STEERING AND FUNDING OF RESEARCH INSTITUTIONS

COUNTRY REPORT: JAPAN

Introduction

This report on the research system of Japan draws on the Japanese response to the project questionnaire, and on data gathered during a visit to Japanese institutions and agencies in Tokyo, Tsukuba City and Yokohama in March 2002. The visit was organised by the Japanese representative on the project working party, the Japanese delegation to the OECD and MEXT.[1]

Japan illustrates a category of national science systems which: have a dominant ministry; higher education as the predominant public research performer (although the bulk of R&D is in industry – some 80%); and mainly direct funding to research performers, but an emergent intermediate research funding level, in the sense of organisations which are funded to fund others, rather than themselves being essentially research performers.

This report begins by outlining the goals of Japan's research system and moves on to an overview of the Japanese public research system. A review of current policies and practices forms the main body of the text.

Goals of Japan's research system

The Japanese research system has clearly articulated goals, identified in its Science and Technology Basic Plan which is a multi-year, government-wide plan co-ordinated at Prime Ministerial level (Cabinet level) through the Council for Science and Technology Policy (CSTP).[2] The second five-year plan (2001-2005)

1. Details of the schedule of visits and meetings are given in the Annexe. The Japanese representative on the project working party is Professor Shinichi Yamamoto of the University of Tsukuba; Mr Yasuyuki Shimotsuma of the Japanese delegation to the OECD coordinated the overall planning and arrangements for the visit; Mr Masayuki Mori of MEXT coordinated the visit arrangements on the ground in Japan.

2. In 1995 the Japanese Diet (parliament) passed the Science and Technology Basic Law which directs Cabinet to draw up a master plan of science and technology policy every five years, and translate the plan into action for the ensuing five years.

   The Science and Technology Basic Law (Law no. 130 of 1995: effective on Nov. 15, 1995.)

   Guidelines for Promotion of Science and Technology: Creativity of researchers and engineers should be fully developed; Harmonized development among basic research and development; Organic co-operation of national research institutes, universities and private sector.

   Responsibilities of the Nation and Local governments: the nation is responsible to formulate and implement comprehensive policies for promoting science and technology; the local governments are responsible to formulate and implement policies for promoting science and technology corresponding to national policies and in accordance with the local characteristics.

   Science and Technology Basic Plan: shall be established by the Government after consultation with the council for Science and Technology; the government shall take the necessary measures for the smooth implementation of the Plan including the necessary fund in the budget within the limits of financial status.

views science and technology as a necessary national investment for a secure future which offers a good quality of life. Between FY 2001-2005, 24 trillion yen are to be spent on science and technology, assuming 1% of GDP and 3.5% nominal GDP rate. The plan takes a comprehensive and strategic approach, seeking an integration of the natural and physical sciences and technology with the social sciences and humanities, alongside an orientation towards science and technology for and in society. Four basic principles are identified for promoting science and technology:

- Prioritizing the allocation of resources to make R&D more effective.
- Improving R&D infrastructure.
- Regarding the investment on R&D in terms of a return to society and industry.
- Positioning Japan's science and technology as a contribution to world knowledge.

Strategic priorities are:

- Promoting basic research, and upgrading research quality through fair and transparent evaluation mechanisms.
- Four major thematic priorities: life sciences; information and telecommunications; environmental sciences; nanotechnology and materials; and four secondary priorities: energy; manufacturing technology; infrastructure; frontiers (outer space and oceans).
- Supporting emerging fields through foresight studies and fostering mobility among researchers.

Measures are identified to internationalise science and technology activities, and to achieve domestic system reforms (see Figure 1).

The reforms in the research area are part of a set of broader structural reform measures underway within the Japanese government as a whole – 'the Koizumi cabin et reform' – intended to move the Japanese economy out of its prolonged downturn. This new policy package has several elements, of which the most directly significant for the research system is the seven-point structural reform program:

- Maximizing the use of the private sector, through privatization/regulatory reform.
- Providing a social system which encourages individual initiative.
- Strengthening welfare and insurance as a way of making people feel secure and stable.
- Human capital development through enhanced individual choice – doubling the knowledge stock.
- Creating an infrastructure that allows people to live and work as they like – effecting a lifestyle revolution.
- Empowering local government to the maximum – supporting local independence and revitalization.
- Undertaking fiscal reform – creating simple, more efficient government.

Annual Report: the government shall annually submit a report to the Diet on the policy measures implemented with regard to the promotion of science and technology.

[Summary taken from RIKEN, 2000c, Appendix 2].

Figure 1. The second science and technology basic plan

This package of reforms impacts on research in different ways:

1. The introduction of free market processes into education, among other fields.

2. The introduction of private management methods into the operation of Japan's national universities.
3. Priority to assisting individuals keen to study, increasing scholarships.
4. Promoting the flow of education and research funds from the private sector by encouraging donations to universities and by preparing the conditions which facilitate commissioned research by universities through such devices as tax concessions.
5. Diminishing the rigidity of resource allocation patterns of national and local governments.

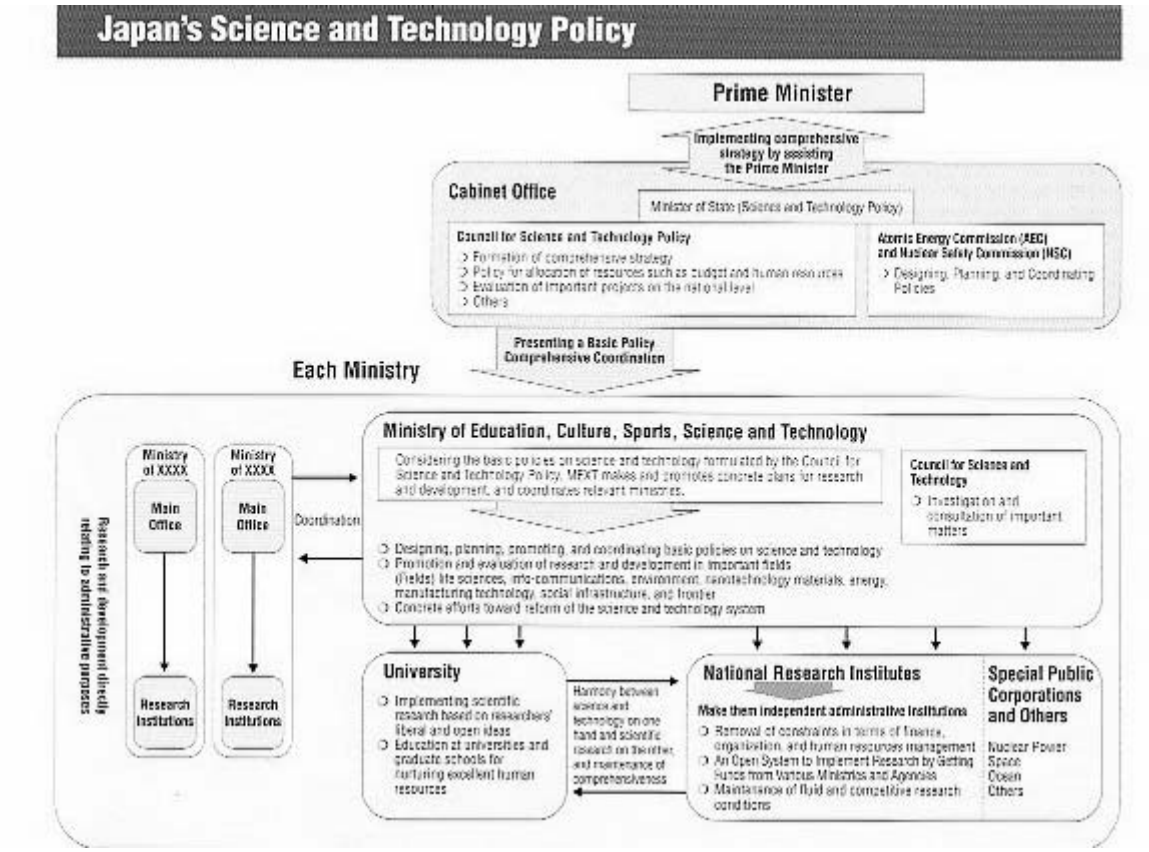
This is a substantial array of reform initiatives whose effect should be felt over several years provided there is a sustained effort by all concerned to implement them and to monitor progress.

Overview of structure of the Japanese public research system

Central government

The key player in policy formulation and public funding of research in Japan is the central government. The overall priority of research has been raised in recent years, and, as indicated above, structural change is a striking feature of the contemporary system. Since 2001, overall responsibility for research planning lies with the Council for Science and Technology Policy (CSTP) of the Cabinet Office. CSTP comprises the Prime Minister, six ministers of state with research/ research funding responsibilities, the President of the Science Council of Japan, five academics, and two industry representatives (see Figure 2). CSTP is responsible for developing a comprehensive government-wide S&T strategy, establishing government-wide policy for the allocation of S&T resources (budgetary and human), and the evaluation of important national level projects.

Figure 2. Structure of Japan' s science and technology policy



In 2001, the number of government ministries was reduced from 20 to 12 through mergers intended to reduce the size of the civil service. For research this has meant the amalgamation of various responsible bodies. Most noticeable has been the merger of the former Science and Technology Agency (STA) and the former Monbusho to form the new **Ministry of Education, Culture, Sports, Science and Technology (MEXT**) which is responsible for some 64% of governmental R&D expenditures for 2002. MEXT provides the institutional funding for universities, supports varied research funding programs open to researchers in universities, government institutes and industry, supports a range of its own research institutes which are at different stages of transition to becoming Independent Administrative Institutions (IAIs), described below. The merger has meant that funding structures and arrangements are currently undergoing a rationalization process, notably between its two key research funding agencies the Japan Science and Technology Corporation (JST) and the Japan Society for the Promotion of Science (JSPS) (formerly of STA and Monbusho respectively). The National Institute of Science and Technology Policy (NISTEP), within MEXT, formerly with STA, is an important policy research group, amongst whose responsibilities are the conduct of Delphi based foresight studies. Seven such surveys have been conducted, but decisions about how the results are to be used remain somewhat open.

The **Ministry of Economy, Trade and Industry (METI**) (reorganized in 2001 from MITI), is responsible for the second largest research budget (16.9% of governmental R&D). The New Energy and Industrial Technology Development Organisation (NEDO) is the Ministry's main vehicle for competitive funding project funding, which focuses mainly on applied/ industry research. Like JST, it favours a top-down approach. METI maintains a network of its own laboratories, the National Institute of Advanced Industrial

Science and Technology (AIST), which underwent a major restructuring in 2001 when it became an IAI (discussed further below).

The **Ministry of Health, Labor and Welfare (MHLW**) (3.6% of governmental R&D) funds the Health Science Research Grants open to all researchers. Its own health research institutes will not be changed to IAI status, as it wishes to keep direct control to enable quick response in the case of health emergencies.

Other Ministries with significant R&D budgets are: Defence Agency (4.1%); Ministry of Agriculture, Forestry and Fisheries (3.5%); Ministry of Land, Infrastructure and Transport (2.3%).

Regional government

The regional level of government (prefectures and city governments) has not in the past been significant in research policy and funding terms, but significant initiatives are currently being taken by some prefectural governments, and the central government's policy of developing regional research strength encompasses this level of government.

Higher education

Turning to the research performing sector, some 80% Japanese R&D is performed in industry. Of the 20% of R&D performed by the public sector, universities play the key role. Of Japan's 649 universities, 99 are national, 72 public (prefectural and city governments) and 478 private. Institutional size varies considerably. Japan has quite a number of single faculty universities (notably medical schools). From a total number of full-time university teachers of 150 563 in 2000, some 60 673 were at national universities, 10 513 at public universities, and 79 377 at private universities. Thus there is an approximate balance between the number of staff in private and in state (national and public) universities, although the number of students in private establishments (some two million) is more than double the total in state universities (some 730 000). Japanese universities offer bachelor's degrees of four – six years duration, depending on the course, and may also have a graduate school offering master's and doctoral programs (of two and four-five years respectively). MEXT is currently pursuing policies aimed at differentiation between universities which have in the past have had similar missions (including both teaching and research) and been funded in similar ways. The number of students at graduate schools doubled during the 1990s (from 98 650 in 1991 to 205 311 in 2000); professional graduate schools were developed; centers of excellence were established within graduate schools in new areas such as biotechnology, nanotechnology, environment and IT; collaboration with industry through *e.g.* cooperative graduate programs has been fostered. Research is focused in university faculties and graduate schools, research institutes attached to universities and Inter-University Research Institutes.

Government research institutions

Until recently, central government research institutions attached to a variety of ministries, which employ some 16 000 researchers overall, comprised mission focused national research institutes (70% researchers) and special public research corporations (30% researchers) which operate on a large scale, such as the Institute of Physical and Chemical Research (RIKEN) and the Japanese Atomic Energy Research Institute (JAERI). Most research institutes are undergoing major reorganisation as part of the overall government restructuring process, either having already become, or about to become Independent Administrative Institutions, a change which offers greater flexibility in many areas of management and financing, notably in relation to collaborative work. While government labs undertake only a small part of overall R&D in Japan, many have an important niche position. A number of laboratories operate on a much larger scale

than is usual in universities (*e.g.* owning large equipment – JAERI, RIKEN), some have strategic mission capabilities (health), and others operate in fields which are of social importance, but not of interest to industry (National Research Institute for Earth Science and Disaster Prevention, NIED).

Government research institutes are also operated by regional governments, with some 15 000 researchers employed, more than half of whom research agriculture.

Review of Policies and Practices

Areas of policy and practice discussed are: developing and implementing government-wide research planning; reforming publicly funded research organizations; structural reform of universities; linkages between research organisations, and overall institutional balance; level of public funding and funding policy; developing human resources; evaluating R&D; regional development of R&D; developing an international profile.

Developing and implementing the government-wide research plan

Japan's first five year Science and Technology Basic Plan was introduced in 1996 under the aegis of the then Science and Technology Agency (STA). It was a multiyear, government-wide plan, overseen and co-ordinated by STA. While the STA did the initial planning for the second five-year plan (2001 – 2006), by 2001 new responsibilities had followed new structures. The newly created Cabinet level CSTP now has strategic responsibility for the plan, although the MEXT, into which STA has been merged, retains some responsibilities for co-ordinating the S&T plans of individual ministries ahead of their presentation to the Ministry of Finance for the annual budget.

While the structure of CSTP is based on centralizing of power in the research domain, CSTP membership, as we have seen, represents the major stakeholders bar the government research organizations (apart from via the relevant Minister), CSTP's seven thematic panels have a representative membership, and the CSTP Secretariat of some 100 people is representative of industry, academia and a variety of ministries. There is, then, a good basis for assuming that plans are based on a spread of viewpoints from the key players, and with access to data from the same range of sources.

The CSTP is intended to be independent of the different ministries, enabling it to act as a 'control tower' for S&T on a government-wide basis, and the Minister of Science and Technology, located in the Cabinet Office, is in charge of CSTP. Many elements of the restructuring are still under way, or in their first phase. Clearly, the Japanese have decided that, in light of the many difficulties they are experiencing and of the perceived significance of science and technology for the national economy, a highly directive policy is required with closely co-ordinated action at the governmental level. Nevertheless, at the level of the research performers, a major loosening is under way, (as discussed further below).

CSTP's functions include developing a government-wide S&T strategy, an allocation policy for financial and human resources, and evaluation of certain projects. It is an advisory body, although it appears influential to date in realising the provisions of its plan in the actions of the different ministries with research budgets. For example, the Ministry of Finance refers to CSTP the proposed research budgets submitted by ministries, and CSTP ranks these in terms of how closely they follow the provisions of the Plan (not in terms of merit), using the categories of A, B, C.

Reforming publicly funded research organizations

As part of the government's overall restructuring, government funded agencies are progressively changing their status to that of **Independent Administrative Institutions or National University Corporations** (IAI), beginning in 2001. This move is effectively a blanket approach, government-wide, affecting research organisations along with organisations with other purposes (*e.g.* museums). The effect of this move will be to reduce considerably the number of civil servants, as the status of staff in such agencies has historically been that of the civil service.

The move to IAI status is generally presented in terms of the anticipated benefits of greater autonomy for the institution with regard to flexibility of management and financing. The implementation of the policy appears to be quite systematic, taken at a steady pace, and with due attention being paid to the special requirements of certain organisations, such as universities.

Within the research domain, **several government laboratories** have already changed to IAIs (AIST, NIED), while others are in the planning phase (RIKEN, anticipated 2003). In DHLW, certain health labs will not become IAIs, for reasons indicated earlier. Certain choices exist for institutions, for example, AIST staff chose to remain civil servants, but staff of some of the other IAIs may not have the civil servant status. Each IAI has its own mission; each year its budget proposals will be scrutinized by CSTP for compliance with the Plan, and additional competitive funding will be available within the context of the funding bodies' interpretation of and compliance with the plan. Thus, while a number of structural, management and financial matters are loosened and made more flexible, relatively strong indirect controls are maintained.

It is anticipated that all **national universities** will become IAIs in April 2004. The planning process for this has been detailed. Some universities organise seminars and training for university staff to help them adapt and develop capacities with regard to the new financial and management responsibilities characterising the new structures, including company style accounting. It is recognized that universities have become caught up in a governmental change which was not originally planned for them, and that they have a number of features which do not fit with the general framework, for example their research and teaching character. Some accommodation to the framework is seen as necessary.

A final report on proposals for giving legal status to national universities issued in March 2002 confirmed that staff working for national universities will become non-government employees. Currently, MEXT gives university targets for five-six years, within which institutions develop their strategic plans. Institutions have freedom of management as far as possible, and at the end of the five-six year period, a National University Evaluation Committee to be established within MEXT reviews the achievements of each institution prior to deciding the next plan. Changes flagged in the recent report are: established targets should be based on universities' initiatives re university autonomy; in relation to the cycle, new funding system based on evaluation should be introduced, based on the quality of education, assessment of research *etc.*, and to reflect the result of this evaluation in resource allocations. How the outcome of evaluation results should be combined and linked to resource allocations is a current point of contention, and the likely direction is still unclear. This point is discussed further below in the section on evaluation.

Details of the new system will be established on the basis of new legislation by summer 2003, ahead of introducing the IAI status in 2004.

Structural reform of universities

Until recently, the Japanese university system has been quite homogenous in the sense that under the School Education Law all institutions have equal status as research and teaching institutions. All national

universities have been funded in the same manner, with a large and relatively stable general university funding based on faculty numbers and research chairs – an input rather than output model. Little money was available separately for research. By the 1980s, the 'catch-up' period with the research attainment of other industrialised countries was over, and the view was that Japan needed to make its own significant contributions to the international research endeavour, including the basic research capabilities of its own industries. Since the early nineties, the government has encouraged basic research through increased investment, largely through the competitive Grants-in-aid scheme to individual researchers operated by the then Monbusho. This scheme grew by an order of five between 1990 and 2002.

The idea of research intensive universities has been of policy interest for some years – the past university funding pattern was seen as too egalitarian. During the 1990s, several of the national universities became graduate universities in the sense that they developed graduate schools. They began to receive higher funding on the basis of a provision for enhanced funding for graduate as distinct from undergraduate students.

A second round in the process of differentiating of universities is now under way, through a three pronged approach outlined in June 2001 by MEXT: re-organisation and merging of national universities; early movement to new 'national university corporations' (introduction of management techniques based on private-sector concepts); development of universities that comply with the highest international standards (introduction of the principles of competition by using third-party evaluations)

Achieving the first of these goals entails a major process of mergers, reorganisations and possible divesting of national responsibility to prefectural governments. Japan has a considerable number of single faculty universities, notably medical schools, which are targeted for merger. There are examples of within-prefecture mergers amongst these latter, and also mergers between institutions in adjacent prefectures. Concern has been expressed that these mergers may reduce learning opportunities through reduction in course options, especially in the regional areas. But at the same time, student cohorts are dropping, and some private universities are in financial difficulties. How the role of these enlarged and merged institutions is to be defined, whether there is a plan beyond the merger, or whether institutions are to be left to sort things out among themselves is unclear at present.

Achieving the second goal entails creation of new 'national university corporations'. This is the move to IAI status as discussed above.

Achieving the third goal of establishing top universities of international standing entails competitive processes including external evaluations. Private and public (prefectural) universities are included in this second step. It is believed that a genuinely competitive process should be started with a number of prospective candidates.

The major element of competitive funding, designed to strengthen institutional research, is the new 21st Century Centers of Excellence program, starting April 2002. Through concentrating resources on the institution not the individual researchers, the target is to develop top level, internationally competitive universities, selected by peer review. From a total fund of YEN 18 billion a sum of YEN 100–500 million yen will be invested each year in between 10–30 universities in each of five selected areas. For FY 2002 the areas are: life science; chemistry and material science; informatics and electrical engineering; humanities; and interdisciplinary research. COE funding is for a period of five years. All universities are eligible, and the usage of funds is at the discretion of each university. Thus, for example funds may be used to invite prominent researchers, hold an international symposium, or provide equipment.

Several arguments underlie this policy direction. First, is the wish to have a number of universities which may be recognized as 'world class', supporting Japan's policy of establishing its international position in

research. Second, is the need to develop a research profile such that Japanese industry will begin to look to these Japanese universities for collaborative work, rather than to universities in the United States and United Kingdom as at present.

Linkages between research organisations and overall institutional balance

For a number of years a clear policy direction has favoured greater collaboration between universities and government research organisations, as well as among universities, government research organisations and industry. Reference has already been made to the fact that Japanese industry currently favours collaboration with overseas rather than Japanese universities. Even the University of Tsukuba, a long established university based for the past 30 years in Tsukuba Science City, attracts only modest industry funding (9% of research funding in FY 2000). Overall, just 3% of total research funds used by Japanese universities for R&D come from industry. Shimoda and Goto (2000) argue that industry-science relationships in Japan are undergoing a major transformation, with the process of structural change of national universities and research institutes acting to lift a number of financial, management and personnel rules which have acted to restrict links with industry. New policy measures support the patenting of research results in universities and government research institutes and promote research co-operation and exchange.

Individual universities and government research organisations have developed a range of strategies to make industry collaboration more attractive. One approach is that of the University of Tsukuba through its Tsukuba Advanced Research Alliance (TARA). This is a special purpose, high profile research center established in 1995 to explore frontier research in interdisciplinary fields, provide a concentration of research personnel (critical mass) and activities across a range of loosely organised research areas, to pioneer ways of working collaboratively with industry, and to provide a means for increasing the research capabilities and opportunities of staff in other parts of the university (*e.g.* through involvement in research groups and other collaborative work, through offering small grants which redistribute a portion of the funds the center has attracted). To date TARA has had limited success in tapping industry sources, but has proved highly effective in getting competitive research funds from public sources. A second mechanism of the university is to retain 8% of overall university research funding by central authorities, to create an internal research 'market' of competitive funds. These examples illustrate the way in which universities are actively seeking mechanisms to improve their overall research capacity and research funding and to develop a more entrepreneurial internal research culture.

The restructuring of METI's AIST has as an important aim to increase applied research and develop closer links with industry. From 15 labs characterised by research area, the new structure introduced following IAI status, has seen the creation of a single agency, comprising some 50 research units divided between research centers (with an applied focus) and research institutes (with a basic focus). As only some 20% of current work is on the applied side which AIST wishes to boost, internal funding policies markedly favour the research centers over the research institutes. Also, the criteria for personal evaluation of researchers within AIST has changed: beyond the traditional criterion of publication. Now included are such criteria as venture business, patents, additional funding from headquarters, collaboration with the private sector (rather than universities). The move to IAI status is seen as helpful in enabling collaboration with industry. IAIs are able to receive funding directly from industry, without funds having to pass through the responsible ministry (as was the case with the government laboratory structure). Also, AIST (not the government) owns the intellectual property generated by its research. This example shows how former government laboratories are being actively reshaped at many levels in an attempt to enable or facilitate easier collaboration, particularly with industry. It will be some time, however, before it is possible to evaluate their success in achieving closer links and to achieve a more entrepreneurial profile.

The balance between institutions within the public sector (universities and government laboratories) does not seem to be of major current policy concern. Perhaps this is because energies are presently focused on the change of institutions within both parts of the public sector to IAI status. Once this period of major structural transformation is passed, the question of the balance may emerge in a rather different form.

Level of public funding and funding policy

In a period when overall budget within government has been cut by some 2%, science and technology funding has increased by 2.3%.

Budget augmentation aside, the most striking feature of research funding policy is the move toward competitive funding practices, a policy which applies to all ministries. During the period of the second basic plan, a doubling of research funds on a competitive basis is envisaged, from USD 2.3 billion in 2000 to USD 4.6 billion in 2005.

There are a number of ways in which competitive funding is organised. Within MEXT, as already indicated, the level of general university funding and base funding for MEXT's own research laboratories has remained relatively stable, and the growth of funding available for research is within a variety of specific competitive programs open to all researchers, some funded directly from the ministry, others funded through either JST or JSPS. It remains true that while base funding of institutions has not fallen (as it did, for example, during the nineties in a number of other countries), the push factor on researchers is uneven, affecting most strongly those whose research is more resource intensive, hence the sciences and engineering more than, by and large, the humanities and social sciences. Nevertheless, the move toward competitive funding, through different programs, offers opportunity for individual researchers (grants-in-aid), research groups (JST programs), and institutions (for universities, centers of excellence). Programs with most potential to reshape the research landscape are those directed at research groups and institutions where larger sums are focused over longer time periods. The grants-in-aid, operated by both MEXT and JSPS, tend to support individual researchers with various scale grants for a period of one to six years. Both the research group and centers of excellence programs run over five year periods, and disburse significantly larger sums. While the grants-in-aid program is seen as a 'bottom-up' program in that decisions are taken on the basis of peer reviews, the JST programs are seen as 'top down'. By way of example, when the JST is establishing a new team for its ERATO (Exploratory Research for Advanced Technology) program, it undertakes intensive surveys of the opinions of researchers in universities and industry to help identify individuals who stand out as being strongly supported by researchers. In this way, 'performers' select the 'director' with whom they would like to work. The Research and Development Council of JST recommends project directors to its president. Project themes evolve in the process of seeking both academic and industrial participation in each project. Each project team comprises between 15 – 20 scientists, usually grouped into some three sub-teams.

Another evolving element of funding policy is the balance between direct funding from ministries and funding through intermediate level bodies. MEXT has two intermediate level bodies, JST and JSPS, as a direct result of the recent merger of STA and Monbusho. The relationship between these two organisations and their respective programs have been reviewed. Both organisations remain separate, and a number of programs have already been transferred or altered in line with reducing overlap. The relationship between MEXT and the intermediate funding bodies is also a significant question, particularly in relation to their forthcoming transition to IAI status. In 1999, the then Monbusho first transferred a substantial portion of its grants-in-aid program to JSPS as a step towards the possible creation of a funding body which could play a role similar to the US National Science Foundation or one of the British research councils. No clear decision appears to have been taken about this to date, possibly because of the intervening array of structural changes needing to be managed, and also the need to define the new closer relationship between

JSPS and JST. At present differences exist within these two organisations, both at the at the establishment (for the 2002 fiscal year, JSPS: 78 employees and 173.8 billion yen budget, JST: 467 employees and 112.8 billion yen budget) and at the purposes of funding research (JSPS' program aims to advance outstandingly creative and pioneering work across a spectrum of fields, from the humanities and social sciences to the natural sciences, on the other hand JST's aims to develop science and technology for the creation of technological seeds and new industries backed by new technologies).

A further change introduced by the Basic Plan for all competitive research fund allocations is the addition of indirect costs as a fixed rate (currently 30%) against research funds (direct costs). The fixed rate is used for administration and operation of the research institution where researchers awarded competitive research funds are based. This indirect funding is a recognition of overhead costs borne by institutions, and should help improve R&D conditions for both the researchers and the research institutions.

Balancing fields and types of research

Japan made tremendous progress during its research 'catch-up' period during the 1970s, but came in for substantial international criticism from the US and other countries, that Japanese industry was using technologies developed in other countries, and Japan was not contributing sufficiently to the advancement of science. This led to the Japanese government, with the backing of the scientific community, beginning to invest heavily in basic research during the 1980s and 90s. Creating the Institute for High Energy Physics in Tsukuba with a large synchrotron facility is an example. At that time, however, there was little linkage between this research and industry, as then prosperous companies had their own applied research facilities. With changed economic times, collaboration is now on the agenda, albeit with some government concerns about too much industry influence being to the detriment of basic research. This government support for basic research continues. A number of research performers, as already indicated, are working to expand applied research, particularly in the context of greater co-operation with industry.

There is a historic pattern of research strength in the national universities lying more in the science and technology fields, with humanities and social sciences strength being more in the private universities. For many years there has been concern in Japan over the decline of good students enrolling in sciences and engineering, as well as a decline in students wanting to become researchers in science and technology. The current balance of research output and research funding by research field has not been possible to ascertain for the purposes of this report and in any case less significant than the delineation of research priorities for the future, as outlined earlier.

For the first time in Japan, government-wide thematic research priorities were defined by CSTP for the duration of the second basic plan. As already indicated, the four major priorities: life sciences; information and telecommunications; environmental sciences; nanotechnology and materials; and four secondary priorities: energy; manufacturing technology; infrastructure; frontiers (outer space and oceans) set an agenda for the foreseeable future. As priorities hold for all government ministries and funding bodies, and the mechanisms for ensuring compliance are relatively robust (CSTP review of ministry funding proposals). It can be expected that other research areas will receive relatively modest support for the duration of this plan. The humanities and social sciences are notably lacking in this list, and the main priorities are strongly biased towards priorities defined in other OECD member countries (life sciences, nanotechnology and materials, information and telecommunications), fields in which intensified international competition can thereby be anticipated.

These priorities are set to dominate research funding. However, the narrowness or breadth with which they are interpreted by funding bodies, remains to be seen. It is not inconceivable that the social, cultural and economic implications of the priorities that have been set will emerge as work progresses and themselves

require research attention even though they are not, at present, prominent in the policy discourse. In the current program for university centers of excellence, three of the national priorities contribute to the five foci, other fields included being chemistry and social science.

The extent to which there is a 'market' amongst research funders within particular fields is unknown. For example, how the Ministry of Health, Labor and Welfare's research funding in the life sciences through its competitive health sciences research grants relates to life sciences funding from other bodies. Life sciences aside, there appears to be an orientation towards making a relatively clear division of responsibility between different funders, if not in terms of research field, at least in terms of type of research activity (*e.g.* as discussed in the case of JST/JSPS).

Developing human resources

A range of initiatives support a broad direction fostering the development of young research talent, and encouraging mobility of researchers.

A program initiated in the mid-nineties to support 10 000 post-doctorates was achieved ahead of schedule by 1999. By 2002, some 11 127 young researchers are receiving funding, the large majority through MEXT (in particular the JSPS Postdoctoral Fellowship Program), but with participation by other ministries including the Ministry of Health, Labour and Welfare, the Ministry of Agriculture Forestry and Fisheries, and the Ministry of Economy, Trade and Industry. The success of this program has brought its own challenges, with Japan now reportedly experiencing an oversupply of post-docs. As the bulk of Japanese research is in industry, presumably this oversupply indicates that the prolonged economic downturn has meant fewer industry opportunities for young researchers than envisaged when the program was initiated.

This program in fact has built on a prior policy focus on doctoral studies. During the nineties, as discussed above, a number of universities developed graduate schools, transferring faculty from departments to the graduate school. A number of students continue to be fast-tracked through masters and doctoral studies.

MEXT is seeking to expand competitive funding opportunities for young researchers in the belief that many researchers who have achieved world class status have built on research undertaken in their thirties. With their university system originally modelled on the German mentor system, the Japanese share with the Germans the challenge of enabling young researchers to develop independent research initiatives. MEXT has two programs of encouragement of individual young scientists up to the age of 37. Recruiting and screening of applications is handled by JSPS.

A further feature of the Japanese system is the relative immobility of staff. Students have tended to take appointments in the universities in which they studied, and to remain at the same institution, progressing within the institution on the basis of seniority rather than merit. Bringing greater staff mobility between institutions in the system is another aim of present policy, through the introduction of a fixed-term system and implementation of an open public appointment system. National research institutes introduced fixed-term arrangements following a June 1997 law; universities and inter-university research institutes can, at their own discretion, introduce fixed-term arrangements. A three-year term is the most common length for new researchers. As of April 2001, fixed term appointments comprised the vast majority of new appointments within public corporations, while at national institutes the balance between fixed term and continuing arrangements for new appointments was highly institution dependent. The fixed term approach certainly offers institutions and research teams greater flexibility in managing their research projects. Combined with the move to greater competitive funding, this would appear to be a highly significant move toward a more dynamic, creative and entrepreneurial national research system. Experience in other countries suggests that in this environment new problems will arise, including the development over time

of a degree of instability in research careers for those who are employed on soft money via a succession of grants. The success of this approach will depend on a continuing and sufficient supply of opportunities for the growing number of qualified researchers coming through Japanese institutions. Particular sensitivity will be required to the concept of a productive, fulfilling research career since the whole edifice depends on the quality and commitment of the researchers themselves.

An additional approach to increasing staff mobility is to encourage use of voluntary actions on the part of university administrations, notably: limiting the proportion of new teachers who are graduates of that university; and limiting the promotion of research fellows to senior posts within the same university.

To encourage international movement, a new regulation in 2001, the Revised Standard for University Establishment, enables a person's teaching in a foreign university to count equally to teaching in a Japanese university. Also strict seniority as a basis for appointments has been addressed by enabling an assistant professor to be promoted directly to a full professorship without becoming an associate professor.

Evaluating R&D

Evaluation is an integral part of the government's Basic Plan. Evaluation is seen both as a means of invigorating and encouraging creativity, and as playing an important role in achieving efficient allocation of both human and financial resources. National guidelines on evaluation for research and development were developed in 1997, revised in 2001.

Evaluation occurs at different levels. The CSTP has responsibility for setting overall R&D evaluation policy, as well as itself commissioning evaluations of nationally important R&D projects. One of CSTP's expert panels focuses on evaluation, with responsibility for fostering competitive environments for research and development and for implementation of effective and efficient resource allocation.

The November 2001 revision of the national guidelines provides for:

- Use of objective criteria, external (third party) verification, and public disclosure of evaluation results.
- Evaluation results to be intended for use in the resource allocation process.
- Enhanced and efficient evaluation systems by appointing senior researchers to evaluation sections, establishing a database of all evaluations in the government sector.

Each ministry is required to prepare practical guidelines for evaluating R&D projects under its responsibility; Cabinet Office checks the R&D evaluation process of each ministry, and evaluates nationally important R&D projects directly.

The most contentious issue appears to be the provision for using evaluation results in the resource allocation process for R&D. Japan is not alone in experiencing this policy use of evaluation. However, in the Japanese setting it is quite a radical departure from a softer funding regime. The process is still being worked out, at least as far as the universities are concerned. Some of the tensions are illustrated in the activities of the National Institution for Academic Degrees (NIAD) and the Centre for National University Finance (CNUF). In April 2000, NIAD was given an additional responsibility for overall institutional evaluations. The program as now developed is based on the premise of evaluation as a tool for improvement, with an emphasis on individual institutional audits, not evaluation for selection based on comparisons between institutions. Objectives are self-improvement and accountability to the public committee for university evaluation. Evaluations are of three distinct types:

- University-wide thematic evaluations (themes 2000-2002 for all national and some public universities: education services to the public; liberal education; co-operation with society for research activities; international co-operation).

- Educational activities by academic fields (2000-2002: six to nine universities for each of nine academic fields).

- Research activities by academic field (2000-2002: six to nine universities for each of nine academic fields).

To date some thirty university evaluations have been completed, with the focus on the institution, not the individual researchers or research unit. The NIAD published results for the 2001-2002 evaluations in March 2002, but the evaluation reports will, naturally, identify strengths and weaknesses of different universities. The question is what uses can or will be made of these evaluations designed for improvement, given the specific political wish to link evaluation with resource allocation.

Once universities become IAIs, they will be subject to external evaluation every six years. Unresolved questions at the moment are who will undertake these evaluations, and what relationship they will have to the existing programme of NIAD. The application of current evaluations are seen by NIAD to be of primary relevance to such audiences as prospective students, employers wishing to recruit graduates, industries interested in joint ventures, and overseas universities seeking partners. 'When necessary', resource allocation organisations, aid groups, corporations and other donors may be able to use the published evaluation results as indices or reference material for their resource allocation decisions. This last appears of rather secondary interest at present. Before the introduction of IAI status for universities in 2004 this question must be resolved, whether NIAD adds this responsibility, and if so how it organises it, or whether another organisation, for example the CNUF which already has a direct interest in resource allocation, comes to have a role in the evaluations.

While a comprehensive program of evaluation has been mapped out alongside Japan's national research program, a number of elements remain to be worked through before this becomes an integral part of the functioning of the research system. These are in fact shared with some other countries. Amongst those challenges raised during meetings were: evaluating activities which require a long time before results appear; and evaluating items which do not always fit well into quantitative evaluations. There is also a wider issue, namely the development of an evaluative culture whose purposes, strengths and limitations are well understood by both the research and policy communities. Transparency, fairness and an overall commitment to improving quality and raising or maintaining standards are at least as important as the procedures and techniques that are applied in assessing the worth of particular projects and their outcomes. Presently, MEXT is working on guidelines for evaluations including the above principles.

Regional development of R&D

One of the aims of the current Basic Plan is to promote science and technology in each geographic region. This is being addressed in a number of ways.

During the 1970s, Tsukuba Science City was established to decentralise government science and engineering research institutes and to relocate the Tokyo University of Education (becoming the University of Tsukuba) to a green fields site with the aspiration of attracting science intensive industry and greater linkages between industry and the government sector. (This growth pole has its parallels in other industrialised countries from the same time period (*e.g.* France, UK).) The evidence of a now well established city suggests a certain degree of success for this longstanding policy, although the policy itself

was not appraised in detail as part of this country visit. Surprisingly, however, connections by train to Tokyo remain inadequate, underlining the point that infrastructure requires attention in large-scale structural change.

Policies dating from the 1990s are extending the growth pole approach beyond Tsukuba, through a process of reinforcing and developing existing nodes rather than developing green fields sites. The fifth NISTEP review of regional science and technology promotion policies is relevant. It demonstrated that the regional government contribution (comprising 47 prefectural and 12 ordinance designated city governments) to the Regional Innovation System framework indicated some 46% of their S&T expenditures (for 1999) were on municipal research institutes (with a strong emphasis on agriculture), and some 33% on science oriented higher education institutions. With these figures trending down, NISTEP concluded that science and technology infrastructure in the regions had been completed. The review noted that over 90% of prefecture governments had adopted at least one key action program for science and technology, from among: establishing a distinct administrative section for science and technology policy; liaison committee of regional administrative bodies; regional council boards for the promotion of science and technology; basic plans for the promotion of science and technology. However, regionalisation is never static and what is 'complete' for one stage or strategy in a given policy framework becomes datum or problematic for the ensuing stage or strategy.

Both METI and MEXT have plans to promote industrial and innovation clusters respectively in each region. By way of example, the JST program on regional research co-operation has several elements. The collaboration of Regional Entities for the Advancement of Technological Excellence selects about four regions and themes each fiscal year, with the aim of establishing and reinforcing science and technology that creates new technologies and industries in priority research areas set by MEXT; regional science promoter program for network formation helps co-ordinate the activities of the foundations that have been established by regional governments for the promotion of science and technology.

Collaboration between national and regional authorities and regional national universities is being encouraged. In Yokohama, for example, the regional government provides free rental of land for the recently established RIKEN Genomic Science Centre, which in turn will work closely with researchers at the Yokohama City University which is strong in bioscience and medical science. In a country such as Japan, where strong central control through powerful national bureaucracies has been a hall mark of policy, both the drive towards greater autonomy for discrete research entities and the regional policies are bound to generate major research policy issues. How these are conceptualised and analysed and how resolution is found will be of the utmost importance in determining the success of the new national directions now being sought.

Developing an international R&D profile

Japanese science and technology research has had a remarkable history, growing through an extended 'catch-up' period until around the 1970s, to itself developing significant creative capacity. Now, after decades of intensive effort and rapidly growing investment, Japan has, of all countries, the second highest R&D expenditure, behind only the United States. With this new position, Japanese policy has moved from a central focus on learning from other industrialised countries, to one of a balance between contributing to and learning from its peers.

A number of policies contribute to this new orientation as advanced in CSTP's Basic Plan: proposing and conducting international co-operative projects – for global-scale issues and international joint activities on fundamental research; enhancing dissemination of information to the world; internationalising domestic R&D circumstances.

Examples of programs include the international researcher exchange supported by a JSPS in which both foreign research experience by young Japanese researchers is supported, equally with bring young foreign researchers into Japanese laboratories. The International Co-operative Research Project (ICORP) of JST, which counted twelve major continuing projects in 2001, develops sustained integrated international research teams operating over a five-year period.

This is an ambitious goal, but it is an important direction which will be achieved only after sustained and consistent support.

Conclusion

Japan has now set itself on a course in national science policy which will require many years of sustained effort if the ambitious targets are to be achieved. It is clear that major changes are in train – structural, organisational, administrative and financial. The aim is not so much a revolution as the consolidation, enhancement and strengthening of trends that have been evident and of growing significance for many years. However, as a result of a very large number of individual changes, a new national research system is emerging, with far more emphasis than hitherto on the initiative and responsibility of the research agencies and personnel and a much greater concern for autonomy, diversity and entrepreneurship at all levels, national and regional. The rate and scale of growth of the national research endeavour are most impressive, but they are also the source of challenges and issues for the future – not only the directions adopted but also the implication for institutions, agencies and personnel. Nor can the overall economic, political, social and cultural contexts be ignored since one of the current preoccupations is research relevance, or significance for the future of Japanese society. There are good reasons for the international community to take a close continuing interest in the progress of the ambitious research agenda as it unfolds over the next decade.

ANNEX

ACRONYMS

AIST – National Institute of Advanced Industrial Science and Technology
CNUF – Center for National University Finance
CSTP – Council for Science and Technology Policy
IAI – Independent Administrative Institution
JAERI – Japan Atomic Energy Commission
JSPS – Japan Society for the Promotion of Science
JST – Japan Science and Technology Corporation
KAST – Kanagawa Academy of Science and Technology
METI – Ministry of Economic, Trade and Industry
MEXT – Ministry of Education, Culture, Sports, Science and Technology
MHLW – Ministry of Health, Labor and Welfare
MONBUSHO – Ministry of Education, Culture and Sports
NEDO – New Energy and Industrial Technology Development Organisation
NIAD – National Institution for Academic Degrees
NIED – National Research Institute for Earth Science and Disaster Prevention
NISTEP – National Institute of Science and Technology Policy
RIKEN – Institute of Physical and Chemical Research
STA – Science and Technology Agency
TARA – Tsukuba Advanced Research Alliance, University of Tsukuba

Visit Schedule

11-14 March, 2002

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Masayuki Inoue, Senior Deputy Director-General, Science and Technology Policy Bureau, Deputy Director-General Minister's Secretariat
Masayuki Mori, Deputy Director, International Science and Technology Affairs Division
Yu Kameoka, Director, Office for Materials Research and Development, Basic and Generic Research Division, Research Promotion Bureau
Masaru Osanai, Director, International Science and Technology Affairs Division, Science and Technology Policy Bureau
Hiroshi Furuta, Chief, Promotion Policy Division, Research Promotion Bureau
Masashi Akiba, Director, Office of Higher Education Policy, Higher Education Policy Planning Division, Higher Education Bureau
Fumihiko Kakizaki, Senior Research Fellow, Third Policy-Oriented Research Group, National Institute of Science and Technology Policy (NISTEP)
Takahashi Kenichiro, Senior Specialist, Human Resources Development, Science and Technology Policy Bureau

Japan Science and Technology Corporation (JST)

Akio Ishida, Manager, Department of Planning and Coordination, Office of Basic Research
Akitsugu Koga, Manager, Department of Planning
Takaharu Atago, Manager, Department of International Affairs
Tatsuo Sakaguchi, Senior Staff, Department of International Affairs

Japan Society for the Promotion of Science (JSPS)

Satoru Endo, Senior Specialist, General Affairs Division

National Institution for Academic Degrees (NIAD)

Nanako Aoshima, Director of Planning, Secretariat for University Evaluation
Takayuki Hayashi, Research Fellow, Evaluation System Division, Faculty of University Evaluation and Research

Center for National University Finance (CNUF)

Hitoshi Osaki, Director General

University of Tsukuba

Hideo Hamaguchi, Vice President for Medical Affairs
Professor Shinichi Yamamoto, Director and Professor, Research Center for University Studies
Takeshi Kato, Assistant Professor, Research Center for University Studies
Masayuki Yamamoto, Professor, Center for Tsukuba Advanced Research Alliance and Institute of Basic Medical Sciences

Ministry of Economy, Trade and Industry

Takeshi Ito, Director, Office of National Institute Management, Industrial Science Technology Policy and Environment Bureau
Nomi Toshihiko, Director, Technology Research and Information Office, Industrial S&T Policy and Environment Bureau
Yuki Naruse, Assistant Director, International Affairs Office, Industrial Science and Technology Policy and Environment Bureau

Ministry of Health, Labor and Welfare

Tatsuhiro Isogai, Assistant Director, Health Sciences Division, Minister's Secretariat
Satoshi Takebayashi, Deputy Director, International Affairs Division

National Institute of Advanced Industrial Science and Technology (AIST)

Akio Nishijima, Deputy Director, International Affairs Department
Tsunenori Sakamoto, Deputy Director, International Affairs Department

Institute of Physical and Chemical Research (RIKEN)

Akihiko Iwahashi, Director, Planning Division

National Research Institute for Earth Science and Disaster Prevention (NIED)

Kenji Morita, Chief, Planning Section, Strategic Planning Department

Kanagawa Prefectural Government Office for Research Policy

Mr Tsukamoto, Director, Science and Technology Promotion

Council for Science and Technology Policy (CSTP), Cabinet Office

Hiroshi Tamada, Deputy Director of Policy Planning Group
Hirotada Matsuki, Deputy Director for Science and Technology Policy (International Affairs and Public Relations), Bureau of Science and Technology Policy

University of Tokyo

Professor Akira Goto, Research Center for Advanced Economic Engineering

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