CRDS-FY2016-SP-03

STRATEGIC PROPOSAL

Towards Optimal Development of Centers of Excellence in Japan

- For the Formation of Sustainable Strength of Organization and Realization of Innovation -

Center for Research and Development Strategy
Japan Science and Technology Agency

The Center for Research and Development Strategy (CRDS) is a public think tank that conduct investigations and analyses and make proposals from a neutral standpoint concerning Japan's policy on innovation in science and technology. The CRDS belongs to the Japan Science and Technology Agency (for which the competent ministry is the Ministry of Education, Culture, Sports, Science and Technology).

The CRDS prepared this Strategic Proposal through dialogues with experts and policymakers in various fields and by grasping a general overview of the science and technology field, analyzing social expectations, studying domestic and international trends, and conducting international comparisons.

As a summary of strategies for research and development efforts that Japan should prioritize in the future as well as of proposals concerning important issues involving science and technology innovation policy, the Strategic Proposal is not only distributed to policymakers and relevant researchers, but also made publicly available.

It is important that public research in science and technology both advances individual research fields and meets various social expectations through integration of these fields. We hope that this Strategic Proposal will be utilized in national policymaking and will contribute to achieving science and technology innovation and solving social issues.

For details please refer to the following website:
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Executive Summary

In Japan, growth in science and technology-related budgets has slowed since around the mid-2000s. Notably, since national universities were incorporated in 2004, there have been repeated cuts in grants for operating expenses from the government. These trends have given rise to concerns about a relative decline in the research capacity of Japan compared with other countries. At the same time, as Japan deals with various social issues, there is growing anticipation that science and technology innovation will play a key role. Therefore, an important issue is to develop policies for promoting innovation in science and technology within limited budgets.

As part of science and technology policies, various types of Center of Excellence (COE) programs have been created in the last 15 years. They are large-scale programs and have tremendous policy significance. These COE programs have created first-rate education and research centers and thereby have achieved various policy objectives including producing fruitful research results, making education and research systems more sophisticated, and creating innovation. In some cases, these programs have had wider effects such as a subsequent institutional reform at the host institution of a COE and strengths unique to a center arising from successive rounds of funding.

Various problems have emerged, however, as numerous COE programs for creating new centers have been launched in an unsystematic manner. The main problems are that the institution hosting a COE has become burdened due to difficulties in planning relevant long-term strategies, that selected centers are concentrated at certain large universities and other large institutions, causing disparities among universities in terms of the educational and research environment, and that maintaining academic diversity is becoming difficult due to constraints on promoting a wide variety of education and research fields. Also, in some cases, it becomes difficult to continue training or securing researchers and developing infrastructure after the end of a project period, and a COE, which by nature should promote advanced education and research, becomes inactive and remains at its host institution without clear objectives.

Considering these issues, this Strategic Proposal puts forward the following proposals, aiming for a shift from the conventional policy, which has resulted in the existence of numerous COE programs intended to create and maintain new centers, to a strategic policy that appropriately responds to the current conditions of universities and other institutions.

Toward a grand design of COE programs
Proposal 1: Making large centers responsive to top-down requests
Proposal 2: Creating a gradual three-tier structure for funding amounts
Proposal 3: Emphasizing support for various education and research fields
Proposal 4: Securing support for institutions other than large research universities

Toward flexible, sustainable operation of centers
Proposal 5: Establishing the life cycle of a center at its host institution
Proposal 6: Creating and strengthening cooperative networks
Proposal 7: Promoting strategic funding plans for center operation

COE programs not only significantly contribute to promoting science and technology innovation policies, but also play an important role in advancing university reforms. This Strategic Proposal considers the characteristics of COE programs and examines the role of these programs from the standpoint of science and technology innovation policy and higher education policy. It is hoped that those who are involved in the issue will have shared awareness of the role and significance of COE programs and will have deeper discussions on the future direction of these programs.

Contents

Full and abbreviated names of programs

Strategic Research Center Development Program	SCOE Program
Twenty-First Century Center of Excellence Program	21st Century COE Program
Global Center of Excellence Program	GCOE Program
World Premier International Research Center Initiative	WPI Program
Program for Creating Innovation Centers for Advanced Interdisciplinary Research Areas	Advanced Interdisciplinary Innovation Center Program
Program for Strategically Promoting Translational Research	Translational Research Program
Program for Leading Graduate Schools	Leading Universities Program
Center of Innovation Science and Technology-Based Radical Innovation and Entrepreneurship Program	COI STREAM Program

1. Content of This Proposal

This Strategic Proposal is based on two main issues. One is the harm caused by launching in an unsystematic manner numerous Center of Excellence (COE) programs for creating new centers and maintaining them. In fact, about 20 programs have been started in the past 15 years. These programs have achieved relevant policy objectives and contributed to development of the unique strengths of universities. However, the launching of competitive COE programs one after another has made it difficult for institutions hosting COEs (universities, national research and development agencies, etc.) to plan long-term strategies, which has consequently become a burden on these institutions. Also, as COEs are concentrated at certain large universities, disparities have arisen among universities in terms of the educational and research environment.

Another issue is emerging difficulties in the sustained operation of COEs. It is not easy to secure sufficient operating funds after a program ends, which makes it hard to continue efforts for securing and training researchers and developing infrastructure. In addition, some centers continue to exist in a state of inactivity. COEs should promote advanced education and research, but when one becomes inactive, the ecosystem of its host institution (i.e., all of the institution's educational and research organizations) may not function sufficiently.

In consideration of the aforementioned issues, this Strategic Proposal makes the following seven proposals, aiming at a shift from the conventional policy, which has resulted in the existence of numerous COE programs intended to create new centers, to a strategic policy that properly responds to the current conditions of universities and other institutions. Taking into account the changing circumstances of universities and the government's policies and initiatives, this Strategic Proposal summarizes and discusses the direction and entire framework of future COE programs. In such discussions, consideration should be given to the fact that COE programs have created first-rate education and research centers and have made a significant contribution to science and technology innovation policy. And, that the programs have also been created in tandem with university reforms through promotion of institutional reform at host institutions and development of their unique strengths and thus have played an important role in higher education policy. Therefore, based on such characteristics of COE programs, it is necessary to hold repeated discussions from the standpoint of science and technology innovation policy and higher education policy, and construct an optimal framework as a whole that extends beyond organizational boundaries between ministries and agencies.

Toward a grand design of COE programs:

Proposal 1: Making large centers responsive to top-down requests
Proposal 2: Creating a gradual three-tier structure for funding amounts
Proposal 3: Emphasizing support for various education and research fields
Proposal 4: Securing support for institutions other than large research universities

Toward flexible, sustainable operation of centers:

Proposal 5: Establishing the life cycle of a center at its host institution—promoting reorganization and clarifying a post-program continuity scheme
Proposal 6: Creating and strengthening cooperative networks
Proposal 7: Promoting strategic funding plans for center operation

Toward a grand design of COE programs

Proposal 1: Making large centers responsive to top-down requests

With the growing need for prompt responses to rapid advances in science and technology and relevant social demands, the policy significance of making intensive efforts concerning specific technological fields or issues has been increasing. In this respect, it is necessary to create large-scale research centers where required human resources, equipment, and facilities are highly concentrated.

There have been cases, however, in which research centers created with large amounts of funds from a COE program have found it difficult to secure the same level of funding on their own at the end of the program period and thus have no choice but to suspend their work or significantly reduce their size. Given this problem, when creating large-scale centers, future COE programs should provide support for a limited number of specific fields selected in accordance with social needs.

Proposal 2: Creating a gradual three-tier structure for funding amounts

The amount of funds for each center provided by existing and past COE programs has tended to become larger and larger. In the future, however, the funding amount of a center created through a program should be consistent with the financial capacity of the host institution. It is necessary to consistently have programs that are aimed at providing small- to medium-scale funding. To this end, this Strategic Proposal suggests a gradual three-tier structure for funding amounts (approximately 400 million, 200 million, and 100 million yen per center annually), taking into account the situations of universities and the objectives of COE programs.

Proposal 3: Emphasizing support for various education and research fields

Trends in science and technology change rapidly, and social and industrial needs extend over various areas. To respond to these trends and needs, it is necessary to put emphasis on supporting various fields and to strive to strengthen their foundation for the sake of constantly advancing a wide range of education and research fields.

Proposal 4: Securing support for institutions other than large research universities

Efforts should be made to create an institutional design that incorporates mechanisms to advance their unique strengths for promoting establishment of COEs at universities that are not large research universities but have great potential. For example, COE programs could give priority to selecting universities that can take advantage of their local characteristics or could be designed for universities that receive Support Priority 1 (i.e., national universities whose core activities include contributing to their local communities through human resource development and efforts to solve local issues and promoting globally or nationally significant educational and research activities in their specialized fields in which they have advantages or special characteristics).

Toward flexible, sustainable operation of centers

Proposal 5: Establishing the life cycle of a center at its host institution: promoting reorganization and clarifying a post-program continuity scheme

Existing and past COE programs have been implemented with a main goal of creating and maintaining new centers; however, future programs should aim at establishing the life cycle of centers to enable them to operate in a flexible, sustained manner. To accomplish this, COE programs should not only maximize the potential of universities, but also ensure that the programs vitalize the educational and research organizations of universities and play a leading role in organizational reforms. Specifically, future COE programs should put emphasis on (1) promoting reorganization and (2) clarifying a post-program continuity scheme.

(1) Promoting reorganization. Various types of large, medium-sized, and small research centers have been created through COE programs, but some of the centers are not necessarily active. Therefore, future programs should try to create new centers by promoting reorganization of existing centers including inactive ones (e.g., consolidation, abolishment, and restructuring with a new mission).
(2) Clarifying a post-program continuity scheme. In the existing and past COE programs, there have been cases in which a center remains at its host institution without a clear role in the institution or clear prospects of securing operating funds. Therefore, a COE, its host institution, relevant government agencies, and other stakeholders should share the continuity scheme for the center, and the role of the center in its host institution should be clarified with consideration given to the prospects for the center's growth.

Proposal 6: Creating and strengthening cooperative networks
To amplify and utilize the potential of the COEs located in Japan, it is necessary to examine an institutional design that emphasizes construction of interorganizational networks. In such a design, efforts should be made to build interorganizational personnel networks, which have conventionally been insufficient, and use them to secure human resources needed for education and research and to increase the movement of personnel.

Proposal 7: Promoting strategic funding plans for center operation
Regardless of the form of COEs after the end of the relevant COE programs, these programs should promote efforts to create a strategic plan for funding the operation of the centers. More specifically, this Strategic Proposal makes the following four recommendations.

(1) Strategic changes in the amount of funding for several years after the start of a program and several years before its end
The initial stage of creating research centers should be regarded as a preparation period for full-fledged implementation of a COE program. Also appropriate amounts of funds should be distributed. The period of several years following the creation of research centers should be also regarded as a period of transition to their independent operation and programs should reduce the amount of funding they provide in stages while gradually increasing the share of the centers' own funds in their operating funds. In other words, it is necessary to strategically distribute funds to COEs according to their operational stages.

(2) Prudent design of an economic support system for students according to program objectives
At present, gaps in economic support to graduate students could arise depending on whether their university is selected for a COE program. It is therefore important to clarify each program's objectives with regard to economic support to graduate students and set reasonable pay levels. In addition, it is necessary to reexamine the framework for supporting top students which is independent of a COE program.

(3) Securing of necessary funds from a host institution for a plan of reorganizing a COE
Reorganizing a COE involves necessary facility development and personnel transfers as well as the development of a management system for all of the host institution's educational and research organizations. It is therefore important for COE programs to secure the funds required for these activities. In addition, COEs should be operated in tandem with their parent programs that are oriented toward university system reform and other types of university reform. To this end, it is important to consider strategies for the entire host institution in reorganizing a COE.

(4) Diversification of sources of a center's operating funds for stable funding
There are cases in which a COE that had relied entirely on its parent program for operating funds faced operational obstacles after the end of the program period. In response, COE programs should aim at creating stable sources of operating funds by encouraging centers during the program period to diversify their funding sources through, for example, the use of private-sector funds. In doing so, allocating part of the host institution's base budget to its COE's operating funds from the standpoint of embedding the center's valuable activities in the institution should be considered.

2. Background and Significance of This Proposal

2.1 Changing Circumstances of COE Policy in Japan

COE programs have created first-rate education and research centers and thereby have accomplished various policy objectives including producing fruitful research results, making education and research systems more sophisticated, and creating innovation. These programs therefore significantly contribute to promoting science and technology innovation policies. At the same time, these programs have had wider effects such as a subsequent institutional reform or a change in awareness at the host institution of a COE and development of strengths unique to a center because of successive rounds of funding. In tandem with university-wide system reforms and other efforts, positive effects of COE programs play an important role in promoting reform at universities. In other words, in some respects, these programs should be considered as part of higher education policy.

It is therefore important to have repeated discussions on the future developments of COE programs from the standpoint of both science and technology innovation policy and higher education policy. Taking into account trends in these policy areas, this Strategic Proposal reexamines the role of COE programs.

2.1.1 Status of Science and Technology Innovation Policy

Japan's Science and Technology Basic Law was enacted in 1995, and the total size of science and technology-related budgets drastically increased during the first period (FY 1996 to FY 2000) and the second period (FY 2001 to FY 2005) of the Science and Technology Basic Plan. With this growth of resources, the government strategically promoted science and technology by doubling competition-based funding, diversifying funding programs, and selecting key areas as funding priorities. Against this backdrop, COE programs were created one after another, and new centers were set up at universities and other institutions. However, since around the mid-2000s, the growth of science and technology-related budgets stagnated as Japan's fiscal situation worsened. Today, it is difficult to expect significant budget increases in the future, and it seems necessary to reexamine the conventional policy on COEs which has aimed at general expansion of centers.

A current major issue concerning Japan's policy on science and technology innovation is that the Japanese presence in science and technology is relatively declining against a background of stagnant budget growth. To improve the situation, the Fifth Science and Technology Basic Plan includes efforts to enhance fundamental competence in science and technology that are centered on university reform and universities' enhanced capabilities. It is important to examine the direction of COE programs in this context.

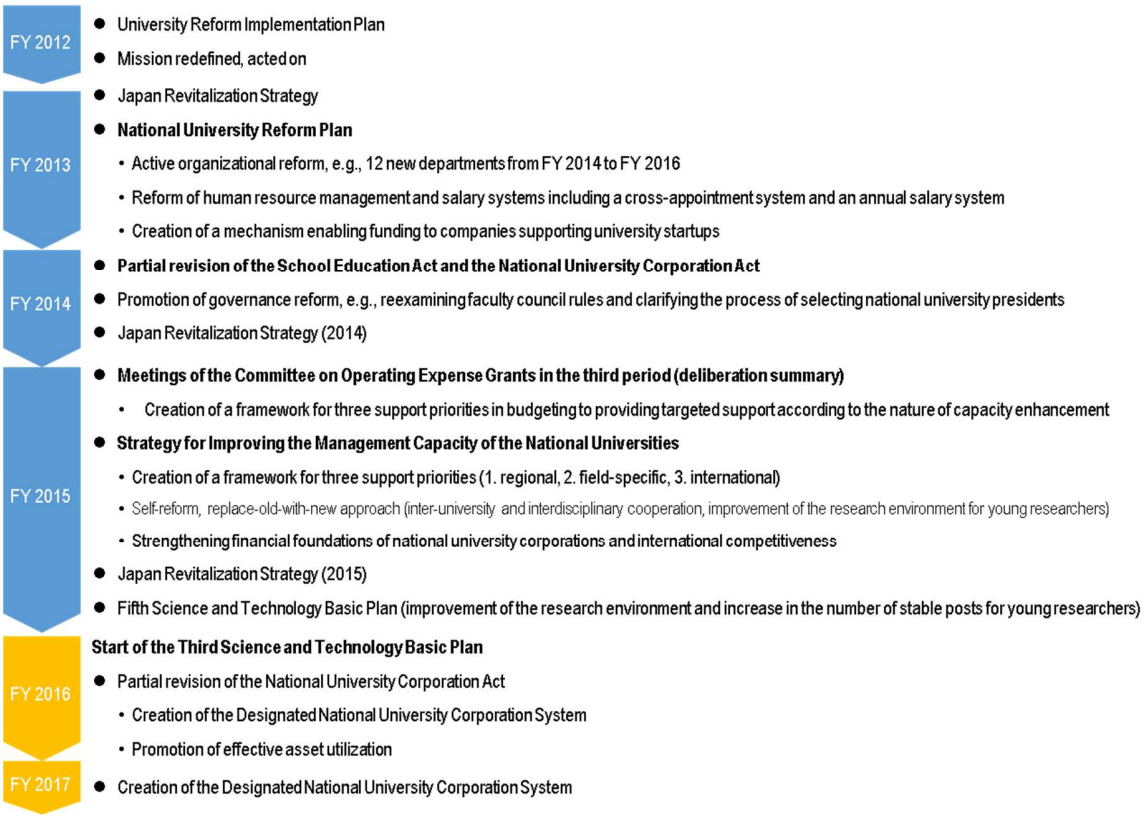
Given that Japan is facing various issues including its aging and shrinking population, global environmental and energy issues, stagnant industrial competitiveness, and regional economic decline, science and technology innovation is expected to play an important role in finding solutions. Also, as global trends in science and technology in general have changed rapidly in recent years, there is a need for policy implementations that promptly respond to such changes. In this context, improving Japan's research capacity and human resource development while dealing with social issues has become one of the government's crucial challenges.

2.1.2 Status of Universities and Other Institutions in Japan

In Japan, the circumstances of universities, which are important players in science and technology innovation, have rapidly changed in the past 20 years. Until the mid-2000s, national universities had engaged in education and research based on stable funding from the government. However, since they were incorporated in 2004, there have been repeated cuts in grants for operating expense under the fiscal policy

of the government, which has led to rapid worsening of universities' financial situation. The cuts in government support have made it difficult for universities to sufficiently secure necessary funds for education and research and, in some cases, have put downward pressure on personnel expenses.

As these changes have occurred, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) set a course of action for promoting reform at national universities, starting with the 2012 University Reform Implementation Plan and has urged each university to independently make reform efforts (Figure 2.1). In particular, a framework for three support priorities in the distribution of grants for operating expenses was set for the start of the third period of the Mid-Term Goals of National University Corporations, which essentially created separate directions of efforts to strengthen the capabilities of universities.[1] In 2017, the Designated National University Corporation System was created, and the role of the national universities is becoming increasingly diversified. At the same time, a strong push is being made for innovation through industry-academia cooperation. And the 2016 Japan Revitalization Strategy sets a goal to triple, by around 2025, the amount of research and development investments from private companies to universities and other institutions.



Source: Document distributed at a government project review session (Cabinet Secretariat, Head Office for Promoting Administrative Reform, November 11, 2016).

Figure 2.1 Activities for national university reform

[1] Support Priority 1: Support for national universities whose core activities include contributing to their local communities and promoting globally or nationally significant educational and research activities in their specialized fields in which they have advantages or special characteristics.
Support Priority 2: Support for national universities whose core activities include promoting globally or nationally significant educational and research activities (rather than locally relevant activities) in their specialized fields in which they have advantages or special characteristics.
Support Priority 3: Support for national universities (comparable to overseas universities that have produced excellent results) whose core activities include university-wide promotion of education and research as well as application of research results to solving social problems.

In response to these policy changes, universities are urgently pursuing reforms based on their characteristics, strengths, and social roles and are engaging in a wide range of efforts including industry-academia cooperation, integration of different fields, and internationalization of various activities. The government has conventionally promoted such reform efforts through various types of COE programs. However, the situation is at a point where the government will need to reexamine the role of these programs, taking into account the fact that the missions of universities are becoming more diverse and that there is an increasing need to strengthen financial and other types of cooperative relationships between universities and private companies.

2.2 Current Status and Issues

2.2.1 Status of COE Programs and Scope of This Proposal

(1) Positioning of COE Programs in Public Financial Support

This Strategic Proposal considers COEs as organizations that gather human and financial resources, build relevant infrastructure, and engage in educational and research activities related to certain issues at a university, a national research and development corporation, or a similar institution. COE programs are aim at creating such centers. Here, the positioning of these programs is considered within the overall framework of public financial support to universities and other institutions in Japan.

Figure 2.2 provides an overview of the operating expenses and various sources of competitive funding for national, prefectural, municipal, and private universities, national research and development corporations, and other institutions. In this public financial support, many of the COE programs are part of the various education and research programs implemented by government agencies, and the financial size of these various programs is about 50 billion yen. (Major programs include the Program for Leading Graduate Schools (17 billion yen) and the World Premier International Research Center Initiative (9.4 billion yen)). Other programs include the Program for Building Innovation Hubs implemented by the Japan Science and Technology Agency (JST) and the Program for Accelerated Translational Research Networks implemented by the Japan Agency for Medical Research and Development (AMED). The figure shows that there are various funding sources and organizations implementing COE programs.

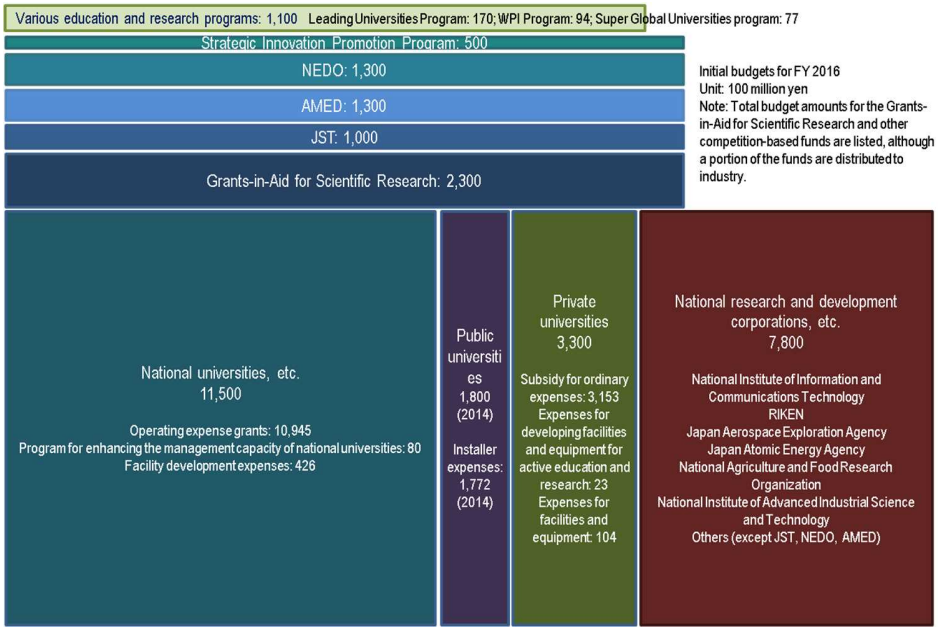


Figure 2.2 Overview of public financial support for universities, national research and development corporations, and other institutions.

As mentioned above, the government currently provides funds related to various competitive programs. Figure 2.3 characterizes these COE programs according to three policy objectives and the type of implementing entity.

The smallest entity that can implement a competitive program is an individual researcher or a group of researchers and is eligible for the Grants-in-Aid for Scientific Research program, the JST CREST program, and the Cross-ministerial Strategic Innovation Promotion Program. Also, there are many programs in which the implementing entities are university departments/programs, such as the WPI Program, the Center of Innovation Science and Technology-Based Radical Innovation and Entrepreneurship Program (hereinafter, the COI STREAM Program), and the Leading Universities Program. As for programs aiming for university reform such as the Enhancement and Promotion Program for Research Universities and the Program for Creating Super Global Universities, the main implementing entities are universities and national research and development corporations. In addition, there are programs aimed at building a research complex or a "super technology cluster" in which local governments, companies, universities, research and development corporations, and other entities go beyond organizational boundaries and make cooperative efforts. According to the characterization of competitive programs by their implementing entities, the type of COE program considered in this Strategic Proposal is one in which the implementing entities are university departments.

The three main policy objectives are promotion of cutting-edge research, advancement of education and research, and innovation-oriented industry-academia cooperation. Various COE programs are implemented for each objective. Needless to say, these programs usually have more than one objective. One should also note that the characterization of programs is not absolute as it is difficult to eliminate subjectivity in the process.

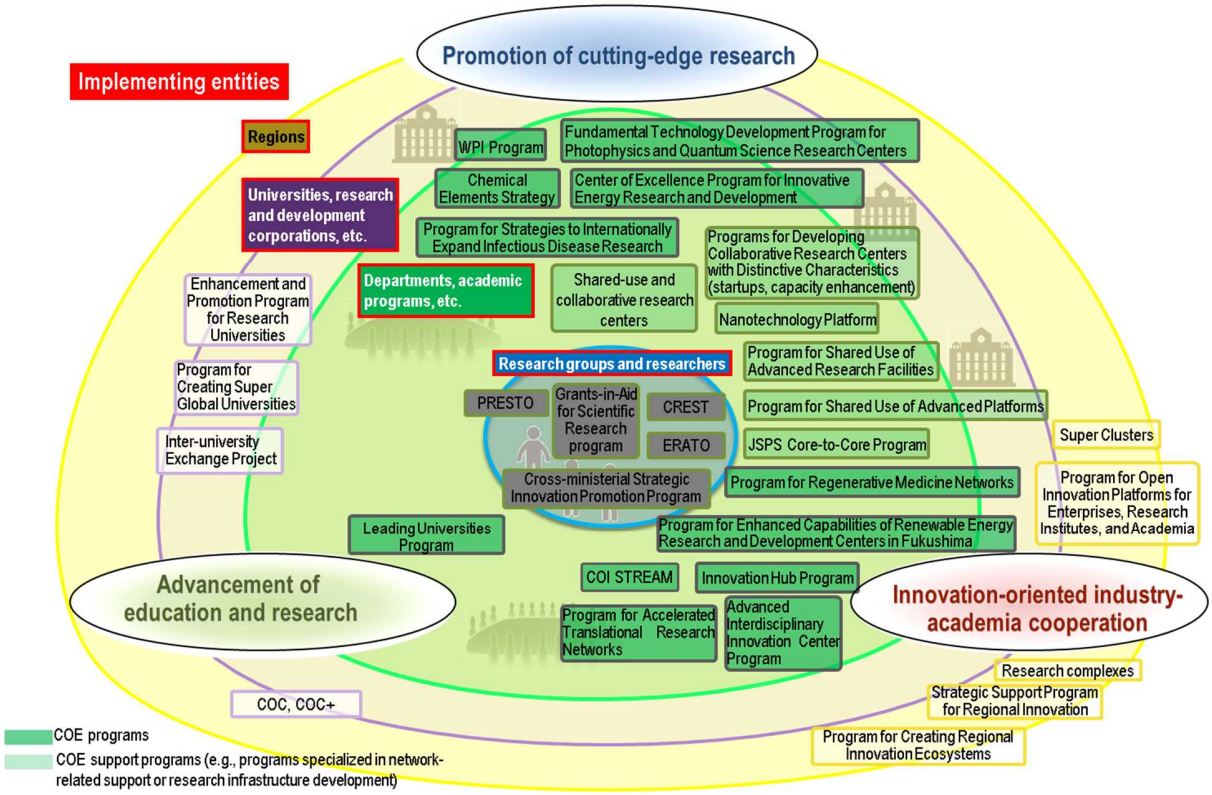


Figure 2.3 Positioning of COE programs

(2) History of COE Programs

In 1992, Japan's plan to create first-rate research centers was officially announced for the first time.[2] As a result, the COE Development Program for national research institutions and the COE Basic Research Funding Program for top researchers were created in 1993 and 1995, respectively. Table 2.1 summarizes the timeline of the implementation of subsequent COE programs.

In 2001, at the same time as the implementation of the Second Science and Technology Basic Plan, the SCOE Program was started to create a productive research and development system as one of the programs supported by the Special Coordination Funds for Promoting Science and Technology. The program publicly solicited applications every year during the following five years, and a total of 13 institutions were created. In the first half of the 2000s, as international competition intensified, training and securing researchers in science and technology came to be considered as an important issue, and in 2001 MEXT put forth a plan for structural reform of universities. The plan included the objective of supporting Japan's top 30 universities, be they public or private, to become world-class universities. Against this backdrop, the 21st Century COE Program was established with a goal of creating world-class top education and research centers. The program had a three-year application period, and a total of 274 institutions were created. In addition to these programs, Program of Founding Research Centers for Emerging and Reemerging Infectious Diseases was created in response to rising public fear of infectious diseases such as severe acute respiratory syndrome (SARS) and highly pathogenic avian influenza.

The Advanced Interdisciplinary Innovation Center Program, the WPI Program, the GCOE Program, the Translational Research Program, and the Strategic Program for Top Regional Researchers were created during the third period of the Science and Technology Basic Plan. Each of the Advanced Interdisciplinary Innovation Center Program, the WPI Program, and the GCOE Program has publicly solicited applications three times (but, the scale of support in the third round of the WPI Program was small). In the Advanced Interdisciplinary Innovation Center Program, support for 9 of the 21 centers in total was suspended based on an interim evaluation conducted three years after the beginning of the support, but this program is the only one, among the all programs considered in this Proposal, in which support was suspended due to such an evaluation. For the GCOE Program, which succeeded the 21st Century COE Program, a total of 140 centers were created throughout a three-year application period, although the number was less than that of the predecessor program. At the same time, field-specific programs were created, including the Fundamental Technology Development Program for Photophysics and Quantum Science Research Centers and the Research and Development Program for Innovative Solar Power Generation Technology. Also, the Japan Initiative for Global Research Network on Infectious Diseases was created as a successor to Program of Founding Research Centers for Emerging and Reemerging Infectious Diseases.

Among the aforementioned programs, the Advanced Interdisciplinary Innovation Center Program, the WPI Program, and the Fundamental Technology Development Program for Photophysics and Quantum Science Research Centers offered a 10-year support period. Around the time of these programs, the support period of COE programs, which had been five years, started to become longer.

With the beginning of the fourth period of the Science and Technology Basic Plan, Leading Universities Program and the Subsidy Program for Top Graduate Schools were created as successors to the GCOE Program. Other programs established around that time were the Research Center Program for the Elements Strategy, the Center of Excellence Program for Innovative Energy Research and Development, the Program for Accelerated Translational Research Networks, the COI STREAM Program, the Program for Enhanced Capabilities of Renewable Energy Research and Development Centers in Fukushima, the Program for

[2] Opinion (January 24, 1992, Council for Science and Technology) to Inquiry No. 18, "On Basic Comprehensive Science and Technology Measures for the New Century"; Opinion of the Science Council, "On Comprehensive Measures to Promote Academic Research for the 21st Century" (July 1992).

Regenerative Medicine Networks, the Program for Strategies to Internationally Expand Infectious Disease Research, and the Innovation Hub Program. Most of these programs aim at innovation in specific fields.

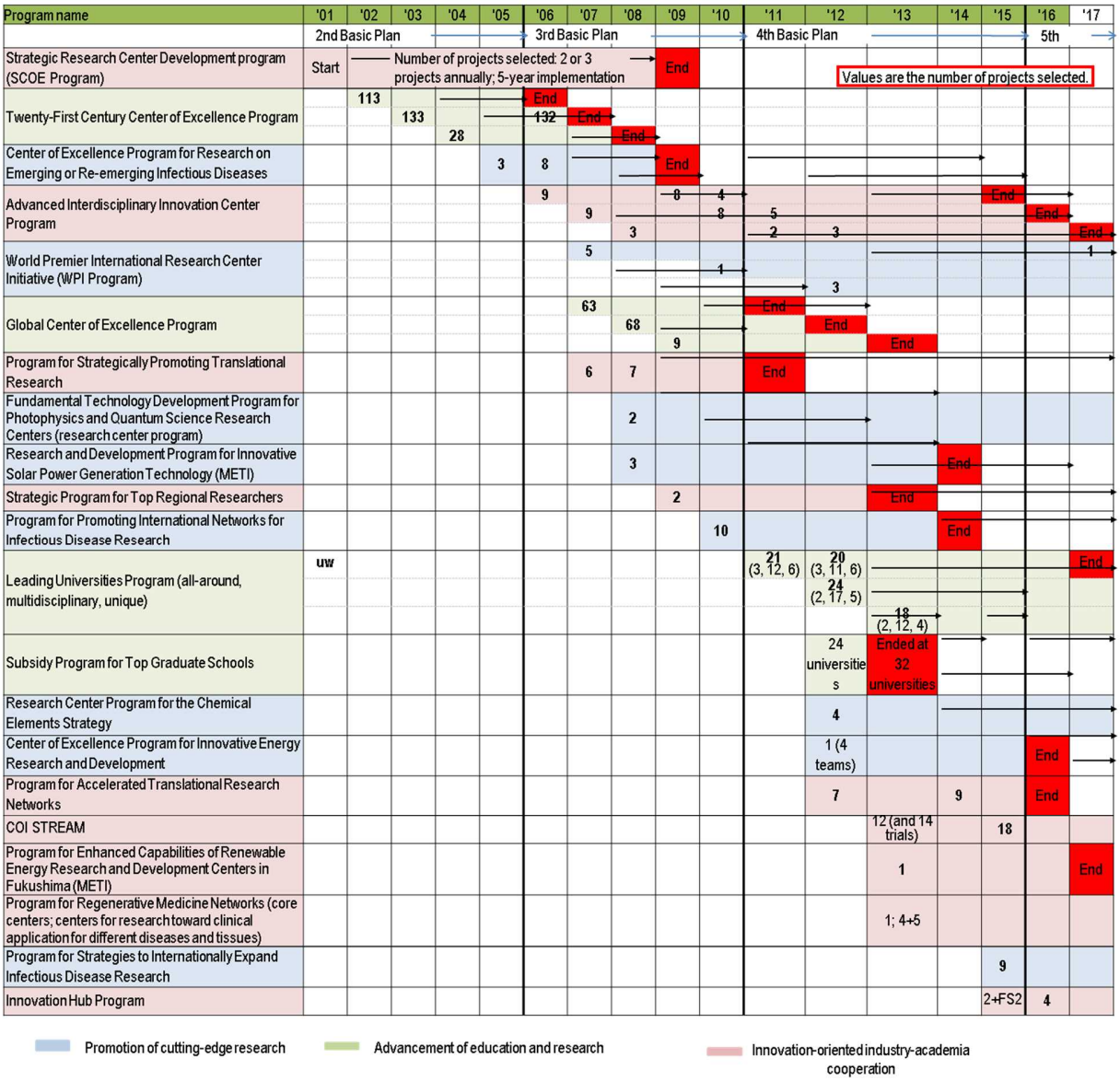


Table 2.1 Timeline of various COE programs

As discussed above, the importance of COEs was officially mentioned in 1992, and various COE programs were started and completed in the following two decades. Against this background, a goal of creating world-class top research centers was included in the Fifth Science and Technology Basic Plan, and discussions, mainly by MEXT, on the role of COE programs rapidly became active in 2016. Therefore, the importance of these programs is expected to increase.

There also have been many programs intended for supporting COEs rather than creating them. These programs include those aimed at building an international or field-specific network and those specialized in developing research infrastructure (Table 2.2). Also, programs for developing collaborative research

centers with distinctive characteristics for Joint Usage/Research Center has been created.[3] Part of the operating funds for Usage/Research Center comes from grants for operating expense distributed to national university corporations (as indicated in Table 2.2). Apart from the programs discussed here, various other programs or research funds have been utilized in operating COEs.

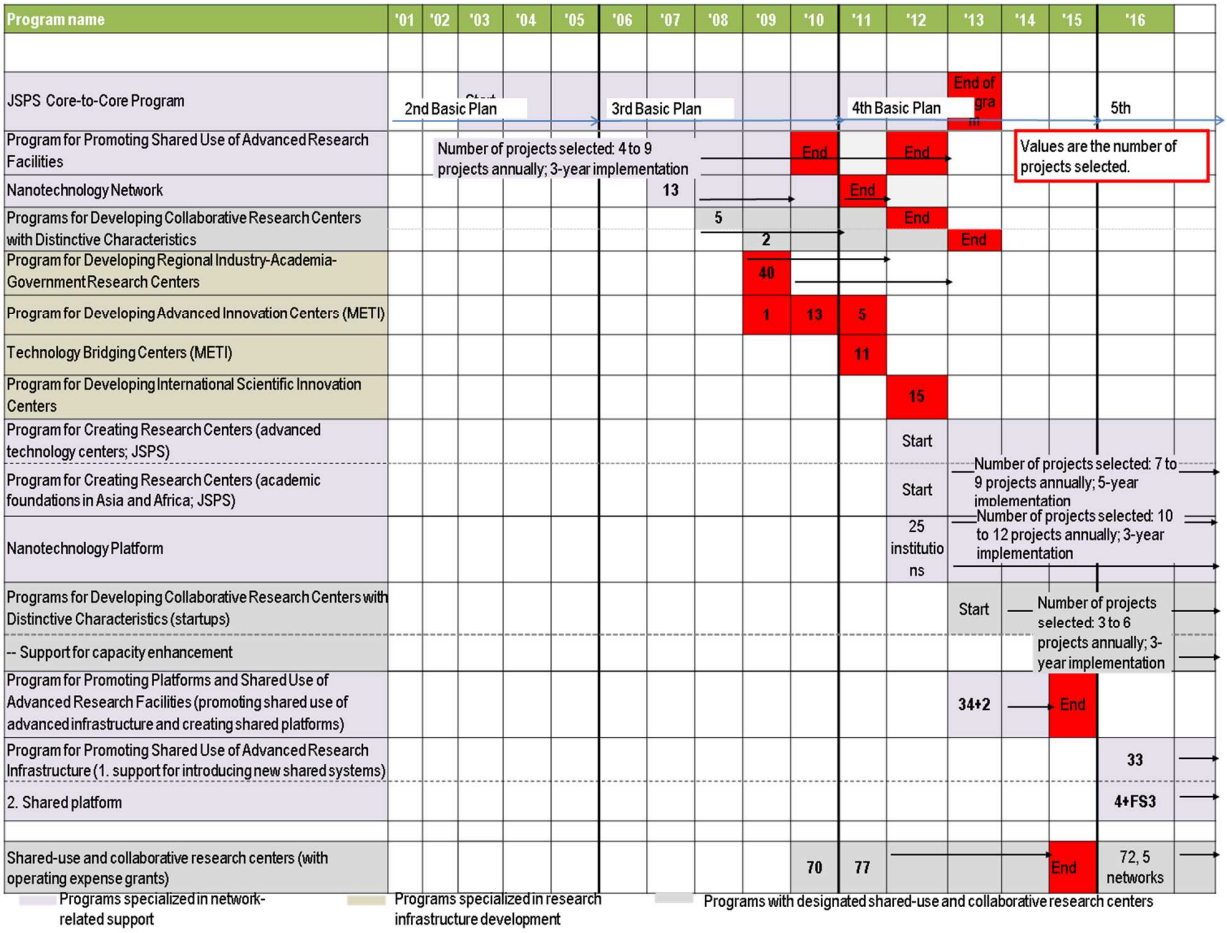


Table 2.2 Timeline of various COE support programs (e.g., programs specialized in network-related support or research infrastructure development)

2.2.2 Analysis of Status of COE Programs

(1) Funding Amounts of COE Programs

To see a trend in the funding amounts of COE programs, the budgets for all of the COE programs for FY 2006 (the first year of the Third Science and Technology Basic Plan), FY 2011 (the first year of the Fourth Plan), and FY 2016 (the first year of the Fifth Plan) are compared in Figure 2.4. The figure shows an increasing trend: The budgets for these years are 48.2 billion yen, 50.1 billion yen, and 57.6 billion yen, respectively.

[3] Usage/Research Centers are those that are certified by the Minister of Education, Culture, Sports, Science and Technology; there were 103 such centers at 51 public and private universities as of April 2016.

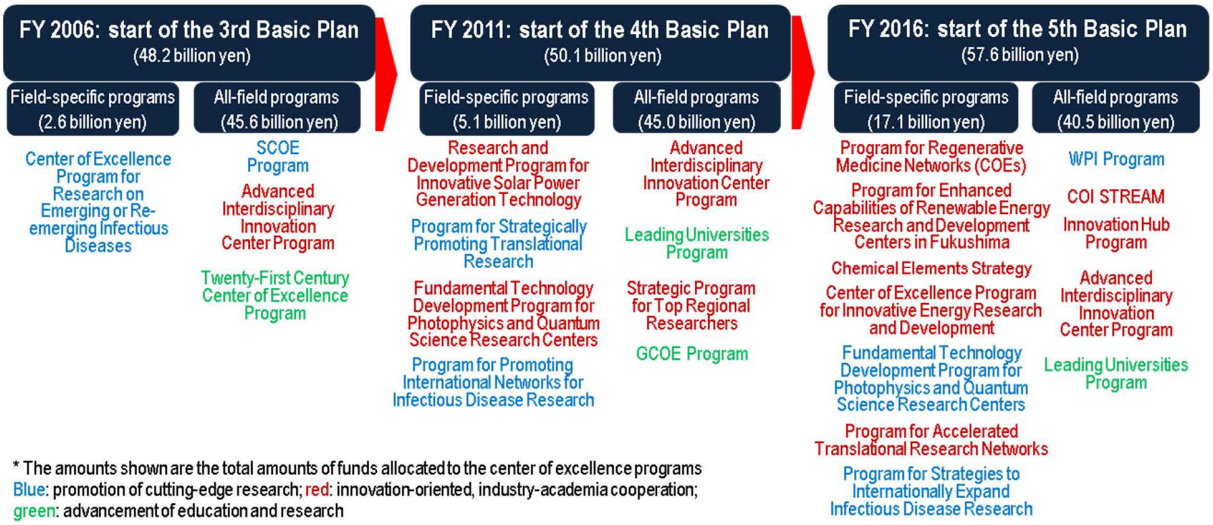
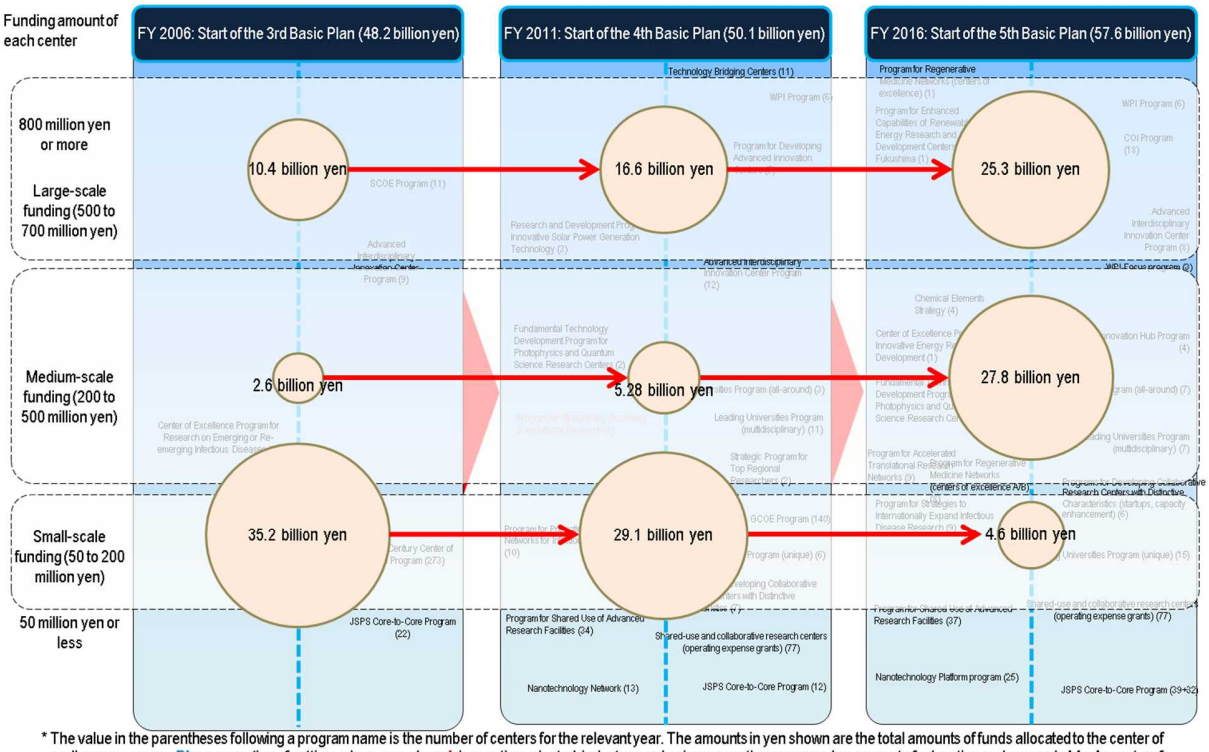


Figure 2.4 Changes in the funding amounts of COE programs

In Figure 2.4, COE programs are also categorized into field-specific programs and all-field programs. As this figure shows, the budget for field-specific programs has increased whereas the budget for all-field programs has decreased.

Figure 2.5 below considers programs offering high, medium, and low levels of financial support per center and shows changes in the total amount of funds allocated to each group. The figure shows that the funds allocated to programs offering a low level of per-center support have decreased, whereas the funds allocated to programs offering medium and high levels of per-center support have increased.

Programs offering large-scale funding support include those supporting fields with policy significance, such as renewable energy and regenerative medicine, and those that are open to all fields, including the WPI Program and the COI STREAM Program. As for programs offering a medium-scale funding, a growing number field-specific programs have been created. Also, the GCOE Program and the Leading Universities Program were created in 2007 and 2011, respectively, as successors to the 21st Century COE Program. After this transition, the total amount of funds allocated to programs offering a medium-scale funding support has increased while that allocated to programs offering a small-scale funding support has decreased. Through a series of such changes in the past decade, the scale of financial support that each center receives under a COE program has increased.



* The value in the parentheses following a program name is the number of centers for the relevant year. The amounts in yen shown are the total amounts of funds allocated to the center of excellence programs. **Blue**: promotion of cutting-edge research; **red**: innovation-oriented, industry-academia cooperation; **green**: advancement of education and research; **black**: center of excellence support program

Figure 2.5 Changes in the total amount of funds available to different types of program

(2) Universities and Other Institutions Selected for COE Programs

It is important to analyze the recipients of funds from COE programs. Figures 2.6, 2.7, and 2.8 show the COEs at each university that were supported by various COE programs as of FY 2006, FY 2011, and FY 2016, respectively. The size of the circles in the figure is roughly proportional to the size of annual funding support from a COE program. In FY 2006, the number of programs was limited, but COEs were widespread in Japan. That is, centers had been created at many regional universities and small and medium-sized universities. As of FY 2011, however, the number of programs had increased while the number of institutions with one or more COEs had decreased. Today, this trend of COEs being concentrated at a small number of institutions has become more apparent.

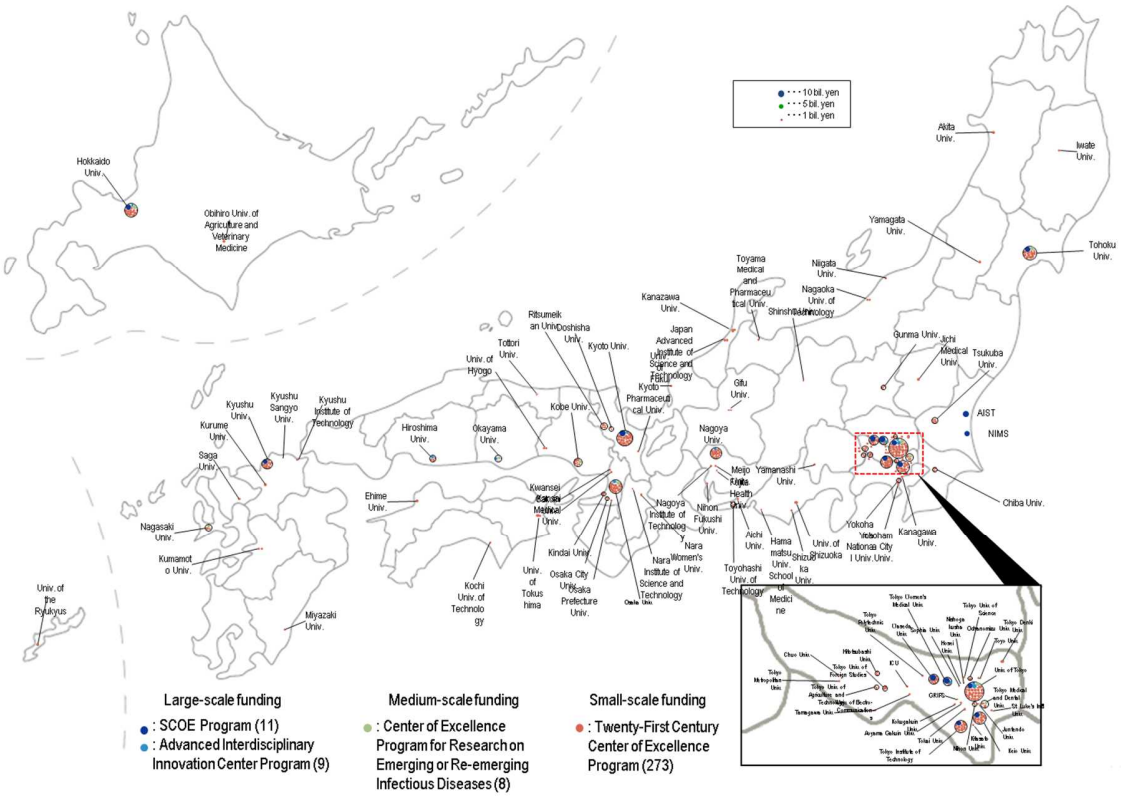


Figure 2.6 Universities and other institutions selected for COE programs (FY 2006)

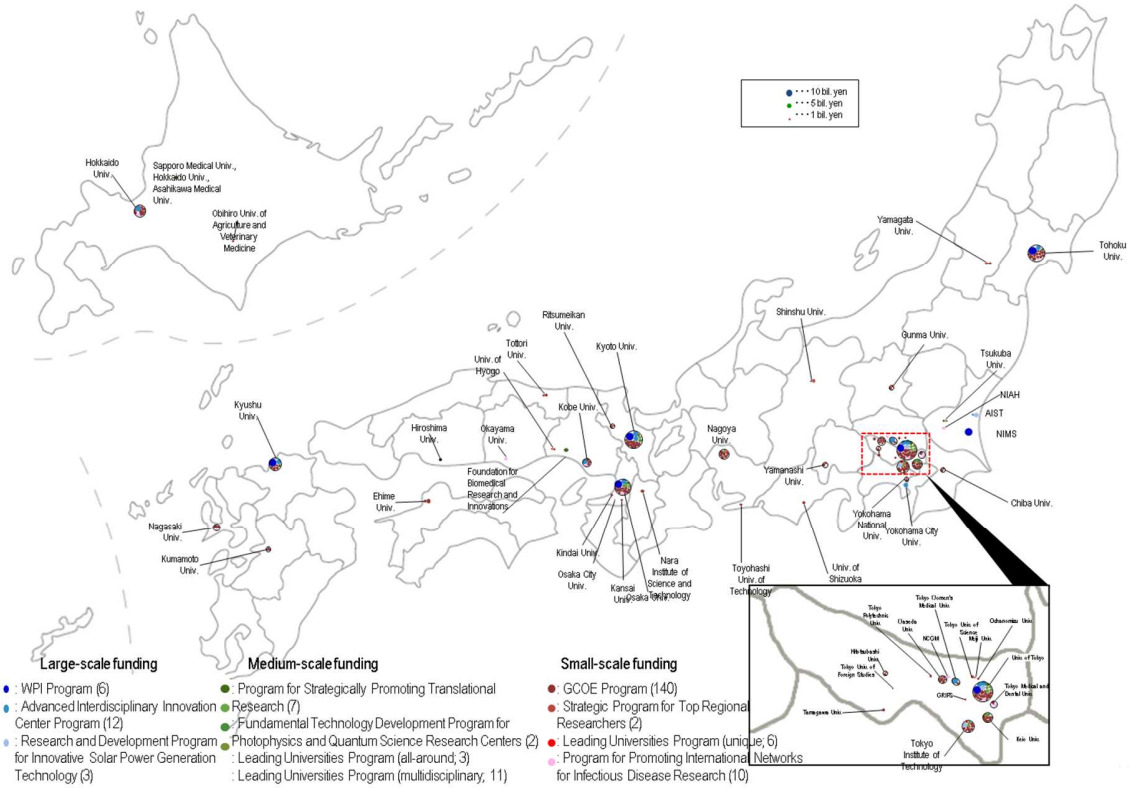


Figure 2.7 Universities and other institutions selected for COE programs (FY 2011)

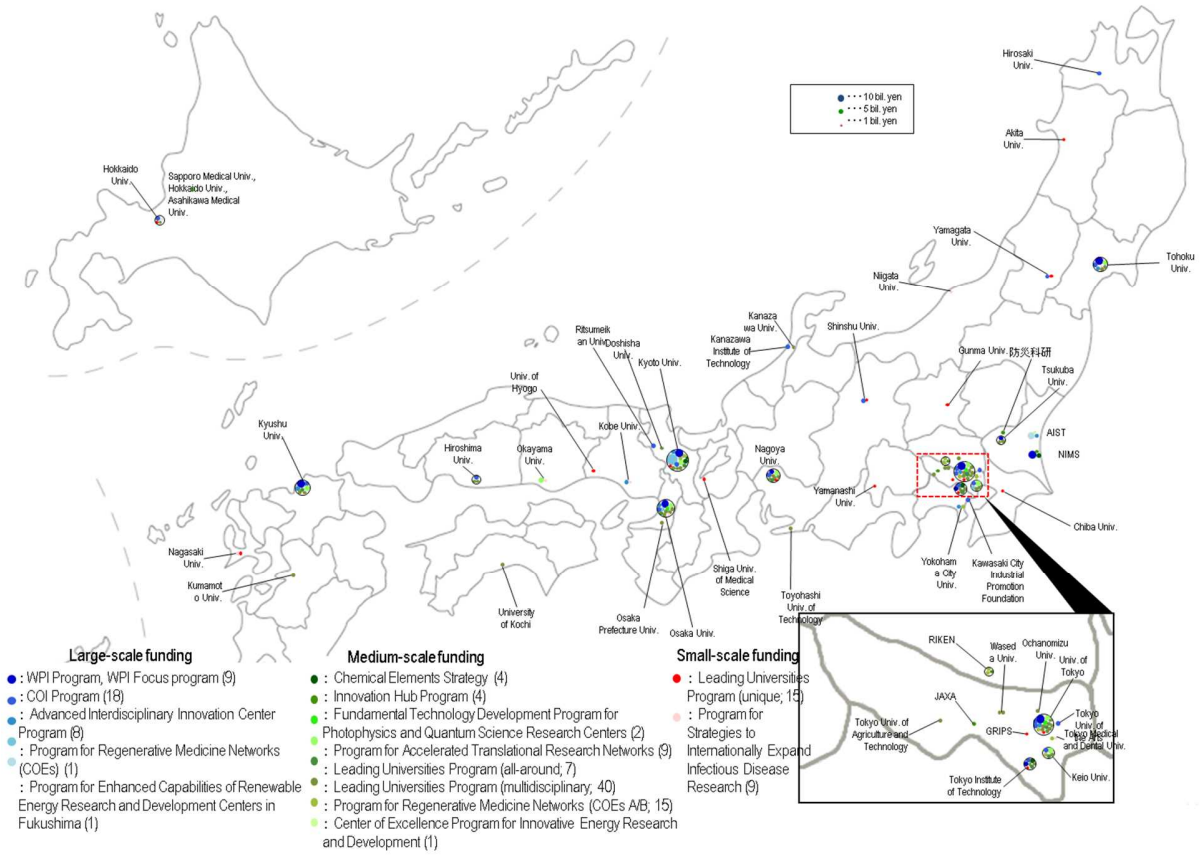
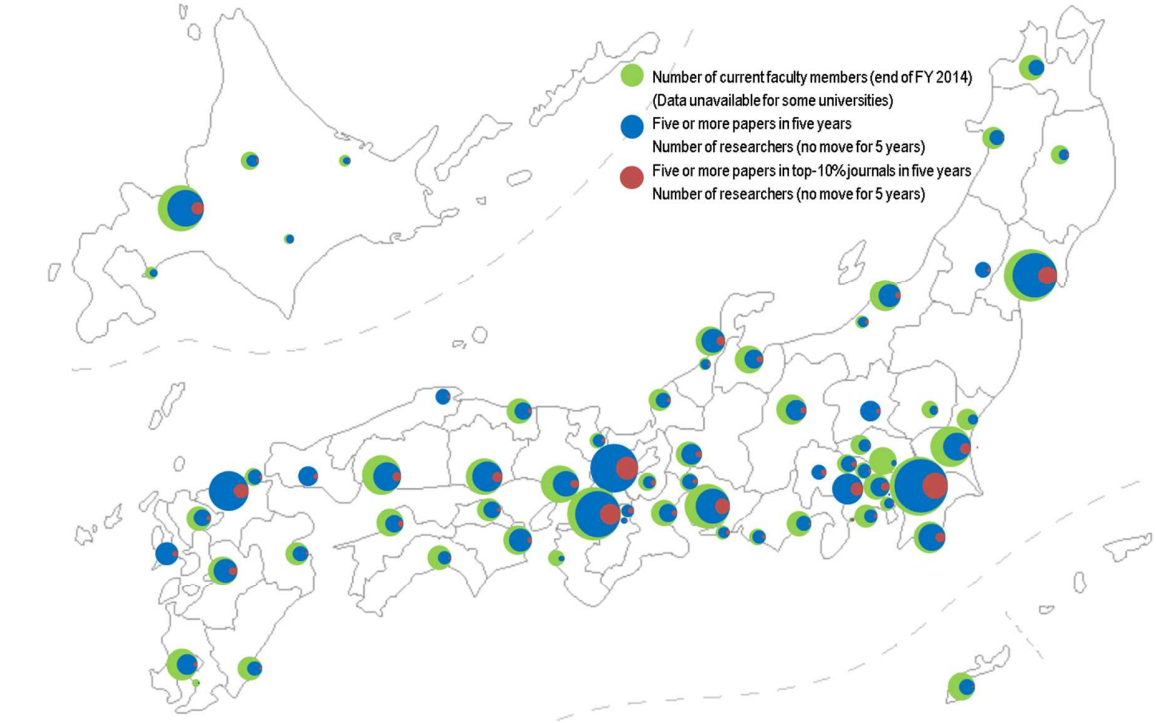


Figure 2.8 Universities and other institutions selected for COE programs (FY 2016)

(3) Distribution of High-Quality Researchers and Presence of COEs at Universities

The argument can be made that the concentration of COEs at a small number of universities and other institutions is attributable to these institutions' excellent research capacities. The question then arises as to how the distribution of COEs in Japan is related to the distribution of research capacities in the country. Although accurately measuring the research capability of universities and other institutions is quite difficult, in this section, researchers who have published more than a certain number of papers over a specific period are considered as active researchers, and the number of such researchers at a university is treated as an indicator of its research capability. As a matter of course, the research capability of a university cannot be measured based solely on the number of published papers, and such measurement involves issues arising from differences among various fields and incompleteness of databases. Yet, the fact remains that the number of papers and the number of citations are some of the metrics used in measuring research capability in world university rankings or used by government councils. In this section, the number and quality of papers published by researchers affiliated with a university is used as an indicator of its research capability.

Figure 2.9 shows, on a map of Japan, the number of researchers who published five or more papers in five years, the number of researchers who published five or more papers in top-10% journals in five years, and the number of current faculty members for each national university. As the figure shows, the number of researchers who published five or more papers in five years varies with attributes of each university, but almost all national universities have some such researchers. In contrast, researchers who published five or more papers in top-10% journals in five years tend to be concentrated at certain large research universities. In this section, these researchers with five or more papers published in top-10% journals in five years are referred to as high-quality researchers.



Note 1: Data on the number of researchers were obtained by counting the number of papers published in 2006 to 2010 that are included in the Scopus database. The period considered is different from the year used for the data on the number of current faculty members. Note 2: "Education-oriented universities" and "humanities universities" (as defined for the former categorization of national universities by the MEXT Higher Education Bureau), all of which have less than 25 researchers with five or more published papers in five years, are excluded. Note 3: Researchers who moved from one institution to another during the five years considered are excluded (in an attempt to avoid double counting and exclude postdoctoral students and graduate students). Note 4: Data from the Japanese College and University Portraits are used to obtain the number of current faculty members. For some universities, specially appointed, temporary faculty members are included in the number of full-time faculty members listed in the Portraits. Also, no faculty data are available for some universities as of the end of FY 2014. Note 5: Attention should be given to the fact that, as described in Notes 1 to 4 above, the data used for the figure are limited in terms of comprehensiveness and accuracy and therefore the information in the figure should be interpreted with care. There is no particular rationale for using the threshold of five or more papers in five years, and the distribution of papers or coauthors across universities varies from one field to another. Also, it is essential to take into account the fact that characteristics unique to each university (its departmental structure, the number of temporary and part-time faculty members and postdoctoral students, etc.) affect the number of researchers at the university.

Figure 2.9 Distribution of researchers across universities

The relationship between the number of high-quality researchers at a university and its COEs is discussed next. Figure 2.10 shows the number of high-quality researchers (those with five or more papers published in top-10% journals) at a university on the horizontal axis and the total amount of financial support provided by COE programs to a university on the vertical axis. The solid green line, the dashed green line, and the dashed light green line indicate the total amount of financial support for FY 2006, FY 2011, and FY 2016, respectively. The yellow lines indicate the amount of the Grants-in-Aid for Scientific Research received by a university. The amount of the Grants-in-Aid for Scientific Research seems, for the most part, positively correlated with the number of high-quality researchers. The total amount of financial support provided by COE programs is substantially lower for universities with less than 145 high-quality researchers.

Also, a comparison of a group of universities with 145 or more high-quality researchers and a group of universities with less than 145 high-quality researchers shows that the percentage of all funds from COE programs that were received by the group with more high-quality researchers was 61%in FY 2006 and 70% in FY 2016. These results imply that funds from COE programs are concentrated at certain universities.

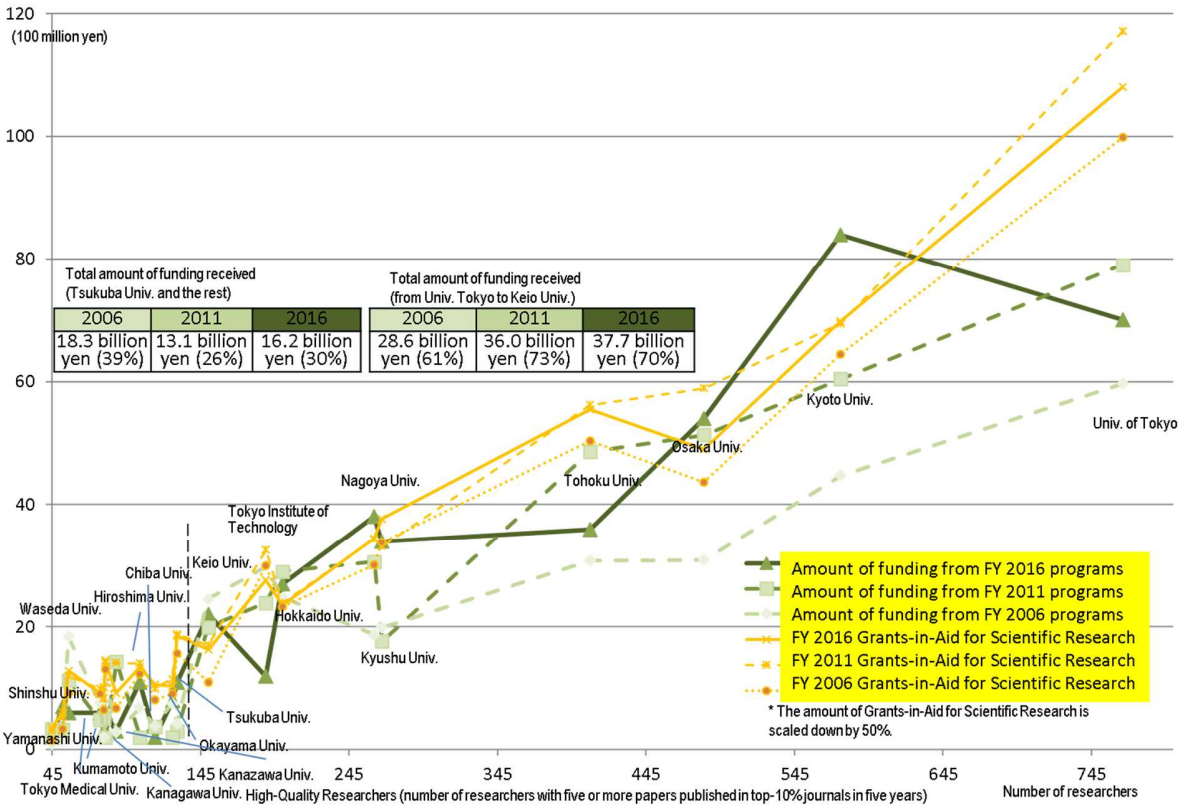


Figure 2.10 Number of high-quality researchers and total amount of support from COE programs

(4) Building Networks

(i) Types and Purposes of Networks

While COE programs aim to create first-rate education and research centers, these centers may be able to further strengthen their capabilities by building networks. The constituents of networks that are related to COE programs include overseas and domestic universities, national research and development corporations, companies, and research institutes. There are mainly two types of networks. One is the interorganizational network, which can be created by a COE acting as a coordinator. For example, under the Program for Accelerated Translational Research Networks, the center at Tohoku University coordinates a network of nine centers created by the program. Another type is the intraorganizational network which can be created with a COE acting as a hub, as in the case of a COE created by the WPI Program and its satellite centers (Figure 2.11).

A network created by a COE is considered to have the following three main purposes. The first purpose is large-scale collaborative research: A network as a whole aims to build first-rate research capacity, taking advantage of each center's unique strengths. The second purpose is shared research infrastructure: Research facilities and equipment, research-related information, and databases are effectively utilized through shared use and shared services. The third purpose is development, securing, and movement of human resources: Each COE builds an optimal educational and research environment through maximum utilization of researchers (faculty members, university research administrators, etc.). Examples include cross-appointments, lectures delivered at various centers, and double degree programs within a network.

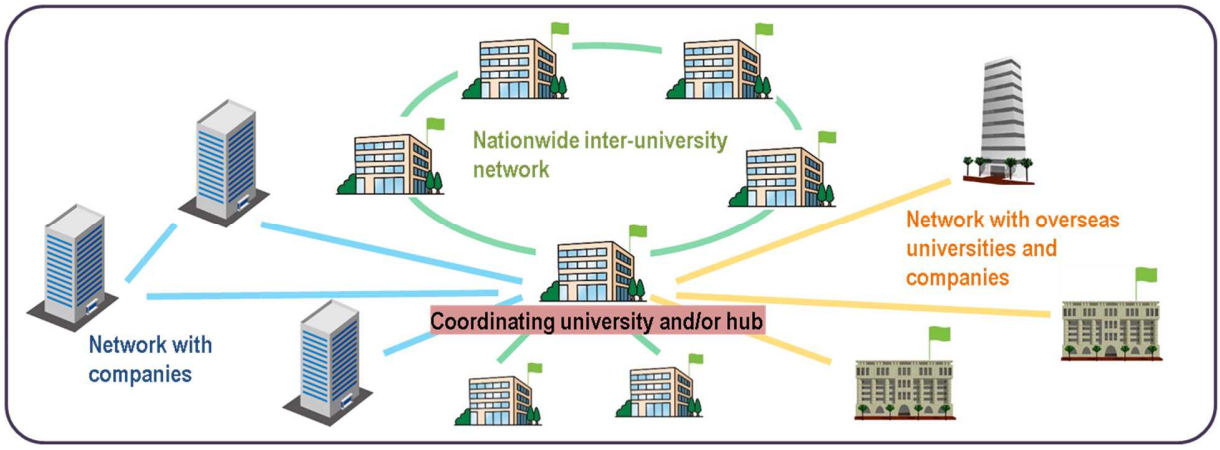


Figure 2.11 Illustration of a network

(ii) Creation of Networks under COE Programs

Figure 2.12 focuses on the aforementioned three main purposes of networks and summarizes relevant COE programs and other programs that have been implemented. There have been many COE programs involving large-scale collaborative research among centers or between a center and companies. Some programs have been created for shared use of research infrastructure, including the Nanotechnology Platform program. In contrast, efforts to create a network are relatively weak in programs that emphasize development, securing, and movement of human resources, and some programs make few such efforts.

Figure 2.12 was prepared with as much consideration as possible given to the application requirements of each program and the circumstances of COEs. It should be noted, however, that the three main purposes of networks are not mutually exclusive, that network-related efforts vary from one center to another, and therefore that the position of each program in the figure is subjective.

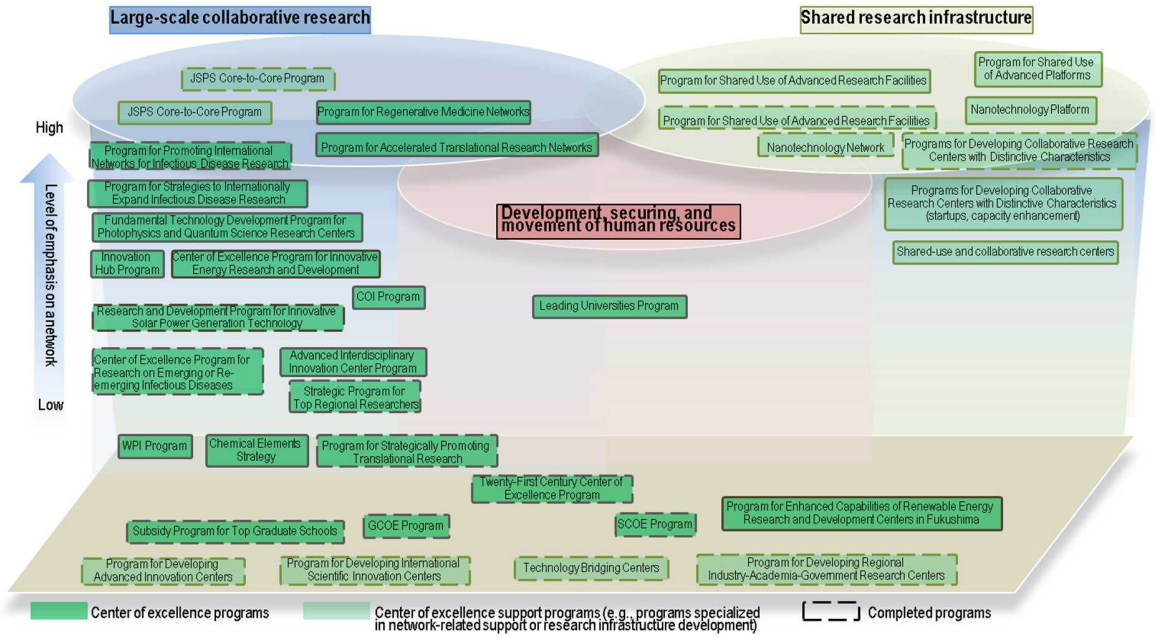


Figure 2.12 Emphasis on network formation

2.2.3 Issues Involving COE Programs

In addition to the analysis of the status of COE programs discussed above, interviews were conducted with a wide range of people involved in COEs, their host institutions, and government agencies.[4] Based on these interviews, this Strategic Proposal summarizes the issues to be examined in considering future developments of COE programs. The following discussion describes the concrete content and effects of (1) fundamental national-level issues, (2) issues related to centers' host institutions, and (3) issues directly related to centers' activities.

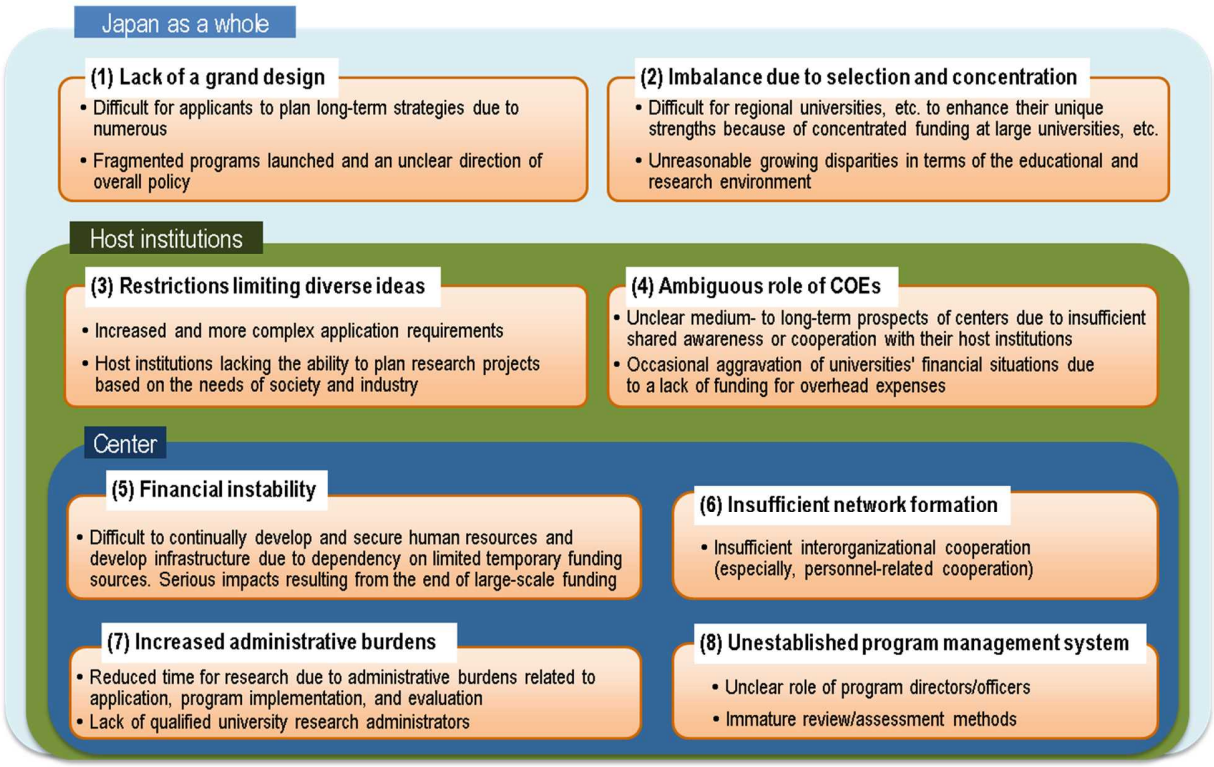


Figure 2.13 Major issues involving COE programs

(1) Fundamental national-level issues involving COE programs include a lack of a grand design that indicates the direction of the programs as a whole. As shown in the timeline of various COE programs (Table 2.2), the creation and termination of these programs have been repeated in the past dozen years or so. They have not necessarily had a long-term strategy. Also, there are various bureaus, divisions, and offices of government ministries that are in charge of COE programs, and they have not necessarily made sufficient efforts in inter-program cooperation.

Numerous such fragmented programs have been launched in an unsystematic manner. The effect of this is complex and has made it difficult for universities and other institutions to plan relevant long-term strategies, which has consequently become a burden on these institutions. As shown in Figures 2.6 to 2.8 (universities and other institutions selected for COE programs), some effects of COEs being concentrated at large universities have emerged. One major consequence is that small and medium-sized universities and other institutions face difficulties not only in developing their unique strengths, but also in building a

[4] See in Appendix 1, Section 2 (Interviews).

sufficient infrastructure for education and research, leading to disparities among universities in terms of the educational environment. The problem that program implementations and research funds from the national government are concentrated at a small number of universities is not limited to COE programs. This is a serious problem that concerns competitive funding programs in general and is a topic considered in discussions on research funding.

(2) Issues related to centers' host institutions include the harm caused by the ambiguous role of COEs at their host institutions. This ambiguity has made it difficult to develop COEs with a view toward their post-program operation and to train and secure human resources and develop research infrastructure in a sustained manner. The ambiguity also caused a more fundamental problem. That is, some centers continue to exist inactively in various forms at their host institutions, rigidifying the operation of educational and research organizations of the host institutions, which should be engaging in advanced education and research.

Given these issues, host institutions should foresee post-program conditions at the time of application and should play a leading role in examining the operational system of COEs. In reality, however, it may be difficult for host institutions to make future plans for the COEs that they host because the institutions' policies can change during the program period which, ranges from several years to as many as 10 years. It is also possible that universities consider the operation of a COE created through a COE program as a limited-time activity. In addition, if programs do not cover overhead expenses, implementing them can become a burden for universities. These factors make it difficult for COEs to sufficiently cooperate with their host institutions, which consequently makes the centers' role at their host institutions unclear.

Besides the aforementioned issues, COE programs that have a variety of application requirements have created some problems. Increased and more complex application requirements can potentially put restrictions on the faculty's proactive plans, the range of education and research, and universities' original efforts. In some cases, the application to a program requires universities and other institutions to submit a plan for a COE that takes into account the trends in society and industry and their needs. It has become apparent, however, that these universities and institutions may lack the system and capacity to create such a plan. These issues facing host institutions are strongly related to not only the creation of COEs, but also universities' overall strategic design and management capacity. Therefore, host institutions need to urgently respond to these issues.

(3) Issues directly related to centers' activities include financial instability in the operation of centers. If a COE relies on its parent program for operating funds, it faces operational difficulties after the end of the program period, which creates obstacles to sustained human resource development and infrastructure development. Particularly, in the case of COEs that receive a large amount of funds from their parent programs, they often depend on limited-time funding at a level exceeding the amount of funds that their host institutions can provide. Therefore, the end of funding at the time of program completion significantly impacts the operation of such centers.

Besides the financial issues involving the operation of a COE, there have been issues arising from insufficient cooperation between centers or within the same field. Today, as the scale of research expands and the number of stakeholders increases, it may be difficult for a COE to secure on its own the human resources, facilities, and equipment that are necessary for educational and research activities. Cooperation therefore has become increasingly important. Also, from the standpoint of the flexible movement of human resources, COE programs need to promote the creation of networks.

Another issue is that administrative burdens related to applications, program implementation, and evaluation that fall on researchers have reduced their time for research. The results of a survey conducted by the National Institute of Science and Technology Policy indicate a decline in time for research and an increasing number of administrative tasks related to winning competition-based funding and completing

evaluations as one factor.[5] A further issue is that a program management system that has a program officer or director and handles review and evaluation processes has not been established. These issues that are related to program management and administrative burdens on researchers exist in not only COE programs, but also competitive programs in general. However, details of these issues are not discussed in this Strategic Proposal.

2.3 Role and Significance of This Strategic Proposal

2.3.1 Policy-Related Role of This Strategic Proposal

As discussed above, many of the COE programs have a total budget of 1 to 2 billion yen per year, and their implementation period is 5 to 10 years. Since these programs are large and long-term, the policy impact of COE programs is particularly significant among Japan's public funding programs. Various government policy documents therefore have mentioned the significance of COE programs. Among recent such documents, "The 2016 General Strategy for Science and Technology Innovation" (approved by the Cabinet on May 24, 2016) discusses the necessity of creating world-class top research centers in order to promote (strategically and as demanded) basic research as a source of innovation. Also, "The Japan Revitalization Strategy" (revised for 2016; approved by the Cabinet on June 2, 2016) explicitly states that, from the standpoint of advancing regional innovation, cutting-edge research should be promoted mainly at COEs at regional universities that potentially have a high level of research capacity.

As these government plans have been presented, MEXT and other agencies have recently intensified discussions on COE programs. With regard to the WPI Program, the application process for creating new centers and the program's long-term plan were examined. This future plan for the WPI Program touched on the need to examine a mechanism to extend efforts made and know-how obtained at a COE to its host institution and other organizations and a center's post-program role that takes into account restructuring with a dual support system consisting of base funding and competition-based funding. After such examinations, the application period for the WPI Program began in February 2017.

The future development of the Leading Universities Program is also being discussed. Such discussions include proposals that graduate students should participate as researchers in industry-academia collaborative research and that efforts should be made to establish and continue the program by actively seeking funding from various sources including domestic and foreign companies.[6] Based on the result of these discussions, a new program is planned to be launched in FY 2018.

MEXT set up two venues of discussion concerning COE programs. One is the Round Table on the Role of Research Centers in Strengthening Research Capacity which was established at the MEXT Research Promotion Bureau in September 2016 and comprehensively examines the role of policies pertaining to COEs. This round table was set up in response to the Academic Subcommittee of the MEXT Council for Science and Technology having pointed out the importance of reforming and strengthening policies pertaining to COEs from the standpoint of enhanced academic research and research diversity.[7] The first round-table meeting was held at the end of September 2016, and a certain direction of future implementation measures for COE programs is planned to be presented in FY 2018.

The other venue of discussion is the Task Force on Strengthening Basic Scientific Capacity that was set up within MEXT in November 2016 in response to the Nobel Prize in Physiology or Medicine being

[5] National Institute of Science and Technology Policy, "A Report on the Survey on General Public Awareness of the State of Science and Technology (2015 NISTEP Fixed-Point Survey)," NISTEP Report No. 166, March 2015.
[6] Expert Council on First-Rate Graduate Schools (Tentative Term), "On the Basic Idea Concerning the Plan for First-Rate Graduate Schools (Tentative Term)," April 2016.
[7] Document 4-5 for the 62nd Academic Subcommittee meeting: Major opinions from committee members in the previous (61st) meeting. Document 5-2 for the 63rd Academic Subcommittee meeting: Major opinions from the previous meetings.

awarded to Yoshinori Ohsumi, Honorary Professor at the Tokyo Institute of Technology. The task force examines a wide range of measures for strengthening basic scientific capacity, and one of the main issues examined by the task force concerns creation of research centers for strengthening research capacity. In passing, the results of the examination by the task force were organized into a document in March 2017 and are planned to be reflected in budgets for FY 2018.

As described above, government discussions on the role of creating COEs has intensified since the beginning of FY 2016, and a favorable environment for advancing substantial efforts is being formed. Further relevant examinations will therefore take place in the future. This Strategic Proposal shows, in a wide context of science and technology innovation policy and higher education policy, perspectives and measures that are considered important in the government's attempt to concretize the results of its examinations.

2.3.2 Significance of COE Programs from the Perspective of National University Reform

Section 2.1.2 (Status of Universities and Other Institutions in Japan) discusses how MEXT has strongly promoted national university reform in recent years and how, based on that promotion, universities have made efforts toward internationalization of various activities, integration of different fields, industry-academia cooperation, and educational reform.

In this context, COE programs can be regarded as a driver of these efforts made by universities. As discussed below, at universities, COEs are not their core organizations, but provisional organizations that engage in cutting-edge education and research, pursue universities' potential in education and research, and contribute to enhancing universities' strengths. COEs also play a role in revitalizing educational and research organizations of their host institutions, whose operation can become rigidified, and in leading organizational reform. This role of COEs shows that COE programs are quite significant in effectively advancing university reform.

3. Concrete Content of Proposals

Taking into account today's science and technology innovation policy, trends in science and technology, and the status of universities and other institutions, this Strategic Proposal make recommendations regarding the future development of COE programs with consideration given to the current status and issues of Japan's COEs and the positive results produced by them.

As discussed in Section 2.1 (Changing Circumstances of Japan's Policy on COEs), the major circumstances of COE programs include the fact that there have been rapid developments in science and technology in recent years and the problem that the total size of science and technology-related budgets has changed little and is not expected to increase drastically in the future, and the need for COE programs to respond to social issues in such a situation. In addition, universities face tight finances, so an important challenge for them is to deal with the government's plan for university reform and engage in their own activities.

COE programs have been implemented in the aforementioned circumstances; have created large, medium-sized, and small centers at universities in the last 15 years or so; have produced preeminent educational and research results; have improved organizational systems and awareness at the host institutions of COEs; and have contributed to building universities' unique strengths. In contrast to such wide range positive results, various issues have also emerged as discussed in Section 2.2.3 (Issues Involving COE Programs), and some of the COEs, which continue to exist in various forms and sizes, are not necessarily conducting active education and research.

This Strategic Proposal therefore puts forward the following seven proposals that take into account the status and issues of COEs.

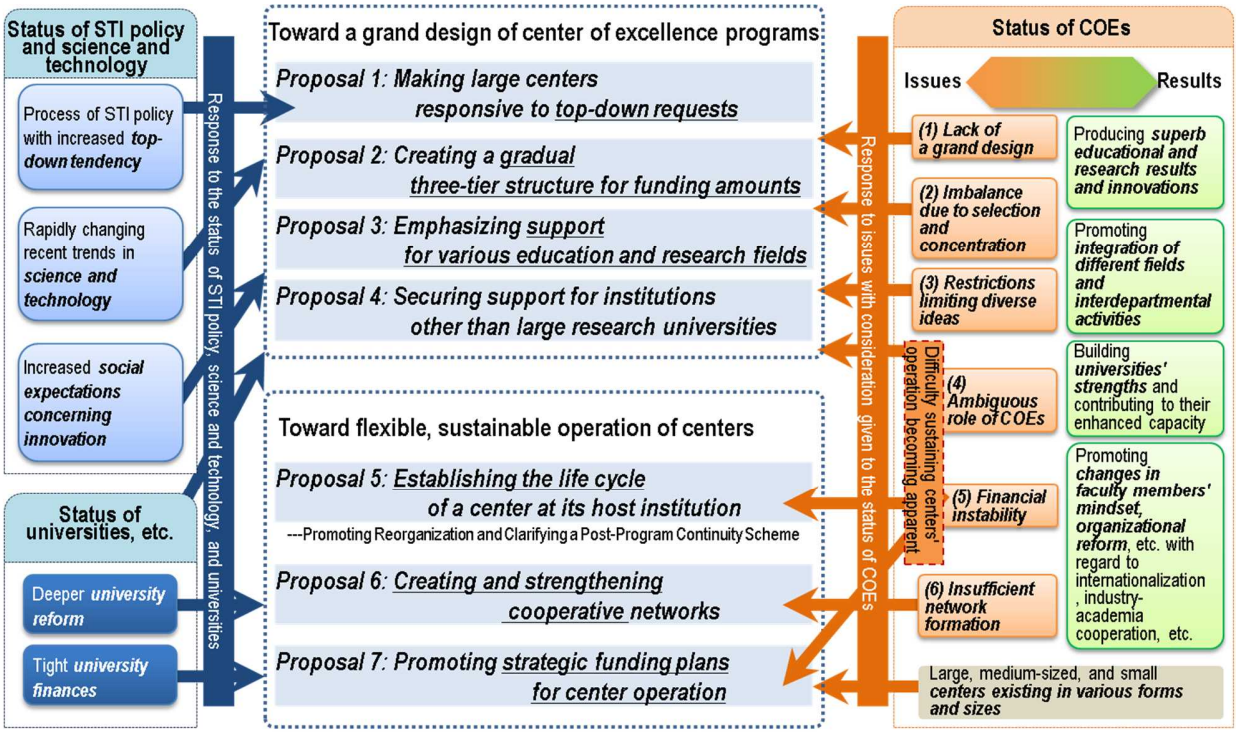


Figure 3.1 Content and background of the proposals

3.1 Toward a Grand Design of COE Programs

The following are four proposals aimed for a grand design of COE programs which takes into account the objectives of centers and the current circumstances of universities.

Proposal 1: Making Large-scale Centers Responsive to Top-Down Requests

For creating large-scale centers, future COE programs should provide support for a limited number of specific fields selected in accordance with social needs. There have been numerous COE programs aiming to create large-scale centers with annual support of 500 million yen or more. However, it is difficult for these centers to secure the same level of funding on their own at the end of the program period and continue their operation. At the same time, COEs need to respond promptly to rapid advancements in science and technology and relevant social demands, quickly secure necessary human resources, facilities, and equipment, and handle top-down requests.

The Program for Regenerative Medicine Networks is an example of programs for creating large-scale centers that respond promptly to various policy considerations. As rapid technological advances and innovation in regenerative medicine intensify international competition in the field, the program was started because of Japan's need to accelerate efforts to commercialize this technology and lead the world in this field. Currently, the Center for iPS Cell Research at Kyoto University has been selected as a center for iPS cell research and has received annual funding of 2 billion yen.

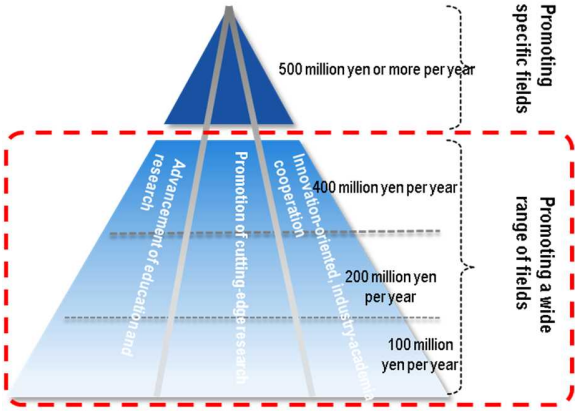


Figure 3.2 Framework for COE programs

Proposal 2: Creating a Gradual Three-Tier Structure for Funding Amounts

With regard to medium-sized and small COEs receiving annual support of 400 million yen or less, it is important to consistently have programs aimed at providing low to medium-scale funding. To this end, this Strategic Proposal suggests a gradual three-tier structure for funding amounts (approximately 400 million, 200 million, and 100 million yen per center annually), taking into account the objectives of COE programs and the current circumstances of universities (Figure 3.2).

The 400-million-yen programs and 200-million-yen programs should support centers that are specialized in a wide range of fields and aim to conduct world-class research, whereas the 100-million-yen programs should support centers that have potential and aim to conduct high-quality education and research in the future in a wider range of fields. It is essential for stakeholders to share a vision of COEs that can be built with each funding and to examine each center's funding scale according to policy objectives.

Issues involving COE programs include the difficulty of continuing to operate a center after the end of the program period. The causes of the issue vary from one center to another, and one of them is the difficulty

for the host institutions to secure operating funds for centers at the end of the program period. It is therefore important to ensure that the funding scale of COEs is comparable to the funding scale that the host institutions can provide to the centers.

This raises the question of how much funds can be provided by host institutions to their COEs. Although it is not easy to show objective data that explicitly provide an answer to this question, comments from people associated with COEs, which were obtained during interviews held at universities, are useful. These comments imply that universities that receive 40 billion yen or more, 15 billion yen to 39.9 billion yen, and 14.9 billion yen or less in grants for operating expenses can receive approximately 500 million yen, 100 to 300 million yen, and 50 million yen, respectively. While situations vary from one university to the next, it seems that about 1% of the operating expense grant corresponds to the maximum level of funding that universities can provide for the operation of a COE. It should be noted that these comments are subjective and constitute a limited sample, but they are data that indicate universities' needs.

Future COE programs should carefully respond to the particular circumstances of host institutions, taking into account the fact that the appropriate scale of support varies according to differences in the financial bases of universities.

Amount of annual support to a center	Comments obtained at the time of interviews
Funding amount class 1 (500 million yen or more)	- With 800 to 900 million yen, we could have created a better center. That level of funding changes the attitudes of all members; 1 to 1.3 billion yen may be too much. (As 300 million yen was distributed when the WPI Program started, it would have been difficult to create a world-class center.) - Since the funding amount was so large, the impact of the end of the program seems significant. It may be appropriate to create a center with about 500 million yen as in the case of the WPI Focus program. It is not that large funding always works. A single department can absorb a 500-million-yen center. - With three 500- to 600-million-yen centers at a university it is possible to be internationally competitive.
Funding amount class 2 (100 million to 400 million yen)	- It is difficult for a center at a regional university to gather 20 PIs, and as the number of PIs increases, the center loses its focus. Supporting a well-focused internationally competitive medium-sized center with about 300 to 400 million yen could enable it to take advantage of its host university's strengths. - A funding amount of 200 to 500 million yen would significantly help a research center. Given the lack of research equipment, a research center will need a certain level of funding. - I think 200 to 300 million yen is enough. If a university takes on programs beyond its capacity, it will be hard for the university to absorb them after the end of the program period. - Support of 100 to 200 million yen would be sufficient. When a center is launched, a large amount of funds are needed to set up its facility and invite world-renowned researchers, but not as much as 1 billion yen.
Funding amount class 3 (less than 100 million yen)	- With a funding amount of around 100 million yen, a center can expand. For example, if a center with 10 researchers can hire 2 or 3 additional researchers, it will become more active. - With only a small-scale center of excellence program (about 100 million yen), it is difficult to create an internationally competitive center. Such a small scale of funding would be effective for a feasibility study and expansion/enhancement of a center. - A funding amount of around 100 million yen is sufficient for an education and research center aiming at system reform. - If there was a program that provided a long-term support (about 10 years, 50 million yen) to a center working on a specific research topic, many regional universities would be interested in it.

Figure 3.3 Comments obtained during interviews on the COE funding amounts

Proposal 3: Emphasizing Support for Various Education and Research Fields

In recent years, trends in science and technology have changed rapidly, and social and industrial needs have extended in various areas. In this context, COE programs should aim to strengthen the foundation in various education and research fields and emphasize providing support for a wide range of fields. To diversify research fields, COE programs should solicit and select applications in a manner to maintain balance among different fields by setting general categories as the need arises, such as the humanities, science and engineering, the life sciences and medicine, and interdisciplinary fields. For example, the 21st Century COE Program set categories for its FY 2002 application—the life sciences, the humanities, interdisciplinary or new fields, chemistry and materials science, and electrical and electronic engineering and information—and thus had a program design that took into account the fields of the selected centers. Daily efforts to strengthen capacities in various education and research fields and build a foundation in these fields make it possible to quickly respond to emerging developments in science and technology and social needs.

Also, it has been pointed out that besides the need to specify the field, various complex application requirements can potentially put restrictions on the proactive plans of faculty for a COE. For this reason, COE programs should simplify application requirements as much as possible and support universities' own efforts and flexible planning for COEs.

Based on Proposals 1 to 3, Figure 3.4 illustrates an overall structure of future COE programs. This illustration is just one example, but it is important for people at government agencies and universities who are associated with COE programs to have shared awareness of such an overall structure. With such common information, they should continue systematizing the operation of COE programs through repeated discussions as existing programs end or get revised.

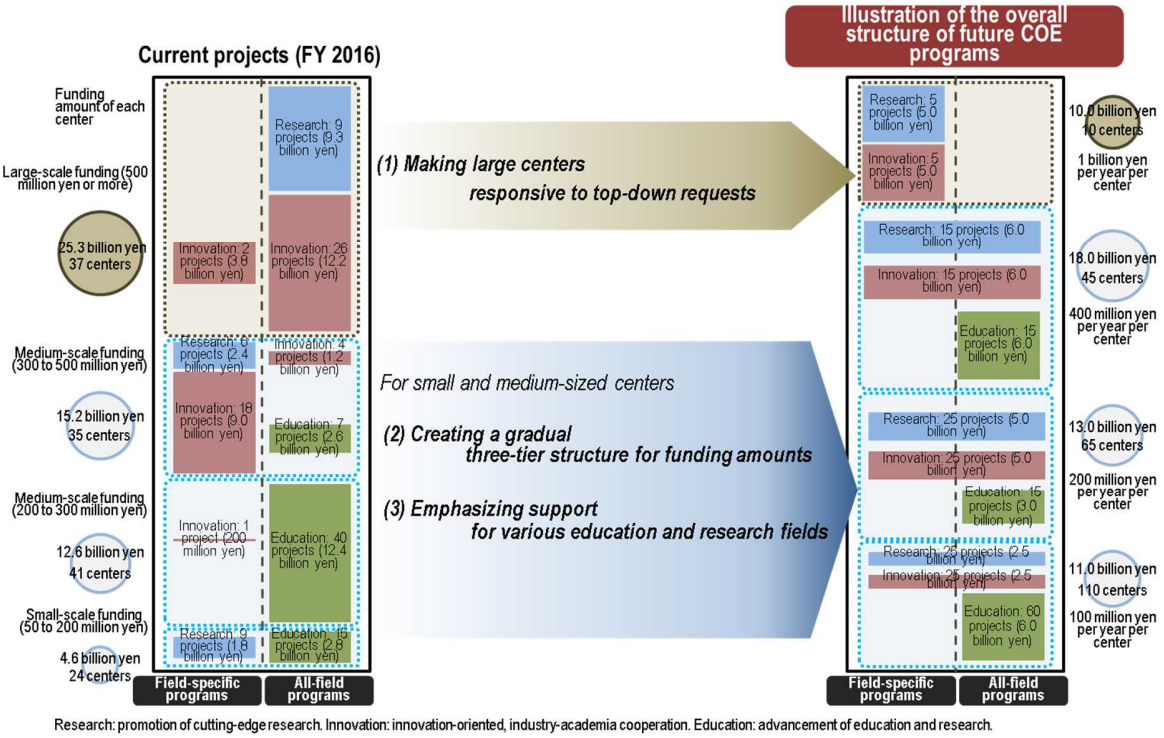


Figure 3.4 Illustration of an overall structure of future COE programs

Proposal 4: Securing Support for Institutions Other Than Large Research Universities

If COE programs providing medium or low levels of funding support are emphasized based on Proposal 2 (creating a gradual three-tier structure for funding amounts) and if the number of centers created per program increases, the opportunities for small and medium-sized universities to be selected are expected to increase. However, it is also important to examine a mechanism that promotes not only creating centers at small and medium-sized universities in a more direct manner, but also building strengths unique to these universities.

Section 2.2.2 (Analysis of Status of COE Programs) shows that COEs are concentrated at certain large research universities. Some argue that such concentration has given rise to disparities among universities in terms of the research environment. Also, the Fifth Science and Technology Basic Plan discusses promotion of activities in which regional universities, in cooperation with relevant organizations, take advantage of regional strengths and characteristics from the standpoint of regional revitalization. Taking such government aims into account, program designers should emphasize efforts to deal with harms causes by the concentration of COEs and should consider and implement actions such as the following.

Recommendation 1. The application information for the Funding Program for Next-Generation World-Leading Researchers (FY 2010 to FY 2013) includes an explicit statement that priority is given to proposals that take advantage of regional characteristics and consideration is given to the target number of accepted proposals in each prefecture (at least one proposal from each prefecture). Taking into account such examples, program designers should secure support for regional universities.

Recommendation 2. Within the framework of the three support priorities, universities that have received Support Priority 1* are required to make regional contributions through innovation in cooperation with local companies and local governments. Program designers should consider creating programs that support these universities' proactive efforts.

* Support for national universities whose core activities for functional enhancement in the third period include contributing to their local communities through human resource development and solution of regional issues, as well as promoting globally or nationally significant educational and research activities in their specialized fields in which they have advantages or special characteristics.

3.2 Toward Flexible, Sustainable Operation of Centers

To enable COEs to operate in a flexible, sustained manner, it is important to clarify the role of centers at their host institutions and promote strategic operation of centers. The following are three relevant proposals.

Proposal 5: Establishing the Life Cycle of a Center at Its Host Institution: Promoting Reorganization and Clarifying a Post-Program Continuity Scheme

Due to an ambiguous relationship between centers created through COE programs and their host institutions, there has been a lack of cooperation between them, and centers face difficulties in obtaining funds from their host institutions after the end of the relevant program. These issues have made it difficult for COEs to sustain their operation. This section considers sustained operation of COEs and the role that they play in the entire system of educational and research organizations of their host institutions.

The educational and research organizations of universities include departments/programs, affiliated laboratories, and temporary research centers (Figure 3.5). Among them, departments/programs play the fundamental role in conducting education and research at universities and are required to receive approvals from and submit notifications to MEXT. Affiliated laboratories and temporary research centers can be established independently by universities, can be characterized as organizations that strive for advanced education and research, pursue universities' potential in education and research, and, needless to say, have contributed to building universities' unique strengths.

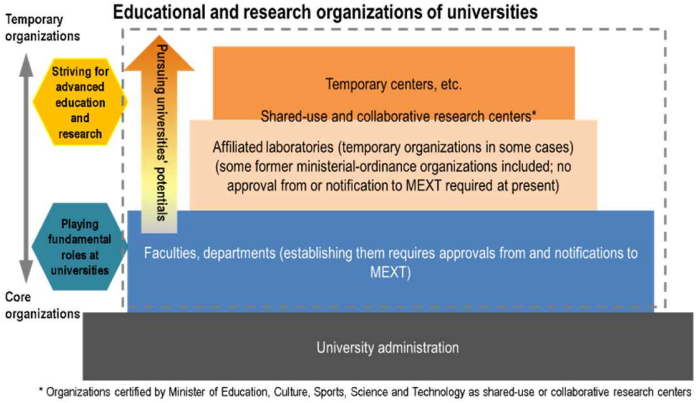


Figure 3.5 Overview of universities' educational and research organizations

Although these educational and research organizations of universities are expected to strive for advanced education and research, their strengths or characteristics cannot be easily observed, and their organization tends to become rigidified, which has slowed down their activities. It is not easy to improve such a situation and rebuild the entire ecosystem of a university's educational and research organizations because the organizations are highly independent and because personnel movements are infrequent as faculty members' sense of belonging to their organizations is high. However, COE programs are becoming recognized as drivers of reform of universities' educational and research organizations, and these programs are indeed acting as effective measures to promote and realize such reform.

<Opinions from interviews>
- We are not applying just to obtain funds. We are contemplating being selected for the WPI Program with the aim to build our university's character and change the university's research organization. (University administrator)
- Since the departments of our university are highly independent, it is difficult to drastically restructure them. However, we are conducting such restructuring, starting with the places where change must occur. Organizational reform is relatively easy when it is triggered by a COE program. (University administrator)

As discussed above, COE programs not only create research centers in pursuit of universities' potential, but also vitalize universities' educational and research organizations and play a leading role in organizational reform. With consideration given to the role of COE programs, this Strategic Proposal emphasizes (1) promotion of reorganization and (2) clarification of a post-program continuity scheme, advocating establishment of the life cycle of a COE toward its sustained operation.

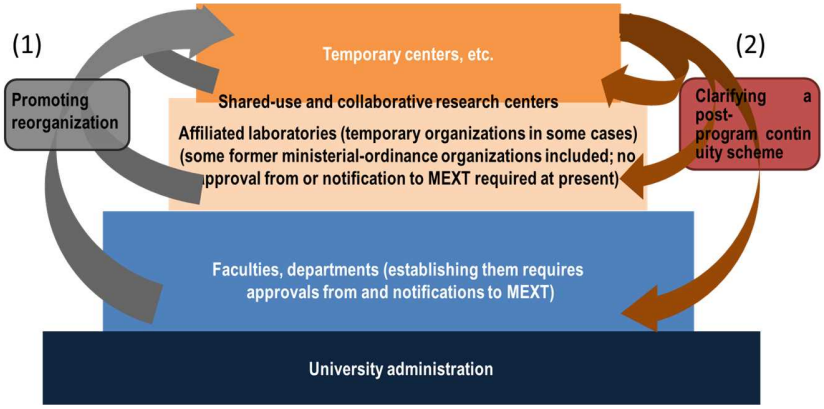


Figure 3.6 Establishing the life cycle of a COE at its host institution

(1) Promotion of Reorganization

Various types of COEs exist based on COE programs. Therefore, future programs should try to create new centers by reorganizing existing centers including inactive ones (e.g., consolidation and restructuring with a new mission). In doing so, COE programs should consider the possibility that universities' prospects are uncertain at the time of application, should examine flexible program designs that require submission of an implementation plan including reorganization of the existing centers during the program period, and should provide support according to universities' own circumstances (Figure 3.7).

In this Strategic Proposal, organizations that should be restructured are not limited to COEs created with support from the national government. It is important to aim at reorganizing all of a university's educational and research organizations, including research institutes established in the past as shared-use research centers belonging to the university, and to build an ecosystem for the entire university.

It is also important to promote reorganization of COEs with consideration given to social and industrial needs and trends. For example, Hokkaido University set up the Global Institution for Collaborative Research and Education (GI-CoRE) as an educational and research organization that is under direct supervision of the university president.

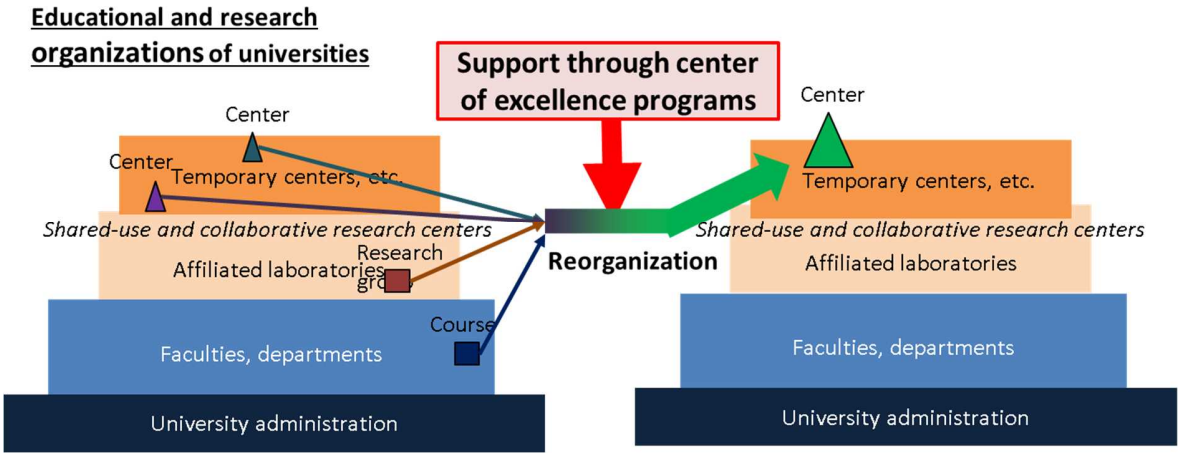


Figure 3.7 Illustration of reorganization

(2) Clarification of a Post-Program Continuity Scheme

To establish the life cycle of a COE, it is important to consider a post-program continuity scheme for the center; have it shared among stakeholders including the center, its host institution, and government agencies; and clarify the role of the center within the host institution with consideration given to the center's growth prospects.

There are various post-program continuity schemes for different policy objectives and different situations of COEs. However, COE programs have conventionally recommended centers to independently operate after the program period, and these centers are left on their own without specific consideration of their continuity. Consequently, centers remain at their host institutions without a clear role within the institutions or clear prospects of securing operating funds and with little growth.

In this context, this Strategic Proposal considers the continuity of a COE from a wide perspective, including not only the organization itself, but also the systems, infrastructure, intellectual resources, and human resources developed at the center and the activity of researchers. Figure 3.8 shows the main continuity schemes. In scheme A, a COE becomes a permanent organization at the host institution. In scheme B, the systems built and knowledge gained at a COE become part of an existing department. In scheme C, the transformation into a permanent organization or the internalization by an existing organization is difficult, and a COE is merged with another center into a new center. It should be noted that the choice of scheme type is significantly affected by policy objectives and the intention of each university or COE, that these schemes are not mutually exclusive, and therefore there are various other types of continuation scheme.

Continuity schemes

Scheme A

If the center is growing and if it is considered appropriate that it becomes a new core organization at the host institution, then the center becomes a permanent organization (new department, new academic program, etc.).

Scheme B

If the center is not considered a beneficial independent center at the host institution, then the center is internalized by an existing organization (department, academic program, etc.).

Scheme C

If the center is not necessarily growing and if it is not considered appropriate that it is internalized by the host institution, then the center is closed and a new center is created through reorganization, etc.

Figure 3.8 Main continuity schemes

Proposal 6: Creating and Strengthening Cooperative Networks

There have been various types of cooperation, such as collaborative research and information exchange among researchers as well as formation of research groups consisting of several researchers. In addition to cooperation among individual researchers, cooperative networks that extend beyond the boundaries of universities, have been created in recent years. Examples of these networks include Research University 11 (RU11), the Research University Network of Japan, and the Council of Research Administrators, which is a network of university research administrators, and their main activities include information exchange and intra-network cooperation. These networks have already played a significant role. However, building more substantial networks is necessary to advance educational and research activities because it has become difficult for a COE to secure sufficient human resources, facilities, and equipment as the size of research projects and the number of stakeholders have increased. Therefore, program designers should consider including support for creating a network of COEs in order to amplify and utilize the potential of centers located in Japan. The networks are also expected to promote inter-university cooperation and post-program utilization of human and intellectual resources (Figure 3.9).

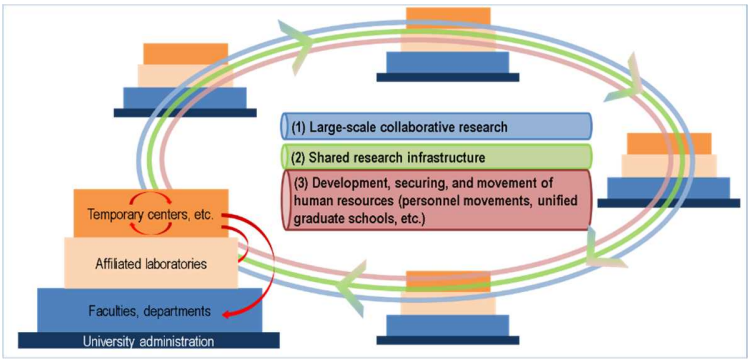


Figure 3.9 Cooperative networks

As mentioned in the discussion of networks of COEs, although networks have been created for various purposes, efforts that emphasize development, securing, and movement of human resources have been relatively weak. This Strategic Proposal therefore suggests a program design that promotes building human resources networks in order to improve the process of securing and moving human resources necessary for education and research. More specifically, the Proposal suggests a design that includes a system for sharing faculty members and management personnel among the centers created by a COE program and an environment where faculty members can work at other centers (Figure 3.10). For example, under the Program for Translational Research Networks (2012 to 2016), information on each center's personnel was shared so that the right persons could conduct seminars and lectures at different centers (see the box below).

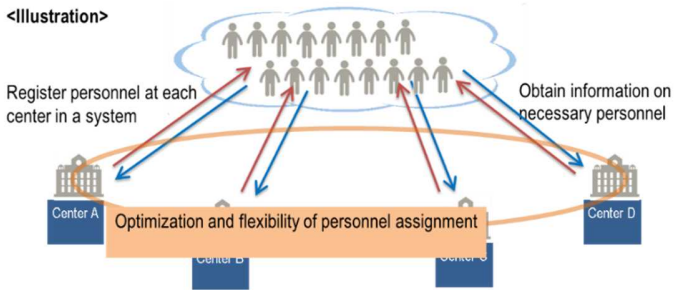
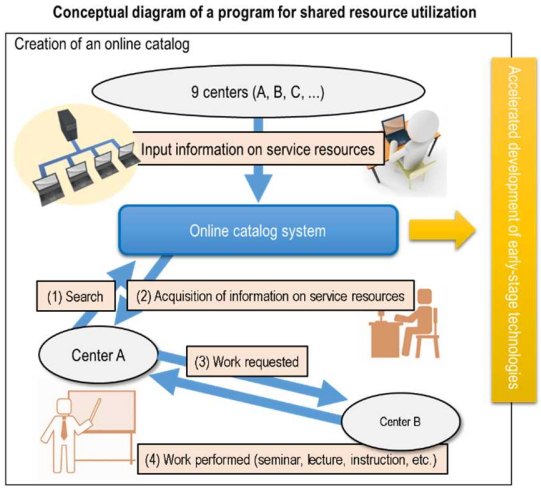


Figure 3.10 Illustration of a human resources network

Box : Example of Activities under the Program for Accelerated Translational Research Networks

The Program for Translational Research Networks started in FY 2012 with a five-year plan as the second implementation of the Translational Research Program. As part of this program, shared resources are utilized in building a network of nine centers, and Tohoku University is in charge of coordination and overall administration. An online catalog of human resources has been developed, in which each center registers its human resources (experts in pharmacy, intellectual property, etc.) through a bilaterally accessible system. The centers began the registration in 2014, and the catalog lists 310 people as of December 2015. The network has made it easy to find people with required skills.



Source: "Abstracts of the Reports on the Results of the 2015 Project for Building Centers for Innovative Medical Technology," Japan Agency for Medical Research and Development.

Proposal 7: Promoting Strategic Funding Plans for Center Operation

COEs should consider funding from their parent programs as pump-priming regardless of the form that each center takes after the end of the program period, and COEs should follow a funding plan for strategic operation of the center that takes into account post-program situations during the program period. The following discusses four actions to be taken in following this Strategic Proposal.

(1) Strategic changes in the amount of funding for several years after the start of a program and several years before its end

COE programs generally provide the same amount of funds each year from the start the program period until its end. However, the initial stage of creating centers under a COE program can be characterized as a preparation period for full-fledged implementation of the program, and funds should be distributed accordingly. In addition to this preparation period, it is necessary to evaluate the centers' activities and the prospect of their reorganization and, if necessary, change the level of funding or stop the funding based on the results of the evaluation. The Advanced Interdisciplinary Innovation Center Program has set up a

feasibility study period in which centers receiving funds are narrowed down and plans for creating centers are made more specific or are modified based on an evaluation. Learning from past programs, program designers should consider designs that are intended for strategic operation of COEs.[8]

COE programs should regard a period of several years following the creation of research centers as a period of transition to their independent operation and should reduce the amount of funding from the programs in stages while gradually increasing the share of the centers' own funds in their operating funds. COE programs should strategically distribute funds to centers according to their operational stages and should promote funding plans aimed at centers' sustained operation.

(2) Prudent design of an economic support system for students according to program objectives

COE programs provide affiliated students with financial support in the form of salaries to teaching/research assistants and scholarships. Future programs, however, should clarify their objectives and appropriately determine the recipients and amounts of payments. It is also necessary to examine the framework for supporting top students that is independent of a COE program. While financial support to students has had a certain positive effect on COE programs, some observers point out its disadvantages. For example, financial support to students ends with the end of the program regardless of the students' remaining time at their university. Also, since only the students who are affiliated with a COE program can receive financial support from the program, whether their university is selected for a program could create gaps in economic support for graduate students.

The Special Researcher Program of the Japan Society for the Promotion of Science provides financial support for doctoral students, but only about 5,000 students, or 6% of doctoral students, receive this support.[9] The role of the Special Researcher Program and other similar programs is currently being reviewed.[10] It is therefore necessary to reexamine financial support to students, paying attention to such developments.

<Opinions from interviews>

- There are many cases in which systems developed under the 21st Century COE Program continue to be used. At the same time, cases of wasteful spending, including those involving payments to research assistants, have been observed. The funding for such expenditures is terminated with the end of the program. Research assistant-related expenditures should be handled with a separate mechanism instead of each center's mechanism.
- Under the 21st Century COE Program and the GCOE Program, financial support was provided to graduate students in the form of payments to research assistants; however, imbalances arose between students who received support and those who did not, even within the same department. I heard a rumor that most of the funds received through the GCOE Program were spent as research assistant-related expenditures. Therefore, there may be cases in which funding does not contribute to establishing a COE.
- If, for example, funds are allocated according to the size of universities, some universities would provide tuition waivers to their top students or pay salaries to research assistants. Also, it is important for a COE program to support top students through research assistant-related budgets.It is necessary to keep a proper balance between these two channels.

[8] For the Advanced Interdisciplinary Innovation Center Program, funding to 9 of the 21 centers that had been created was ceased based on an interim evaluation, while the total amount of support was increased by 50% after the interim evaluation.
[9] "On the Role of Financial Support to Students," Committee on Student Financial Support (August 29, 2014).
[10] "On Measures to Improve the Human Resource Development Programs of the Japan Society for the Promotion of Science (First Proposal)," Japan Society for the Promotion of Science, Committee on Human Resource Development Planning (August 12, 2016).

(3) Securing of funds necessary for a host institution's plan for reorganizing a COE

Proposal 5 suggests that for sustained operation of a COE, it should be reorganized in tandem with restructuring of the ecosystem of the host university's educational and research organizations. Many of such reorganization efforts should be led by the host institution. Examples include facility development, personnel transfers, and development of a management system for all of the host institution's educational and research organizations. Given that these activities may involve substantial costs, it is essential to secure funds available to host institutions.

For such funds, a portion of the funds from COE programs can be effectively used for the purpose of supporting universities' administrative activities. Also, according to the Common Guidelines for the Use of Overhead Expenses Covered by Competition-Based Funding (April 20, 2001, an agreement by the Ministerial Coordination Committee on Competition-Based Funding), overhead expenses are those necessary for improving the research and development environment for researchers awarded competition-based funding and the capabilities of the research organization as a whole. Given the purpose of overhead expenses, universities' administrative expenditures associated with a COE program should be treated as overhead expenses. In addition, it is effective to secure necessary funds by linking reorganization efforts promoted by a COE program with various existing programs intended for university reform, such as the Program for Creating Super Global Universities and the Enhancement and Promotion Program for Research Universities. University reform and efforts promoted by COE programs influence each other, producing a multiplier effect. Therefore, host institutions should play a leading role in reorganization.

Box : COE Programs and Overhead Expenses

The rules on overhead expenses were put in place based on the Second Science and Technology Basic Plan (approved by the Cabinet on March 30, 2011) in order to effectively and efficiently utilize competition-based funding. The level of funding for overhead expenses subsequently increased until peaking in FY 2009, after which the number of programs providing funds for overhead expenses has fallen and shown little change in recent years. As for COE programs, the percentage of funds that cover overhead expenses ranges widely from zero to 30% (see the table below), which may be significantly attributed to the situation surrounding each program. The following describes how overhead expenses are treated under COE programs.

The objectives of COE programs include systemic reform that improves research and development environments and the capacity of research organizations as a whole. Such activities require expenditures (direct expenses). At the same time, such expenses overlap with "overhead expenses" as defined by the government—expenses necessary for improving the research and development environment for researchers awarded competition-based funding and the capabilities of the research organization as a whole.* For this reason, the expenses necessary for a COE program (i.e., direct expenses) can be interpreted as overhead expenses, which gives rise to ambiguity between them. However, some expenses related to organizational activities (e.g., personnel management and ethics education) that are incurred at a division providing background support to a COE (e.g., the university administration) cannot be treated as direct expenses. A certain level of funding for overhead expenses is therefore considered necessary.

In passing, an interim report prepared by the Committee on Reforming Competition-Based Research Funding discusses the treatment of overhead expenses in programs aimed at systemic reform.** The report considers expenses for systemic reform (i.e., expenses for promoting systemic reform or educational reform at universities) and argues that further consideration is needed with regard to the range of expenses for systemic reform that can be considered as overhead expenses and the proportion of such expenses in direct expenses.

* Common Guidelines for the Use of Overhead Expenses Covered by Competition-Based Funding (April 20, 2001, an agreement by the Ministerial Coordination Committee on Competition-Based Funding).

** The Interim Report of the Committee on Reforming Competition-Based Research Funding (June 24, 2015, Committee on Reforming Competition-Based Research Funding).

Overhead expenses under major COE programs

Main policy objective	Program name	Overhead expenses
Innovation	Program for Creating Innovation Centers for Advanced Interdisciplinary Research Areas	0%
Research	World Premier International Research Center Initiative (WPI Program)	0%
Research	Fundamental Technology Development Program for Photophysics and Quantum Science Research Centers	30%
Education	Program for Leading Graduate Schools	0%
Innovation	Center of Innovation (COI) Program	30%
Innovation	Program for Regenerative Medicine Networks	30%
Research	Program for Strategies to Internationally Expand Infectious Disease Research	30%
Innovation	Innovation Hub Program	10%

Research: Promotion of cutting-edge research. Innovation: Innovation-oriented, industry-academia cooperation. Education: Advancement of education and research.

(4) Diversification of sources of a center's operating funds for stable funding

There are cases in which a COE that has entirely relied on its parent program for operating funds faces operational obstacles after the end of the program period. Therefore, COEs should secure diverse financial sources, including their host institutions' base budget and private-sector sources, and maintain sufficient operating funds.

As discussed above, COE programs have pursued universities' potential, leading to university-wide organizational reform and capacity enhancement. Therefore, efforts of COE programs should be incorporated in each university and should be promoted university-wide for positive results. In this context, each university should consider a mechanism that use grants for operating expenses to continuously implement various efforts originating from COE programs, and, at the same time, appropriate policy efforts should be made. For example, in order to sustain achieved success, some of the COEs created by the WPI Program, which will end in FY 2016, secure financial resources by taking advantage of the capacity enhancement funds that are included in grants for operating expenses for national university corporations.

It is also important for COEs to secure their operating funds through cooperation with private-sector companies. Universities and companies have cooperated, based on their existing strengths, mainly through collaborative research or donations for specific research topics. For example, in 2015 the Kyoto University Center for iPS Cell Research and Application started collaborative research on iPS cells with the Takeda Pharmaceutical Company and will receive 20 billion yen in sponsorship over 10 years. In addition to such cooperation for specific research topics, there have been new activities including industry-academia collaboration that begins at a stage in which research topics are explored. With consideration given to such new trends, which go beyond the framework of conventional collaboration, COE programs should secure and diversify funding sources to achieve sustained operation of centers.

Box : Final Report on the Public and Private Investment Expansion Initiative for Science and Technology Innovation

The Council on Economic and Fiscal Policy and the Council for Science, Technology, and Innovation set up the Committee for Vitalizing the Economy and Science and Technology Innovation and, on December 21, 2016, prepared a final report on vitalizing science and technology innovation, which is a driver of Japan's economic growth.

The report shows the basic direction of research and development investments made by the government and the private sector to vitalize innovation. According to the report, as European countries, the United States, and China have steadily increased budges for science and technology innovation, it is necessary to expand, both quantitatively and qualitatively, the public- and private-sector budgets for research and development and human resource development in order to make Japan the most suitable country in the world for innovation and grow its economy to a 600-trillion-yen economy. The report also proposes the following three actions to achieve this. Currently, efforts associated with increased public and private investments, such as selecting specific target areas for research and development, are underway based on the report.

(1) Reform of the budgeting process

In the budgeting process, the government should continue the existing Strategic Innovation Promotion Program, select new target areas that are likely to induce investments, and expand similar programs to increase public and private investments. Policy measures led by not only the Cabinet Office, but also various Ministries should be coordinated with these efforts. The type of research and development management observed in the Strategic Innovation Promotion Program is characterized by clear exit strategy, concentrated power held by the program director, and the stage-gate process and is highly regarded in industry.

(2) Institutional reform for expanded research and development investments

Innovation leading to change in all of society, such as the fourth industrial revolution and Society 5.0, requires organizational and institutional reform. The report puts forward the following six proposals.

1. Accelerating university reform and strengthening industry-academia cooperation to promote open innovation
   - University management reform; acquisition of various funds; organization-to-organization industry-academia cooperation
2. Promoting establishment of research and development startups
   - Continuous support from establishment to independence
3. Expanding public procurement to create new markets
   - Introduction of a public procurement mechanism that facilitates adoption of innovative technologies
4. Regional revitalization through science and technology innovation
   - Promotion of active use of the "benefit-your-hometown" tax system for corporations
5. Promoting investment in human resources that support science and technology innovation
   - Creation of degree-granting programs based on industry-academia cooperation
6. Designing budgets that are effective for science and technology innovation
   - Introduction of a system that evaluates the level of technological development

(3) Evidence-based effective expansion of public and private investments for research and development

The government should facilitate visualization of investment performance and policy performance, analyze them, and establish a PDCA cycle.

Box: On the Guideline for Enhanced Collaborative Research through Industry-Academia-Government Cooperation

To promote innovation based on industry-academia-government cooperation, MEXT and the Ministry of Economy, Trade and Industry (METI) prepared a guideline (published on December 5, 2016) that discussed, from the standpoint of industry, issues arising when universities and national research and development corporations strengthen industry-academia cooperation and presented measures to deepen organization-to-organization, industry-academia cooperation. The guideline is a product of discussions and examinations conducted by MEXT Conference for Industry-Academia-Government Dialogue for Promoting Innovation and the METI Working Group for Deepening Industry-Academia-Government Cooperation, which were established in July 2016 and September 2016, respectively, in response to the request from the Federation of Economic Organizations for swift, full-fledged government actions related to industry-academia cooperation. To achieve the goal of tripling companies' investments in universities and national research and development corporations by 2025 that was set by the 2016 Japan Revitalization Strategy (approved by the Cabinet on June 2, 2016), the guideline presents the following four factors that are expected to be present in all universities and national research and development corporations.

(1) Enhanced capacity of the head office for industry-academia cooperation
Building a system capable of planning and managing interdepartmental collaborative research; making plans and proposals; supporting the execution of collaborative research
(2) Virtuous funding cycle
Presenting the rationale behind the calculation of expenses related to industry-academia collaborative research; setting proper levels of personnel expenses, overhead expenses, expenses for strategic industry-academia cooperation, and other expenses related to collaborative research
(3) Virtuous intellectual cycle
Executing high-level intellectual property management that reviews the treatment of the results of collaborative research from a comprehensive viewpoint; enhancing capabilities to manage risks involving conflicts of interest, contracts, etc.
(4) Virtuous personnel cycle
Promoting industry-academia cross-appointments; reforming personnel assessment systems of universities and national research and development corporations.

In contrast to the use of private funding to diversify the operating funds of COEs, which is put forward in this Strategic Proposal, the guideline strongly argues that both industry and universities should conduct collaborative research with an acceptable approach to cost burdens. Concrete measures include justifying cost burdens by presenting the necessity of overhead expenses and other expenses and the rationale behind expense calculations; making plans and proposals to strengthen the capacity of universities and national research and development corporations to conduct industry-academia cooperation; presenting the necessity of expenses for strategic industry-academia cooperation as expenses needed for intellectual property management and infrastructure development; and securing funds for personnel expenses that depend on the commitment to success of the faculty members involved in collaborative research and appropriate management of personnel efforts.

The key to these measures is enhanced capacity of the head office for industry-academia cooperation, which is discussed above. Regarding efforts toward enhanced capacity, the guideline lists the following: building an interdepartmental system under the top management of universities and national research and development corporations; setting objectives of and plans for industry-academia-government cooperation; centralizing information on early-stage technologies and collaborative research within the organization; and securing highly skilled experts including university research administrators. These efforts would generate superb plans for research centers and therefore are important in responding to social expectations concerning rapidly advancing science, technology, and innovation.

4. Measures and Timeline for Implementing Proposals

4.1 Importance of Shared Awareness

This Strategic Proposal puts forward recommendations regarding the future role of COE programs, including measures for fundamental reform. Implementing these measures requires, as a precondition, shared awareness of the role and characteristics of COEs and their parent programs. COEs are organizations that not only conduct superb education and research, but also pursue the potential of an entire university and promote organizational reform. COE programs should therefore support the process for these activities. Today, this view is not necessarily shared among people associated with COE programs.

It is also important to recognize that the role of COE programs should evolve in response to trends in both science and technology innovation policy and higher education policy. As substantial growth in science and technology-related budgets cannot be expected and as further university reform will steadily occur, the conventional approach to COE programs, which have been oriented toward creating new centers, should be changed as need arises. It is hoped that concrete reform measures will be considered based on such understanding.

4.2 Coordination with Government Discussions

As mentioned above, MEXT is currently examining future designs for programs including the WPI Program and the First-Rate Graduate Schools program, which is a successor of the Leading Universities Program. MEXT also set up the Round Table on the Role of Research Centers in Strengthening Research Capacity (September 2016) and the Task Force on Strengthening Basic Scientific Capacity (November 2016) and is discussing the future development of COE programs. The CRDS has been involved in these activities in various ways since the time of preparing this Strategic Proposal and will provide information that will serve as the foundation of government discussions.

It is also important to implement COE programs in coordination with trends in university reform. This is because various reform activities at universities are closely linked with the reorganization efforts intended for flexible, sustained operation of centers that are put forward in this Strategic Proposal. Also, at the policy level, an important issue is the relationship between expenditures based on subsidies from COE programs and grants for operating expenses that are provided according to the redistribution rules set in the third period of the Mid-Term Goals of National University Corporations. Such issues should be concretely examined one by one.

4.3 Importance of Dialogue

This Strategic Proposal puts forward recommendations aiming for a grand design of COE programs. Implementing these recommendations requires strategic, unified actions that extend beyond the boundaries of government ministries, bureaus, and offices. In the process of preparing this Strategic Proposal, a workshop was organized for government administrators in charge of COE programs, and they discussed the role of the COE programs as a whole, going beyond the boundaries of these programs. It is important to constantly create a place for cross-government discussion.

In addition, in order to implement the proposals put forward in this Strategic Proposal, it is important that a wide range of stakeholders, including universities and funding organizations as well as government agencies, discuss a variety of issues. These stakeholders should hold repeated discussions, focusing on devising better policies based on their experiences, instead of giving one's views from a specific standpoint.

Appendix 1. Process of Preparing This Strategic Proposal

1. Survey Report

Before the preparation for this Strategic Proposal began, a survey on COE programs was conducted in FY 2015, and its results provided a basic perspective from which this Proposal would be written. In the preparation process, a questionnaire survey of COEs was conducted in order to understand the status of their operation. This questionnaire survey was an attempt to systematically ascertain the characteristics of centers' operation.

For details on the survey results, see the CRDS survey report, "Implementation of Center of Excellence Programs in Japan: Issues and Prospects" (June 2016, CRDS-FY2016-RR-01).

2. Interviews

Interviews were conducted with representatives of the following universities and COEs from May 2016 to December 2016.

- University administration
Hokkaido University: vice president, etc.
Tohoku University: vice president, trustee in charge of research activities, etc.
Chiba University: vice president, etc.
University of Tokyo: executive officer, vice president
Tokyo Institute of Technology: vice president
Nagoya University: vice president, president's aide, etc.
Kobe University: vice president, etc.
Okayama University: vice president, etc.
Ehime University: vice president, etc.

- Director, etc. of centers created by COE programs
Hokkaido University: Program for Innovations in Future Drug Discovery and Medical Care (Advanced Interdisciplinary Innovation Center Program)
Hirosaki University: Center for Healthy Aging Innovation (COI STREAM Program)
Tohoku University: Micro System Integration Center (Advanced Interdisciplinary Innovation Center Program)
Tohoku University: Advanced Institute for Materials Research (WPI Program)
National Institute for Materials Science: International Innovation Zone for Young Researchers (SCOE Program)
University of Tokyo: Institute for Nano Quantum Information Electronics (Advanced Interdisciplinary Innovation Center Program)
Tokyo Institute of Technology: Academy for Co-creative Education of Environment and Energy Science (Leading Universities Program)
Keio University: Keio Leading Graduate School Program (Leading Universities Program)
Nagoya University: Institute of Transformative Bio-Molecules (WPI Program)
Nagoya University: Innovation Design Center for a Diverse, Individualized Society (COI STREAM Program)
Kyoto University: Institute for Integrated Cell-Material Science (WPI p Programrogram)
Kyoto University: Advanced Technology Hub for High-Order Bioimaging (Advanced Interdisciplinary Innovation Center Program)
Kobe University: Innovative BioProduction Kobe (Advanced Interdisciplinary Innovation Center Program)

Okayama University: Center for Translational Research on Next-Generation Medicine Aimed at Longer Healthy Life Expectancy (Program for Accelerated Bridging Research Networks)
Okayama University: Okayama Medical Innovation Center (Program for Developing Regional Industry-Academia-Government Research Centers, Program for Promoting Shared Use of Advanced Infrastructure)
Ehime University: Center for Marine Environmental Studies, Geodynamics Research Center (21st Century COE Program, GCOE Program)

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3. Pre-workshop Conference

Before the workshop for this Strategic Proposal (February 2, 2017), a pre-workshop conference was held on January 17, 2017. At the conference, the content of this Strategic Proposal, which was being prepared by the CRDS, was discussed with the heads of the relevant offices (see below) of MEXT from the standpoint of government administration.

Relevant MEXT offices:
Office for University Reform, University Promotion Division, Higher Education Bureau; National University Corporation Support Division, Higher Education Bureau; Industrial Cooperation and Regional Support Division, Science and Technology Policy Bureau; Basic Research Promotion Office, Research Promotion Bureau; Scientific Research Institutes Division, Research Promotion Bureau; Scientific Research Aid Division, Research Promotion Bureau; Office for Science Policy Planning, Promotion Policy Division, Research Promotion Bureau

4. Workshop

The workshop on this Strategic Proposal was held on February 2, 2017 (see Appendix 3).

5. Other

Information on the latest trends related to the content of this Strategic Proposal was continually collected from government officials. A meeting with university research administrators was held on September 2, 2016 to conduct interviews about their role at universities.

Appendix 2. Case Studies: France, Germany, and China

France: Excellence Initiative

1. Background

France, where national research institutes had historically been the center of research activities, was facing the problem that research was not actively conducted at universities and the research were not highly regarded internationally. Also, there were a variety of academic degrees, which made it difficult for people from other countries to understand the France's higher education system. In 2006, a process of reform was started to improve the research capacity of universities and their international standing. The Excellence Initiative (Initiative d'Excellence, IDEX), which began in 2010, is one such reform effort and aims at creating world-class research and education centers in France.

To consider IDEX-related activities, one needs to know COMUE, a regional research community that implements IDEX. COMUE is a corporate entity equivalent to a university and is established so that universities can jointly promote their common activities (e.g., applying for competition-based funding and administering certain educational programs). The role of IDEX is to make COMUE a world-class institution by encouraging cooperation among various participating organizations.[11]

2. Implementation

Under the IDEX program, a total of 10 universities were selected (3 in 2011, 5 in 2012, and 2 in 2016). The support period is, in principle, 10 years, but could be cut short depending on interim assessments. Also, additional universities are planned to be selected. Through IDEX funding, roughly 700 million euros is distributed to each university over a 10-year period, but it must be returned after the end of the program period. Therefore, the amount of funds that are in effect "given" to each university equals the amount of interest on the funds distributed to it.

For example, the University of Paris-Saclay, one of the universities selected for the IDEX program, cooperates with 27 universities, the Grandes Écoles, and public research institutes. Some of the activities of these organizations have been transferred to COMUE Paris-Saclay and are administered within a common framework. In conducting these activities, to the issue arose of how to promote interorganizational cooperation, which is dealt with by the IDEX program. The program provides the organizations participating in COMUE Paris-Saclay with support for international cooperation and applications for research funding and is leading to COMUE Paris-Saclay becoming a world-class institution.

3. Results and the Future Direction

As discussed above, the role of IDEX is to coordinate multiple organizations into becoming a world-class institution. Such an institution must be attractive to students and researchers overseas; however, this has not been achieved yet. The IDEX program has nevertheless been successful in solidifying COMUE, which consists of various entities, as an organization because credits earned at COMUE count toward an academic degree and its researchers list COMUE as their organization on their published papers, making its name appear in journal publication rankings.

The program is expected to continue for at least four more years, but its fate after the program period has not been announced. However, in France, highly regarded programs tend to be continued after their initial program period. Therefore, depending on the results that the IDEX program produces, it is possible that the program will continue after its initial program period.

4. Summary

University reform in France is significantly different from that in Japan. The core issue for France is cooperation among various organizations, and the IDEX program has dealt with this issue and committed to its mission of creating a world-class institution.

(Contributor: Izumi Yamashita, Fellow, JST CRDS)

[11] The IDEX program was in place when PRES (centers for higher education and research) existed before the introduction of COMUE in 2013. For simplicity, the discussion here focuses on COMUE.

Germany: Excellence Initiative

1. Background

In Germany, a decision was made in the latter half of the 1990s to evaluate the system in place for basic research and fundamentally reform the country's university system which had become inflexible. In response, the federal government announced the Excellence Initiative (Exzellenzinitiative), which aims to create core research centers that are internationally recognized. Instead of creating new universities, the program solicits applications from existing top universities and provides support to those that are selected. For this purpose, a total of 4.3 billion euros was disbursed during a 12-year period from 2006 to 2017. The program received considerable attention, both domestically and internationally, because it was a major shift from the principle of improving the level of universities nationwide, which Germany previously promoted, to a policy for turning universities into centers of research activities. In soliciting applications, it was emphasized that the government would not recognize certain universities as elite universities, that all universities had the right to apply, and that the program would provide support based on competition in a fair and transparent manner.

2. Overview of the Excellence Initiative Program

The German Research Foundation and the German Council of Science and Humanities pushed for the Excellence Initiative program, which was then approved by an independent review committee. Seventy-five percent of the total amount of support comes from the federal government, and the rest comes from state governments. The program is structured as shown in the table below. For the Institutional Strategies subprogram (see the bottom row), 11 universities are currently selected out of 104 state universities and are certified as Excellence universities.

Name of subprogram	Description
Clusters of Excellence	Builds networks that are internationally highly regarded and facilitate competitive interdisciplinary research. Provides support for building clusters in which university research centers cooperate with external research organizations.
Graduate Schools	Supports graduate schools that are established to provide a high-quality environment for graduate students in doctoral programs and lay the groundwork for innovation.
Institutional Strategies	Selects universities from those that have been selected for both the Clusters of Excellence subprogram and the Graduate Schools subprogram.

3. Continuation of the Program

According to the program assessment report that was submitted by an external expert committee in early 2016, the Excellence Initiative Program achieved overall success and should be continued with two of its subprograms, Clusters of Excellence and Institutional Strategies. Subsequently, a successor program, the Excellence Strategy, was announced, and a new application process for Clusters of Excellence is underway. Under the Excellence Strategy program, a university that has been selected for two or more Clusters and a group of universities that have been selected for a total of three or more Clusters can apply for Institutional Strategies. Another difference from the Excellence Initiative is that while the Excellence Initiative was a limited-time program, the Excellence Strategy is a permanent program and grants the title of Excellence to universities that have been selected for Institutional Strategies. The application period for Institutional Strategies is planned to start in the fall of 2017.

4. Summary

The Excellence Initiative program is considered to have promoted structural reform by clarifying the vision of universities and reaffirming their strengths. The German term for Institutional Strategies is Zukunftskonzept (future concept), and it was a program for which universities applied after they decided what kind of university they would become. Also, it is considered that cooperation with external research organizations not only led to research-related success, such as an increased number of published papers, but also changed the mindset of university researchers.

(Contributor: Tomoko Sawada, Fellow, JST CRDS)

China: The State Key Laboratory Program

1. Background

In China, the Cultural Revolution (1966-1976) led to suspension of most activities in university education and research. However, university entrance exams resumed in 1978, and training of researchers began in a substantial manner in the first half of the 1980s. Against this backdrop, the State Planning Commission started the State Key Laboratory Program in 1984 to concentrate limited research resources in key areas. The following is a brief list of relevant activities.

Initial stage (1984-1997): Emphasis on basic research
- 1984-1993: 910 million yuan in support for research centers; establishment of 81 state key laboratories nationwide
- 1991-1995: Establishment of 75 state key laboratories using World Bank loans (86.34 million dollars and 178 million yuan).

Development stage (1998-2007): Exploration of new forms of state key laboratories; focus on management of state key laboratories
- 2000: Establishment of large-scale interdisciplinary national laboratories considered
- 2003: Establishment of central-local cooperative state key laboratories started
- 2006: Promotion of privatizing state key laboratories and corporate-type state key laboratories
- 1998-2007: Establishment of new state key laboratories; support to 17 state key laboratories canceled based on assessments

Enhanced development stage: 2008 to present
The Ministry of Science and Technology and the Ministry of Finance jointly set a budget for state key laboratories in 2008 and have stably provided research funds to promote opening state key laboratories to a wider range of researchers, setting the topics for independent research, upgrading research facilities and equipment, and introducing brand-new research facilities and equipment.

2. Implementation

The expenses for the State Key Laboratory Program have shown an increasing trend: 1.4 billion yuan in 2007, 2.5 billion yuan in 2009, and 2.748 billion yuan in 2013 (expenses for administering open laboratories and research expenses: 2.072 billion yuan; expenses for upgrading research facilities and equipment: 667 million yuan). Under the program, the amount of annual support per laboratory is 8 to 10 million yuan, and the funds provided are used for subsidies for the open use of research facilities and research expenses. The laboratories must use their funds to pay for the facilities, researchers, and other personnel. Also, although the support period is five years, whether the support continues with additional funds (70 million yuan for upgrading facilities and equipment) is determined based on an assessment conducted after the support period.

The State Key Laboratory Program has thus far provided support to 305 laboratories selected through several rounds of applications. Support to 17 laboratories was suspended based on assessments. A total of 288 laboratories (252 labs at national universities and national research institutes; 30 labs at companies; 6 labs at center-local cooperative organizations) thus currently receive support.

One of the laboratories is the State Key Laboratory for Superlattices and Microstructures, which was established in 1990 by the Chinese Academy of Sciences Institute of Semiconductors. The laboratory currently has about 60 researchers, 20 postdoctoral students, and 120 graduate students, conducts its research activities, receiving 8 million yuan (about 125 million yen) per year, and is subject to assessment every five years.

3. Results and the Future Direction

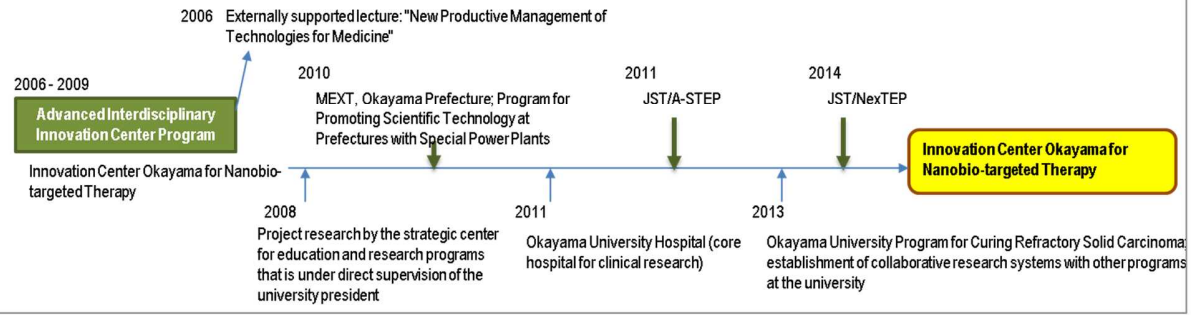
Research conducted at the state key laboratories covers most of the important basic research fields in China and is significantly contributing to enhancing the country's research capacity. There is no plan to end the State Key Laboratory Program for the time being. Also, in response to the country's strong demand for strategic development, attempts have been made since around 2000 to create national laboratories that are similar to the national laboratories in the United States and would have higher status than that of state key laboratories. However, the plan is to create the new national laboratories based on the past experiences, that is, through unification of several state key laboratories and other means.

(Contributor: Shaodan Zhou, Fellow, JST CRDS)

Appendix 3. Examples of Centers' Continued Operation

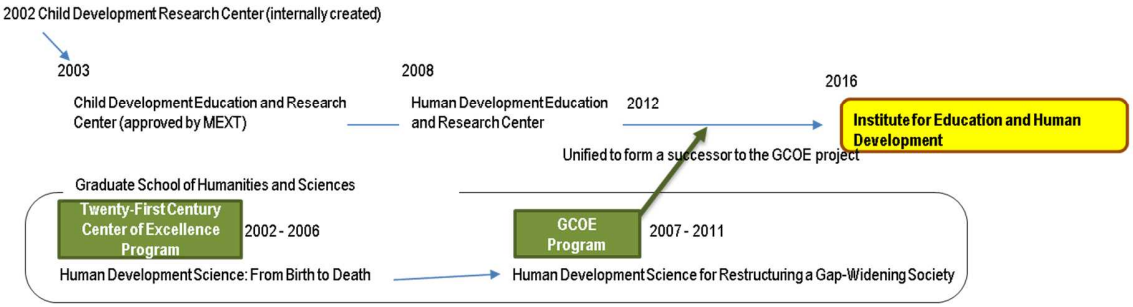
Okayama University: Innovation Center Okayama for Nanobio-targeted Therapy

Cooperation with other organizations at the university; continuation with successive fundings



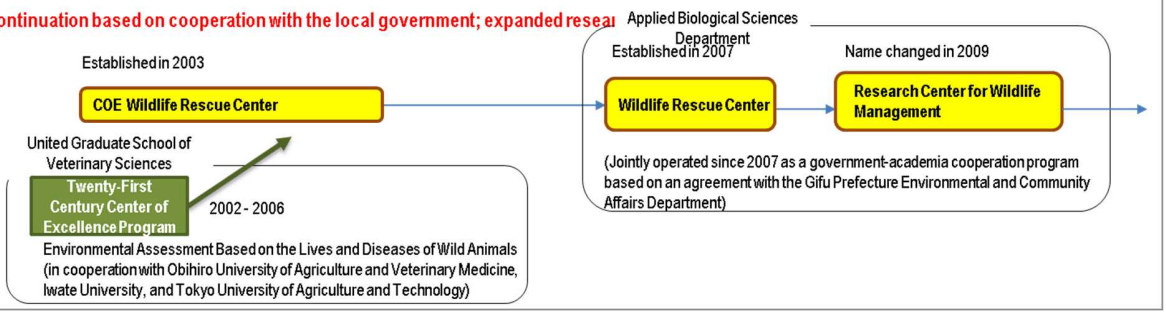
Ochanomizu University: Institute for Education and Human Development

Incorporation in an existing affiliated laboratory

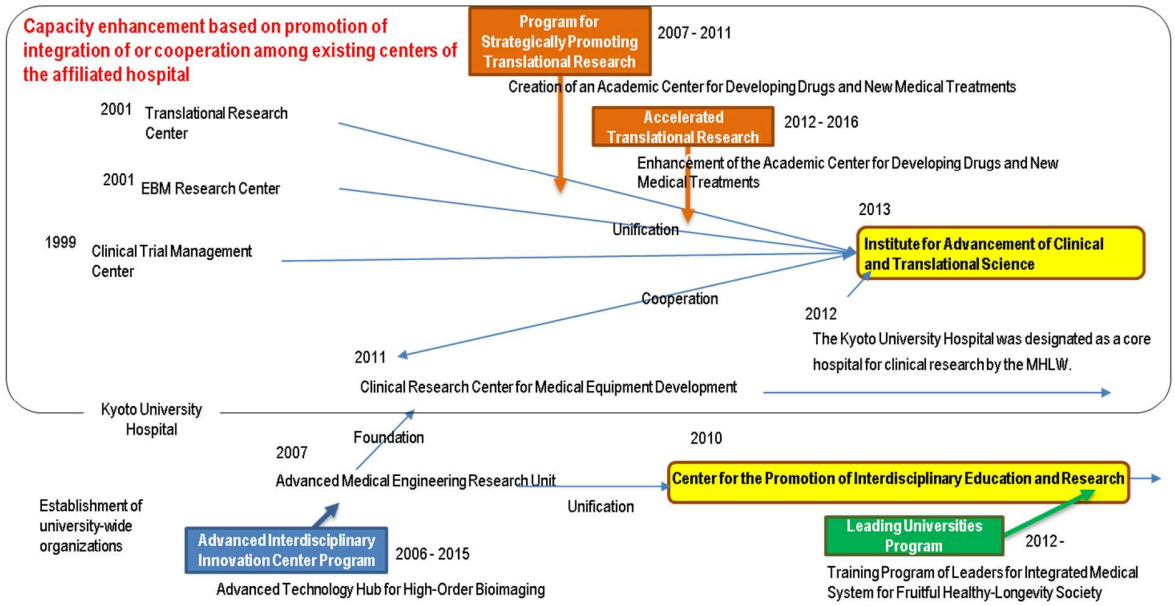


Gifu University: Research Center for Wildlife Management

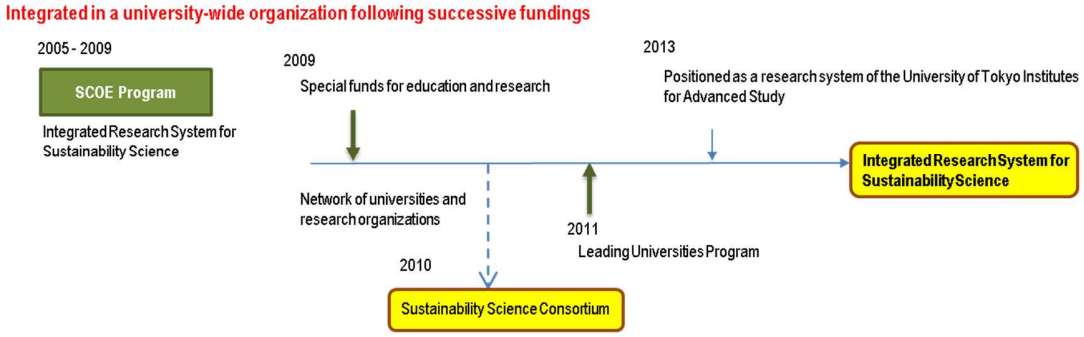
Continuation based on cooperation with the local government; expanded resea



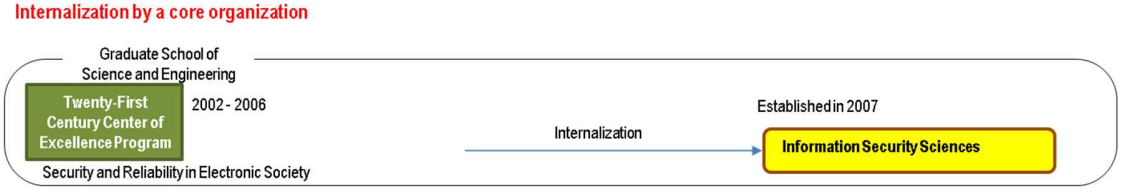
Kyoto University: Institute for Advancement of Clinical and Translational Science



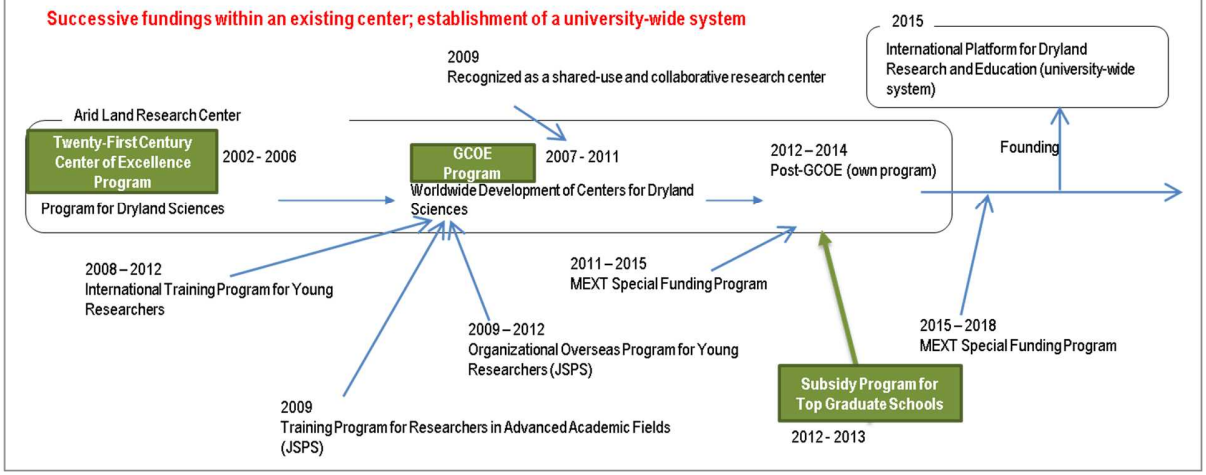
University of Tokyo: Integrated Research System for Sustainability Science



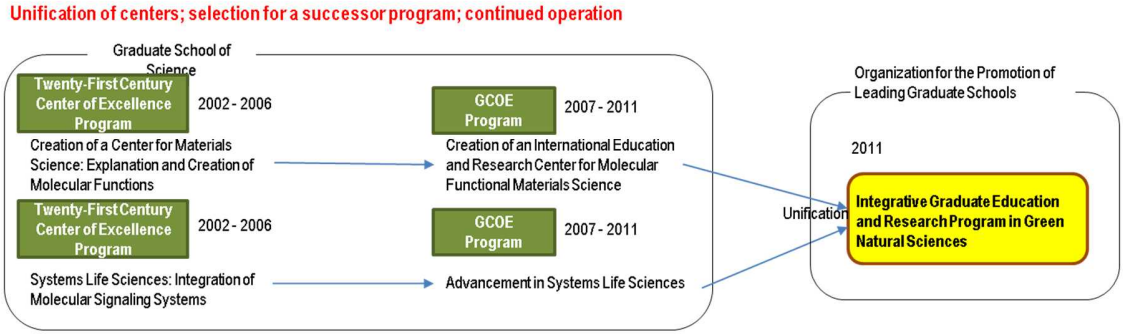
Chuo University: Information Security Sciences, Graduate School of Science and Engineering



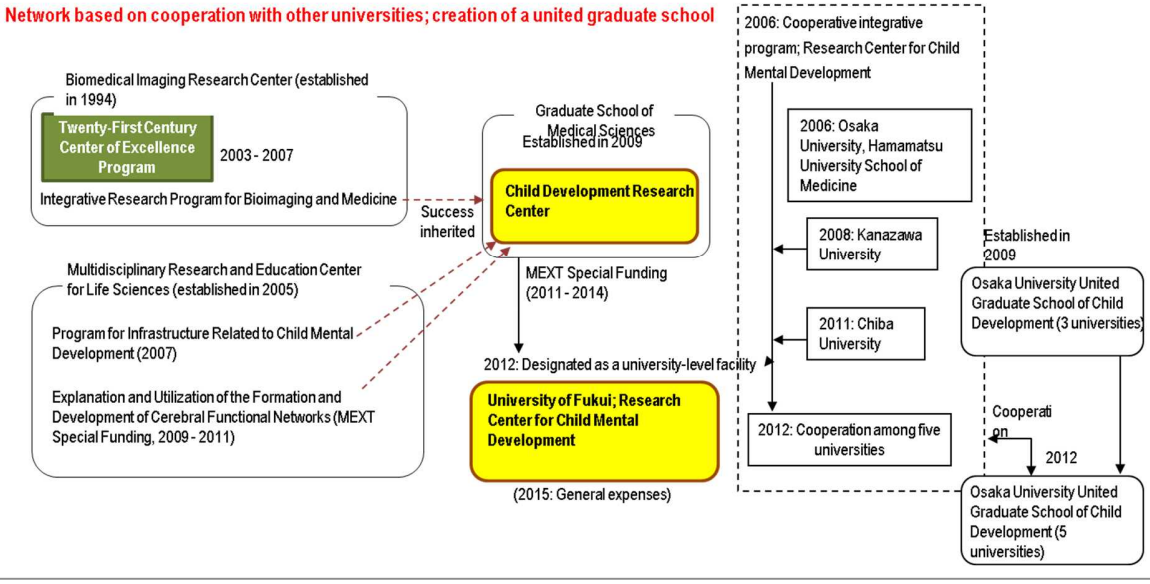
Tottori University: International Platform for Dryland Research and Education

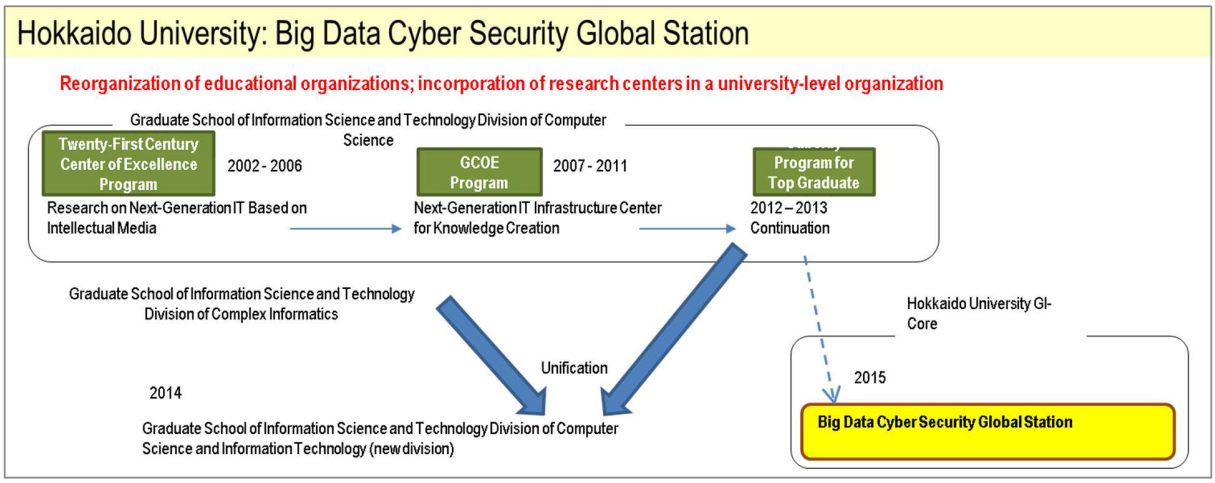


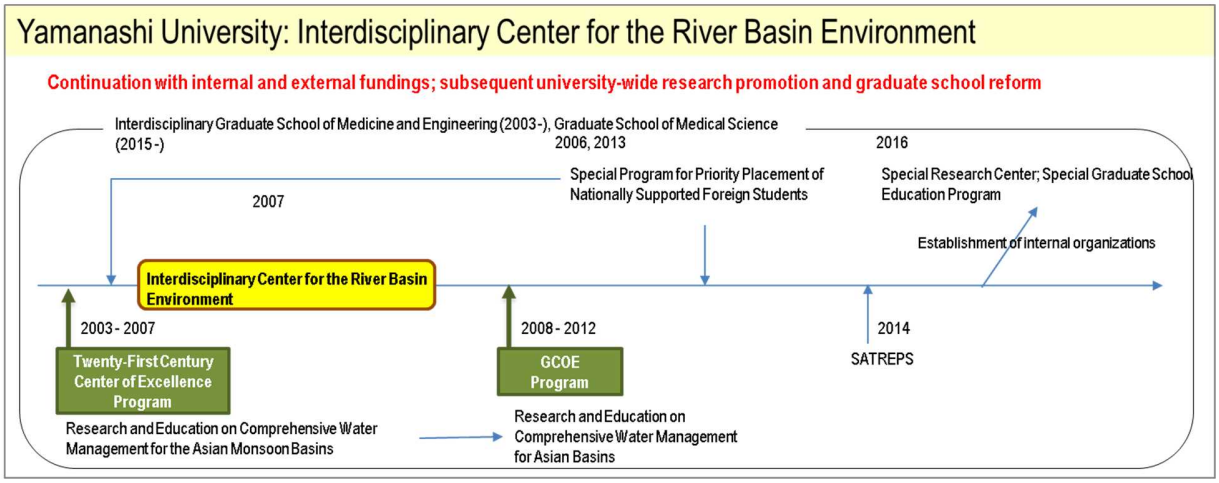
Nagoya University: Organization for the Promotion of Leading Graduate Schools



University of Fukui: Research Center for Child Mental Development




Hokkaido University: Big Data Cyber Security Global Station
Reorganization of educational organizations; incorporation of research centers in a university-level organization
Graduate School of Information Science and Technology Division of Computer Science
Twenty-First Century Center of Excellence Program
2002 - 2006
Research on Next-Generation IT Based on Intellectual Media
GCOE Program
2007 - 2011
Next-Generation IT Infrastructure Center for Knowledge Creation
Program for Top Graduate
2012 – 2013
Continuation
Graduate School of Information Science and Technology Division of Complex Informatics
Unification
2014
Graduate School of Information Science and Technology Division of Computer Science and Information Technology (new division)
Hokkaido University GI-Core
2015
Big Data Cyber Security Global Station


Yamanashi University: Interdisciplinary Center for the River Basin Environment
Continuation with internal and external fundings; subsequent university-wide research promotion and graduate school reform
Interdisciplinary Graduate School of Medicine and Engineering (2003-), (2015-)
Graduate School of Medical Science 2006, 2013
2016
2007
Special Program for Priority Placement of Nationally Supported Foreign Students
Special Research Center; Special Graduate School Education Program
Establishment of internal organizations
Interdisciplinary Center for the River Basin Environment
2003 - 2007
Twenty-First Century Center of Excellence Program
Research and Education on Comprehensive Water Management for the Asian Monsoon Basins
2008 - 2012
GCOE Program
Research and Education on Comprehensive Water Management for Asian Basins
2014
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