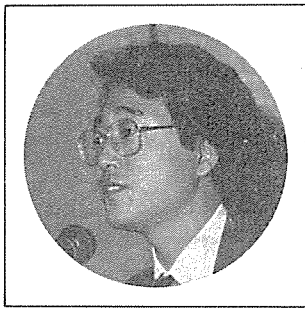

Policies for the Promotion of Basic in Japan



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Recently, many countries are interested in science and technology. Some of them consider those issues important to for their national policies. I assume that science and technology will become key issues for surviving in the future international community. Furthermore, basic science will be a fundamental element in the treasure box of future high technology. In addition, it may become a measure in international power politics.

I hope that my speech will help you for understand what Japan's science policy is. First, I will explain the structure of science policy making, then I will refer to the present issues of science policy and their future development, thirdly, I will introduce on-going measures taken for the promotion of science, and finally, I will add my own opinion concerning the promotion of basic science.

Structure of Science Policy Making

- Roles of government agencies in research

Many government organizations are related to research in science and technology, but, frankly speaking, the Ministry of Education, Science and Culture(Monbusho) is responsible for basic research and its application, and other 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 research in science and technology by establishing research and examination institutes.

As for the coordination of research activities at those 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 over-all basic policy on science and technology.

As for nuclear and space science, 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.

Let me give you some explanation in relation to research of space and nuclear fusion, because in these fields, there arises a problem about the inter-relation 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 institutes, and programmes for development and Launching utility satellites, including weather satellites and communications satellites are conducted by the National Space Development Agency under STA, with the 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 Institution of Plasma Physics at Nagoya University, the Plasma Physics Laboratory, Kyoto University, the Institute of Laser Engineering, and Osaka University. Full scale projects aimed at developing utility reactors are promoted at the Japan Atomic Energy Research Institute under STA. The overall coordination of fusion research programs is conducted by the Committee on Nuclear Fusion set up by the Atomic Energy Commission.

The structure and function among the government agencies are as I mentioned above. Of course, the countries Which have strong bureaucratic systems may have the same structure. In Japan, there are many jurisdictional disputes among the government agencies even in the area of science and technology.

There is a phrase "A bureaucrat Who does not insist on his own power in the jurisdictional conflict is not a bureaucrat".

Therefore, several ministries or agencies may have the same project on the same matter sometimes. He seems like a useless conflict Which wastes large budgets. On the other hand, ironically, it evolved into a competition for promoting science and technology.

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

② To respect free conception of researchers, 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 of the Monbusho, were established within Monbusho in order to reflect scientist's opinions on the formulation of science policies.

The Science Council plays a leading role in the formulation of science policies and has offered valuable advice and recommendations on the basic policies for the promotion of science and measures to be taken to promote research in specific field, such as space science, fusion research, bioscience and ocean science. Its report on basic measures to be taken to improve the scientific research system, which was submitted in 1984, suggested basic measures and the framework to be adopted for the systematic and effective development of policies on 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. Moreover, some 1,200 researchers 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 programs of government agencies, and, when necessary, submits recommendation to various ministries. The most important role of the council lies in the formulation of plans on the prediction of earthquakes and

volcanic eruptions, a subject of great social concern today. The Geodesy Council is also involved in the planning of Japan's contribution to such international cooperative programs as the Middle Atmosphere program(MAP), the Dynamics and Evolution of Lithosphere Project (DELP) and the world Climate Research Program (WCRP). This council has 27 members who are mostly scholars and scientists, but some of them are representatives from other government agencies such as the Meteorological Agency and the Geographical Survey Institute.

• Institutions

① Universities

There are currently 491 universities in Japan now(1988). They carry out research as an integral part of the activities of their academic staffs. 96 of the universities are national institutions established by Monbusho : 38 are public institutions established by local governments, and the others are private. 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% of the total academic staff of the higher education system. There are 715 junior colleges and 62 technical colleges in Japan. Among the 491 universities, 294 have graduate schools. 197 provide master's and doctoral courses and the remaining 97 provide only a master's course.

② University research institutes

Research activities are conducted not only in the faculties and graduate schools, but also in various research institutes established within the universities, and the National Inter-University 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 the cooperative research and joint use of research facilities by all university researchers. Today, of the 66 research institutes attached to national universities, 13 are available for joint use. They include institutes in the fields of fundamental physics, plasma physics and ocean research among others.

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, however, are large in scale and open for joint use by all university researchers.

Research institutes of private and public universities

Many private and universities have their own research institutes, primarily in the fields of the humanities and social sciences. There are 214 institutes established by private universities and 26 by public universities.

③ National Inter-University Research Institutes

During the 1970's a new type of research institute called the National Inter-University Research Institute was created to meet the needs arising, from the rapid progress of certain area of science. Such institutes are not attached to particular universities and are open for the joint use of all university researchers. Today, there are 13 such institutes established in various fields of science.

As national centers for research activities, 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 in international cooperative research programs 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, 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 institutes operated directly by Monbusho

Besides those which I mentioned above, Monbusho is directly operating six research institutes in such fields as educational research, Japanese language, cultural properties, etc. Monbusho also operates 8 national museums and art galleries, playing important roles in the research of arts and cultural properties. They are usually treated separately from scientific research.

• Researchers and research expenditure

① Researchers and research expenditure

As of April 1988, the total number of res-

earchers was approximately 513,000. of those, 195,000 worked in the universities and 279,000 in private industry. The number of university researchers has grown rapidly in accordance with the increase of student enrollment, but the number of researchers in private industry has increased even more rapidly over the last 20 years, and this trend is expected to continue. Therefore, the ratio of university researchers, which accounts for 38% of the total, will decrease in the future, although they may still play an important role in scientific research.

The total national research expenditure in 1987 was 9,837 billion yen(\$68 billion) accounting for 2,60% of the GNP, of which 1,958 billion yen was for research activities at universities. Universities thus account for 20% of the total national research expenditure.

A remarkable characteristic of the research expenditure in Japan is the large contribution from private industry. If compared internationally, while the government contribution in other countries occupies as much as 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 private industries rarely support research activities of the government and universities. In other words, universities cover research at their own expense.

Recently, this situation is changing. The flow of resources from the private sector to universities and national research institutes has been increasing rapidly. There are several reasons for this. To commence, the R&D itself has come to attach importance to basic research. Secondly, there has been increasing need for interdisciplinary researchers with which specific research alone cannot cope successfully, and these tendencies have necessitated the cooperation

among industry, government and the university system.

② Monbusho's budget for scientific research

The national universities are almost totally financially dependent on the Monbusho both for their management and for their education and research activities. Private and public universities, which are selffinancing in principle, are also supported by Monbusho through subsidies that cover a little more than 17% of their total expenditures.

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 education 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, was estimated to be 372 billion yen(\$2.6 billion) in 1988.

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

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 a committee of specialists established by the Research Grant Committee of the Science Council. Research grants are expected to make an important contributions to the progress of science.

Urgent Issues of Science Policies and Future Trends

- New circumstances of scientific research

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

- ①Need 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 anticipated. In addition, research in complicated problems which efforts within a limited discipline cannot clarify may make epochal progress through application of new findings and methods obtained in different research disciplines. Under these circumstances, systematic cooperation across relevant disciplines is deemed increasingly important.

- ②Increase in the amount of research expenses per project

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

- ③Increase in social demands

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

- ④Importance of scientific research as the foundation of science and technology.

Currently, one of the most important policy issues is how to promote original and pioneering research which will form the foundation for establishing science and technology rich in creativity.

- ⑤Need 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 programs of international scientific exchange and cooperation.

- ⑥Development of information processing techniques

By virtue of the development of the computer and other information processing apparatuses, the preciseness and efficiency of scientific research may safely be expected. Moreover, new research fields have evolved utilizing techniques.

- Important items to be emphasized for the future

In its 1984 report the SCIENCE Council pointed out the five items most important in the planning of future programs for the promotion of scientific research.

- ①Priority implementation of researchers in accordance with characteristics of scientific research.

- ②Training and securing of excellent researchers.

- ③Promotion of university-industry cooperation

tion.

④Promotion of international exchange and cooperation.

⑤Due consideration to advancement of humanities and social sciences.

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

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

In recent years, however, the budget for scientific research has been restrained, because of the government's constricted budget due to the elimination of financial deficits in line with the proposed principles of administrative reforms. Under the circumstances, it is strongly recommended that measures for the promotion of science be planned to make more efficient use of both human and financial resources, by evaluating existing systems and applying the "scrap and build" method.

Important Measures for the Promotion of Science

• Priority measures

Among many measures for the promotion of scientific research, a major emphasis in research organization is laid on the strengthening of joint research systems. In respect to research expenditures, on the improvement and expansion of the reserch grant system are stressed.

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 FY1988 was 48.9 billion yen, which has been distributed among some 18,000 research projects.

• Training researchers

From the view point 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. Last year we established such a graduate school, the so-called "Graduate School for Integrated Research" in the Yokohama area. The school will have three departments and will be supported by seven inter-university research institutes located various cities in Japan. We project the institution's education and research will begin in coming April.

The Japan Society for the Promotion of Science (JSPS) also launched a new fellowship program in 1985 under which fellowships are provided to selected junior scientists, who are studying doctoral courses or who have just obtained doctoral degrees. This fellowship program is expected to expand in the future.

In the training of young researchers, interaction with foreign researchers through scientist exchange programs is also important. In this respect, JSPS is conducting programs of this kind, dispatching Japanese scientists abroad and inviting foreign scientists to Japan.

• Industry-university research cooperation

①As mentioned before, efforts are being made for the improvement and expansion of joint research systems including national inter-

university research institutes. The institute of Space and Astronautical Science, one of the national inter-university research institutes, succeeded many times in launching scientific satellites and conducting space research. This is a good example of a smooth, successful joint cooperation effort in a broad-scale program among scientists from universities and the private sectors.

②A number of individual universities and research institutes have established with their framework special units in charge of the promotion of research cooperation within 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. For example, we have already established 8 cooperative research centers at so called local universities and will have 5 centers this year.

③Expenditure for joint research

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

b. Monbusho's programs for joint research : The system of joint research was established in 1983 for the purpose of encouraging cooperative research with researchers in the private sector, with funding from industry, and some from Monbusho.

The system provides industry with access to university research and with incentives for developing treatments for patents. In 1987, 396 projects were undertaken with 205 industrial firms in 54 universities and other institutions, involving 2.1 billion yen, for research into materials, instruments, biotechnology, computer software, and so on.

c. Contract research : The contract research system enables researchers in national universities to carry out research activities with funds from external bodies. In 1986, a total of 3.2 billion yen was received by national universities for conducting 1,700 research projects on a contract basis.

d. Contract researchers : The contract researcher system provides researchers and engineers in industry with the opportunity to conduct research in national universities at the graduate level. More than 900 contract researchers are implementing research projects at national universities under this system.

e. Donations : National universities are authorized to receive donations from outside organs, such as private companies, for the purpose of encouraging scientific research in the universities. These donations are utilized for research and educational activities which are in line with the objectives of the donors. In 1986, a total of 25 billion yen was received by national universities in the form of donations.

By accessing these three programs, one can see that national universities received a total of 31 billion yen from external sources in 1986, which accounted for 9% of the total direct

research budget of national universities, excluding staff costs.

④ Usefulness of foundations

In order to encourage university researchers to extend cooperation to scientific research needed by the district where the university is located, foundations are considered very important. In many cases, foundations have been set up by funds contributed by local governments and industries to conduct university-industry cooperative research and developmental activities. There are also many examples of university researchers who participate in research meetings for local industrial development, initiated by local governors.

• Industry-University Cooperative Research Committee

It has been said that there are many barriers to university-industry research cooperation. First, there is a lack of information in both universities and industry. Professors do not know the real need of research and development in industry, and industry engineers do not know what kinds of research is going on at universities. In order to overcome this difficulty, the JSPS has provided a forum for promoting cooperation between universities and industry by creating Industry-University Cooperative Research Committees on specific themes. Researchers from both universities and industry meet and discuss recent research results. Since 1933, 151 such committees have been dissolved after fulfilling their assignments. These committees are established at the initiative of scientists both in industry and universities, and have been supported by industry funding.

• Promotion of international cooperation

The promotion of international exchange and cooperation in science is especially important not only to raise the level of academic research in Japan, but also to contribute towards the advancement of scientific research in the world. Among the programs for which Monbusho is responsible, project research based on intergovernmental agreements is carried out by Monbusho itself, and programs of a general nature are carried out by JSPS in line with the science policy of Monbusho.

A few examples of international research projects follow :

In the field of high energy physics, Japanese researchers are participating in joint experiments at American laboratories, as well as the LEP experiment at CERN with researchers from European countries. In Japan, too, American research groups are taking part in the "TRISTAN" program at the National Laboratory for High Energy Physics(KEK).

In the area of nuclear fusion research, Japanese researchers cooperate in the international TEXTOR (Torus Experiment for Technology-Oriented Research) project at Jurich, F. R. G.

In space science, Monbusho's Institute of Space and Astronautical Science, took part in the joint observation of Halley's Comet.

As for the antarctic research, the National Institute of Polar Research acts as the central coordinating body for research under the direction of the Headquarters for Japan Antarctic Research Expeditions established within Monbusho. Scientific exchange programs with developing countries are mainly those carried out by JSPS under its core university system and those included in the intergovernmental research programs under the auspices of UNESCO. The core university system is a cooperative network which is established in each

priority field specified through negotiations between JSPS and its counter-part agency in each country. The role of the core university is to coordinate the activities of cooperating universities and individual researchers, so that exchange of scientists and scientific seminars may be carried out on a systematic and continuous basis. At present, various cooperative programs are carried out in 13 priority fields with five countries in South East Asia.

My Point of View for Promoting the Basic Science

In my personal opinion, there are two ways to encourage basic science. The first is to give researchers a "free hand" to conduct their research. The second point is to promote researcher training.

I'll start by discussing the former point. While a country is developing, mission-oriented research yields effective, good results. However, after reaching a certain level, there is no model for science and technology. Therefore, the em-

phasis should be placed on basic science. In that case, the key is to encourage free thinking among researchers which is produce excellent, beneficial results in advanced and creative research. The second point, to promote researcher training, is equally important. The future of science depends on young researchers produce new projects. Consequently, great importance needs to be emphasized in this area.

If we can accomplish these two points, training young researchers and giving researchers a free hand in their projects, then the results will be very positive for basic science as a whole. Each country may have their own way to promote the basic science. Perhaps, in the future, Korea will produce novel prize winners, which would be a strong indication of basic science progressing in this country.

At The symposium to Celebrate the 10th Anniversary of the Union of the Research Institutes for Basic Science in Korea. February 16, 1989

인공 關節 디자이너

중전의 관절이식이 필요한 환자들은, 표준 사이즈의 인공 관절로 이식되었기 때문에, 종종 환자의 건강한 뼈가 절단되기도 하고, 혹은 뼈가 기형이어서 수술 자체가 불가능하기도 했다.

런던 근교 체싱턴 소재 핀즈버리 인스트루먼트사는 컴퓨터를 이용한 관절설계로 이 문제

를 해결하였다. 사진의 작동자는 후면에 불이 들어오는 계수화페드와 특별 소프트웨어를 이용하여, X-레이에서 나온 상들을 집어넣어 엉덩이 관절의 크기를 알아낸 후 병든 관절을 정확하게 측정한다. X레이판위의 적절한 크기의 강철



불이 보조역할을 하여 X-레이 본래의 오차를 보장한다. 디자인이 끝나면, 모든 숫자로 조정되는, 제작에 필요한 정보가 입력되어 완제품이 생산된다.

관절이식에 있어 정확성은 매우 중요한데, 특히 장기간 사용이 불가피한 선천성 관절 기형의 젊은 환자들에게 절대적이다. 핀즈버리 인스트루먼트사는 새로운 의료기술 개발의 선구자로서, IDO System을 택했는데, 이용이 간편하고 신속하여 단일시스템으로 충분하기 때문이다.