Chapter 3 State of Science and Technology in the Age of Fierce Competition

(1) Need for further strengthening S&T policy

In Chapter 1, we state that continuous creation of innovation by S&T is essential to handle the rapid aging of society and the declining birthrate, maintain economic growth in our country, survive as a major player in the world, and sustain and promote our current plentiful lifestyle in the situation of progress of advancing information technology and globalization, as well as the advent of fierce competition generated by the rise of BRICs countries that will have a significant impact on the global competitive landscape.

In addition, Chapter 2, Section 1, we state that, in fierce competition, not only major advanced countries but emerging countries, such as China and Russia, recognize S&T as a wellspring of innovation for planning the increase in capital investment in R&D and perform drastic R&D reform and competition of acquiring excellent research human resources.

Now in the situation of global S&T policy competition, it is essential to implement appropriate measures without falling behind other countries. Once left behind, it is extremely difficult to catch up and make up for lost time. Accordingly, Japan must further reform and strengthen its S&T policies in response to such major shifts in other countries.

(2) Need for making continuous efforts to reform with a sense of crisis

The transition of the US S&T-driven innovation policies provides our country with a significant model. The US was once alarmed at the rapid rise of Japanese manufacturing industries and promoted a series of strong S&T and innovation policies as described in the *Young Report*. The US subsequently advanced into new industrial areas of IT and biotechnology to secure its position as a world innovation center. Moreover, in response to the recent emergence of China and India, the US once again redoubled its efforts to sharpen its competitive edge by further diverting S&T policies in a series of events starting from the *Palmisano Report* in 2004 and leading up to the America COMPETES Act as described in Part 1, Chapter 2. We should understand that continuous S&T revolution and innovation policies, based on a sense of crisis, enables the US to occupy the position of a global center of innovation. It is essential that Japan also continuously reform its own S&T policies with such a sense of crisis.

(3) Need for Global Strategies

When developing S&T policies, what our country should note first is that approaches from the global viewpoint, in other words the viewpoint of a *global strategy*, are essential in fierce competition. In further development of our S&T policies, there is no question as to the importance of paying attention to the trends in S&T policies of foreign countries that are changing rapidly. In addition, when Japan develops measures against foreign countries, we should sufficiently understand the current status of the international level of our S&T capabilities in comparison with that of foreign countries, priority areas on which they focus, and differences in the career paths of researchers between Japan and other countries. Otherwise, it is predicted that effective and efficient resource investment and acquisition of excellent overseas researchers will encounter difficulties. Therefore, the perspective of a *global strategy* is essential for Japan to develop S&T policies in response to other countries.

(4) Method for implementing future measures

From this point of view, it is necessary to develop an overview from resource supply to practical use of R&D achievements and then extract and solve the bottleneck issues after grasping the status of other countries. First, for the aspect of resource input, it is important that Japan obtain accurate information on the trends in the enhancement of R&D capabilities in foreign countries and improve

government R&D investments in terms of both quality and quantity to compete with other countries in the race to build R&D capabilities. However, in order to compete with rapidly increasing R&D investments by China, we should formulate an unwavering strategy concerning the inputs and improvement of methods for utilizing resources. Therefore, we should continuously move ahead on enhancement of innovation capabilities for Monodzukuri industries that played a role as the engine of conventional economic growth and further positively perform promotion of R&D in the new area described in Part 1, Chapter, Section 1 to develop our own unique innovation in these industries.

In addition, acquisition of excellent human resources is most important for our country with insufficient natural resources to compete with foreign countries. In the current situation where the birthrate in Japan is declining and the number of S&T-inclined students is dropping, it is essential to train researchers that will assume leading roles in cutting-edge S&T and product development for companies that are exposed to international competition. As a prerequisite for this goal, math and science education must be strongly encouraged at the elementary and secondary school levels.

Moreover, because there is a limit on quantitative expansion of resource input, it is imperative to strongly promote R&D system reform efforts to improve R&D capabilities, namely the quality of R&D, and avoid the wasteful use of resources.

Finally, but not least, from the perspective of overcoming the weakness of Japan in converting R&D investments into innovation, it is also necessary to promote efforts with an orientation toward more efficient dissemination of R&D results to society through, among other things, enhanced MOT capabilities and international standardization policies as described in Part 1, Chapter 2, Section 2.

1 Enhancement of Government R&D Investments

As described in Part 1, Chapter 2, Section 1, the US, the world champion in S&T, as well as China and other newly emerging countries have established plans to strengthen their R&D capabilities. On the other hand, although our country has made efforts to increase government R&D investments, it is almost at the same level in recent years, meaning that our country is in the situation in contrast to China where its rapid growth continues.

In fierce global competition, significantly increasing importance is that we should create a greater impact on the social economy and develop and practically utilize technologies that allow Japanese economic growth to accelerate. Some technologies can have a strong positive impact on society and the economy. The other side of the same coin is, however, that it can often be difficult to achieve practical application of such technologies in a short period of time due to restrictive factors.

A typical example of this case is provided by the vertical magnetic recording method for hard disk drives (HDDs). In 1977, Prof. Shun-ichi Iwasaki of Tohoku University presented the high-density recording property of the vertical magnetic recording method at an international conference, and this technology was commercialized remarkably around the year 2000. Now as a product with a huge market (approximately ¥2.5 trillion), this product is the result of more than 20 years of industry-academia-government cooperation under the initiative of Tohoku University and continuous financial support from the government[fn.1].

In the establishment of practical application of blue light emitting diodes (LEDs) where development was delayed in comparison to other types of LEDs—become popular because of its low power consumption and long life—many years of government subsidies such as the Grants-in-Aid for Scientific Research or JST's Exploratory Research for Advanced Technology (ERATO) played an important role.

We are now in an age of increasingly fierce competition and short-term investment cycles due to accelerating commoditization of technologies, and there is no denying the possibility that it may

fn. 1 Figure 1-1-23 in *White Paper on Science and Technology 2007*

become difficult for private enterprises to support medium- to long-term R&D projects. From the perspective of prioritized investment for the future, it is important to enhance government-funded R&D programs, including more selective allocation of subsidies for truly necessary fields.

The Third Science and Technology Basic Plan provides that the ratio of government R&D investments to GDP shall be on a par with those of the US and major European countries. To achieve this, the Third Plan estimates that the total amount of approximately ¥25 trillion must be budgeted for the period (on the assumption that the ratio of government R&D investment to GDP will be 1% during the period of the Plan, and the average nominal GDP growth rate will be 3.1% for the same period).

In the budgeting process every year, we will try to secure the expenditures necessary to promote the measures incorporated in the Plan, taking into consideration the future social and economic trend, the necessity of S&T promotion, and the severe financial situation for the purpose of maximizing the effects of governmental R&D investments by steadily implementing S&T system reform in the Plan.

2 Fields Prioritized for Intensive Resource Allocation for Strengthening International Competitiveness

1 Promotion of R&D in New Fields

When considering resource input into S&T, it is hereafter important to deal with various global issues confronted by human beings. It is necessary for Japan to invest in meeting the challenges of environmental problems or the world's unprecedented aging society with a shrinking population and declining birthrate and play a leading role in international cooperation and collaboration toward solutions to these problems. This is essential for the benefit of society and so that Japan can maintain and improve its competitiveness. At the same time, it is also imperative that Japan increase investments in the following fields, each expected to become an important arena of future international competition, and should continuously improve its international competitiveness toward sustainable economic growth:

(1) Promotion of service science

As described in Part 1, Chapter 2, Section 2, the current low productivity in the service industries along with their increasing importance is an issue that may negatively affect Japan's international competitiveness and must be urgently addressed. Therefore, MEXT provides education programs by systematizing new knowledge and integrating the social sciences and the natural sciences. The program offers an education that fosters human resources with a high level of knowledge and specialties in business, IT, and the humanities. The excellent program will be widely disseminated to universities as a model to promote education practices regarding services in universities, and promote the Program for Practical Human Resource Development by Industry-Academia Cooperation—Service Innovation Human Resource Development—aiming for the reform of various industrial fields and enhancement of international competitiveness (Table 1-3-1). It is necessary for the government to strengthen such efforts in order to promote service science from now.

Table 1-3-1 Outline of Funded Projects under the Program for Practical Human Resource Development by Industry-Academia Cooperation -Service Innovation Human Resource Development-

University	Project	Outline
Tohoku University	Development of service innovation manager — Human resource developments for controlling productivity in service sector —	This project fosters human resources (service innovation managers) who can correctly evaluate the productivity of workers, create new productivity in the service sector, and control quality. Therefore, this project educates by providing *new knowledge* integrating mathematics and engineering science and economics and business science as well as *practical projects* for measuring and evaluating productivity in the service sector and improving productivity in the workplace.
University of Tsukuba	Development of advanced professional fostering program based on service science for customer-oriented business innovation	Establish interdisciplinary education system of *service science* for customer-oriented business innovation by integrating knowledge of economics and mathematical, statistical, and information-scientific techniques in the master's program in Business Administration & Public Policy, Graduate School of Systems & Information Engineering. In addition, create integrated database for service innovation education to foster advanced professionals in the MBA course and develop an education model and teaching materials that can be applied to other universities and enterprises.
Tokyo Institute of Technology	Program for fostering social service value designing innovators	•Foster social service value for innovators who can design, create, evaluate, and innovate service values truly useful for society in order to quickly return S&T achievements as social technology; •Formulate a liberal arts program that strengthens high level humanity-science integrated abilities capable of drawing a chart of knowledge; and •Establish it as essential literacy education of the 21st century for S&E graduate students and adult graduate students with work experience.
Kyoto University	Development of education program *Service Value Creation Management*	The Graduate School of Management develops curricula consisting of two features, anthropological methodology for creating innovation based on service field analysis and an integrated framework for improving service values, including utilization of IT and educating students in order to newly establish the education program called *Service Value Creation Management*. This humanity-science integrated education aims to develop human resources with service creativity (creative intelligent workers) who will lead a high level service society.
Bunri University for Hospitality	Formulation of program for fostering middle managers with the simulation mind to produce high added value — Development and operation of Service Management 100 (three-stage case method) —	Establish a new education program that consists of packaged case study materials using case method teaching. This program seeks to develop analysis/determination/conception abilities called the "simulation mind" by repetitively learning important training subjects focusing on middle managers in service fields. It also aims to strengthen the ability to grasp the service field with a worm's eye approach and the entire business management with a bird's eye approach to create bottom-up type innovation led by human resources with high motivation.
Meiji University	Human resource development project for grasping and utilizing quintessence of service innovation	Although it is possible to generally study the features of services, the actual status is exceedingly individualized and diversified because they have shapeless characteristics at the industrial level where consumers directly contact them. This program has two stages, the general level and individual level to ensure the effectiveness of human resource development. In addition, the services have self-developing features that modify and develop the program while collecting and organizing information in order to acquire implicit knowledge of service development and production in individual industries.

(2) Promotion of S&T related science-based industry

Since the Second Science and Technology Basic Plan, Japan has intensively allocated resources to four designated high-priority fields, including life sciences, and information and telecommunications, which contribute to promoting science-based industries. Such measures have led, for example in the life sciences field, to the successful generation of induced pluripotent stem (iPS) cells (to be mentioned later) and other significant contributions to the health of the nation. In addition, as stated in Part 1, Chapter 2, Section 2, considering the fact that universities played important roles in similar R&D projects in other countries, Japan should continue to strongly promote R&D activities at universities and continuously encourage industry-academia cooperation in the above fields.

(3) Responses to newly emerging and interdisciplinary fields

Great inventions and discoveries in the 20th century owed much to inspirations from intellects in different disciplines and to intellectual fusions through friendly competition between such intellects. With this fact in mind, MEXT has introduced measures to support optical and quantum S&T, interdisciplinary fields between information S&T and nanotechnology, and molecular imaging research programs in order to further promote cutting-edge technological R&D. More specifically, the measures are as follows:

1) Search of breakthroughs in collaboration between mathematics and other various fields

Since mathematics is the underlying basis of various sciences and brings breakthroughs in R&D in many areas by collaborative research with other fields, the strategic target for mathematical field has been set in the JST Basic Research Programs from FY 2007; they promote collaborative and interdisciplinary researches between mathematics and other fields.

2) Development of emerging and interdisciplinary researches focusing on light and quantum beams

Bringing in view the participation in optical industry where the market size is expected to exceed ¥100 trillion by 2015, S&T for light and quantum beams that are strongly promoted by Europe and the US as important measures is to be promoted. It is also promoted that R&D of cutting-edge methods for controlling and measuring light/beam source and beam by integrating seeds of light and quantum S&T with needs from each important fields and industries by constructing network research hubs, and young human resources development.

In addition to these measures, projects are conducted in emerging and interdisciplinary researches such as light, information, and bioscience through the JST Basic Research Programs. Moreover, MEXT fosters researchers and engineers for the next generation in collaboration with government, industry, and academia in advanced interdisciplinary fields to be considered especially important for creating innovation from the long-term perspective by the Special Coordination Funds for Promoting Science and Technology (SCF). At the same time, the program Innovation Center for Fusion of Advanced Technologies is established for the purpose of creating a research center where R&D activities are to be performed from the basic level targeted for a practical application in the future.

In addition to these measures, competitive funds will be utilized to encourage R&D that allows flexible orchestration of the knowledge necessary for solving problems across the existing boundaries between research fields. An environment that encourages intellectual inspiration and fusion between different areas also will be nurtured for the creation of new wisdom in the age of fierce competition.

2 Development and Recruitment of Internationally Competitive Human Resources

As described in Part 1, Chapter 2, Section 1, foreign countries are focusing on recruitment of excellent domestic and overseas human resources to successfully promote research system reform for the creation of innovation. Also in the Third Science and Technology Basic Plan, the political point of view is shifting from the concept of taking precedence for "products," such as infrastructure development as hardware to the concept of investment by focusing on development of excellent human resources to give them opportunity to demonstrate their abilities ("products to people"). In order to maintain and strengthen international competitiveness, it is necessary to form an environment where a variety of individuals, such as young researchers, female researchers, and foreign researchers, can exercise their eagerness and abilities. It is also important to develop and enhance facilities and equipment, which are the infrastructure for S&T activities, to attract excellent human resources from within Japan and abroad and develop world-class human resources.

(1) Establishment of systems for attracting outstanding foreign researchers

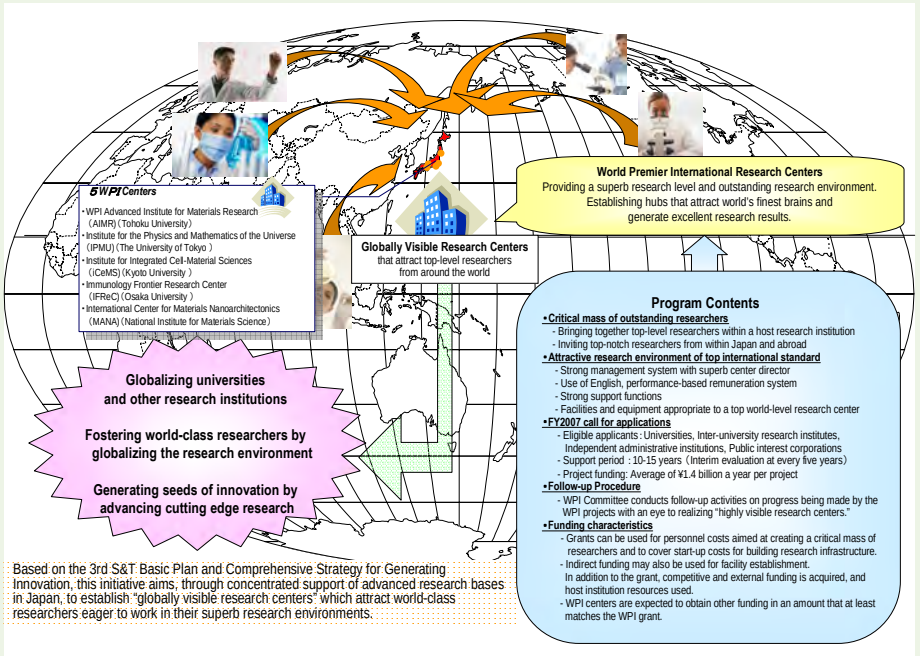
1) Establishment of hubs that attract the world's brains

As introduced in Part 1, Chapter 1, the creation of innovation is an urgent issue for our country where an aging society with declining birthrate and population are unprecedentedly fast progressing without any similar examples among advanced countries, meaning that it is born from people. Therefore, it is important to attract outstanding foreign researchers from around the world and allow them to exercise their abilities in the course of intellectual activities. Equally important is to ensure that excellent foreign and Japanese researchers vying with each other produce synergy effects.

As described in Part 1, Chapter 2, Section 1, many countries in the world are increasingly enhancing the awareness that S&T is the backbone of national strength, thus intensifying competition for human resource acquisition by attracting outstanding foreign researchers to their own countries. In addition, it is essential to create an environment where outstanding foreign researchers stay in Japan for a long period of time to continuously produce research results in order to construct the world's preeminent research bases.

Accordingly, it is essential in our country that, by providing concentrated support to an initiative for establishing top world-level international research bases under the leadership of top-notch researchers and a high degree of autonomy, including system reform, *globally visible* research centers be established, each of which can attract and assemble a cadre of the world's best frontline researchers from around the world with its superb research environments and very high standards of research (Figure 1-3-2).

Figure 1-3-2 World Premier International Research Center Initiative (WPI Program)

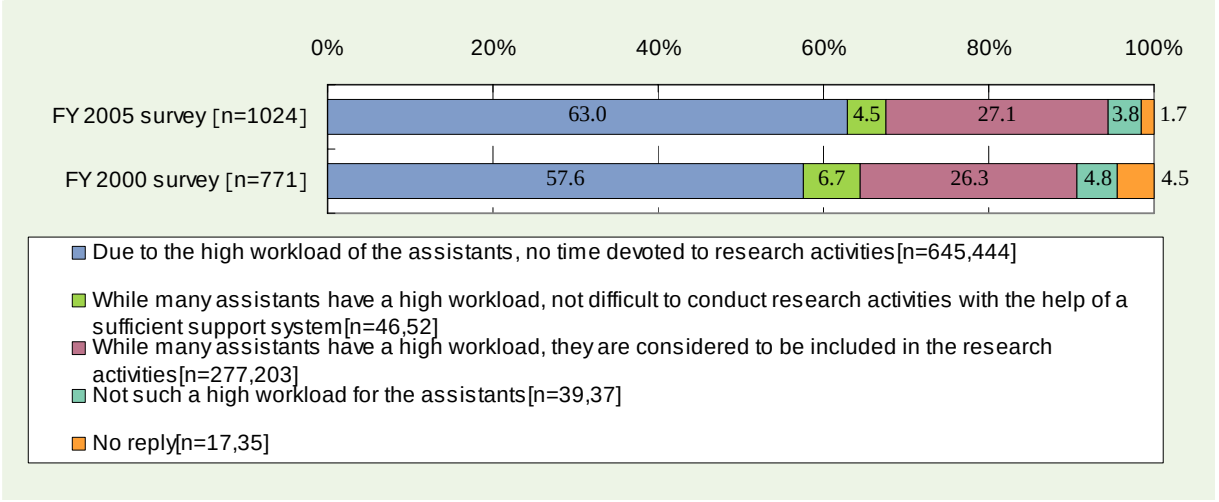


To attract excellent foreign researchers to Japan, it is further necessary to make improvements in various aspects of society, including the immigration control system and the visa system, housing and accommodations, medical insurance, and the workplace environment. Furthermore, efforts in aspects not directly related to R&D are also considered important, including fundamental enhancement of university secretariats and other liaison functions, and establishment of inter-university network systems for coordinating the acceptance of foreign researchers.

2) Research-First environment creation (Enhancement of research support)

To promote creative R&D activities, it is necessary to develop an environment where researchers can concentrate on their own research activities, and improvement of the system is one of its important elements. As shown in Part 1, Chapter 2, Section 2, the number of researchers in our country increased almost constantly during this quarter century. On the other hand, research assistants are decreasing almost constantly in the past two decades. MEXT's *Survey of the State of Japan's Research Activities (2005)* shows that 63% of researchers replies that research support system is insufficient and "it is difficult to concentrate on their own research activities due to many kinds of assistant work we must do," meaning that they feel such kind of work is a burden for them (Figure 1-3-3).

Figure 1-3-3 Views on Assistant Works other than Research Activities



On the other hand, the career paths for research assistants are unclear and they cannot deal with the progress of research and technology because they tend to be involved in the same facilities and duties for many years. Moreover, various problems become obvious: their shift to part-timers results in a decrease in salary, reduction of promotion opportunities, deterioration of working conditions, and a declining technical level. Therefore, it is essential to devise new measures for personnel and salaries in a spirit of recruiting competent research assistants. Moreover, since research organizations encounter severe financial situations, a utilization of indirect costs of competitive funds is one of the effective measures for enhancing the research support system. Thus, the rule of indirect costs equivalent to 30% of direct costs should be established at the earliest time possible.

(2) Enhancement of international competitiveness of universities and graduate schools

To ensure that Japan will win out in global competition in research, it is imperative to produce internationally active human resources from Japanese universities and graduate schools and to develop research environments attractive to international students and foreign researchers. In the situation where foreign countries promote R&D mainly from research human resources at the level of doctorate holders, for sustainably creating innovations, Japan is required to make doctoral courses more attractive and foster research human resources who can exercise their abilities under the environment of global competition. Industries in our country, on the other hand, need to utilize human resources with doctoral degrees as research potential for creating an enterprise's own innovations.

In addition, as for corporate R&D, its themes or subjects may be changed due to market situations and other factors or strategies of individual enterprises, unlike academic R&D conducted at universities with wide latitude for discretion by researchers. To foster a researcher capable of leading corporate R&D, it is important to develop flexibility in young talent so that they can tackle diverse themes, including ones outside their own fields of expertise.

1) Reform of fostering researchers

(Facilitating smooth social circulation of doctorate holders)

First, it is necessary for universities to review the role of higher education and research institutions to suit social needs and universities are required to ensure enrollment of suitably qualified individuals in doctoral courses by clarifying the acceptance criteria for doctoral course candidates. After taking these measures, in order to realize coursework at the international level, it is imperative that students take courses systematically and organizationally with their own diversified career paths, join internships, and foster extensive and deep expertise along with general knowledge and leadership quality, so that they can work actively in various fields of society. Furthermore, universities should

award doctoral degrees only to those stringently screened by final examination and found suitably qualified for the degrees in order to ensure international compatibility of Japanese doctorates.

Enterprises are expected to refrain from the early start of recruitment activities, positively adopt excellent doctoral resources after sufficiently assessing education results in graduate school, and provide them with attractive conditions in performance-based systems. It is expected that these measures will lead to making doctoral courses more attractive, to increasing the number of applicants to the courses, further lead to improvement of doctoral resources quality, and increase the number of students to be employed in enterprises and governmental agencies. These expectations will, as a whole, result in a creation of socially virtuous circulation of researcher resources.

(Promoting activities of postdocs in diverse fields)

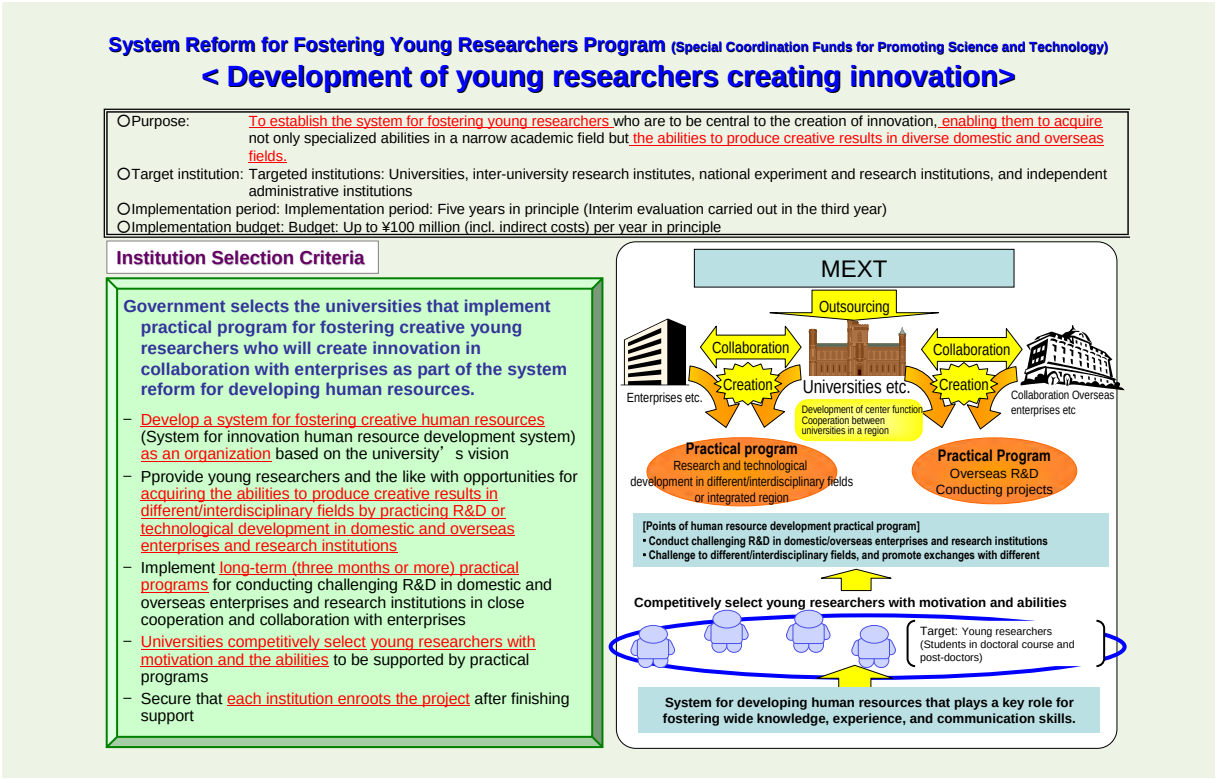
In the situation where relations between S&T and society are increasingly deepening and diversifying, postdocs[fn.2] are expected to play active roles in various fields of society. However, in the current situation in our country, career development support regarding a path outside the research institutions is not systematically performed, thus there are not necessarily diverse career paths open for human resources with high expertise, as shown by the fact that the proportion of doctorate holders in private sectors remains at about the half that of the US.

Currently, MEXT promotes approaches for systematic support and environment development to diversify the career paths of postdocs. Further, it was decided to offer the Development of Young Researchers Creating Innovation to support young resources, who will become the cores of the creation of innovation, not only to acquire specialized abilities in a limited academic field but to produce ideas taking into consideration an internationally wide vision and the needs of society, such as industries in the SCF program from FY 2008.

Now and in the future, it is important to further encourage young researchers to find their way into diverse fields of society by promoting reform of human resources development system in universities, public research institutions, and industrial fields.

fn. 2 Postdocs: Either (i) doctorate holders working as researchers at research institutions under limited-term contracts, or (ii) those similarly positioned who have withdrawn after at least the standard years of attendance and with the required number of credits obtained. (Neither (i) nor (ii) include those employed as professor, associate professor, lecturer, assistant professor, assistant, chief researcher, etc.)

Figure 1-3-4 Development of Young Researchers Creating Innovation



(Increasing overseas work opportunities for Japanese researchers)

In order for Japan to become a pole of international circulation of researchers along with the US and Europe, it is most important to make the research environment in our country more attractive. In addition, it is considered that promotion of overseas activities of Japanese researchers and enhancement of international dissemination of research results are also important agendas. Accordingly, it is necessary to increase overseas experience opportunities for young researchers, for example, by increasing the number of dispatched doctoral students abroad, in order to develop human resources capable of playing active roles in international communities of researchers. In addition, it is also important to facilitate bidirectional exchange of human resources by providing assistance to those having completed a doctoral course in finding appropriate positions overseas. Moreover, it is necessary to examine from the aspect of the system by, for example, analyzing factors that obstruct the international mobilization of our researchers.

(Promoting acceptance of foreign researchers)

Although the importance of expanding the acceptance of foreign researchers is widely recognized, it cannot be said that this measure is sufficiently promoted. Therefore, it is important that universities should make organization-wide commitment to promote the acceptance of foreign researchers by implementing such measures as international open recruitment of researchers, startup support for foreign researchers, and the introduction of flexible salary systems.

In order to accept greater numbers of international students and foreign postdocs, it is important to develop internationally attractive educational and research environments by improving curricula and teaching methods at the postgraduate level, enhancing industry-academia cooperation with a view to employment in Japan, placing English-speaking personnel in the secretariat and other administrative sections, and improving living environments.

COLUMN 12

Systematic and Strategic Promotion of International Development of Universities

- Strategic Fund for Establishing International Headquarters in Universities -

Since internationalization of the research environment is required as an approach to "Establishment of Universities with International Competitiveness," MEXT launched the Strategic Fund for Establishing International Headquarters in Universities (five years from FY 2005) aiming systematic and strategic internationalization of universities. The purpose of this project is to support approaches, such as development and promotion of international strategy having university-wide systematic characteristics, and to develop an excellent model of international development strategy to encourage voluntary studies of other universities with originality and ingenuity. Twenty pilot universities selected promotes university-wide internationalization by enhancing functions of the International Strategy Headquarters, and the Japan Society for the Promotion of Science (JSPS) challenges development of the model based on these activities.

• Example activity of this project

Development of Professional Human Resources Actively Working in the Advanced Field of International Cooperation (Establishment of Graduate School of International Health Development)
[Center for International Collaborative Research (CICORN), Nagasaki University]

Infectious diseases, such as malaria, pneumonia, AIDS, etc., and the health problems of children and women are now the significant issues in international society that target elimination of poverty and sustainable development. Further, newly emerged infectious diseases, such as SARS, highly pathogenic bird flu, etc., not only adversely affect people's health, especially in developing countries, but have social and economic impacts on the national level. In the situation where Japan is expected by the world to contribute to the challenge of addressing these global health issues, Nagasaki University launched the Graduate School of International Health Development for fostering professional human resources capable of comprehensively tackling solutions to global health problems and internationally playing an active role in April 2008 in order to respond to such expectations. This graduate school provides for the first time in Japan a program that offers Master of Public Health (MPH) degrees, specialized in the field of international health. Students in this graduate school are provided with education so that they can grow individual quality, acquire knowledge in a wide research area interdisciplinarily and systematically, and obtain abilities for quickly applying the knowledge on the site in order to produce abilities for challenging solutions to various problems in collaboration with specialists in various fields in the world. Therefore, the program has interdisciplinary and attractive curricula focusing on tropical public health as an independent graduate school in which specialists fom wide and diversified fields (medical science, public health, political management, anthropology, behavioral science, economics, etc.) can participate. Moreover, it is to produce wide and practical abilities for solving problems of specific events and conducting the formation of governmental policies by effectively combining short-term on-site field training and a long-term internship over eight months. Thus, many graduates are expected to play active roles in the advanced regions of international cooperation while viewing the Japanese future vision.

This graduate school was planned mainly by the Center for International Collaborative Research (CICORN), Nagasaki University, as a university-wide project. University's overseas infectious disease research hubs (in Kenya, Vietnam, etc.) to be operated and participated by CICORN are also planned to be entirely utilized for field training.

Graduate School of International Health Development, Nagasaki University

2) Invigorating research environments at universities
(Expanding internships)

In order to properly meet the needs of society and to develop and secure S&T human resources with an eye to exit strategies in R&D, it is quite effective to spread and promote internships as partnership between the industries belonging to demand side of human resources development and the universities on the development side.

Although the percentage of universities offering internships by positioning it in an education course remarkably increased from 18% in 1996 to about 66% in 2006, almost all the courses still implement short-term internships shorter than three weeks (MEXT *Investigation Results of Internship Implementation Status in 2006*).

The graduate school stage requires implementation of higher level internships that lead to the development of highly professional human resources capable of understanding various social problems and industry-side approaches and supporting knowledge-based society in diversified ways, but does not require internships aiming at the formation of work experience and professional consciousness so far executed.

Therefore, since FY 2005, MEXT supported practices, such as academia-industry collaboration and cooperation in high-quality long-term (three months or longer including pre- and post-education) internship programs in order to develop and disseminate long-term internship in the graduate school level. These approaches will be enhanced hereafter, and enterprises are also expected to participate actively in such programs as part of their efforts of fostering researchers.

(Prepaid retirement benefit plan and annual salary system)

A system relating to an economic problem when researchers move from one research institute to another is the retirement benefit system. In both private and public organizations, many maintain retirement benefit levels low for employees who have not worked with them for 30 consecutive years. This is considered extremely detrimental to motivating researchers in their 30s or 40s to move between organizations. As far as researchers are concerned, organizations can effectively retain competent human resources and recruit new human resources by paying monthly salaries topped up with a prepaid portion of retirement allowance, or introducing an annual salary system based on performance appraisal.

(3) Expansion of the foundation of S&T human resources for the next generation

1) Increasing scientifically and mathematically inclined children

With the advent of the knowledge-based society, S&T global competition becomes more severe than ever. Therefore, it is necessary to develop S&T human resources for the next generation in our country. At the same time, with the fruit of S&T widely used in every aspect of today's society, it is extremely important to improve the basic literacy of science of each and every Japanese national. From these two points of view, improvement of scientific and mathematics education, a base of S&T, is a most urgent task of our country.

Although the results of PISA 2006 Survey show that Japan's ranking in "scientific literacy" is high internationally and it is not changed in comparison with the same questions in the 2003 survey, the following issues are newly recognized: the scales such as "identifying scientific issues" and "explaining phenomena scientifically" are lower than the scale of "using scientific evidence;" many pupils do not write the in-class essays; the ratio of students' interests in or enjoyment of science is low.

Considering these issues, in the recommendations (January 2008) after revising the entire National Curriculum Standards, the Central Council for Education proposed: i) that science class hours be increased to secure sufficient time for preparation of written reports, discussions on observations, experiments, and for nature experience, ii) that appropriate curriculum improvements be made from the perspective of ensuring international compatibility and smooth curricular continuity from elementary to lower to upper secondary school, and iii) that, in addition to curriculum improvements, educational conditions be arranged that support the improved curricula.

To answer these recommendations, the revised Standards for Elementary School and Lower Secondary School (March 2008) recommended an increase in the total class hours for Japanese language, social studies, arithmetic and mathematics, science, foreign language, physical education, and health and physical education by about 10%, respectively. The total hours have been increased from 869 to 1,011 hours for elementary school arithmetic: from 350 to 405 hours for elementary school science, from 315 to 385 hours for lower secondary school mathematics, and from 290 to 385 hours for lower secondary school science, respectively. Thus, hours for arithmetic, mathematics, and science have been intensively increased.

Moreover, as for arithmetic and mathematics, it was also decided to i) improve teaching by repetition (spiral) corresponding to degree of growth or school years; ii) improve necessary teaching contents from the viewpoint of assured international availability, systematic curricula, and smooth connection of learning from elementary to lower secondary school; and iii) enhance activities for applying knowledge and skill about quantity and graphics to the actual situation where pupils can actually experience the meaning and usefulness of learning.

In science, it was decided to i) enhance consistency of curricula throughout elementary and lower secondary schools; ii) improve necessary teaching contents from the viewpoint of assured international availability and systematic curricula and the smooth connection of learning from elementary to lower secondary school; iii) enhance learning activities for analyzing and interpreting the results of observation and experiment, and learning activities for considering and explaining using scientific concepts from the viewpoint of obtaining abilities for scientific thinking and expression; and iv) attach importance to and improve relations to daily life and society from the viewpoint of actually experiencing the meaning and usefulness of learning science, and increasing concern about science.

The revised Standards will be completely applied to elementary schools from FY 2011 and to lower secondary schools from FY 2012, and some curricula may be applied in advance from FY 2009 if possible. There are also other efforts in progress; external talents are invited to elementary schools as Science Corabo Teachers (science education assistants or special lecturers) to enrich experiment and observation activities in science classes and improve the overall quality of teachers. At lower and upper secondary school levels, advanced math and science education programs as well as math and science teacher training support programs have been introduced with cooperation from universities, science museums, and enterprises.

2) Development of individual qualities and abilities of scientifically and mathematically inclined pupils and students

In order to promote development of Japan's S&T, it is necessary to foster human resources that may grow into the next generation of leading scientists by providing scientifically and mathematically inclined pupils and students with more and better opportunities for receiving high-level, advanced math and science education, and for fostering international sense and professional vision by contacting "the differences." Therefore, MEXT implements various measures for upper secondary school students, such as support for International Science Olympiads; international science and engineering fairs (mathematics, physics, chemistry, biology, informatics, and assigned research; promotion of programs at Super Science high schools (math-/science-intensive education high schools), as well as cultural exchange programs with their overseas counterparts. Moreover, the programs for supporting universities that provide school children and pupils having outstanding eagerness and abilities with advanced and promising learning opportunities (Figure 1-3-5).

COLUMN 13

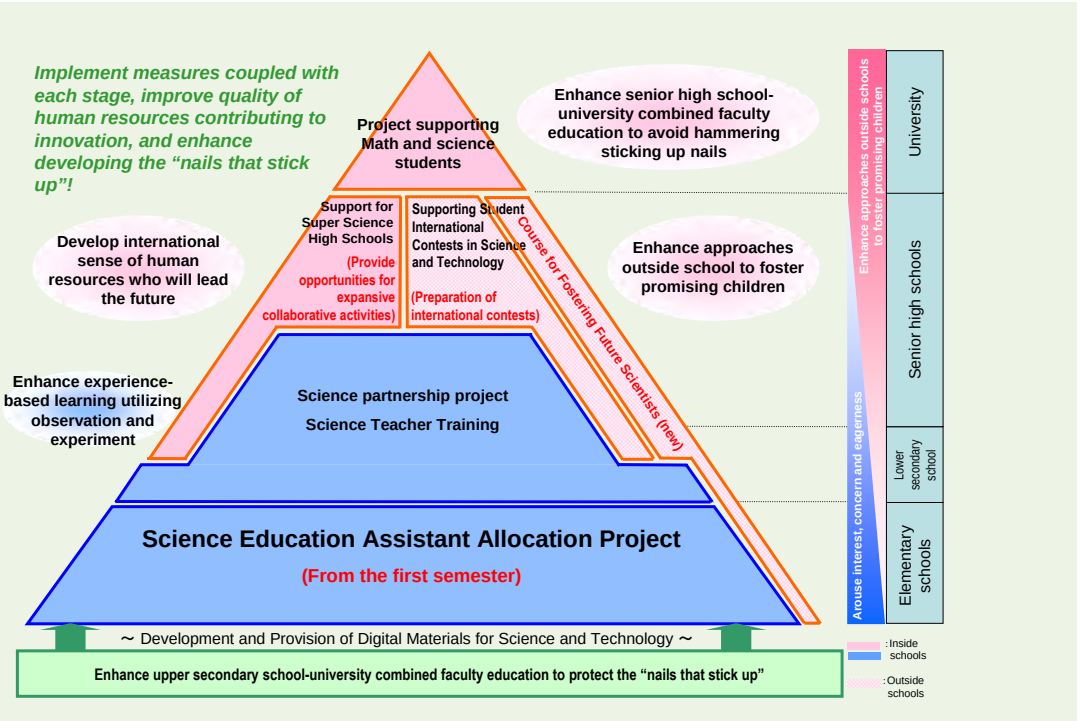
Course for Fostering Future Scientists

The importance of fostering scientifically and mathematically inclined human resources (human resources of "sticking-up nails") that are to support S&T innovation was proposed in Innovation 25 (Cabinet decision: June 1, 2007). For this purpose, it is said to be necessary to "support universities to provide school children and pupils having outstanding eagerness and abilities with advanced and promising learning opportunities."

In order to further improve their abilities, it is necessary to provide learning opportunities not only in schools but in places outside of schools as shown by an example of Olympic players in sports and to foster leaders having knowledge and learning abilities as well as abilities for identifying and solving problems.

From this point of view, JST newly implements the Course for Fostering Future Scientists in FY 2008. This course supports universities and colleges of technology that continuously provide advanced and expansive learning environment aiming university level all through the year by developing and implementing selecting methods for appropriately assessing eagerness and abilities of school children and pupils with outstanding eagerness and abilities in math and science. The course aims to develop and continuously implement systematic education programs that will contribute to further improve their eagerness and abilities. It is expected that the most advanced aspiring scientists who lead development of S&T in our country will be born by this project.

Figure 1-3-5 Measures for Math and Science Education Enhancement for Fostering Innovation-oriented Human Resources



3 R&D Capability Enhancement through Efficient Use of Resources

In order to win in the fierce competition of the creation of innovation by S&T, it is important to utilize and expand collection of knowledge relating to S&T so far accumulated in our country and to maximize the potentials of R&D institutions and researchers. At present, however, only insufficient progress has been made by Japan in reforming its R&D system, when the reform supposedly will greatly improve Japan's R&D capabilities and the effectiveness and efficiency of government-sponsored R&D programs. Thus, further acceleration of this reform is our urgent duty.

Therefore, without falling behind other nations, as described in Part 1, Chapter 2, that have already started R&D system reform, Japan should make redoubled efforts in the same direction toward enhanced R&D capabilities through R&D system reform regarding the role of public R&D institutions or the management of competitive funds distribution.

1 Public R&D Institution Reform

After many national research institutions were transformed to independent administrative institutions, as well as national universities to national university corporations, a large part of R&D activities using national funds are shouldered by them. Thus, these organizations are core bearers of R&D functions contributing our country to win in the age of fierce competition.

In this situation, the independent administrative institutions in charge of R&D are basically controlled by their common system. Considering the concept of their establishment in the spirit of efficiently performing the operations by transferring R&D related activities from the government to the independent administrative institutions, it is important to ensure to provide environments producing many outstanding R&D results that strengthen the national competitiveness by effective use of national expenditures on the institutions. Therefore, it is hereafter necessary to implement the following measures:

1) Securing budget for covering the personnel expenses for researchers engaged in important R&D and making active use of the capabilities of young, female, and foreign researchers in order to ensure recruitment of competent researchers and planned human resource development and retention,
2) Ensuring flexible and agile budget and manpower allocation to facilitate intensive and speedy implementation of R&D programs of high national priority to suit the national needs, and
3) Encouraging the introduction of external funds to promote social contribution and inter-institutional cooperation.

2 Measures to Be Taken for Effective Use of Research Funds

In order to enhance R&D abilities of our country, it is necessary to implement the following measures while referring to the use of research funds in foreign countries:

(1) Improvement of issues concerning single-year budget

One of the points of the argument concerning expense rules of competitive funds relates to single-year budget system of our country. As typically seen in experiments using biological samples, there is an aspect that R&D work proceeded over the breakpoint of the fiscal year and flexible expenditures are required depending on the period and contents corresponding to progressive status. Therefore, some researchers point out that R&D expense-related needs do not fit in with the single-year accounting system, and not only does this aspect obstruct smooth running of research activities but hinders the effective and efficient use of funds. From this perspective, efforts are currently in progress to identify and publicize the conditions for promoting multi-year contracting

authorized carryover of unexpended funds through independent administrative institutions.

(2) Improvement of operation procedures of fund system

The second point of the argument concerning expense rules of competitive funds relates to restrictions due to various rules established for proper operations. Fund recipients should bear in mind that it is natural that there should be some restrictions on the use of tax-funded resources because research expenditures have its own characteristics, purpose, and role. However, among some problems pointed out so far is inaccessibility to grants due to complicated procedures defined inside the institution. As for such problems, more efforts should be made on the part of research institutions to find solutions and improvements, and on the part of resource granting entities to publicize accessibility of funds under their control by preparing Q&As to prevent misunderstanding and showing model cases of procedures in easily understandable expressions. Further progress must be made toward speedier fund allocation, establishment of an ex post facto check system for research plans/financial plans, more flexible diversion of grants, and reduction of items for which grants cannot be used.

(3) Integrated and organized management of competitive fund systems

The third point of the argument concerning expense rules of competitive funds relates to the problems of the difference in rules between competitive funds. To solve this problem, it is necessary to facilitate more effective and efficient use of funds by standardizing rules concerning items for which competitive and other public research funds can be used, and by consolidating different competitive funds.

(4) Ensuring of appropriate use of research funds

On the other hand, the big issue recently disclosed is unauthorized use of research funds by particular researchers. Considering that research grants are tax funded, it is necessary to ensure proper use and promote measures against misappropriations in addition to the above approaches toward more efficient use of research funds. From such a perspective, it should be encouraged to prevent the concentration of research grants by particular researchers, enhance monitoring of proper execution of individual competitive funds, promote stop-gap funding provided from fund-recipient research institutions, and enforce punitive measures, such as restricting applications from researchers with history of dishonesty.

3 Promotion of High-risk Research

For the purpose of improvement of R&D abilities, various studies and trials about research aiming high-risk and high-reward in addition to conventional R&D systems are performed also in Europe and the US. As for high-risk research where the promotion is stipulated in the America COMPETES Act and China's Science and Technology Progress Law, studies of implementation methods are performed in European and the US research funding agencies. For example, in order to materialize research that greatly change existing concept, a support for the transformative research by evolving consciousness of program officers is examined in NSF. In addition, in the EU's Seventh Framework Programme, the initiative for Future and Emerging Technologies (FET) in which researchers in various fields challenge the high-level target is implemented.

Also in our country, it is necessary to appropriately subsidize promising research that may lead to significant innovation, while studying screening and management practices in other countries with a view to introduction of screening criteria and management systems different than those for conventional competitive funds.

4 Steady Dissemination of S&T Outcome to Society

1 Elimination of Institutional Bottleneck to Dissemination of S&T Outcome to Society

To create S&T-based innovation, it is necessary to ensure that research results achieved at universities and other research institutions be steadily disseminated to society. Active exchange of researchers, smooth implementation of research activities, industry-academia-government cooperation, etc. have great effects not only on activation of R&D but on the return of research results to society and are the keys for enhancing effects of human and material investment on S&T. In order to realize this, approaches for elimination of institutional bottleneck in various aspects, such as the research exchange system, fixed-term system for researchers, independent administrative institution system, national university corporation system, and the intellectual property system, were performed to obtain significant progress. However, it is often said that there still exist institutional bottlenecks: emigration and immigration management of foreign researchers; working environment of female researchers who are involved in childbirth and child rearing; treatment of retirement allowance associated with movement between the research institutions; and fund procurement environment of research institutions have been identified. Among those, it is very important that elimination of institutional bottlenecks relating to clinical research involving clinical trials is pointed out. In our country encountering an aging society with a declining birth rate, which is the fastest in the world, clinical research involving clinical trials is the R&D means for realizing innovation leading to health enhancement of our nation and activation of the research is considered to bring great national benefits. It is essential to ensure that Japanese nationals can have earlier access to the world's most advanced medical technologies; that the Japanese medical industry can aggressively pursue R&D activities and sharpen its international competitive edge; and that the health of the nation will further improve by eliminating institutional bottlenecks obstructing research activities and promoting clinical research involving clinical trials.

(1) Current state of clinical research

In the situation where international competition becomes increasingly more severe because of progress in advanced medical science in China and South Korea and the rapidly enriched environment for clinical trials in addition to competition with Europe and the US in recent years, Japanese pharmaceutical products have been less and less internationally competitive, as can be seen from the fact that Japanese pharmaceutical manufacturers saw a drop in the share of their combined sales volume in the total sales volume of the world's top 100 pharmaceutical enterprises from 14.2% in 1997 to 9.2% in 2005. Therefore, our urgent task is to make efforts to enhance development power by concentrating total energy of industry-academia-government, and it is necessary to lay the groundwork for promoting clinical research for pharmaceutical product development.

However, clinical research in our country is placed at an extremely low level. For example, the number of applications of new drug trials based on the Pharmaceutical Affairs Act was about 1,200 in 1993, but significantly reduced to 406 in 1998, and remains at around 500 in recent years. In addition, as for our current status of research that verifies the effects of treatment on human-beings or analyzes epidemiologically, the number of articles posted by Japan in high quality clinical research magazines, such as *The Lancet* and *The New England Journal of Medicine*, only occupies 0.6% among other countries. This percentage is extremely low in comparison with 3.3% in magazines of basic medical science field such as *Science* and *Nature*.[fn.3]

The US and European countries possess established clinical research systems and lead the world

fn. 3 Tsuguya Fukui *Gakujustu no doko (Academic Trends)*, August 2006

in clinical research because they have made various efforts, including courses for fostering biostatistician[fn.4] with a history from the 1950s, enhancement of the Office of New Drugs (ODN) in the U.S. Food and Drug Administration (FDA), early realignment of clinical research laboratories compliant with international standards, and aggressive clinical research investments for developing facilities and systems for creating investigational products or cells for use in compliance with clinical research standards.

It is now a pressing issue for Japan to promote domestic clinical research by fostering clinical researchers and clinical research assistants (clinical research coordinators (CRCs), data managers, and biostatisticians), and developing support systems including facilities.

(2) Measures for clinical research promotion

In the Promotion Strategy decided by the Council for Science and Technology Policy (CSTP) in March 2006, "Translational Research" was selected as strategic prioritized S&T in life sciences, and it was pointed out that four approaches, i) improvement and enhancement of support system, ii) acquisition and fostering of clinical researchers and clinical research assistants, iii) enhancement of environment for research promotion and approval review, and iv) public participation, are important as a promotion measure for system enhancement for clinical research promotion.

In addition, as for the aspect of system reform for clinical research promotion, CSTP advised the relevant Ministers in the December 2006 recommendation titled System reform toward S&T promotion and dissemination of results to society that enhancement of clinical research support system; acquisition and fostering of human resources involved in clinical research; establishment of health insurance system enabling both insurance treatment and research-related treatment; and enrichment of review system in the Pharmaceuticals and Medical Devices Agency (PDMA).

Following the CSTP recommendation, MEXT, the Ministry of Health, Labour and Welfare (MHLW), and the Ministry of Economy, Trade and Industry (METI) established the Five-Year Strategy for Creation of Innovative Drugs and Medical Devices in April 2007 in order to enhance international competitiveness in innovative drugs and medical devices based on excellent R&D abilities of our country and to quickly provide to the public with drugs and medical devices of the top world-level. The Five-Year Strategy positions the following items as emphasized issues: i) concentrated research financing, ii) nurturing ventures, iii) improvement of the clinical research/trial environment, iv) collaboration with Asia, v) faster and better reviews, vi) appropriate assessment of innovations, and vii) public-private dialogue (Figure 1-3-6).

According to the Strategy, MHLW designated 10 organizations (five in FY 2006 and additional five in FY 2007) as core hospitals that are expected to be capable of acquiring and fostering human resources necessary for implementing clinical research; formulating research plans; and performing statistical analysis and data management. Thirty institutions were designated in FY 2007 as core medical institutions expected to be capable of smoothly implementing clinical research.

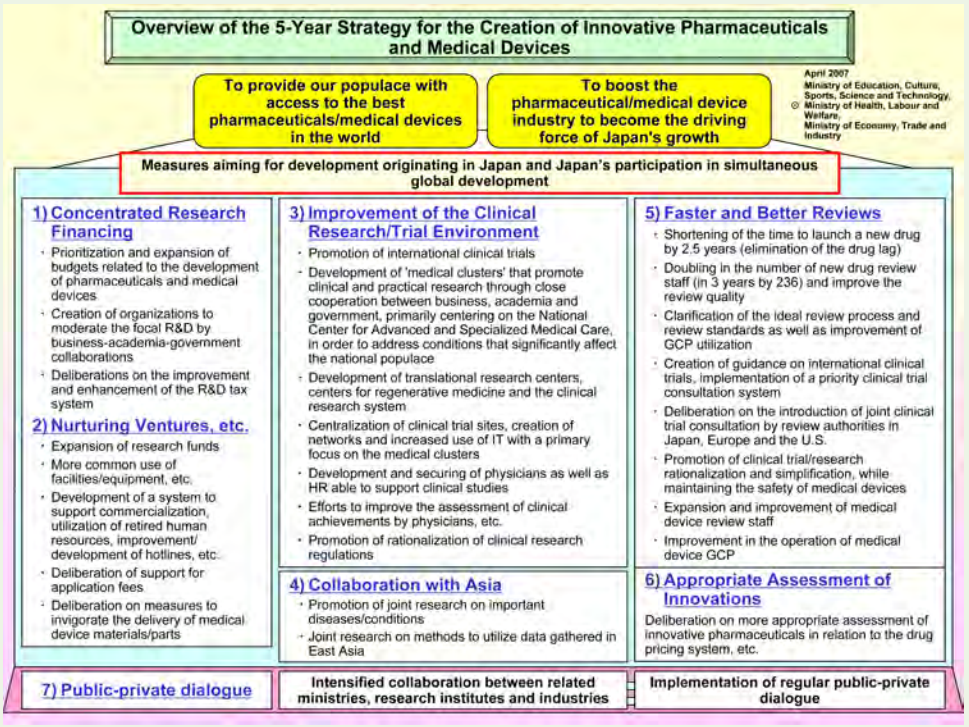
In FY 2007, MEXT adopted six organizations as translational research support institutions that perform establishment of development strategy for medical drugs and devices; acquisition, recruitment and development of human resources including biostatisticians; and production of experimental substances capable of satisfying criteria stipulated in the Pharmaceutical Affairs Act. The Ministry also fosters clinical researchers and clinical research assistants in universities. In addition, METI promotes projects in which clinical research organizations and private companies jointly approach development of new drugs from FY 2007.

Moreover, in order to improve the speed and quality of the pharmaceuticals and medical device review process, efforts are made to work double the number of new-drug reviewers of PMDA. It is expected that further continuation of these efforts aiming elimination of institutional bottleneck

fn. 4 Biostasticians are "statistics specialists sufficiently educated/trained and experienced to provide effective support to clinical research and responsible for statistical aspects of the relevant clinical research." Biostatistics is used in the whole process of clinical research from the planning phase to data analysis and final report.

through cooperation between the related ministries will lead to establishment of a framework for clinical research promotion and facilitate domestic clinical research including clinical trials.

Figure 1-3-6 Five-Year Strategy for Creation of Innovative Drugs and Medical Devices

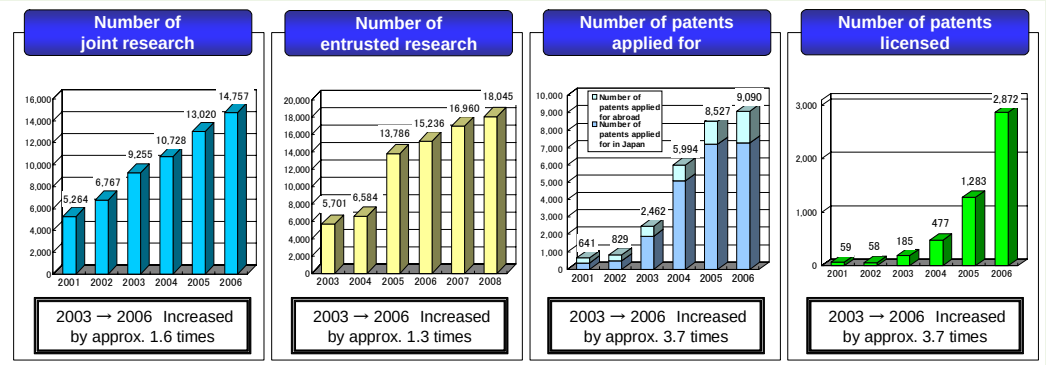


2 Promotion of Dissemination of Research Outcomes at Universities to Society (Promotion of Diverse Partnership between Industry, Academia, and Government)

In order to create S&T-based innovation, it is very important to ensure dissemination of the seeds of innovation born as the fruit of innovative research to industries toward practical applications. The reason is, even if universities produced excellent research results that are assumed to be innovation seeds, the results will lead to innovation for winning out the competition only when the results can be technologically transferred to private sectors in the form protected as intellectual property quickly and appropriately.

There has been substantial progress in the development and/or improvement of the intellectual property rights protection systems of universities in Japan, thanks to individual efforts at each institution, system reform in support of their efforts, and governmental assistance. Consequently, industry-academia joint research and industry-funded entrusted research have been steadily increasing, resulting in the increasing number of patents applied for and licensed by universities. Some of such patents have resulted in remarkable success (Figure 1-3-7).

Figure 1-3-7 Trends in Joint Research Projects, etc. Implemented by Universities



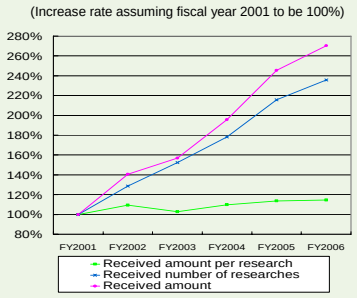
* Universities: Inter-university research institutes, junior colleges, and colleges of technology are included.
* The number of patents licensed includes only patent rights (including rights to obtain). Both the number of patents licensed and that of patents transferred are counted.
* The figures for 2001 and 2002 include national universities only. The figures for 2003 and after include national, public, and private universities.

On the other hand, a look at the received amount per joint research reveals that the amount keeps about ¥2 million yen from FY 2001, and the number of large-scale joint research has not necessarily increased (Figure 1-3-8). The ratio of the number of patents licensed to the cumulative total number of patent applications filed between FY 2003 and 2006 is only about 10%, indicating that not much progress have been made in the use of patents. The future challenge is to file patent applications for quality inventions and strategically obtain intellectual property rights.

As for the status of international industry-academia-government cooperation, Industry-Academia Cooperation Implementation Status Investigation (FY 2006 Actual) shows that the number of joint research with and entrusted research from overseas enterprises is extremely small, that is to say, both the number of research and the amount account for less than 1% of each total (Figure 1-3-9).

Figure 1-3-8 Percentage Growth of Joint Research in National Universities, etc. and Amount per Research

[Percentage growth (FY 2001: 100%)]



Received actual amount per research

Fiscal year	Received amount (1,000 yen)
2006	2,443
2005	2,419
2004	2,338
2003	2,193
2002	2,331
2001	2,130

Note: Universities include national colleges of technology and inter-university research institutes.

Figure 1-3-9 Track Records of Joint Research, etc. between Universities and Overseas Enterprises

• Joint research

Fiscal year	Total number	Overseas enterprises among total	Ratio (%)	Total amount (1,000 yen)	Overseas enterprises among total (1,000 yen)	Ratio (%)
2003	9,255	15	0.16	21,620,823	64,383	0.30
2004	10,728	32	0.30	26,375,829	100,678	0.38
2005	13,020	51	0.39	32,343,275	272,693	0.84
2006	14,757	83	0.56	36,843,149	361,456	0.98

• Funded research

Fiscal year	Total number	Overseas enterprises among total	Ratio (%)	Total amount (1,000 yen)	Overseas enterprises among total (1,000 yen)	Ratio (%)
2003	13,786	45	0.33	85,904,359	748,395	0.87
2004	15,236	39	0.26	101,227,322	117,412	0.12
2005	16,960	41	0.24	126,479,747	181,234	0.14
2006	18,045	73	0.40	142,035,360	306,127	0.22

Note) Universities include colleges of technology and inter-university research institutes.

In order to continuously create S&T-based innovation, it is necessary to enhance international mechanisms for industry-academia-government coordination and to further promote inter-institutional cooperation between national, public, and private universities toward the establishment of regional systems for diverse intellectual property activities, while protecting intellectual property rights of universities. Therefore, it is important to intensively support activities of which implementation has a high risk as activities by universities and those to be positively promoted by the government from the viewpoint of political measures. In addition, industry-academia-government cooperation coordinators, appropriately knowledgeable and experienced to meet the needs of universities and colleges, must be appointed to provide intensive support to initiatives for transferring knowledge and research results from universities to industries and local communities. Furthermore, as for cutting-edge research projects such as iPS cell-related ones in life sciences, it is essential to ensure prompt industry-academia-government cooperation from the research phase, with a view to the use of intellectual properties.

COLUMN 14

Induced Pluripotent Stem (iPS) Cells Successfully Derived from Human Skin Cells

• **Successful derivation of induced pluripotent stem (iPS) cells**

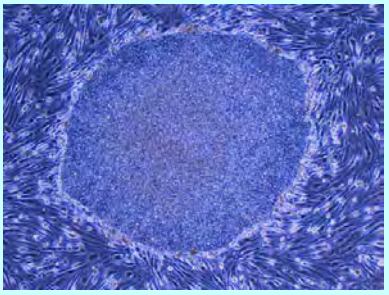
In November 2007, Professor Shinya Yamanaka of Kyoto University announced that, using human skin cells, he had successfully derived induced pluripotent stem (iPS) cells, which can differentiate into cells/tissues of nerves, bones, and internal organs in a living body. Earlier in August 2006, Professor Yamanaka had published his success in the world's first derivation using mouse cells. This time, his derivation of human iPS cells is attracting much attention as a success achieved in Japan. A human body consists of nerve cells, cardiac muscle cells, cartilage cells, and other differentiated tissue cells, all

descending from one single fertilized egg. The ability of a cell to change into different types of cells constituting the human body is called pluripotency. Once differentiated into a tissue cell such as a skin cell, a somatic cell is no longer pluripotent and normally cannot develop into a cell of a tissue other than that particular tissue. However, Professor Yamanaka and his team successfully achieved the recovery of pluripotency of human skin cells by introducing four types of genes into cells that had lost pluripotency (later, an alternative method was also developed using three types of genes). Further progress in this research will lead to the generation of cells of various tissues, such as nerves or muscles. It is expected that tissues thus obtained can be used for regenerative medicine (cell transplantation) for treatment of skin injuries, spinal cord injuries, juvenile diabetes, myocardial infarction, leukemia, osteoporosis, and other diseases. In addition, differentiated cells may be used in studies that determine the effectiveness of pharmaceuticals or identify the causes of diseases.

- **Further initiatives for acceleration of iPS cell research**

Since Professor Yamanaka's successful generation of mouse iPS cells, international competition in iPS cell-related research has intensified. On the very same day as Professor Yamanaka announced his success in derivation of human iPS cells, Professor James A. Thomson of the University of Wisconsin-Madison, the world's first producer of human ES cells, also announced that he produced iPS cells using four factors different from those used by Professor Yamanaka.

In the context of ongoing international competition, it is important to strategically promote and accelerate iPS cell research nationwide in Japan. As part of the strategy, the Center for iPS Cell Research and Application (CiRA) was established in Kyoto University as Japan's key research organization for promoting iPS cell research in January 2008. Moreover, in February 2008, Kyoto University, Keio University, The University of Tokyo, and RIKEN were designated as four iPS cells-related research bases according to the MEXT Project for Realization of Regenerative Medicine. At these key bases, related researchers across the country will promote relevant research in an integrated manner. Additionally, MHLW plans that, toward clinical research of iPS cells, guidelines and criteria should be swiftly established to catch up with developments and progress in research.



Successful derivation of iPS cells from human skin cells. Photo: Prof. Yamanaka

Prof. Yamanaka talking on establishment of iPS cells. Photo: The Science News Ltd.

3 Intellectual Property Strategies for Globalization

In the situation where global competition grows increasingly more severe and newly developing countries are catching up energetically, in order that our country continues to hold technologies with international competitiveness far stronger than that of other countries, it is always necessary to have breakthrough based on S&T, that is to say, to create innovative intellectual properties, and appropriate protection and utilization of the properties are the urgent task to be dealt with. Especially, it is important among others to acquire high quality intellectual property rights not only in our country but in foreign countries.

It is necessary to promote close coordination of intellectual property policies and R&D policies. Accordingly, when establishing and promoting policies on R&D projects, it is imperative to pursue policy-making including intellectual property perspectives, to install intellectual property producers (IP producers) for developing intellectual property strategies, and to construct a human resource database storing names of IP producer candidates.

It is also necessary to support approaches that provide young researchers such as postdocs, with abilities for converting R&D results, especially those in advanced technology field, to intellectual properties, and further converting the intellectual properties to the actual business through OJT training in Technology Licensing Organization (TLO), university intellectual property headquarters, university ventures, and venture capitals.

For Japan to win out in fierce international competition, it is essential to conduct many ingenious basic research projects or advanced field research projects likely to produce greater spillover effects. For example, in order to promote R&D and practical applications of epoch-making technologies represented by iPS cells, it is essential to promptly provide necessary support from the perspective of intellectual properties, and to accelerate the development of intellectual property human resources well versed in advanced technologies and with international mind-set.

4 Initiatives toward Enhanced MOT Capabilities

In Part 1, Chapter 2, Section 2, we describe the issue of MOT capabilities. Japan has fallen behind other countries in MOT because neither Japanese universities nor private educational institutions have systematically fostered MOT specialists well versed, double-majored in both technology and management. Therefore, in order to sharpen Japan's industrial competitive edge, it is important to systematically foster human resources capable of conversion of domestically developed excellent technologies into businesses.

With such awareness, the Industrial Technology Enhancement Act was revised in May 2007 to define the enhancement of MOT capabilities as the responsibility of the government and business operators and oblige the government to take measures necessary to enhance the national MOT capabilities. In addition, the New Energy and Industrial Technology Development Organization (NEDO) Act was revised to add to the duties of NEDO submission of advice on MOT capability building. The National Institute of Advanced Industrial Science and Technology (AIST) Act was also revised to include in the duties of AIST development of human resources useful for enhancement of the national capabilities.

METI implemented the Initiatives for Inducement of MOT Human Resources Development Program from FY 2002 to 2006 in which supported development of MOT education program in totally more than 150 educational institutions and reviewed for the state of evaluation and authorization of various MOT education programs. The Ministry continuously examines specific schemes capable of autonomous evaluation.

5 Enhancement of International Standardization Measures

(1) Current state of international standardization activities

Currently, the Intellectual Property Strategy Headquarters of the Cabinet Secretariat promotes the International Standardization Comprehensive Strategy as a national strategic initiative for international standardization, while METI established the strategic objectives for international standardization (November 2006) according to which the Ministry steadily works to double the number of Japanese proposals by 2015 in order to, among other things, increase Japan's presence in the international standardization arena to suit its economic power and S&T levels.

COLUMN 15

Typical R&D Results: Market Development Promoted by International Standardization

International standardization of R&D results plays an important role from the viewpoint of strengthening competitiveness, and also for enhancing academic evaluation in basic research fields.

As for an example of photocatalyst, after finding the "Honda-Fujishima Effect" as seeds, development of its application needs did not sufficiently progress for a while. Therefore, the value of academic results was not sufficiently recognized. Then, promotion of international standardization of measurement and evaluation methods for various functions such as self-cleaning characteristic and air purification provided by photocatalyst enabled appropriate evaluation and facilitated market development of products. Thus favorable circulation is generated that dissemination of photocatalyst in daily life further encourages relevant research, and academic evaluation of discovered effects is autonomously heightened.

Antifouling/ self-cleaning applied product (Photocatalyst paint coated guardrail)
Photo: Okitsumo, Inc.

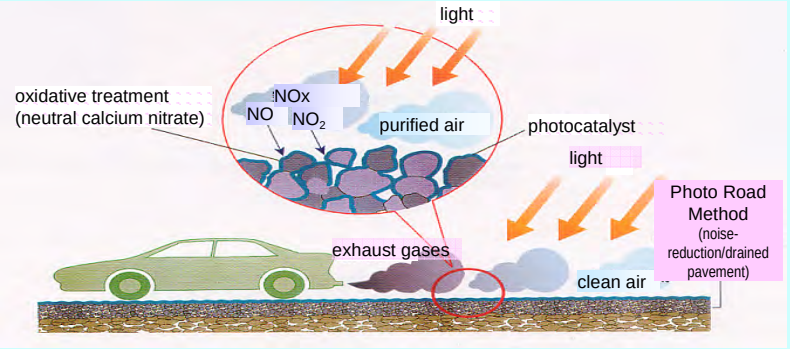


Photo Road Method (photocatalystic road coating)
Photo: Fujita Corporation

(2) Enhancement of initiatives for unified promotion of R&D and standardization

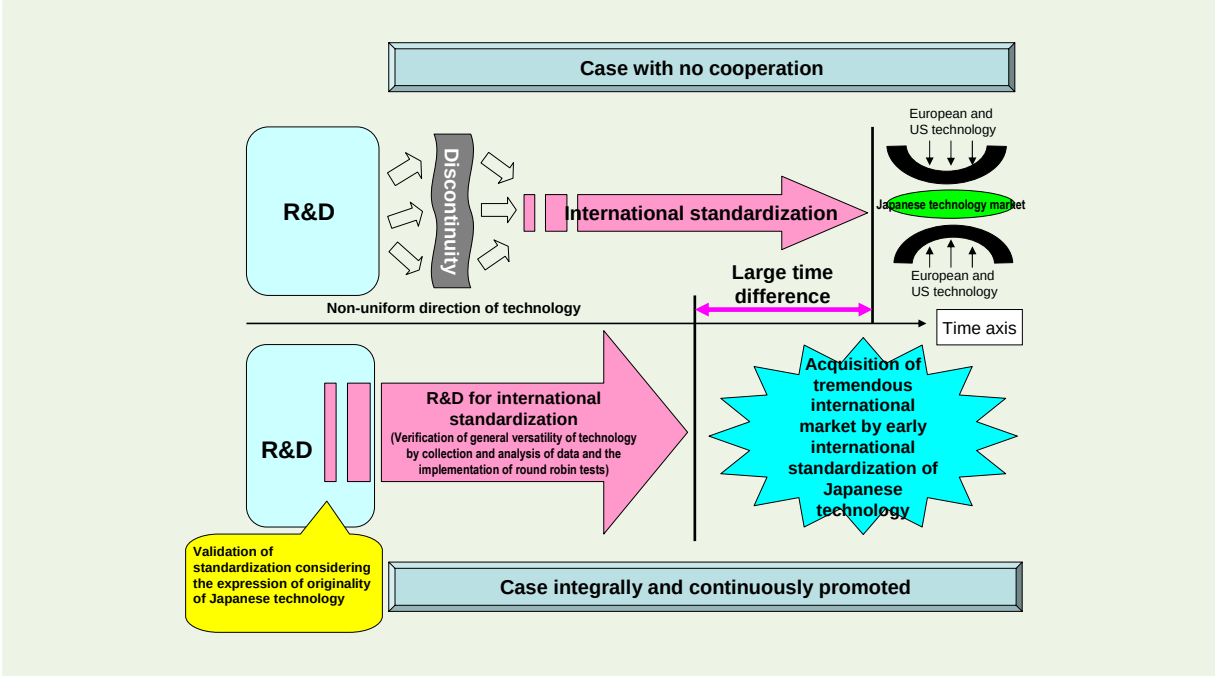
Government-led R&D projects have the main purpose to win out in R&D competitions in advanced and competitive fields. Thus research results produced as the primary goals may not always be suitable to be adopted as international standards. However, it is often necessary to pick up seeds of international standards from the R&D implementation stage as appropriate and prepare sufficiently for international standardization in competitive fields.

In order to promote international competitions in new markets dominantly, it is an important task to incorporate international standardization strategy in advance from the stage of planning, formation, and implementation of individual R&D projects and establish a system enabling examination of elements of which international standardization may be realized. However, as a matter of fact, the number of R&D projects funded by the government aiming for adoption of obtained R&D results as

international standards such as ISO is still small (Figure 1-3-1).

The number of competitive funds that clarifies to support international standardization activities associated with R&D activities still remains small. Therefore, it is desirable to urge researchers to engage in international standardization activities by stating clearly in the application guidelines of competitive funds that cover international standardization activities. It is also necessary to further promote the expansion of R&D competitive funds aimed at adoption of the results as international standards.

Figure 1-3-10 Importance of Integrated Promotion of R&D and Standardization



(3) Development of human resources for international standardization activities in R&D fields

For the purpose of heightening a possibility that R&D results are adopted as international standards, it is important to make researchers, engineers, and technicians sufficiently knowledgeable about obtaining the status of international standard in order to enable them to accurately find valuable seeds of international standardization existing in the achieved R&D results without omission.

Therefore, courses regarding international standardization were established in the MOT course of the Graduate School of Tokyo Institute of Technology and the MBA course of the Graduate School of Kwansei Gakuin University; they lecture on roles of international standardization in R&D activities. In order to develop human resources sufficiently knowledgeable about the role of standardization in R&D, it is essential that universities provide education on standardization through such opportunities as researcher, engineer, and technician training courses, and that enterprises enhance their in-house training programs for the same purpose. Also important is to expand reward systems for those having made significant achievements in international standardization activities and to expand the pool of human resources by establishing qualifications as indicators of professional capabilities.

(4) Other approaches to be promoted

1) Considering the situation where the number of international standards including patents is globally increasing, it is important to promote investigation and statistical analysis by collecting information on the workers involved in international standardization activities among the workers involved in activities relating to intellectual property rights in order to identify how intellectual property rights

obtained by the achievements of R&D activities are converted to international standards.

2) The Relevant Governmental Agencies Liaison Meeting on International Standardization is established to promote activation of international standardization activities in the governmental agencies through exchange of information on approaches to R&D-related international standardization activities. It is important to operate this Liaison Meeting continuously and steadily. **fn.5**

fn. 5 Secretariat: Japan Industrial Standard Committee (JISC)