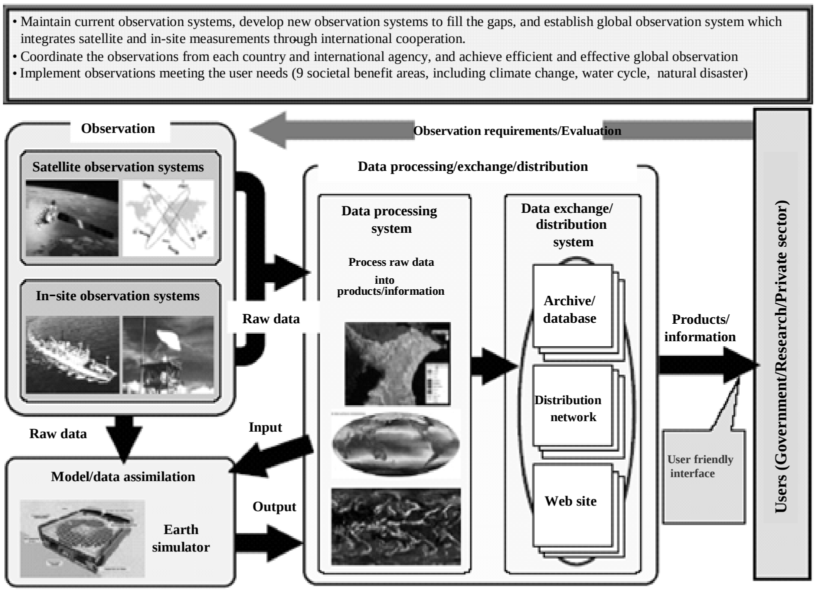


Figure 1-2-17 Global Earth Observation System of Systems (GEOSS)

Source: Ministry of Education, Culture, Sports, Science and Technology

[Column 5]

Science and Technology Expected to Be Useful for Prevention of Disaster

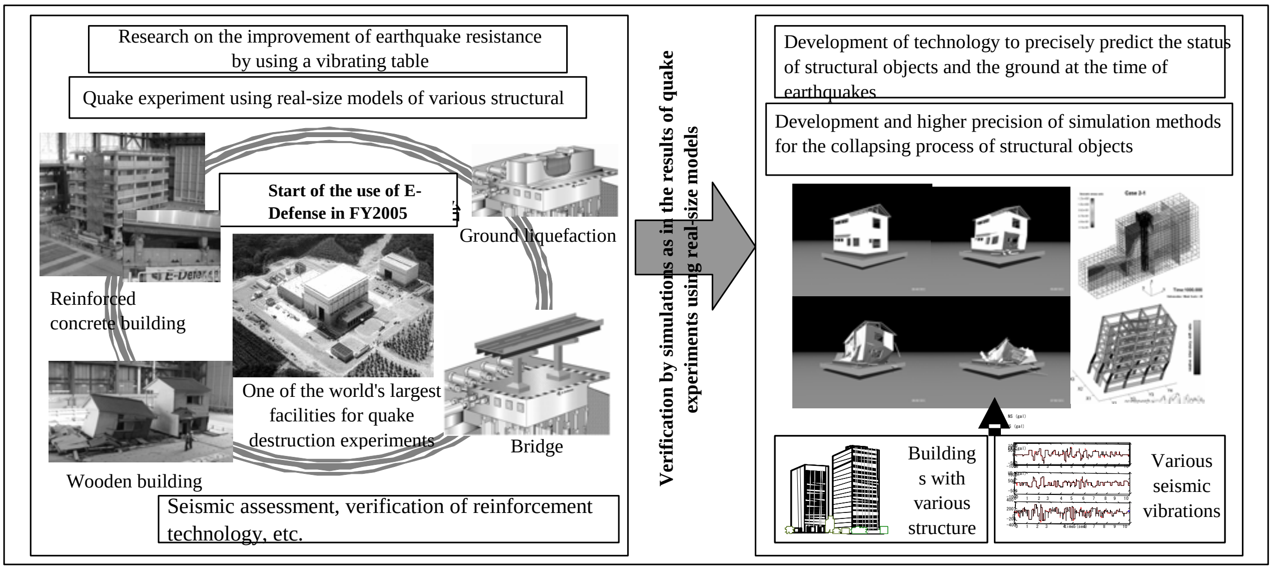
Japan is one of the countries that have earthquakes most frequently in the world, and science and technology play a big role in protecting people's precious lives and property from earthquakes and making society safe.

With the present level of science and technology, it is impossible to prevent earthquakes from happening and also difficult to predict precisely when, where, and what size of earthquake would happen. However, for us who live in Japan, "to know about earthquakes" is a precondition to make preventive measures. From this viewpoint, based on the results of survey and observation research on earthquakes, a seismic hazard map was made, which shows predictions of earthquakes all over Japan, including their strength, from a long-term viewpoint. There is also a website from which you can get information such as the seismic hazard map of the area you wish to know about and the information used to make the map (J-SHIS, Japan Seismic Hazard Information Station http://www.j-shis.bosai.go.jp).

In the Hanshin-Awaji earthquake in 1995, about 6,400 precious lives were lost and the reasons over half of these were compression or suffocation by collapsed houses. Many public buildings, roads, and bridges received major damage as well. Based on this as a lesson, E-Defense, which is an ultra-large experiment apparatus that can actually shake various buildings of up to 1,200 tons on the scale of the Hanshin-Awaji earthquake, has been in operation from 2005 for verifying the earthquake-proof safety of buildings and examining reinforcement methods and earthquake-resistant buildings.

The development of a security system has been promoted, which can detect the primary wave (P wave) when an earthquake occurs and can, before the secondary wave (S wave) reaches, stop electricity, gas, factory production lines, elevators, etc., and announce urgent earthquake information to local governments, power plants, factories, and the people related to emergency medical care and others.

Furthermore, the development of a system to send image information of disasters site via satellite connection from a camera attached to a helmet, and a system to find victims who are trapped under collapsed buildings have been promoted for prompt handling after an earthquake occurrence.



Source: Created by Ministry of Education, Culture, Sports, Science and Technology

●Energy/Resources

As the world population continues to grow and standards of living increase, there is an increasing demand for energy. There is a limit to the fossil fuel resources, such as the petroleum and natural gas that we currently use, and it is reported that their production will hit a peak in the not-so-distant future. It is necessary to continue research and development on energy conservation and energy alternatives to fossil fuels, in order to halt global warming and air pollution, to increase Japan's stability and independence instead of relying on imports for most of our energy resources, as well as to contribute internationally through advanced technology.

In Japan, nuclear power provides about 26% of the total electricity supply (2003 results, Ministry of Economy, Trade and Industry), but there are limits to the supplies of the enriched uranium used as the fuel. Research and development is proceeding on fast breeder reactors and nuclear fuel cycles, to effectively reuse the plutonium that is created at the ordinary nuclear power plants and make it possible to greatly alleviate the restrictions from the uranium resources. In addition, from the perspective of increasing the range of energy options in the future, research and development is continuing on nuclear fusion energy, which has a minimal impact on the environment, and for which there is an abundance of resources.

Research and development are also continuing in government, industry and academia on the technology for renewable energy and energy conservation. Examples of results include improved conversion efficiencies and lower costs for solar cells, resulting in Japan producing nearly half of all solar cells made in the world. Further research and development is needed in the future to overcome the disadvantages of the higher cost in comparison to current energies, and to promote the widespread introduction and use. Japan is a small country in terms of land area, but has the 6^{th} largest exclusive economic zone in the world.

Development is progressing on ocean exploration systems to search for undiscovered and unused resources in the oceans.

●Serious accidents

An important issue for realizing a safe society is ensuring the safety of the traffic and transportation systems, starting with the prevention of traffic accidents, and including railways and other forms of public transportation. According to a 2005 police department white paper, in 2004 there were 1.18 million people injured in traffic accidents, of which 7,358 died within 24 hours. Among those who died, 41.4% were elderly people aged 65 years or more. In contrast, among the drivers who were the primary parties concerned in fatal accidents[10], 15.7% were aged 65 or more. In 2005 there were many victims of train derailment incidents, one on the JR West Fukuchiyama line in April, and another on the JR East Uetsu line in December. Many Japanese still remember both these incidents.

To prevent traffic accidents, there is research and development being conducted on systems to grasp road and traffic conditions and the circumstances of the surrounding vehicles through the use of various sensors and detecting devices on roads and in vehicles, in order to improve traffic safety through ITS[11]. In addition, as a countermeasure to accidents that single vehicle cannot avoid, government, industry and academia are working together on the research and development of driver support systems using telecommunications technologies to relay information between vehicle and between the road and vehicles. In particular, there is progress on (1) Driving Safety Support Systems (DSSS), (2) Automated Highway Systems (AHS), and Advanced Safety Vehicles (ASV).

[10] Primary party concerned: Means the person who is most at fault or the person with the lightest injuries in cases where fault is shared equally.
[11] ITS: Acronym for Intelligent Transport System. An integrated system linking people, roads and vehicles using telecommunications technology to solve road and traffic problems including traffic jams, accidents and environmental deterioration.

Further, to prevent accidents due to human error[12] on public transportation, there is development underway on technology to prevent dangerous situations from occurring, by monitoring the mental and physical condition of train operators or drivers in real time, and detecting indications of fatigue or panic.

With regard to major accidents, there are examples of failures in the past that are similar. By analyzing these past examples of failure, in many cases commonalities can be found in the various factors contributing to the failures. Sharing and utilizing the data and understanding obtained from failure experiences can be valuable in preventing the recurrence of failures and in lowering the risk of failure in the development of ground-breaking new technology.

Based on this concept the Japan Science and Technology Agency has been providing public access to a failure knowledge database (http://shippai. jst.go.jp) since 2005.

●Emerging and reemerging infectious diseases

The World Health Organization (WHO) reported 41 cases of death due to avian influenza during 2005, mainly in Southeast Asia. Emerging and reemerging infectious diseases are usually caused by viruses, which are common to humans and other animals. In the past 30 years, there have been at least 30 emerging infectious diseases, including Ebola hemorrhagic fever and AIDS (Figure 1-2-18). One cause for this is thought to be an increase in the opportunities for contact between people and animals infected with these viruses, as the population increases and forests and jungles are destroyed. In many cases, the virus does not cause a serious disease in the originally-infected animal, but becomes highly lethal in humans or other animals. With globalization, the movements of people now extend over a broad range, and there is concern of expansions of infected areas due to increases in the habitats of insect carriers, like mosquitoes, resulting from the effects of warming.

To deal with these diseases it is necessary, first and foremost, to strengthen coordination and information sharing among relevant agencies and specialists both domestically and abroad, and to quickly and accurately identify the pathogen, carriers, and patients exhibiting symptoms. It is also necessary to identify the characteristics of the pathogen, and develop detection methods, and to enhance and fully support the basic and application research on prevention, diagnosis and treatment, including the development of vaccines and wonder drugs.

However, special facilities, equipment and materials are required to handle fatal and unknown pathogens. Japan is the only G7 nation that does not operate facilities capable of handling this type of pathogen. This means that not only is Japan unable to participate in investigations of pathogens arising in other countries, we also cannot investigate pathogens that arise within our own country. In the past, Japan has relied on the USA for such analyses, but the situation has changed, including terrorism countermeasures that ban delivery of pathogens, creating an urgent need for such facilities. Therefore, it is necessary to thoroughly investigate the nation's handling of safety assurance and crisis management, and continue to engage in dialog with citizens, particularly those living near a facility site.

[12] An intentional or unintentional action by a person that unexpectedly compromises safety. This includes actions based on judgment errors as well as unintentional mistakes.

- **The majority of emerging and reemerging infectious diseases are zoonotic diseases. In the last 30 years outbreak of more than 30 diseases have been newly reported**

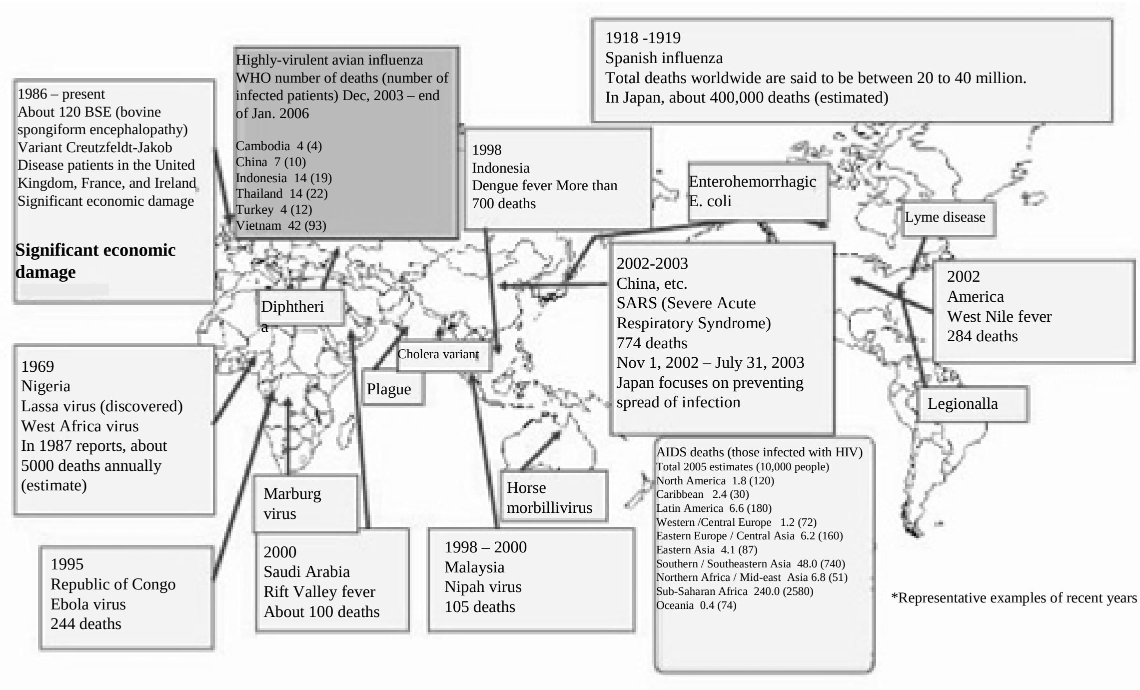


Figure 1-2-18 Expansion of emerging and reemerging infectious diseases

Source: Created by the Ministry of Education, Culture, Sports, Science and Technology based on basic policy expert survey materials, Council for Science and Technology Policy

●Food safety problem

With the progress of the globalization of society and the economy, as well as mass production and wide-spread distribution, if a problem with food safety should ever occur it would have an impact over a broad range (Table 1-2-19). For this reason, there is development underway on rapid detection methods for harmful microorganisms and chemical substances, and progress on technology development to trace the production history information using radio frequency identification (RFID) tags, etc., to make it possible to easily verify product indications, provide suitable information, quickly discover the cause, and recall defective foods when a problem occurs.

Throughout the long history and civilization of mankind, the substances in our world have been classified as either edible or inedible. During times when careful verification was not possible and information was limited, not eating anything labeled as “not safe” was considered to be a basic strategy for increasing the probability of survival. However, determining whether a given substance is unhealthy depends on the toxicity of the substance and the amount consumed, and any food can have some harmful effect, depending on how it is eaten. In modern society, it is necessary to develop an environment that encourages communication among citizen, manufacturers, experts and government agencies to exchange information and opinions on the dangers of food products, to allow logical and reasonable judgments to be made.

Table 1-2-19 Reasons for anxiety regarding food safety

	Largest percentage reasons for anxiety and response rate	Percentage of "doubts about scientific evidence"
Contaminants	There are concerns due to some problems that have occurred in the past (32.4%)	6.4%
Pesticides chemicals	Doubts about operator's adherence to the law and sanitation management (36.8%)	7.7%
Livestock antibiotics	Doubts about operator's adherence to the law and sanitation management (44.3%)	10.6%
Harmful microorganisms	Doubts about operator's adherence to the law and sanitation management (34.4%)	32.0%
Genetically modified foods	Doubts about the scientific evidence (44.0%)	44.0%
BSE	There are concerns due to some problems that have occurred in the past (32.0%)	18.1%
Food additives	Inadequate standards and labeling regulations (32.4%)	12.1%
So-called health foods	Doubts about the scientific evidence (29.2%)	29.2%

Source: Created by the Ministry of Education, Culture, Sports, Science and Technology based on the results from the Cabinet Office food safety monitor issue report “Survey of Awareness of Food Safety” (May 2005)

●Terrorism and other crime

Since being shaken by the multiple, simultaneous terrorism attacks in the USA in September 2001, the international community has strengthened alliances and been working on terrorism countermeasures. However, terrorist attacks appear to be more widespread, including multiple bombings in London, as well as bombings in Bali in Indonesia. With regard to domestic crime, in 2004 there were about 580,000 crimes, excluding thefts, the largest number after the World War II. There appears to be a greater malignancy, skillfulness and organization to crime, including confiscation of record-high amounts of cannabis and synthetic narcotics like MDMA.

In order to deal with this kind of terrorism and crime, it is necessary to improve the technology for customs and immigration examinations, the technology for detection and decontamination of harmful substances, and the technology for collection and analysis of crime information. For this reason, there is development on devices to detect substances associated with criminal and terrorist activity, such as illegal drugs, explosives, and biological agents, which are hidden in the mail, without opening the envelope, etc. (Figure 1-2-20).

There is also development work on portable detectors for biological agents and chemicals, research on the creation of 3-D facial image databases of criminals and automatic matching systems, research on high-speed identification systems for individuals using DNA single nucleotide polymorphisms (SNP-s), handwriting analysis, and document forgery detection, and research on detecting areas with a lot of criminal activity using geographic information systems (GIS), and identification of the relationship between area characteristics and the occurrence of crime.

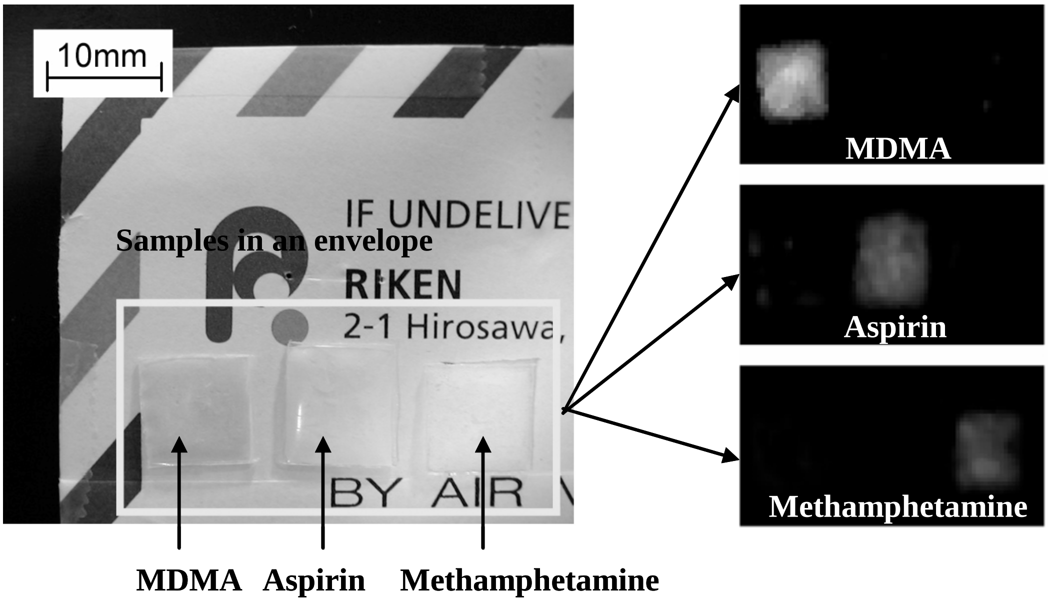


Figure 1-2-20 Devices to detect illegal drugs and hazardous substances without opening the envelope

Furthermore, in order to ensure the safety of children, there are a variety of systems being developed; including systems using cameras and devices mounted at schools entrances, public transportation ticket checkpoints, and on vending machine, to read electronic tags and IC cards carried by the children to track their locations, and notify guardians by email, and emergency information communication systems also used as crime alarms for guardians and local support people (Figure 1-2-21). When this kind of system is used, it has been pointed out that it will be necessary to investigate the issues of children's safety and privacy, including the interception of radio waves transmitted from the electronic tags.

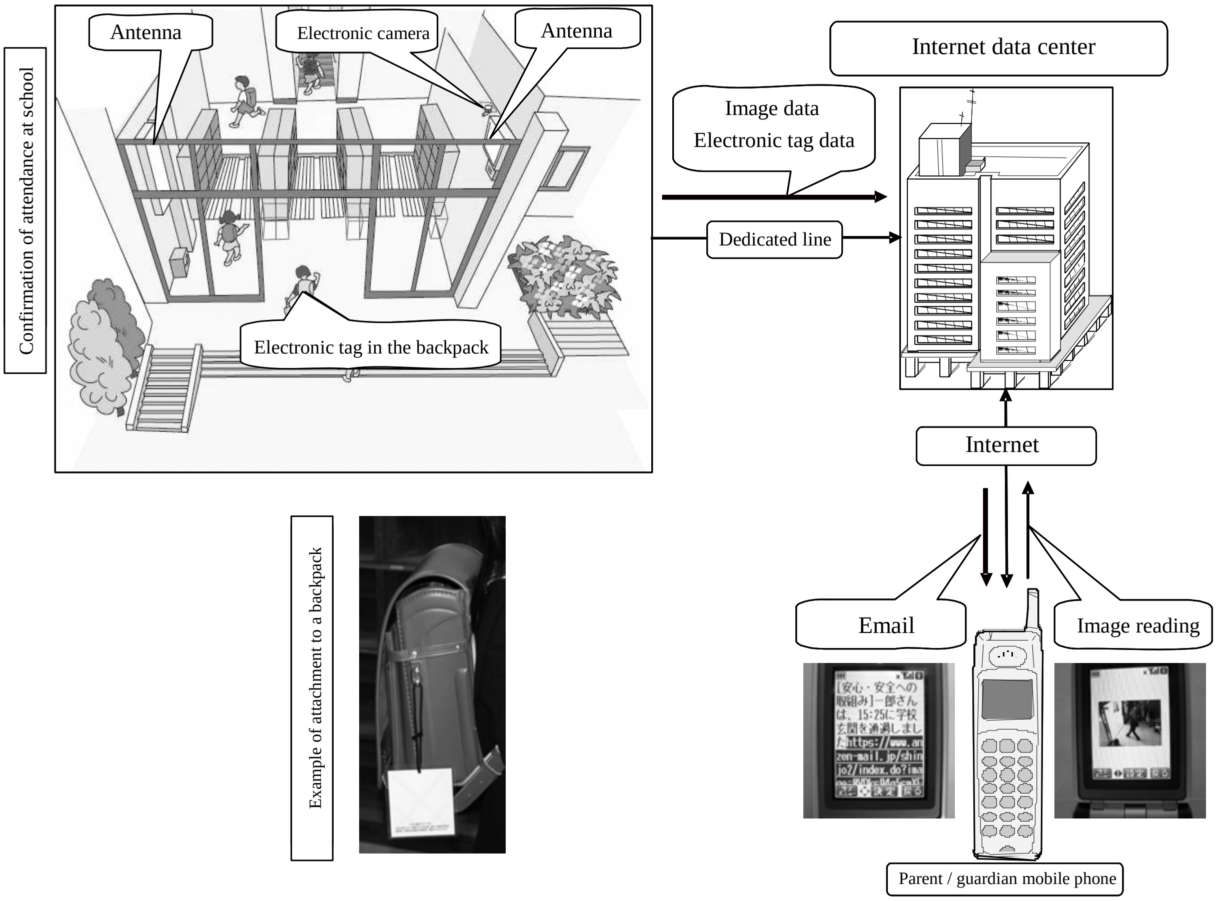


Figure 1-2-21 Summary of tests of electronic tag systems to ensure the safety of children attending school

Source: Ministry of Internal Affairs and Communication, Kinki Bureau of Telecommunication “Study on the Use of Electronic Tags in Public Fields” (March 2005)

●Information security problems

In 2005 the cyber-crimes using IT investigated by the police nationwide increased dramatically by 51.9% in comparison to the previous year, and exceeding 3,000 cases for the first time. Information security measures are becoming more necessary to deal with the use of new technology for this kind of intentional attack. There is also a need for measures to handle unintentional causes, like human error, and to deal with IT damage due to natural disaster, etc.

The comprehensive research and development needed to ensure the security and reliability of information and communications networks is being implemented, including science and technology to prevent, detect and analyze cyber-crime, verification and cryptographic technology, risk management, communication mechanisms in an emergency, and quantum information communications technology.

[Column 6]

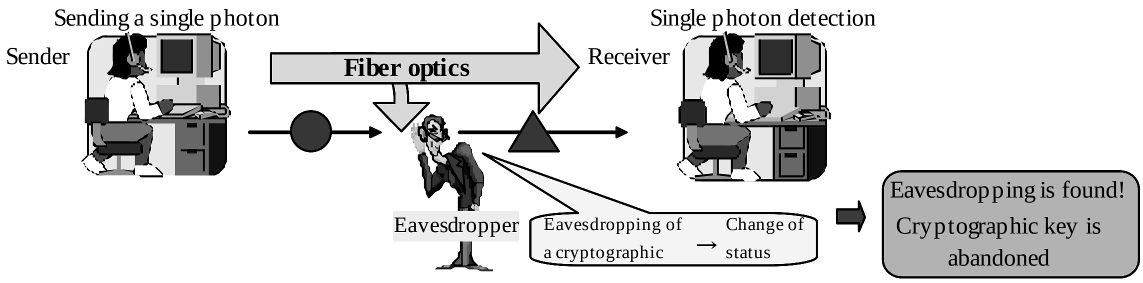
Technology for Quantum Cryptography Communication

The cryptography widely used on the Internet currently is guaranteed by "conditional security" based on the limit of computer's ability, that is, "deciphering is difficult because the time necessary for the calculation is quite long." Generally, the strength of cryptography is decided on the presumption that it will not be broken until 10 to 40 years later. However, you cannot tell when an effective calculation method may be developed. To begin with, sending information that you do not want to be deciphered for several decades is not guaranteed to be secure.

The technology for quantum cryptography communication is a new communication technology that can protect the security of information transmission for a long time. It is actively researched in some countries in the world, and Japan is targeting to realize it around 2020 to 2030. By using this communication technology, a cryptographic key can be safely shared between sender and receiver by using quantum mechanics. From quantum mechanics, that, "the information of a photon cannot be copied by dividing it into two," when eavesdroppers try to steal the photon, it is transmitted as a loss of photon or changed information, so that the eavesdropping can be detected. When it is materialized, it is expected to be used at sites where high quality security is necessary, such as public offices, financial institutions, and medical care facilities. For materialization, however, various problems need to be solved, and the most important one is a single-photon generator that can limit the photons per optical pulse to one.

With the wavelength band used for practical fiber-optic communication (1.3-1.55 micrometers), a laser light source with an extremely weakened light had to be used, as there was no technology to generate a single photon in the past. Its transmission speed over a long distance was quite slow, and there was a problem that a long cryptographic key, which was necessary to decipher the cipher of which absolute security quantum cryptography communication guarantees, could not be sent.

In a series of experiments conducted from 2005 to 2006, a single photon was successfully transmitted on a 1.55 micrometer band by which the loss is the smallest in fiber-optic transmission. It is expected that it will accelerate, making longer distances possible for quantum cryptography communication.



Source provided by: Japan Science and Technology Agency

1.2.2 Science and Technology to Vitalize the Economy

Summary

Amidst the changes in population structure of our country with the population decrease and the aging of society with fewer children, the development and maintenance of the economy through innovation is necessary in order to create an affluent society and keep and enhance its vitality. Foreign countries also hold science and technology and innovation policies up as important government policy issues. In order to strengthen Japan's international competitiveness, it is important to actively implement policies to create innovation based on the results of ground-breaking research and development including the achievements of Japan's unique superior basic research realized at universities and public research institutes.

At universities, which are the wellspring of innovation, the efforts to revitalize research activity have been proceeding recently through the reorganization of national universities into corporations. The establishment of science and technology systems needed for innovation is also progressing, through industry-academia-government collaboration, intellectual property strategy, and the promotion of regional science and technology.

1.2.2.1 Role of Science and Technology in Economic Vitalization

(1) Impact of population reduction/aging society on economic vitality

The population structure in Japan is changing as a result of rapid declines in population and the progression of an aging society with fewer children. It is also expected that the labor force will decrease due to the effect of the baby-boomers reaching an age range characterized by a relatively low labor force participation rate. (Figure 1-2-22) The shrinking of the labor force population constitutes a decrease to one of the important contributors to economic growth, and this is likely to become a negative factor for revitalization of the economy.

However, the changes in the labor environment, such as diversification in employment systems and raising of the retirement age to compensate for the labor shortages, may work to resolve the problem of the decline in the labor force.

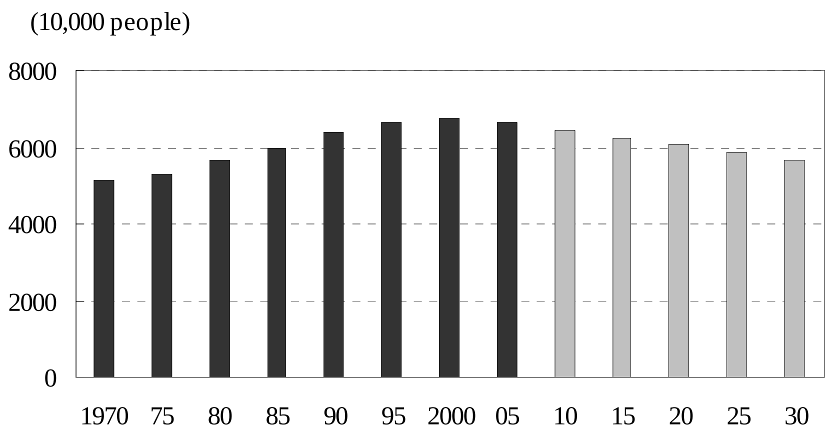


Figure 1-2-22 Labor force trends in Japan in 5 year increments

Note: 1. For 2010 and after the labor participation rate by age group in 2004 are assumed to calculate estimated values. The future predicted population is based on the intermediate projection.
2. The labor force is the total of working people and unemployed people aged 15 or above.

Source: Created by the Ministry of Education, Culture, Sports, Science and Technology based on the Ministry of Internal Affairs and Communication "Labor Force Survey," "Population Estimates," the National Institute of Population and Social Security Research "Population Statistics of Japan," OECD data, and the Cabinet Office "Report on the Japanese Economy and Public Finance 2005"

The shrinking of the labor force is a direct negative factor for economic growth, but assuming that a certain capital is assured, the per capita capital normally increases and can result in a per capita increase in labor productivity. However, from past example in Japan, even in the midst of a transition from a slowing labor population growth rate to a decreasing trend, there has been no increase in the rate of improvement of labor productivity. Accordingly, a decrease in the labor force population does not necessarily result in an increase in per capita capital and an increase in labor productivity.

Looking at the relationship between the growth rate of the Gross Domestic Product (GDP) and the labor force, the GDP growth rate since 1970 has fluctuated up and down, with a gradual declining trend overall, while the trend for the labor force has been relatively stable. There is therefore no conclusive correlation between the two (Figure 1-2-23). Based on this, it is possible that some factor other than the labor force has contributed significantly to the past economic growth of the country.

Figure 1-2-23 GDP growth rate and Labor population growth rate

Note: 1. The Annual Report on National Accounts uses 68SNA through 1980, and 93SNA in subsequent years.
2. The calculation formula for the GDP deflator used a fixed standard year method until 1994, and has used a progression method since 1995
3. The 2004 GDP growth rate is from the quarterly GDP flash reports from January-March 2005

Source: Cabinet Office “National Accounts,” Ministry of Internal Affairs and Communications “Labor Force Survey,” Ministry of Economy Trade and Industry “White Paper on International Economy and Trade 2005.”

With a declining population and an aging society improvements like raising the quality of the labor force and increasing productivity through the innovation that is the wellspring of science and technology, will help overcome the negative impact on the economy. It is also expected that there will be a shift from an economy that depends on “volume” to a new economy based on science and technology.

[Column 7]

What Is Innovation?

Joseph Schumpeter, an Austrian economist, defined the term "innovation" for the first time. In his book " Theory of Economic Development," he stated that internal factors such as innovation play a main role in economic development, rather than external factors such as population growth and change of climate. He also stated that innovation is to produce new things or produce existing things by new methods and that production is to combine things or powers. As examples of innovation, he pointed out (1) development of new products by creative activity, (2) introduction of new production methods, (3) cultivation of new markets, (4) acquirement of new (source of supply for) resources, and (5) organizational reforms. In addition, he stated that destruction of existing value and creation of new value (creative destruction) by so-called entrepreneurs are the source of economic growth.

The 3rd Science and Technology Basic Plan describes the importance of ensuring sustainable prosperity of the Japanese economy and the life of Japanese people by using the potential of science and technology, through the realization of our country's innovation in wide-ranging fields of economy and society, to achieve superiority in full-fledged industrial competitiveness and contribution towards the solutions to a wide range of social problems including security and health. It further defines innovation as "the reform to merge scientific discovery and technological invention with insight, and develop it to create new social value and/or economic value."

- Types of innovation by market or technological impact

It is said that there are the following four types of innovations depending on the degree of impact from the viewpoints of technology and the market:

(1) Architectural innovation: disrupts existing technology and production systems and creates completely new markets (Example: Invention of airplanes and computers)
(2) Revolutionary innovation: disrupts existing technology and production systems, yet is applied to existing markets (Example: Technological innovation of audio from analog to digital, Transfer of automobiles from manual to automatic)
(3) Market niche innovation: cultivates new markets within existing technology and production systems (Example: Headphone stereo, home video game)
(4) Regular innovation: provides cheaper and higher quality products or services by improving technology and production methods

Technological impact

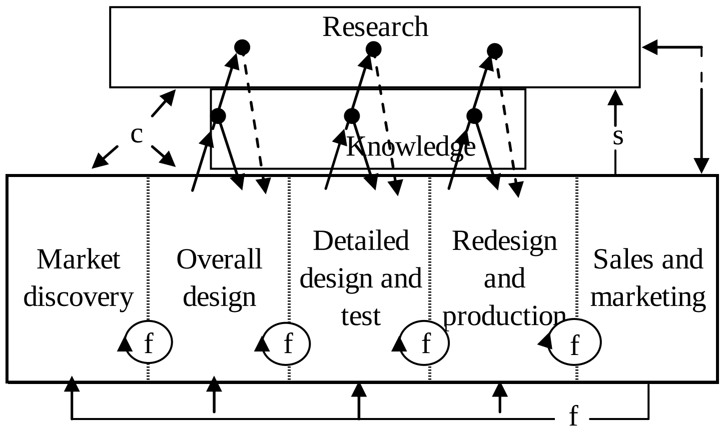
Conservative ↔ Innovative

Conservative ← Technological impact → Innovative		Market impact
Market niche innovations (Headphone stereo, home video game, etc.)	Architectural innovations (Airplanes, computers, etc.)	Innovative
Regular innovations (Providing cheaper and higher quality products by improving technology and production methods)	Revolutionary innovations (From analog to digital, etc.)	Conservative

Source: Created by Ministry of Education, Culture, Sports, Science and Technology using information from Professor Seiichiro Yonekura of Hitotsubashi University

- Models of innovation concerning the creation of economic value

Stephen J. Kline has recently shown that technological innovation does not follow a linear flow (linear model) of "research" - "development" - "design" - "production" - "sales," but is explained by a chain-link model, as shown below, where each function is linked and interacts, and feedback is generated.



f: Feedback
I: New equipment stimulates science, and science generates new equipment
C: Idea germination
S: Company's support for long-term research

Source: Created by the Center for Research and Development Strategy based on the chain-link model of Stephen J. Kline

(2) Innovation and science and technology to improve productivity

An indicator to show the contribution of science and technology to economic growth is a concept called total factor productivity (TFP) contributing to the rate of growth of GDP. Total factor productivity means productivity with consideration of all factors contributing to production, except for amount of labor investment and capital stock. It increases with changes in the business climate and improvements in labor quality, and the progress of technology is said to be a major factor for such an increase.

After World War II, Japan did not simply achieve economic recovery, but had major development as a result of high economic growth. Looking at the contributions from labor, capital, and total factor productivity to the GDP growth rate in Japan indicates that while the GDP growth rate increased from the second half of the 1950s until the end of the 1960s, the labor contribution declined or only had minute increases, showing that increases in capital and in total factor productivity made the greatest contribution increases in capital and in total factor productivity made the greatest contribution (Figure 1-2-24). For the increases in GDP growth rate in the late 1980s there was basically no change in the contributions from labor or capital, and the greatest contribution came from total factor productivity. This suggests that it could be possible to stimulate economic growth without being affected by the amount of labor investment through increases in total factor productivity.

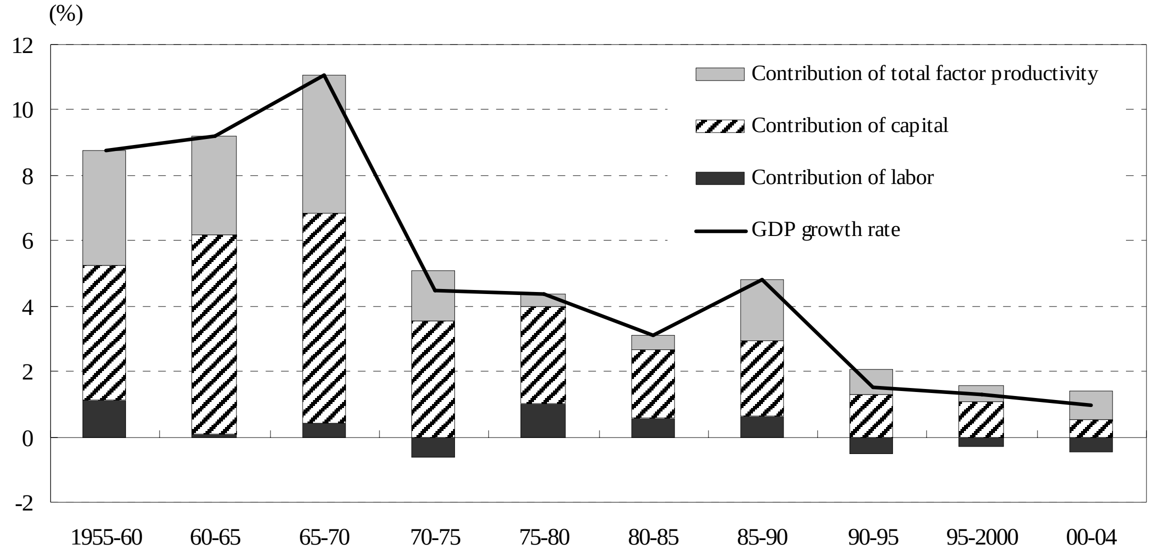


Figure 1-2-24 Attribution analysis of GDP growth rate

Note: The labor contribution is based on man-hours.
The capital stock for years since the 1970s have been by operating ratio.
Source: Ministry of Health, Labour and Welfare "White Paper on the Labour Economy 2005"

Changes in the growth rate of total factor productivity in Japan between 1990 -1995 and between 1995 -2000 were compared to data from other countries. The total factor productivity growth rates increased in Canada, the USA, and France, while it decreased in Japan, the United Kingdom, Germany and Italy (Figure 1-2-25).

In the midst of the progression of the aging of society, it is necessary to increase all-factor productivity in order to maintain and improve economic growth in Japan. Innovation and science and technology improvements are the important elements, and are expected to be even more important in the future.

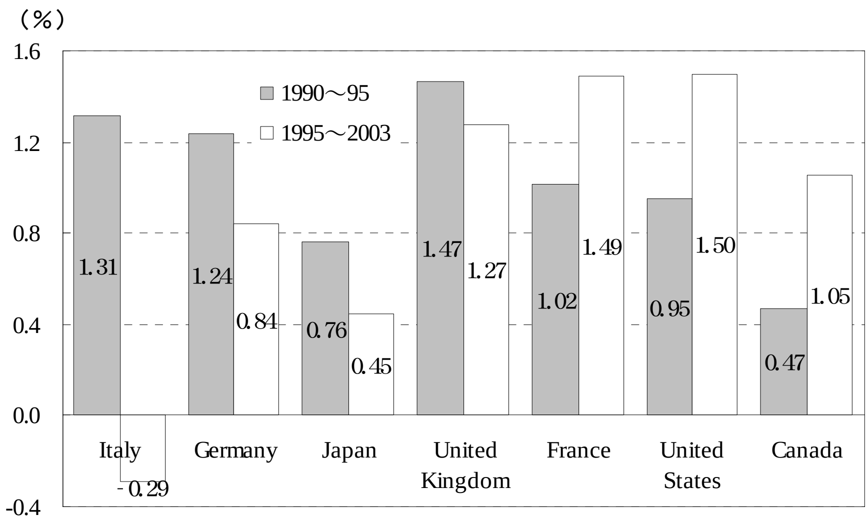


Figure 1-2-25 Changes in growth rate of total factor productivity

Source: Created by the Ministry of Education, Culture, Sports, Science and Technology from the OECD "Compendium of Productivity Indicators 2005"

(3) Trends in various countries on science and technology policies to achieve innovation

Modern Japan and economic societies in other advanced nations are knowledge-based economies and societies, founded on knowledge like the results of science and technology. To maintain and grow these economies it is important to make use of the knowledge base in industrial technology, develop new goods and services, and cycle the knowledge back into society and the daily lives of citizens. For this reason, the development of mechanisms to promote innovation has become an important policy issue for many countries, and a variety of science and technology and innovation policies are being developed (Table 1-2-26).

Table 1-2-26 Science and technology policies to promote innovation in various countries

	Japan	USA	EU	United Kingdom
Basic law; Basic plan	Science and Technology Basic Law (1995) Second Science and Technology Basic Plan (FY 2001-2005) Third Science and Technology Basic Plan (FY 2006-2010)	None	Treaty establishing the European Community Framework Programme (FP): Sixth (2002-2006), Seventh (2007-2013) Competitiveness and innovation framework programme (2007-2013)	Science and Innovation Investment Framework (2004-2014)
Priority fields	Four priority fields to be promoted under the Third Science Basic Plan: Life sciences; Information and telecommunications; Environmental sciences; Nanotechnology and materials; and interdisciplinary fields	R&D focus items of related departments and agencies: Homeland security; Network and information technology; Nanotechnology; Natural science; Environment and energy; Life sciences	Sixth FP: Life sciences; Information society technologies; Nanotechnologies and nanosciences; Aeronautics and space; Food quality and safety; Sustainable development; Citizens and governance	E-science; Life science, like genome research; Basic technology (nanotech etc.); Stem cells; Sustainable energy/economy; Agricultural economy and land utilization (use of farming regions, disease control in animals, food safety, etc)
Innovation-related policy/strategy	Third Science and Technology Basic Plan (Ch 3, 2. Creating scientific development and persistent innovation)	President's American Competitiveness Initiative	Competitiveness and innovation framework programme (2007-2013)	Science and Innovation Investment Framework (2004-2014)
Goals/programs of the above innovation policies	(Third Science and Technology Basic Plan) Maintaining the various research fund systems according to the development stage of R&D; Building a sustainable and progressive industry–academia-government collaboration system; Promoting the utilization of new technologies in the public sector; Promoting entrepreneurial activities, R&D ventures; Promoting R&D by private enterprises	Expanding R&D investment by the federal government; Promoting R&D investment by the private sector; Strengthening elementary and lower secondary school education ($380 million for math and science education); Educating/training national labor force; Obtaining talented personnel; Economic policy to promote sustainable growth	Entrepreneurship and Innovation Programme; ICT Policy Support Programme; Intelligent Energy -Europe Programme	Promoting world class research; Sustainable university research; Promoting industry–academia alliances; Increasing R&D investment in industry; Knowledge transfer and innovation; Science, technology and engineering education; Confidence of citizens in science and technology Innovation across agencies; International cooperation
New activity on innovation		Competitiveness Committee "Palmisano Report"; National Academies "Rising Above The Gathering Storm"; House Democratic Party "Innovation Agenda"(bill); Senate "American Innovation and Competitiveness Act" (bill); House "PACE Act" (bill)	A group of experts (headed by former Prime Minister of Finland, Esko Aho) advise on concrete action for innovation (Aho Group Report)	
R&D expenditure (Note)	3.4 trillion yen (0.68%) (FY2004)	10.2 trillion yen (0.81%) (FY2003)	8.8 trillion yen (0.67%) (FY2003)	1.2 trillion yen (0.59%) (FY2003)

	Germany	France	China	Korea
Basic law; Basic plan	None	Long Range Plan for Research (2006-)	National Guidelines for Medium- and Long-Term Plans for Science and Technology Development (2006-2020) Eleventh Five-Year Plan (2006-2010)	Science and Technology Basic Law (2001) The Long-Term Vision for Science and Technology Competitiveness by 2025 (1999) Science and Technology Basic Plan (2002)
Priority fields	Life science; New technology; Sustainable development	Strengthening ability on defining strategic directions and priority topics; Building an integrated, transparent system for research assessment; Promoting research cooperation; Providing attractive science careers; Supporting industry-academia cooperation and industrial R&D; Enhancing the French research system and integrating French research with European research	Focus areas in the National Guidelines for Medium- and Long-Term Plans for Science and Technology Development: Energy; Water and mineral resources; Environment; Agriculture; Manufacturing; Transportation industry; Information industry and service industry; Population and health; Urbanization and urban development; Public safety; National defense	6 technology fields in the Science and Technology Basic Plan (2002-2006): IT (information technology); Biotechnology; Nanotechnology; Space and aviation Environment and energy; Culture technology
Innovation-related policy/strategy	Innovation Policy–More dynamic for competitive jobs (BMBF 2002) Agenda 2010 (2004) Pact for Research and Innovation (2005)	Innovation Research Law (1999) Innovation Support Policy (2002)	Summary of National Guidelines for Medium- and Long-Term Plans for Science and Technology Development: Feb 2002 announcement. Independent creativity (independent innovation); 863 Plan: R&D program to develop high-tech industry technologies. Continuing since 1986; Torch Program: Preparation of high-tech development zones for internationalization, industrialization and commercialization of science and technology results. Continuing from 1988	Roh Moo-hyun administration (2003-) advocating "establishment of a science and technology-oriented society" as one of its national policy targets; Establishing a strategy to promote the next-generation growth effort in 2003 to build a science and technology-oriented society aiming to achieve sustainable economic growth through the development of core technology and new industrial innovation and by becoming the world's No.2 nation based on science and technology; Establishment of an innovation bureau (2004)
Goals/programs of the above innovation policies	(Innovation Policy) Innovation & society/employment Open markets; Human resources; Business based on new technologies; Local and international innovation network; (Pact for research and innovation) Improving research competitiveness; Strengthening cooperation between agencies; Educating young people; Promoting bold research approaches; Increasing joint financial assistance to research institutes by federal and state governments	(Innovation support policy) Government support for business R&D; Improving business access to funding assistance; Improving existing funding assistance systems and establishing new systems; Employment support for young people in research fields; Enhancing priority research areas	Following target until 2020: Raising R&D investment to 2.5% or more of GDP (2.0% or more by 2010); Science and Technology contribution rate: 60% or more; Reliance on foreign technology: 30% or less; Number of citations of Chinese scientific papers/patents: Be top 5 in the world	Defining a 10 Future Growth Industry as a strategy to promote next generation growth activities while aiming to build a science and technology-oriented society
New activity on innovation		Established Industrial Innovation Agency (2005)		
R&D expenditure (Note)	2.2 trillion yen (0.78%) (FY2003)	1.8 trillion yen (0.89%) (FY2003)	0.6 trillion yen (0.63%) (FY2003)	0.4 trillion yen (0.63%) (FY2003)

Note: Government-financed R&D expenditures and the percentage of GDP include the portion from the local governments.
The government-financed R&D expenditures are calculated using the IMF rates for the national currency.
For the EU, values are based on total research funding for the 25 member states.

Source: Created by the Japan Science and Technology Agency Center for Research and Development Strategy from data for various countries

●USA

Since the economic stagnation in the late 1970s, there has been an emphasis on "enhancing industrial competitiveness through innovation" and adoption of policies focusing on science and technology as a "source of innovation," which have been continued to today. A characteristic of the US innovation policy is the effort to achieve the twin goals of "national security and defense" and "enhanced industrial competitiveness" by taking advantage of its competitive edge in science and technology.

In the president's State of the Union address on January 31, 2006 it was mentioned that the main policy issues were to overcome dependence on oil from the Middle East and enhanced competitive strength in order for the USA to maintain a top position in the future. The American Competitiveness Initiative announced in the address indicated emphasis on a preparation of an innovation environment, the obtaining and training of human resources, and increases in basic research in order to promote innovation through science and technology, based on the assumption that science and technology is the foundation of US competitiveness.

●United Kingdom

Based on recognition that the country's great potential had not effectively led to innovation in the past, competitiveness and innovation have been designated as important strategies. A goal of the science and technology strategy is the creation of broad benefits to society through widespread economic gains (creation of wealth and improved productivity) and improvement to the health, environment and quality of life of the people. Since the 1993 White Paper on Science, Engineering and Technology, there have been a series of strategies based on science and technology and aiming at economic development. In 2004 the "Science and Innovation Investment Framework 2004-2014," a 10 year long- term strategy, was announced, indicating measures including expansion of research and development investment, education of human resources, and alliances between the central government and local areas.

●Germany

Immediately after the reunification of eastern and western Germany, the finances of the central government were strained to support the former East Germany, and the attention on research and development declined. In addition, since Germany is a nation originally founded on traditional industries like chemicals, machinery and steel, movement into new industries, like computers, electronics, and biotechnology was delayed. At present, there are policies being hammered out to strengthen economic power through innovation and continuing growth, and to create job opportunities in the future.

In 2003 the "Agenda 2010" was announced, presenting a comprehensive program for economic growth and redevelopment of labor markets and social security systems. In 2004, it was announced that focus would be placed on "Agenda 2010 Part 2," which aims to aggressively develop innovation in research, education and vocational training.

●France

In June 1999 the Law on Innovation and Research was enacted. This law permits the establishment of companies through transfer or reassignment of researchers from public agencies, and participation by these researchers in the companies for a limited period (maximum of 6 years), such as being a board member, as well as recognizing investment in a company (limited to 15% of total capital) or provision of advice to a company on the science and technology aspects while continuing their public duties. In addition, the public agencies became able to utilize and promote research results by providing locations and facilities to business.

Since 2002 innovation support policies have been implemented. Specifically, there is government support of business research and development, simplification of access to grants by businesses, improvements to the existing grant system, establishment of a new grant system, employment support in research fields for young researchers, and strengthening priority research areas

In December 2005 the upper house of the legislature approved a bill on a long term plan for research, which is now being discussed in the committee on culture, family and social issues in the lower house.

●EU

In addition to strengthening industrial competitiveness the EU has placed a priority on science and technology as a means to achieve a variety of policy goals for health, the environment and consumer protection. In Article 163 of the union's fundamental charter (Nice Charter), the goals of research and development policies are defined as "strengthening the science and technology bases of Community industry," "strengthening international competitiveness," and "promoting the research activities required for other EU policies."

In 2000 the European Commission adopted the Lisbon Strategy, a comprehensive economic and social policy to extend through 2010. The focus is on promoting economic reform to appropriately adapt to a knowledge-based economy, and enhancing the European social model through investment in human resources, with a goal of developing a vigorous knowledge-based economy.

With regard to innovation, the Framework Program was started in 1984 as a general plan for EU research and development. At present, the 6th Framework Program is underway, covering the period from 2002-2006, and the 7th Framework Program is being created. For the competitiveness and innovation framework, there is a business innovation program, a telecommunications technology policy sup- port program, and the intelligent energy Europe program.

●China

Thus far, several measures have been taken according to the circumstances at the time, such as the "863 Plan" aimed at promoting high-tech research, and the "Torch Program" to promote the development of the foundations to support a national innovation system.

In March 2006, the outline of the 11th Five-Year Plan for National Economy and Social Development was announced by the Central Committee of the Communist Party of China. The 9th Nine-Year Plan through fiscal year 2000 and the 10th Five-Year Plan through fiscal year 2005 rapidly raised the level of science and technology, and in the 11th Five-Year Plan outline, one of the two main goals described is to reduce the consumption of energy by 20% and reduce the amount of primary contaminants emission by 10%, revealing a clear policy trend toward handling the pressing problems of resources and the environment.

In February 2006 an outline of a national mid and long-term plan on science and technology development for the next 15 years was announced. In this plan the idea of "independent innovation" is raised, with concrete goals established, such as raising research and development investment to no less than 2.5% of GDP by 2020, decreasing the dependence on foreign technology to below 30%, and having the frequency of citation of patents and scientific reports of Chinese people ranked in the top 5 in the world.

●South Korea

In 1999 the "Long-range Science and Technology Development Vision Toward 2025" was established, with a goal of promoting science and technology competitiveness to the G7 level by 2025. In 2001 the Science and Technology Basic Law was enacted. The Science and Technology Principle Plan (2002 - 2006) was enacted in conjunction with a 5-year plan on science and technology reform that was already underway. In 2004, the Headquarters of Science and Technology Innovation was established under the Ministry of Science and Technology.

Each country has put forward science and technology and innovation policies, along with the support for research and development, aimed at the utilization and development of research results and return of benefits to society. For a nation like our own, with few natural resources, it is important to actively continue with policies to promote innovation based on science and technology in order to strengthen international competitiveness.

[Column 8]

Proposal of Innovation Policy in the United States

In his State of the Union address in January 2006, President Bush stated that innovation focusing on science and technology was important to keep and strengthen the country's international competitiveness. As its background, there are many political suggestions from private organizations. Among them, "Innovate America," which has attracted widespread attention from the time it was announced, and "Rising Above the Gathering Storm," which was said to have had a big influence on the State of the Union address of this time, are introduced here.

"Innovate America"

The "National Innovation Initiative," promoted by Council on Competitiveness of the U.S., announced a report in December 2004, after discussions made for 15 months by the top 400 people in industry, university, and government. It is called the "Palmisano Report" after Samuel J. Palmisano (Chairman of the Board and Chief Executive Officer of IBM Corporation) who served the chair. With the decline in the number of foreign students studying in the U.S. and the number of American students who study science and engineering, and the long-term decrease in the federal government's investment on research as its background, there is a sense of crisis in the U.S. that, although the U.S. still has superiority over other countries at present, the difference has been getting smaller and the U.S. may not be coping with the quality and changing speed of recent innovations. Based on the recognition that innovation is the biggest sole driving force for the U.S. to continue in the 21st century to develop and grow, proposals were made on the three fields of talent, investment, and infrastructure, in particular.

"Rising Above the Gathering Storm"

The report was announced in October 2005 by the "Committee on Prospering in the Global Economy of the 21st Century" (Chair: Norman R. Augustine, Retired Chairman and Chief Executive Officer, Lockheed Martin Corporation). This committee consists of 20 leaders from industry, university, and government and was established by the National Academies. In response to the question of the members of the United States Senate Committee on Energy & Natural Resources, this report was made about the measures that the persons in charge of making policies in the federal government should take and the strategies to put the measures into practice to enforce science and technology activities for the U.S. to be successful in competition, prosperity, and safety in the international society in the 21st century. The report insists that, although the U.S. has been a world leader in economy and strategy since the end of World War II, it has been losing its strength recently in the fields of market and science and technology, and comprehensive and immediate measures are necessary. It is considering China and India as competitors. Its concrete proposals are (1) vast improvement in K-12 science and mathematics education, (2) strengthening science and engineering research, (3) improvement in higher education of science and engineering, and (4) improvement of the innovation environment.

1.2.2.2 Measures Connecting Science and Technology with Innovation

As countries adopt innovation policies and global competition becomes more intense, it is important to develop new technology and to continue to effectively connect the superior research results to innovation, while also promoting and ensuring diversity in basic research, such as by universities and public research institutions which are the sources of innovation, in order to maintain and develop Japan's economic growth. Therefore, it is necessary for industry, government and academia to work together to enhance the systems for generating innovation. There is a need to establish innovation systems that are best suited to our country, not simply mimic what other countries have done, because of differences in the basic structure and operation of businesses and universities in each country, as well as the large differences in the culture, economy and legal systems in each country.

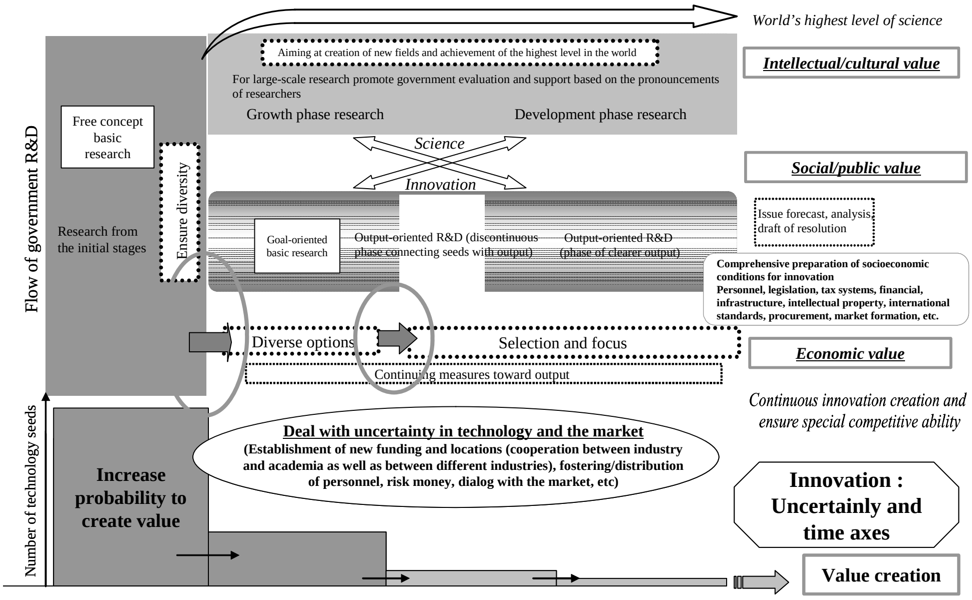


Figure 1-2-27 Development of science and creation of continuous innovation

Source: Created by the Economic and Social Research Institute, Cabinet Office based on the White Paper on Science and Technology 2005

(1) Promotion of basic research at universities, which are the wellspring of innovation

Universities are a source of [knowledge], and are a treasure trove of the seeds that give rise to innovation. In FY2004 the national universities and inter-university research institutes became independent organizations. As a result, there is a demand for each university to make use of their independence and autonomy to develop their own individuality and characteristics to vitalize research based on the free ideas of researchers, work in coordination with industry and the government, and make a contribution to the local area. Examples of new research and development efforts following the corporatization of national universities are below.

●Prioritization of research funds

Promote vitalization of research activities through focused distribution of funds, such as establishment of a public recruitment research project system within universities using funds under the discretion of their president, and selective distribution of the budget among departments.

●Flexible reorganization

Take advantage of the ability to flexibly reorganize that comes from incorporation, and develop systems that enable research to be conducted effectively and flexibly.

●Development of international research centers

Develop research systems and organizations to improve and fully utilize the inter-agency function throughout the country, and promote creative, cutting-edge research as an international center of research.

In order to develop world-ranked universities with the ability to lead the world in science and technology, it is important to create top class bases of research education. To achieve a research and development system that produces superior results and personnel, strategic research base formation is being performed with the goal of promoting organization and operation reforms for research and development institutes based on the vision and leadership of the organization chief, and of forming bases of superior research and personnel development that are internationally attractive (Table 1-2-28).

Table 1-2-28 Table of issues adopted for strategic research base formation

Fiscal year adopted	Topic	Implementing institute	Summary
2001	Cutting edge science and technology open lab for humanity and society	University of Tokyo Research Center for Advanced Science and Technology	Open labs and off-campus organizations are established and promotion policies are advanced on returning research results to society and feedback, and training and exchange of personnel
	Frontier Research Base Vision	Osaka University, Graduate School of Engineering Research, Frontier Research Center	The Frontier Research Center was established within the school of engineering research, and strategic fields defined to build a research base attracting the attention of the world for the research systems and results.
2002	Formation of a base of medical research through the integration of cutting-edge fields	Kyoto University Graduate School of Medicine, Horizontal Medical Research Organization	Establishment of a research organization centered on medical research, open labs with young team leaders, a research support center and mechanisms to announce and distribute research results.
	Venture development strategy research center	National Institute of Advanced Industrial Science and Technology, Venture development strategy research center	Preparation of an open research environment and a support system for business start-ups based on technology seeds
2003	Formation of an advanced medical engineering research base	Tohoku University Biomedical Engineering Research Organization	Creation of biomedical engineering through the fusion of cutting-edge engineering technology with health and life sciences
	Hokkaido University research & business park concept	Hokkaido University Creative Research Initiative “Sousei”	Development of a model base of government-industry-academia alliances for economic and regional vitalization driven by science and technology
	A special area for innovation with young international researchers	National Institute for Materials Science, International Center for Young Scientists	Introduction of salary and human resources systems strictly based on results, and a research system using English as the primary language
2004	Creation of a research base merging health & medicine with cutting-edge science	Waseda University Consolidated Research Institute for Advanced Science and Medical Care	Establishment of a combined research facility with the participation of researchers at the school in the fields of natural science, humanities and social science as well as medical researchers from inside and outside the school, to train young researchers to acquirer not only research skills but also the ability to identify potential for commercialization and industrialization.
	Comprehensive research base for digital media and content	Keio University Research Institute for Digital Media and Content	Build an organization for digital content, and attract international interaction and creativity with a fusion of humanities, social sciences, science, engineering and medicine.
	Organization combining user-based technology and the senses	Kyushu University User Science Institute	A fusion of sensitivity and technology from a user’s perspective. Building a research and development base to pioneer the new field of “user science”
2005	Create an international integrated base of medical research and human resources development	Tokyo Women’s Medical University	Formation of a base of R&D and human resources development, combining the various specialties in medicine as well as traditional medicine to establish “integrated health care”
	Unified research institute at Tokyo Tech	Tokyo Institute of Technology	In addition to imagining the ideal society and devising solutions, build a base to actually implement the research to solve the problems
	Concept of “research linked to sustainability study”	University of Tokyo	Aim is to build a base that is highly-competitive internationally through partnerships between multiple institutes mediated through the University of Tokyo and sharing a theme of “sustainability”

In order to work toward promoting innovation, from the perspective of finding research areas in which to take the lead internationally, it is likely to be very effective to concentrate investment on the formation of bases of research and education focusing on cutting-edge fusions of research areas.

(2) Enhancing systems for creating innovation

●Maintaining the various systems according to the development stage of R&D

The various research and development funding systems to support the development of science and creation of innovation must be properly prepared to handle the special characteristics and development stages of research. Expanding competitive funds[13] will gradually improve the level of research and contribute to the development of a robust foundation for the creation of knowledge in Japan. In the future it will be necessary for the new scientific knowledge and technological concepts to be utilized in the economy and society in a visible manner, from the perspective of further strengthening the foundation of knowledge creation and to return the results to society.

Except for competitive funding systems, the majority of external research and development funds in Japan are assumed to be targeted at research and development of technology that is relatively close to becoming practically usable, within the range for which a roadmap can be established based on the scientific prospects. In order for Japan to produce completely new, revolutionary technology as a breakthrough based on its own promising basic research results that are still at the germination stage, and to use it for ensuring the country's competitive strength, it is essential to strengthen research and development for creating and fostering the seeds of innovation from a diverse range of basic research results and to strengthen research and development aimed at tangible technological revolution, not mere announcements of theories.

[13] A form of research and development funds for which a call is made for a wide range of research and development topics and proposals. Several people, including specialists evaluate the topics and proposals from the scientific and technological perspective and select the topics that should be studied; and the research and development funding is distributed to the researchers.