

Enhancing Science and Mathematics Education for Next-Generation (Science Education Assistant Allocation Project)

As the development of next-generation related to science and technology is essential for promoting science and technology, it is necessary both to cultivate environments that enable children to become familiar with science and technology and to provide effective opportunities for developing their capabilities. From this viewpoint, MEXT will start implementing the "science education assistant allocation project" in fiscal 2007 at about 3,000 schools across Japan through the Japan Science and Technology Agency.

Under this project, "science education assistants" will be allocated to help teachers with preparations and implementations of science lessons for fifth and sixth graders that involve activities such as observation and experiments as well as planning of such lessons and development of relevant education materials. People who are knowledgeable in science, such as retired researchers and engineers from universities and corporations, and graduate school students as well as retired teachers, will be expected to serve as science education assistants.

Giving opportunities to teachers to tackle challenges such as devising methods for observation and experiment in science lessons and to develop education materials with assistants, this project is expected to not only enhance science lessons but also contribute to an improvement in the quality of teachers. Ahead of full-fledged implementation of the project, Chiba, Ishikawa and Hyogo Prefectures conducted trials in fiscal 2006. At one of the schools where trials were conducted, for example, three science undergraduates participated in eight hours of lessons per week to provide comprehensive assistance, helping to make preparations for experiments and implement lessons.

The following comments were offered by teachers at schools where science education assistants were allocated:

"The sight of science education assistants advising children gave us new perspective and clues as to how to provide guidance, which we can take advantage of in the classroom."

"Sharing burden with science education assistants, we could give children detailed guidance and advice to find that children could grow more willing to learn."

Students acting as science education assistants offered positive comments such as:

"This experience will be useful for my future career (as a teacher)."

"I want to introduce my friends to this project."

Under the science education assistant allocation project, assistants may be allocated not only for the purpose of making preparations for observance and experiments and implementing lessons but also for the purpose of helping to develop education materials and providing in-school lessons for teachers. Schools are expected to raise the standard of education by utilizing this project in a manner suited to their own circumstances.

(2) Drastic enhancement of graduate school education

Amid the rapid progress of science and technology, it is necessary to develop human resources equipped with both "deep expertise" that can adapt to the increasing specialization and segmentation of knowledge and "broad versatility" that can adapt to new academic fields and technology innovations. Industry needs human resources that are equipped with both advanced knowledge and creative thinking as well as with leadership ability and are capable of producing successful results immediately after graduation. In this context, it is important to drastically enhance graduate schools' function of developing human resources capable of playing an active role in various sectors of society.

MEXT conducted a survey on researchers working at companies, universities, public research organizations, etc. as to what kind of researchers are needed at the type of organization they belong to and how they view the current status of graduate school education. When we asked respondents to select and prioritize three important attributes and capabilities, out of 15 items, that are required for researchers working at their own organizations, "expertise in specialized area" was selected

as the first priority by the most respondents, at all types of organization. The survey indicated that the second most important element required for researchers is "creativity" at universities, "inquiring spirit" at public research organizations and "problem-solving ability" at private companies (Figure 1-1-48).

With regard to the question about how graduate school education should be enhanced in order to foster the kind of researchers required at the type of organization to which the respondent belongs, the most common response, across all types of organizations, was need for "enhancing coursework for acquiring knowledge not only in the area of specialty but in a broad range of related fields." The ratio of respondents citing this was particularly high at public research organizations and private companies. The most popular reply among the respondents belonging to private companies was "developing education programs and supporting internship through industry-university partnership", while the most popular reply among the respondents belonging to universities was "enhancing financial support programs for graduate school students such as scholarship, TA (teaching assistantship) and RA (research assistantship)" (Figure 1-1-49).

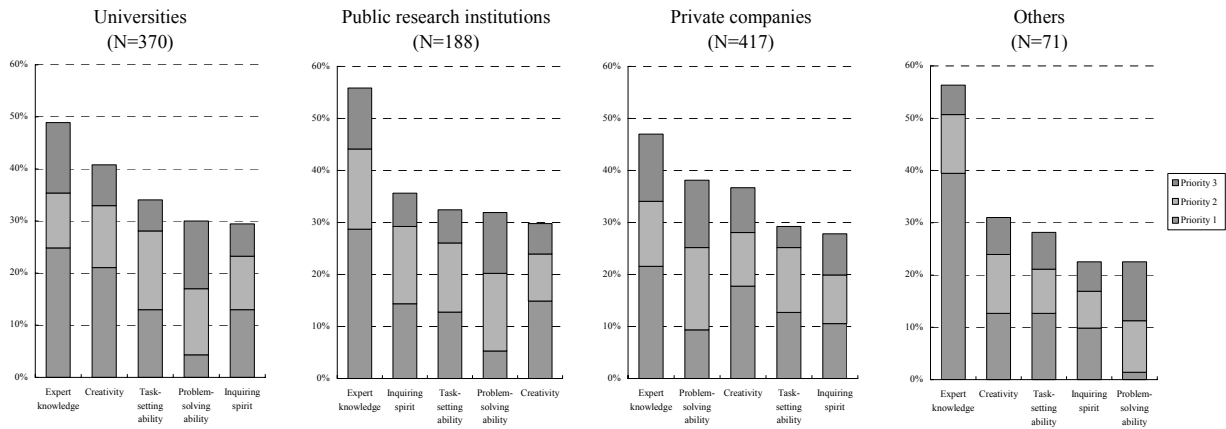


Figure 1-1-48 "What are attributes/capabilities required for researchers working at your organizations?" (Top 5 most often cited items)

Notes:

1. "N" indicates the number of respondents.

2. The 15 items of attributes and capabilities provided for selection are as follows.

A. expert knowledge, B. basic knowledge, C. task-setting ability, D. problem-solving ability, E. systematic thinking, F. creativity, G. inquiring spirit, H. cooperativeness, I. logical thinking, J. internationality, K. patience, L. competitive mind, M. well-balanced thinking/broad perspective, N. social common sense, O. general education

Source: "Survey of the State of Japan's Research Activities (FY2006)" by MEXT

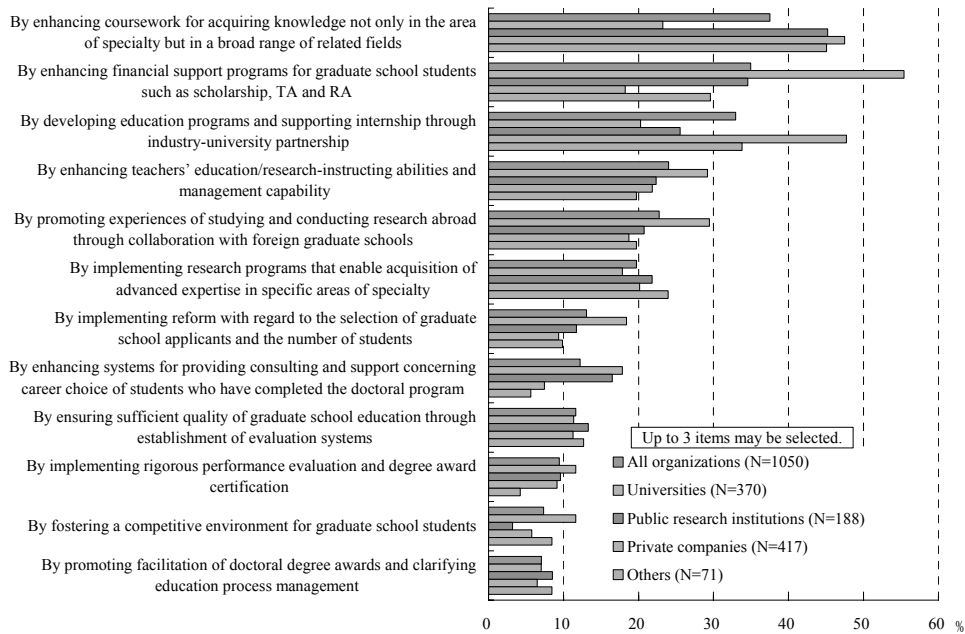


Figure 1-1-49 "How do your organizations want graduate school education to be enhanced in order to foster researchers?"

Note: "N" indicates the number of respondents.

Source: "Survey of the State of Japan's Research Activities (FY2006)" by MEXT

"Graduate School Education in a New Era — Building Internationally Competitive Graduate Programs" (proposed by the Central Council for Education on September 5, 2005) and the Third Science and Technology Basic Plan recommended that in order to enhance graduate schools' human resource development function, Japan needs to strengthen efforts to develop school curricula in a systematic manner and establish education and research centers capable of attaining international acclaim.

Based on this recommendation, MEXT formulated the "Platform for the Promotion of Graduate School Education" (March 30, 2006), which is a systematic and intensive five-year initiative that started in fiscal 2006, and the ministry intends to enhance graduate school education based thereon. On March 31, 2006, MEXT amended the "Standards for Establishment of Graduate Schools" (This amendment was put into effect on April 1, 2007.) so as to require graduate schools to enhance their education function by adding provisions for the requirements of the establishment of objectives related to human resource development for each graduate school and field of major, the implementation of faculty development⁴⁰ and the specification of the criteria for academic performance evaluation.

(Establishment of education and research centers with international acclaim)

Based on the results of the 21st COE Program mentioned above, MEXT plans to introduce the "Global COE Program," which, while retaining the basic concept of the 21st COE Program, seeks to further develop research centers by providing targeted support (Figure 1-1-50). This program will provide funding support for establishing education and research centers that perform at the apex of global excellence to elevate the international competitiveness of Japanese universities. The program will strengthen and enhance the education and research functions of graduate schools, to foster highly creative young researchers who will go on to become world leaders in their respective fields through experiencing and practicing research of the highest world standard.

This program seeks to promote the establishment of international research centers by, in particular, cultivating a research environment that enables young researchers and doctoral program students to devote themselves to research independently, enhancing financial support and promoting collaboration with foreign research organizations and invitation of foreign teachers.

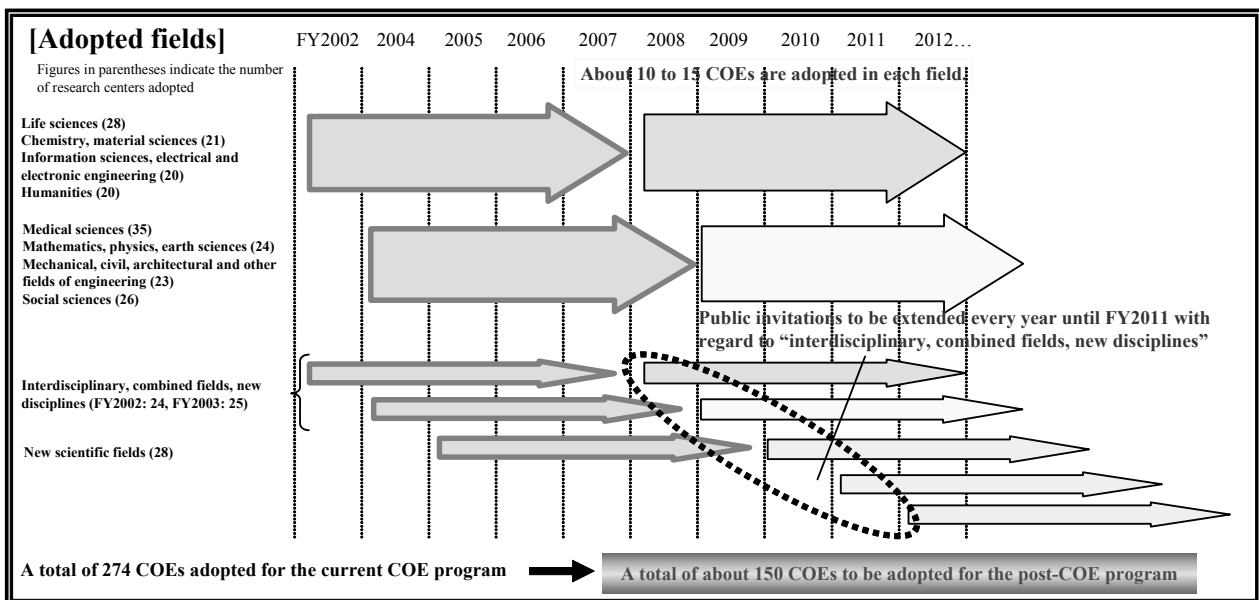


Figure 1-1-50 Global COE Program

Source: MEXT

⁴⁰ Faculty development (FD) means institutional efforts by the teaching staff to improve the contents and method of lessons.

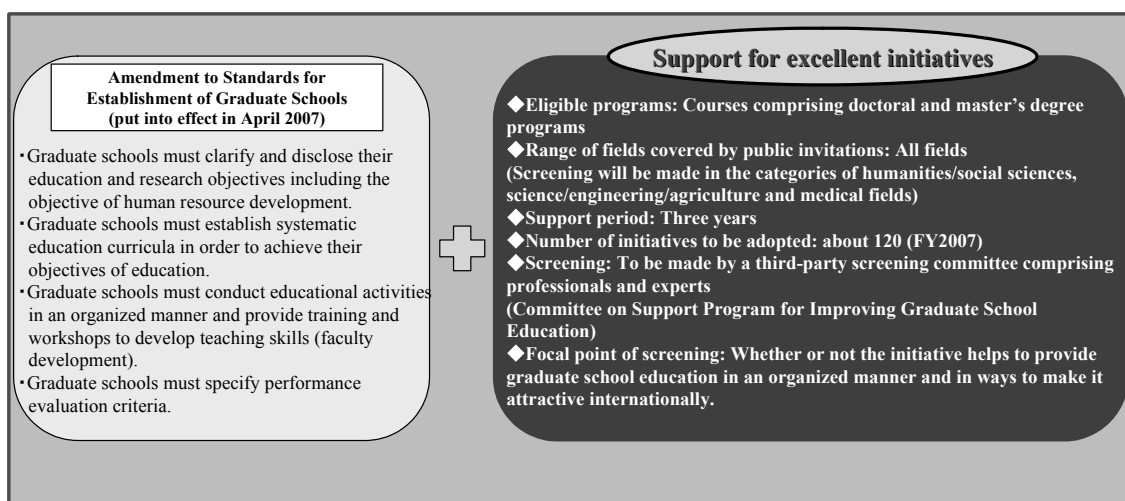


Figure 1-1-51 Support Program for Improving Graduate School Education

Source: MEXT

(Support Program for Improving Graduate School Education)

Together with the amendment to the Standards for Establishment of Graduate Schools, MEXT intends to implement the "Support Program for Improving Graduate School Education," a reform program for doctoral programs and master's degree programs that seeks to make graduate school education more effective by providing targeted support to excellent education initiatives being carried out in an organized and systematic manner (Figure 1-1-51).

It is an urgent task for Japan to reform graduate school education so as to enhance its competitive edge in the global arena and develop advanced human resources capable of attaining international acclaim, and Japan needs to quickly develop internationally attractive graduate school programs that are open to students in and outside Japan.

(3) Securing excellent science and technology-related human resources

Amid the intensifying global competition for human resources, it is an urgent task for countries around the world to secure an abundance of excellent human resources. As shown in Table 1-1-54, the adoption of measures for securing excellent resources has become an international trend in recent years, and programs to invite top-level researchers are increasing.

Under such international circumstances, it is important for Japan to establish bases for securing excellent human

resources. Therefore, MEXT is implementing the World Premier International Research Center (WPI) Initiative, while the Cabinet Office is promoting a plan to establish a world-top-class natural science graduate school open to the world in Okinawa Prefecture as part of efforts to promote the development of the prefecture.

As the number of foreign researchers working in Japan stays low at about 11,000, accounting for only 1.4% of the total number of researchers in the country, it is necessary to promote the acceptance of foreign researchers to increase their number as a way to cultivate a research environment that enables foreigners to play an active role.

(World Premier International Research Center Initiative)

As a first step toward raising the standard of science and technology in Japan and consistently spurring innovations, which should serve as the engine of future development of the country, it is necessary to enhance the country's basic R&D function and international competitiveness. To do so, Japan must establish world-leading research centers in a manner not constrained by conventional thinking so that the country may bring together brain powers from around the world, produce excellent research results and establish a base for the development of excellent human resources.

From this viewpoint, MEXT intends to start in fiscal 2007 the World Premier International Research Center Initiative. This program aims to establish centers with "global visibility" that will attract top-level researchers

from around the world by cultivating a research environment that meets the global standard through measures such as: extending invitations to top-level researchers from within and outside Japan, introducing a strong management system and performance-based remuneration system, adopting English as the working language and providing vigorous support; and by promoting collaboration with other universities and institutions (Figure 1-1-52).

(Plan to establish the Okinawa Institute of Science and Technology)

This plan aims to establish an open-to-the world, world-leading natural science graduate school in Okinawa Prefecture with a view to developing the prefecture as the

leading-edge knowledge cluster of the Asia-Pacific region. As a basic concept, it seeks to cultivate a truly international research and educational environment, with foreigners accounting for more than half of its teaching staff and students. Foreign researchers have already been invited to the Okinawa Institute of Science and Technology, which was founded in September 2005 as the implementing agency of the plan, and seminars and conferences are held there in English.

The institute is making preparations to open the planned graduate school under the leadership of Sydney Brenner (Nobel Prize laureate in physiology or medicine 2002), who is the president of the institute, by consulting with foreign Nobel laureates and other experts (Figure 1-1-53).

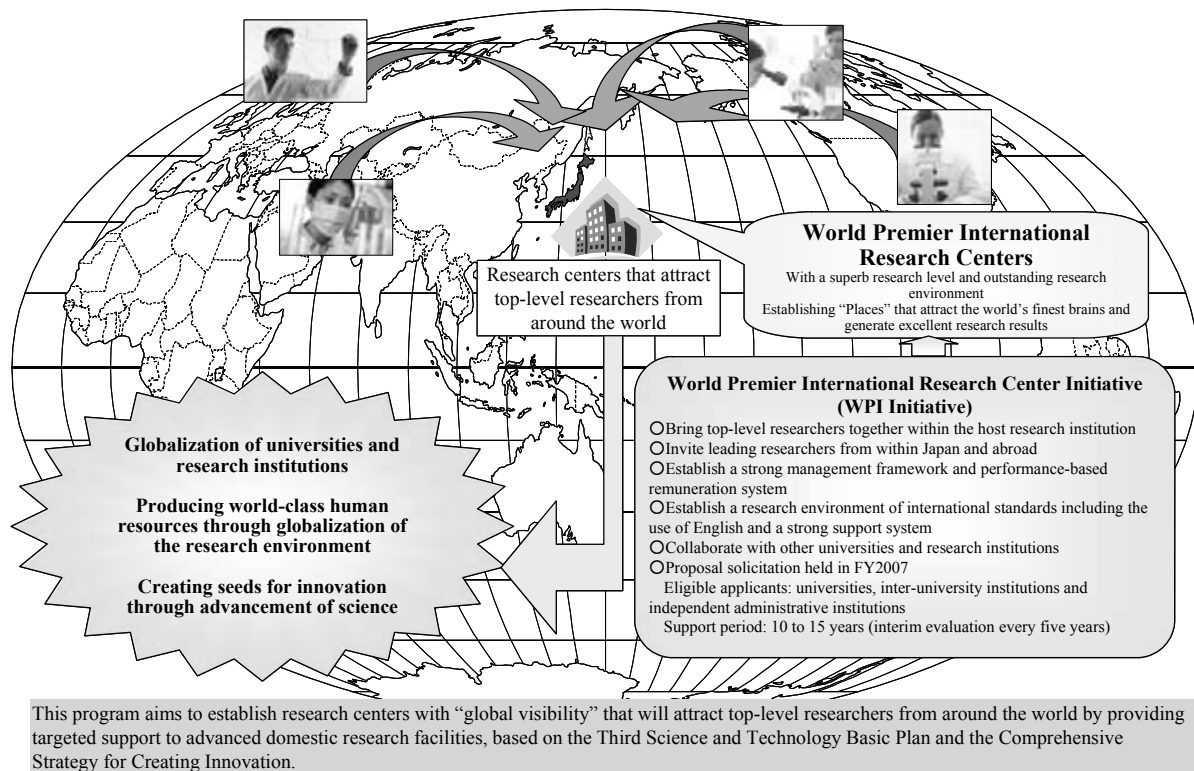


Figure 1-1-52 World Premier International Research Center (WPI) Initiative

Source: MEXT



Figure 1-1-53 Laboratory building of the Okinawa Institute of Science and Technology (concept drawing)

Source: Okinawa Institute of Science and Technology

Table 1-1-54 Measures taken by other countries to secure excellent human resources

○ **Supporting exchanges of researchers**

In recent years, programs to invite top-level researchers have increased around the world. Such programs have been adopted in European countries, Canada, China, South Africa, etc. Bilateral exchange programs targeting young researchers such as post-doctorals are also being actively implemented by France, Germany, the United States, Australia, etc. Meanwhile, Norway has adopted a unique approach to invitation programs targeting top-level and post-doctoral-level researchers, focusing its screening process on research projects of the host institution, rather than on individual researchers.

○ **Bringing back and utilizing researchers staying abroad**

Countries afflicted with a brain drain, such as China and Thailand, provide subsidies to researchers staying overseas (expatriate researchers) to cover the costs of returning and resuming research back at home. Such countries also implement short-stay programs for expatriate researchers so that they may return on a temporary basis and provide intensive lessons and deliver speeches and transfer knowledge so as to contribute to the development of the homeland as well as to the R&D activities thereof. Industrial countries also try to maintain contacts with expatriate researchers, with the EU implementing the “International Reintegration Grant” program and Austria and Germany building networks of expatriate researchers working in North America. Moreover, Austria facilitates the return of expatriate researchers by providing subsidies to such researchers who are willing to return home to cover expenses necessary for looking for a job in the homeland (Foreign researchers wishing to go to Austria are also eligible for such subsidies.).

○ **Promoting mobility indirectly through infrastructure improvement**

As stumbling blocks to the mobility of researchers include indirect ones such as the ineligibility of foreigners to receive research grants, some countries give foreigners access to subsidies. In most cases, only foreign researchers studying in host-country universities are eligible for such subsidies. The United Kingdom, however, has adopted a more open policy, providing subsidies to not only researchers studying in the country but also those studying in other European countries.

Another way of resolving an indirect stumbling block to mobility is promoting international joint research programs by providing subsidies. In Australia, for example, efforts are under way to support collaboration between institutions of higher education and research organizations in the country and foreign institutions. In Singapore, meanwhile, the government has led the development of a research cluster called Biopolis and invited foreign companies, universities and research organizations.

Example of World Leading Research Centers

Carnegie Mellon University's Robotics Institute

The financial foundation of Carnegie Mellon University, located in Pittsburg, is not quite solid compared with other general universities, partly because it has neither a medical school nor a law school and also because it is a relatively young institution. Therefore, this university has concentrated strategic resources on specific fields as its management principle. The Robotics Institute was established in 1981 with a view to building a leading robotics research center by taking advantage of Carnegie Mellon University's expertise in computer sciences and artificial intelligence. Dr. Raj Reddy, the founding director of the institute, worked hard to secure the necessary funds and human resources by highlighting the university's strength in these fields. It is said that once world-class robotics researchers started to gather at the Robotics Institute, their excellence drew talented young researchers to the institute, creating a virtuous circle of talents attracting more talents. Then, this virtuous circle created a "critical mass" of human resources (diverse and multilayered pool of researchers, enhanced creativity produced thereby, network, fusion of fields). In this way, the Robotics Institute came to be regarded as a top-level research center in the field of robotics. One notable thing about this institute is that the ratio of researchers adopted for senior posts from within the institute is high, which is a rare distinction for U.S. universities. This reflects the Robotics Institute's adoption of a very rigorous screening process for the employment of new researchers for the purpose of selecting really excellent researchers. The institute's employment policy gives precedence to younger applicants, and its screening of applicants takes account of peer-review letters written by noted outside researchers in the relevant fields.

The University of Arizona's College of Optical Sciences

The College of Optical Sciences, which is part of the University of Arizona, was established in 1969 in Tucson, a major city in the state of Arizona. Dr. Aden Meinel, a leading expert on reconnaissance satellite research, played the central role in efforts to establish this optical sciences college, through lobbying efforts targeted at the federal government. At that time, there was only one college undertaking a specialized optical science research program in the United States. It is said that Dr. Meinel exerted strong leadership in lobbying the federal government based on his belief that the United States needed more colleges specialized in optical science research. Dr. Peter Franken, who was headhunted by the College of Optical Sciences in 1973, undertook the role of realizing Dr. Meinel's belief by leading the college's research activities. Dr. Franken made great contributions to establishing the organization of the college by recruiting talented researchers from the outside. Dr. James Wyant, who is the current president of the college, was among the researchers recruited by Dr. Franken. Dr. Wyant decided to move to the University of Arizona because the prospect of conducting research alongside Dr. Franken and researchers recruited by him seemed attractive to him. Dr. Franken carried out his recruitment activities based on his strategic thinking that recruiting talented researchers will lead to recruitment of talented researchers again in the future. In line with this strategic thinking, the University of Arizona's College of Optical Sciences has now developed into a research center that attracts excellent human resources (researchers and students) from around the world.