ADVANCED MATERIALS,

STRATEGIC TECHNOLOGIES

AND

SCIENCE AND TECHNOLOGY POLICY

IN JAPAN

REPORT ON A VISIT TO JAPAN

JUNE 16 - 25, 1986

BY

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INTRODUCTION

This report summarizes the findings of my visit to Japan during the period June 16 to June 25, 1986. The objectives of the visit were:

- to learn of Japanese experience in the use of various policy instruments (such as mechanisms for cooperative R&D) to stimulate innovation in advanced materials and other strategic technologies;
- to learn of recent and upcoming or anticipated Japanese initiatives relevant to issues in Canadian science and technology policy;
- to learn of Japanese policies and programs in international R&D cooperation, especially in advanced materials, with a view to identifying opportunities for Canada;
- to gain a better appreciation of the state-of-the-art in advanced materials technologies; and
- to provide information to Japanese organizations on Canadian policies and programs in advanced materials and other strategic technologies.

A program comprising 23 visits was arranged with the advice and assistance of the Science and Technology Office of the Canadian Embassy. The visits were to the following types of organizations:

Government Departments and Agencies	8
Government Laboratories	4
Industry Associations and Foundations	6
Manufacturing Companies	3
Consulting and Investment Companies	2

While not related directly to the Canada/Japan Science and Technology Agreement signed in May 1986, the visit followed closely the signing of that agreement as well as a visit by the Minister of State for Science and Technology to Japan in September 1985. Accordingly, the discussions with government officials often broached the subject of Canada/Japan relations.

While the visit was intended to focus on advanced industrial materials, much of the discussion and the information received was of a more general nature, in the fields of science policy, strategic technologies and industrial and international cooperation. This is reflected in the outline of this report. Wherever possible, however, I have related my report to the materials field.

The report, being based on a limited number of meetings with selected organizations and on the reading of directly related literature, is not intended to be exhaustive.

The main text is organized according to the main issues or categories of activity that I encountered in Japan. The appendices include detailed accounts of each meeting. Reference documents listed at the end of each appendix are available for loan through the MOSST Library.

I am grateful to Peter Eggleton, Science and Technology Counsellor at the Canadian Embassy in Tokyo, Seishii Tanaka and Noriko Abe of his staff, Hiroshi Shimizu of the Ontario Research Foundation (temporarily attached to the Japan Fine Ceramics Center), Michael Farley and François Leclair of External Affairs and Joe MacDowall, Cheryl Henry and Diane Trottier of MOSST for their assistance in planning, organizing and carrying out the visits that are the basis for this report.

Principal Observations and Recommendations

The following observations are generalizations which are elaborated and illustrated in the subsequent sections of the report and in the appendices. While the visits and discussions revealed that generalizations about Japan, like those about any country, can be misleading, the observations below have been carefully selected and qualified.

- New materials, if electronic materials are included, is arguably the top priority subject for research and development in Japan. This is reflected in the priority attached to this field by the Council for Science and Technology, the Science and Technology Agency, the Ministry of International Trade and Industry, the Ministry of Education, Science and Culture and the Japan Key Technology Center. Evidence to this affect is presented in the appendices.

- The reasons for worldwide concern over Japanese advances in new materials and other strategic technologies were very much in evidence. In materials, for example, government and industry programs are wide-ranging, carefully planned and aggressively pursued. While Japan's strength in science and the development of technology may be considerable, the real threat to companies in other nations continues to come from Japanese companies' venturesome approach to commercialization and relentless search for technologies that can be turned into commercial products. Examples from the materials field include the use of composite materials in sports equipment, and Nissan's introduction of the ceramic automotive turbocharger.

- The principles behind national science policy guidelines, as handed down by Cabinet in March 1986, are the encouragement of highly creative basic research (especially in industry), harmonization of science and technology with social goals, and internationalization of S&T. In almost all organizations that I visited, these principles appeared to be understood and accepted.

- The government is encouraging industry to do more basic research, but there is little evidence that industry is taking up the challenge. Indeed, the powerful Federation of Economic Organizations (Keidanren) has publicly taken the position that the Japanese government expects too big a share of R&D from industry while the government is not pulling its own weight. Many companies do recognize the need for more fundamental research, but performing it in Japan is only one of several options; some Japanese companies are acquiring access to research capability through formal links with firms or universities in the U.S.A. and Europe. There appears to be some disenchantment with the capabilities of Japanese university and government laboratories. One of the objectives of the Japan Key Technology Center to foster more fundamental research through joint efforts in industry.

- The priority on harmonization of S&T with social goals is reflected in the emphasis on the Human Frontiers Program, which is now the top priority of MITI's Agency for Industrial Science and Technology (last year the priority was the establishment of the Japan Key Technology Center, which is described later).

- The international dimension of S&T is very much on the minds of Japanese managers and researchers. A range of programs is available for exchange of information and researchers. A leading objective is to bring foreign researchers to Japan. For many years Japanese scientists and students have been spending periods of time overseas, and most of the technical people I met with had worked or studied in the United States or Europe.

- Cooperative industrial R&D is very much a part of the S&T scene in Japan. It takes various forms, the most common being engineering research associations established under a 1961 law, and "juridical foundations." In many cases, it seems that these are catalysed by MITI through its identification of key potential contractors for national technology programs, coupled with its preference to deal with associations rather than individual companies. Companies' motives in joining usually are related to access to MITI contract funds, sharing of risks, creating an advantage for Japan which can mean an international advantage for each company, and strategic positioning among the leading firms in an industry.

- The Japan Key Technology Center, a corporation established in 1985 by MITI and the Ministry of Posts and Telecommunications, promises to be an important force for the development of strategic technologies. Through a range of services the Center is expected to play the role of venture capitalist, fill a perceived gap in R&D support that results from Japan's lack of large military and space programs, and foster generic R&D through joint industrial efforts.

- On the other hand, because there have been so many Japanese initiatives in strategic technologies in recent years, it is difficult to assess the significance of any one, especially given that the same core group of companies tends to be involved in all of them.

- While I was prepared for a proliferation of committees in science and technology, it is even more widespread than I had expected. While there is undoubtedly a great deal of duplication and "unproductive" time spent, it appears to be all part of Japanese-style networking and consensus-building.

- I was very impressed with the quality of the English language information (brochures, etc.) given to me by the Japanese, and regretted that what I had to offer in return was not as informative and well presented. A comprehensive summary of science and technology policy, programs and performers in the federal government would have been especially useful.

- While Canadian firms, universities and government agencies may be very actively pursuing interests in Japanese developments, other countries are much more active. For example, on several visits I heard about Sweden's interest (example: four Swedish scientists will spend time at the Government Industrial Research Institute, Nagoya, during the coming year.) The Swedish Embassy's Science and Technology Office in Tokyo is about three times the size of Canada's.

- The program of visits included no stops at universities. While Japan's universities may not be major players in technology development, some professors are highly regarded for their knowledge and views of S&T policy and are regularly called on to head advisory councils and task forces. Visits to such individuals would have been useful.

- While Japanese executives appear to have a special allegiance to the nation, fundamentally they are pragmatic business people who are continually seeking a commercial advantage. With Japanese companies being predominantly domestically owned and clearly identifiable as Japanese, an advantage for Japan as a whole in world markets is seen as an advantage for each aggressive Japanese company - just as a general expansion of the automobile market is good for any company that can hold its market share. Increasing internationalization can be expected to gradually erode this loyalty.

- Japan is a society in transition in many respects, mostly as a result of international influences and pressures. The trade surplus, the rising value of the yen, competitive responses from the U.S. and Europe, Japan's special relationship with the developing countries, the aging of the population, and the push for a five-day work week are among the factors.

Recent Science Policy Developments

The "General Guideline for Science and Technology Policy" (Reference Document B-6), handed down by the Japanese Cabinet on March 28, 1986, outlines the government's priorities for science and technology promotion. The guideline is based largely on the report of the 11th Inquiry of the Council for Science and Technology (CST), dated November 11, 1984 (Reference Document B-4) and also the report of the 12th Inquiry dated December 3, 1985.

The CST, chaired by the Prime Minister, is a deliberative and authoritative body that advises the Prime Minister on science policy. Its recommendations usually become policy to be followed by all government ministries and agencies.

The 1986 Guideline is based on the following three principles, which were laid out in some detail in the 11th inquiry:

1. the importance of highly creative basic research;

2. the need to develop science and technology in harmony with man and society; and

3. due attention to Japan's increasingly significant role in the community of nations.

Priority programs under the Guideline are:

1. strengthening of systems for basic research, including review and improvement of R&D programs in government laboratories, promotion of industrial-academic-government research exchanges and cooperation, flexible research systems, etc.;

2. increased government investment in R&D;

3. special public sector efforts to secure and train R&D personnel;

4. improved availability of necessary literature, databases, equipment, materials, genetic resources, etc. that the private sector cannot be expected to provide;

5. expanding international exchanges and cooperation; and

6. promotion of public understanding in S&T and stimulation of interest among the younger generation.

The Prime Minister is to prepare a series of basic R&D plans in each of the following priority areas:

1. Basic research as the foundation of the future progress:

    a) matter/materials sciences and technologies;

    b) information/electronics sciences and technologies;

    c) "Soft series" of sciences and technologies (e.g. systems engineering, behavioral science, mathematical science, etc.);

    d) space sciences and technologies;

    e) ocean sciences and technologies; and,

    f) earth sciences and technologies.

2. S&T for activating the economy:

    a) development and management of natural resources;

    b) development and utilization of energy;

    c) upgrading of production technologies and distribution systems;

    d) recycling and effective utilization of resources; and,

    e) improvement of service to society and life.

3. S&T for improving the quality of life:

    a) Maintaining and improving the mental and physical health of the people;

    b) formulation of individual and cultural life;

    c) formulation of a comfortable and safe society; and,

    d) improving the human environment.

The Guideline must be adhered to by ministries. The Science and Technology Agency, which is attached to the Prime Minister's Office, coordinates the implementation of the policy using its own budget (about $600 million)* of "special coordination funds" to support targeted research in government laboratories. The Ministry of Education, Science and Culture (Monbusho), which shares responsibility for the CST secretariat, supports fundamental research in universities. Industrial technology is MITI's responsibility. In addition, various line ministries have R&D programs. The spending allocation is shown in Table 1.

Another recent development is enactment of a scientific and tehnological promotion bill on May 14. The bill, designed to overcome certain restrictions to international scientific exchange and cooperation, deals with employment of foreign scientists, attendance at professional conferences, intellectual property rights, use of state research facilities, and other matters. (See Appendix B.)

The Human Frontiers Program, announced at the Economic Summit in May 1986, is the current priority of MITI's Agency for Industrial Science and Technology. In 1985 the priority was establishment of the Japan Key Technology Center (Appendix D).

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*NOTE concerning exchange rates: Throughout this report, the rate of one yen = $0.0090 (Cdn), or $1 = 111 yen, is used. This is the prevailing rate in August 1986.

Table 1
Fiscal Year 1985 and 1986 Budget Related to Science and Technology
(millions of Canadian dollars)**

	1985	1986
Ministry of Education, Science and Culture	6 426	6 714
Science and Technology Agency	3 717	3 780
Ministry of International Trade and Industry	1 737	1 962
Ministry of Agriculture, Forestry and Fisheries	549	594
Defence Agency	531	*
Ministry of Health and Welfare	306	*
Ministry of Posts and Telecommunications	126	*
Ministry of Transport	117	*
Environment Agency	90	*
Other	99	1 530
Total	13 698	14 580

* Data not available - included in "other".
**One yen = $0.0090 (prevailing rate in August 1986).

Sources: Science and Technology Agency and Ministry of Education, Science and Culture.

The Human Frontiers Program, currently in the feasibility study phase, has a large biotechnology content.

While Japan is a unitary state and a much more homogeneous society than Canada, there is an important regional dimension to MITI/AIST's industrial technology promotion. In 1982 a "Specific Regional Technology Development System was inaugurated, and six major R&D projects were established in 1984 to promote the introduction of advanced technology into selected regions. The system also includes a range of measures for technology transfer (see Reference Document C-1, page 17). The regional activities are managed by MITI's regional offices, usually without formal negotiations with prefectural governments.

Reality continues to chip away at the well-worn notion of "Japan, Inc." An example is the public position of the Federation of Economic Organizations (Keidanren) on government R&D policy, as outlined in the February 1985 issue of Keidanren Review. While Canada and other countries regard Japanese industry's 80% share of GERD as admirable, the Keidanren is of the view that industry is doing more than its share, and government should spend more. Elaboration of the Keidanren's position can be found in Appendix I and Reference Document I-2.

Finally, a central and increasingly important aspect of Japanese science policy relates to strategic technologies, the subject of the next section of this report.

Strategic Technologies

Strategic technologies (more commonly referred to in Japan as fundamental, basic or key technologies) are very clearly a priority of the Japanese government, and are most in evidence in MITI programs. A selected list of government-assisted initiatives is given in Table 2. Most of those listed are related to advanced materials.

The leading program is the "R&D Project of Basic Technologies for Future Industries", a ten-year government/industry research program established in 1981 to promote the development of new technology in the fields of new materials, biotechnology and electronic devices. Project funding is summarized in Table 3.

The Project is one of several sources of funding for government laboratories. It is now, for example, the single largest source of funds (28%) for MITI's Research Institute for Polymers and Textiles. It is also a small but significant source of research funds for STA laboratories.

Most of the funds, however, are used for contract research. In this regard, R&D consortia play a large role, and in most cases have been spawned by MITI to coordinate contract research in specific fields.

Table 2
Recent Japanese Initiatives in Strategic Technologies: A Selected List
(All subsidized or otherwise directly facilitated by the government)

Title	Date Established	Description
General Guideline for S&T Policy	1986	Cabinet decision on government investment in R&D. Lists materials science, information/electronics sciences and life sciences as the first three priority fields for support of basic research.
Japan Key Technology Center	1985	Quasi-governmental corporation to provide capital and other services to companies doing research in strategic technologies (electronics, materials, telecommunications, etc.)
Japan Fine Ceramics Center (Nagoya)	1985	Research, testing and standardization center for fine ceramics.
New Materials Center, Osaka	1985	Testing and standards institution for new metallic materials.
Japan High Polymer Center	1985	Testing and standards institution for polymers.
Japan Research and Development Center for Metals	1985	Center for joint R&D.
Japan Fine Ceramics Association	1983	200-member trade association.
R&D Project of Basic Technologies for Future Industries	1981	Ten-year MITI government/industry R&D program in new materials, biotechnology and electronic devices.
Engineering Research Association for High-Performance Ceramics	1981	R&D consortium of 15 companies.
Research and Development Institute of Metals and Composites for Future Industries	1981	R&D Consortium (juridical foundation).

Table 3
R&D Project of Basic Technology for Future Industries
(in millions of Canadian dollars)

		Fy 1985	Fy 1986
New Materials		32.3	32.1
1985 breakout:			
High-performance Ceramics	8.6		
Synthetic Membranes	5.0		
Synthetic Metals	3.4		
High-performance Plastics	2.7		
Advanced Alloys	5.5		
Advanced Composites	6.5		
Photo-responsive Materials*	0.6		
Biotechnology		11.3	11.0
Bioreactors			
Large Scale Cell Cultivation			
Utilizing Recombinant DNA			
New Electronic Devices		14.4	15.5
Superlattice Devices			
Three Dimensional IC's			
Fortified IC's for Extreme Conditions**			
Bio-IC's*			
TOTAL		58.0	58.6

* Added 1985
** Discontinued 1985

Sources: MITI, SRI Asia

Above all, the project and its goals - indeed the identification of new materials, biotechnology and electronics as R&D priorities - are widely understood and accepted. The emphasis in new basic research and international exchange as emphasized by the CST is largely on these three technologies.

The Project was also a major factor in the establishment of the Japan Key Technology Center, which could become the major vehicle for the promotion of research in these fields. The emphasis is on cooperative, generic research.

Advanced Materials

Materials R&D is very clearly one of the S&T priorities of the Japanese government and of a host of companies. The state-of-the-art, and industrial activity in this field, have been amply investigated by several commercial missions sponsored by the Canadian government over the past two years. Readers are referred to the reports of these missions (available from mission organizers), to mission participants, and to certain of the reference documents attached to this report for details. Below I summarize some impressions from my visit of June 1986. Mostly these impressions are related to government policy and business strategy.

The Council for Science and Technology, through the Science and Technology Agency, is preparing a ten-year plan for new materials R&D. This should be ready within 18 months, and will be an elaboration of the approach outlined in the Report of the 11th Inquiry (Reference Document No. B-4).

The Japanese leadership position in the commercialization of advanced ceramics is well known. The extent and intensity of the R&D underway in this field indicates the Japanese will continue to hold the lead for many years to come. Kyocera and NGK, for example, have a wide range of products and a technical capability that is perhaps unmatched outside of Japan.

As the industrial visits on this trip were to ceramics companies, it is difficult to assess Japanese strength in other materials. In national programs, however, ceramics does not enjoy a significant advantage over other advanced materials in terms of government attention or funding. Ceramics is, however, the subject of a greater promotional effort by the leading companies involved.

Other companies, such as Nippon Steel, see themselves increasingly as user-oriented integrated materials suppliers, rather than as single-commodity companies. This reflects both the uncertainty surrounding the future of traditional materials as well as a fundamental change that is taking place within the materials field, shifting the control over materials specifications toward product designers and engineers.

Cooperation in Industrial Research and Development

Japan is well known for its proliferation of committees, advisory councils, associations and similar groupings. This groupiness is very much in evidence in the prevalence of industrial R&D consortia as a significant force in the development of generic technologies. It must be recognized, however, that while cultural factors facilitate the formation of such groups, pragmatic business interests are the real driving force.

There appear to be several principal reasons why companies will readily form or join R&D consortia:

1. Membership can bring with it access to MITI contract funds. MITI prefers to deal with groups of companies rather than be seen to be aiding individual companies, and therefore often catalyses the formation of consortia by identifying prospective contractors and encouraging them to organize.

2. Consortia and their members are entitled to preferential tax treatment. For example, Engineering Research Associations formed under a 1961 law are entitled to, among other things, accelerated depreciation of fixed assets.

3. "Positioning" among industry leaders, and the national and international recognition it brings, is of strategic value to the firm.

4. Cooperative research is seen to generally improve the competitiveness of Japanese industry ("advantage Japan"), and is therefore of benefit to each company that keeps pace.

5. The sharing of the risks of R&D in generic technologies, and of leading-edge information, is a considerable incentive to join.

6. Membership is part of the process of building networks - which in Japan are plentiful and complex, forming a web through which innovations move with considerable speed.

While there are various ways in which Japanese collaborate to carry out or promote R&D, the following discussion focusses on three: Engineering Research Associations, foundations and a special case: The Japan Key Technology Center.

I visited the Engineering Research Association for High Performance Ceramics. This is one of about 100 targetted, limited-lifetime consortia formed since the passage of the 1961 Act. Fifty-two are still active.

This Association was formed when MITI identified new materials, including ceramics, as a priority, identified 15 leading companies as prospective contractors, and encouraged them to form an association to mediate and coordinate the contract program.

The R&D Institute of Metals and Composites for Future Industries performs a similar function but legally is a foundation. Initial "donations" from member companies form a fund that generates interest to cover operating expenses. The Institute receives a general request for proposals from MITI, in turn calls for proposals from member companies, and submits an omnibus proposal to MITI incorporating the individual companies' proposals and a management plan to, among other things, avoid duplication in research. MITI then lets a contract to the Institute which subcontracts to each performing company. Not all member companies are subcontractors.

The Japan Key Technology Center was formed in 1985, jointly by MITI and the Ministry of Posts and Telecommunications (MPT), to promote generic, high-risk R&D on a cooperative basis, in key technologies such as those identified under MITI's R&D Project of Basic Technologies for Future Industries (new materials, biotechnology, new electronic devices) and telecommunications, which of course is MPT's priority interest.

The Center, with an initial staff of 60, is a corporation at arm's length from government. It offers equity investment and conditional loans for R&D enterprises formed by two or more companies, as well as a range of other services.

While it is difficult to assess the Center's significance at this stage, it clearly has the potential to become a major force in the further development of strategic technologies in Japan through inter-company cooperation. Some observers describe it as filling a gap left by Japan's lack of major military and space R&D programs. It is an initiative that is well worth watching.

There remain a few features of the Japanese industrial scene that might strike Western observers as curious. Despite the widespread interest in cooperative R&D, I was told by a seasoned observer that it is very difficult to arrange joint R&D between two Japanese companies in the same business because of their fiercely competitive nature. Joint ventures and the like are more likely to be arranged with foreign companies, as a way to gain an edge on the Japanese competition, or between Japanese companies in different industries but with complementary assets (for example, the arrangement between Kyocera and Isuzu to develop the ceramic engine).

Another noteworthy aspect of industrial R&D cooperation is that there is very limited participation by small and medium-sized companies (SME's) - those that are often identified in Canada as potentially being the greatest beneficiaries of risk- and information-sharing. Consortium members are normally industry leaders, already with large R&D programs. Aspects of Japan's industrial structure facilitate the diffusion of technology from these leaders to affiliated SME's. In addition, MITI's Small and Medium-sized Enterprise Agency has a range of programs for SME'S.

International Science and Technology Cooperation

Earlier I noted the high priority given to international exchange and cooperation in Japanese science policy. This priority is shared and taken very seriously by many of the organizations I visited. A sampling of the many government programs available that might be of interest to Canadians is given in Table 4. The emphasis is on strategic technologies and advanced materials, but programs can include a wide range of fields.

A significant push was given to international exchange by the 1986 enactment of the Research Exchange Promotion Law. Its provisions include the following:

- foreign researchers can become high-level, non-executive employees of government laboratories on a temporary basis; and,
- while patent rights from joint research with governments of foreign countries can be used reciprocally free of charge or at low cost, a claim for damage can also be reciprocally abandoned.

Other provisions are designed to encourage government/university/industry cooperation within Japan, another priority of science and technology policy.

The current emphasis in Japan's growing interest in international cooperation and exchange appears to be on the following:

1. attracting foreign researchers to Japan;
2. creating links with foreign centers of excellence in fundamental research in key technologies; and,
3. bringing the world's best expertise to bear on Japanese technology development efforts.

Despite Japan's high proportion of university graduates, its excellent university system, and extensive company training and development programs, Japan is short of expertise in some critical areas, such as computer software. At least one leading electronics company has launched a recruitment program in the United States.

To gain access to foreign R&D expertise, Japanese companies are forming strategic partnerships with Western companies, and forming links with leading universities - for example, by funding chairs. Surprisingly, some Japanese companies seem to lack faith in the capability of their own government and university laboratories to supply the necessary new knowledge.

Table 4
Japanese Government Mechanisms to Promote International S&T Cooperation

Title and Sponsoring Agency	Description
Japan/Canada Bilateral Agreement on Science and Technology. (Ministry of Foreign Affairs in cooperation with other ministries).	Umbrella agreement signed in May 1986. Subsumes some 70 projects established under consultative arrangement dating back to 1972.
Research Exchange Promotion Law (Science and Technology Agency)	Passed May 1986 to overcome restrictions to domestic and international exchange of researchers, technology and information.
Exploratory Research for Advanced Technology (ERATO) (Research Development Corporation of Japan, STA)	Program of leading-edge projects in strategic S&T fields; teams led by eminent Japanese researchers can include invited foreign participants.
Human Frontier Program (MITI)	Announced May 1986, a five-year Japanese program of research focussing on living organisms; foreign governments have been invited to participate.
Japan Trust International Research Cooperation Service (Japan Key Technology Center)	Charitable trust to finance post-doctorate level researchers visiting Japanese companies.
Invitation Program for Foreign Researchers (Japan Industrial Technology Association, MITI)	Fellowships for foreign researchers to work at MITI laboratories.
International programs of the Japan Society for the Promotion of Science (Ministry of Education, Science and Culture)	Fellowships for foreign researchers visiting Japanese universities, international agreements with foreign academic institutions, etc.
International Exchange and Cooperation (Japan Fine Ceramics Association)	International symposia, invited lectures by foreign experts, etc.
International Cooperation (Japan Fine Ceramics Center)	e.g. Twinning with foreign institutes.

Appendix A

SRI International Asia Regional Headquarters, (Tokyo)
Monday, June 1, 1986, 13:00 - 15:30

Present: Tomotsugu ("Tom") Teshima
Assistant to Executive Director (13:00 - 13:30)

Peter K. Yokoyama, Director
Advanced Technology Consulting Department (13:30 - 14:50)

Junichiro Shimosato
Senior Industrial Economist
Chemical and Resources Department (14:50 - 15:30)

The Tokyo Office of SRI services the growing market in the Asia-Pacific Basin, covering the fields of advanced technologies, chemicals, resources and energy, information systems management and the service industries. The staff of the office is about 30, including 20 professionals, all bilingual, serving some 300 clients. Increasingly, the focus of the office appears to be the Advanced Technologies (ADTEC) program, about 10 persons dealing mainly with information technologies. Other strengths are in the chemical and energy industries. The office is more heavily into multi-client business than is SRI as a whole.

Advanced materials has not been a major field of activity, but this should change with the recent transfer of Gerry Shroff from Menlo Park. The demand for services in the materials field is growing rapidly.

Overall, demand for the services of the Tokyo office is growing. Traditionally, the Japanese have not been heavy users of consultants, but this is changing. Mr. Teshima attributes this largely to the time factor. The Japanese are finding that they no longer have the luxury of long lead times to develop strategies by the analysis and consensus route. Also, as Japanese companies continue to diversify their products and markets, they find they cannot always afford full-time expertise to cover new territory.

Asked whether the Japanese government is a frequent client, Mr. Teshima replied in the negative. Government procedures require detailed cost estimates before a contract can be awarded, and this is not easy for SRI; however, SRI indirectly gets the benefit of government contract programs because the priority is to let contracts to Japanese companies, which are increasingly using the services of SRI Tokyo in connection with these contracts.

Mr. Yokoyama pointed out that the European clientele for the Advanced Technologies program is growing rapidly, mostly involving companies seeking strategic alliances. Concerning strategic alliances from Japan's perspective, he made the following comments:

- the Japanese have perceived that simple trading is no longer sufficient to maintain a position in world markets; cross-border alliances are essential;
- trade pressures (political) are also forcing companies to form more alliances;
- as they diversify, Japanese companies sometimes experience shortages of expertise; this is most noticeable in the trend toward integration in electronics and is compounded by the fact that technologists rarely move from company to company; this is forcing companies to obtain expertise through international partnerships;
- Japanese companies often link up with foreign companies to gain an edge on their competitors within Japan; industry is extremely competitive within Japan and partnerships of two companies are not common; and,
- research associations (consortia) are normally guided and subsidized by the government, and are rarely started by companies.

Mr. Yokoyama also walked me through a presentation entitled "Japanese Electronics Industries: Successes and Issues, Focussing on Semiconductor and Computer", which he delivered to an audience in Taiwan in November 1985. The main points are:

- the computer and semiconductor industries in Japan have experienced rapid growth, largely through government (MITI, NTT) stimulation, but now face a changing environment;
- the companies are trying to enter world markets by various types of international cooperation such as licensing, joint venturing, equity participation and OEM agreement;
- as these industries will be more "strategically positioned" than other industries for the next decade, their future should be closely examined;
- vertical integration enabled the companies to attain world competitiveness effectively and efficiently (all major semiconductor companies are vertically integrated);
- despite experiencing its first down-turn in 1985, the semiconductor industry expects steady growth of over 20% through 1990;
- new entries are observed as ASIC becomes important for system developers;
- opto-electronics is an area of aggressive growth;

- IBM's worldwide strategy in software protection will have a major impact on Japanese PC makers;
- new frontiers are opening for computers as OA, communication, network and new media (VTX, VRS, VAN) become foci of all industry sectors;
- Japan is strong in hardware, but price reduction is hurting industries;
- the Japanese are acutely aware of their weaknesses in software and this will be the basis for management concerns;
- the new research areas are so broad that shortage of capable researchers is a problem;
- integration of data processing and communication is a strategic goal of Japan toward the 21st century;
- the Japanese industry faces major uncertainties;
- in view of these uncertainties, four different scenarios should be considered by companies in developing strategy:
  - sub-optimized (fragmented) system market;
  - entrepreneur business market (competitive);
  - harmonized market (coordinated); and,
  - fully integrated society.

Mr. Yokoyama also made the following observations:

- smaller companies are not in on the big national projects, except as subcontractors; the government does not expect much from them;
- important: integrated companies can use semiconductor-generated cash for IC investment;
- computers: share of larger companies is increasing, so smaller companies are getting into specialties (low-priced, high-performance);
- despite government policy, there is no evidence that Japanese companies are doing more fundamental R&D; but companies do not expect much from government labs and universities and are therefore looking to foreign alliances for fundamental research;
- the many ad-hoc tie-ups contradict the traditional views of the structure of the Japanese company;

- Japanese companies must look more to user needs and benefits (software, services and systems approach);

- major adjustments are coming!

Dr. Shimosato emphasized the importance of the government's R&D Project of Basic Technologies for Future Industries. New categories aded in 1985 are Photoreactive Material (under New Materials) and Bio-IC's (under Electronic Devices). He also presented the information shown in Tables A-1, A-2 and A-3.

Other observations made by Dr. Shimosato:

- the engineering plastics market is still very small, but growing;

- concerning rapid solidification processing (RSP):

  - have to bring costs down;

  - there are severe limitations on shape;

  - chemical vapour deposition (CVD) for amorphous film could be more economical than RSP for electronics applications;

- chemical companies in Japan are now so diversified (e.g. into new materials) and dynamic that it is hard to classify them;

- Nippon Steel's strategy is interesting - it has established a microelectronics subsidiary and is also into biotechnology.

Reference Documents

A-1 "Japanese Electronics Industries: Successes and Issues Focussing on Semiconductor and Computer", SRI Asia, November 29, 1985.

A-2 "Research and Development Project of Basic Technology for Future Industries" (AIST/MITI).

Table A-1

Significant Topics	

I. Organic Materials	Engineering Plastics
	Advanced Engineering Plastics
	Advanced Composite Materials
	Electronic Chemicals
	   Packaging Materials
	   Photoresist
	   Specialty Gas
	   Liquid Crystal
	   Substrates
	Electro Conductive Polymers
	Photo Conductive Polymers
	Membrane
	Fiber Optics
	Bio Sensors
	Artificial Organs

II. Inorganic Materials	Ceramics Advanced Ceramics Ceramic Fiber and Whiskers Ceramic Coating Fiber Optics Metals Shape Memory Alloy Advanced High Temperature Alloy Amorphous Metal Super Electroconductive Metal Semiconductors Silicon Compound Semiconductor III-V Group

Table A-2

Market for Advanced Materials in Japan
(billions of Canadian dollars)

	1985	1990	1995
Fine Ceramics	5.4	10.8	17.1
Polymers	5.4	9.9	14.4
Inorganic Fiber	-	1.8	3.6
Metallic Material	1.8	5.4	9.9
TOTAL	12.6	27.9	45.0

Source: SRI Asia

(Data for composites not available.)

Table A-3

R&D Expenditure in Major Japanese Companies
(millions of Canadian dollars)

	1981		1984	
	R&D	Sales	R&D	Sales
Mitsubishi Chemical Industries	153	7,056	243	7,200
Toray Industries	144	5,112	180	5,643
Asahi Glass	117	4,428	180	5,409
Sumitomo Electric Industries	108	4,212	144	4,554
Kyocera	18	936	99	2,547
Nippon Steel	405	28,116	450	25,740
TOTAL	945	49,860	1,296	51,093
R&D/Sales (%)	1.9		2.5	

Source: Annual Reports

Appendix B

Science and Technology Agency

a. International Affairs Division, Promotion Bureau
Monday, July 16, 1986, 16:00-16:45

Present: Akira Sakai,
Director for International Cooperation,
International Division

Peter Eggleton
Counsellor for Science and Technology
Canadian Embassy

Seishii Tanaka
Science and Technology Office
Canadian Embassy

The Science and Technology Agency, established in 1956, and attached to the Prime Minister's office, has the following principal responsibilities:

- planning, formulation, implementation and coordination of basic science and technology policies;
- general coordination of vital research activities, using the Special Coordination Funds for Promoting Science and Technology, expended in accordance with the policies of the Council for Science and Technology;
- advancement of the system for promotion of Exploratory Research for Advanced Technology (ERATO), administered by the Research Development Corporation of Japan;
- promotion of research and development in priority fields, including:
  - atomic energy;
  - space development;
  - ocean development;
  - life sciences;
  - materials;
  - disaster prevention;
  - aviation;
  - remote sensing; and,

- laser and heavy ions.

- promotion of international cooperation in science and technology;

- general coordination of science and technology activities in other ministries, including review of their expenditure estimates before submission to the Ministry of Finance;

- reinforcement of the foundations for R&D;

- surveys and analyses of domestic and foreign S&T activities; and,

- administrative affairs of nine advisory bodies.

The Agency has no real equivalent in Canada, although a rough equivalent might be created if MOSST and NRC were merged and attached to the Prime Minister's Office. In addition to its policy role the Agency has several research institutes and technology transfer functions.

By some accounts, the STA is the most powerful science and technology organ in the Japanese government. In terms of guidelines and priorities for S&T this is probably true. In terms of the activities of non-government, R&D-performing bodies (companies, universities, etc.) other ministries such as MITI and the Ministry of Education are more important.

The power of the STA derives largely from its role as the administrative arm of the Council for Science and Technology. A major function is administration of the Special Coordination Funds ($535 million in FY 1984) on behalf of the Council. The funds are used to support R&D projects, surveys and analysis in designated priority areas.

The Council for Science and Technology is chaired by the Prime Minister and attached to his office.

The Prime Minister is required by law to consult with the council on matters of S&T policy, and to "fully respect" its reports. In addition to the chairman, there are ten members: four cabinet ministers, the President of the Science Council of Japan, and five other persons "of outstanding knowledge and experience". The Minister of State for Science and Technology is a member of the Council and chairman of its steering committee. He is also head of the STA.

The Science Council of Japan is another advisory body with no formal links to the STA or CST except that its president is a member of the CST. The JSC is a state body established under law as "the representative body of the scientists of Japan both in and out of the country." While financed by the government, it functions independently of the administration, and its members are elected directly by scientists. Hence the JSC is often dubbed the "Parliament of Scientists."

The JSC is often taken for a science academy by foreign scientists. However, the JSC is neither a science academy in the usual sense nor a research institute like the Academy of Sciences in the USSR. It is primarily a deliberative body which prepares recommendations for government but which also holds scientific gatherings and participates in international programs. For further detail see reference document B-3.

On March 28, 1986 the Japanese Cabinet handed down its "General Guideline for Science and Technology Policy". (Ref. Doc. No. B-6.) It derives largely from the 11th inquiry (recommendation) of the CST (Ref. Doc. B-4) and is based on the 12th inquiry, which has the same title. The Guideline is reproduced at the end of this Appendix.

The basic thrusts of Japanese science policy, which were evident in most of my visits in Japan, are:

- expansion of fundamental ("creative") research;
- expansion of international exchange and cooperation; and,
- a greater emphasis on the role of science in improving the quality of life in Japan, and harmonization of science with social goals.

Other notes from the meeting with Mr. Sakai:

- there is no formal relationship between the JSC and the STA;
- the elements of R&D policy originate in the CST's Panel on Research Objective, which is made up of 30 scholars; under this panel is a sub-panel of another 30 scholars which deals with research "priorities";
- the STA is promoting more fundamental research in industry under the Guideline;
- more cooperation between government and university research is being promoted;
- on May 14, 1986, the government passed the Research Exchange Promotion Law (prepared by the STA) which opens the way for foreign researchers to become employees of the Japanese government laboratories (below the executive level), and in other ways (such as joint ownership of patents) facilitates international and government-industry cooperation; this is a major step under the policy of increased international cooperation (see attachment to this appendix);

- three sections of the STA are directly involved in international cooperation: the Research and International Affairs Division of the Atomic Energy Bureau; the International Space Affairs Division of the Research and Development Bureau; and the International Affairs Division of the Promotion and International Affairs Bureau.

- within the Planning Bureau (now called the National Policy Bureau), a proposal is being considered to set up a fund dedicated to support international projects in basic research; the proposal may be funded in the next fiscal year;

- to obtain Special Coordination Funds of the STA, each agency must submit proposals;

- leadership in nuclear energy is provided by the STA while MITI leads in energy-related research and the Agriculture Department is very strong in biotechnology.

b. Research Coordination Bureau
Monday, July 16, 1986, 16:45 - 17:45

Present: Mikio Hattori
Director
Office of Material Science and Technology
Inter-Ministerial R&D Division

Yoichi Ito
Inter-Ministerial R&D Division

Seishii Tanaka
Canadian Embassy

Highlights of the discussion:

- the STA's principal concern is pure science, while applied and industrial S&T is more the concern of MITI;

- the Research Coordination Bureau (now the Research and Development Bureau) is responsible for the management of policy-related R&D, including that in STA laboratories;

- Mr. Hattori is a member of the Versailles Summit Project on Materials Standards (VAMAS); Canada is represented by Georges Bata;

- a coordination committee coordinates all the projects receiving Special Coordination Funds;

- once a year the CST Committee on Policy Matters decides on the basic principles for the use of the Special Coordination Funds; the Committee has 3 sub-committees, the two most influential being the Research and Study sub-committee, which decides on new themes to be started, and the Research Evaluation Sub-Committee;

- Special Fund projects are of 5 years duration; the Research Evaluation Sub-Committee reviews each project at the end of phase I (3 years) and at project completion;

- the Council, through the STA, is now working on a ten-year plan for new materials R&D as an elaboration of the 11th report of the CST; this work is to start this summer and will take one to one and one-half years to complete; already similar plans have been published in biotechnology (copy obtained in Japanese) and in energy R&D.

- Funds are supporting seven projects in new materials; these may involve university, industry and government laboratories:

  a) basic technologies on superconductivity and cryogenics,

  b) reliability assessment of structural metallic materials;

  c) new materials based on hybrid material design;

  d) ultra-high temperature technology;

  e) high-power, variable wave-length laser and laser processing technology;

  f) new electron beam technology;

  g) international cooperative research on the measuring technology for new materials.

Reference Documents

B-1 "STA: Its Role and Activities 1985", Science and Technology Agency, 33 pp., plus notes on 1986 reorganization, 4 pp.

B-2 "Council for Science and Technology", 1986, 10 pp.

B-3 "Science Council of Japan: An Outline", 1983, 13 pp.

B-4 "Recommendation of the Council for Science and Technology on the 11th Inquiry Titled 'Comprehensive Fundamental Policy for Promotion of Science and Technology to Focus Current Changing Situations from the Long-Term View'", Council for Science and Technology, November 1984, 96 pp.

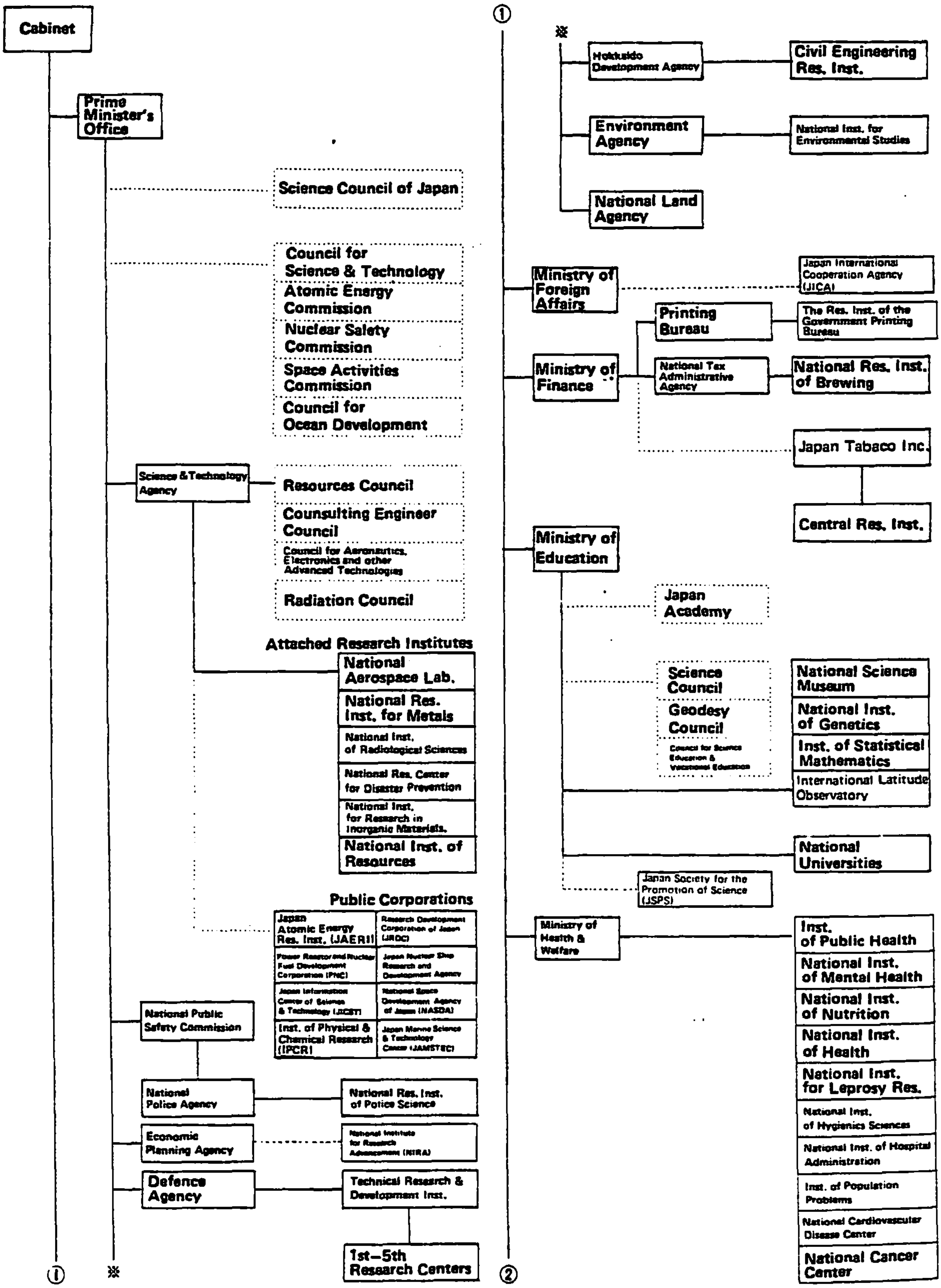
B-5 "White Paper on Science and Technology 1983: Towards Creation of New Technology for the 21st Century (Summary)", Science and Technology Agency, December 1984, 26 pp.

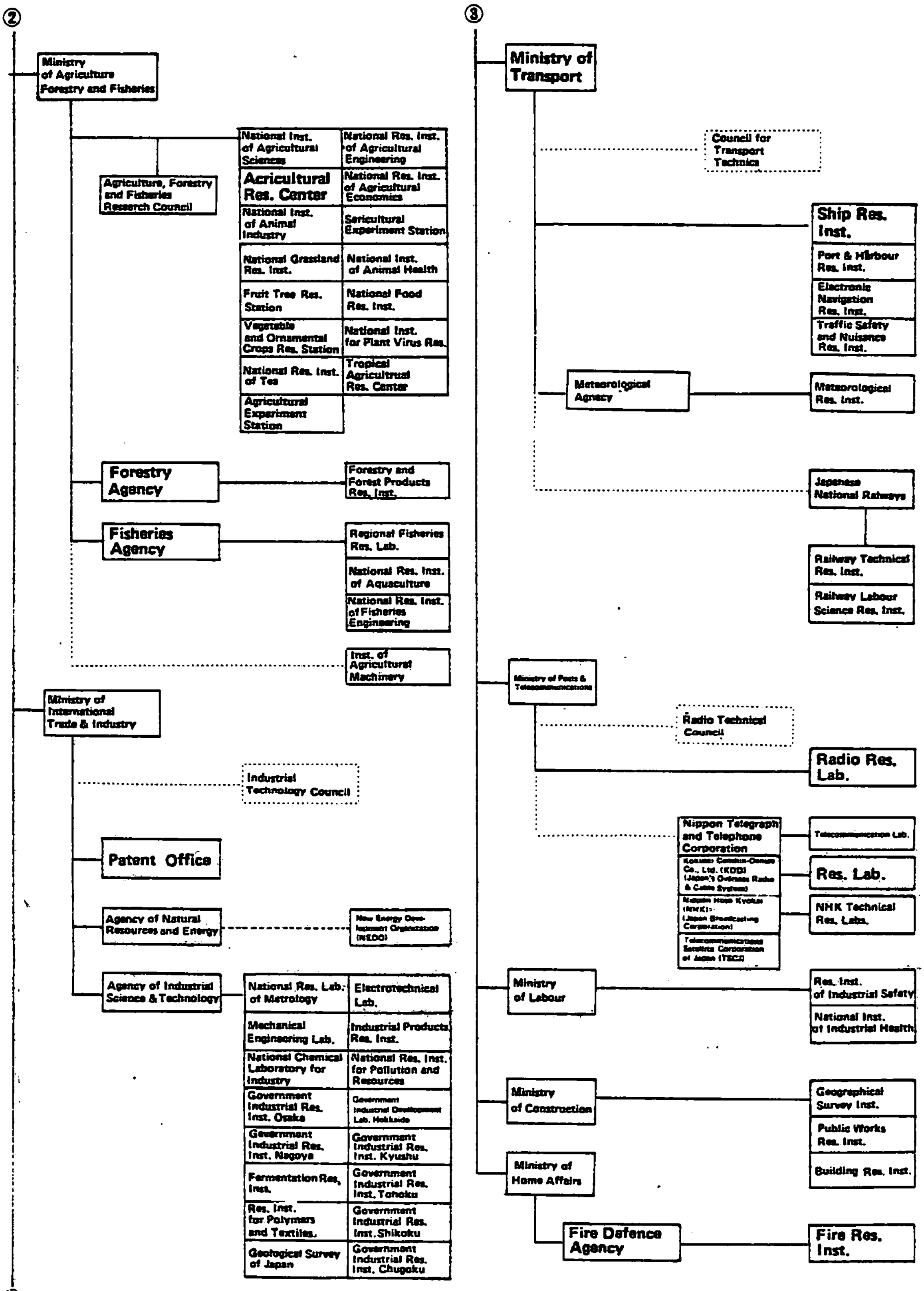
B-6 "General Guideline for Science and Technology Policy", Cabinet Decision, March 28, 1986, 6 pp.

B-7 "Special Coordination Funds for Promoting Science and Technology", 2 pp.

B-8 "Scientific and Technological Exchange Promotion Bill Enacted", 1 pp.

○ Administrative Structure of Science and Technology in Japan

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Ministry of Agriculture Forestry and Fisheries
Agriculture, Forestry and Fisheries Research Council
National Inst. of Agricultural Sciences
National Res. Inst. of Agricultural Engineering
Acricultural Res. Center
National Res. Inst. of Agricultural Economics
National Inst. of Animal Industry
Sericultural Experiment Station
National Grassland Res. Inst.
National Inst. of Animal Health
Fruit Tree Res. Station
National Food Res. Inst.
Vegetable and Ornamental Crops Res. Station
National Inst. for Plant Virus Res.
National Res. Inst. of Tea
Tropical Agricultrual Res. Center
Agricultural Experiment Station
Forestry Agency
Forestry and Forest Products Res. Inst.
Fisheries Agency
Regional Fisheries Res. Lab.
National Res. Inst. of Aquaculture
National Res. Inst. of Fisheries Engineering
Inst. of Agricultural Machinery
Ministry of International Trade & Industry
Industrial Technology Council
Patent Office
Agency of Natural Resources and Energy
New Energy Development Organization (NEDO)
Agency of Industrial Science & Technology
National Res. Lab. of Metrology
Electrotechnical Lab.
Mechanical Engineering Lab.
Industrial Products Res. Inst.
National Chemical Laboratory for Industry
National Res. Inst. for Pollution and Resources
Government Industrial Res. Inst. Osaka
Government Industrial Development Lab. Hokkaido
Government Industrial Res. Inst. Nagoya
Government Industrial Res. Inst. Kyushu
Fermentation Res. Inst.
Government Industrial Res. Inst. Tohoku
Res. Inst. for Polymers and Textiles.
Government Industrial Res. Inst. Shikoku
Geological Survey of Japan
Government Industrial Res. Inst. Chugoku
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③
Ministry of Transport
Council for Transport Technics
Ship Res. Inst.
Port & Harbour Res. Inst.
Electronic Navigation Res. Inst.
Traffic Safety and Nuisance Res. Inst.
Meteorological Agency
Meteorological Res. Inst.
Japanese National Railways
Railway Technical Res. Inst.
Railway Labour Science Res. Inst.
Ministry of Posts & Telecommunications
Radio Technical Council
Radio Res. Lab.
Nippon Telegraph and Telephone Corporation
Telecommunication Lab.
Co., Ltd. (KDD) (Japan's Overseas Radio & Cable System)
Res. Lab.
(NHK) (Japan Broadcasting Corporation)
NHK Technical Res. Labs.
Telecommunications Satellite Corporation of Japan
Ministry of Labour
Res. Inst. of Industrial Safety
National Inst. of Industrial Health
Ministry of Construction
Geographical Survey Inst.
Public Works Res. Inst.
Building Res. Inst.
Ministry of Home Affairs
Fire Defence Agency
Fire Res. Inst.

Fiscal Year 1985 Budget Related to Science and Technology

Items / Ministries and Agencies	Science and Technology Promotion Expenditure and other items						Other Expenditure for Research and Development						Total	
	Science and Technology Promotion Expenditure		Research and Development promotion energy expenditure policy expenses				General Account		Special Account					
	(A)	Increase rate over previous year (%)	(B)	Increase rate over previous year (%)	(C=A+B)	Increase rate over previous year (%)	(D)	Increase rate over previous year (%)	(E)	Increase rate over previous year (%)	(F=D+E)	Increase rate over previous year (%)		Increase rate over previous year (%)
Diet	517	0	–	–	517	0	–	–	–	–	–	–	517	0
Science Council of Japan	–	–	–	–	–	–	889	* 12.8	–	–	889	12.8	889	12.8
Natl. Piolice Agency	847	1.0	–	–	847	1.0	–	–	–	–	–	–	847	1.0
Hokkaido Development Agency	141	0	–	–	141	0	–	–	–	–	–	–	141	0
Defence Agency	–	–	–	–	–	–	58,677	31.8	–	–	58,677	31.5	58,677	31.5
Economic planning Agency	704	–1.8	–	–	704	–1.6	–	–	–	–	–	–	704	–1.8
Science and Technology Agency	146,986	4.4	165,700	7.4	312,685	5.8	16,843	–60.7	83,809	15.6	100,652	–5.6	413,337	2.8
Environment Agency	8,524	–3.3	–	–	8,524	–3.3	1,655	–0.8	–	–	1,655	–0.8	10,179	–2.9
Natl. Land Agency	288	New	–	–	288	New	–	–	–	–	–	–	288	New
Min. of Justice	787	1.8	–	–	787	1.8	–	–	–	–	–	–	787	1.6
Min. of Foreign Affairs	–	–	2,633	5.8	2,633	5.8	3,633	3.8	–	–	3,633	3.9	6,266	4.7
Min. of Finance	318	2.5	–	–	318	2.5	–	–	578	2.9	578	2.9	897	2.8
Min. of Education	55,888	0.7	–	–	55,888	0.9	123,650	–1.0	534,251	–0.0	657,901	–0.2	713,789	–0.1
Min. of Health and Welfare	26,333	5.3	–	–	26,333	5.3	1,296	1.1	6,130	11.2	7,426	9.3	33,759	5.1
Min. of Agriculture Forestry and Fisheries	59,539	1.9	–	–	59,539	1.9	1,727	–2.9	–	–	1,727	–2.9	81,266	1.8
Min. of Intl. Trade and Industry	59,069	–1.0	4,407	–16.2	63,476	–2.2	10,147	–2.1	119,563	24.3	129,710	21.7	193,186	12.7
Min. of Transport	11,400	–23.2	–	–	11,400	–23.2	524	–0.1	1,383	73.1	1,906	44.1	13,306	–17.7
Min. of Post and Telecommunication	4,209	–5.7	–	–	4,209	–5.7	49	–29.2	10,000	New	10,049	14,433.2	14,258	214.4
Min. of Labor	585	–0.6	–	–	585	–0.6	1	–10.0	2,233	–30.8	2,234	–30.9	2,819	–26.2
Min. of Construction	4,915	3.4	–	–	4,815	3.4	271	–76.1	–	–	271	–76.1	5,185	–11.9
Min. of Home Affairs	515	0.4	–	–	515	0.4	–	–	–	–	–	–	515	0.4
Total	381,575	1.3	172,739	6.6	554,314	2.8	219,361	–2.4	747,947	4.9	967,308	3.1	1,521,622	3.0

1. F.Y. 1985 budget of Hokkaido Development Agency in "Other Expenditure for Research and Development" is not added to Total because its budget is decided at the stage of excution. So "Increase rate over previous year" is calculated by F.Y. 1984 budget without its corresponding expenditure.
2. Concerning to expenditure related to science and technology in Special Account for Industrial Investiment which is within competence of Ministry of Finance,
   a. 2.9 billion yen in expenditure of Japan Information Center of Science and Technology is counted into Science and Technology Agency
   b. 10 billion yen in expenditure of "Basic Technology Research Promotion Center (tentative name)" is double-counted to Ministry of International Trade and Industry and Ministry of Post and Telecommunications (however, in Total not double-counted)
3. Souce: Science and Technology Agency

● Budget of Science and Technology Agency for Fiscal Year (F.Y.) 1985

in Million Yen
*Government Guarantee for Appropriation for Ensuring Several Years

Items	Budget for F.Y. 1984 (A)	Budget for F.Y. 1985 (B)	Increase (B–A)	Ratio Over Previous Year (B/A)
I. General Account	*109,006 329,346	*93,090 329,529	*–15,916 183	100.1%
II. Special Account for Industrial Investiment	–	2,900	2,900	–
(Subtotal)	*109,006 329,346	*93,090 332,429	*–15,916 3,083	100.9%
III. Special Account for Power Sources Development	*76,535 78,745	*89,168 88,478	*12,633 9,733	112.4%
(1) Account for Smooth Siting Power Plants and Other Atomic Energy Facilities	10,481	12,124	1,643	115.7%
(2) Account for Diversification of Power Sources	*76,535 68,264	*89,168 76,354	*12,633 8,090	111.9%
(Total)	*185,541 408,091	*182,258 420,907	*–3,283 12,816	103.1%

1. General Account and Special Account for Industrial Investiment

Items	Budget for F.Y. 1984 (A)	Budget for F.Y. 1985 (B)	Increase (B–A)
1. Strengthening Planning and Coordination Functions in Science and Technology Administration	6,530	7,330	800
(1) Special Coordination Funds for Promoting Science and Technology	6,300	7,100	800
(2) Synthetic Planning and Coordination by the Council for Science and Technology and Other Organs	230	230	0
2. Providing Foundations for Promoting Science and Technology	4,739	5,198	459
(1) Activation of Currency of Informations on Science and Technology	4,205	4,666	461
General Account Special Account for Industrial Investiment	4,205 –	1,766 2,900	–2,439 2,900
(2) Promoting of Exchange of Researchers and Other Items	534	532	–2
3. Promotion of International Cooperation on the fields of Science and Technology	*2,976 5,259	*3,345 6,594	*369 1,335
Strengthening and Widening of International Personal Exchange (including above)	[926]	[1,164]	[238]
4. Advancing National Conprehension for Science and Technology	*5,619 26,894	9,412	*–5,619 –17,482
(1) The International Exposition for Science and Technology	*5,619 26,703	9,241	*–5,619 –17,462
(2) Activities for Public Relations on Science and Technology	191	171	–20
5. Promoting of Research and Development in the fields of Advanced and Important Science and Technology	*103,387 288,112	*93,090 307,313	*–10,297 19,201
(1) Promotion of Creative Science and Technology by Flexible Research Systems	2,296	2,570	274
(2) Promotion of Atomic Energy Research Development and Utilization	*46,101 166,112	*41,614 178,020	*–4,487 11,908
a. Administration of nuclear safety regulation and environmental Safety Measures	2,046	2,054	8

Items	Budget for F.Y. 1984 (A)	Budget for F.Y. 1985 (B)	Increase (B–A)
b. Power Reactor and Nuclear Fuel Development Corporation	*10,556 63,702	*9,780 65,769	*–776 2,067
c. Japan Atomic Energy Research Institute	*31,808 90,319	*30,704 99,674	*–1,104 9,355
d. National Institute of Radiological Science	6,052	*345 5,551	*345 –501
e. Research at National Research Institutes	1,732	1,733	1
f. Research at Institute of Physical and Chemical Research	*3,737 1,516	*785 2,545	*–2,952 1,029
(3) Promotion of Space Development	*55,401 85,812	*48,818 91,585	*–6,583 5,773
a. National Space Development Agency of Japan	*54,327 84,358	*48,818 88,861	*–5,509 4,503
b. Research on space development at National Aerospace Laboratory	*1,074 918	2,197	*–1,074 1,279
(4) Promotion Ocean Development	5,146	6,875	1,729
a. Japan Marine Science and Technology Center	4,963	6,700	1,737
b. Other Ocean Development Projects	183	175	–8
(5) Promotion of Life Science	[*604] [7,657]	[*611] [8,456]	[*7] [799]
(6) Research and Development of Materials Technology	7,507	7,810	303
(7) Promotion of Important Integrated Researches etc.	*1,885 21,239	*2,658 20,453	*773 –786
a. Promotion of Disaster Prevention Science and Technology	2,109	*203 2,091	*203 –18
b. Promotion of Research and Development of Aviation Technology at National Aerospace Laboratory	*1,281 8,863	*1,844 7,813	*563 –1,050
c. Others	*604 10,267	*611 10,549	*7 282

II. Special Account for Power Sources Development

Items	Budget for F.Y. 1984 (A)	Budget for F.Y. 1985 (B)	Increase (B–A)
Account for Smooth Siting Power Plants and Other Atomic Energy Facilities	10,481	12,124	1,643
1. Commission Feeds for Nuclear Power Safety Measures, etc.	4,533	4,738	205
2. Power Plant Siting Promotion Subsidy	2,507	3,659	1,152
3. Special Subsidies for Power Plant Siting	1,300	1,319	19
4. Subsidies for Nuclear Power Safety Measures, etc.	2,023	2,293	270
Account for Diversification of Power Sources	*76,535 68,264	*89,168 76,354	*12,633 8,090
1. Power Reactor and Nuclear Fuel Development Corporation	*76,535 63,963	*89,168 72,013	*12,633 8,050
(1) Development of Advanced Power Reactor	*53,107 33,315	*86,112 45,232	*33,005 11,917
(2) Development of Technology for Reprocessing of Spent Fuel	*3,825 22,490	*2,719 16,221	*–1,106 –6,269
(3) Development of Uranium Enrichment Technology	*19,603 8,158	*336 10,560	*–19,267 2,402
2. Others	4,301	4,341	40
Total	*76,535 78,745	*89,168 88,478	*12,633 9,733

"General Guideline for Science and Technology Policy"

March 28, 1986

Cabinet Decision

The Japanese Cabinet Council set down the outline of the science and technology promotion policy in the immediate future as " General guideline for science and technology policy ", which is based on the cabinet decision titled "The administrative reform embodiment policy in the immediate future" dated September 24, 1985, and based on the recommendation of the Council for Science and Technology on the 11th inquiry from the prime minister titled "Comprehensive fundamental policy for promotion of science and technology to focus current changing situations from the long-term view " dated November 11, 1984, and the 12th inquiry titled "General guideline for science and technology policy " dated December 3, 1985.

General Guideline for Science and Technology Policy

I. Basic Principles

Highly creative science and technology should be the core of the nation's science and technology policy if we are to respond correctly to the various needs, to make our society and national life richer in the coming 21st century as well as to open up new possibilities in the future.

Especially, we should concentrate on encouraging basic research to pave the way for technological progress in the next generation. Steps should be taken to create technological seeds brought up from further studies and reviews of theories, principles and phenomena, which will lead to the promotion of more creative and imaginative science and technology capable of exceeding the bounds of mere modifications and improvements by combining such seeds with the emerging social needs.

In doing so, we should be aware that developments in science and technology are greatly dependent on a wide range of domains related to national life, dignity of man, ethics, etc. While maintaining the basic recognition that science and technology should serve man and society, and deepening our understanding of man itself, we should develop science and technology in harmony with man and society. We should also realize that Japan's contributions to science and technology should be appropriate for its increasingly significant role in the world community of nations. On this recognition, we should seek to internationalize our science and technology personnel, organization and activities and to promote international exchanges and cooperation, while giving sufficient consideration to the importance of cooperation with developing countries and to the latest international trends in high technology areas. Due attention should be paid to this global aspect in our science and technology promotion program.

II. Emphasizing Priority Programs

In encouraging creative science and technology, it is important to develop and strengthen favorable systems and conditions for R & D activities. Therefore, we should carry out the following programs in a comprehensive and flexible manner, while continuing to formulate timely and improve basic guidelines for implementing priority programs for this purpose.

1. Developing and Strengthening Systems

Universities, which are endowed to make academic research for continued progress in basic research, should further improve and upgrade their research activities to keep up with and exceed the international level while taking into account the social requirements and acting on their initiative based on their missions and objectives.

National research institutes and similar bodies should expand and strengthen their basic, leading research and development programs while properly reviewing their internal systems in accordance with changing social and economic needs.

From the viewpoint of activating national research institutes, the basic principles for their intermediate- and long-range operations should be established on the basis of our Council's finding.

Considering that private enterprises are stepping up basic research as a basis for expanding into new areas of activity, resulting in increased opportunities for industrial-academic-Government cooperation in all stages of R & D ranging from basic research to applications and product development, the Government should endeavor to promote industrial-academic-Government research exchanges by improving pertinent systems, operating them more flexibly, encouraging practical applications of research findings, and taking other appropriate steps. The Government should also improve cooperative research projects, comprehensive research projects, flexible research systems and other systems and encourage contacts among researchers through research meetings and so forth.

2. Developing and Improving Conditions

1) Increasing R & D investment

Continued investment in research and development should be ensured since the capacity of R & D depends largely on the accumulation of knowledge and skill generated by R & D investment. For this purpose, the Government should provide more R & D funds, use them more effectively, and improve environmental conditions favorable for vitalizing private R & D activities while taking steps to increase the national total of R & D investment.

2) Securing and training R & D personnel

Since people are a key factor in promoting science and technology, it is essential to secure and train young researchers and other R & D personnel at universities, national research institutes and other facilities that constitute the core of the nation's basic research sector while paying attention to the needs for such personnel in these new growth areas of activity.

Special efforts should be made to improve the quality of undergraduate-level training and graduate-level training, research guidance, etc., to secure necessary personnel mainly in the public sector where private initiatives cannot be continued on, and to improve conditions for more successful performance on the part of the researchers.

3) Consolidating the basis for science and technology promotion

Considering the markedly increasing importance of the intellectual basis on which the promotion of science and technology rests, efforts should be made to expedite the production and distribution of science and technology information by facilitating transfers of literature and encouraging the construction and utilization of factual databases, to upgrade facilities for developing, maintaining and making available such equipment, materials, genetic resources, etc., as the private sector cannot be counted on to provide, and to improve environmental conditions to give vitality to the supporting activities, thus helping to consolidate the basis for further promotion of science and technology.

4) Expanding international exchanges and cooperation in science and technology

Under the basic principles outlined in I, we should endeavor to promote mutual understanding between nations and positively expand international exchanges and cooperation activities. For this purpose, the Government should take steps to develop an internationally open research system, by increasing the number of foreign researchers employed and admitted to universities and national research institutes. Also, efforts should be made to improve and upgrade various international cooperative research projects, to expedite exchanges of researchers and information, and to develop necessary conditions to deal with such problems as protection of rights involved in research cooperation.

5) **Promoting public understanding and securing cooperation**

Now that science and technology have reached every corner of the economy and society as well as national life, it is important to develop a climate in which the people cannot only take advantage of science and technology effectively but also cooperate in promoting science and technology. Therefore, the Government should endeavor to stimulate the interest of the younger generation in science and technology, and to take other steps for the fulfillment of this purpose.

III. Encouraging Important Areas of Research and Development

To promote highly creative sciences and technologies, we should, while taking the various steps mentioned above, emphasize research and development not only in the areas mentioned in 1 below but also basic, leading sciences and technologies in the areas indicated in 2 and 3 by properly evaluating research projects and carrying out R & D activities energetically and effectively.

For this purpose, the Prime Minister should formulate a series of basic research and development plans each intended for a specific area to be encouraged with priority.

1. Encouraging Basic, Leading Sciences and Technologies in which New Progress Can Be Expected

Efforts should be made in a much more energetic manner to encourage basic, leading areas of science and technology with emphasis on developing new scientific findings, looking for seeds of revolutionary technological developments and helping them grow while being aware of the importance of basic scientific research and taking care to promote growth in that area.

Special emphasis should be laid on the following objectives:

(1) Investigating the limitations of the existing technology in dealing with matter, energy, information and other basic factors involved in science and technology, looking for and unveiling new principles and phenomena, and exploring new possibilities in science and technology exceeding the bounds of the existing technology;

(2) Investigating life phenomena by taking advantage of latest developments in molecular

biology and related areas in recent years, and looking for possible applications of new knowledge resulting therefrom;

and

(3) Acquiring better insight into man, the earth, outer space, the ocean, and other macroscopic entities in the environment around us, and looking for possible applications of new knowledge resulting therefrom.

For this purpose, the following areas of research should be more energetically encouraged:

a) Matter/materials sciences and technologies
b) Information/electronics sciences and technologies
c) Life sciences
d) Soft series of sciences and technologies
e) Space sciences and technologies
f) Ocean sciences and technologies
g) Earth sciences and technologies

2. Encouraging Sciences and Technologies for Activating the Economy

Now that it is important for the nation to revitalize its economy in relation to the rest of the world as well as to maintain and increase economic growth at home, thus further strengthening the basis for our survival, we should endeavor to encourage the following areas of research as sciences and technologies for activating the economy:

a) Development and management of natural resources
b) Development and utilization of energy
c) Upgrading of production technologies and distribution systems
d) Recycling and effective utilization of resources
e) Improvement of service to society and life

3. Encouraging Sciences and Technologies for Improving the Quality of Society and Life

At a time when the nation is becoming more mature socially and more advanced in average age while it is increasingly required to operate in harmony with the rest of the world community, it is important for us to promote sciences and technologies characterized by still greater respect for man, better adapted to people and society, and contributing to their sound growth. In particular, the following areas of research should be encouraged:

a) Maintaining and improving the mental and physical health of the people

b) Formulation of individual and cultural life

c) Formulation of comfortable and safe society

e) Improving the human environment based on a global viewpoint

Scientific and Technological Exchange Promotion Bill Enacted

A scientific and technological exchange promotion bill was approved and enacted in the plenary session of the House of Councillors on May 14. The law was prepared principally by the Science and Technology Agency to promote joint studies on scientific and technological research and development among industries, universities and governmental institutions and with foreign countries. The law consists of 10 articles, which for the first time open the way for foreigner researchers to become public servant researchers of Japan. It can be expected that the law will provide impetus to the development and promotion of the best technologies. The main points in the law are as follows:

To make it possible to employ a foreign person as a high-level public researcher except as an executive, such as a director or deputy director of national laboratories or research institutes and excluding the Defense Agency.

Formerly, when a public researcher attended a meeting of an academic society, the number of days spent for attending the meeting was treated as absences, but now such days will be treated as quasi-official duty, exempt from full-time official work.

Further, while both results of R&D that the Government has assigned and results of R&D assigned to the Government have been the property of the State, it is possible for part of such results to be gratuitously granted to private companies.

While patent rights from joint research with Governments of foreign countries can be used reciprocally free of charge or at low cost, a claim for damage can also be reciprocally abandoned.

When research undertaken by a private company is closely connected with research undertaken by Government laboratories and research institutes, the state research facilities can be used at low cost.

When international exchanges are advanced in research undertaken by the State, it is arranged for special attention to be given to the observance of treaties and other international agreements, and to the maintenance of international peace and safety.

State laboratories and research institutes to be covered by the new law, will be designated by Government ordinance; they must be institutions carrying out examinations and research on science and technology (excluding establishments concerned solely with the cultural sciences), such as the National Institute of Radiological Sciences, the National Research Institute for Metals (Science and Technology Agency) laboratories under the Agency of Industrial Science and Technology of MITI, and others.

The law is designed to permit exchanges of scientific and technological research, overcoming the restrictions of a conventional system, taking into consideration recommendations submitted by the Special Advisory Council on Enforcement of Administrative Reform, a private advisory organ to the Prime Minister.

Appendix C

Ministry of International Trade and Industry

a. General Affairs Division
Agency of Industrial Science and Technology
Tuesday, June 17, 1986, 10:00 - 10:50

Present: Bin Ayako Kuwahara
Senior Researcher
International R&D Cooperation Division

Naoki Kajita
Technical Officer

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

Ms. Kuwahara handles the Canada/Japan S&T agreement file for MITI.

The Agency of Industrial Science and Technology is an influential organization with a wide range of programs and instruments used to promote innovation in priority fields. These are outlined in some detail in the excellent brochure "AIST 1985" (Ref. Doc. C-1). Some of the most important tables are reproduced at the end of this Annex.

From the point of view of strategic technologies, the most noteworthy program is the "Research and Development Project of Basic Technologies for Future Industries," a 10-year program of R&D in new materials, biotechnology and new electronic devices. It is summarized in Table C-1.

The following are notes from the discussion with Ms. Kuwahara and Mr. Kajita:

- overall authority for S&T policy is clearly in the hands of the Science and Technology Agency; within these broad guidelines MITI is responsible for industrial aspects;

- each Ministry has at least one deliberation (advisory) council attached to it.

- Mr. Kajita is an "officer" for the Industrial Technology Council (ITC); this council investigates and deliberates on important industrial S&T matters, normally in response to inquiries from the Minister;

- the ITC has 30 members representing industry, consumer groups, universities and labour; in addition it has 10 committes and 41 subcommittees which meet about four times a year; at least 4 of these subcommittees deal specifically with advanced materials;

- MITI's industrial policies are basically sectoral;
- the Fine Ceramics Division with the Consumer Goods Industries Bureau is responsible for projecting the outlook for fine ceramics, and might identify the technologies essential for growth; however, the task of promoting R&D in these technologies rests with AIST - in all technology fields of interest to MITI;
- AIST focusses on screening technologies, setting priorities and overseeing crucial, specific, technological developments;
- recommendations on key technologies and possible projects are fed in to AIST from other bureaux; AIST then decides what projects will be undertaken;
- AIST oversees 16 national laboratories, which are "national agencies for technology development;" AIST influences the programs of these laboratories by preparing the major "themes" for their research programs;
- there is an intricate feedback system involving AIST, the sectoral bureaux, industry and the national laboratories.

b. General Affairs Division
Agency of Industrial Science and Technology (AIST)
Monday, June 23, 1986, 15:15 - 16:30

Present: Bin Ayako Kuwahara

Masayoshi Amano
Director
International R&D Cooperation

Notes from the discussion:

- Mr. Amano opened the discussion by mentioning the Siddon/Murata meeting of September 1985 and the fact that MITI sent a representative (an official) to the international S&T Ministers meeting in Canada in October 1985; he also mentioned the joint committee meeting under the S&T agreement, to be held in Vancouver in September 1986;
- MITI participates in various types of international cooperation;
- one type of cooperation is "legalistic" government-to-government agreements such as those with the U.S., France and various developing countries; these may involve informtion exchange, exchange of researchers, joint research, etc.

- several ministries may be involved, but always there is one central contac point, which could be at MITI;
- ceramics is currently one of the key fields for discussion;
- a second type of cooperation is multilateral arrangements such as the economic summit projects and International Energy Agency projects;
- eighteeen projects were agreed upon at the Willamsburg summit; among these, Japan (AIST) has the lead in solar cells and robotics, while Canada has the lead in fish culture and in new technology for vocational training;
- the Technology Growth Economics Committee is handling the 18 projects; the Director-General of AIST is a member of this committee; it held a conference in Bonn last year;
- a third type of cooperation is of the informal variety (e.g. Japan/Sweden) - see "AIST 1985" booklet;
- a fourth type is specific joint projects such as the current project on aerospace ceramics between the Government Industrial Research Institute, Kyushu and West Germany;
- in addition various forms of private sector cooperation are under way;
- some industry associations are proceeding with international cooperation;
- some quasi-governmental organizations regulated by law, such as the Japan Key Technology Center, invite researchers from overseas;
- Mr. Amano drew my attention to the Human Frontiers Program (HFP), which was announced by Japan during the 1986 economic summit (see Ref. Doc. C-3);
- the HFP was formally approved by the Council for Science and Technology, and a feasibility study is now under way; AIST is taking the initiative through its HFP office;
- the HFP is currently AIST's priority; last year it was the Japan Key Technology Center;
- there is a regional dimension to AIST's technology promotion activities: in 1982 a regional R&D system was established and 6 projects are now operating in 6 regions (see p. 17 of Ref. Doc. No. C-1);

- regional (prefectural) governments are not usually directly involved in these regional projects; the projects are set up by regional offices of MITI together with government laboratories and private laboratories; some informal consultation with prefectural governments may take place;

- last September Minister Murata mentioned to Minister Siddon the possibility of establishing an international high-technology university in Tokyo; but this initiative has now given way to the HFP emphasis;

- there are various kinds of industry associations;

- R&D associations sometimes play the role of contractors;

- AIST does a range of technology assessment reports which are usually made public but only in Japanese;

- concerning project and program evaluation, each project is handled by an executive office which together with the Industrial Technology Council does some evaluation work;

- companies readily join R&D associations for two major reasons: (1) MITI prefers to negotiate with associations rather than individual companies, especially for new subjects and (2) risks can be shared.

- not all consortia are contractors. Most of the associations established under the 1961 law are not contractors; being a research association is not a prerequisite to being a contractor, but most contractors are research associations;

- the Technology Promotion Division of AIST is responsible for approving R&D associations;

- concerning MITI's role in establishing associations, "theoretically" the association should be founded first, then apply to the government for approval;

- the government provides no direct support to R&D associations other than the tax incentives in the Act, but may cover costs of setting up contracts;

- only companies that are actually doing R&D are members of R&D associations;

- it is not essential to be a member of an association to be eligible for government financing.

c. Basic New Materials Policy Office
Basic Industries Bureau
Tuesday, June 17, 1986 11:00 - 12:00

Present: Masaharu Higuchi, Director

Mr. Watanabe

Mr. Yamada

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

This meeting covered a great deal of familiar territory. Highlights follow.

- this Bureau is concerned with "basic" industries such as steel and chemicals;

- under the R&D Project of Basic Technology for Future Industries, photo-responsive materials is a new project started this year; it and other projects are implemented by a network of committees; biomaterials (e.g. implants) represent a potential new project that would be of special interest because of the national concern over the aging of the population;

- under the R&D Project of Basic Technologies, most of the work is done via contracts;

- Regarding who initiates R&D Consortia, this varies; consortia may involve makers and users of materials or projects; industries may recognize certain trends (e.g. new diamond), identify priorities, form an association, and prepare a proposal for government consideration;

- much of the time of the meeting was spent going through the short document (Reference Doc. C-5) which is reproduced at the end of this Annex.

Reference Documents

C-1 "AIST 1985", Agency of Industrial Science and Technology, MITI, 32 pp.

C-2 "Research and Development Project of Basic Technology for Future Industries", 5 pp., (1986 update).

C-3 "Human Frontier Program", MITI, May 1986, 5 pp.

C-4 "MITI Handbook 1984", 290 pp.

C-5 "MITI's Policies and Measures on New Materials", Basic New Materials Office, Basic Industries Bureau, MITI, October 1985, 5 pp.

TABLE C-1

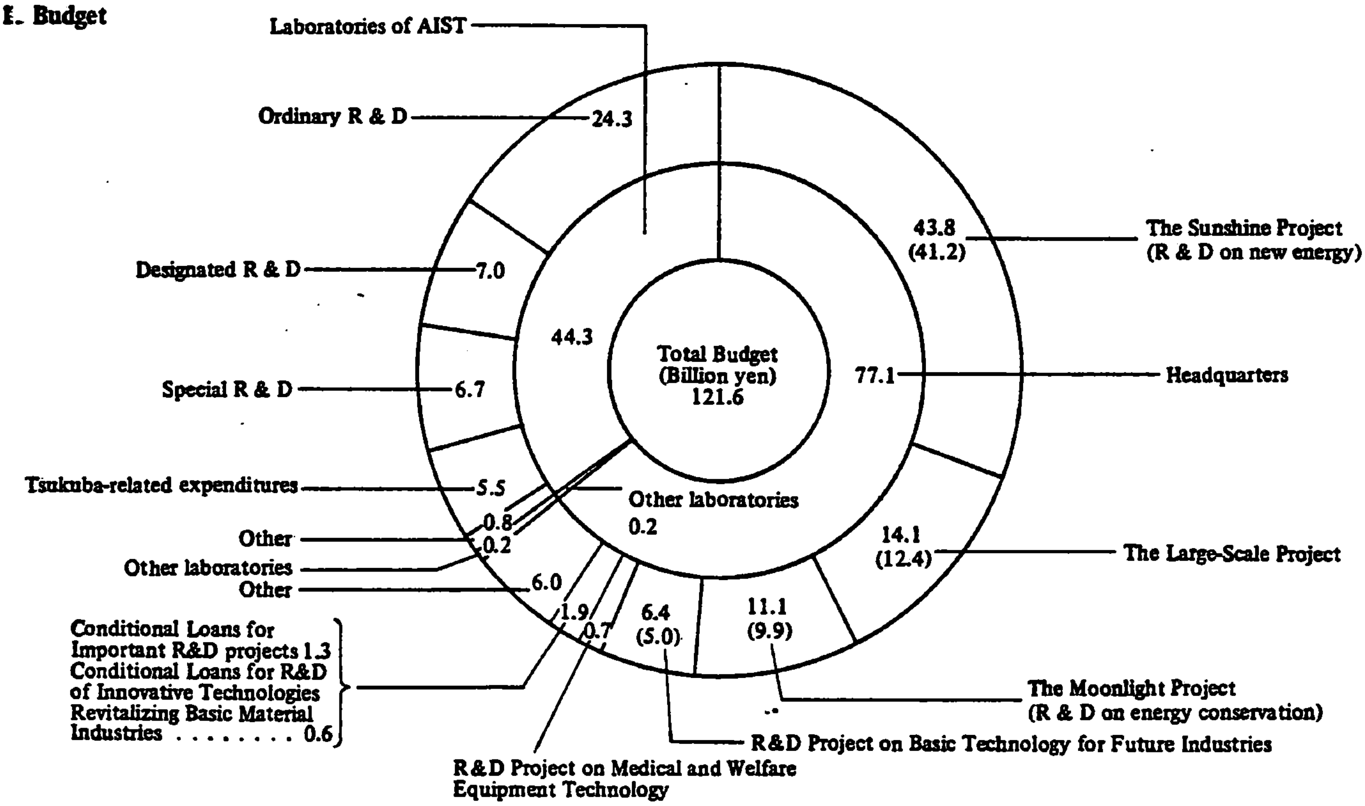
RESEARCH AND DEVELOPMENT PROJECT OF BASIC TECHNOLOGY FOR FUTURE INDUSTRIES
(MILLIONS OF CANADIAN DOLLARS)

	DURATION	TOTAL R&D EXPENDITURE	FY 1985 BUDGET
NEW MATERIALS			
HIGH-PERFORMANCE CERAMICS	1981-90	117.0	8.6
SYNTHETIC MEMBRANES	1981-90	90.0	5.0
SYNTHETIC METALS	1981-90	45.0	3.4
HIGH PERFORMANCE PLASTICS	1981-90	54.0	2.7
ADVANCED ALLOYS	1981-88	72.0	5.5
ADVANCED COMPOSITES	1981-88	99.0	6.5
PHOTO-RESPONSIVE MATERIALS	1985-?	?	0.6
TOTAL MATERIALS		477.0 +	32.3
BIOTECHNOLOGY			
BIO-REACTOR	1981-90	99.0	4.3
LARGE SCALE CELL CULTIVATION	1981-89	45.0	3.9
UTILIZING RECOMBINANT DNA	1981-90	90.0	3.4
TOTAL BIOTECHNOLOGY		234.0	11.6
NEW ELECTRONIC DEVICES			
SUPERLATTICE DEVICES	1981-90	72.0	4.1
THREE-DIMENSIONAL IC'S	1981-90	81.0	7.2
FORTIFIED IC'S	1981-85	72.0	3.0
BIODEVICES	1986-?	?.	-
TOTAL ELECTRONICS		225.0	14.3
GRAND TOTAL		936.0	58.2

FY1985 BUDGET AND PERSONNEL

(Agency of Industrial Science and Technology

1. Budget



Note: **Ordinary R & D:** Personnel expenditures and ordinary research expenditures of AIST laboratories.
Designated R&D: Research expenditures incurred by research laboratories through work connected with the Large-Scale Project, the Sunshine and Moonlight Projects, R&D Project on Medical and Welfare Equipment Technology, R&D Project on Basic Technologies for Future Industries and the Regional Large-Scale Project.
Special R&D: Expenditures incurred through Special research, Expansion of Laboratory Facilities, Operation of Geological Research Vessel, Nuclear Research, R&D Promotion for Small Industries, Research Related to Prevention of Environmental Pollution.
Tsukuba related expenditures: Expenditures in operating joint facilities at Tsukuba.
Budget for individual projects: This refers to the total budget for each of the Large Scale Project, Sunshine and Moonlight Projects and R&D Project on Basic Technology for Future Industries.
Figures in parenthesis are the amount of the total budget for each project excluding Designated R&D expenditures, etc., which are also excluded from the total budget for AIST.

2. Budget and Personnel for each Laboratories

	Budget (Million yen)	Personnel	Researchers	Administrators
Agency of Industrial Science and Technology (Headquarters)	77,090	321	0	321
National Research Laboratory of Metrology	1,947	228	128	100
Mechanical Engineering Laboratory	3,281	291	221	70
National Chemical Laboratory for Industry	3,734	377	292	85
Fermentation Research Institute	1,365	86	67	19
Research Institute for Polymers and Textiles	1,393	128	105	23
Geological Survey of Japan	4,406	387	252	135
Electrotechnical Laboratory	9,044	698	556	142
Industrial Products Research Institute	1,351	133	105	28
National Research Institute for Pollution and Resources	3,734	347	252	95
Government Industrial Development Laboratory, Hokkaido	1,187	101	74	27
Government Industrial Research Institute, Tohoku	583	56	39	17
Government Industrial Research Institute, Nagoya	2,613	260	199	61
Government Industrial Research Institute, Osaka	2,621	230	174	56
Government Industrial Research Institute, Chugoku	656	53	41	12
Government Industrial Research Institute, Shikoku	554	45	34	11
Government Industrial Research Institute, Kyushu	828	91	69	22
Common Expenditurs	5,005	–	–	–
Other laboratories	216	–	–	–
Total	121,609	3,832	2,608	1,224

(Reference)

List of Appropriations Related to Industrial Technology
Ministry of International Trade and Industry
[Fiscal 1985]

(Unit: Million yen)

Item	Fiscal 1984 Appropriation			Fiscal 1985 Appropriation		
	General accounts	Special accounts	Total	General accounts	Special accounts	Total
1. Active promotion of technological R&F						
(1) R&D project on basic technologies for new industries	5,952	0	5,952	6,445	0	6,445
(2) National R&D Program	9,044	2,035	11,080	7,698	6,437	14,135
(3) R&D for resources and energy technology	5,227	91,544	96,771	4,407	100,905	105,311
1 Sunshine Project	3,651	33,163	36,813	3,022	36,791	36,813
2 Moonlight Project	1,577	7,981	9,558	1,385	9,706	11,091
3 Oil-related projects	0	13,865	13,865	0	13,027	13,027
4 Nuclear-energy related projects	0	25,173	25,173	0	30,025	30,025
5 Coal-related Projects	0	5,487	5,487	0	4,509	4,509
6 Other resources & energy technology and development	0	5,875	5,875	0	6,846	6,846
(4) R&D for realizing information-intensive society	5,243	0	5,243	4,890	0	4,890
(5) Aerospace R&D	5,509	1,340	6,849	5,249	1,350	6,609
(6) R&D for basic leading technologies at experimental research laboratories	34,039	0	34,039	34,450	0	34,450
2. Providing environmental conditions for promotion of private R&D						
(1) Establishment of Center for Research Facilitation of Fundamental Technology	0	0	0	0	10,000	10,000
(2) Conditional Loans for Important Research and Development Projects	1,284	0	1,284	1,284	0	1,284
(3) Conditional Loans for Research and Development of Innovative Technologies Revitalizing Basic Material Industries	691	0	691	622	0	622
3. Providing a R&D system through government, private and university cooperation						
(1) Government and private joint research	(0)	(0)	(0)	(157)	(0)	(0)
(2) Important regional technology	215	0	215	246	0	246
4. Positive promotion of international cooperation (including summit meetings, international cooperation projects two-country cooperation, etc.)	(1.601)	(23,522)	(25,123)	(1.314)	(26,627)	(27,942)
5. Promoting an industrial standardization administration	594	0	594	582	0	582
6. Providing small-business R&B	4,073	0	4,073	4,366	0	4,366
7. Others						
(1) Development of medical and welfare equipment	719	0	719	684	0	684
(2) Environmental conservation and disaster prevention measures	22	450	472	20	523	543
(3) Improving quality of housing	245	255	501	239	348	587
(4) Water-producing technology	122	0	122	110	0	110
R&D-related appropriations (including industrial investment accounts)	75,299	96,188	171,487	73,623	109,563	193,186

Note: Figures in parenthesis are not included in the total in order to avoid duplicate entry under other items.

Draft of Appropriations Related with Science and Technology for Fiscal 1985 (Summary)

(Unit: Million yen)

Item / Agency/ministry	Science/technology promotion expenses, etc.			Other research-associated expenses (special account included)			
	Science/technology promotion expenses A	Research-associated expenses in energy expenditure B	Subtotal C=A+B	General accounts D	Special accounts E	Subtotal F=D+E	Total C+F
Ministry of Education	55,888	–	55,888	123,650	534,251	657,901	713,789
Science and Technology Agency	146,986	165,700	312,686	16,843	83,809	100,652	413,338
Ministry of International Trade and Industry	59,069	4,407	63,476	10,147	119,563	129,710	193,186
Ministry of Agriculture, Forestry and Fishary	59,539	–	59,539	1,727	–	1,727	61,266
Defense Agency	–	–	–	58,677	–	58,677	58,677
Ministry of Health and Welfare	26,333	–	26,333	1,296	6,130	7,426	33,759
Ministry of Posts and Telecommunications	4,209	–	4,209	49	10,000	10,049	14,258
Ministry of Transport	11,400	–	11,400	524	1,383	1,907	13,307
Environment Agency	8,524	–	8,524	1,655	–	1,655	10,179
Ministry of Foreign Affairs	–	2,633	2,633	3,633	–	3,633	6,266
Others	9,627	–	9,626	1,160	2,811	6,029	3,597
Total	381,575	172,739	554,314	219,361	747,947	967,308	1,521,622

PROMOTION OF TECHNOLOGICAL DEVELOPMENT IN THE PRIVATE SECTOR

1. The Center for Research Facilitation in Fundamental Technologies

The Center was established in response to a proposal by the private sector to engage in the overall improvement of the environment for private research and development in fundamental technologies.

(1) Investment

The Center finances companies which are established for joint study.

(2) Financing

The Center, from the viewpoints of risk compensation and cost reduction, provides no-interest financing.

(3) Joint study promotion

To promote study of fundamental technology, the Center provides assistance to the government-private sector joint study system" to be implemented jointly by 16 laboratoies and research institutes under AIST and also plans to commission private companies to conduct research at the Center.

(4) International study cooperating

Training creative talents will require a more frequent and active exchange with foreign researchers. Particularly needed is a substancial improvement of the foreign guest researcher system, which still remains less active than the overseas dispatching of Japanese researchers. In concrete terms, the Center plans to implement the foreign guest researcher system (international study cooperation Japan Trust business) through the public trust system.

(5) Furnishing study information

The Center provides a variety of information to the private sector in addition to conducting surveys and gathering related information.

Outline of Activities of The Center for Research Facilitation in Fundamental Technologies, and Financial Resource Measures

Business Activities	Contents	Measure for Financial Resources: Endowment	Measure for Financial Resources: Fund for Activities
Financial Activities	Subject: primarily technological development projects starting from the applied research stage Interest: no interest (7.1 percent if successful)	Investment by Japan Development Bank . . ¥3,000 million Investment by private sector . . . . ¥1,000 million Total . . . . ¥4,000 million	Industrial investment and financing . . . . . . ¥2,000 Interest (7.1% (no interest during unredeemable period)
Investment Activities	Subject: the following projects undertaken jointly by two or more enterprises: (1) technological development project to be implemented starting from fundamental research or applied research stage (2) fundamental and leading projects involving sufficient elements, publicly beneficial in character, and requiring a long period of time before they become profitable.	Industrial investment ¥6,000 million Investment by private sector. . . . . ¥2,000 million Total . . . . ¥8,000 million	Industrial investment . . . . ¥2,000 million Private funds. . . . .
Joint Study Activities, etc.	Strengthening of industrial-academic-governmental cooperation, international study cooperation, etc.		
Total		Industrial investment . ¥6,000 million Investment by Japan Development Bank . . ¥3,000 million Investment by private sector . . . . ¥3,000 million Total . . . . ¥12,000 million	Industrial investment. . . . ¥2,000 million Industrial investment and financing . . ¥2,000 million

2. Tax Incentives for Technological Promotion

(1) Tax system for the facilitation of research and development in fundamental technolgies, and special tax deductions for increased expenditure for experimental research

A new tax system to promote research and development in fundamental technologies was introduced to provide tax deduction for assets subject to depreciation. This system was implemented by expanding the existing system for deductory of additional research expenses.

Outline of System

Structure Amounts shall be deducted from corporate (income) taxes.	(1) Amount equivalent to 20% of the cost of research and development during the business year exceeding the highest cost of research and development in the past. (Existing tax system for deduction of additional research expenses) (2) Amount equivalent to 7% of the cost of acquisition of assets for research and development in fundamental technologies. (Tax incentive for the promotion of research and development in fundamental technolgies, newly added as a subject of tax reduction.) (3) Amount equivalent to 6% of the cost of research during the business year by small and medium enterprises, applied selectively with (1) above.
Maximum deductible amount	Maximum deductive amount shall be 15% for corporate (income) tax (10% in regard to (1)).

(2) Tax system for mining and industrial technological research associations

A. Special depreciation of expenditures charged by cooperatives to their members for the acquisition of fixed assets for research in mining and industrial technology .

B. Condensed recording, of down to one yen, of charges imposed by cooperatives for the acquisition of fixed assets required for the study of mining and industrial technology.

C. Reduction of fixed asset tax on fixed assets for research.

(3) Special permission to calculate donations to research corporations as losses

(4) Specially reductions in life of research assets subject to depreciation.

3. Financing for the promotion of industrial technological development (Japan Development Bank)

Funds are provided at attractive interest rates for the commercialization of important industrial technologies and the construction of special structures for advanced vasic research which will make a significant contribution to the advacement of industrial technology and play a key role in raising the level of the industrial structure.

Outline of Finance System for Promotion of Industry and Technology, and Budget for Fiscal 1985

	Development of new technology			Test production of new equipment
	Commercialization of new technology	Development of commercialization	Improvement of research facilities	
Construction cost qualified for financing	o Production line construction o Development of heavy machinery	Cost required for acquisition of machinery, equipment, land and buildings.	Cost required for acquisition of special buildings and structures for fundamental and applied research.	Cost required for acquisition of machinery for test production, which will become the property of the test producer.
Ratio of financing	Approximately 50% of construction cost of works qualified for financing			60% and less of construction cost of works qualified for financing
Financing period	In principle 15 years or less			
Redeemable period	In principle two to three years			
Budget for fiscal 1985	¥50,000 million			

4. Conditional loans for R & D projects

In fiscal 1985, a specific subject (methene zymosis system) was added to those equalifying for conditional loans for the development of practical technologies related to oil-substitute energy.

Conditional loans for R & D projects

			R & D projects for 1985
Conditional Loans for Important Research and Development Projects	Weighty Technology	Significant technology	1. Living 2. High technology 3. Resources
		Innovative basic technology	1. Opto-electronics 2. Biotechnology 3. New materials 4. Electric devices
	Environmental protection and safety technology		1. Environmental protection 2. Safety
	Regional technology		1. Regional resources 2. Regional environment 3. Regional industry
	Energy conservation technology		1. Energy conservation
Conditional loans for research and development of innovative technologies revitalizing basic material industries			1. New technology for synthesized fiber 2. New technology for pulp production (Solvolvsis method) 3. Power-metallurgy technology for alluminum 4. Development of new functional materials 4-1 Shape memory alloys 4-2 Electrically conductive in organic compounds 5. New technology for fine chemical production 6. New technology for high performance synthetic resin production

	R & D projects for 1985
Conditional loans for development of practical technologies related to oil-substitutes energy	General projects 1. Methanol conversion technology 2. Coal conversion technology 3. Natural energy conversion technology 4. Untapped energy conversion technology
	Special projects 1. Heat pump for cooling, heating and supplying hot water. (confined to electric pump) 2. Methene zymosis system
Conditional loans for development of new & practical technologies for power generation	1. Power generation using methanol 2. Power generation using natural energy sources 3. Power generation using untapped energy sources

5. Research association system for the promotion of mining and industrial technology

This system takes into account the efficiency and importance of joint research by enterprises and gives legal status to cooperative research organizations producing technology in industry and mining. It was started in May, 1961 and 52 associations are currently active.

MITI's Policies and Measures on New Materials

October,1985
Basic new Materials office
Basic Industries Bureaw MITI

1 Significance of New Materials

(1) key to new technology development

(2) contribution to upgrading products in consumer industries

(3) vitalization of the basic material industry

2 Market Trends (ref.1 attached)

3 Problems concerning New Materials Development

(1) capital risks related with R&D

(2) difficulties finding the uses of new materials

(3) poor methods for testing and evaluation

(4) insufficient man power in R&D

4 National Policies and Measures

(1) R&D projects promoted by the government (ref.2 attached)

(2) Establishment of The Center for Research Facilitation in Fundamenta Technology (ref.3 attached)

(3) tax incentives for technological promotion (ref.4 attached)

(4) establishment and standardization of testing and evaluation

(5) promotion of international cooperation

・Market Trends

The following figures should only be regarded as an estimation.

(trillion yen)

NEW MATERIALS	1981	2000		
	new	new	current	total
high-performance and/or functional polymeric materials	0.2	1.5	0.5	2.0
fine ceramics	0.2	1.9	1.9	3.8
new metals	0.1	1.5	2.3	3.8
advanced composite materials	–	0.4	–	0.4
total	0.5	5.4	4.8	10.2

① Price in 1981

② The totals have been round up. Thus,they might be slightly different when added.

③ The new materials market scale of 1981 has been calculated from the data available through various document.

Research and Development Project of Basic Technology for Future Industries

- NEW MATERIALS (million yen)

R&D Subjects	1985 FY	1981-1984 FY
High Performance Ceramics	961	2738
Synthetic Membranes for New Separation Technology	556	1760
Synthetic Metals	375	1063
High Performance Plastic	297	997
Advanced Alloys with Controlled Crystalline Structure	610	610
Advanced Composite Materials	721	1802
Photo response Materials	70	---
TOTAL	3593	10401

The Center for Research Facilitation in Fundamental Technologies

The Center was established in response to a proposal by the private sector to engage in the overall improvement of the environment for private research and development in fundamental technologies.

(1) Investment

The Center finances companies which are established for joint study.

(2) Financing

The Center, from the viewpoints of risk compensation and cost reduction, provides no-interest financing.

(3) Joint study promotion

To promote study of fundamental technology, the Center provides assistance to the government-private sector joint study system" to be implemented jointly by 16 laboratoies and research institutes under AIST and also plans to commission private companies to conduct research at the Center.

(4) International study cooperating

Training creative talents will require a more frequent and active exchange with foreign researchers. Particularly needed is a substancial improvement of the foreign guest researcher system, which still remains less active than the overseas dispatching of Japanese researchers. In concrete terms, the Center plans to implement the foreign guest researcher system (international study cooperation Japan Trust business) through the public trust system.

(5) Furnishing study information

The Center provides a variety of information to the private sector in addition to conducting surveys and gathering related information.

Tax Incentives for Technological Promotion

Amounts shall be deducted from corporate (income) taxes.

(1) Amount equivalent to 20% of the cost of research and development during the business year exceeding the highest cost of research and development in the past. (Existing tax system for deduction of additional research expenses)

(2) Amount equivalent to 7% of the cost of acquisition of assets for research and development in fundamental technologies. (Tax incentive for the promotion of research and development in fundamental technolgies, newly added as a subject of tax reduction.)

(3) Amount equivalent to 6% of the cost of research during the business year by small and medium enterprises, applied selectively with (1) above.

Maximum deductible amount

Maximum deductive amount shall be 15% for corporate (income) tax (10% in regard to (1)).

Appendix D

a. Japan Key Technology Center (Japan Key-TEC)
Tuesday, June 17, 1986, 13:30 - 15:00

Present: Kenzo Hayashi
Director, General Affairs Division

Kenjiro Kobayashi
Generals Affairs Division

Peter Eggleton
Counsellor for Science and Technology
Canadian Embassy

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

Established in October 1985, this Center promotes private-sector R&D in fundamental technologies (new materials, electronics, biotechnology, telecommunications, etc.). Following the Japanese Diet's June 1985 announcement and implementation of the Law for the Facilitation of Research in Fundamental Technologies, some 60 people - many of them industrial and financial leaders - came together to initiate proposals for the establishment of the Center. The Center is a joint effort of MITI and the Ministry of Posts and Telecommunciations. Initial capital, from both government and private sources, totalled 14 billion yen. Of this, 5 billion yen was invested by more than 600 private enterprises. Flow of sustaining funds is shown in Figure D-1.

Japan Key-TEC's services for promoting private sector investments and research in key technologies include investments in joint R&D companies, conditional interest-free loans, arrangement of joint reserach with various national research laboratories, research consignment, provision of important research literature on file at various government-affiliated organizations, invitation and support of foreign researchers, and more. For details the reader is referred to the Center's excellent brochures (Ref. Docs. No. D-1 and D-2).

The Center is significant not only because of the practical impact it is expected to have on industrial R&D, but because of what it represents, namely:

- a commitment of Japanese government and industry to the development of fundamental (strategic) technologies in the national interest;

- a recognition of the need for more, longer-term basic and applied research in Japan in key fields.

The stature of the organization is reflected in the fact that its first chairman, Yoshihiro Inayama, is a former head of the Keidanren, Japan's most powerful business organization.

Initial staffing of the Center will be about 60 persons, but as the Center operates like a for-profit business, ultimate size depends on volume. To add staff, approval of both MITI and MPT is needed. Staff are not public servants, but employees of the corporation. The Chairman is appointed by MITI upon recommendation by the Board.

Highlights of the Discussion:

- there is concern in Japan that private-sector R&D, which accounts for 80% of GERD, is too short-term in nature and too limited in scope; the Center aims to build a better base of basic and applied R&D in the long-term national interest.

- the Center can generate a profit; any losses are expected to be covered by MITI and MPT.

- the Center is essentially a way of sharing the risks of research in fundamental, innovative technologies; in addition, companies are willing to participate to obtain the benefits of the synergism between the various key technologies; by definition, a key technology must be applicable to more than one field;

- the following observations relate to the various services provided by the Center:

- Capital Investment: Japan Key-TEC will provide up to 70% of the capital required for restricted-theme R&D projects undertaken jointly by two or more companies (this is, among other things, a way of promoting research cooperation); the companies must form a separate R&D company to receive the funds.

- Loan Services: Conditional loans are available for up to 70% of the cost of development-phase projects; interest (at commercial rates) is repayable only if the project is commercially successful (as in Canada's PAIT program); success is determined by an appraisal committee with public, private and academic sector members; "foreign-affiliated" companies are eligible; only MITI/MPT -type projects are allowed (not agriculture, medical, marine, etc.);

- Mediation: Japan Key-TEC will advise and assist companies to establish joint research projects with national research institutions; the role is essentially that of a broker, and includes administrative services; the requesting company is billed only for direct expenses;

- <u>Consigned Research</u>: The Center will commit to undertake R&D on behalf of a company lacking capability or facilities, by consigning it to an appropriate public or private sector laboratory; the research report is issued by the Center; patent rights may be subject to regotiation but in most cases will go to the company; government laboratories will often readily accept requests to do research;

- <u>International Research Cooperation (Japan Trust)</u>: This is currently one of the government's priorities; the Japan Trust is a charitable trust established by Japan Key-TEC and includes separate memorial trusts registered in the names of individuals or corporations making large contributions; the operating profits are used to invite foreign researchers, usually at the post-doctoral level, to work in private companies in Japan for one year or less; mechanisms for extending invitations haven't been finalized, but likely will be done through governmental or other appropriate institutions; Japanese companies will be encouraged to nominate specific individuals, but this is not necessary; travelling and living expenses, "preparation allowance", and certain insurance premiums will be covered;

- <u>Information Services</u>: Technical data and information (not promotional) generated by government laboratories in key technologies will be sold by the Center usually on video or magnetic tape.

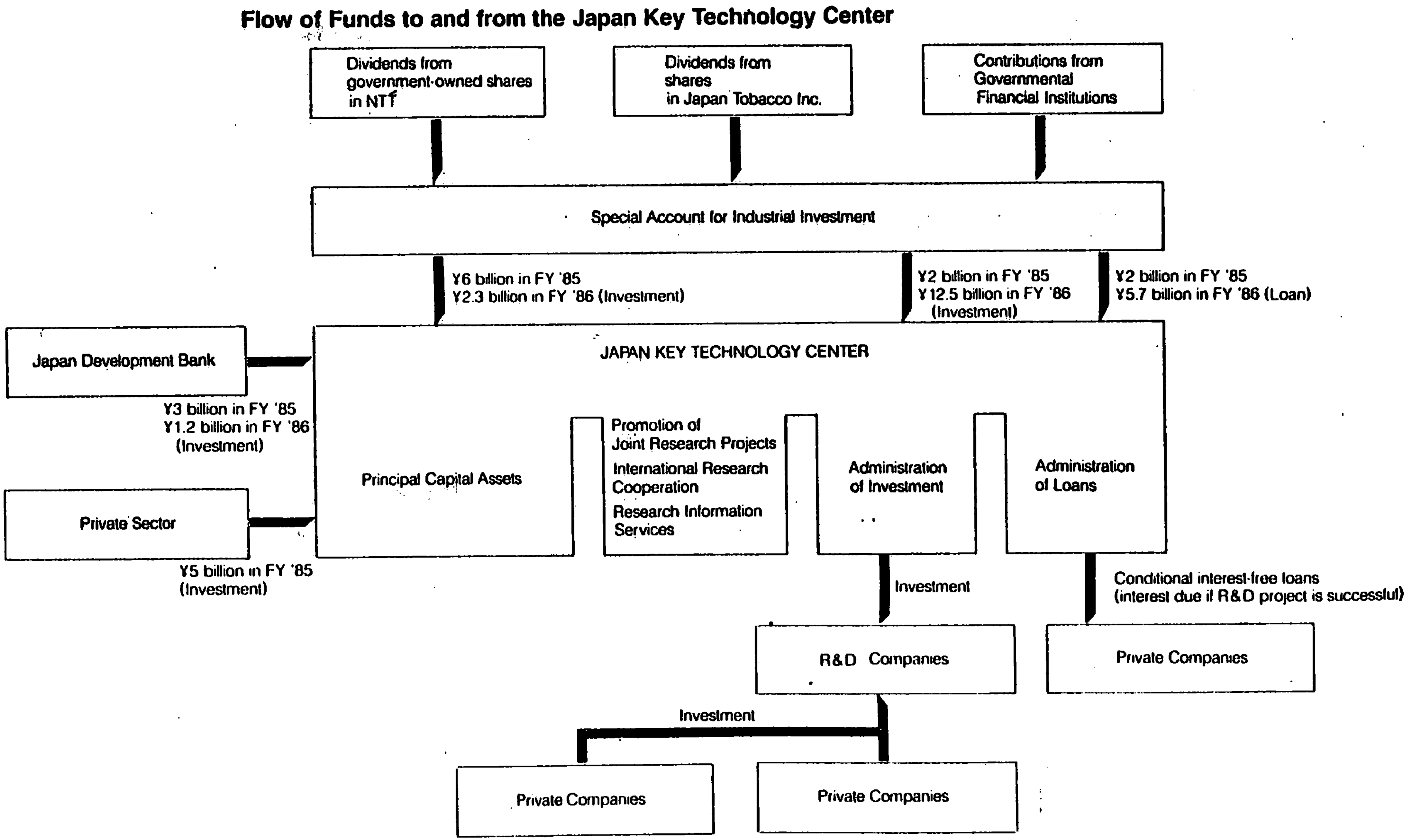
- <u>Surveys</u>: The Center will conduct technology surveys, feasibility studies, etc. as required, and provide related information services.

<u>Reference Documents</u>

D-1 "The Japan Key Technology Center", 10 pp.

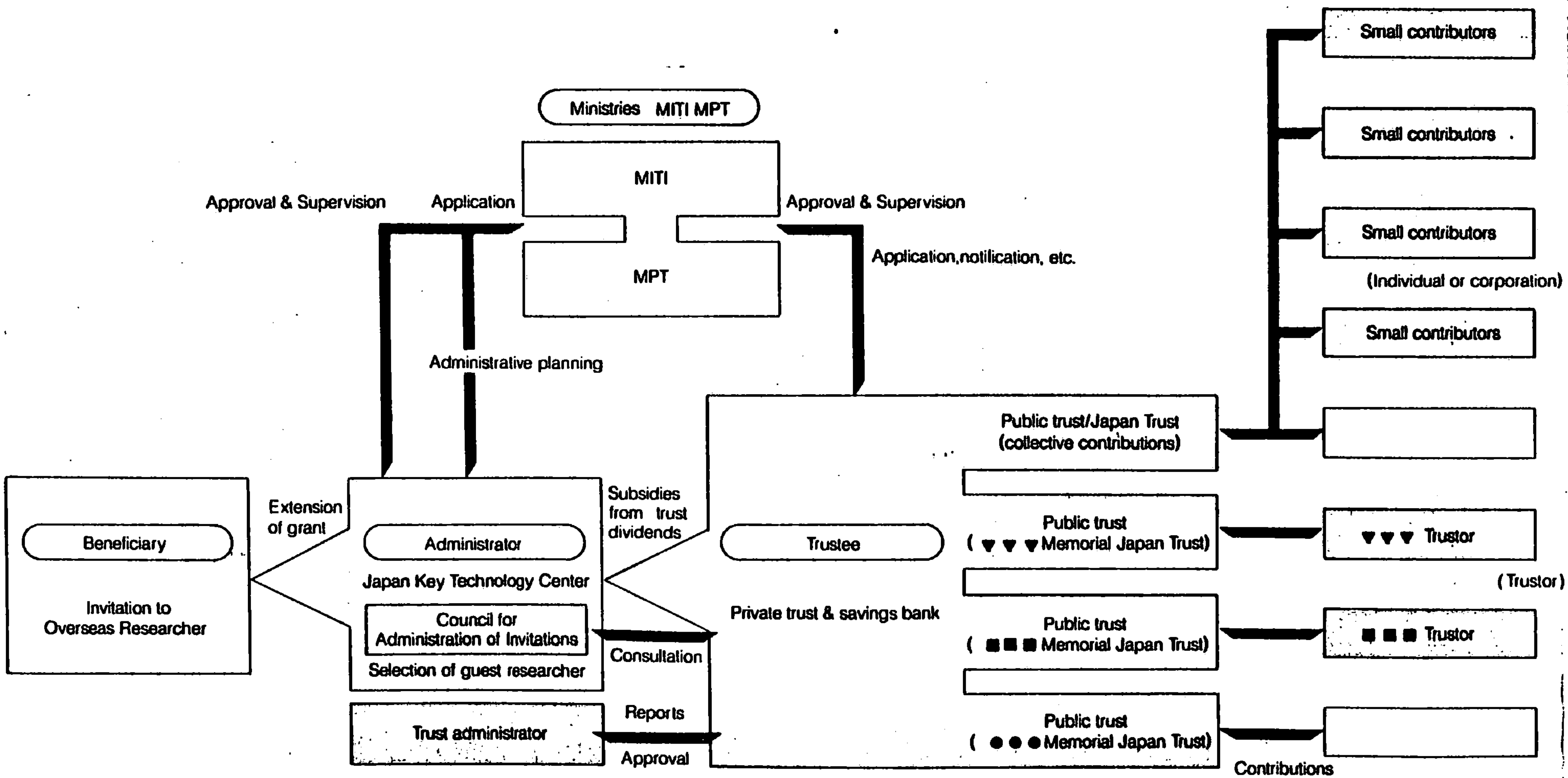
D-2 "International Reserach Cooperation: Japan Trust", Japan Key Technology Center, 6 pp.

Figure D-1


Flow of Funds to and from the Japan Key Technology Center
Dividends from government-owned shares in NTT
Dividends from shares in Japan Tobacco Inc.
Contributions from Governmental Financial Institutions
Special Account for Industrial Investment
¥6 billion in FY '85
¥2.3 billion in FY '86 (Investment)
¥2 billion in FY '85
¥12.5 billion in FY '86 (Investment)
¥2 billion in FY '85
¥5.7 billion in FY '86 (Loan)
Japan Development Bank
¥3 billion in FY '85
¥1.2 billion in FY '86 (Investment)
Private Sector
¥5 billion in FY '85 (Investment)
JAPAN KEY TECHNOLOGY CENTER
Principal Capital Assets
Promotion of Joint Research Projects
International Research Cooperation
Research Information Services
Administration of Investment
Administration of Loans
Investment
Conditional interest-free loans (interest due if R&D project is successful)
R&D Companies
Private Companies
Investment
Private Companies
Private Companies

Japan Trust

Figure D-2



Appendix E

Research Development Corporation of Japan (JRDC)
Tuesday, June 17, 1986 15:30 - 17:00

Present: Yasuichi Matsukawa
Vice-President

Koji Oshima
Manager, Patent Licensing Dept.

Shigeo Tsukakoshi
Counsellor, Patent Licensing Dept.

Hiroko Okumura
Patent Licensing Dept.

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

The JRDC, an arm of the Science and Technology Agency, was established in 1961 to link public research institutions with industry to commercialize outstanding research achievements and "establish Japan's own technology". In 1981, JRDC inaugurated a research system called Exploratory Research for Advanced Technology (ERATO) to create and foster advanced technology. The Corporation is also promoting international R&D cooperation.

A flow chart of JRDC'S technology commercialization services is reproduced as Figure E-1. Acting as an intermediary, JRDC engages in cooperative development of technology or coordinates licensing.

In cooperative development, JRDC organizes development projects for industrial utilization of some of the results of research carried out by academic, government and public institutions. JRDC contracts companies in the private sector to carry out high-risk development on selected topics in cooperation with their original developers. Costs are borne by JRDC. Successful developments are then commercialized, usually by the contracting company. If commercial success is achieved, JRDC's costs must be repaid in instalments and half of the royalties accrue to the owner of the technology. JRDC's costs are not repayable in unsuccessful cases. Up to April 1, 1984 there had been 247 projects. More than half originated in universities (see Figure E-2). A list of those in advanced materials since 1975 is given as Table E-1.

JRDC also coordinates the transfer of low to medium risk innovations from researchers to companies. Up to April 1, 1984 21 inventions had been licensed. More than 70% originated in government laboratories (Figure E-3). This is a much high proportion than in cooperative development projects (23%) and is attributable to aspects of JRDC's mission and to the more advanced stage of government projects compared with those in universities. A list of those in advanced materials is given in Table E-2. Increasingly, technologies are licensed abroad. These are promoted in a periodical bulletin entitled "Opportunities for License".

The ERATO project (Figure E-4) is a novel approach to research designed to "get rid of the fixed system of the Japanese research organizations" and invite researchers from different sectors of society as well as form abroad to carry out research activities without being biased by traditional academic disciplines. The system is centered around key individuals who are appointed by JRDC as project directors. Each project team is made up of young researchers who engage in research on open-ended innovative projects for a period of up to five years. JRDC administers and fully funds the system. Project directors recruit and manage their own teams. Project team members are employed by JRDC on a yearly contract, and carry out work in appropriate laboratories as JRDC has no facilities of its own. All project team members other than the Director must be under 35 years of age. Details are in Reference Document E-2.

Nine exploratory projects are now in progress. See Figure E-4.

Other highlights from the discussion:

- Current annual budget of the JRDC is 5 billion yen;
- JRDC often becomes involved in a development project after the inventor/developer link has already been established;
- biotechnology, electronics and materials are priority fields, and account for an increasing proportion of projects;
- use of JRDC by STA laboratories for development and licensing is optional;
- Mitsubishi Trading Co., with offices in New York and London, is the overseas agent for JRDC; each year Mitsubishi has a booth at the Hanover Fair; inquiries from abroad are handled by Mitsubishi.
- An internal committee of JRDC establishes research topics for ERATO;
- ERATO Project Directors select team members either by general tender or by their own knowledge of leading scientists;
- Generally, foreign researchers involved in ERATO relocate to Japan, but in future some of the work may be done abroad;
- Each year ERATO projects are discused in a symposium; H. Shimizu will receive reports.

<u>Reference Documents</u>

E-1 "Research Development Corporation of Japan", 1984, 20 pp.

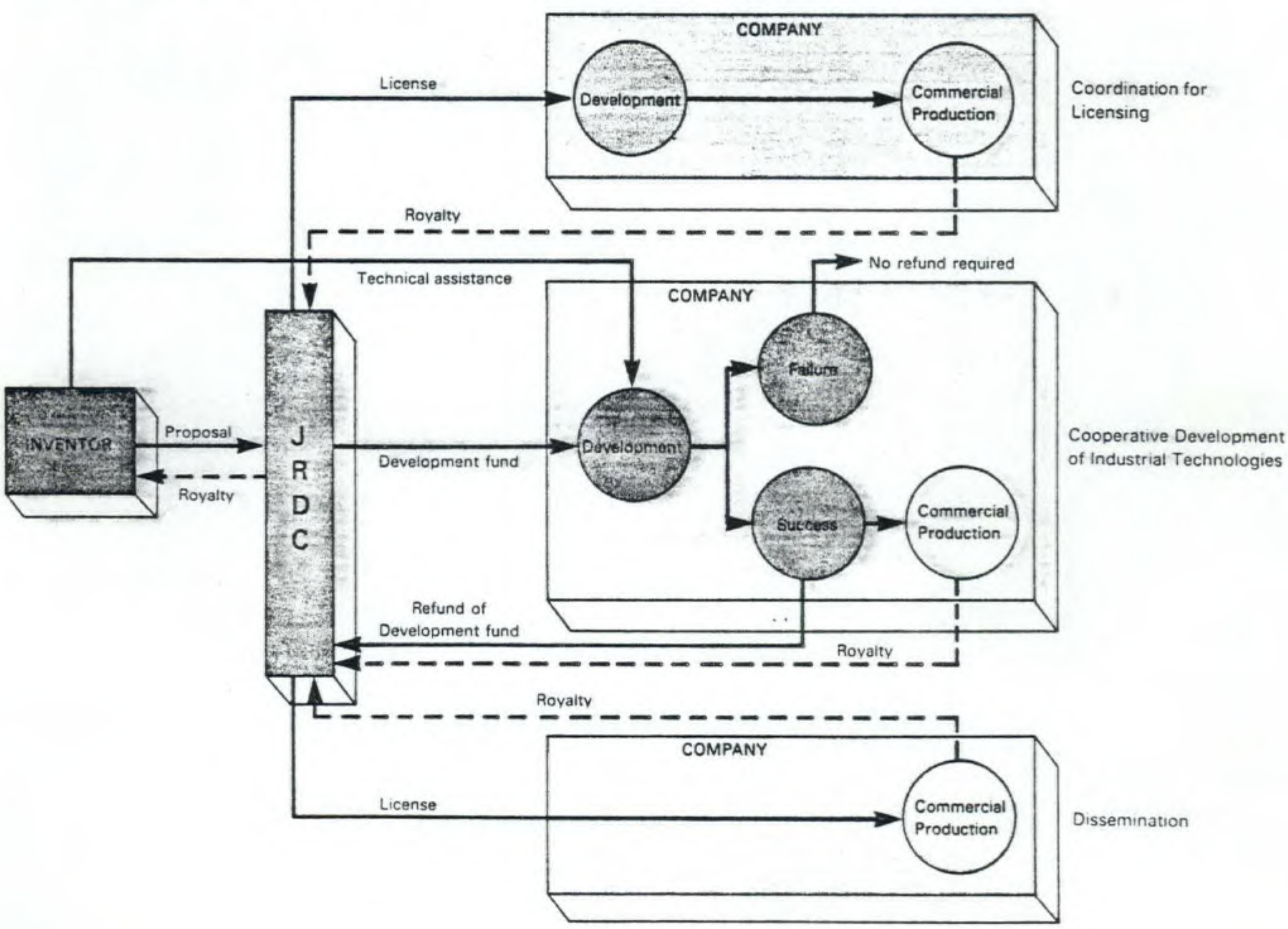
E-2 "ERATO: Exploratory Research for Advanced Technology", Research Development Corporation of Japan, 1986, 28 pp.

Development of New Technology

The activity JRDC has been carrying out since its foundation is to promote commercialization of new technology that contributes to the improvement of national economy. JRDC collects information on the research outcome from universities and public research institutions as well as from individual researchers across the nation to promote "Cooperative Development of Industrial Technologies" or "Coordination for Licensing" depending on the degree of risk in developing the technology so that technology can be exploited by industry. JRDC is an intermediary that links inventors and companies.

Figure E-1

Flow Chart of JRDC's Services



Cooperative Development of Industrial Technologies

JRDC organizes development projects for industrial utilization of some of the results of research carried out by academic, government and public institutions.

After careful screening, JRDC contracts companies in the private sector to carry out development on selected topics in cooperation with their original developers. The fund necessary for the development is borne by JRDC. These topics, though very promising, would not otherwise be pursued due to their high risk nature for commercialization. It is expected, however, that many of the research and development projects thus engaged will result in industrial utilization and commercialization.

If a development is judged to be a success, the contractor is authorized to commercialize the new technology under a renewed contract and pays royalty depending on its sales. Half of the royalty, as a rule, is paid to the owner of the technology. The development expenses paid by JRDC to the company are to be refunded in installments within five years. In the case of an unsuccessful development, the contractor is under no obligation to repay to JRDC the development expenses.

In implementing a developed technology for commercial and industrial use, priority is given to the company that has been contracted by JRDC. If a company not in contract with JRDC applies to implement the technology, JRDC may license this company to do so after considering the market requirements and licensing conditions. The royalty paid by the company is divided among the owner of the technology, the contractor and JRDC. Furthermore, if there is a prospect of the technology being licensed to foreign companies, JRDC carries out licensing activities to foreign countries.

The number of projects JRDC sponsored up to April 1, 1984 since its foundation is 247. The figure below shows the number of projects as broken down by source and technological fields.

Figure E-2

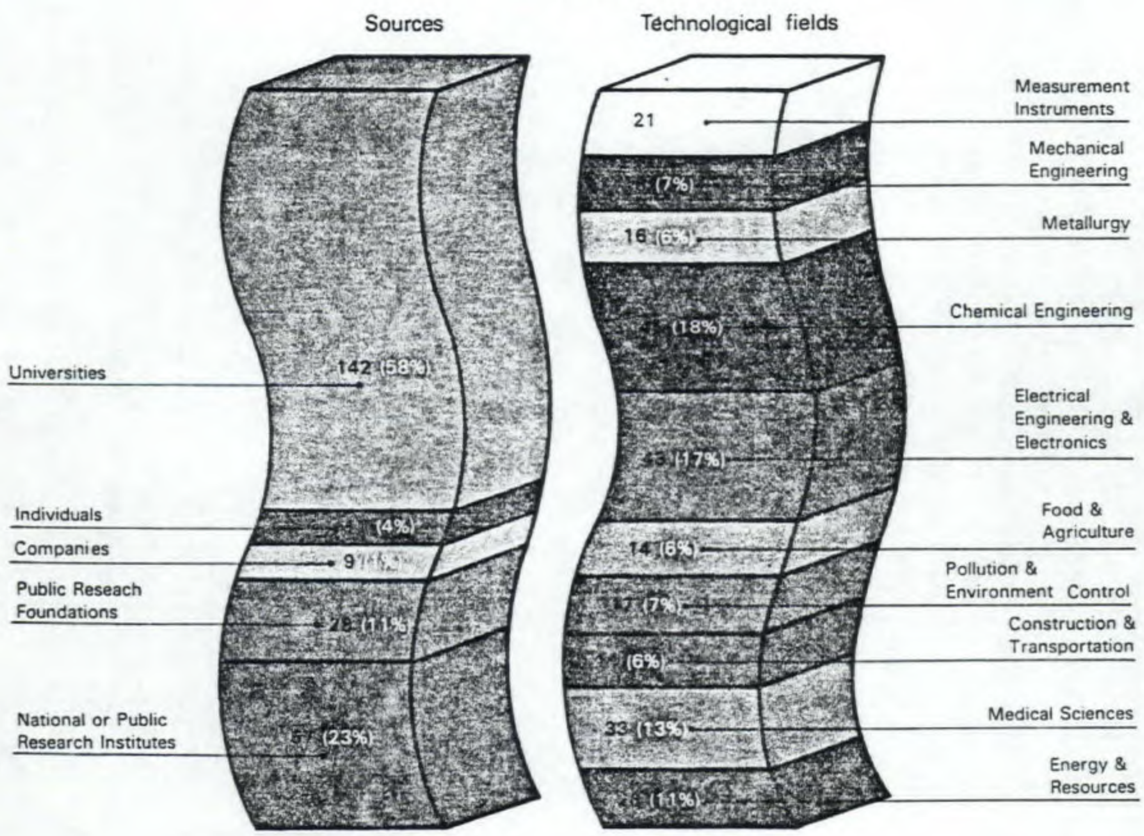


Table E-1

ADVANCED INDUSTRIAL MATERIALS (Cooperative Development of Industrial Technologies)

No.

Entrusted year	Our Ref.	Name of Technology	Inventor	Entrusted Company
'75	134	Production Process for polyphenol Heat Resistant resin by Addition Polymerization	K. Kanezaki (Kitakyushu College of Technology)	Maruzen Petro Chemical Co., Ltd
	135	Production Method for Boron Nitride Cutting Tools by Ultra High Pressure Sintering	S. Saito et al., (Tokyo Institute of Technology	Nippon Oil & Fats Co., Ltd.
'76	146	Production Process of Maltols by Electolytic Organic Synthsis	T. Shono (Kyoto Univ.)	Otsuka Chemical Co., Ltd.
	149	Production Process for Artificial Tooth and Bone of Apatite Ceramics	K. kato et al., (Tokyo Medical & Dental Univ.)	Asahi Optical Co., Ltd.
	150	Production Process for Amino Acid Based Surfactants	S. Masuyama et al., (Osaka Municipal Technical Research Institute)	Taiyo Kagaku Company, Ltd.,
	D77-02	Production Method of Amorphous Metals for Electro Magnetic Materials	K. Masumoto (Tohoku Univ.)	Hitachi, Ltd., Hitachi Metals, Ltd.
'77	D77-03	Application of Amorphous Metals such as High Magnetic Permeability	K. Masumoto (Tohoku. Univ.)	Matsushita Electric Industrial Co., Ltd.
	D77-04	Application of Amorphous Metals such as High Magnetic Distorsion Materials	K. Masumoto et al., (Tohoku Univ.)	Sony Corporation
'79	D77-05	Production Method of Thermionic Emission Cathode Having a Tip of Single Crystal of Lanthanum Hexaboride	N. Kawai et al., (Osaka Univ.)	Denki Kagaku Kogyō Kabushiki Kaisha
	D79-01	Production Process for Antithrombogenic Materials by Immobilizing Fibrinolytic Compounds	T. Oshiro et al., (Osaka Univ.)	Unitika, Ltd.
'80	D79-11	Production Method of Carbide Continuous Fiber with Organic Silicon Polymer	S. Yajima et al., (Tohoku Univ.)	Nippon Carbon Co., Ltd.
	D80-05	Production Method for High-Purity and Easily Sinterable Alumina Powder	S. kato et al., (Government Industrial Research Institute, Nagoya)	Taimei Chemicals Co., Ltd.
	D80-09	Production Method for Amorphous Metals for Power Transformer Core	K. Masumoto et al., (Tohoku Univ.)	Nippon Steel Corporation
'82	D82-02	High Performance Ceramic Film Continuous Manufacturing Technique	Y. Ozaki (Seikei Univ.)	Mitsubishi Mining & Cement Co., Ltd
	D82-11	Production Method for Sialon Sinters	M. Mitomo et al., (NIRIM)	Sinagawa Refractories Co., Ltd.
'83	D83-03	Production Method of High-Purity Diamond Sinters	O. Fukunaga et al., (NIRIM)	Toshiba Tungaloy Co., Ltd.
	D83-08	Production Method of Silicon Nitride Sinters by Gas Pressure	M. Mitomo (NIRIM)	NGK Spark Plug Co., Ltd.

Coordination for Licensing

JRDC coordinates the transfer of such inventions that can be implemented in a production process between a researcher and a company. JRDC also solicits information on new technologies developed in academic, government and private institutions, and when deemed promising with the assitance of outside evaluators, arranges for the transfer of these technologies to private corporations in need of them. Nine-tenths of the royalty is paid to the owner of the technology and the rest is retained by JRDC.

To smoothly and effectively promote activities for licensing, JRDC publishes periodicals containing information of new technology and cooperates with private organizations engaged in the local development in each district to complete the network covering the entire country.

The number of inventions JRDC dealt with up to April 1, 1984 since its foundation is 212 and the number of companies granted license is 285. The figure below shows the number of inventions and companies granted license as broken down by source and technological fields.

Figure E-3

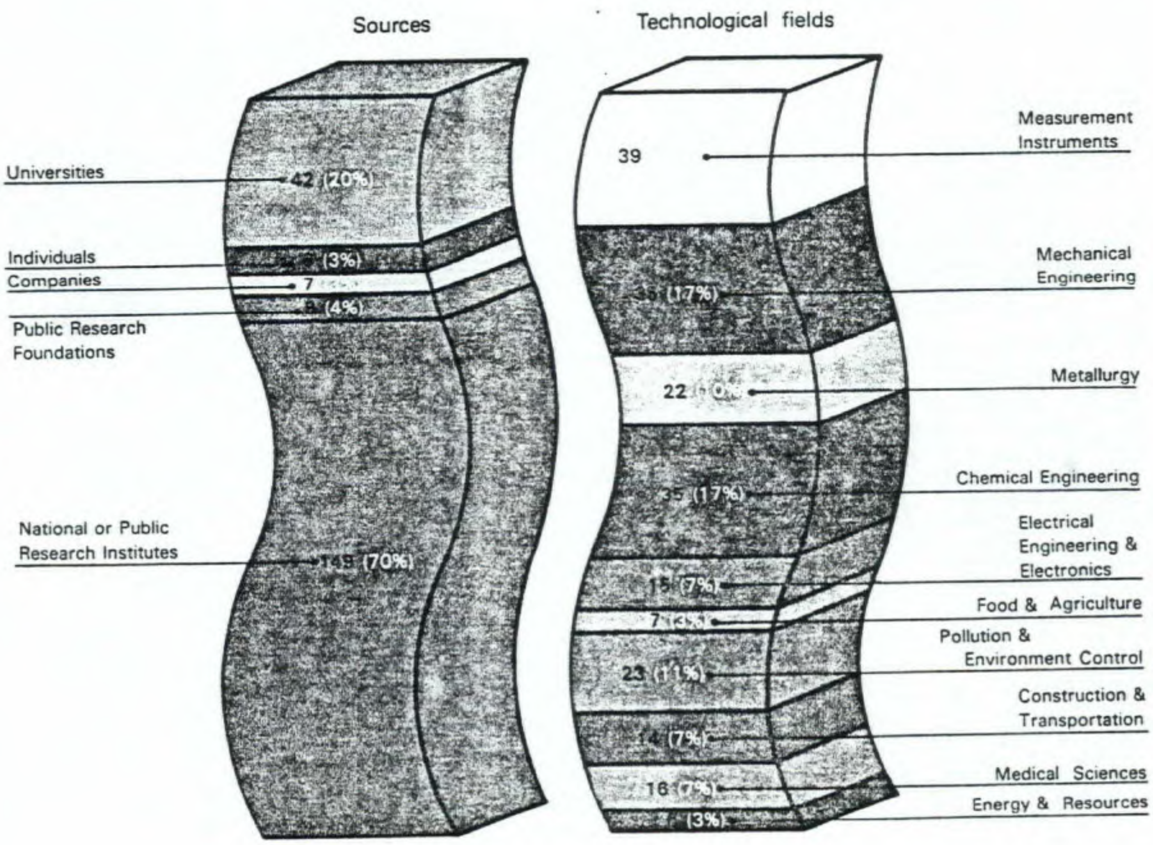


Table E-2

No.

(COODINATION for Licensing)

Licensed year	Our Ref.	Name of Technology	Inventor	Licensee
1978	L78-09	Preparation of Magnesium Titanate Single Crystal	I. Shindo et. al. (NIRIM)	Tsukuba ASGAL Corporation et al.
1979	L79-15	Production Method of Nb_3Sn Composite Superconductors	Y. Tachikawa et al. (NRIM) *2	The Furukawa Electric Co., Ltd. et al.
1980	L80-05	Process to Produce Cubic System Boron Nitride	T. Endo et al., (NIRIM)	Showa Denko K. K.
	L80-09	Production Method of Metal Short Fibers by Chatter Machining	I. Nakagawa et al., (Tokyo Univ.)	Aishin Seiki Co., Ltd., et al.
1984	L80-11	Preparation of Silicon Carbide Sinter	Y. Inomata et al., (NIRIM)	Ibiden Co., Ltd. et al.
1982	L82-14	Fe-Ti-O System Hydrogen Strong Materials	M. Amano et al., (NRIM).	Daido Steel Co., Ltd. et al
1983	L83-04	Production Process and Equipment for Ultrafine Metal Particles	M. Uda et al., (NRIM)	Tokyo Tekko Co., Ltd. et al
1985	L83-14	Production Process for Fine Metal Particles	H. Suga et al., (NRIM)	Ishituku Metal Industry Co., Ltd. et al.
	L83-16	Production Process Dispersed Fiber Type Nb_3Sn Superconductor	Y. Tachikawa et al., (NRIM)	The Furukawa Electric Co., Ltd.
1983	L83-18	Heat Resistant Alumino Silicate Glass	Y. Hasegawa (NIRIM)	Hoya Corporation
	L83-23	Process for Producing Alkali Metal Titanate Fibers	Y. Fujiki (NIRIM)	Otsuka Chemical Co., Ltd.
	L83-26	Fine Short Fibers Sintered Grinding Material	I. Nakagawa (Tokyo Univ.)	Sinto Brator, Ltd.
1984	L84-02	Fiber Sintered Self Lubricating Friction Material	I. Nakagawa (Tokyo Univ.)	Kobe Cast Iron Works, Ltd.
1985	L85-06	Optical Information Transmission Glass Fiber	D. Kato (Electrotechnical Laboratory)	Dainichi-Nippon Cables, Ltd.

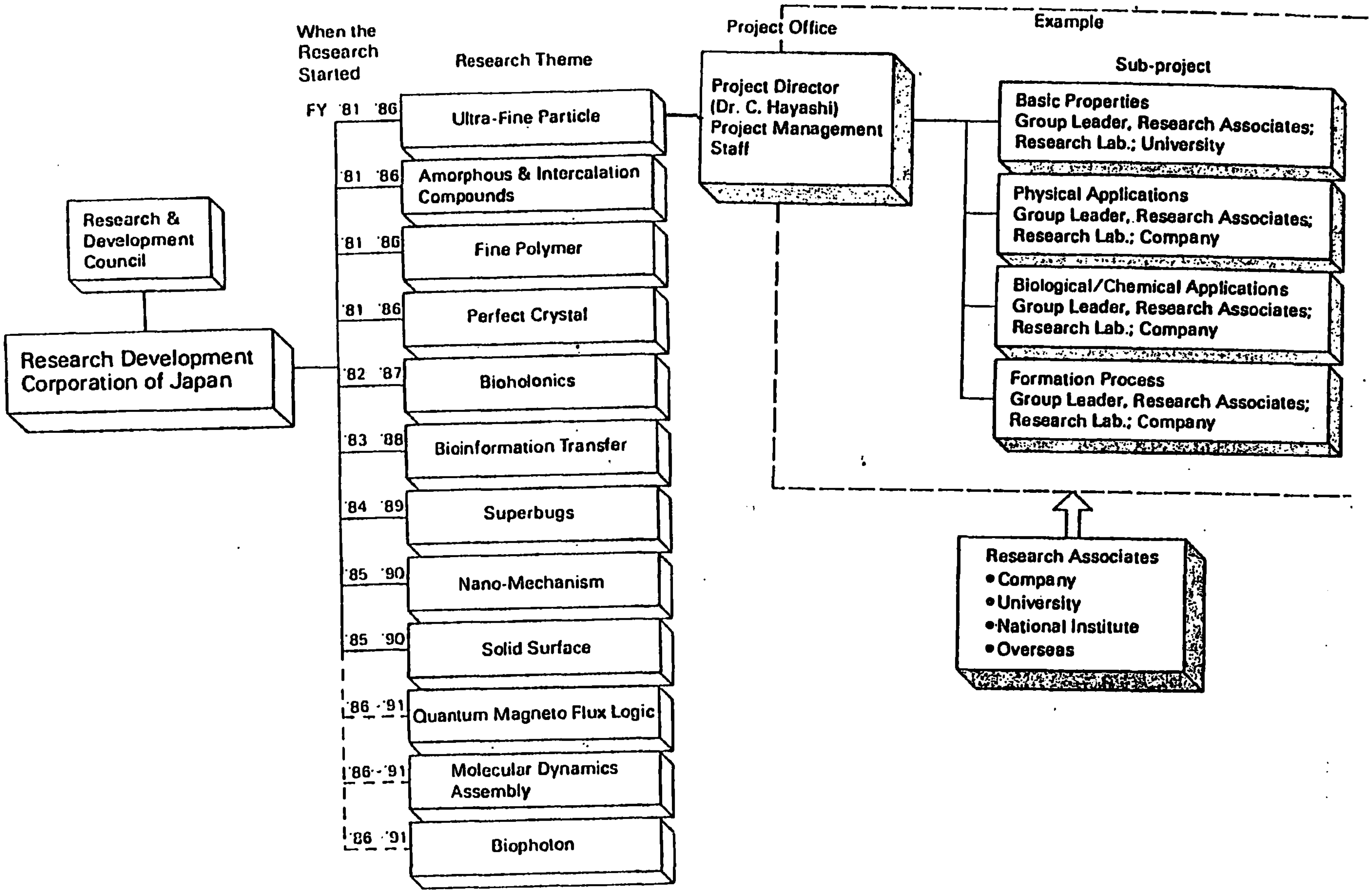
*1 NIRIM : National Institute for Researchs in Inoganic Material

*2 NRIM : National Research Institute for Metals

コクヨ シヨ-15 (35×32)

ERATO

Figure E-4



Appendix F

Government Laboratories

a. Research Institute for Polymers and Textiles, Tsukuba
Wednesday, June 18, 1986, 10:00 - 13:15

Host: Dr. Masatoshi Iguchi
Head, Research Planning Office

Also met with: Dr. A. Okada, Director-General

Accompanied by: Noriko Abe
Science and Technology Office
Canadian Embassy

The RIPT is one of 12 laboratories under the Agency of Industrial Science and Technology, MITI. Esablished in 1918 to improve the quality of silk exports, the Insitute has had an interesting history which tracks the history of the textile and polymer industies in Japan. Now the emphasis is much more on polymers than on textiles. Primary areas of interest are:

- upgrading of polymer materials;
- synthesis of new functional polymers;
- bio-function utilizing technology;
- innovative technology for textile industries;
- energy technology;
- antipollution technology;
- international standardization; and
- international research cooperation.

Total budget in FY 1986 is 1.5 billion yen. For details see Figure F-1. Permanent staff totals 127. Details of the research program are available in the Institute's excellent brochure (Ref. Doc. F-1).

Highlights of the Discussion:

- The Institute is keenly interested in international cooperation; an annual high-technology Japan/France symposium is held and similar efforts are under way with Sweden;
- MITI started in 1986 a two-year full-scale review of the Tsukuba science complex;

- The government provides 100% of RIPT's budget; no money is received from industry; the Institute has no contracting-out programs; these are all handled at the agency (AIST) level;

- Some years ago the bulk of the Institute's research was in the "ordinary research" and "special research" categories; now the largest single source of funds is MITI's R&D Project of Basic Technology for Future Industries, established in 1981 (see Figure F-1); the laboratory also receives large-scale project funds from MITI and special coordination funds from the Science and Technology Agency; with the establishment of the Basic Technology Project, aggregate funds flowing to the laboratory did not increase significantly; instead, re-allocations took place.

b. National Institute for Research in Inorganic Materials, Tsukuba Wednesday, June 18, 1986, 13:30 - 15:30

Host: Dr. Zenzaburo Inoue
Senior Researcher

Accompanied by: Noriko Abe
Science and Technology Office
Canadian Embassy

This Institute, established in 1966, is one of the national laboratories under the Science and Technology Agency. With a staff of 168, including 120 researchers, NIRIM conducts multi-disciplinary research on the synthesis, analysis and properties of inorganic compounds, including a wide-ranging program on ceramics. Details are provided in Ref. Doc. No. F-2.

Highlights of the Discussion:

- Dr. Inoue and Dr. Serge Dallaire of NRC's Industrial Materials Research Institute have jointly proposed a cooperative project on ceramic crystal chemistry under the Canada/Japan S&T agreement.

- The laboratory operates under a novel research group system, in which research teams are formed with specified goals for a five-year period; at the end of five years the team is dissolved even if the goals have not been met; the position of group leader is not permanent, and scientists rotate through such positions; currently there are 15 such groups; the Institute has high-pressure and high-temperature research facilities that serve all 15 groups; research themes are developed by the project leader and the theme "dissolves" with the group; proposed new themes are discussed in "hearings", with the Director-General making the final decision; to become a group leader, a researcher must bring forward a theme proposal; the system is quite competitive;

- In some cases, a portion of royalties arising from inventions can accrue to the researcher;

- NIRIM developed the sintering technology for Nissan's ceramic turbocharger rotor, which is manufactured by NGK.

c. <u>National Research Institute for Metals, Tsukuba</u>
<u>Wednesday, June 18, 1986, 15:45 - 17:00</u>

Host: Dr. Kyoji Tachikawa
Director, Tsukuba Laboratories

Accompanied by: Noriko Abe
Science and Technology Office
Canadian Embassy

This Institute, also an STA national laboratory, has two laboratory complexes. Of the total staff of 330, 75 are at Tsukuba, the remainder being in the older Tokyo facilities. Eventually the Tokyo compus is expected to be relocated to Tsukuba.

The clear emphasis of the Tsukuba laboratories is on superconducting and cryogenic materials, in which Dr. Tachikawa has considerable expertise. Work is also carried out on high-strength materials and nuclear materials. Work on intermetallics is also beginning.

Total NRIM budget in 1985 was about 4.2 billion yen. Of this, the research budget was 1.6 billion, the remainder being for facilities and personnel. Details are available in Reference Documents F-3 and F-4.

d. <u>Government Industrial Research Institute, Nagoya.</u>
<u>Friday, June 20, 10:30 - 13:30</u>

Host: Eichii Ishii, Director of Fifth Division

Also met with: Dr. Shunji Nagase
Director

Yoshio Ishiguro
Chief, International R&D Cooperation

Hideyo Tabata
Research Manager
Engineering Ceramics Section

Tatsuki Ohji, First Division
Several Other Officials

This institute, one of MITI's (AIST) regional laboratories, has a very active program of research in advanced ceramics, which was the subject of the visit. The ceramics program originated in the Government Research Institute for Ceramics, one of the three laboratories that were merged to create GIRIN in 1952. Details are in Reference Document F-4.

Highlights of the Discussions:

- No financial support is received from industry; like other government laboratories, GIRIN receives support from a variety of "projects" including the R&D Project of Basic Technologies for Future Industries; the research budget is 884 million yen; total staff is 265;

- Industry is not permitted to use the Institute's equipment; however, companies can second personnel, and often do in the case of young researchers;

- There is no real cooperative work with universities;

- No foreign scientists are on the site now (June 1986), but four are coming from Sweden for one to six month periods;

- The laboratory occassionally sends researchers overseas, aided financially by the STA;

<u>Reference Documents</u>

F-1 "Research Institute for Polymers and Textiles, 40 pp.

F-2 "NIRIM 1984", National Institute for Research in Inorganic Materials, 23 pp.

F-3 "National Research Institute for Metals, 1985-86", 20 pp.

F-4 "Recent Research and Development Activities on Superconducing Materials in Japan" by K. Tachikawa, 1986, 9 pp.

F-5 "GIRIN", Government Industrial Research Institute Nagoya, 20 pp.

F-6 "Outline of Vertical Heliostat Type Solar Furnance", GIRIN, March 1978.

予算・人員　Budget/Personnel

昭和61年度予算額（単位：千円）
Budget for Fiscal Year 1986 (unit: ¥1,000)

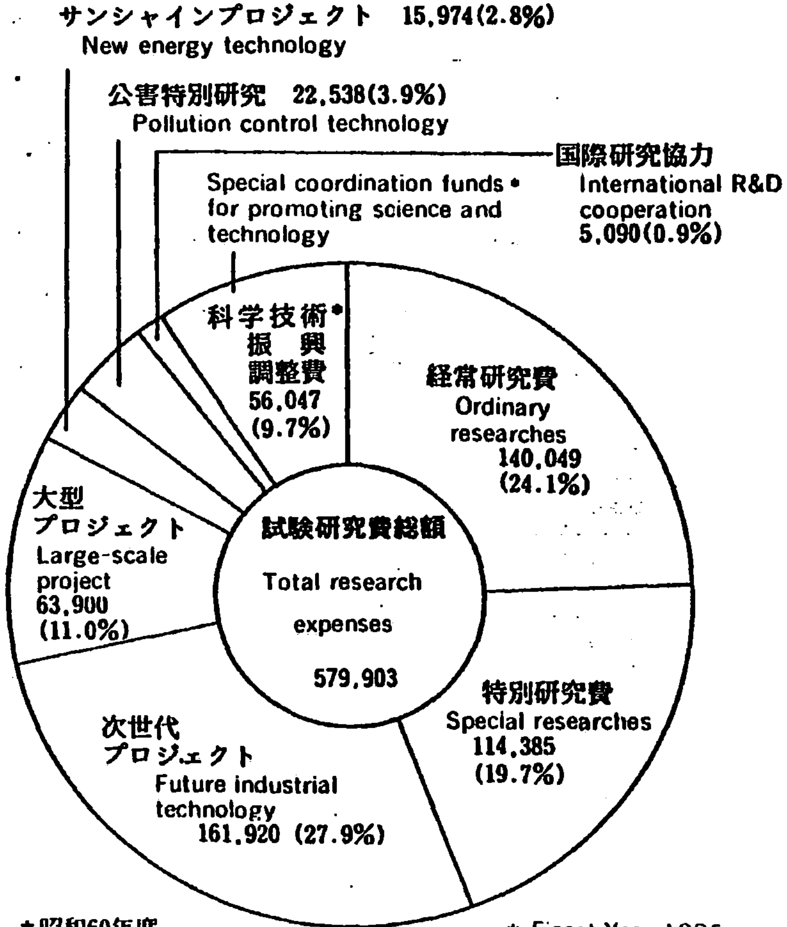
内　訳　Item	金 額 Account
試験研究費総額　Total research expenses	579,903
設備整備費　Facilities and instruments	31,000
人件費　Personnel expenses	816,447
その他　Miscellaneous	68,562
合　計　Total	1,495,912

職員　Personnel

定　員　Permanent staff	127人
研究職* Research officials* 行政職　Administrative officials	104人 23人

*指定職を含む　including Director General

試験研究費内訳（単位：千円）
Research Expenses (unit: ¥1,000)



*昭和60年度　* Fiscal Year 1985

NATIONAL INSTITUTE FOR RESEARCH IN INORGANIC MATERIALS

3-2. Budget

Figure F-2

Unit: Thousand yen

Items / Year	Budget for FY 1985	Budget for FY 1986
I. Ordinary budget		
1. Special research	95,243	90,250 *1)
2. Ordinary research	388,755	391,876
3. Instruments for research	128,563	122,132
4. Expenses for construction	198,279	181,399
5. Personnel expenses	955,505	1,033,307
Sub total (I)	1,766,345	1,818,964
II. Special budget		
6. Special coordination funds of promoting science and technology	212,199	unknown *2)
7. Research project on atomic energy	30,476	31,024 *3)
8. Research and development project of technology for future industries	14,116	11,888 *4)
Sub total (II)	256,791	
Total (I + II)	2,023,136	
Researcher	117	118

*A detailed budget of the items marked *1, *2, *3, *4 in the above table is ~~as follows~~ shown below

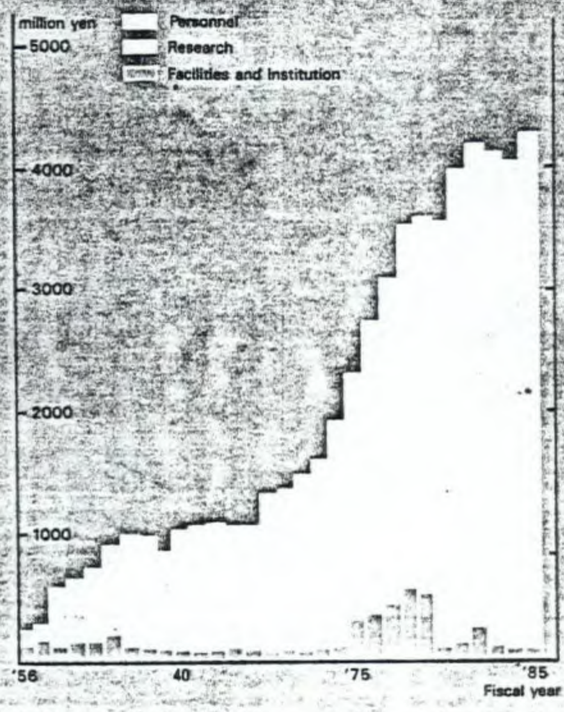
Items / Year	Budget for FY 1985	Budget for FY 1986
*1. Special research		
(1) Research on bioceramics	50,007	27,456
(2) Research on the synthesis of semiconducting diamond	0	38,010
(3) Research on super abrarive ceramics	0	24,784
(4) Field electron emitter	25,339	0
(5) Sintered materials for optoelectronics	19,897	0
Sub total	95,243	90,250
*2. Special coordination funds for promoting science and technology		unknown
(1) Research for creation of new material in microgravity environments	15,243	
(2) Research on the high-power tunable laser of variable wavelength and laserprocessing technology	33,827	
(3) Research on the development of new materials based on hybrid material design	71,643	
(4) Study on the ultra-high temperature technology	0	
(5) Others	91,486	
Sub total	212,199	unknown
*3. Research project on atomic energy ... Radioactive treatment characterization by means of RI, etc.	30,476	31,024
*4. Research and development project of technology for futureindustries ... High-performance ceramics	14,116	11,888

National Research Institute for Metals

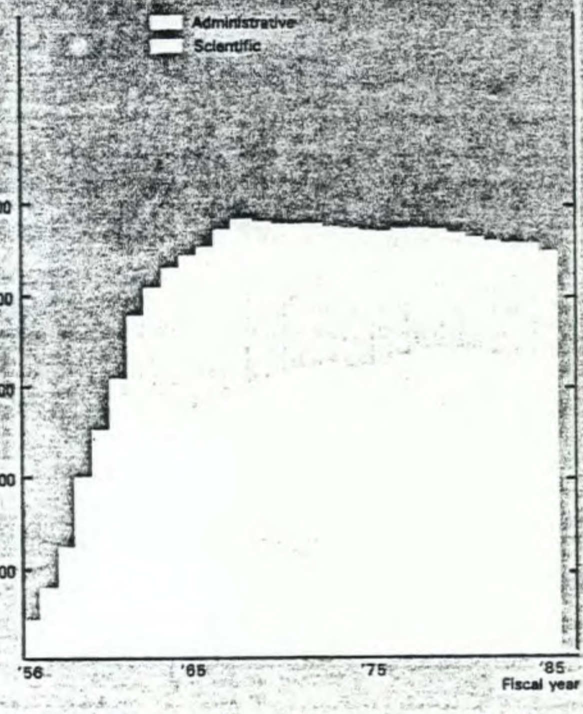
Figure F-3

Total Budget and Number of Personnel

Growth of Annual Budget
(Budget for Fiscal 1985; 4,151 million yen)

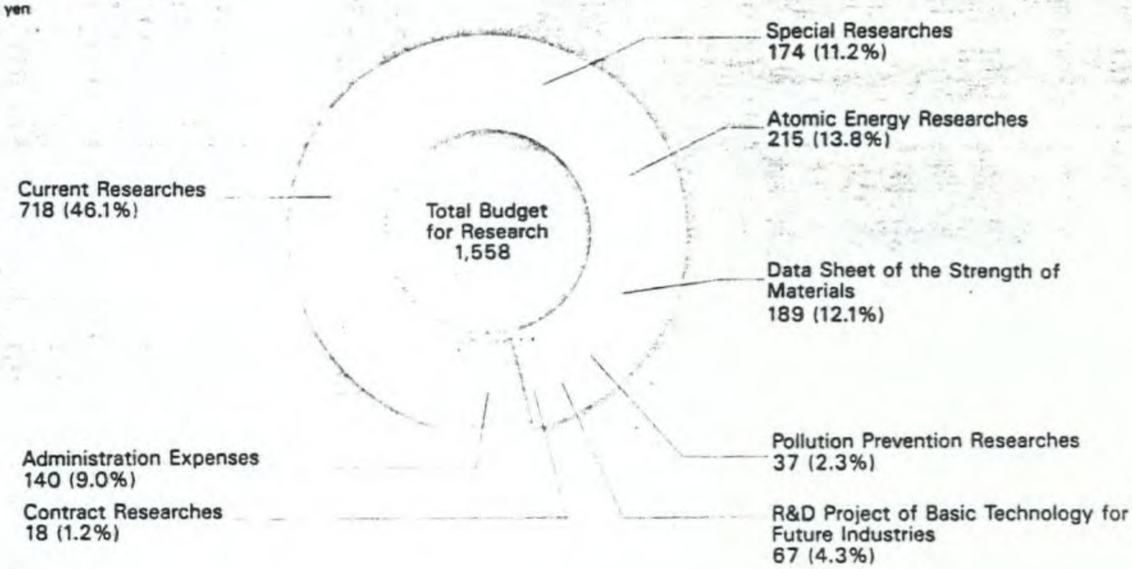


Personnel
(Personnel for Fiscal 1985; 447)



Research in 1985

Unit: million yen



Appendix G

Japan Industrial Technology Association (JITA)
Thursday, June 19, 1986, 09:30 - 10:30

Present: Dr. Mitsuo Suzuki
Senior Executive Director

Hiroshi Tagaya
General Manager, Research Dept.

M. Hosaka
Manager, International Department

JITA was formed in 1969 as a not-for-profit foundation with government subsidies (1.2 billion yen) and private donations (340 million yen). Its purpose is to transfer technologies developed in MITI's 16 laboratories. In 1983 JITA initiated a Mission Delegation Program to promote these technologies abroad. In October 1986 a mission emphasizing advanced ceramics will visit Canada (seminars at B.C. Discovery Park and Ontario Research Foundation) and the U.S.A.

Like the Research Development Corporation of Japan, JITA also promotes joint research between AIST laboratories and private industry, carries out technology surveys and assessments, and organizes conferences and symposia.

JITA's revenues in 1984 came from the following sources:

Interest on 1.5 billion yen fund	Yen 130 million
Subsidy from Government	120 million
Contract Reserach Fee from Government	120 million
Membership Fees (@ 120,000 yen)	90 million
Royalties	24 million
Publication Sales	30 million
Administration Margin of Tsukuba Research Facilities	40 million
TOTAL	Yen 554 million

Permanent staff totals 40; in addition 7 patent attorneys and 10 consultants are engaged on contract.

JITA has the exclusive right to all national industrial properties and know-how possessed by AIST (a total of 19,000 intellectual properties). In principle, JITA will grant a license to anyone who wants it. License agreements, options on licenses and secrecy agreements are used.

In 1983 AIST, through JITA, launched the Initiation Program for Foreign Researchers under which scientists are granted fellowships to work at AIST laboratories.

Other Highlights of the Discussion:

- 75% of Japanese government-developed technology originates in MITI laboratories.
- JITA has the right to transfer technology to foreign countries, while JRDC does not.

Technology assessments are of two types:

- On request of MITI, studies of impacts of advanced technologies on industry (not very active because of tight budget); and,
- Studies of impacts of more mature technologies, often carried out in cooperation with industry, e.g. potential application of new fibres or fabrics in space programs (very active - one project per year);
- Technology assessments are published in Japanese.

Reference Documents

G-1 "JITA", Japan Industrial Technology Association, 1985, 21 pp.

G-2 "Now & Future", Special Edition on Fine Ceramics, Vol. 1, No. 2, 1985, 15 pp., (Quarterly published by JITA).

G-3 "National Technologies held by MITI", JITA, 1985, 68 pp.

G-4 JITA High Tech Mission 86: Primary Plan of Mission Delegation to Canada/USA", 4 pp., (Note: The mission is on advanced materials).

Appendix H

Ministry of Education, Science and Culture (Monbusho)
Thursday, June 19, 1986, 11:00 - 12:00

Present: Mr. Kizawa
Deputy Chief, Research Planning Office

Monbusho is responsible for the general promotion of scientific research, and specifically for research carried out within universities and associated institutes. Its functions are outlined in the excellent booklet "The University Research System in Japan" (Reference Document H-1). The booklet also contains much useful data. Monbusho, in conjunction wth the STA, provides certain secretariat services to the Council for Science and Technology particularly in relation to links between university research laboratories and government institutes.

To promote scientific research in the universities, Monbusho provides;

1. funds for management and for the research and educational activities of national universities and related research institutes;

2. subsidies to private and public universities;

3. research grants to individual scientists and groups of scientists;

4. funds for the activities of the seven government research institutions under its jursidiction and the Japan Academy; and,

5. subsidies to the Japan Society for the Promotion of Science.

The Japan Academy is a 108-year-old organization which affords membership and prferential treatment to those who have made outstanding contributions to science. There are 150 members.

The Japan Society for the Promotion of Science (JSPS) is a quasi-governmental body under the jurisdiction of Monbusho. It operates programs to promote scientific activities in Japan, including research fellowships and international exchanges.

In addition to its links with the Council for Science and Technology and the Science Council of Japan, Monbusho is advised by its own 27-member Science Council, a 27-member Geodesy Council, and 15 independent science advisers (university professors).

Japan has 96 National Universities established by Monbusho, with 69 attached research institutes and 12 national inter-university research institutes. In addition there are 34 public and 331 private universities, with 526 attached research institutes. All are eligible for financial support from Monbusho, and 281 have graduate schools. There are also 543 junior colleges and 62 technical colleges.

During the 1970's a new type of research institute called a National Inter-University Research Institute was created to focus research in leading areas of science, especially where large-scale facilities and equipment, systematic collection of data, or team research are required. They are also expected to assume an important role in international cooperative research. They have the same legal classification as universities and their research staffs have the same status as faculty members of the universities. There are 12 such institutes.

Monbusho has embarked upon the establishment of a National Center for Science Information System (see Figure). Links have been established with 8 computer centers and 31 information processing centers set up in national universities.

The total Japanese government budget for science and technology (excluding social sciences and humanities) is 1,620 billion yen in FY 1986. The big spenders are:

Monbusho	Yen 746 billion	46%
STA	420	26%
MITI	218	13%
Agriculture, Forestry and Fisheries	66	4%
Other	170	11%

Monbusho and JSPS are also actively promoting university-industry cooperation throuh joint research, contract research, contract researchers, private donations, and cooperative research committees. The number of joint projects quadrupled between the years 1983 and 1985.

The Ministry lists nine priority areas of research ("big science"). These are:

1. Fusion research
2. Accelerator science
3. Space Science
4. Prediction of earthquakes and volcanic eruptions
5. Bioscience
6. Ocean Science
7. Antarctic research
8. Electronics and information engineering
9. Materials research

These fields have been identified as requiring "special measures", large-scale facilities and equipment, and extensive research networks.

Other Highlights of the Discussion:

- The National Council on Educational Reform, in its second report (1986 - Reference Document H-2), urges a comprehensive reorganization of the nation's educational system, with the transition to a lifelong learning system as the core element and respect for individuality as a basic principle. This is one of many indicators of the adaptations expected in Japan as its people cope with social and cultural changes and increasing international influences. Among other things, the report recommends the creation of "flexible research structures" in universities, more industry/government/university cooperation, strengthening of scientific information dissemination systems, and promotion of international exchange in science.

- Mr. Kizawa commented that while Monbusho supports research in private universities, this support is considered by many observers to be insufficient.

- In 1985 the Ministry received 55,000 applications for research grants from 136,000 researchers, and approved 16,000. The Ministry has a goal of maintaining an approval rate of 30%.

- Monbusho has a program of "special researches" in priority areas such as cancer, disaster prevention and pollution prevention. These long-term projects have a special budget and professors are specially encouraged to apply.

- Monbusho also has a program of specific 3-year research projects in key areas. Advanced materials is one such area.

- Overall, government spending on research is increasing, but thre is no big increase in basic research spending despite the national thrust in this area; the government hopes the real increase in basic research will take place in industry.

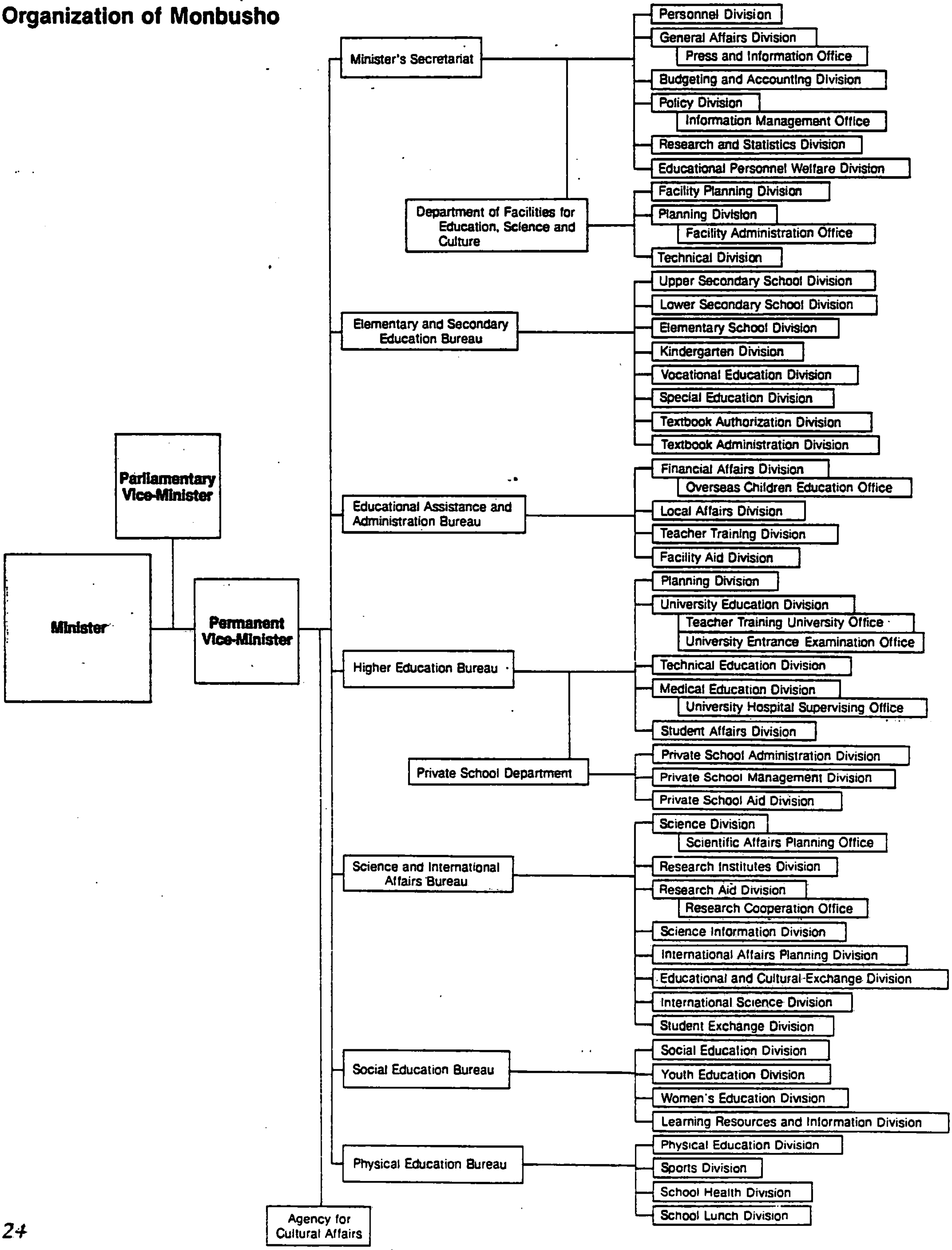
- Monbusho, like other ministries, must adhere to the guidelines and policies of the Council for Science and Technology.

Reference Documents

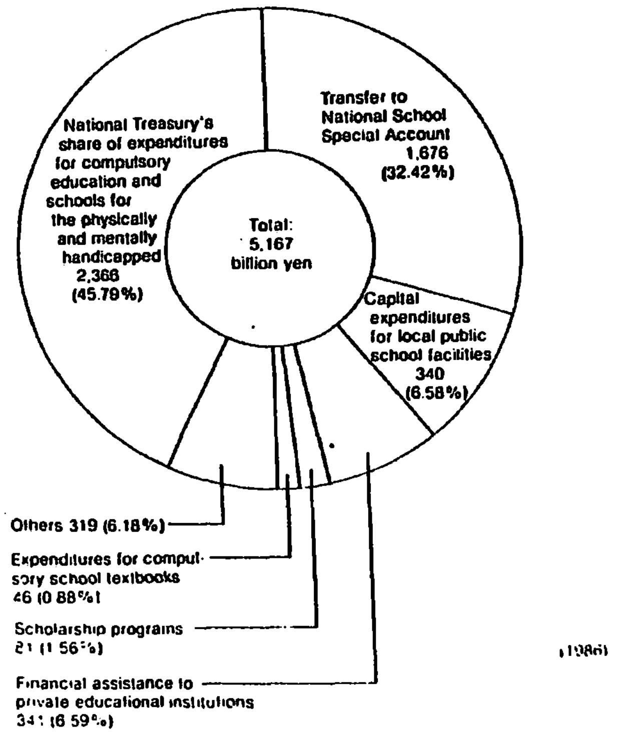
H-1 "The University Research System in Japan", Ministry of Education, Science and Culture (Monbusho), 1986, 24 pp.

H-2 "Summary of Second Report on Educational Reform" (Provisional), National Council on Educational Reform, April 23, 1986.

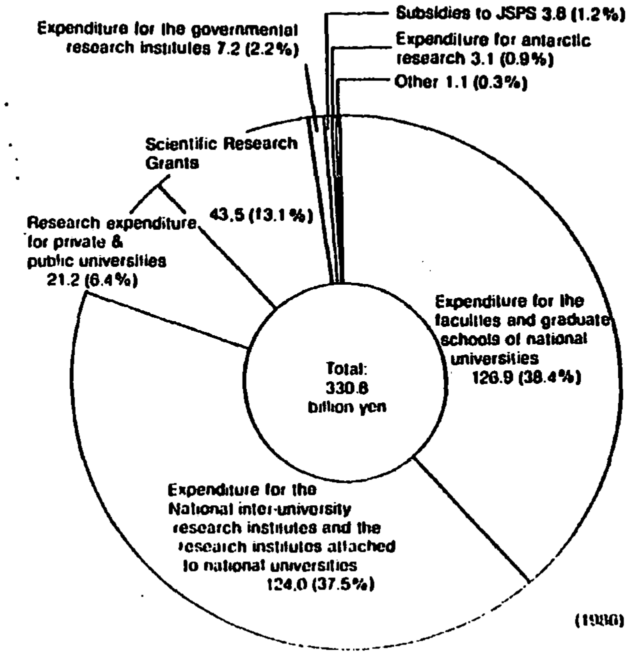
Organization of Monbusho



General Accounts Budget of Monbusho

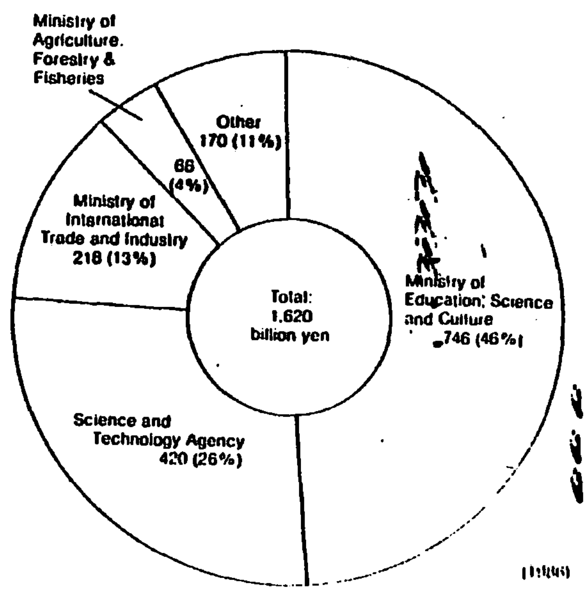


Monbusho's budget for the promotion of scientific research

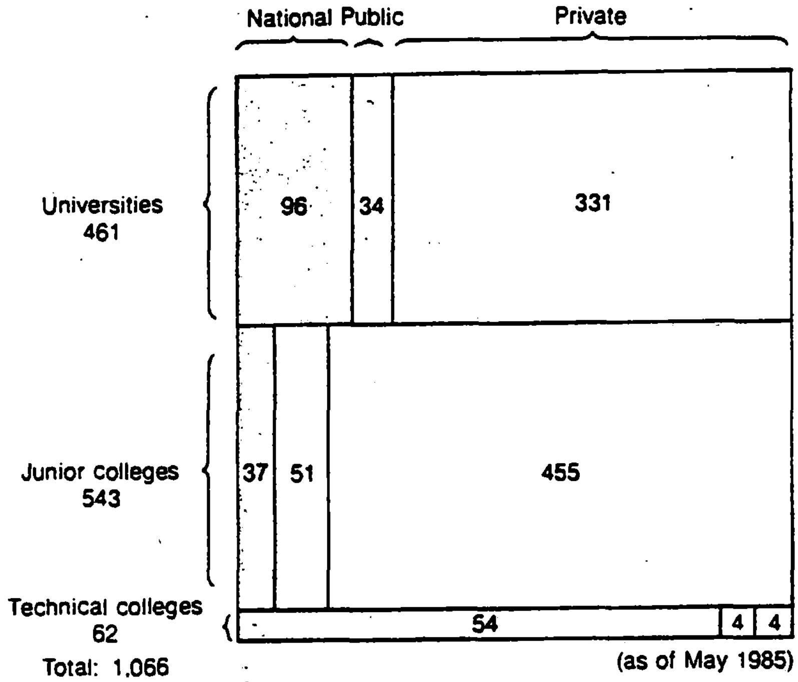


Government budget related to science and technology

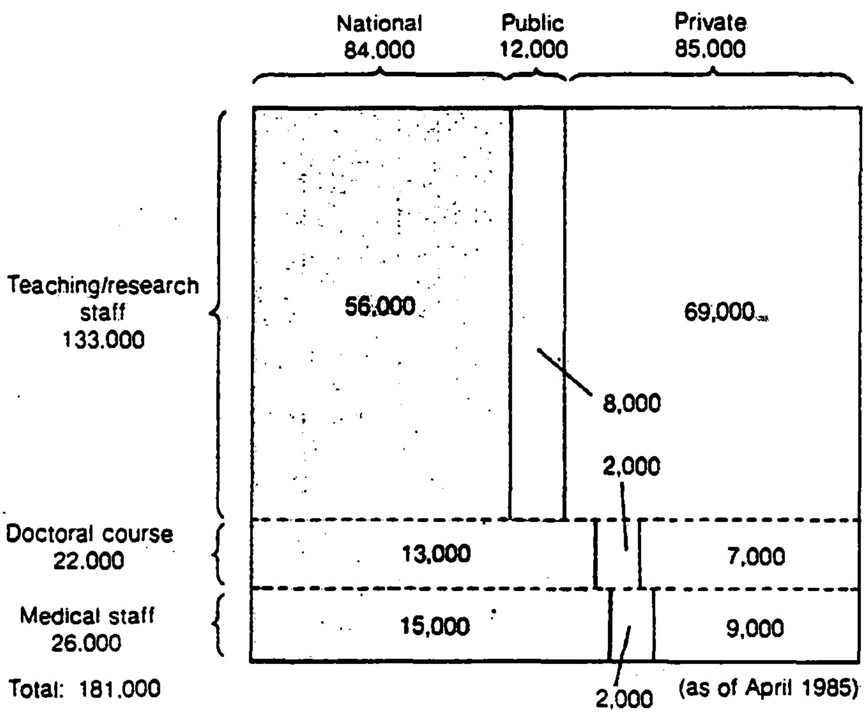
(excluding humanities and social sciences)



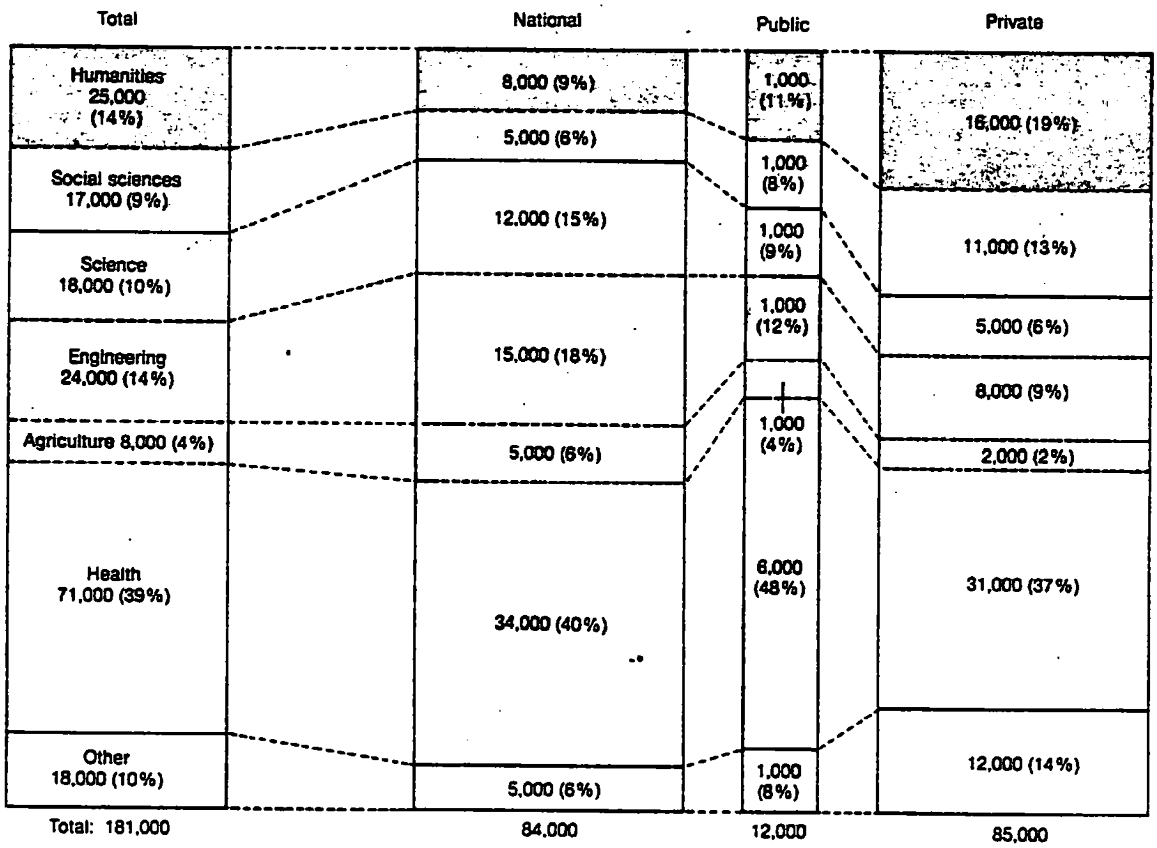
Number of institutions of higher education



Number of university researchers by type of institution

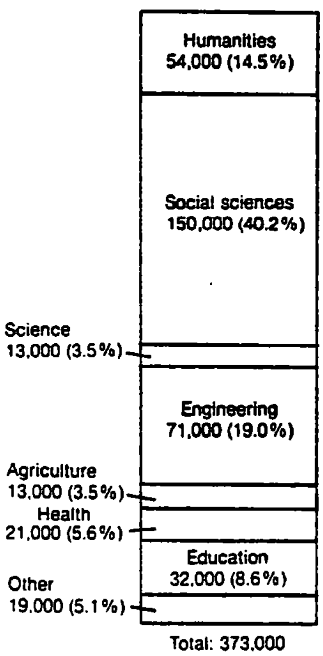


Number of university researchers by field



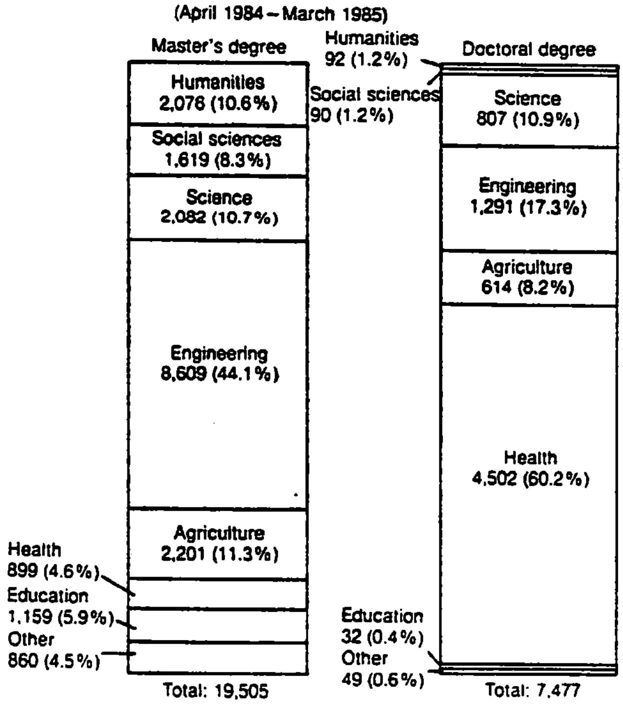
(as of April 1985)

Number of university graduates by field (March 1985)

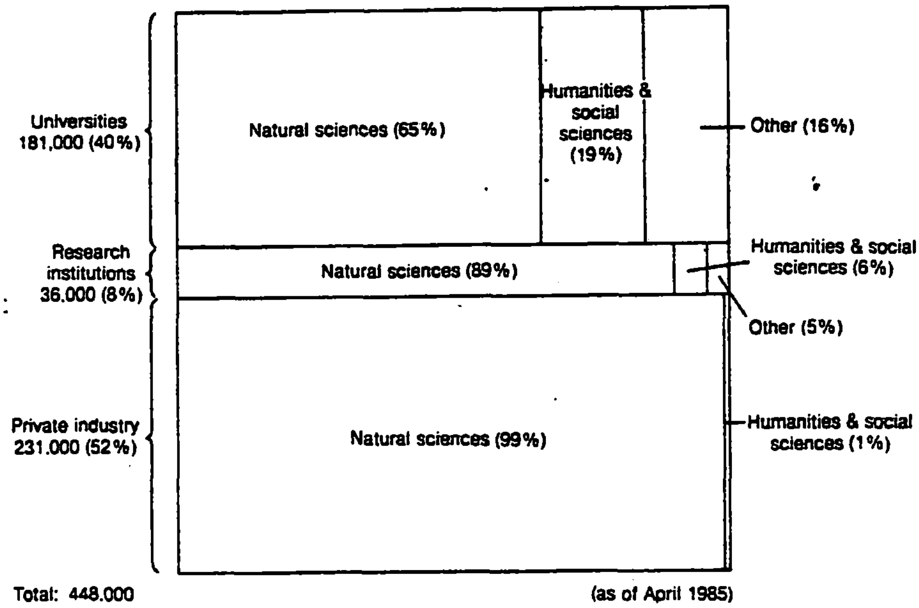


Number of degrees awarded by field

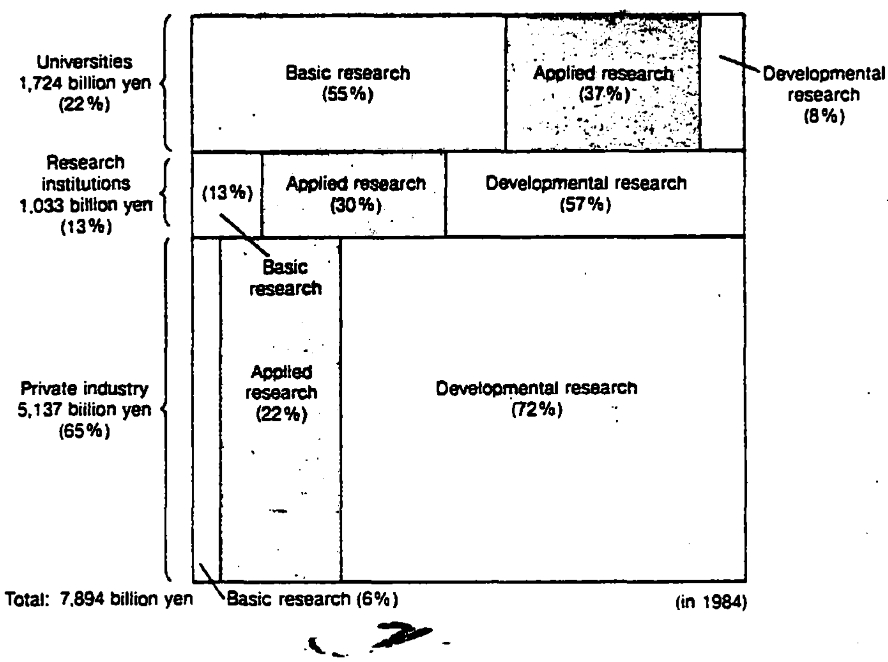
(April 1984 – March 1985)



Breakdown of researchers by sector and by field of science



Breakdown of research expenditure by sector and by type of research



Appendix I

Keidanren
Thursday, June 19, 1986, 13:30 - 14:30

Present: Hiroshi Morikawa
Director, Department of Science and Technology

Yoichi Anzai
Deputy Director

Makoto Watanabe
Staff Economist

Keidanren (Japan Federation of Economic Organizations) is without question the most influential business organization in Japan. It has 120 association and 866 corporate members. Its chairman is sometimes referred to as the "Prime Minister of Japanese Business" and is often consulted by political leaders. In a recent survey, Japanese workers rated Keidanren as more powerful than the Diet or the Cabinet.

The Federation takes public positions on economic issues, advises government, sponsors domestic and international meetings, promotes international business linkages and takes a leadership role in national economic consensus-building.

Keidanren has a Committee on Industrial Technology (Chairman: Sadakazu Shindo, Honorary Chairman, Mitsubishi Electric Corp.) and a Committee on International Investment and Technology Exchange (Chairman: Akio Morita, Chairman and CEO, Sony Corp.).

Highlights of the Discussion:

- The Science and Technology Department collects views and recommendations from industry and transmits these to government provided they are in the national interest and not self-serving.

- The February 1985 issue of the bimonthly Keidanren Review outlines the Federation's position on R&D in Japan (see paper at end of this Appendix. Basically Keidanren the govenment is not pulling its weight in the support of research, and the proportion of R&D done by Japanese industry is too high compared with that in other countries. (To an extent this position appears to be a reaction to the government's stated policy of promoting more fundamental research in the private sector). Recommendations include:

    - a stronger administrative and coordinating role for the Council for Science and Technology;

    - increased government support for fundamental research;

    - improved tax incentives for R&D (current environment is considered less favourable than that in other countries);

- improved patent rights policy for government-owned technology;

- streamlined S&T administration, particularly the removal of institutional baarriers to government/industry/university cooperation;

- promotion of international cooperation.

° The Keidanren also believes better focus is required in R&D spending given the tightening of budgets.

° Japan's defence R&D spending is 60 million yen and increasing (considered small by Keidanren).

° The Keidanren has taken a very active role in the expansion of the Japanese space program for peaceful purposes (see Ref. Doc. I-4); the program is considered to lack focus.

° Lack of military and space-related channels for industrial R&D is considered a weakness in Japan's R&D effort.

° On international R&D cooperation, Mr. Morikawa made the following comments;

  - international cooperation starts with government agreements;

  - the private sector will join under the framework of these agreements;

  - Japan needs more such cooperation to survive;

  - cooperation is more fruitful when both sides have excellent technology to offer.

° As a major function of <u>Keidanren</u> is coordination, it does not set out to take policy positions and lead its members, but instead takes direction from its members.

° Keidanren operates the Japan-Canada Economic Committee (Co-Chairmen: Minoru Kanao, Chairman, Nippon Kokan K.K., David Culver, CEO, Alcan).

<u>Reference Documents</u>

I-1 "Keidanren 1985", 20 pp.

I-2 "Keidanren Review", No. 91, February 1985, (includes articles on industrial robots and R&D policy)

I-3 "Keidanren Review", No. 95, October 1985, (includes article on promotion of life science)

I-4 "Space in Japan 1986-87", Keidanren, 34 pp.

edly.

As for intelligence robots, optical robots such as wire bonders for transistors and ICs and die bonders were produced in large numbers from 1977 to 1979. In other fields, however, development and application of such "smart robots" remains a major challenge.

3. Future Prospects and Challenges

Production of industrial robots is expected to expand rapidly in the years ahead, supported by a combination of demand factors. Specifically, the following factors may be cited:

(1) The mode of production has shifted from mass production to flexible manufacturing with the deceleration of economic growth. At the same time, manufacturers must improve productivity.

(2) The need to save labor has increased, particularly in the manufacturing industry, as a result of the rise in the number of people with a higher education, the decline in the population growth rate and the movement of labor from the secondary (manufacturing) to the tertiary (service) industry.

(3) The availability of young and skilled labor has decreased because the education level has risen.

(4) Both labor and management are calling for the improvement of the working environment and workers' welfare.

(5) The Japanese labor union system, which consists of unions organized on an industry-by-industry and company-by-company basis rather than by trade, creates conditions conducive to the introduction of robots.

Demand for robots came initially from the automobiles and electrical machinery and equipment industries. Robotics cultivated in these industries are expected to develop as basic robot technology for use in other industries such as food, textiles, chemicals, ceramics, building materials, paper and pulp, and rubber. Thus the scope of application is certain to expand.

The development of sensors having functions equivalent to the five human senses, the use of ICs, LSIs and VLSIs and the development of software will lead to the production of new-generation intelligence robots. These robots will be used in the automation of the assembly, testing and measuring processes. Thus demand for industrial robots is likely to grow by leaps and bounds.

According to a long-term forecast made by Japan Industrial Robot Association in 1979, demand will reach ¥290 billion in 1985 and ¥520 billion in 1990 (**Charts 2 and 3**).

These figures, however, represent demand in manufacturing fields. In 1980 the association made a similar estimate for demand in a wide range of non-manufacturing fields, including primary industries, construction and civil engineering, mining, gas, water supply, nuclear power, space development, medical service and welfare, firefighting, garbage and trash disposal, and service industry.

According to this study, demand is estimated to reach ¥6.5 billion in 1985 and ¥66.5 billion in 1990, posting a 10-fold increase in five years. Add these numbers to the manufacturing-industry demand estimates in Chart 3 (¥290 billion in 1985, ¥520 billion in 1990), and total demand will be worth about ¥300 billion in 1985 and about ¥600 billion in 1990. A different estimate puts total demand for industrial robots in 1990 at more than ¥1 trillion. The current long-term demand estimate is being revised.

The development of pioneering robot technology and establishment of related basic technology are essential in order to meet the diverse needs of industrial robots in a broad range of fields. For this reason, expectations are placed in the National Research and Development Program (Large-scale project) of Advanced Robot Technology launched by the Agency of Industrial Science and Technology, an affiliate of the Ministry of International Trade and Industry started from fiscal 1983. Hopes are also pinned on the International Center of Robotics and Flexible Automation (ICORF) to be established in fiscal 1985 to promote cooperation among the government, industry and the academic community.

R&D in Japan: Facts and Tasks of Policy

In the postwar period, Japan introduced advanced technology from the West, improved and adapted it ingeniously to its needs and thereby successfully established a high level of industrial technology for itself. It was this process of technological development that made possible Japan's industrial and economic growth after the last war. Today, Japanese industries have become highly competitive even in high-technology areas such as electronics and numerically controlled machine tools.

Meanwhile, the energy crises of the 1970s brought a large increase in raw material and energy costs, prompting industrial nations to start looking seriously for non-oil, alternative energy sources. Simultaneously, the increasingly acute problem of pollution compelled them to accelerate technology development for environmental control. Technology development today has

This report was prepared by the Science and Technology Department, Keidanren.

thus extended in scope beyond the immediate area of concern to individual businesses and took on wider, social significance.

Also, as Japanese industries grew more competitive, foreign technology became less readily available to Japan. Japanese industries today no longer have an easy access to foreign know-how as in the earlier years. The current trend is increasingly directed to a two-way, rather than a one-way, transfer of technology. Because of such developments, Japan now finds itself placed in a situation where it must step up its own efforts in basic research and development programs, no longer content with imported technology and its refinement.

The perception, in the meantime, seems to persist among Japan's Western trading partners that the government and private industry in Japan are acting as one in pursuing R&D activities in order to make Japanese industries more competitive. The truth is that R&D activities in Japan are carried out primarily by the private sector and not by the government. Here lies a secret of the Japanese industrial and technological vitality; this point does not seem to be widely recognized in other countries. This article will outline the actual status of R&D activities in Japan.

Some Features of Japan's R&D

R&D outlays in Japan totaled ¥7,180.8 billion ($30.6 billion) for fiscal 1983, most of which was concentrated in the field of natural science ($27.6 billion as against $2.8 billion in social sciences). Total R&D expenditure in fiscal 1983 is equal to 2.58 percent of the GNP. Compared with other advanced countries, the level of Japanese R&D outlays is equivalent to about one-third of U.S. spending in this area and roughly on a par with that in the Soviet Union. Japanese R&D outlays exceeds those in West Germany, France and the U.K. As percent of the GNP, the Japanese disbursement is roughly similar to that in major Western countries while exceeded by those of the Soviet Union (3.66 percent of the GNP).

In the field of natural sciences, Japan has as of April 1, 1984, 370,000 researchers, of whom 220,000 were employed by private businesses. The number of Japanese natural science researchers totaled 340,000 in 1983, only behind those in the Soviet Union (1,430,000 for 1981) and the U.S. (720,000 for 1982). The Soviet Union by far leads other nations in the number of researchers per 100,000 of population (53). The figure for Japan is 29 and close to 31 for the U.S. (Table 1). But the problem of human resources for R&D lies less in numbers than quality. For this reason, the opinion is gaining ground here that the Japanese educational system should be improved so that it emphasizes creativity from childhood onward to secure talented people or human resources indispensable to development of original technology.

While Japan is similar to major Western nations in the ratio of R&D expenditure to the GNP and the number of researchers per 100,000 of population, it falls far behind them in one area — the government's share of the national total far R&D expenditure. It is limited to a small 23.6 percent (fiscal 1982, natural science) in Japan, compared with 46.1 percent for the U.S. (US FY1982), West Germany (43.5 percent, FY1982), 57.8 percent for France (FY 1982) and 49.8 percent for the U.K. (FY1981) The situation remains much the same when defense-related expenditure is excluded; the government share of the national R&D outlays minus defense-related items is 23.1 percent for Japan, 30.1 percent for the U.S., 41.4 percent for West Germany and 47.6 percent for France. This relates to the fact that R&D spending by the government is on an extremely low level even in the defense-related field. The ratio of R&D outlays to the total defense expenditure is 1.5 percent for Japan, compared with 11.0 percent for the U.S., 12.4 percent for the U.K., 4.1 percent for West Germany and 12.1 percent for France.

In the case of Japan, government R&D funding flowing to the private sector is also small in volume. It was ¥70.2 billion ($282 million) in fiscal

Table 1 R&D Expenditures as Percent of GNP, Number of Researchers — an International Comparison

Countries	F.Y.	Total R&D outlays ($ million)	Percent of GNP (%)	Number of researchers (1,000 persons)	Per 100,000 of population
Japan	1983	30,557	2.58	342	29
U.S.	1983	87,863	2.64	732	31*
U.K.	1981	12,247	2.42	87	15**
W. Germany	1982	18,370	2.79	128	19
France	1982	11,670	2.05	85	16
Soviet Union	1981	32,577	3.66	1,432	53

Sources: Office of Management and Coordination Agency: "Survey on Science and Technology Research, a Summary"; Science and Technology Agency: "1983 White Paper on Science and Technology."

Note: * The U.S. figures for the total number of researchers and their number per 100,000 of population are for 1982.
** The similar U.K. figures are for 1979.

1982, compared with ¥4,764.8 billion ($19.1 billion) in the U.S. and between ¥200 billion ($10 billion) and ¥400 billion ($20 billion) for Western European countries. As a result, governmental contribution to the total R&D funds spent by the private sector is limited to a mere 2 percent in Japan, while it is over 15 percent for the major Western countries (Table 2).

Table 2 Share of Government Contribution To R&D Spendings by Private Industry — an International Comparison

Countries, F.Y.		Total in absolutes ($ million)	Percent of total private industry spendings (%)
Japan	1982	282	1.7
U.S.	1982	19,136	32.3
W. Germany	1981	1,949	16.9
France	1981	1,642	24.5
U.K.	1978	1,293	29.2

Source: Science and Technology Agency, "1983 White Paper on Science and Technology"

In the light of the inadequate contribution by the government to R&D investment in Japan, for a long time Keidanren has been urging the government to shoulder a greater share of the burden. Increased government expenditure, in Keidanren's view, is necessary for two objectives — boosting basic researchs carried out by universities and public research institutions, as well as pioneering and basic projects in high-priority areas not adequately covered by private businesses. The latter includes aviation, space, ocean, life science, nuclear energy, safety and anti-disaster projects, information, new elements and ultimate materials, etc.

In response, there has been increased emphasis in recent years on basic research in areas such as new energy, new materials and biotechnology by the Science and Technology Agency, the Ministry of Agriculture, Forestry and Fisheries.

Tasks of Science and Technology Policy for Future

(1) Science and Technology Policy in Japan

In Japan many government departments are involved in the affairs of science and technology. Citing agencies spending $4.5 million or more a year in budgted outlays on science and technology alone, there are as many as eight. They are the Science and Technology, Defense agencies, Education, Welfare, Agriculture, International Trade and Industry and Transport ministries. Providing overall coordination of policies and operations among the many agencies is the Science and Technology Council chaired by the prime minister. Considering the fact that different government agencies responsible for science and technology affairs are being called upon to work together on a cross-departmental basis in an expanding area of R&D activities, the industrial community desires to see stronger coordinating function of the council. The council last November adopted a recommendation setting forth the basic direction of Japan's science and technology policy for the next 10 years.* Listed as a goal of that policy is, first, strengthening basic research and what is called the infrastructure for technology development. Japan is thought to need such efforts if it is to positively promote creative accomplishments in science and technology as one of the leading world powers in this field of endeavor. Second, the recommendation rejects science and technology development for its own sake and reaffirms that science and technology ought to benefit human beings and their society. It calls for improved understanding of human nature and a harmonious development of science and technology with such an understanding. Third, it is held likely that Japan will be asked to bear an ever increasing share of the responsibilities as a member of the world community. The policy recommendation emphasizes an internationalist approach, advocating that Japan must offer her technological capabilities to the benefit of the international community in the future.

(2) Strengthening of R&D assistance by governemt Essential to successfully promoting original technology development in Japan is the creation of a kind of environment that encourages the private sector to give full play to its R&D potential. The government can do a great deal to help bring into being such a better climate for private R&D activities, for example, by offering an improved system of tax incentives. Special taxation measures offered to private businesses' R&D in the fields of science and technology are estimated to reduce their corporate income tax burden by 32.5 percent in the U.S. and by 64.6 percent in the U.K. By contrast, the tax relief is limited to only 2.6 percent in Japan. There is today a tax credit system in Japan for increased expenditure on R&D. Under this system, 20 percent of an increase in such outlays over the largest amount recorded previously is to be credited against the corporate income tax payable. But the amount of tax credit is subject to a

* "On Comprehensive Measures for Promotion of Science and Technology in Response to New Situational Changes and Based on a Long-Term Outlook," Science and Technology Council, November 1984.

ceiling which is one-tenth of the income tax due. In the U.S., where this Japanese tax incentive for R&D has been emulated, however, corporations are entitled to a tax credit of 25 percent of an increase in R&D investment over the average level of such expenditure for the previous three years. There is no upper limit to the amount of tax credit. Clearly, the American scheme is more advantageous to corporate taxpayers than is the Japanese system.

Strong hopes have been expressed for some time now by the Japanese industrial community for more tax incentives for research and development. The Japanese government, partly accommodating such requests, plans to launch in fiscal 1985 a new tax credit system for R&D investment in technologies of a pioneering kind and of basic importance to industry, including new materials, biotechnology and electronics. This scheme offers, when a set of specified requirements is met, a 7 percent tax credit on the value of new assets acquired by corporations for R&D purposes. The ceiling is set at 15 percent of the corporate income tax due for the combined tax credits resulting from the new system and the existing scheme for increased R&D expenditures.

One of the problems undermining private business willingness to undertake R&D activities uner contract with the government has been the rule that patent rights accruing from such government-commissioned R&D projects belong to the government. This problem also poses an obstacle in the way of cross-licensing between Japan and other countries. In the U.S., the direction of policy is such as to confer upon private contractors patent rights arising from government-awarded R&D contracts.

In this regard, Keidanren has been working for some time at the government to effect an improvement in the handling of patent rights with respect to government-commissioned work in R&D. As a result, study has been initiated by the government to make it more attractive for private companies to participate in government-financed R&D projects. It seems on the whole that there is still considerable room for improvement in the mode and extent of government assistance for private R&D activities in Japan.

Another important task of policy is to improve the infrastructure for R&D. For instance, much more will have to be done to accelerate the development of data bases and secure supply in genetic resources, both being areas of R&D where Japan lags behind Western countries.

(3) Collaboration among industry, government and universities

A key to promoting creative technology development is to expand and improve basic research in universities and public research institutions and feed back the fruits of such basic research to private industry. At present, the flow of private business funds to domestic universities is no more than ¥12 billion ($50 million), whereas much more, or ¥31.4 billion ($130 million) in R&D money is channeled to foreign research institutions, including universities. This marked imbalance in the allocation of private R&D funds between the institutions at home and abroad, obviously needs improvement. Major impediments to collaboration among private industry, the government and academia in R&D activities, particularly between industry and academia, are, first, a gap in attitude (consciousness), second, a lack in personnel exchanges and, third, the existence of institutional barriers. While the prospect of solving the first two problems might be small, alleviating the third problem of institutional barriers separating private industry and universities can be faciliated by positive government action. Keidanren has repeatedly pointed to the need for such action.

Defferent government agencies, as a result, have started taking steps, albeit gradually, toward removing the institutional wall. For instance, the Education Ministry, which is responsible for administering state universities, opened the way in 1983 for university and private industry personnel to participate in joint research projects. Also, an improvement was effected last year in the existing system for university researchers to engage in research financed by private industry, so that incentives may be increased for the private donor. Likewise, the Ministry of Agriculture, Forestry and Fisheries last year started providing active assistance to joint research projects in which personnel from both private industry and public research institutions take part.

(4) Promotion of international cooperation

We are confronted today with problems of resources, energy, food, environment and population, all of which demand solutions on a global scale. Hence the urgency of international cooperation in each problem area. Technology and science, no doubt, have a large role to play in grappling with each of these awesome challenges. There is increasing recognition that Japan must beef up its contribution as an economically advanced nation to sustaining and improving the well-being of the international community, making use of its capabilities in the science and technology.

The government for its part is taking positive steps toward accelerating international cooperation in several areas. Participation in superlarge international R&D projects, like space programs and nuclear energy, is one example. Accepting an increased number of foreign researchers and promoting technical assistance to developing countries are further demonstrations of Japanese readiness to step up international cooperation in science and technology.

Appendix J

NGK Spark Plug Co. Ltd., Nagoya
Friday, June 20, 1986, 14:00 - 16:00

Present: Masao Sasaki
General Manager, Sales Dept.

Masashi Furuta
Assistant Manager
Overseas Sales Section

Masakazu Watanabe
Research Engineer, Research Dept.

Toru Shimamori
Senior Engineer, Research Dept.

NGK has 70% of the domestic spark plug market and 20% of the world market (covering 140 countries). Based on technology for the producton of spark plugs, the company has been manufacturing technical ceramic products for industrial use since 1949. Sales of ceramic products now account for half of total sales, and include a wide range of structural and functional products. The company is one of the leading companies in this field in the world. The Ceramics Division, selling under the NTK brand, is now considered the backbone of the company, and the basis for future growth. Net sales in 1985 were 81 billion yen, up 23% over the previous year. The company has a sales office in Toronto. I was given to understand that the company has a policy of not entering into international joint ventures or partnerships to develop technology.

While the company produces a wide range of alumina and PZT products, nonoxide ceramics are the focus of current R&D. Particularly active areas are multilayer and highly integrated packages for semiconductors, nonoxides for automobile engine parts, bioceramics, and new applications for piezoelectrics.

Much of the time at NGK was spent viewing and discussing products in the products display.

Discussion focussed on information which was subsequently provided in the Reference Documents J-1 through J-3.

Reference Documents

J-1 "NGK Spark Plugs, New Ceramics NTK", 17 pp.

J-2 "NTK Technical Ceramics", NGK Spark Plug Co. Ltd., 20 pp.

J-3 "NGK Spark Plug Co. Ltd., Annual Report 1985", 17 pp.

Appendix K

Engineering Research Association for High-Performance Ceramics
Monday, June 23, 1986, 10:00 - 11:30

Present: Minoru Uki
Senior Managing Director

Akio Nagahiro
Managing Director

This association was established in 1981 by 15 leading Japanese companies in various aspects of industrial ceramics. The companies have essentially organized to perform a 10-year national R&D program under MITI's R&D Project of Basic Technologies for Future Industries. The Association is one of about 50 Engineering Research Association currently operating under the terms of the 1961 Law on Mining and Manufacturing Research Consortia. Six government laboratories and four universities are involved in the association's program.

The program has very specific goals for the development of advanced ceramics (Table K-1). The work is divided into three fields: manufacture, evaluation and application (Figure K-1). The program is outlined in a recent paper by Mr. Nagahiro (Reference Document K-2).

Highlights of the Discussion:

- The association functions as a moderator of a program carried out by several private companies, and handles the distribution of funds recieved from MITI (and predetermined by MITI) to the participating companies and universities. The arrangement reflects MITI's preference to deal with associations rather than individual companies.

- Several evaluation committees composed of private sector and university researchers have been set up to evaluate the progress of the research.

- All R&D funds come from MITI; the companies make no direct contributions of funds except to cover administrative costs. The association, on behalf of and in cooperation with the member companies, makes representations to MITI for funds.

- It is difficult to say exactly how the Association started. The priority on fine ceramics was set by MITI/AIST, which then identified fifteen leading companies to participate in the R&D. These companies were asked to form an association to receive the funds.

- The structure of all Engineering Research Associations is similar.

- The main reason companies join is to gain access to government R&D funds through an association that deals with the bureaucratic process. The companies are competitive but the association promotes the exchange of generic information in its role as a moderator. The advantages of membership outweigh the commercial risks associated with sharing information.

- Involvement in the national project is believed to enhance the credit rating of the company.

- Membership is theoretically open, but there is no plan to change the current roster. It is believed that a company must be incorporated in Japan to become a member. Theoretically, then, a subsidiary of a foreign company could join. It is unlikely, however, that MITI would select such a subsidiary to be a founding member of such an association, and my impression is that the membership is difficult to change later.

- The Association has no formal links with other countries' associations.

- There is also no formal relationship with the Japan Fine Ceramics Association although the two may cooperate, for example in holding meetings. While both organizations promote R&D, their roles are decidedly different.

- The Association has no explicit role in international research collaboration.

- Strictly speaking there is no membership fee. However, each year operating costs of the Association are estimated and the companies are asked to share these in proportion to the amount of funds each receives from the government.

- The Association doesn't sponsor visits overseas but might assist (informally) in making arrangements.

- Total permanent staff is 5.

<u>Reference Documents</u>

K-1 "Outline of the Engineering Research Association for High-Performance Ceramics", 6 pp.

K-1 "Present Status of the National Project of R and D of Fine Ceramics" by Akio Nagahiro, Engineering Research Association for High Performance Ceramics, FC Annual Report 1986, pp. 61-66.

Table K-1

Table 1. Objective of Performance Properties of Fine Ceramics

Classification	Objective	Values
High strength materials	≧1200℃, in air, after 1000 h holding. Weibull modulus	$M \geqq 20$
	Average tensile strength	$\bar{\sigma} \geqq 30$ kg/mm²
	1200℃, in air, after 1000 h continuous loading. Creep rupture strength	$\bar{\sigma} \geqq 10$ kg/mm²
Corrosion-resistant materials	≧1300℃, in air, after 1000 h holding. Weibull modulus	$M \geqq 20$
	Corrosion resistance (weight gain)	≦1 mg/cm²
	Average tensile strength	$\bar{\sigma} \geqq 20$ kg/mm²
Wear-resistant materials	Room temperature. wear resistance	≦10^{-9}mm³/kg·mm
	surface flatness	$R_{max} \leqq 2$ μm
	800℃, in air, after 1000 h holding. Weibull modulus	$M \geqq 22$
	Average tensile strength	$\bar{\sigma} \geqq 50$ kg/mm²

Figure K-3

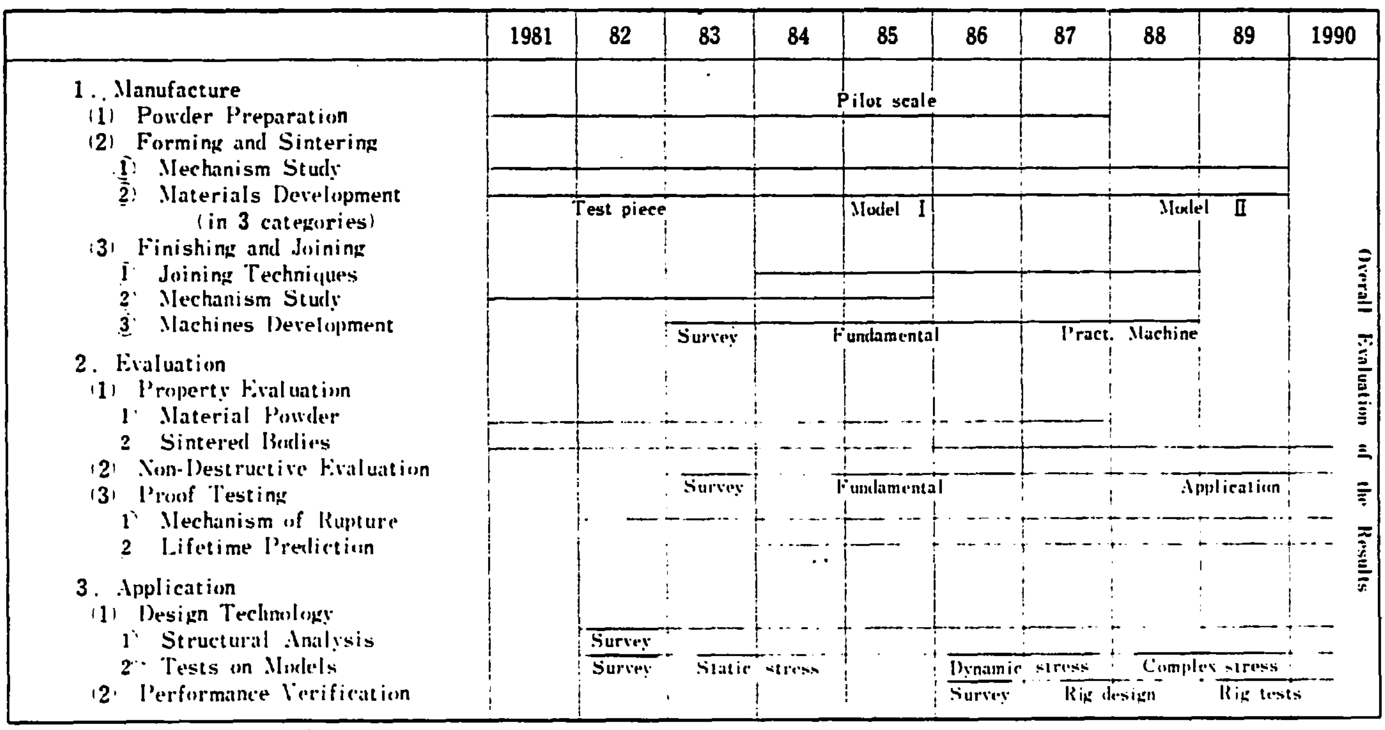


Fig. 1 Total Schedule

Appendix L

a. **Research and Development Institute of Metals and Composites for Future Industries**
Monday, June 23, 1986, 13:30 - 15:00

Present: Hajime Nishimura
Executive Director

Peter Eggleton
Counsellor for Science and Technology
Canadian Embassy

This Institute performs functions very similar to those of the Engineering Research Association for high performance ceramics, but with some notable differences.

The Institute was formed in 1981 as a "juridical foundation", not a research association under the 1961 law. Thus it has an unlimited life and a slightly different administrative structure. Like the Engineering Research Association, its present functions are related to the R&D Project of Basic Technologies for Future Industries; however, the concept for this Institute predated that project.

There are 32 supporting members. Most of the research is carried out by 12 of these companies, often in collaboration with one of six government laboratories.

The Institute essentially functions as a single contractor with MITI on behalf of its members (MITI prefers not to contract with individual companies). The Institute receives a generic "request for proposals" from MITI and negotiates performance of the research with member companies. Each company prepares a proposal of its own and these are rolled up into a single proposal by the Institute. The proposal delineates in detail the role of each participating company. The Institute then signs a contract with MITI and subcontracts all the work to the members according to the original proposal. The Institute has no authority to alter the allocation of funds or the content of subcontracts after the contract with MITI has been signed.

Essentially the Institute functions as a vehicle and mediator for MITI's support of R&D. The concept forces a certain discipline on the industry, requiring the leading companies to get together to decide on R&D programs and performers. Presumably it also reduces duplication.

The contracting arrangement for FY 1985 is shown below. The table shows that the Institute itself sponsors some R&D (through separate subcontracts).

	Alloys	Composites
*Contract with MITI	4.032	4.734
*Companies' research projects	3.852	4.554
*Institute research projects	7	12
No. of participating companies	0.180	0.180
*Millions of Canadian Dollars		

Administrative costs of the Institute are covered by the interest on the original fund (donations from 17 founding member companies) and by membership fees collected from the companies.

Other Highlights of the Discussion:

- Swedish scholars have visited the Institute and are "very interested".

- MITI's program of wholely supported contract research in fundamental technologies essentially started in 1966. Two to three years prior to the initiation (in October 1981) of the R&D Project of Basic Technologies for Future Industries, discussions began about the need for R&D cooperation in metals and composites. The Institute was formed two months before the launching of the project.

- Five cooperative research groups have been formed under the Basic Technologies R&D Project. Three are Engineering Research Associations and two are foundations.

- Technology developed under the contract program is owned by the government.

- The concept forces companies to collaborate in the national interest.

- There are no plans to take on new members as subcontractors, but new "general members" are welcome.

Reference Documents

L-1 "New Materials: Metals and Composites", Outline of the Research and Development Institute of Metals and Composites for Future Industries, December 1984, 8 pp.

Appendix M

Japan Fine Ceramics Association (JFCA)
Tuesday, June 24, 1986, 10:00 - 11:00

Present: Masatoshi Shiota
Secretary General

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

The JFCA, established in July 1982, is an association of about 200 companies representing producers, processors and users of fine ceramics as well as equipment suppliers. Trading companies and banks are involved as associate members (banks being represented by their "R&D" people, who of course are interested in investment opportunities). Regular members' annual fee is $3,600; that for associates is $1800.

The objective of the JFCA is formally stated as "to contribute to the development of the national economy by laying the foundation for a fine ceramics industry through exchanges of information, improvement of technologies, diffusion of fine ceramics and diversification of applications."

The following activities are under way or planned:

- research and development;
- information collection and exchange;
- compilation and dissemination of statistics on markets and technological trends;
- standardization of products and test methods;
- international exchanges and cooperation;
- negotiation and coordination with government agencies; and,
- cooperation and coordination with associated organizations.

The discussions indicated that actual activities are much less extensive than this list would imply. To date the activities have been almost entirely of a study and information exchange nature. A number of seminars and meetings have been held, and several reports issued, including an excellent annual collection of papers entitled "Fine Ceramics for Future Creation" (see table of contents, Table M-1).

Highlights of the Discussion:

- It is hard to say exactly how the association started. Its actual beginnings about 7 or 8 years ago were related to MITI's encouragement of the industry to take a longer-range view in fundamental technologies.

- The JFCA doesn't do any R&D; its role in this sphere is informational.

- There are no formal links with the Engineering Research Association for High Performance Ceramics.

- Concerning standardization, JFCA is concerned with on-going business needs, and best practice given present standards; future standards are the role of the Japan Fine Ceramics Center.

- Foreign subsidiaries with a major operating subsidiary in Japan can belong.

- The JFCA provides no official representatives to MITI committees or councils but has many informal links.

- Strategic partnerships (both domestic and international) are on the increase.

- The Association doesn't take part in the formation of partnerships but might act as a catalyst.

- The JFCA deals only with MITI, not directly with other ministries, except for specific contacts with agencies such as the Ministry of Labour on health and safety.

Reference Documents

M-1 "JFCA: Creating a New World Through Fine Ceramics", 14 pp.

M-2 "Fine Ceramics for Future Creation", FC Annual Report for Overseas Readers, 1985, Japan Fine Ceramics Association, March 1985, 36 pp.

M-3 "Fine Ceramics for Future Creation", FC Annual Report for Overseas Readers, 1986, Japan Fine Ceramics Association, April 1986, 76 pp.

CONTENTS

"Fine Ceramics for Future Creation" 1986 JFCA Annual Report for Overseas Readers

Appendix N

Japan Fine Ceramics Center
Tuesday, June 24, 1986, 11:00 - 12:30

Present: Dr. Eikichi Inukai

Dr. Satoru Kurita
Director
Office of New Diamond Forum

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

Established in May 1985, the Japan Fine Ceramics Center will carry out R&D, testing, and standardization on fine ceramics, promote industry/govenment/university cooperation, establish data bases, and provide education and training. A $10 million laboratory building is being constructed in Nagoya. I visited the Tokyo office.

Initial capital is:

Donations by industry and organizations	Yen 5.9 billion
Subsidies by local governments	4.6
Subsidies by other public sector sources	0.5
Total	Yen 11.0 billion

Organization of the research groups is shown in Table N-1.

Projects already established include:

- development of components for light water nuclear reactor (under MITI auspices);
- development of corrosion-resistant materials and sealing technologies (Petroleum Corporation and Metal Materials R&D Center);
- survey of fine ceramics industry for 1985 (MITI);
- survey of foreign institutes involved in fine ceramics R&D and testing.

Work will begin in 1987 with 40 research personnel. Eventually staff will total 100-150.

The Center is established as a foundation, with a board of directors composed mainly of CEO's of leading associations and companies in the ceramics field.

Other Highlights of the Discussion:

- The Japan Fine Ceramics Association may have "fathered" the JFCC (although it did not originate the concept) but the formal relationship between the two organizations has yet to be worked out.

- The Center will serve the combined objectives of national policy and regional industrial development. It is located in Nagoya to be close to certain industries. Land was donated by the City of Nagoya.

- In addition to interest on the esablishing fund, revenues will come from fees for test services, selling data bases, charging for surveys, etc.

- The Center might have been established as a corporation but then could not have accepted the donation of the land.

- Dr. Shimizu is on assignment with the JFCC for several months. He also has a close relationship with Canadian embassy staff and serves as a sort of ambassador for Canada and adviser to Canadian visitors.

Reference Documents

N-1 "Japan Fine Ceramics Center", 8 pp.

N-2 "Japan Fine Ceramics Center (JFCC)", 5 pp.

Japan Fine Ceramics Center

Group Name	Responsibilities
Chemical Properties Research Group	Chemical Composition Analysis Microanalysis Microstructural Analysis Surface Analysis Bonding Analysis Others
Physical Properties Research Group	Electrical Properties Magnetic Properties Optical Properties Others
Mechanical Properties Research Group	Fracture Dynamics Instantaneous Fractures Delayed Fractures Defect Investigation Thermal Constants Thermal Shock Resistance Corrosion Resistance Others
Manufacturing and Processing Methods Research Group	Synthesis and Evaluation of Raw Powders Molding and Sintering Machining and Joining Others
Information Service Research Group	Establishment of Data Base

Appendix O

Isuzu Motors Limited, Fujisawa
Tuesday, June 24, 1986, 14:30 - 16:00

Present: Hideo Kawamura
Manager
Engine Development Research Center

Peter Eggleton
Counsellor for Science and Technology
Canadian Embassy

Hiroshi Shimizu
Ontario Research Foundation
(Japan Fine Ceramics Center)

The subject of this visit was primarily Isuzu's ceramic diesel engine which is being developed under the direction of Mr. Kawamura. The project is conducted under an arrangement with Kyocera, which supplies ceramics expertise and has its own test engines. Details are given in Reference Document O-1.

Highlights of the Discussion:

- Isuzu has installed the adiabatic prototype engine in a test automobile, which I drove. It is noisy and smoky, but compact and easy to service (no liquid coolant system). The exterior is done in a 4" x 4" ceramic tile motif.

- The engine has now been tested for 3500 hr.

- The program involves the incremental addition of more ceramic components as testing proves successful. (It is expected also that this incremental, evolutionary learning-by-doing approach will be used at the commercial end as well. This is a contract to the less successful U.S. approach of attempting to create a fully ceramic engine in one program.)

- The engine has multi-fuel capability and no need for coolant.

- The best-performing fuel is alcohol. Isuzu is also testing diesel/alcohol blends, heavy oil and low-quality diesel. NASA is doing tests using pulverized coal.

- The engine has been proven at an equivalent road speed of 130 km/h. Isuzu is trying to improve the performance to 200 km/h.

- An all-ceramic valve has been tested for 500 hr. at 600 rpm. A 300-hr piston ring test is now underway.

- A new joining system for piston parts is being developed.

- A ceramic exhaust manifold consists of alumina fibre wound around stainless steel tube.

- The valve is a critical part because it is subjected to so much stress.

- The glow plug used consists of a tungsten wire embedded in ceramic sintered by hot pressing. It has been a standard production item since 1981.

- The hot plug used in the precombustion chamber has been produced since 1983.

- Temperature of the piston is 800° C at the crown, 200°C at the bottom.

- The engine is fitted with an energy recovery system consisting of a super high speed (100,000 rpm) generator producing 10 kW; the system is important in part load and stop-and-go traffic.

- Friction and the compatibility of sliding parts are very important; they are affected by differences in grain sizes and binders, among other things.

- A major problem is the cost of ceramics: 5000 yen/kg versus 100 yen/kg for metal.

- Isuzu's plan is to complete the development by 1990, gradually increasing the numbe of ceramic parts.

- Metal/ceramics joining techniques represent a key technology.

- Development work has been done on a ceramic turbocharger but cost is a problem. Nissan has already introduced such a turbocharger (manufactured by NGK) on certain production vehicles, but according to Isuzu, Nissan lags in work on ceramic parts and has introduced its turbocharger to gain a marketing edge and put itself on a fast development track.

- According to Mr. Kawamura performance improvement from the use of ceramics in the turbocharger is very limited. Yield in production is low (70-90%), but reliability is acceptable for parts that pass.

- The relationship with Kyocera began about ten years ago. Some difficulty might be expected as there is apparently a view in the upper ranks of Isuzu that Isuzu should eventually make its own ceramic components.

- Mr. Kawamura will visit Canada in September to present seminars at the Ontario Research Foundation (Sept. 19) and the Transportation Development Centre in Montreal (Sept 22).

Reference Documents

O-1 "The Development Status of Isuzu's Ceramic Adiabatic Engine", 20 pp.

Appendix P

Kyocera Corporation
Wednesday, June 25, 1986, 10:00 - 11:30

Present: Ryusho Nagai
Manager, Tokyo Office

This meeting was rather informal. As Kyocera is well known to the Canadian ceramics community and Canada seems to be well known to Mr. Nagai (who lived in the United States for 18 years), most of the discussion was mostly on general trends and issues in Japan and Canada. In response to Mr. Nagai's questions I explained at length the organization of science policy development in Canada, the role of MOSST, and my own responsibilities.

The Kyocera story is quite remarkable. The President, Kazuo Inamori, started in 1959 with little more than a pottery kiln and 28 employees. In 1985 net sales reached 326 billion yen (about 3 billion dollars).

The company produces a wide range of advanced ceramic products. Recently it has broadened its strategy by becoming involved in the manufacture and sale of systems and products that use its ceramic components. In 1983 it merged with Yashica Ltd., the camera company, with a plant in Ontario. It has an arrangement with Sony to produce a small video camera which contains several Kyocera components and is marketed in North American under the Kyocera name. The company is heavily involved in solar energy systems and has its own solar energy research center.

A few other Observations from the Discussion:

- Kyocera is known to many Canadians as the producer of ceramic consumer products such as knives and scissors. These are aimed mainly at the up scale gift market. The company hopes to familiarize consumers with ceramics and to gain valuable experience in the household market. Ceramic scissors sell for about $30 Canadian and up.

- Kyocera has been on a major expansion program in the United States and recently opened a plant in Vancouver, Washington. This, I learned subsequently, is the subject of much interest and some concern in the U.S. The company plans eventually to build three more plants and an R&D Center in the area.

- The rising value of the uen is the cause of concern, and may mean future company expansions will have to be located overseas (Canada?).

- Like many companies in the materials fields, Kyocera has formed a number of strategic partnerships as part of its worldwide growth and diversification strategy. These include:

- joint venture with Philips to supply data communications network systems in Japan;
- formation with 24 other companies of Daini-Denden, a Japanese telecommunications company;
- merger with Yashica, including the Contax and Zeiss brand names.

Reference Documents

P-1 "High Technology Kyocera", 34 pp.

P-2 "Kyocera Corporation Annual Report 1985", 40 pp.

A Brief History of Kyocera Corporation

1959 • Kyoto Ceramic Co., Ltd. founded as a manufacturer of fine ceramics. Employees: 28. Capital: ¥3 million.

1963 • Shiga Gamo Plant constructed.

1969 • Kagoshima Sendai Plant constructed.
• Kyocera International, Inc. established as a sales company in Sunnyvale, California, U.S.A. Capital: $4,000.

1970 • Initial production of multilayer ceramic packages for ICs.

1971 • Joint venture company, Feldmühle Kyocera Europa Elektronische Bauelemente GmbH established with Feldmühle AG of West Germany. Capital: DM2,000.
• Fairchild Camera and Instrument factory leased in San Diego, California, U.S.A. and manufacturing activities begun for Kyocera International, Inc.
• Company stock listed on Osaka Stock Exchange, Second Section, and Kyoto Securities Exchange.

1972 • Head office relocated to Yamashina-ku, Kyoto.
• Kagoshima Kokubu Plant constructed.

1973 • Capital increased to ¥1,044 million.
• CERATIP ceramic cutting tool bits developed.
• Semiannual sales of the parent company first exceeded ¥10,000 million. Annual sales of the parent company: ¥23,900 million. Net profit: ¥4,400 million. Employees: 2,000.
• Recrystallized emerald developed and marketed as "Crescent Vert Emerald".

1974 • Company stock listed on Tokyo Stock Exchange and Osaka Stock Exchange, First Section.

1975 • Factory of Honeywell Inc. purchased in San Diego, California, U.S.A. and head office and plant of Kyocera International, Inc. relocated.
• Ceramic bio-material developed and marketed as Bioceram.
• Japan Solar Energy Co., Ltd. established as a joint venture for research and development of solar cells.

1976 • New shares of common stock (in the form of ADR) issued in the U.S.A.
• Crescent Vert Alexandrite developed.

1977 • Crescent Vert Co., Ltd. established as a sales company for recrystallized gemstones.
• Kyocera (Hong Kong) Ltd. established. Capital: HK$250 thousand.

1978 • "INAMORI" store opened on Rodeo Drive in Beverly Hills, California, U.S.A., for the sale of recrystallized gemstones.
• FDA premarket approval granted for Bioceram in the U.S.A.

1979 • Crescent Vert Ruby developed.
• Capital assistance granted to Cybernet Electronics Corporation.
• Central Research Laboratory established inside Kokubu Plant.
• Kagoshima Electronics Co., Ltd. established.

1980 • Crescent Vert Opal marketed.
• Company stock listed on New York Stock Exchange.

1981 • World's smallest thermal printer head for facsimile machines developed.
• Solar hot water system marketed.
• Crescent Vert Padparadscha Sapphire marketed.
• Annual sales of the parent company exceeded ¥100,000 million. Net profit: ¥13,400 million. Employees: 5,058.
• Kyocera Business Machine Co., Ltd. established.
• Ceramic glow plug for diesel engine use developed jointly with Isuzu Motor Co., Ltd.
• Solar powered lamps (34 sets) installed along the Kamo River in Kyoto, Japan.
• Amorphous silicon photoreceptor drums developed for use in plain paper copiers.
• Kyoto Institute of Implantology established to promote use of Bioceram dental implants.

1982 • Test run completed of world's first ceramic engine.
• Cybernet Electronics Corporation, Crescent Vert Co., Ltd., Nihon Cast Co., Ltd. and New Medical Co., Ltd., merged into the Company.
• Company name officially changed from Kyoto Ceramic Co., Ltd. to Kyocera Corporation.

1983 • Merger agreement concluded with Yashica Co., Ltd.
• Kyocera Electronic Co., Ltd. established with the purpose of marketing office and electronic equipment.

1984 • Capital increased to ¥340,22 million.
• Inamori Foundation established.
• Tokyo Central Research Center established.
• Chiba Sakura Plant and Solar Energy Center newly established in Sakura, Chiba Prefecture.
• Daini-Den Den Inc. established with ¥1,600 million in capital along with 24 other companies including USHIO INC., SECOM CO., LTD., SONY CORPORATION and Mitsubishi Corporation. After capital expansions August and November 1984, the number of companies holding shares increased to 255 and capital, to ¥8,000 million.

1985 • Videotex Center, Ltd. established with ¥1,250 million in capital together with SECOM CO., LTD., Mitsubishi Corporation, Seikatsu Kozo Research Center, Ltd. and Shakai Kougaku Research Center, Ltd.
• A joint corporation with the N.V. PHILIPS' GLOEILAMPENFABRIEKEN, Kyocera and Philips Date Communication Network Corporation, formed with ¥1,000 million in capital.

Appendix Q

Richardson Greenshields of Canada Limited, Tokyo Office
Tuesday, June 24, 1986, 08:30 - 09:30

Present: Robert A. Fairweather
Vice-President

Peter J. O'Marra
Representative

This meeting, set up by Richardson's Toronto office, was primarily for the purpose of discussing the role of venture capital in the development of technology-based industries in Japan.

Japan has a very large stake in Canada's future, holding about 45% of Canadian long-term debt, and at least $20 billion in total debt. Most of these investments were made during the inflationary period of the 1970's when inflation was much lower in Japan, returns in Canada looked very attractive and North American investors were concentrating on short-term instruments.

Venture capital is very active in Japan, but because of structural differences it is not the same kind of industry as we have here. A major difference is the central role of the big securities companies in Japan, and the function of regional banks as promoters of regional development and financial referral centers. It would appear too that the fact that investment dealers in Canada work mainly on a commission basis tends to discourage interest in risky ventures with longer-term payoffs. My impresson is that this is not the case in Japan, where securities firms in many cases support new ventures in the hope of generating revenues in the future from public offerings of growing companies.

Other Observations:

- Daiwa Securities, which is very actively involved in venture capital (see Reference Document Q-1) has a Toronto office and could provide an excellent account of this aspect of their business in Japan.

- The Canadian government should consider providing an advisory service to assist venture capitalists to make decisions about investments in high technology.

- The Japanese are keenly interested in investing in Canada and should be steered to businesses that add value to Canadian resources and therefore are in our long-term economic interests. (Their tendency now is to invest in resource companies).

Reference Documents

Q-1 "NIF: Nippon Investment & Finance Co. Ltd.", June 1985, 10 pp.

Appendix R

Miscellaneous Reference Documents

R-1 "Tsukuba Science City: Research Institutes and Universities", 1984, 36 pp.

R-2 "Industrialization of New Materials is Making Rapid Progress", Industria, April 1986, pp. 8-14; and "'New Materials' Producers That Lead the World", Industria, May 1986, (two articles in a series)

R-3 International New Materials Conference and Exhibition, 16-19 October 1986, Osaka, Japan, Program

R-4 Science and Technology in Japan, Vol. 5 No. 18, April 15, 1986. Contains several articles on recent policy developments and initiatives.