National Strategies to Foster Innovation in Japan: Achievements, Shortcomings and Challenges to the Science and Technology Basic Plans in Japan[1]

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Abstract

Japan's First and Second Science and Technology (S&T) Basic Plans (1996-2001 and 2001-2006), developed in response to the 1995 Science and Technology Basic Law – along with broader Japanese government reforms enacted starting in January 2001 - have significantly altered the science and technology enterprise in the country, not only substantively but also in the ways that Japanese (and foreign) scientists think about the enterprise. Although there some continuity between the two plans, they differed in their objectives. Whereas the First Plan sought to expand the enterprise, the Second also aimed at its reorientation. The Second Plan also served as a partial agenda for the National Council for Science and Technology Policy (CSTP), created at the time of the reorganization of the Government of Japan in January 2001. Additional, complementary measures have also contributed to changes in the science and technology enterprise.

Quantitative assessments of the impacts of the two plans and related measures by the National Institute for Science and Technology Policy (NISTEP) and its contractors provided inputs into the formulation of the Third Basic Plan (2006-2011). The Third Plan was released by the CSTP on March 22, 2006. It promises to remedy some of the deficiencies of the First and Second Plans, as

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1. For presentation at a meeting of the AFOSR Asian Science and Technology Forum, May 25, 2006.

2. See, www.law.gmu/nctl//stpp

well as undertake additional significant reformations of the Japanese science and technology system including, significantly, its academic sector.

Overview: A Personal Note

Not only the structure but also the modes of activity associated with Japan's science and technology (S&T) system (particularly though not exclusively its government- supported sectors) have changed dramatically since the fall of 1997 when I first began to become seriously interested in Japanese science policy. The stage was set with passage by the Diet of the Science and Technology Basic Law in November 1995, which resulted in the formulation of the First and Second Science and Technology Basic Plans (Japanese fiscal years 1996-2001 and 2001-2006, respectively). It is worth recalling briefly the unusual circumstances through which the November 1995 Basic Law came into existence[3]. Most legislation considered by the Diet is drafted not by Diet Members themselves, but by bureaucrats within the Government of Japan's relevant ministries and agencies working in cooperation with key Diet Members. By contrast, the 1995 Science and Technology Basic Law was an initiative of a small group of Members of the Diet itself, led by Koji Omi, a former Ministry of International Trade and Industry (MITI) since January 2001, the Ministry of Economy, Trade and Industry (METI) bureaucrat. Omi became Japan's first Minister of State for Science and Technology after that position was created in January 2001. By 1995, he had become convinced that strong measures were required if Japan's science and technology system was to remain internationally competitive into the 21st Century. In formulating the provisions of the Basic Law he and his colleagues worked closely with leading members of Japan's scientific community with whom they shared concern for the future of their country's science and technology system.

In September 2004, Japan's National Center for Science and Technology Policy (NISTEP) convened an international workshop in Tokyo to review the principal achievements – and shortcomings - of the First and Second Basic Plans[4]. In preparation for the workshop, NISTEP and its contractors carried out several detailed, statistically-based evaluations. Many of their

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3. An unofficial English language translation of the Basic Law can be accessed at http://www8.cao.go.jp/cstp/english/law/law.html.

4. The agenda and PDF files of all presentations at the September 13-14 *International Workshop on the Comprehensive Review of the S&T Basic Plans in Japan* can be accessed at www.nistep.go.jp.

conclusions were distributed in advance to workshop participants, and others were presented during the two-day meeting itself.

This paper begins by reviewing some of the principal reorganization and reform measures taken by the Government of Japan in addition to the two Basic Plans , some of which helped to revitalize the country's science and technology system, and then summarizes the principal features of the two Plans themselves. Next, it presents some of the more salient data and conclusions from the 2004 NISTEP review, and discusses what are, to me, some of the principal, positive changes – and challenges - which I have observed in the Japanese science and technology system since I first began to observe it seriously almost nine years ago.

These changes have come about in part because of the two Basic Plans, and those were quite properly the primary focus of the NISTEP workshop. But it is also essential to emphasize that other measures during the past seven years have also complemented and reinforced the key provisions of the two plans. Regrettably, neither NISTEP nor any other organization has engaged in any comprehensive, quantitative analysis of major trends in the Japanese science and technology system since the results of the analysis carried out in conjunction with the September 2004 workshop were released in March 2005[5].

The Council on Science and Technology Policy (CSTP) released the Third S&T Basic Plan (2006-2011) in March 2006. This plan is based in part on the evaluations of NISTEP and its contractors and on the results of the September 2004 NISTEP workshop. I will conclude by summarizing briefly the more significant provisions of the Third Plan, and by providing my impressions of the extent to which they address the shortcomings that NISTEP and I detected in the Second Plan.

Reorganization of the Government of Japan: 2001

Merger of Monbusho and STA. In addition to the First and Second Science and Technology Basic Plans, no doubt the most far reaching of the measures that have transformed the Japanese science and technology system during the past five years was the reorganization and restructuring of the entire Government of Japan which, symbolically, took place during the first days of the new

5. *Study for Evaluating the Achievements of the Science and Technology Basic Plans in Japan – Key Figures for FY 2003 and 2004*, National Institute for Science and Technology Policy, March 2005 http://www.nistep.go.jp/index-e.html.

century - January 6, 2001. Indeed, in the absence of this reorganization, it is virtually certain that many of the objectives of the two Plans could not have been reached. Although this restructuring had impacts that have gone well beyond the country's science and technology system, it has had major and in my view largely positive impacts on that system. In particular the former Ministry of Education, Science, Sports and Culture (*Monbusho*) and the Science and Technology Agency of Japan (STA) were merged to form *Monbukagakusho* or, in English, the Ministry of Education, Culture, Sports, Science and Technology, MEXT. Additionally, the former Ministry of International Trade and Industry (MITI) became the Ministry of Economy, Trade and Industry (METI) and assumed responsibility for most of the nuclear-related programs of the former STA.

The impacts of the merger of *Monbusho* and STA on the cultures of the two former organizations have been impressive. Prior to 2001 there was virtually no official communication between these organizations; indeed each barely recognized the existence of the other. NISTEP, as an organization within STA, often had serious difficulties obtaining data from national universities which were, of course, controlled and regulated by *Monbusho*. When I was a staff member in the Division of International Programs of the National Science Foundation (NSF), now the Office of International Science and Engineering, I received numerous foreign visitors. If any such visitors requested my assistance in obtaining a meeting at another agency such as the National Institutes of Health or the Department of Energy I was most often able to oblige. But if on my first visit to Japan in 1997 I had asked someone at *Monbusho* to help arrange an appointment at STA, for example, he or she would have been surprised and, perhaps, even more than a little outraged at my request.

In contrast, today staff members of MEXT who were formerly from *Monbusho* and STA work together closely, and MEXT communicates and cooperates with other ministries to an extent unthinkable before 2001. As an example, MEXT and METI are the two principal ministries supporting Japan's National Nanotechnology Initiative. Relevant staff members from one of these ministries routinely brief foreign visitors about the highlights of the activities of the other, and vice-versa. The merger has also facilitated working relations between scientists and institutions supported by the former STA and scientists at national universities: for example, between the Tokyo University Ocean Research Institute and the Japan Marine Science and Technology Institute (JAMSTEC).

Creation of the Cabinet Office. Even more significant than the merger of *Monbusho* and STA into MEXT or the conversion of MITI to METI was the creation, on January 6, 2001, of a Cabinet Office responsible for providing the Prime Minister and his Cabinet with the tools required to

manage their government effectively. (This was also the principal objective of the creation in the United States of the Executive Office of the President in 1939, during the second administration of President Franklin D. Roosevelt.) At the same time, the Council on Science and Technology Policy within STA was elevated to the status of the National Council for Science and Technology Policy (CSTP) within the Cabinet Office. One of the first, most visible actions of the CSTP was to approve the Second Science and Technology Basic Plan and recommend its adoption to the Cabinet to go into effect on April 1, 2001. Also, the Diet created the new position of Minister of State for Science and Technology within the Cabinet Office who, by law, outranks all ministers in charge of the line ministries which support and regulate the Japanese science and technology system.

Prior to 2001, it was literally impossible for the Japanese government to implement effectively or even to formulate a coherent, long-term science policy. Rather, each individual ministry or agency pursued its own science policy consistent with its budget, as approved by the Ministry of Finance. Overall science policy was characterized by a senior NISTEP official as "policy-by-stapler." That is, one simply took the annual budgets of the various ministries and agencies and stapled them together. And of course there was little or no coherence among the stapled items.

But since the creation of a Cabinet Office and the CSTP, a mechanism has existed to take a broad view of the programs of the science- and technology-related ministries of the government and to formulate a cross-cutting government-wide science and technology policy. Additionally, the means also exist to enforce discipline on the various ministries to implement that policy. I first became aware of the impacts of CSTP on the government's science and technology system early in September 2001 when I was serving as Director of NSF's Tokyo Regional Office. Prior to that time we were able to obtain approximate data on the science-and technology-related budgets of the ministries and agencies from STA soon after August 31 when those budget requests are submitted to the Ministry of Finance. But we were unable to obtain budget figures for Japan fiscal year 2002 until after December 31, 2001, when the entire government budget is submitted for consideration to the Diet. From September through December of that year the newly created Cabinet Office, in consultation with the CSTP, reviewed the budgets of the various ministries for consistency, and no doubt obliged them to make changes. Thus starting in 2001, the Japanese Government began to move forcefully to develop and implement a coherent national science and technology policy, which became effective at the start of fiscal year 2002 ― that is, April 1, 2002.

One notable feature of the Third Basic Plan, released in March 2006, is its bold assertion of the role of the CSTP as ultimate arbiter of the Japan's government's science and technology enterprise.

Changed Status of Government Laboratories. Another significant event which occurred within three months of the overall government reorganization was the conversion, on April 1, 2001, of virtually all government or public laboratories and related research facilities to the status of Independent Administrative Agencies. This change also affected other institutions such as hospitals and museums supported and managed by the central government, for example. Their new status provided the government or public laboratories and related facilities with substantial operating autonomy from their parent ministries, with the provision that after three years their respective budgets would be determined largely on the basis of evaluations of how well they were performing their relevant activities.

As the principal example, on April 1, 2001, the former Agency for Industrial Science and Technology (AIST) within MITI, which formerly operated 15 large research facilities directly (eight in Tsukuba and the remaining seven scattered around the country) became the National Institute for Advanced Industrial Science and Technology (the "new" AIST) funded by, but with its operations largely independent of the new METI. AIST itself was promptly reorganized into more than 40 research units: 20 of these units (the great majority in Tsukuba) are now designated as institutes. These institutes set their own research agendas determined primarily in a bottom up manner under broad guidelines established by the AIST leadership. Also, approximately 20 new research centers were created on April 1, 2001. In contrast with the research institutes, these centers can exist for no more than seven years and pursue more narrowly defined objectives determined in a top-down manner.

Budgets for the various institutes and centers are now determined in part on the basis of annual evaluations conducted both by AIST and by METI itself. Institutes and centers are grouped into disciplinary clusters. Since by design each such unit is too small to pursue a viable research program on its own, they are obliged to cooperate. Additionally, there is now considerable cooperation between the AIST facilities and private industry. Prior to April 1, 2001, AIST facilities were an integral part of METI, which also had responsibility for regulating private industry. Thus, institutional cooperation between an AIST laboratory and a private company could have constituted a serious conflict of interest. Now that the AIST facilities are no longer an integral part of the new METI, there can be no such conflict.

From my limited perspective, this reorganization has greatly enhanced the overall ability of the AIST institutes and centers to conduct industrially-relevant research, often in cooperation with industrial researchers on temporary detail to its institutes and centers. That the annual evaluations are taken seriously is evidenced from the fact that two or three or the original centers were

terminated within three years of April 2001, presumably on the grounds that they were not living up to prior expectations.

Changed Status of National Universities. On April 1, 2004, Japan's national universities attained a status somewhat analogous to the independent administrative agency status that was granted to national laboratories three years earlier. The enabling National University Corporation Law of July 16, 2003, gave them the status of corporations with substantial "management autonomy and independence". At the same time, national university faculty ceased to be employees of the central government and began to work under renewable five-year contracts rather than lifetime appointments.

The impacts of the new, largely autonomous status of national universities and their faculties could be significant. For example, national universities are now free to make decisions regarding personnel and compensation, as well as curricula. Many are likely to seek their own competitive niches, with the result that the academic scene in Japan is likely to become considerably more lively and interesting during the next few years. Since Japanese professors are no longer government employees, they are able to consult more freely with industry, to create their own companies, or to serve on the boards of other companies. In principal, one or more national university could decide to abolish or weaken considerably the *koza* system in which junior faculty members attach themselves to the research group, or *koza*, of a senior professor and remain in that group until the professor retires or they attain sufficient seniority to establish their own *kozas*. But the jury is still out on this possibility.

Additional Measures

Technology Licensing Organizations. Two additional actions by the Diet which have facilitated some of the changes in the ways that Japanese universities operate are also worth noting. In 1998, the Diet passed a law authorizing the creation of Technology Licensing Organizations, or TLOs. Since that time, more than 50 university-associated TLOs have been created with the objective of licensing intellectual property of faculty members to industrial organizations. AIST has also created its own TLO which has succeeded in licensing several discoveries of its researchers. As in the United States, only a relatively small minority of these organizations are making money. A more important issue is the extent to which they are succeeding in moving potentially commercializable research results into the marketplace.

Japanese Bayh-Dole Act. Finally, in 2000 the Diet passed a law which unambiguously granted researchers rights to any intellectual property resulting from their research so that university professors, as well as researchers in government laboratories, are now able to seek patents (either through associated TLOs or independently) and to license their patent rights. The 2000 legislation is sometimes referred to as the Japanese Bayh-Dole Act, a 1980 law granting intellectual property to discoveries made by university faculty supported by U.S. government grants and contracts to the universities themselves. Significantly, whereas the U.S. Bayh-Dole Act grants such intellectual property rights to universities, the comparable Japanese Law grants it directly to researchers rather than to their organizations.

Highlights of the Basic Plans

Let me now present briefly the highlights of the First and Second Science and Technology Basic Plans. Both set specific government expenditure targets for science and technology during their respective five-year terms. The First Plan called for total expenditures of 17 trillion yen (roughly $155 billion), an objective which was not only met but slightly exceeded. The Second Plan called for total expenditures of 24 trillion yen (roughly $220 billion), but included a caveat tying annual government expenditures on science and technology to the growth of the country's Gross Domestic Product (GDP). Namely, the Second Plan assumed an average annual growth rate of 3.5 percent in Japan's GDP. The 24 trillion yen goal was 0.86 percent of the assumed total five-year GDP growth. It was implied that if the average annual growth rate were to be less than 3.5 percent, the five year goal for the science and technology budget would also be less than 24 trillion yen. In fact, it turned out to be 21.65 trillion yen.

First Basic Plan. In addition to its budgetary goal, the First Science and Technology Basic Plan included several key provisions, namely:

1. Introduction of system of limited-term appointments for researchers in national research institutes;
2. Creation of 10,000 post-doctoral research positions by the year 2000;
3. Measures to facilitate university-industry research cooperation, including changes in intellectual property provisions and a relaxation of regulations governing the external activities of national university faculty;
4. An increase in the proportion of research support awarded on a competitive basis as opposed to the more traditional formula-based funding; and

5. Promotion of public understanding of science and the "establishment of a national consensus on science and technology."

Second Basic Plan. Likewise, the Second Science and Technology Basic Plan included what were referred to as principal objectives[6]:

1. Adopting a strategic approach to government research investments;
2. Building a competitive research environment;
3. Enhancing the independence and mobility of young researchers;
4. Improving the research evaluation system;
5. Utilizing research outcomes by promoting cooperation among the academic, industrial and government research sectors;
6. Promoting regional innovation; and
7. Enhancing communications with society.

Similarities and Distinctions. It is useful to consider similarities and distinctions between the two Plans on the basis of these two lists. Both emphasized:

- Limited term appointments and mobility for young researchers;
- Competitive research; and
- University-industry cooperation.

But whereas the primary emphasis of the First Plan was on expanding the Japanese academic research system, the Second aimed to reorient or, some would say, to reform that system. This is most evident in its emphasis on a strategic approach to research investments and on a rigorous system of evaluation.

However, the most significant distinction between the First and Second Plans has to do less with their substance but with their timing. As already noted, one of the first visible actions of the CSTP after it was created on January 6, 2001, was to recommend adoption of the Second Plan to the Cabinet, effective on April 1, 2001. I have already suggested why development and implementation of a coherent national science policy was virtually impossible in Japan prior to creation of a Cabinet Office and the CSTP. From this perspective, it is perhaps remarkable that

6. An unofficial English language translation of the 2nd Science and Technology Basic Plan can be accessed at: http://www8.cao.go.jp/cstp/english/s&tmain-e.html

many of the key provisions of the First Plan seem to have been realized. Perhaps the relevant ministries and agencies became convinced that the Ministry of Finance and the Diet would look more favorably at their aggregated requests for annual funding consistent with the five-year, 17 trillion yen goal if they appeared to be moving purposefully towards implementing the non-fiscal provisions of the Plan.

The Second Plan and the CSTP. Be that as it may, the Second Science and Technology Basic Plan provided the CSTP with a template for a national science and technology policy. More broadly, the Plan was used by that organization to set much of its own agenda. The CSTP held 26 monthly conferences chaired by the Prime Minister between January 2001 and March 2003. Starting with the 10th monthly conference on September 21, 2001, one or another of the principal objectives of the Second Basic Plan were on the agenda for all but five of these conferences. At its first monthly conference on January 18, 2001, more than two months prior to its formal adoption of the Second Plan at its fourth, March 27, 2001, meeting, the CSTP established five expert panels. Three of these (S&T Promotion Strategy, Evaluation, and R&D System Reform) corresponded to principal objectives of the Second Plan. Thus, it may not be unfair to suggest that a good deal of the success (or lack of success) of the CSTP during its first five years can be gauged in terms of the success of the Second Plan itself.

Ministry Initiatives. It is also useful to note that both MEXT and METI have adopted several initiatives since 2001 designed to help implement the Second Plan. Two key initiatives aim to facilitate technology transfer from universities to the commercial sector. In particular, METI (and the former MITI) began to provide grants to universities to establish and maintain TLOs soon after the Diet legitimized their creation in 1998. Since 2003, MEXT has been providing grants to universities to establish Intellectual Property Centers. Both ministries have also established programs to catalyze the enhancement of science and technology capabilities at the regional level.

Significant Achievements – and Shortcomings

In preparation for its September 2004 workshop in Tokyo, NISTEP summarized its findings regarding the achievements and shortcomings of the First and Second Basic Plans, with an emphasis on the latter. According to NISTEP, these were:

- The growth of S&T budgets in Japan has exceeded the growth of nominal GDP and government budgets as a whole (general expenditures).

- Japan maintained basically the same ratio of government-funded R&D expenditures to GDP as in the U.S. during the 1st Plan, but recently, the U.S. has again increased the difference with Japan.
- Basic research has shown an increasing trend in Japan, but the U.S. has strengthened basic research to a greater extent than Japan.
- Competitive research funds have been increased without putting pressure on appropriations for basic cost of education and research; however, it will be difficult to achieve the target of doubling competitive funds during the 2nd Plan.
- Development of facilities and intellectual infrastructure is basically progressing as planned.
- Among intellectual achievements, successful results have been achieved in papers, which have shown improvement in both quantity and quality. Patents have shown qualitative improvement, but quantitative improvement has lagged.
- Looking at prioritization in total R&D expenditures, budgets for four priority areas have been increased. Papers have also tended to show positive results in priority areas, but the same tendency cannot be seen in patents.
- In human resources, support for post-doctorates/doctoral graduates and researcher mobility were analyzed. Post-doctorates have achieved the quantitative goal of 10,000, but many problems remain in support measures and creation of career paths. A system intended to improve researcher mobility has been introduced, but little progress have been made in its application (the number of persons hired under the system is small).
- In industry-academia-government cooperation, joint research with industry and commissioned research performed by universities have expanded, and university-initiated start-ups have also shown growth, particularly in the four priority areas.
- In regional innovation, both the national government and local governments are actively involved in promoting science and technology. An analysis of the results of these efforts will be made in the future.

I will now summarize NISTEP's analysis that led it to arrive at several of the more salient of these findings, then offer some of my own perspectives..

Government S&T Budgets The budgetary goal of the First Plan - for the central government to expend 17 trillion yen for science and technology by the end of fiscal year 2001 (March 31, 2001) so that by that time its annual contributions would be double those during fiscal year 1992 - was

actually exceeded by approximately 1 percent. During the five years of Second Plan period, which ended on March 31, 2006, the government expended 21.65 trillion yen, thus falling short of its original 24 trillion yen expenditure goal, or .086 percent of the assumed 3.5 percent average annual growth in GDP over the five year period of the plan. However, the total growth in GDP was less than 3.5 percent – or 2,518 trillion yen rather than the 2,783 trillion yen assumed when the Plan went into effect. Since the government's S&T expenditures of 21.65 trillion yen over the period of the Plan was, in fact, 0.86 percent of the actual 2,518 trillion yen growth in GDP, the CSTP announced that, in fact, the Second Plan's budgetary goal had been met.

The principal rationale for the budgetary goals of both the First and Second Plans was to bring central government research and development (R&D) expenditures as a percentage of total national R&D expenditures more in line with those of the United States and other G7 countries on the reasonable grounds that research in national laboratories and universities is financed primarily by the public rather than the private sector. While the Japanese government's R&D expenditures as a percentage of total R&D remain the lowest of any of the G7 countries, that percentage has converged with that of the other countries, (Fig. 1), in part because that same percentage has declined elsewhere – particularly in the United States.

Double the Amount of Competitive Research Funds to Universities. The Second Plan set a goal of doubling the amount of competitive funds provided to universities from 300 billion to 600 billion yen between April 1, 2001 to March 31, 2006 – or increasing the fraction of competitive funding to total funding from 9 to 18 percent. Although competitive research funding did increase to 400 billion yen during the first three years of the Plan (Fig. 2), NISEP concluded that it was very unlikely that the 600 billion yen goal would be reached during the remaining two years. Indeed, the rate at which competitive funding increased was appreciably greater during the five years of the First than during the first three years of the Second Plan. According to NISTEP's analysis, "competitive research funds have been increased without putting pressure on appropriations for basic cost of education and research" that is, the block funding for research at national universities provided by MEXT. By the end of the Second Plan's five year period, the percentage of competitive funding had increased from 9 to only 13 percent, falling far short of the original 18 percent goal. The Third Basic Plan promises to pursue the matter of competitive funding more aggressively.

Adopting a Strategic Approach: Priority Areas. The Second Plan's objective of adopting a strategic approach to research expenditures was operationalized by emphasizing funding in four broadly defined priority areas: 1) life sciences, 2) information and communications technologies

(ICT), 3) environment, and 4) nanotechnology and materials, and four additional so-called promotional areas: 5) energy, 6) manufacturing technologies, 7) social infrastructure, and 8) frontier science. During the first three years of the Second Plan period, government research expenditures for the four priority areas increased from 37.6 percent during the period of the First Plan to 41.9 percent. According to NISTEP, the number of highly cited papers in the international peer reviewed literature also increased noticeably during the first three years of the Second Plan. However, the number of patent applications in these four areas fell short of expectations.

Regional Programs. NISTEP's May 2004 report noted that, "in regional innovation, both the national government and local governments are actively involved in promoting science and technology," but provided no detailed analysis of these promotion efforts. A map of Japan color-coded to indicate the intensity of these efforts by prefecture (Fig. 3) indicates that these efforts remain uneven.

Issues. What are the most significant issues associated with the First and Second Basic Plans for which NISTEP has provided data? My own biased selections are these:

1. Increasing the competitiveness of the research system;
2. Utilizing research results through better links among academic, industrial, and government research facilities;
3. Establishing an effective and fair research evaluation system; and
4. Increasing the independence and mobility of young researchers;

How well have these issues been addressed? The jury is still out on the effectiveness and fairness of the research evaluation systems created since 2001, in part because such systems have only now begun to be implemented in the newly autonomous national universities. And, as already noted, the increase in the fraction of competitive funding envisioned by the Second Plan has yet to materialize as rapidly as had been envisioned.

Technology Transfer. Perhaps the most significant change to have taken place in the Japanese science system during the past few years has to do with technology transfer from universities. In addition to enhanced university-industry research cooperation, universities now employ TLOs as a means for technology transfer. Additionally, there has been considerable activity associated with the creation of entrepreneurial start-up firms by both university faculty and researchers at the now independent national laboratories – particularly those of the National Center for Advanced Industrial Science and Technology (AIST).

For example:

1. Between 1998 and May 2004, 37 Technology Licensing Offices were established to facilitate the commercialization of university research results. The number of patent applications filed by TLOs in Japan and abroad increased from 310 in 1999 to 1,619 in 2002.
2. The number of joint research projects among universities and private firms almost doubled in five years, from 2,362 in 1997 to 5,264 in 2001.
3. The number of start-up companies created to commercialize university research results increased from a cumulative total of 315 in 2000 to 800 in 2003.

Several new university-based centers have been established with the objective of conducting basic research of relevance to industry. Two with which I have some familiarity are the Tohoku University New Industry Creation Hatchery Center and the Kyoto University International Innovation Center. But there are others as well. According to Fig. 4, although the number of joint university-industry research centers continued to increase during the first three years of the Second Plan, the rate of increase had begun to level off. On the other hand (Fig. 5), the number of joint research *projects* was continuing to increase.

According to Fig. 6, the number of new university-initiated startup firms rose from 11 in 1995, the year prior to the start of the First Plan, to 118 in 2001, the first year of the Second Plan, and has continued to grow. In 2001, METI set a goal of having a cumulative total of at least 1,000 such startups by the end of the Second Plan period. That goal appears to have been exceeded. However, no data are readily available about the number of new startups that have remained viable five years after they were established.

Status of Young Researchers. The least impressive achievement of the two Basic Plans involves the status of young Japanese researchers and the continuing failure of the country to promote and encourage labor mobility.

It is true that there are now many attractive short term (normally five-year) post doctoral research appointments for young researchers which did not exist at the inception of the First Science and Technology Basic Plan in 1996. Additionally, since the national universities became Independent Administrative Agencies on April 1, 2004, all faculty appointments, including those of senior professors, have been limited to five years, with options for renewal, of course.

A critical question, of course, is what are the career options for talented young Japanese researchers after they complete a five-year post-doctoral research appointment at an AIST facility or at a prestigious laboratory such as are found at RIKEN, for example? If these young researchers elect to pursue academic careers, they have little choice but to become associated with a *koza* and thus tie their careers to those of full professors until the latter are obliged to retire – or until one or more of the now autonomous national universities take the bull by the horn and abolishes or significantly downgrades the *koza* system.

At the risk of being labeled as a brazen *gaijin* (foreigner), let me suggest that the dead weight of the Japanese university seniority system may be the most important element of the country's science system that still requires serious attention. When I spent six weeks in Japan in the fall of 1997, a very eminent senior Japanese physicist asked, rhetorically, "How can I release the energies of my young bears and tigers?" To me, the answer is painfully obvious: grant them a greater degree of autonomy! The Third Basic Plan proposes to do just that, although it is somewhat vague about how the CSTP, as the primary arbiter of the system, intends to proceed.

Are the prospects of post-Docs or newly minted PhDs any better in the private sector? They are most certainly not. Japanese companies remain notoriously reluctant to hire PhDs, although that situation seems to be changing, albeit slowly. According to the results of a survey conducted in 2000 and repeated in 2001 and 2002, NISTEP found that approximately 60 percent of the companies who responded stated that they would never or rarely hire a newly-minted PhD (Fig. 7). According to that same survey, in 2002, 89 percent of those same companies stated that they would never or rarely hire a post-Doc, a fraction that decreased to 82 percent two years later.

Mobility. Nor has intersectoral mobility or even mobility among universities increased appreciably. According to Fig. 8a, the number of moves made by Japanese university professors increases with their age, which is a quite reasonable expectation. However, according to Fig. 8b, the average number of moves expected by a university professor during his/her professional career is 0.8, suggesting that many never move at all. By contrast, the average number of moves for a university professor in the United States is 1.5 and in the Netherlands 3.5.

According to Fig. 9, intersectoral mobility remained almost statistically insignificant in 2001. During that year, 301 university faculty members moved into private industry, while the universities hired 1,104 faculty members from private industry. During that same year, 228 researchers made a transition from a public (i.e., national) research facility to a private company, while 1,278 private company researchers obtained positions in public facilities.

The Third Basic Plan[7]

The 1995 Science and Technology Basic Law required that one or more Basic Plans to implement its broad provisions should be formulated to be effective for 10 years starting with fiscal year 1996 – that is, from April 1, 1996 through March 31, 2006. As already noted, two successive five year Basic Plans were formulated and implemented to cover this required 10 year period. The Diet has taken no subsequent action to require any comprehensive Science and Technology Basic Plan extending beyond March 31, 2006. Apparently, however, the CSTP became convinced that such plans which, in effect, constitute statements of government science policy, should be institutionalized, at least to some extent. The moving spirit behind this conviction was almost certainly Iwao Matsuda, a member of the House of Counselors (the upper house of the Diet), currently the Minister of State for Science and Technology, and formerly the Minister of Economy, Trade and Industry (METI). In any event, on March 22, 2006, the CSTP released a Third Science and Technology Basic Plan, to be effective from April 1, 2006 through March 31, 2011. In releasing this plan, the CSTP stated that its primary mission would be "to complete the items not finished in the first and second plans".

The 70-odd page provisional English language version of the Third Plan is divided into five chapters, as follows:

Chapter 1 – Basic Ideas
Chapter 2 – Strategic Priority Setting in S&T
Chapter 3 – Reforming the S&T System
Chapter 4 – S&T to Be Supported by Society and the Public
Chapter 5 – Role of the Council for Science and Technology Policy

Budgetary Goal. Like the First and Second Plans, the Third Plan emphasizes a budgetary goal: namely, that the government will invest 25 trillion yen in science and technology during the five year period of the Plan, which is one percent of GDP, on the assumption that the average annual GDP growth rate will be 3.1 percent during the period. In contrast, the Second Plan's goal was to invest 0.86 percent of GDP in science and technology.

7. An unofficial English language translation of the Third Science and Technology Basic Plan may be accessed at http://www8.cao.go.jp/cstp/english/basic/index.html#third.

Chapter 1 – Basic Ideas

Chapter 1 reviews the objectives, as well as the achievements and shortcomings of the Second Science and Technology Basic Plan (April 1, 2001 – March 31, 2006). It then goes on to list six goals for the Third Plan, namely:

Goal 1 – Quantum jump in knowledge, discovery, and creation – accumulation and creation of diverse knowledge to ensure a bright future:

- Discover and clarify new principles and phenomenon
- Create knowledge as a basis of discontinuous innovation

Goal 2 – Breakthroughts in advanced S&T – efforts for human dreams to come true

- Bolster S&T by conducting the world's most advanced projects

Goal 3 – Economic growth & environmental protection

- Overcome global-warming and energy problems

Goal 4 – Innovator Japan – realizing a strong economy and industries creating innovation constantly

- Realize a ubiquitous Internet society attracting global interest
- Become the world's top manufacturing nation
- Enhance industrial competitiveness to win in global S&T competition

Goal 5 – Protect the nation's health and security – making Japan a country where people ranging from children to the elderly can stay healthy

- Overcome diseases afflicting the public
- Realize a society where everyone can stay healthy

Goal 6 – The world's safest country – making Japan the world's safest country

- Secure national, social safety
- Ensure safety in life

Chapter 2 – Strategic Priority Setting in S&T

The Third Plan is virtually identical to the Second in emphasizing the same four broad priority areas and the same four promotion areas, namely: 1) Life Sciences, 2) Information Technology, 3) Environment, 4) Nanotechnology/Materials, 5) Energy, 6) Manufacturing Technologies, 7) Social Infrastructure, and 8) Frontiers. The chapter devotes considerable space to justifying these priority and promotional areas and the ways they are to be implemented.

Chapter 3 – Reforming the S&T System

This chapter constitutes the core of the Third Basic Plan. Its principal subsections are:

1. Developing, securing and activating human resources,
2. Creating scientific development and persistent innovation,
3. Reinforcing the foundation for promoting S&T, and
4. Strategically promoting international activities.

Developing, securing and activating human resources. This section recognizes implicitly the institutional barriers that have partially, even largely negated the intent of the objectives of the First and Second Basic Plans to award prestigious five-year postdoctoral research fellowships to the most promising and creative young scientists in Japan. Industry remains indifferent, at best, to hiring these fellows following their tenure, and those post-Docs who subsequently decide to pursue careers in academia are subject to the still prevalent seniority system based on the *kozus* ruled by senior professors. The Plan announces that steps will be taken to break down barriers that inhibit the creativity of young people. But concrete proposals are largely lacking.

The Plan also sets a goal of having women occupy 25 percent of the S&T workforce by the end of its five year period. Also, positions are to be made available for "excellent" foreign researchers. What the Plan fails to note is that there are already reasonably large numbers of first-rate young foreign researchers working in the country, a sizeable number – perhaps a majority of them - being Chinese. Yet there is a glass ceiling for Chinese – as well as Korean researchers in Japan, with virtually none attaining permanent positions. The Third Plan pledges to reduce barriers such foreign (Chinese?) researchers experience in obtaining visas. For example, it proposes that any foreign national who obtains a PhD from a Japanese university should be given preferential consideration in obtaining a postdoctoral position. But it is silent about problems associated with their cultural assimilation.

Creating scientific development and persistent innovation. This section deals primarily with increasing the competitiveness of the national university and national or public laboratory sectors of the Japanese S&T system. The Second Plan set the objective of doubling the percentage of research funds awarded on a competitive basis – from 9 to 18 percent. In fact, as already noted, that objective fell short by five percent. Steps are proposed to increase the percentage beyond 18 percent during the five year duration of the Third Plan, particularly in public research facilities.

Reinforcing the foundation for promoting S&T. Here the Third Plan's objective is quite concrete: "It is expected to establish 30 world-class centers, research centers in frontier and interdisciplinary areas, intelligence centers in local areas as well as to strengthen the activities at public research institutions in local areas." MEXT established a competitive Centers of Excellence Program in fiscal year 2002 with five-year awards for each grant and by the completion of the third annual competition in fiscal year 2004, had awarded 274 projects to 93 universities in 11 fields[8]. Of the 51 national universities awarded Centers of Excellence grants during the first three rounds, 28 were awarded to Tokyo University, 23 to Kyoto University, with the remaining five of the original Imperial Universities receiving the lion's share of the remainder, namely: Hokkaido – 12, Tohoku – 13, Nagoya – 14, Osaka – 15, and Kyushu – 8. After the completion of the third Centers of Excellence competition in 2004, questions were raised about whether the program had fulfilled its objectives and should be discontinued. The Third Plan's emphasis goal of establishing 30 new centers may be largely an admonition for MEXT to continue its good work, while spreading its largess more broadly.

Strategically promoting international activities. In marked contrast with the First and Second Basic Plans, the Third emphasizes the need for enhanced international cooperation if Japan is to attain the goals of the Plan, particularly reform of its science system. On several occasions it refers to rising competition from other Asian nations, although it never singles out China by name. Indeed this section on international activities stresses cooperation with Asian nations:

> *As well as continuing to improve the prior international frameworks, and cooperation and collaborations with European nations and the United States of America, the government will strengthen the ties of S&T with Asian nations to fulfill the role that is expected of Japan from both inside and outside the country, in view of international situations, i.e., the geographical and environmental accessibility, the rapid improvement of the S&T standards, and the increasing closeness of economic relations.*

To this end,

> *the government will implement a policy dialogue called "Asian Region S&T Ministerial Summit" (tentative name) at a high level including ministers involved*

8. National Science FoundationTokyo Report Memorandum #04-06, dated July 20, 2004., www.nsftokyo.org .

in S&T nations, based on the existing government-to-government dialogue and interaction by researchers.

Chapter 4 - S&T to be Supported by the People. The Third Plan reiterates the public understanding and accountability objectives of the First and Second Plans but in a somewhat altered manner: "The government's efforts to obtain the people's support for S&T activities are essential. The accountability of the S&T activities needs to be made clear. Also, the government is required to establish measures to resolve ethical, legal, or social problems caused by S&T."

Chapter 5 - Role of CSTP (Council for S&T Policy). The Third Plan is quite specific regarding the responsibilities and authority of the CSTP which is expected to take leadership across the ministries/agencies by making oversight, evaluation, and advice to S&T-related activities. It should establish "living strategies," promote international activities, and reform S&T systems, including establishing countermeasures for abuse of the government. In essence, this chapter firmly asserts the primacy of the CSTP in all science policy matters within the Government of Japan.

Impacts of Events Since 2001 on the Formulation and Implementation of the Third Plan.

In assessing the provisions of the Third in contrast with the First and Second Science and Technology Basic Plans, it is essential to recognize that significant changes have occurred in the Japanese science system since the adoption of the Second Plan on April 1, 2001. The CSTP played no part in formulating the Second Plan, although its less effective predecessor, the Council for Science and Technology Policy within the STA played a somewhat limited role. However, the CSTP was only elevated to its status within the newly created Cabinet Office in January 2001, and one of its first official acts was to recommend adoption of the Second Basic Plan. Equally important, on April 1, 2001, most national laboratories which up to that time had been closely controlled by their parent ministries became Independent Administrative Agencies with a considerable degree of autonomy. Likewise, on April 1, 2004, the national universities achieved an analogous status.

Thus, central government ministries now exert considerably less control over the directions of science and technology in public research facilities and national universities than they did at the beginning of the Second Plan period. Although the Minister of State for Science and Technology and the CSTP which serves as his/her implementing and enforcing arm takes precedence over all operational ministries of the government, that official's authority over the country's science system

has been diminished. Thus, for example, whereas the Minister of State and the CSTP – and MEXT itself – might entertain thoughts of reforming the seniority system at national universities to improve better opportunities for rapid advancement by the best young people, such an initiative would have to come from the universities themselves rather than be dictated by any central government authority. On the other hand, the CSTP and relevant government ministries do have considerable leverage via the budget and the closely coupled evaluation process. Therefore one requirement for a successful application for one of the 30 new Centers of Excellence to be created during the five year period of the Third Basic Plan might well include the provision of greater autonomy for creative young scientists and engineers.

The Need for Additional, Continuing Analysis

In several important respects the Japanese science and technology system is almost unrecognizably different from what it was at the inception of the First Science and Technology Basic Plan in 1996. In 2003 and 2004, NISTEP was commissioned by the CSTP to conduct an extensive analysis of achievements and shortcomings of the First Plan and the first three years of the Second Plan. Nothing nearly so comprehensive has been undertaken during the last two years, nor are there any hints that such a follow-on study will be undertaken. In addition to assessing the achievements–and shortcomings–of various government programs intended to reform the Japanese science system, it would be useful to have reliable, quantitatively based analyses of, for example:

- How well the university-based Technology Licensing Organization (TLOs) are functioning,
- The success and failure rates of university-based start-up companies,
- The experiences – positive and negative – of the former government controlled research facilities since they became Independent Administrative Agencies on April 1, 2001,
- Analogous studies on the experiences of national universities since April 1, 2004, and
- The career paths of young researchers after they complete their prestigious five-year post-doctoral research experience.

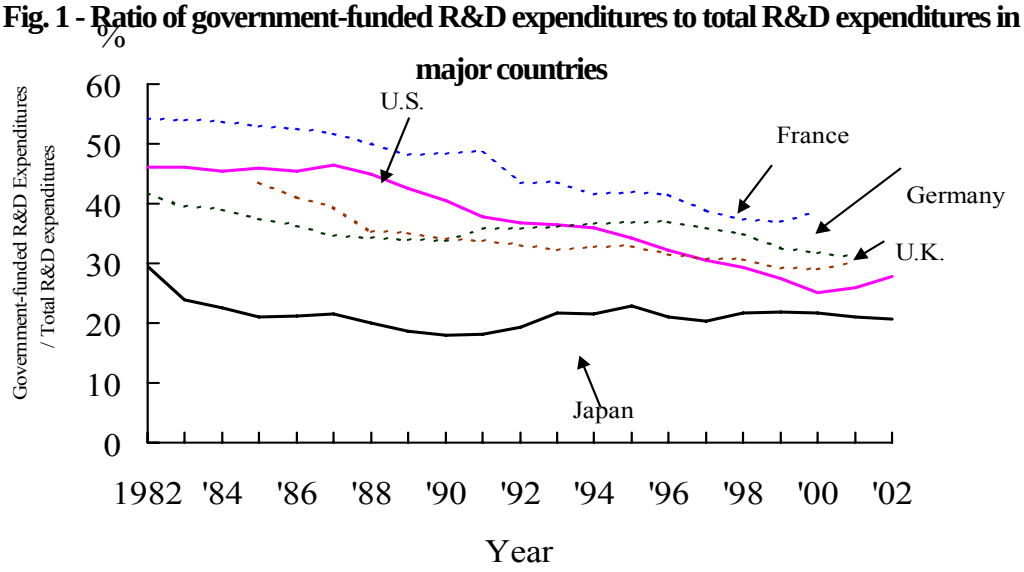
Acknowledgements

It is a pleasure to thank the Japan Society for the Promotion of Science (JSPS) whose award of a Senior Post Doctoral Fellowship in 1997 enabled me to come to Japan for six weeks in the fall of that year to study the ways that the First Science and Technology Basic Plan was being implemented during its initial months – and to spark my interest in science and technology in the country. Thus, JSPS was instrumental in my success in competing for the position of Director of the National Science Foundation's Tokyo Regional Office, a position I held from July 1999 through August 2002, and of course I am grateful to NSF for providing me with the opportunity to witness the changes in the Japanese government's S&T system during those years. A second JSPS Senior Post Doctoral Fellowship enabled me to spend six weeks in Japan in the spring of 2003 following my retirement from NSF to explore some of the achievements – and shortcomings – of the First and Second Plan. I am indebted to NISTEP for serving as host on that second occasion. I am also grateful to NISTEP for designating me as an International Affiliated Fellow, and for inviting me help plan, and then to participate, in its September 2004 International Workshop on the Comprehensive Review of the S&T Basic Plans in Japan.

Figures

NB: All figures are taken from NISTEP's March 2005 report entitled, *Study for Evaluating the Achievements of the Science and Technology Basic Plans in Japan – Key Figures*

Fig. 1 - Ratio of government-funded R&D expenditures to total R&D expenditures in major countries



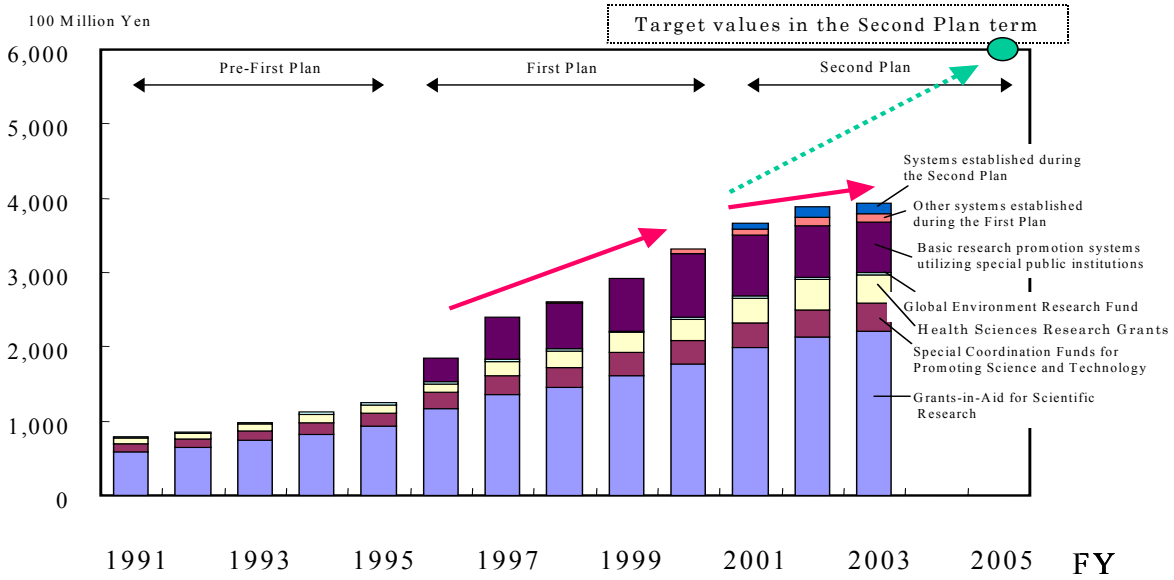


Fig. 2 Trend in budgets for competitive research funds

Fig. 3 Progress in implementation of S&T policies by local governments

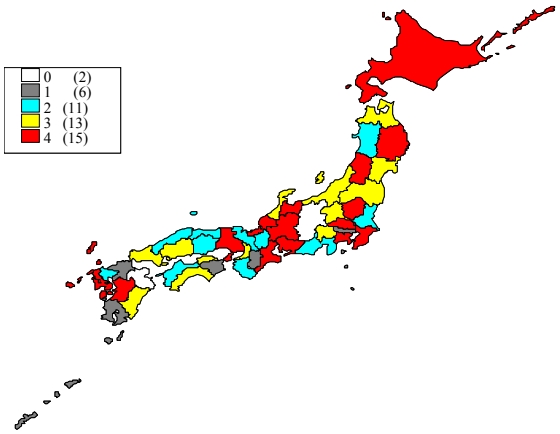
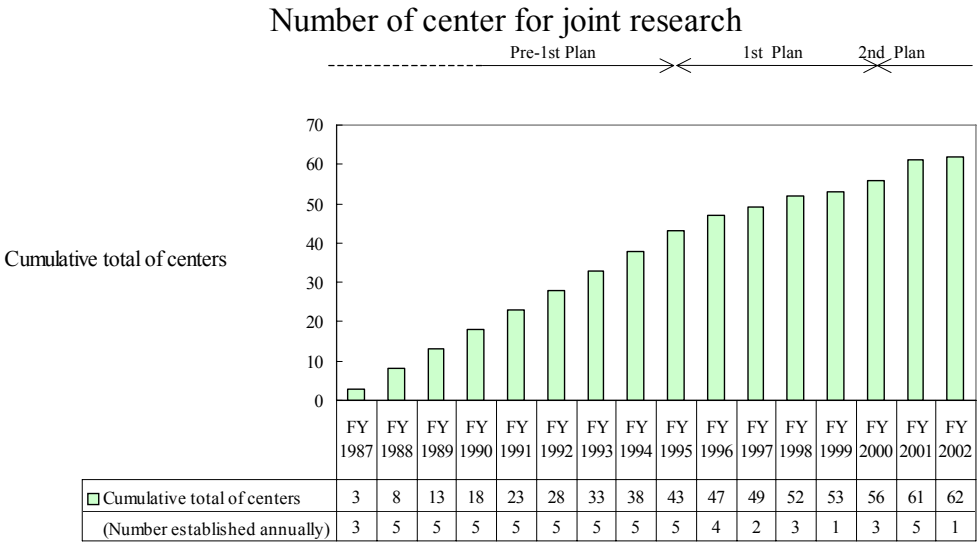
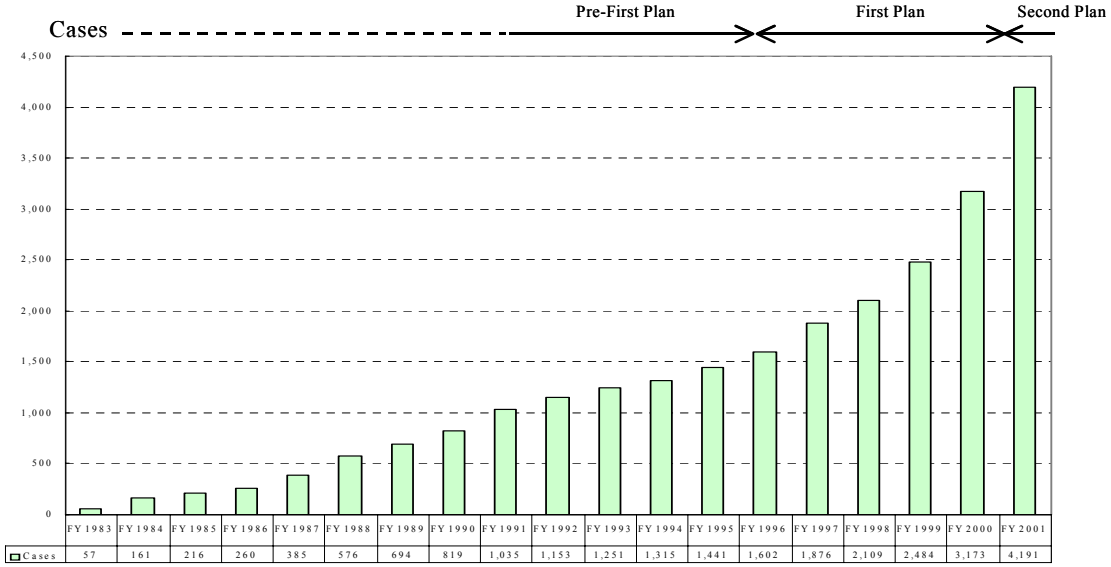


Fig. 4 Number of joint university-industry research centers



	FY 1987	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
Cumulative total of centers	3	8	13	18	23	28	33	38	43	47	49	52	53	56	61	62
(Number established annually)	3	5	5	5	5	5	5	5	5	4	2	3	1	3	5	1

Fig. 5 Number of joint research projects by national universities and industry



	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
Cases	57	161	216	260	385	576	694	819	1,035	1,153	1,251	1,315	1,441	1,602	1,876	2,109	2,484	3,173	4,191

Fig. 6 Trend in number of university-initiated startups

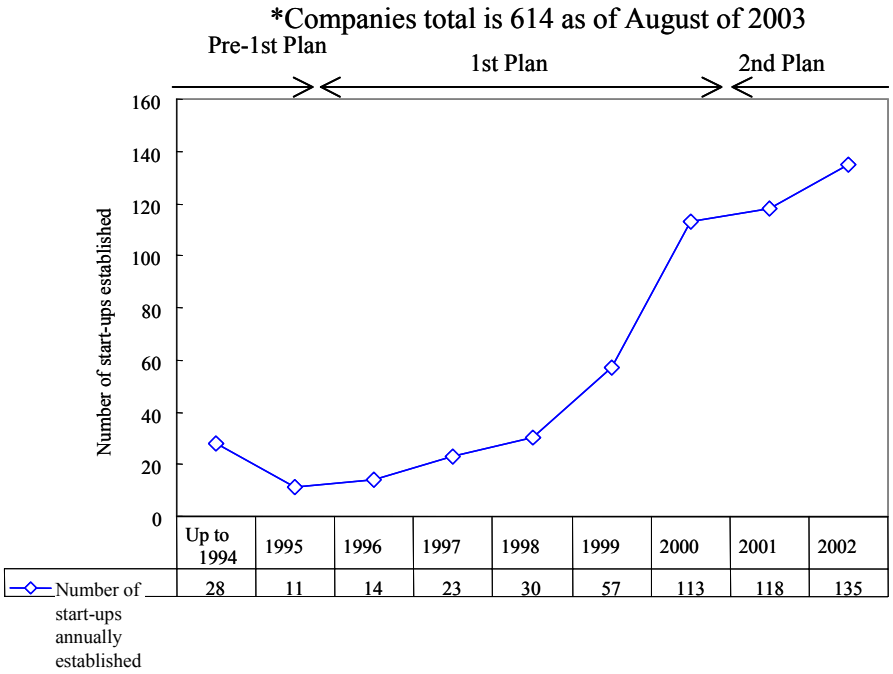


Fig. 7 Hiring of doctoral course graduates and post-docs in the private sector, 2000-02

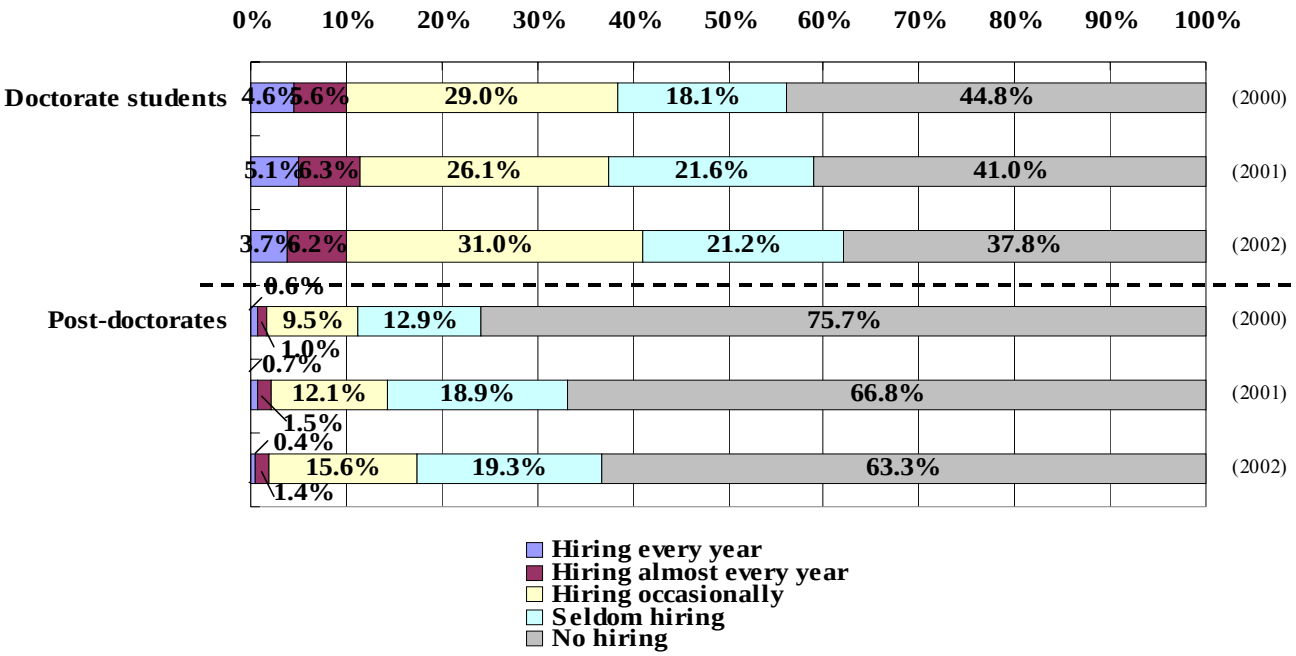


Fig. 8 Researcher mobility in Japan and comparison with other countries

Number of moves by university professors

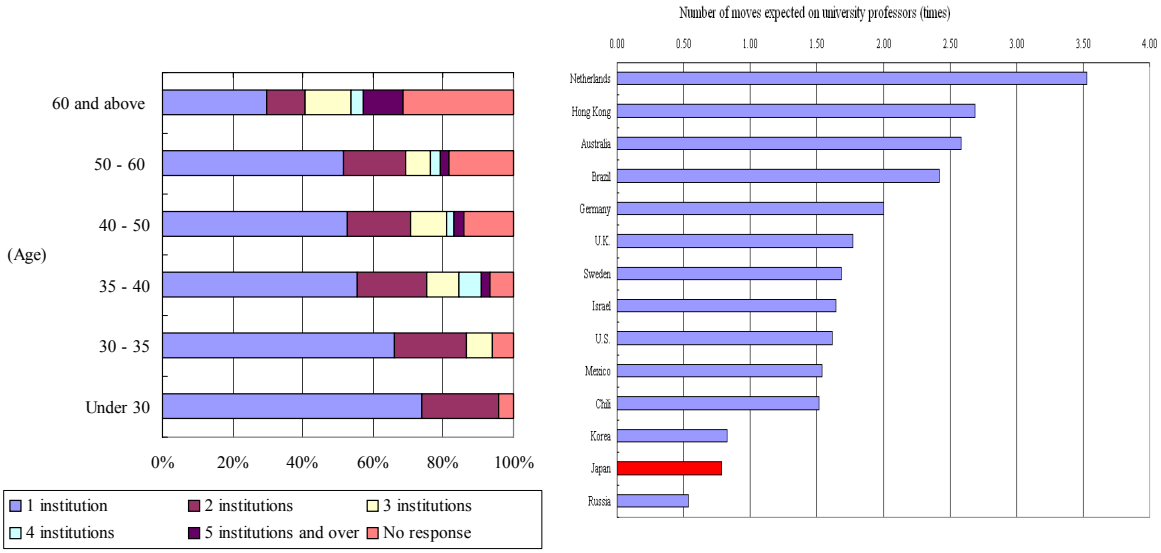


Fig. 9 Researcher mobility among universities, national research institutes, and industry in FY2001