

## Japan's Science Policy

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Japan and Great Britain are located at either end of the Eurasian Continent, and have respectively formed histories and cultures of their own. We Japanese people have paid our respects to the British, who, living in a small island country like Japan, have attained excellent achievements in developing modern industrial civilization. It is because of this respect that Japan has adopted many of British systems and institutions in arts and sciences. The engineering education which underlies today's industrial development of Japan was initiated by the guidance of Dr. Henry Dyer, a graduate of the University of Glasgow who was invited to Japan about 110 years ago as the first president of an engineering college which later became the Department of Engineering of the University of Tokyo. At that occasion Dr. Dyer stayed in Japan for nearly ten years from 1873 to 1882.

In the Japan-U.K. trade in education and science, there is still much excess of imports over exports on the Japanese side, but now I am happy to say that today Japan's education and science has developed enough to attract attention of foreign nations.

Now, I sincerely hope that my speech will be of a help for you to understand what Japan's science policy is. My speech will be consisted of three parts: first I will explain the structure of science policy making, secondly I will refer to the present issues of science policy and their future development, and lastly I will introduce on-going measures taken for the promotion of science.

### I Structure of Science Policy Making

1. Roles of government ministries and agencies in research administration and coordination thereof. (Chart I-1)

Many government organizations are related to research in science and technology, but, roughly speaking, the Ministry of Education, Science

and Culture (Monbusho) is responsible for basic research and its application, and other ministries and agencies are responsible for applied or developmental research. That is to say that, while Monbusho is responsible for the promotion of scientific research carried out at universities, their research institutes and national inter-university research institutes, other ministerial organs, such as the Ministry of International Trade and Industry (MITI), the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Health and Welfare, and the Science and Technology Agency (STA), are promoting so-called mission-oriented researches in science and technology by establishing research and examination institutes as deemed necessary for the fulfillment of their respective administrative responsibilities.

As for the coordination of research activities at research institutions of various ministries, Monbusho is responsible for coordination among universities and their research institutes, and STA is responsible for overall administrative coordination of R&D activities carried out by ministries and agencies other than Monbusho.

The Council for Science and Technology of the Prime Minister's Office, an advisory organ to the Prime Minister, is aimed at deliberating the government's overall basic policy on science and technology.

As for nuclear and space sciences which need national-scale plans for research and development, the Atomic Energy Commission and the Space Activities Commission conduct overall policy planning and coordination of activities of government institutions concerned in their respective fields.

Here some explanation is necessary in relation to research of space and nuclear fusion, because in these fields, there arises a problem about the interrelation between scientific research and mission-oriented research. In the field of space science, programs for development and launching of scientific satellites are carried out by the Institute of Space and Astronautical Science, one of Monbusho's inter-university research institutes, and programs for developing and launching utility satellites, including weather satellites and communications satellites are conducted by the National Space Development Agency under STA with cooperation of relevant ministries and agencies, while the total

national plans are coordinated and determined by the Space Activities Commission.

In the field of nuclear fusion, basic research for confining plasma are conducted at research centers and faculties of various universities, not to speak of the Institute of Plasma Physics at Nagoya University, the Plasma Physics Laboratory, Kyoto University, the Institute of Laser Engineering, Osaka University, while big projects aimed at developing utility reactors are promoted at the Japan Atomic Energy Research Institute under STA. The overall coordination of fusion research programmes is conducted by the Committee on Nuclear Fusion set up in the Atomic Energy Commission.

## 2. Formulation of science policies at Monbusho (Chart I-2)

Monbusho is responsible for the promotion and extension of scientific research in parallel with the advancement of education and cultural activities. The word "scientific research" here means the basic research in all the fields of humanities, social sciences and natural sciences (including engineering, medical sciences and agricultural sciences) and application research resulting from such basic research.

In fulfilling its responsibilities for the promotion of scientific research, Monbusho holds the following three principles:

- 1) To maintain and further solidify the foundation of research in all the fields of humanities, social sciences and natural sciences.
- 2) To respect free conception of research workers, as well as their independent will for research.
- 3) To promote scientific research and training of scientists in a systematic and integrated manner.

The Science Council and the Geodesy Council, both advisory organs to the Minister of Education, Science and Culture, are established within Monbusho with a view to reflecting scientists' opinions to the formulation of science policies.

The Science Council plays a leading role in the formulation of science policies and has ever brought forth valuable advices and recommendations on the basic policies for the promotion of science and

measures to be taken to promote research in specific fields of science, such as space science, fusion research, bioscience and ocean science. Its report on basic measures to be taken to improve scientific research system, which was submitted in 1984, suggested the basic measures and the conception framework to be adopted at the systematic and effective development of policies on the promotion of scientific research, with due consideration given to new circumstances arising around scientific research activities.

At present, the Science Council consists of 27 eminent scholars and scientists from various fields, and Prof. Yuichi Yamamura, ex-President of Osaka University is serving as Chairman. Moreover, some 1,200 research workers are taking part in the activities of the Science Council as expert members.

The Geodesy Council deliberates on scientific research in the broad area of earth science, as well as geodesy programmes of governmental ministries and agencies, and, when necessary, submits recommendations to competent ministers. The most important job of the Geodesy Council lies in the formulation of plans on prediction of earthquakes and volcanic eruptions, a subject of great social interest of today. The Geodesy Council is also concerned with the planning of Japan's participation in such international cooperative programmes as the Middle Atmosphere Programme (MAP), the Dynamics and Evolution of Lithosphere Project (DELPE) and the World Climate Research Programme (WCRP). The Geodesy Council is composed of 27 members, Prof. Toshi Asada, Emeritus Professor of the University of Tokyo acting as Chairman. Members of the Geodesy Council are mostly scholars and scientists, but government agencies concerned, such as the Meteorological Agency and the Geographical Survey Institute, are represented at the Geodesy Council.

### 3. Institutions

#### 1) Universities (Chart I-3-1)

There are 461 universities in Japan, where research is carried out as an integral part of the activities of their academic staffs. Of these, 96 are national institutions established by Monbusho, 34 are public institutions established by the prefectural or municipal governments, and 331 are private institutions. However, research is

also conducted in other types of institutions of the higher education system, namely, junior colleges and technical colleges, which comprise about 10 per cent of the total academic staff of the higher education system. There are 543 junior colleges and 62 technical colleges.

Of the 461 universities, 281 have graduate schools of which 188 provide master's and doctoral courses and the remaining 93 provide only master's courses.

## 2) University research institutes

The research activities are conducted not only in the faculties and graduate schools, but also in various research institutes established within the universities, as well as in the National Inter-University Research Institutes.

### Research institutes of national universities

Many research institutes have been established within the national universities to promote research in particular fields, most of them dating back to the 1920's and 1930's. Since the mid-1950's, emphasis has been placed on the promotion of cooperative research and joint use of research facilities by all university researchers. Today, of the 69 research institutes attached to national universities, 12 are available for joint use (Chart I-3-3). They include institutes in the fields of fundamental physics, solid state physics, plasma physics, ocean research, and so on.

In addition, there are about 330 other research facilities of the national universities, often called centers, that are designed to serve more specific research purposes and are comparatively small in scale. Some of them are, however, large in scale and open for joint use by all university researchers.

### Research institutes of private and public universities

Many private and public universities have their own research institutes, primarily in the fields of humanities and social sciences. There are 497 such institutes established by the private universities and 29 institutes established by the public universities, and some of them have a long history.

### 3) National Inter-University Research Institutes (Chart I-3-3)

During the 1970's a new type of research institute called National Inter-University Research Institutes was created to meet the needs arising from the rapid progress of certain areas of science. Such institutes are not attached to particular universities and are open for the joint use of all university researchers. Today, there are 12 such National Inter-University Research Institutes established in various fields of science.

As national centers of research activity, they have been established in fields of science where there are clear needs for either the use of large-scale research facilities and equipment or the systematic collection of data, or for team research with the participation of a large community of researchers. They are also expected to assume an important role for international cooperative research programmes in their respective fields of science.

The first institute of this type, the National Laboratory for High Energy Physics (KEK), was established in 1971. This was followed by other research institutes in the fields of Japanese literature, polar research, ethnology, molecular science, basic biology, physiological science, space and astronautical science, Japanese history, genetics, statistical mathematics, and science information.

The National Inter-University Research Institutes belong to the same legal classification as the national universities, and their research staffs are accorded the same status as professors or other titular faculty members of the universities. Each of these institutes is run by a board consisting of representatives of the universities and related research institutions and other eminent scholars.

### 4) Research institute operated directly by Monbusho

Besides those introduced above, Monbusho is directly operating seven research institutes in such fields as educational research, Japanese language, cultural properties, etc. Monbusho also operates national museums and art galleries, totalling eight in number, respectively playing important roles in the research of arts and cultural properties, but commonly they are treated separately from institutes for scientific research.

#### 4. Researchers and research expenditure

##### 1) Researchers and research expenditure

As of April 1985, the total number of researchers was approximately 448,000. Of these, 181,000 work in universities and 231,000 in private industry. The number of university researchers has grown rapidly in accordance with the increase of enrollment number of students but the number of researchers in private industry has increased more rapidly over the last 20 years, and is expected to increase continuously. Therefore, the ratio of university researchers, which is accounting for 40 percent of the total, will decrease in future, but still they may play an important role in scientific research. (Chart I-4-1-1)

The total national research expenditure in 1984 was 7,894 billion yen (\$33 billion) accounting for 2.60 percent of the GNP, of which 1,724 billion yen was for research activities at universities. Universities thus account for 22 per cent of the total national research expenditure. (Chart I-4-1-2)

One of remarkable characteristics of the research expenditure in Japan is the great contribution of the private industry. If compared internationally, while the government contribution in other countries occupies as much as a half of the total research expenditure, it is less than a quarter in Japan. Moreover, resources from the government seldom go to the private sector, and the private industries rarely support research activities of the government and universities (Chart I-4-1-3). In other words, universities cover their research at their own expense.

In recent years, changes are taking place in this situation. The flow of resources from the private sector to universities and national research institutes has been increasing rapidly. There are several reasons for this increased flow. Firstly, the R&D itself has come to attach importance to basic research. Secondly, there has been an increasing need for interdisciplinary researches with which specific research speciality alone cannot cope successfully, and these tendencies have necessitated the cooperation among industry, government and university. Lastly the government has been obliged to follow the retrenchment policies.

## 2) Monbusho's budget for scientific research

The national universities financially are almost totally dependent on Monbusho both for their management and for their educational and research activities. The private universities and the public universities, which are self financing in principle, are also supported by Monbusho through subsidies that cover a little more than 20 per cent of their total expenditure.

Monbusho also supports scientific research activities through research grants to individual researchers and subsidies to the Japan Society for the Promotion of Science JSPS.

The fact that research and education are conducted as an integral part of the activities of university faculties and graduate schools makes it difficult to estimate the exact amount of expenditure for research purposes. However, if one assumes that half of such research and educational expenditures are for research activities, Monbusho's budget directly used for the promotion of research, excluding the personnel and management expenditures of university faculties and graduate schools, is estimated to be 331 billion yen (\$1.6 billion) in 1986. (Chart I-4-2-1)

If one adds to this half the amount of the personnel and management expenditures of national universities and the subsidies for the current expenditures of private and public universities, the total estimated budget of Monbusho related to scientific research, excluding the humanities and social sciences, represents about half of the total government budget for the promotion of scientific and technological research. (Chart I-4-2-2)

In addition to supporting national universities and subsidizing private and public universities, Monbusho makes research support available in the form of research grants directly to researchers or groups of researchers working at all universities and research institutions. Research grants are awarded upon the basis of unsolicited proposals which are examined by specialist committees established within the Science Councils' Research Grant Committee. Recipients of such grants are expected to make an important contributions to the progress of science. (Chart I-4-2-3)



In 1985, a total of 42 billion yen (\$176 million) was granted for about 15,000 research projects selected from among 53,000 applications. The amount of 43.5 billion yen is budgeted for 1986.

## II Urgent Issues of Science Policies and Future Trends

### 1. New circumstances of scientific research

In recent years circumstances of scientific research are making remarkable and rapid changes. In its last report the Science Council has pointed out the main features of these changes, as follows:

#### 1) Need for cooperation between different disciplines

While scientific research in one discipline becomes more and more advanced and specialized, interdisciplinary, compound research across individual specialities are increasingly hoped for. In addition, research in those complicated problems which efforts within a limited discipline cannot clarify may make an epochal progress through application of new findings and methods obtained in different research disciplines. Under these circumstances, systematic cooperation across relevant disciplines are deemed increasingly important.

#### 2) Increase in the amount of research expenses per project

Amount of research expenses per project is increasing to meet higher efficiency of research equipments and rapid increase of information to be processed. This tendency is especially remarkable in such research fields as high energy physics, space science and fusion research.

#### 3) Increase in social demands

In keeping with the important role which new findings from scientific research have come to play in the social prosperity, expectations on scientific research from industrial and other quarters are increasing.

#### 4) Importance of scientific research as the foundation of science and technology

It is now one of the most important policy issues how to promote original and pioneering research which makes the foundation for the establishment of science and technology rich in creativity.

#### 5) Need for international cooperation

The importance of international exchange and cooperation in science is growing as scientific research develops, and it is also necessary to promote Japan's positive participation in various programmes of international scientific exchange and cooperation.

6) Development of information processing techniques

By virtue of the development of the computer and other information processing apparatus, the preciseness and efficiency of scientific research may safely be expected. Moreover, new research fields have been opened up by utilizing these techniques.

2. Important items to be emphasized for the future

In its 1984 report the Science Council pointed out the five items as given below as most important to be taken into account in the planning of future programmes for the promotion of scientific research.

- 1) Priority implementation of researches in accordance with characteristics of scientific research.
- 2) Training and securing of excellent research workers
- 3) Promotion of university-industry cooperation
- 4) Promotion of international exchange and cooperation
- 5) Due consideration to the advancement of research in humanities and social sciences

In November 1984 the Council for Science and Technology submitted its report to advocate fundamental principles of the national science and technology policies. Especially emphasized in this report was to develop science and technology policies upon the basis of the following three objectives:

1) to promote creativeness of science and technology, 2) to promote science and technology harmonious with man and society, and 3) to promote international activities.

In recent years, however, the budget for scientific research have been restrained, because of the government's constricted budget for elimination of financial deficits in line with the proposed principles of administration reforms. Under the circumstances, it is strongly requested that measures for the promotion of science be planned so as to

make more efficient use of both human and financial resources, through evaluation of existing systems and applying the 'scrap and build' method.

### III Important Measures for the Promotion of Science

#### 1. Priority measures

Among many measures for the promotion of scientific research, a major emphasis in the aspect of research organization is laid on the strengthening of joint research systems, and in the aspect of research expenditure, on the improvement and expansion of the research grants system.

The research grants are aimed at stimulating and promoting scientific research activities on a selective basis, and expansion of the research grants constitutes one of the highest priority issues of Monbusho every year. The total amount of the research grants for FY1986 is 43.5 billion yen, which have been distributed among some 16,000 research projects. Research areas, such as cancer research, energy research including nuclear fusion, cerebral nerve research, information processing, etc., whose advancement is especially hoped for scientifically and socially, are chosen as priority areas and invested so as to make research activities carried out continuously and systematically. (Chart I-4-2-3)

#### 2. Training of researchers

From the viewpoint of researcher training, it is necessary to expand and increase graduate schools at universities. In some specific fields where researcher training cannot sufficiently be expected of universities, Monbusho is examining the possibility of uniting relevant national inter-university research institutes into a consortium which would act as a graduate school.

The Japan Society for the Promotion of Science (JSPS) also launched from 1985 a new fellowship programme under which fellowships are provided to selected junior scientists, who are studying at doctor courses of graduate schools or who have just obtained doctorate degrees. This fellowship programme is expected for future expansion.

For the training of young researchers, confrontation with foreign researchers under exchange of scientists programmes is also important. From this viewpoint JSPS is conducting programmes of this kind, dispatching Japanese scientists abroad and inviting foreign scientists to Japan. The expansion of these programmes is earnestly hoped for.

### 3. Industry-university research cooperation

1) As mentioned before, efforts are being made for improvement and expansion of joint research systems including national inter-university research institutes. And it is a matter of course that at these national inter-university research institutes those researchers from outside universities, who are engaged in the same research areas, participate in joint research programmes. The Institute of Space and Astronautical Science, one of the national inter-university research institutes, succeeded many times in launching scientific satellites and in exploring space researches. This may be a good example of smooth and successful joint cooperation in a broad-scale programme among scientists from universities and private sectors.

2) A number of individual universities and research institutes have established within their framework special units in charge of the promotion of research cooperation with outside researchers. The Center for Research Cooperation and Information Exchange, Tokyo Institute of Technology, and the Technological Development Centers of Technological Universities of Nagaoka and Toyohashi, are some examples of such efforts. This trend of setting up systems for cooperation with local industries is also prevailing among universities.

### 3) Expenditures for joint research

a. Research grants: One of the categories of the Research Grants Programme is "experimental research", which aims at encouraging applied research based on results obtained from basic research, which can be carried out jointly by university researchers and researchers in industry.

b. Monbusho's programmes for joint research (Chart III-3-3-1): The system of joint research was established in 1983 for the purpose of