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JAPANESE TECHNOLOGY POLICY: HISTORY AND A NEW PERSPECTIVE

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Abstract

The last decade of the 20th century was marked by the emergence of a "knowledge-based economy," with governments in most OECD countries intensifying their commitment to the underlying research and development activities.

Japan is no exception. The Japanese government affirmed setting the objectives of a "Nation Based on Science and Technology" as the fundamental policy goal in 1980 and since then it has implemented several laws and policy packages in the fields of science, technology, industry and higher education, with the common denominator being "Industry-University-State cooperation." This policy orientation has been consolidated by the Science and Technology Basic Law, introduced in 1995, which gave the government legal competence in science and technology.

This trend tends to reinforce stereotypic images of the Japanese innovation system, such as the "government picking up technological paths" or "industry and government working hand-in-hand." Does this perception reflect reality? This study attempts to clarify this by examining:

- How the technology policy evolved during the postwar period in Japan;
- What its impact was on the private sector's decision on R&D activities;
- What the underlying philosophy was of the government's R&D policies, if one existed;
- What the new perspective is.

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1. Introduction

The last decade of the 20^{th} century was marked by the emergence of a "knowledge-based economy" (OECD, 2000), where technological innovation seemed to function as the engine of growth, and governments in most OECD countries intensified their commitment to the underlying research and development (R&D) activities. Reflecting this orientation, we are also observing a phenomenon of convergence among economic, technology and research policies.

Japan is no exception. The Japanese government affirmed setting the objectives of a "Nation based on Science and Technology" as the fundamental policy goal in its 1980 white paper on science and technology (STA, 1980). Since then it has implemented several laws and policy packages in the fields of science, technology, industry and higher education, with the common denominator being "Industry-University-State[1] tripartite cooperation." This policy orientation has been consolidated by the Science and Technology Basic Law, introduced in 1995, which gave the government legal competence in promoting the advancement of science and technology. The R&D expenditure financed by the government is expected to attain 1% of GDP during the second term Science and Technology Basic Plan (2001-2005).[2]

This trend tends to reinforce stereotypic images of the Japanese innovation system, such as the "government picking up technological paths" or "industry and government working hand-in-hand," despite the fact that, in Japan, R&D activities are financed and performed mainly by the industry sector.[3]

Does this perception reflect reality? This study attempts to clarify this. Pursuing the proposition of Nathan Rosenberg (1994) that "technology and science, which are now acknowledged to be central to the achievement of economic growth, need to be understood as path-dependent phenomena", we examine:

- How the technology policy evolved during the postwar period in Japan;
- What its impact was on the private sector's decision on R&D activities;
- What the underlying philosophy was of the government's R&D policies, if one existed;
- What the new perspective is.

Our analysis will be based on a literature survey and interviews conduced by the author with government officials in charge of the planning of the industrial technology policy.[4]

This study is organized as follows. Section 2 identifies the evolutionary path of the Japanese technology policy after WWII, with a particular emphasis on the first white paper on technology (1949) and the Large Scale Industrial Research and Development System introduced in 1966. Section 3 focuses on the Science and Technology Basic Law (1995) and Basic Plan (1996) to investigate how Japan expects to shift towards a "nation based on the creation of science and technology." Section 4 attempts to perceive the new trend for the 21^{st} century's technology policy through the analysis of the Science and Technology Basic Plan II (2001). Section 5 concludes.

A complete overview of science, technology and industrial policies in Japan is beyond the scope of this study. Our emphasis is just on the technology policy. This choice reflects our point of view that places the technology policy at the intersection between the industrial and science policies.

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[1] In this context, the "State" represents national research laboratories.

[2] 0.70% in 1998 (Follow-up of the Science and Technology Basic Plan, 2000).

[3] More than 70% of domestic R&D expenditure is performed by the industry sector (STA, 2000).

[4] See the list of interviewed persons in the appendix.

2. Emergence of the Japanese technology policy

2.1 The Situation Before WWII

For a better understanding of the genesis of the technology policy, we start with a brief description of the state of science and technology in Japan before WWII.

At the beginning of the Meiji Era (1868-1912), almost all laboratories[5] founded during the Edo Era (1603-1868) were integrated into the imperial universities,[6] becoming "Research Laboratories" (Miyahara, 1982). However their research activities were limited in the sense that there was no specific budget allocated for this purpose, or a clear idea about "research" at this time (Saito, 1987). Besides these universities, there were also some research laboratories[7] attached to the government.

As part of the industrial restructuring initiated around 1910, the first policy statement in favor of setting up public research institutes with the aim of improving industrial technology was issued in 1912 by the Industrial Council.[8] Along this line, a group of researchers initiated the idea of a chemical laboratory as a means to go beyond imitating imported technology, that is, for Japan to develop its own technologies.

With the advent of WWI, which resulted in a drastic fall in the importation of manufactured goods, particularly industrial raw materials, the government was urged to support manufacturing these products. Thus the Chemical Industry Council, established in 1914 within the Ministry of Agriculture and Commerce, recommended setting up a chemical research institute based on Industry-State cooperation. The convergence of this recommendation and the above-mentioned private researchers' initiative, materialized in 1917 with the creation of the Institute of Physical and Chemical Research (Riken), a public utilities organization financed by subsidies and private donations.

After a difficult start-up phase, characterized by financial problems and opposition between physicists and chemists, Masatoshi Okochi, the second director,[9] succeeded in bringing a new philosophy to the institute in the following ways:

- Being devoted to fundamental research, while at the same time keeping close ties with industry;
- Basing it on a decentralized research management, giving the head of each research group financial and personal autonomy;
- Using the idea of a virtuous cycle that starts from the valorization of the research results, passing through to licensing and commercialization, from which the benefits will be injected into fundamental research activities, and so on.

Riken continued to function on this basis until the end of WWII, generating a great number of what we call today "venture businesses."

We conclude that in Japan during the prewar period, private initiative in the field of fundamental research was present and the government played a supporting role. So too did the idea of science contributing to the development of industry.

[5] For example, the Medical Plants Garden.

[6] Imperial Universities of Tokyo, Kyoto and Tohoku.

[7] Electric Experimental Laboratory (1891), Tokyo Industrial Experimental Laboratory (1900), Railway Research Laboratory (1913).

[8] Founded in 1910.

[9] Nominated in 1921.

2.2 The First White Paper on Technology

The end of WWII marked the departure from the national objective of military strengthening. Japan opted for an economic-oriented objective with a strong emphasis on social benefits. Along this line, thirty-one delegates from different divisions of the Ministry of Commerce and Industry (MCI), the Patent Office, the Small and Medium Enterprise Agency, the National Experimental Laboratories, and the Ministry of Transport, with the support of the Industrial Technology Agency,[10] worked together to give birth to the first white paper on technology, called "the state of our country's industrial technology" (ITA, 1949; Masuda, 1998a). This white paper expressed the great concern of Japanese officials over technology matters and contained practical and pragmatic proposals to improve the state of Japanese industry, thus conferring a certain orientation to the postwar science and technology policy. It also undertook the mission of awakening the public conscience concerning the critical role of technology in economic development.[11]

The white paper starts by identifying the weaknesses of Japanese industry, which were:

- The lack of Japan's own technology, partly due to the myopic attitude of Japanese industrialists foreseeing short-term returns and preferring to import technology rather than invest in costly R&D activities;
- Difficulty in translating the research results accumulated within academia into industrial products, due to the lack of applied research and development. This point was mentioned as Japan’s primary problem by the US Academic Commission;[12]
- Predominance of tacit knowledge, embodied skills, tricks and craftsmanship in the production process, in particular within small and medium enterprises (SME), causing low productivity of labor and long training periods, and preventing a large-scale diffusion of technology;
- Presence of sectionalism in technical fields, reflecting the hierarchical structure of academic disciplines, the consequence being the underdevelopment of technology requiring an interdisciplinary approach;

Being aware of these facts and in the context of increasing international competition, it became urgent for Japan to strengthen its technological capability. The white paper proposed:

- Enhancing applied research and development, as suggested by the US Academic Commission;
- Soliciting academia's active enrollment in the technology transfer;
- Applying the "scientific method"[13] in production control through the establishment of standards and norms, the enhancement of quality control and the development of assessment technology and measurement instruments;
- Giving technical support to the small and medium enterprises which dominated Japanese industry in terms of the number of establishments and employees;
- Favoring a comprehensive approach to development of a new technology.

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[10] Founded in 1948 within the Ministry of Commerce and Industry.

[11] The argument being that a rise in the productivity of labor and of exportations in the technology-intensive sector will induce the improvement of living standards.

[12] The Commission also noted that "Japan is forced to improve its technology level by importing from the US and Europe during the kick-off period, but Japan would have excess technology to export if it made the effort to climb out of its post-war apathy and generate innovative technologies."

[13] This idea was already present in the discourse of Masatoshi Okochi (Saito, 1987).

Given these guidelines, the government could intervene in several ways, for example by giving fiscal incentives for technology transfers, by subsidizing the training of engineers, investing in the technological infrastructure, and by fixing the rules of the game concerning standardization,[14] normalization and measurement.

Three existing institutions – the patent system, academic societies, and training of engineers – were expected to play a crucial role in making these government measures efficient.

The patent system, allocating a temporal monopoly to the inventor, was considered as an incentive mechanism for technological innovation in accordance with Schumpeter's point of view. Japanese officials were already aware of the property rights issue as a means of diffusion and dissemination of new technology rather than the passive use of rights for defensive purposes. The white paper, however, recognized that there were some problems in its application. The existing laws related to industrial property rights, such as the patent law, the utility model law, the trademark law, etc. These were copies of Western countries' laws without any adaptation to the Japanese context, so that social acceptance of this institution was limited. Furthermore, there was no institution to control and enforce property rights.

Japanese officials viewed academic societies as having two roles: through meetings and publications, they provided a place of exchange and communication among university researchers and people from industry; and by participating different government commissions, members of academic societies contributed to the formulation of guidelines on technology issues, such as standardization. However, these possible contributions were not adequately perceived by the industry people at the time, as noted by Masaru Masuda.[15]

The formal training of engineers was considered to be a key factor in being able to implement the above-cited scientific approach of production. To ameliorate the quality of future engineers, the white paper pointed out the importance of having a background in the fundamental sciences for high-level engineers on one hand, and the need for students to have some practical experience within industry during their university curriculum on the other.

What should be retained from this overview? First, the white paper emphasized "industrial technology," i.e. technology with a practical application in industry, rather than focusing on technology seeds based on R&D activities. Second, the idea of an innovation system based on the patent system, standardization, quality control, the contribution of academic societies and the high-level training of engineers was already present. Third, the white paper urged strong political support to develop a technology-based economy. It is worth noting that all these elements constituted the key ideas of the "national strategies for industrial technology,"[16] which marked a keen shift in the Japanese technology policy by the end of the 1990's.

2.3 Paradigm Shift: A Large-Scale Industrial Research and Development System

During the 1950's, the trend for importing technologies continued. Japan was successful in incorporating and improving imported technologies,[17] and backed by reinforced quality control, the production process was greatly improved during the 1960's. A new trend in technology appeared during the same period: private companies started to set up research laboratories, called "Central Research Laboratories," which were devoted to developing their own technologies. Despite the official intention of Japan developing its own technology, in

[14] The "Law on the standardization" (No. 185) and the "Subsidies for development system" were voted on in 1949.

[15] Interview by the author.

[16] See Section 4.1.

[17] The most cited example is Sony's transistor radio.

practice, few technological breakthroughs emerged. The efforts of industry concentrated mainly on improving existing or imported technologies.

With this background, the Law on Industrial Technology Research Association" (No. 81) was promulgated in 1961. Its purpose was to improve industrial technology by giving incentives to private companies to join efforts in applied research activities (AIST, 1998). This law, which gave a juridical personality to the "research association," constituted the first step towards the forthcoming "Big Projects."

In 1963, the Industrial Structure Research Committee [18] recommended that the Minister of the Ministry of International Trade and Industry (MITI) implement targeted research projects based on Industry-University-State cooperation, the objective being the development of innovative technology (Group for promoting the 20th anniversary, 1987). Research results were to be shared by all participants. It is worth noting that the underlying idea of research cooperation here was the commissioned research system. This meant that each institution would individually execute one part of a research project, so no on-site research collaboration was planned.

The Industrial Structure Council, recognizing technological innovation as the key factor to increasing competitiveness and generating economic growth, presented in its intermediary report (1965), the concept of the "Big Project" as follows:

- Objectives: to develop new technologies and new products that would not be developed by the private sector alone due to the presence of high risk and high cost;
- Characteristics: long-term investment in terms of researchers, engineers and money;
- Targeted fields: to select fields which have the potential for large spillovers and economic impact, or fields in which there is some urgency for development;
- Participating private companies: selected according to their research capacity and their weight in the potential market;
- Scheme: totally financed by the government, mobilizing the research capacity of the private sector operating in the targeted field;
- Organization: based on the commissioned research system involving universities, national research laboratories and private companies;
- Management: implement a structure charged with surveying, managing and evaluating each step of the project, with the capacity to adjust and stop the research agenda if necessary.

Following this agenda, in 1966, the Japanese government implemented its "Large Scale Industrial Research and Development System," commonly called "Big Projects," with the aim of supporting high-cost, long-term, and high-risk research projects, which have a large potential to induce technological breakthrough and large spillovers, but have little chance of being initiated by private companies in the absence of government intervention. By selecting some technological avenues and subsidizing intensively on one hand, and by gathering the efforts of private companies, universities and national research laboratories on the other, the government sought to consolidate its technological base in promising industries, and subsequently to increase Japan's competitiveness. This preference for "seed money," which

[18] Founded in 1961 and later becoming the Industrial Structure Council.

finds its justification in the linear model of innovation,[19] marked the orientation of Japan's technology policy until the late 1990's.

Practically, a big project is implemented in the following way. The Industrial Technology Council at the MITI selects a technological avenue after consultation with industrial circles. The Agency of Industrial Science and Technology (AIST) attached to the MITI is then charged with designing and planning a big project along the selected technology avenue, after consultation with the Industrial Science and Technology Commission located within the AIST. Generally, a big project covers the phase of development of the "basic technologies" and the phase of "system set-up" that gathers these basic technologies – that is to say, a big project is expected to present a "pre-commercial product" in its final stage. In accordance with the concerned industrial circle, a research association is founded. This is charged with coordinating sub-research projects commissioned by the AIST to its member companies, and surveying up-to-date information on the technological avenue. Related AIST national research laboratories contribute to develop a basic technology and evaluate it. They also carry out feasibility studies on how to use research results. As for research results, patents and know-how generated within a big project become the property of the State. However, priority is given to commissioned companies to use the patents (Nihon keizai chosa kyogikai, 1988). The Japan Industrial Technology Association (JITA) was founded in 1969 to handle the task of technology transfer, dissemination and the valorization of these results.

What this research system introduces is the presence of a research association. The latter provides member companies with a place to meet other industrial people working in a related field, exchange information, share ideas, and to share the results generated by ongoing research activities. Thus a research association facilitates establishing a network of people and ideas. Another merit of a research association is its light structure: it is easy to create and dissolve a research association through the choice of a technological avenue (Group for promoting the 20th anniversary, 1987).

For member companies, being enrolled in a big project guarantees long-term financial support from the government, gives credibility to pursuing risky research projects without immediate prospects for commercialization, allows easy access to up-dated information and facilitates information-sharing among them. All these elements were expected to consolidate the technological capability of member companies in the new technology field.

The lack of flexibility is often perceived as a drawback. Once objectives were defined and research planned, adapting them to the intermediate results obtained within the advancement of the project became a complex and arduous task, the consistency of the initial planning having a high priority. Another drawback was the fact that the technologies developed within a big project were not easily translated into a commercial end product, especially when the selected technology avenue had not been experimented with elsewhere (Harayama, 2000).

The choice of technological avenues pursued during the 1960's and 1970's was dictated in some cases by social needs, such as finding solutions to the problems of pollution, traffic jams, and water shortages, but the main driving force was the need to fill the technology gap between Japan and the United States. During this period, Japan had a model of a technological path, and following this direction, participating companies consolidated their technological base and succeeded in catching up with American companies in appropriate fields (Group for promoting the 20th anniversary, 1987).

[19] The "Linear model of innovation" describes the step-by-step process of turning an idea into a commercial product, starting from basic research, passing through application research and development, and ending in commercialization.

The situation became more complex in the 1980's when Japan entered the post catch-up phase. With no model to follow, Japan had to select technological avenues in its own way, which involved more risk and uncertainty; the technology required became more complex and sophisticated.

What was the significance of the big projects? The MITI was successful in enlarging its competency; hence the "industrial technology policy," which included the underlying R&D activities. One of the consequences was that the MITI's technology policy would be more focused on technology creation rather than on technology innovation closer to product commercialization. The AIST, through its functions of planner and manager of big projects, acquired a certain authority vis-à-vis private companies, moving from its original function to give technological support to Japanese companies.

2.4 Incremental Changes

Parallel to the big projects, but based on the same scheme, several R&D systems were introduced during the 1970's and 1980's.

The advent of the first oil crisis urged the Japanese government to diversify its energy supply and to exploit new and clean energy sources. Following the recommendation of the Council for Science and Technology[20] (5th Report), the "New Energy Technology R&D System," called the Sunshine project, was implemented in 1974 by the MITI (Nihon keizai chosa kyogikai, 1988). The "Energy Conservation Technology R&D System," called the Moonlight project, was added in 1978 to complement the Sunshine project. As R&D systems, the Sunshine and Moonlight projects function in exactly the same way as the big projects, and differ only in the fields covered. The New Energy Development Organization (NEDO), a special corporation,[21] was founded in 1980 under the authority of the MITI with the aim of managing the Sunshine and Moonlight projects. It is worth noting that with the NEDO, the MITI was equipped with a dual structure of R&D management: the AIST and the NEDO.

In 1981, the MITI founded the "Next Generation Industry Basic Technology R&D System," called Next Generation, along the lines of the government's objective to become a "Nation based on Science and Technology," as noted in the 1980 white paper on science and technology. It marked the end of the catch-up phase and the government's intentions were reflected in its targeted fields, such as biotechnology, information processing, and new materials, which required basic level R&D. However, the way the Next Generation was planned and managed was exactly the same as the big projects. Because of this fact, the basic and innovative nature of this new system was somewhat diluted according to Masuda.[22]

Besides the MITI, the Science and Technology Agency (STA) introduced the "System for Promotion of Coordinated and Creative Science and Technology" in 1981 (Nihon Keizai Chosa Kyogikai, 1988). The Ministry of Education (ME)[23] implemented "Cooperative

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[20] Founded in 1959 as a consultative body attached to the cabinet of the Prime Minister with a secretariat at STA. The Prime Minister shall consult the Council on science and technology policy and respect its recommendations. The Council, presided over by the Prime Minister, is composed of ten members, among them ministers of the Ministry of Education and the Ministry of Finance, presidents of the Economic Planning Agency, STA and the Science Council of Japan.

[21] "Special corporation" is defined as a public enterprise not directly attached to a Division of a Ministry, an agency, or a local government. It may be founded under a special law or jointly established by the government and the private sector (Furuta, 1996).

[22] Interview by the author.

[23] There is a rough division of competency among the ME, the STA and the MITI: the ME is competent in the "academic sciences", which covers social sciences, humanities, exact sciences and life sciences, including their applications (Law for Establishing ME); the STA for the "science and technology" which covers finalized

Research with the Private Sector" in 1983 and the "Center for Cooperative Research"[24] in 1987. The STA's system consisted of contract-based five-year Industry-University-State joint research projects focusing on technological seeds. The ME, as the competent authority on higher education, focused on the research cooperation between national universities and industry. "Cooperative Research with the Private Sector" gave private sector researchers and engineers open access to university laboratories, and the "Center for Cooperative Research" provided the space within national university campuses to carry out cooperative and commissioned research and training to private sector engineers. It is worth noting that all these policies underscored the need for Industry-University research cooperation.

In 1988, the NEDO was transformed into the New Energy and Industrial Technology Development Organization[25] acquiring a new competency in industrial technology R&D. Although the budget envelope for this new function was limited with regard to the energy issue, the NEDO was charged with supporting private-sector basic research activities by providing R&D infrastructure. Thus the NEDO supplemented the AIST to some extent: the former is charged with implementing the industrial technology policy that the latter designed. However, in reality the distinction in terms of competency between the AIST and the NEDO became blurred, with increasing duplication of paperwork and a more complex bureaucracy.

Following this organizational change, a structural change occurred in the MITI's R&D systems. In 1993, the MITI decided to merge the Large Scale Industrial Research and Development System, the Next Generation Industry Basic Technology R&D System and the National Research and Development Programs for Medical and Welfare Apparatus (1976) into the Industrial Science and Technology System.[26] The main reason for this change was to overcome contradictions that occurred within these systems and to reduce redundancy. The idea of "system set-up," inherent to the big project, was abandoned, leaving it able to accumulate the basic knowledge underpinning innovative technologies. However, at the management level, the established order was difficult to remove, and the inertia of going back towards the idea of "system set-up" remains today.[27]

In fact, this shift towards more fundamental work followed the trend that became apparent during the 1980's as a consequence of external pressure and internal circumstances. Indeed the United States solicited Japan to do more fundamental research and not just behave like a free rider. Japanese private companies were successful in accumulating experiences and capability in R&D, exploiting different R&D programs and supports provided by the government, and also benefiting from the fruits of their economic growth. They invested heavily in basic research activities generating the boom of the "Central Research Laboratories." AIST's national research laboratories were no exception. They clearly oriented their activities toward basic research, moving further away from industry and the market needs.

To sum up, by the end of the 1980's, the catch-up strategy was replaced by the search for innovative technologies. This orientation shift implied change not only in R&D targeted fields, but also in the way R&D was conceived, planned and managed, so that the "Big

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research and excludes social sciences and humanities; and the MITI for "industrial technology" which is simply defined as "industry related technologies under the authority of the MITI" (Law for Consolidating Research and Development System Relating to Industrial Technology).

[24] In 2000, there were fifty-three Centers founded within national universities.

[25] Its legal base is the Law for Straightening R&D System for industrial technology (1988, No. 33). Despite this functional change, the institution continues to be called "NEDO."

[26] The system continues to be called "Big project."

[27] One of the Big projects, "Micromachine Technology Project," illustrates this fact (Harayama, 2000).

Project," which became the reference point for the Japanese research system, had to be restructured. It also highlighted the problem of competency: the officially recognized distinction between "industrial technology," "academic sciences" and "science and technology" lost its pertinence, as did the complementarity among the MITI, the ME, and the STA in their function as science and technology policy planners. They concentrated their efforts to gain a share of the budget allocation. As a result, the lack of coordination tended to reduce the efficiency of government R&D investment.

3. The Shift Toward the "Nation Based on Creation of Science and Technology"

Being aware of this fundamental change, the government adopted the "Science and Technology Basic Law" in 1995 and implemented policy measures to adapt the way the Science and Technology (S&T) was organized and managed.

3.1 The Science and Technology Basic Law

The 1990's were often called "the lost decade," referring to the prolonged economic recession Japan faced. With this background, the Science and Technology Basic Law was promulgated in 1995 to equip the government with a legal basis to pursue the objective of the "Nation Based on the Creation of Science and Technology,"[28] which required the costly and long-term engagement of the government.

It is worth noting that in 1968 the Council for Science and Technology recommended that the government formulate a Science and Technology Basic Law (Group for promoting the 20th anniversary, 1987). However, this failed due to a strong opposition by academia against the unavoidable idea of Industry-University cooperation (Haseda, 1996). In the 1990's, the social pressure on academia to increase efficiency and accountability became apparent. In this context, a closer tie with industry could be considered an argument to justify public support for its research activities.

Given the stake in terms of the political power such a law assigns to the concerned ministries and agencies,[29] this law took the form of a member bill. A group of cross-party Diet members prepared the outline with the STA's support. A compromise among different related ministries, agencies and political parties was negotiated before the bill was submitted to the Diet.

The Law can be summarized as follows: The State becomes "responsible for formulating and implementing comprehensive policies with regard to the promotion of S&T." Thus the former is expected to take the necessary measures, especially a budgetary one. The Law emphasizes concern about the cooperation between national research laboratories, universities and the private sector, the right balance between basic research, applied research and development, and the training of researchers. Particular attention is paid to preserving the autonomy of researchers and specifying research activities within the university sector. This clause left the university sector a means of circumventing those applications that were unacceptable to them. The Law envisages the establishment of a basic plan to promote S&T, which will contain operational policies. The Council for Science and Technology has to be consulted prior to formulation of the basic plan.

[28] The additional term "Creation" compared to the former objective of "Nation Based on Science and Technology" also signals the end of the catch-up phase.

[29] The STA, the ME, the MITI and the Ministry of Finance (MoF).

3.2 The Science and Technology Basic Plan

The first Basic Plan, covering the 1996-2000 period, mainly focused on the improvement of R&D conditions. The Basic Plan recognized the need to increase government investment in R&D to the level of Western countries, to create a competitive R&D environment, to improve R&D capability in the private sector, and especially, to reinforce Industry-University cooperation. The Basic Plan proposed:

- To double the domestic expenditure on R&D financed by the government as a percentage of GDP by 2000;
- To increase research funds allocated on a competitive base;
- To attain the objective of 10,000 financially supported post-doc positions[30] by 2000;
- To implement measures to facilitate inter-sector[31], inter-regional and international exchanges, for example by increasing the number of fixed-term positions and cooperative research projects, and by facilitating technology transfers;
- To implement assessment systems regarding publicly supported R&D themes, management of research institutions, and activities of researchers in the public sector;
- To improve the R&D infrastructure regarding physical assets, information technology and intellectual assets (for example databases and standardization).

Indeed, these measures largely reflected the views expressed by the Industrial Structure Council and the Industrial Technology Council in their joint report (1995). Recognizing that "intellectual assets," defined as a stock of "scientific and technological results" (MITI, 1996), constitute the "intellectual social infrastructure," they urged the government to increase its efforts, to improve the R&D environment, for example by increasing the competitive base allocation of resources, and to implement incentive mechanisms to facilitate the exploitation and valorization of "intellectual assets." The main issue of this report was reproduced in the Basic Plan.

Along the lines of the Basic Plan, a certain number of laws and measures were implemented, reinforcing the tie between industry and universities. Indeed, universities were expected to become major players, as knowledge-creating institutions and through their training function, leaving behind their ivory tower image.

3.3 The Expected Contributions of Universities

The shift from the status of follower to front runner in the innovation race requires a strong complementarity between basic and applied research, which implies reinforcement of the cooperation between universities and industry and collaboration between the ME and other S&T related ministries and agencies, especially the MITI, and the foundation of an integrated innovation system based on the Industry-University-State tripartite cooperation.

How can synergy be induced between universities and industry? And how can this synergy be stimulated and exploited? Since the Basic Plan went into effect, the government took measures to facilitate the technology transfer from universities to industry (Law for Promoting University-Industry Technology Transfer), to remove the barriers against exchanging people between industries and universities, to give incentives to private

[30] Called the "Program to support 10,000 post-docs." This program was expected to revitalize S&T activities in Japan. The ME, the STA, the MITI, the Ministry of Agriculture and the Ministry of Health contributed to this program.

[31] Between industry, universities and national research laboratories.

companies for joint research, and to improve the quality of training engineers (Internship and Accreditation).

The Patent Issue Related to National Universities

Before getting into the analysis of technology transfer, we proceed with a brief review on the patent issue related to national universities. The reason for focusing on national universities, which are expected to play a leading role in the process of technology transfer, is that they do not have a legal personality in Japan. They are considered divisions of the ME, so that the State, as the employer of national university's faculty members, shall be the patent owner, as opposed to the case of private universities.

Who has the right to own the patent when an invention is made by faculty at a national university as a result of research activity conducted within the national university? The answer depends on the conditions of the funding, on the nature of the research (applied research or basic research), and on which researcher contributed to the generation of the invention (faculty and/or private company's researcher).

Article 35 of the Patent Law on "employees' inventions" stipulates that "the employer shall have a non-exclusive license to the patent right concerned, where an employee has obtained a patent for an invention which falls within the scope of the business of the employer." Regarding inventions made by a national university's faculty,[32] the rights related to the invention belong to the employee, i.e. the faculty,[33] since 1978, following the recommendation of the Science Council which mentioned the incentive nature of patent ownership (WG on external research funds, 1999).

There are some exceptions to this rule. The State owns the right to a patent in cases of applied research when expenditure was supported by the State, including joint and commissioned research by the private sector.[34] Applied research in the fields of big sciences using state-owned large-scale research facilities, such as nuclear reactors or accelerators, are also similar to the case of "employees' inventions." In these cases, the Japanese Science and Technology Cooperation (JSTC) is charged with carrying out the patenting operation.

Whatever the ownership of the right to patent, the faculty is obliged to report the invention to the rector. National universities have an obligation to set up a "Committee for Invention," which must state who owns the right to patent the inventions made by faculty members and to decide whether or not the State exerts this right when the latter is allowed to do so. The rector validates recommendations expressed by the Committee.

Regarding joint research with the private sector, the Committee for Invention states whether the invention is made jointly between the faculty and private-sector researchers or not, and whether or not the invention belongs to the State. In the case of joint inventions, in general the patent is jointly applied. Then the private sector can designate a third party entitled to the status of preferential licensee.[35]

In the case of commissioned research where the State owns the right to patent, the funding institution[36] or a third party designated by the former, shall have the status of preferential licensee. Article 7 of the Law for Promoting Research Cooperation gives the

[32] Notice No.117 on "the patent issue of invention made by faculty at national university" by the director of the Science and International Affairs Bureau and the chief of the Budget and Accounts Division, ME (1978).

[33] The employee always has the option to transfer this right to the State.

[34] Private sector includes private companies and special corporations.

[35] Notice No.195 on "joint research with the private sector" by the director of the Science and International Affairs Bureau and the Chief of the Budget and Accounts Division, ME (1999).

[36] Including private companies, semi-governmental special corporations, cooperatives, state organizations, international organizations, foreign governments, and foreign institutions.

possibility of assigning the patent to up to 50% of a funding institution located outside the nation, and by extension, to special corporations.

Once patented by the State, the invention becomes national property.[37] The concerned ministry or agency is allowed to manage and to dispose of this asset, in particular with regards to the license. To prevent the invention from becoming obsolete during the patenting procedure, licensing is authorized once the patent is filed. The JSTC is also charged with carrying out the licensing operation.[38]

Technology transfer from universities to industry

Observing that inventions made within universities are under-exploited and recognizing that valorization of these dormant technologies in terms of new products or creation of frontier industries is of social value, the Law for Promoting University-Industry Technology Transfer, called the Law on Technology License Organizations (TLOs), was promulgated in 1998. This Law, prepared jointly by the MITI[39] and the ME, aimed at facilitating technology transfers from universities to industry.

Given the number of non-finalized research projects within universities, the right to patent the invention falls into the hands of the faculty in the majority of cases (WG on external research funds, 1999). In general, the technology transfer takes place on the basis of a case-by-case contract or that of an informal agreement between a faculty member and a private company, which results in a limited return to the inventor and his affiliate institution. Thus, the Law on TLOs was implemented to create a "virtuous cycle of technology transfer" by facilitating the patenting and licensing of privately patentable inventions,[40] which shall generate a financial return that will be reinvested in research activities within the university.

The technology transfer business is defined as follows:

- Information gathering on inventions with a potential for commercialization generated within associated universities;
- Acquisition of the right to patent and patent filing of selected inventions among the latter, or assignment of a patent, and acquisition of an exclusive license of already patented inventions;
- Licensing (exclusive and non-exclusive license) or assignment of above patents to private companies;
- Passing on to the researchers and to their affiliate institution a part of the licensing and other revenues.

The TLO, charged with executing the technology transfer business, may be organized as a stock company or a corporation according to the Commercial Code in the case of national universities, and also as a division of a school corporation in the case of private universities.

The TLOs, once approved (*shonin*) by the Minister of ME or Minister of MITI on the basis of the execution plan they present, become eligible to receive subsidies,[41] debt guarantees and support for information gathering, provided by the Industrial Structure Improvement Fund.

[37] Thus it falls under the jurisdiction of the Public Finance Law and the National Property Law.

[38] Between1978 and 1999, the Japan Society for the Promotion of Science was also charged with administrative tasks and the licensing of patents generated within national universities.

[39] The Office for the Promotion of University-Industry Cooperation implemented in 1996 was in charge of this task.

[40] Regarding national universities, they consist of faculty-owned inventions, and regarding private and public universities, they also cover those owned by the university.

[41] Limited to an annual subsidy of 20 million yen per TLO during the first five years.

Besides the conditions guaranteed by the law, the TLOs may benefit from the service of the "patent distribution adviser" dispatched by the Patent Office and managed by the Japan Technomart Foundation without charge to reinforce their competence in legal issues.[42]
Regarding patents generated within national universities and owned by the State, the Law defines another category of TLOs – those said to be "accredited (*nintei*)" by the competent Ministers. They are allowed to file and to keep the patent free of charge, and to exploit these patents.[43]

As for the licensee, the law introduced a derogation to the Law for Facilitating the Creation of New Business allowing SME to remain the beneficiary of the investment provided by the SME Investing and Promoting Company beyond the limit of capital fixed to 100 million yen.

After the first period of application, some supplementary measures were taken to improve the operation of the TLOs. The Industrial Revitalization Law,[44] enacted in 1999, allowed the TLOs to benefit from a reduction in the filing and patent fees during the first three years of their operation. The Law for Reinforcing Industrial Technology, enacted in 2000, allowed the approved TLOs to use facilities located on national university campuses for their operation free of charge.

Despite these incremental adjustments, the number of approved TLOs and licensing contracts remained limited.[45] Indeed, the implementation and the functioning of TLOs needs the support of both faculties and private companies, which implies a rupture in the informal relationship based on tacit agreements and the acceptance of the new rules of the game, such as contract-based relationships. TLOs have to prove themselves and convince these players of their usefulness by culminating in successful experiences.

The focus of current TLOs on patenting activities may be another source of limitation. The TLOs have to aim at transferring technologies in a more pragmatic way, in that the transfer of the right to patent to the private sector has to be envisaged as one option. However, in this case, TLOs have to preserve the right to force the private sector party to valorize the invention within a reasonable amount of time and to guarantee a reasonable level of return to the inventor and his institution. Another possibility would be to reinforce the TLO's function of intermediary by informing the private sector not only about existing inventions but also about the potential of universities to generate new inventions through joint or commissioned research projects. The crucial question for the TLOs becomes: "How to build a mutually beneficial relationship between industry and universities?"

Facilitating the Exchange of People

Deregulation is underway regarding the exchange of people.

- Measures[46] facilitating national university faculties to conduct research or to act as consultants within the private sector were taken in 1999.

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[42] In 2001, there are thirty-one advisers deployed for a five-year term (http://www.jtm.or.jp/jpo/advisor/index.html).

[43] The article on this issue went into effect in 1999.

[44] Another important issue of this law concerns commissioned research funded by the State, including special corporations. Hence the right to intellectual property rights belongs to the commissioned research institution. This law is called "Japanese Bayh-Dole Act" for this reason.

[45] There are twenty approved TLOs (August 2001) and sixty-nine cases of licensing (December 2000) (Data from the Japan TLO Association).

[46] Amendment to the Special Law on the Public Servants in Education (1998) and other notices by the ME.

- According to the "Revised Three-Year Program for Promoting Deregulation" (1999), national university faculties have been allowed to become members of the executive board of the TLO since 2000.
- The Law for Reinforcing Industrial Technology provided the legal basis to the above derogation and at the same time extended it to members of the executive board of a private company active in technology transfer and to the auditor of the TLO, insisting on the public utility of these functions.

These measures are expected to facilitate technology transfers from universities to industry, thus the valorization of research results. Their effects are difficult to assess at present given their recent application.[47]

Promotion of Industry-University Cooperation

The ME's approach to promoting Industry-University cooperation is largely oriented on physical infrastructure. Besides Centers for Cooperative Research, mentioned in section 2.4, which provide research facilities to conduct joint and commissioned research, "Venture Business Laboratories" were implemented[48] among national universities with the "Fund for the Promotion of Creative R&D Based at Graduate Schools" as a part of the 1995 supplementary budget, as training centers for "venture spirit" and "entrepreneurship." In practice, these laboratories are used as ordinary research facilities and, in some cases, they are used for cooperative research with industry.

The amendment of the Law for Promoting Research Cooperation in 1998 followed the same line. It allowed private companies, desiring to set up research facilities within a national university campus within the framework of cooperative and commissioned research, to benefit from a reduction in half the rent.

On the MITI side, the Law for Reinforcing Industrial Technology brought a certain flexibility to the cooperative research system: national universities could receive research funds from the private sector in bloc and multi-year contracts were allowed. The NEDO is charged with supporting university faculties in research fields that have the potential to generate industrial technologies, especially through subsidies.

Internship

The lack of practical experience for graduates from universities was starting to be perceived as a handicap by the private sector, given that the latter tended to express its preference for personnel who were immediately operational rather than having to spend time with on-the-job-training as had been practiced in the past.

Noting this change, in 1997, on the initiative of the MITI in cooperation with the Ministry of Labor (ML) and the ME, a liaison group was founded to launch the policy discussion and to define a common strategy on internship. The latter was expected to fill the gap between the quality of training service provided by the university and the expectations of the private sector. Provisions have been budgeted since 1998 and different measures have succeeded since then. After a phase focused on the promotion of the concept of internship, in 1999, a pilot project called the "Internship Program" was implemented.[49] It provided financial support to companies accepting interns from universities by covering 50% of their expenses.

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[47] At the end of March 2001, there were thirty-six faculties acting as members of the executive boards of private companies (www.jinji.admix.go.jp/kengyo/).

[48] Twenty-one laboratories were implemented.

[49] In 2000, 218 four-year universities accepted attributing a certain number of credits to the internships (of which 72.7% are national universities), enrolling 21,063 students (http://www.mext.go.jp/b_menu/houdou/13/07/010739a.htm).

It is worth noting that the ME expressed reservations that internship must remain as part of a training program and not be used as a recruitment tool. Indeed, private companies perceive internships as a means of picking up some students well-suited to their needs and also to their "company's culture," given that having an intern is costly in terms of time, personnel and administrative tasks. That is, the success of the internship rests above all on the recognition that private companies have of their social role: by acting as a training-partner, they contribute to improving the average level of the quality of future graduates, which is beneficial for the industry and also for the society as a whole.

Accreditation of Education Programs

The University Council at ME recognized in its report (November 2000) the potential of the accreditation system to improve the quality of education programs within universities. At a more practical level, the engineering community in the search for international recognition of their diplomas found a means to attain this objective in the accreditation system, as noted by Masahiro Hashimoto.[50] In this context, the engineering community was the first to move by supporting a study group comprised of representatives of the STA, ME, MITI, and Ministry of Construction.

The Japanese Accreditation Board for Engineering Education (JABEE) was founded in 1999 as a non-governmental association. It is supported by the government, i.e. ME, MITI and Ministry of Agriculture, and by representatives of industry, mainly the Japan Federation of Economic Organizations, with the participation of academic societies related to the field of engineering. The JABEE proposes to evaluate engineering educational programs and to decide whether or not to accredit the program according to the results of its evaluation. The evaluation committee will be composed of representatives of member academic societies.

The implementation of the accreditation system is in progress: some twenty universities will participate to test the proposed evaluation during the coming year. The accrediting activity is expected to start officially in 2002, according to Kitami.

At this stage of advancement, there are some foreseeable problems:

- There are no experienced examiners. Thus a training program for the task of evaluation has to be envisaged.
- How will such accreditation acquire social acceptance and recognition?
- How will the results of the evaluation be exploited to improve the quality of the engineering educational program?

Summary

All these measures rest on the idea that universities must be players in the national innovation system in reconstruction. However, the expectation among related ministries, mainly the ME and the MITI, diverge on the way in which universities and their faculties must act at the ground level. Thus, the coordination and cooperation among these ministries becomes crucial in order to successfully exploit the complementarity between industry and universities.

Given the fact that these measures have been through a cumulative process, the landscape of the Japanese technology policy became more complex and less transparent. To build up a coherent system for a technology policy, a revision of the way in which the government conceives and implements policy measures is urged.

On the university side, in the context of diminishing numbers of eighteen-year-olds, increasing demand for social accountability, and a vast administrative reform of the Central Government in progress, this repositioning of universities within the social structure provides

[50] Interview by the author.

a justification for their raison d'être. It is up to the universities to find the right balance between their fundamental missions and these newly claimed social contributions. The ME's reservations do not mean that universities have an alibi to stay inside their ivory towers.

4. New Trend for the 21st Century

Since the publication of the first white paper on technology in 1949, the MITI's stance on industrial technology has evolved over time, and accordingly, new laws and measures were added as described in the above sections. However, building up a national innovation system requires more than assembling individual measures. It implies the founding of a philosophy on industrial technology, a structural and organizational reform of the actual systems based on it, and a clear indication of the policy direction.

4.1 MITI's New Philosophy or the Return to the Source

This move toward the rebuilding of the technological innovation system[51] was initiated in 1998 at a meeting of the Industrial Technology Council's General Committee at the MITI (Masuda, 2000). The new orientation of industrial technology policy presented at this meeting proposed:

- A comprehensive approach to build a fertile social structure for technological innovation;
- A management with the objective of industrial technology policy;
- A review of the existing policy tools to build a more coherent and comprehensive system of policy instruments.

There are two innovations in this proposal: first, the social contributions of technological innovation were considered the final technology policies instead of technological advancement; second the idea of "National Strategies for Industrial Technology"[52] was evoked. This new orientation received a positive echo at the Industry Competitive Council[53] and the Prime Minister made a commitment to implement a strategic plan for industrial technology based on Industry-University-State cooperation. It is worth noting that the Japan Federation of Economic Organizations (1998) expressed their interest in building up a comprehensive strategic technology policy. Concretely, the Industrial Structural Reform and Employment Measures Headquarters, headed by the Prime Minister, decided that the strategic plan for national industrial technology will be reflected in the Science and Technology Basic Plan II scheduled for 2001. Herewith, the Committee for National Strategies for Industrial Technology consists of representatives of industry, universities and the government, and a working group on industrial technology within the Special Committee for a Basic Plan at the Council for Science and Technology was founded.[54]

How do we define the underlying philosophy of this new approach? First, while maintaining the dichotomy between fundamental research and applied research, which justifies the division of labor between the ME and the MITI, it is recognized that applied research may lead to the discovery of new fundamental knowledge. This first point implies the move from the "Linear Model of Innovation" to the "Chain Linked Model" (Aoki and

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[51] The "technological innovation" includes the full range of conceptualization & planning, technology creation, technology transmission and diffusion, technology valorization, technology management and social acceptance, social evaluation and feedback.

[52] See Section 4.2.

[53] At its fourth meeting in June 1999. This Council, consisting of Ministers and representatives from industry and those attached to the Prime Minister's office, was founded in 1999 by Prime Minister Obuchi with the aim of tackling the problem of unemployment and promoting new industry.

[54] Within the MITI, the Strategy Planning Office was founded in July 1999.

Rosenberg, 1989), which recognizes the presence of feedback between different steps leading to product innovation. Second, the industrial technology policy is regarded as the result of academic policy, science policy, education policy, and economic & industry policy (Masuda, 2000). The consequences are that the Industry-University-State tripartite cooperation becomes the core issue of industrial technology policy, and that the university is expected to become a key player through its research function, training function and also its guiding role vis-à-vis society. Third, the consequent social benefit must form part of the criteria for the selection of policy tools. Thus the latter must indicate clearly the objective it wishes to attain and assure social accountability. It is worth noting that the policy tools presented in Section 3.3 can be seen as a first sign of this philosophy.

How will this philosophy be translated in terms of a technological innovation system? The MITI proposes to build a system of R&D policy measures consisting of four categories of support instead of the actual patchwork of several dozen systems and programs:

1. Grants for finalized basic research;
2. Support for finalized research projects;
3. Subsidies to support the practical use of new knowledge responding to the social needs;
4. Strengthening of the social infrastructure[55] beyond the research infrastructure, including culture collections, technologies of measurement, metrology, standardization, and data gathering on the security of chemical products.

In this new environment the functioning of the proposed system rests on a more active participation of universities and academic societies. Being aware of this fact, the Office for the Promotion of University-Industry Cooperation was upgraded to a division within the framework of the Administrative Reform of the Central Government in January 2001.

Regarding the selection and implementation of industrial technology policy, the MITI proposes to implement a three-level evaluation system:[56]

- Policy evaluation, which will be done as a last resort by the voters;
- Adequacy of projects implemented with the objective of their supporting policy, with a particular focus on the technical aspect;
- Project evaluation according to its objective, essentially based on peer review.

What is striking is the similarity of MITI's new philosophy with that of Riken, and especially with the main ideas of the first white paper on technology. Indeed, Riken was built on the dynamics generated by the valorization of the research result and the reinvestment of this fruit into fundamental research activities. The creation of a virtuous cycle is precisely the ultimate goal of MITI's new philosophy. With regards to the first white paper, the elements, such as valorization of knowledge generated within the university, industry-university cooperation, and consolidation of the technological infrastructure, were already emphasized as keys to a successful foundation of the innovation system.

Fifty years separates these precepts and Japan has sailed various seas during this period. So how do we explain this return to the source? One of the reasons that may be put forward is that this period was dominated by a myopic vision in the absence of an underlying philosophy. During the 1950's, the development of the basic industries such as coal, electricity and steel was the priority. Thus the objective of the technology policy was above all to help private companies working in these industries. During the 1960's, effort was concentrated on the

[55] The National Institute of Technology and Evaluation and the Chemical Evaluation and Research Institute are expected to play leading roles in this perspective.

[56] The Basic Plan II proposes an evaluation system along this line. See Section 4.3.

adaptation and improvement of imported technologies and Japan grasped the catch up with success. The 1970's were dominated by energy and environmental problems and Japan succeeded in shifting from a technology policy orientated to heavy industry to one orientated to the high tech industry, with a particular focus on electronics. The international pressure against a "basic research free ride" during the 1980's, in the context of the "bubble economy," induced the private sector and national research laboratories to invest strongly in the fields of basic research, deviating the concern of policy-makers from the valorization of industrial technology. The economic recession, which characterized the 1990's, was the incentive to review past policies. The government was attentive and responsive to the change in environment, and proposed a number of incremental and individual policy measures that were far removed from building up a coherent innovation system founded on a long-term vision.

Hence, these last fifty years allowed Japan to accumulate knowledge, not only within universities and national research laboratories, but also within private companies. There is an important stock of intellectual assets in terms of ideas, know-how and people waiting to be utilized in a more coherent way. In this context, the rethinking of the role of government and the reconstruction of the industrial technology policy were timely and indispensable.

One can find another similarity between MITI's philosophy and the US technology policy pursued during the 1980's and reinforced under the Clinton administration. As noted in Section 2.4, Japan's free-ride attitude was considered a serious threat during the 1980's. Congress decided to enlarge the federal government's role in R&D, and proposed supporting development of a technology conducive to marketable products by reinforcing the cooperation between industry, university and government laboratories[57] (Schacht, 1998). The Clinton administration (Clinton Technology Policy Initiative, 1993) considered technical advancement as part of its economic policy and clearly indicated that the federal government's effort should be directed into the valorization of technology in terms of new products and a production process through targeted investments and Government-Industry-Academia cooperation, beyond its traditional support of basic research. The National Science and Technology Council was founded in 1993 with the aim to "coordinate science, space, and technology" and to "coordinate the diverse parts of the Federal research and development enterprise." It is worth noting that again Japan was cited as a successful case of industrial technology advancement orchestrated by the government; hence it gave a rationale for a more active role of the federal government in the technology issue.

Is Japan catching up to the US in the field of technology policy? Undeniably, the US technology policy gave Japan the rationale for a more development-oriented and targeted technology policy.[58] However the challenges that face these respective governments seem to be quite different, so that the significance of their technology policy is far from being identical. In the US, industry and research universities have long and consolidated experiences of cooperation (Rosenberg, 2000), and the federal government reinforced its role of complementation and catalyst, while in Japan, the cooperation between industry and research universities has remained limited due to the existing institutional, legal, and cultural barriers. The implementation of the new philosophy calls for the removal or reduction of these barriers and the cohesion of all implied players – industry, universities and State – beyond the incentive measures. In this context, the Japanese government's task will be above all to convince industry and universities to build up a mutually beneficial relationship, and not just to complement one another.

[57] Several laws and programs, such as the Advanced Technology Program, the Stevenson-Wydler Technology Innovation Act and its successive amendments, and the Bayh-Dole Act, were implemented in this direction.

[58] As mentioned in the Overview of the "National Strategies for Industrial Technology" (2000). See Section 4.2.

4.2 National Strategies for Industrial Technology

The National Strategies for Industrial Technology (called the Strategic Plan) was presented for the first time in April 2000, and a revision is planned every two years.

Recognizing that Japanese competitiveness has decreased during the last decade and that Japan will face a decline in its labor force, and the increasing awareness of the sustainable development in the near future, technological innovation became the designated candidate to resolve all these problems. Thus the Strategic Plan declares the objective of shifting from the "catch up" style of technological innovation to that of "frontier creation." It proposes investing in a number of targeted fields,[59] which have the potential to develop new markets, and to set up a national innovation system capable of generating innovative and socially valuable technologies.

The Strategic Plan selects three R&D areas as beneficiaries of prioritizing government investment: those responding to social needs, seed technologies presenting innovative and basic characteristics, and intellectual infrastructure.

With regards to the national innovation system, four goals are specified:

1. To create a truly operational Industry-State-University relationship;
2. To reform Japanese universities with the aim of making them internationally competitive;
3. To nurture creative researchers and engineers;
4. To restructure the government's industrial technology support system.

The Strategic Plan also indicates a plan for each goal: for the first goal, to facilitate the exchange of people, capital and ideas; for the second, to set a competitive environment; for the third, to create a mobile labor market of researchers and engineers; and for the last one, to make the supporting system more flexible and responsive to the ever-changing technology trends.

There are two innovations with respect to the approach used to design the Strategic Plan. As opposed to the traditional way – i.e. a blueprint prepared by the administration is presented to the related committee and approved by the latter – working groups consisting of representatives from academia, industry and related Ministries and Agencies, were formed at the early stage with the aim of finding a common understanding of technological issues, to identify the drawbacks of Japanese industry and to investigate remedying measures, both at the national and sector levels. Thus, civilians were offered the opportunity to express their points of view and a cross-ministerial cooperation took place. Another point is that a cross-sectional approach was used to overcome the compartmentalization of decision-making. In the first instance, sector-level working groups formulated their expectation on the national innovation system, then these points were aggregated to design the common goals stated above.

4.3 Science and Technology Basic Plan II

The Science and Technology Basic Plan II has been prepared according to the following schedule: presentation of the draft by the end of 2000; discussion and presentation of the final version by the General Council for Science and Technology newly founded within the framework of the administrative reform of the Central Government, and adoption by the government by the end of March 2001.

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[59] Sixteen sectors were selected to implement the sector-specific strategy. Among them were biotechnology, information technology, machinery, chemistry, energy, environment, materials, and automotive.

The Preparatory Office of the Science and Technology Basic Plan,[60] set up at the STA and consisting of representatives from the STA, the ME and the MITI, started to review the Basic Plan I in 1999. Its aims were to assess the effects of the Basic Plan I, to identify inherent problems and to take them into consideration when preparing the Basic Plan II. Their conclusion[61] is summarized in Table 2.

Table 2. Review of the first Basic Plan

Items	Effects	Remaining problems
Competitive environment	Research funds allocated on a competitive basis were doubled between 1995 and 2000 Research funds targeted to young researchers were more than doubled during the same period	Limited total amount
Mobility	The objective "10,000 post-docs" was attained in 1999	Problem of follow-up after the post-doc period due to lack of a competitive market of researchers
	Time limited positions were increased within national research laboratories (129 positions in a total of 9,791 in 1999) Timid introduction in national universities (75 in 59,557 in 1998)	National universities not enthusiastic
Research environment	Investment in physical infrastructure was insufficient (total amount of budget has decreased between the period 1991-1995 and 1996-2000) The number of research support staffs by researcher remained low (0.84 at national labs and 0.24 at national universities in 1999)	To be improved
Evaluation	Assessment system on R&D themes and research institutions was introduced	Absence of feedback
	National universities have obligation to proceed to a self-assessment	Lack of transparency
Tripartite cooperation	Certain number of measures facilitating technology transfer were implemented	Limited effect

Source: "Follow-up of the Science and Technology Basic Plan" (January 2000)

The result is that the expectation of the Basic Plan I was not fully realized although the quality of the R&D environment was improved to a certain extent. Nevertheless, given that, the first Basic Plan I remained inertly tied to the linear model of innovation and was focused on "science" and "research activities," so that Japan still encounters difficulties when translating inventions in terms of innovative products. In other words, the "interface with the society" is not yet wholly established. To overcome this problem, the Basic Plan II launches its concept of science and technology as follows: science and technology within the society,

[60] Called the Office of Science and Technology Basic Plan later.

[61] See the reports "Follow-up of the Science and Technology Basic Plan" (Interim summary published in April 1999 and final report in January 2000).

serving the society, and receiving feedback from the society.[62] Accordingly, it defines three general objectives that Japan has to pursue, which are:

- To become a center of knowledge creation and exploitation;
- To build up a secure society;
- To ensure international competitiveness and sustainable development,

and specify how science and technology may contribute to reach these objectives.

Table 3. Innovation System According to the Basic Plan II

Targets	Means
Competitive environment	To increase competitive research funds following the US model To introduce the system of overhead
Mobility and autonomy of young researchers	To increase non-tenured and public offering positions To redefine the status of assistant professor and assistant
Evaluation system	To increase equity and transparency To reflect the results of evaluation on resource allocation To invest in staff training and in research on the evaluation system
Supporting system	To allow carrying over of research funds To increase autonomy and flexibility of public research institutions
R&D management	To enlarge the competency and the responsibility of the head of a research institution To make organization of R&D flexible
Tripartite cooperation	To inform the private sector on the public sector's R&D activities To reinforce matching between the private sector's needs and public sector's seeds To make the use of existing research cooperation systems more transparent and simpler
Technology transfer to the private sector	To reinforce support to technology transfer organizations To set the incentive mechanism to license privately-owned patents To open the way to transfer the right to patent or patents, and to grant exclusive license to the private partner within the framework of commissioned or joint research projects To open the way to transfer nationally owned patents to technology licensing organizations To set up an incentive mechanism for the creation of high-tech venture companies
Training of researchers & engineers	To improve the practice of evaluation carried out within universities To implement an internationally recognized accreditation system To make researchers & engineers aware of their social responsibilities
Science and technology infrastructure	To improve physical infrastructure To increase the ratio of support staffs to researchers To consolidate the "intellectual infrastructure" To become a participant at the international meetings on the intellectual property rights and standardization
Internationalization	To reinforce international R&D cooperation To become an information emitter To facilitate the international exchange of researchers

Source: Basic Plan II (March 2000).

[62] See the Basic Plan II (March 2000) at http://www8.cao.go.jp/cstp/english/summary.html.

The major change with regards to the Basic Plan I is that the government clearly affirms its intention to build a technological innovation system which will serve the society as a whole, and its preference for a "strategic" and "targeted" approach.

Besides the traditional support for basic research, research funds will be allocated giving priority to the fields of life sciences, information technology, environment, nano-technology and materials, energy, manufacturing technology, social infrastructure, and new frontiers likely to bring solutions to the major problems that will face society in the future. This choice reflects the guidelines of the National Strategies for Industrial Technology, though the argument to develop new markets is attenuated.

Regarding the innovation system, the Basic Plan II indicates the way the reform must be pursued.[63]

In summary, the Basic Plan II presents a vision of an innovation system functioning in a competitive environment and is based on close ties between industry, universities and national research laboratories, and on the dynamics generated by the exchange of people and ideas across these three sectors. Given the case of the United-States, which successfully stimulated the high-tech industry and engineered economic growth during the last decade by exploiting the synergy and complementarity between these sectors in a highly competitive environment, the Basic Plan II seems to go in the right direction. However the question remains as to whether the measures and means it proposes are justified, adequate and adaptable in the Japanese context.

The first point, "the creation of a competitive environment coupled with an evaluation system", can be perceived as a remedy for the malfunctioning of State intervention. Indeed, the market force alone is unable to induce an efficient level of R&D activities due to their public good characteristics and the presence of high costs, externalities, and high risk. Generally the State can intervene by implementing patent law, by executing R&D itself (through national research laboratories), by subsidizing R&D activities, by picking up winners, and by forming research consortia, etc. The efficiency of these measures depends greatly on the capacity of the State to overcome the problem of asymmetric information. The State faces problems such as:

- On which criteria the allocation of research funds must be based;
- How to guarantee that the researcher pursues an initially declared objective once research funds are allocated;
- If the State has allowed researchers the discretion to adjust their research projects according to the intermediary research results.

There is no guarantee that the State has better information than the private sector, thus the problem of public failure may arise. In this context, the decision to increase competitive research funds and to reinforce an evaluation system, which are likely to increase transparency of the State's decision-making process, is a move in the right direction, assuming that the administrative tasks remain manageable and that all players accept these new rules. It is worth noting that these measures are more easily applied in some research fields, mainly engineering, applied sciences, and life sciences, than in others, such as humanities and social sciences. In the latter, research activities contribute to increasing the knowledge base, and thus are likely to increase social welfare in the long-term, though their immediate social contribution remains limited. For this reason, and recognizing that only the State can maintain "discipline-diversity," the competitive allocation of research funds must be prevented from being directed only by a myopic approach and short-term gain.

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[63] See Table 3.

With regard to tripartite cooperation, legal,[64] administrative, and cultural barriers exist between industry, universities and national research laboratories. They restrain the free movement of people and ideas, which may result in an inefficient allocation of resources and in a deceleration of the process of innovation. Thus it is up to the State to remove or reduce these barriers and it has the capacity to do this, at least with legal and administrative barriers as illustrated in Section 3.3. The revision of the status of national universities is beyond the scope of the Basic Plan II. However, our point of view is that the acquisition of legal status by national universities is a pre-condition[65] before discussions on mutually beneficial tripartite cooperation can take place, the reason being that the latter should be based on decision-making by each player, and not by their tutors. The example of patent ownership within the framework of commissioned research by a private company is illustrative: the host national university is not eligible to become a patent owner, so that all inventions resulting from research activities under the contract fall into the hands of the State. As for the cultural barrier, the top-down approach is less well suited, the reason being that the perception one has of others does not change by decree. The State shall provide occasions to establish an informal network of people across sectors, for example by supporting private initiatives to organize forums or meetings. This is the solution proposed by the Basic Plan II to resolve the problem of asymmetric information between public research institutions and industry. By giving incentives in this direction, the State may play the role of catalyst.

The coordination among Ministries and Agencies involved in the sciences and technology, especially the ME, MITI and STA, constitutes a key element for a successful implementation of technology policy.[66] The reason for this is that each of them has its own competency and research institutions so that there is a strong possibility that their interests will diverge and that they will act as substitutes and even as competitors, instead of playing a complementary role. Putting aside the cultural aspects specific to each institution, the main barrier to the coordination comes from the fact that these Ministries and Agencies have a double function: a planning function and implementation, i.e. the execution of research projects. The weight in terms of R&D budget[67] is likely to induce a certain political power, thus policy planning may be biased towards the Ministry's or Agency's interests.

Until January 2001, the STA was assigned to plan, design, and implement science and technology policy with the aim of promoting science and technology in a coherent, efficient and effective way. The Council for Science and Technology, as a consultative organ on science and technology policies, has the means to play the role of coordinator. The fact is that neither the STA nor the Council for Science and Technology were able to arbitrate different points of view. One of the reasons may be the double function of the former, and the limited number of permanent staff and restricted competency of the latter. In practice, the Ministry of Finance plays the role of arbitrator at times of budget negotiations, with the risk that the financial considerations overshadow the scientific, technological, economic and social considerations.

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[64] For example, the national university is under the jurisdiction of the Special Law for Civil Servants in Education, the Official Requirements for the Establishment of Universities, the Law for Establishing National Schools, and National Schools Special Public Finance Law among others.

[65] Independent of the actual discussion on whether or not to apply the Independent Administrative Institution Law to national universities.

[66] Since January 2001, the MITI was renamed Ministry of Economy, Trade and Industry (METI). The ME and STA were merged and became Ministry of Education, Culture, Sports, Science and Technology (MEXT). However this fusion will certainly take time to become operational, and the problem of coordination between the MEXT and the METI remains. For these reasons, we maintain our argument in favor of coordination.

[67] Percentage of R&D expenditures by Ministry and Agency on the total R&D expenditure of the government in 1999: 41.7% ME, 24.5% STA, 16.1% MITI (ME, 1999).

The General Science and Technology Council, the successor of the Science and Technology Council founded in January 2001, is expected to play the role of coordinator. The main changes are as follows:

- The General Council, including its secretariat,[68] is directly attached to the Cabinet Office;
- Its membership was enlarged[69];
- There are fifty to sixty staff[70] including representatives of the industry sector.

In addition to these organizational changes, the General Council is allowed to advise the Prime Minister and other related Ministers on the science and technology policy, including resource allocation, beyond its consultative function (Law for Establishing Cabinet Office, 2000; Council for Administration Reform of the Central Government, 1997). Another innovation is the move from "science and technology" to the "academic sciences." By adding the term "General", the General Council intends to cover science and technology in a comprehensive way, including the humanities and social sciences, going beyond exact sciences, life sciences and engineering. The General Council shall prove its capacity to coordinate at the ground level, starting with the Basic Plan II.

5. Conclusion

The evolution of the Japanese technology policy shows that it is not just limited to technological advancement, but rather, there are significant economic, political and institutional implications. Thus, a comprehensive approach is needed to prevent generating any negative outcomes and to take advantage of the synergy that may exist among different policies.

With regards to the investment in the innovation process, the presence of market failures and the fact that the social rate of return is superior to the private rate of return justifies the State's intervention. The question remains over how to choose the means. Although a clear philosophy was already expressed in the 1949 white paper, the Japanese technology policy has often been dictated by short-term visions and external pressures. Japan had to wait until the advent of the 1990's recession before any reconsideration of its technology policy was instigated. The new philosophy, with a particular emphasis on social contribution, fixes objectives that promote tripartite cooperation, to create a competitive environment and set an evaluation system. Accordingly, different means are proposed within the framework of the Basic Plan II. However, one must keep in mind that these objectives are not the ultimate aims of the plan, just a means to remove or reduce existing barriers to free the flow of people and ideas, to set the rules of the game, and to generate the dynamics of innovation.

This is our last comment on the decision-making process. The trend, which dominates throughout this review of Japan’s technology policy, is the top-down approach. The State acts as a social planner by making decisions based on the information it possesses. In this context, the problem of asymmetric information may arise, and in some cases it is less costly to let private agents decide on their own preferences and then take advantage of the private

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[68] The secretariat of its predecessor was hosted by the Bureau of Science and Technology Policy (STA) and with the support of the Division of Academic Affairs at the Science and International Affairs Bureau (ME) regarding the university issue.

[69] Passing from ten to the maximum number of fourteen and leaving to the Prime Minister a greater margin to define the composition of members.

[70] Representatives from the STA and MITI and one civilian were appointed as chief executives of the secretariat. The five positions for counselor are occupied by representatives from the STA, MITI and Ministry of Agriculture (Yomiuri, October 29th 2000).

initiative, i.e. to benefit the bottom-up approach. How do we find the right balance between these two approaches? Our point of view is that the principle of subsidiarity has to decide on the relationship between private agents and the State: when private agents manifest difficulty in overcoming market failures, it is up to the State to intervene in a concerted manner, respecting the principles of accountability and assuming its social responsibility.

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Hikaru Sasagawa, Office for the Research Cooperation, ME, September 1999.

Akito Tani, Technology Strategy Planning Office, AIST, MITI, August 2000.

7. Translation

Academic Corporation	Gakko hojin	学校法人
Accounts Law	Kaikei ho	会計法
Agency of Industrial Science and Technology	Kogyo gijutsu in	工業技術院
Applied research	Oyo kenkyu	応用研究
Basic Law on the Administrative Reform of the Central Government (No.103)	Chuo shocho to kaikau kihon ho	中央省庁改革基本法
Bureau	Kyoku	局
Cabinet Office	Naikakufu	内閣府
Cabinet decision	Kakugi kettei	閣議決定
Center for Cooperative Research	Kyodo kenkyu shisetsu	共同研究施設
Chemical Evaluation and Research Institute	Kagaku busshitsu hyoka kenkyu kiko (http://www.cerij.or.jp/)	科学物質評価研究機構
Chemical Industry Council	Kagaku kogyo chosakai	化学工業調査会
Commissioned research	Itaku kenkyu	委託研究
Committee for National Strategies for Industrial Technology	Kokka sangyogijutsu senryaku kento kai	国家産業技術戦略検討会
Committee for S&T Basic Plan II	Kagaku gijutsu kihon keikaku tokubetsu kaigo	科学技術基本計画特別会合
Committee for Invention	Hatsumei iinkai	発明委員会
Cooperative Research with Private Sector	Minkan to tono kyodo kenkyu	民間等との共同研究
Council	Kaigi (Shingikai)	会議（審議会）
Council for Science and Technology	Kagaku gijutu kaigi	科学技術会議
Council for Administration Reform of the Central Government	Gyosei kaikaku kaigi (http://www.kantei.go.jp/jp/gyokaku/report-final/II.html)	行政改革会議
Current research expenditure	Ippanteki kenkyu keihi	一般的研究経費
Development	Kogyoka shiken	工業化試験
Development Programs for Medical and Welfare Apparatus	Iryo fukushi kiki gijutsu kenkyu kaihatsu seido	医療福祉機器技術研究開発制度
Division	Ka	課
Division of Evaluation	Hyoka bu	評価部
Division of Higher Education	Kotokyoiku kyoku	高等教育局
Dormant patent	Kyumin tokkyo	休眠特許
Effective utilization for commercialization	Jigyoka	事業化
Energy Conservation Technology R&S System (Moonlight project)	Sho energi gijutsu kenkyukaihatsu seido (Moonlight keikaku)	省エネルギー技術研究開発制度 (ムーンライト計画)
Evaluation Committee	Hyoka iinkai	評価委員会
Experimental Laboratory	Shikenjo	試験所
Fund for the Promotion of Creative R&D Based at Graduate Schools	Daigakuin wo chushin to shita dokusoteki kenkyukaihatsu suishin keihi	大学院を中心とした独創的研究開発推進経費
General Committee	Sogo bukai	総合部会
General Council for Science and Technology	Sogo kagaku gijutsu kaigi	総合科学技術会議

Grants and Endowments	Shogaku kifukin	奨学寄付金
Grants-in-Aid for Scientific Research	Kagaku kenkyu hi hojokin	科学研究補助金
Independent Administrative Institution	Dokuritsu gyosei hojin	独立行政法人
Independent Administrative Institution Law (No.103)	Dokuritsu gyosei hojin ho	独立行政法人法
Industrial Competitiveness Council	Sangyo kyosoryoku kaigi (http://www.kantei.go.jp/jp/sangyo/index.html)	産業競争力会議
Industrial Council	Seisan chosakai	生産調査会
Industrial Rebirth Council	Sangyo shinsei kaigi (http://www.epa.go.jp/2000/b/1019b-taisaku2-e.html)	産業新生会議
Industrial Revitalization Law (No.131) (Japanese Bayh-Dole Act)	Sangyo kassei saisei tokubetsu shochi ho (http://www.miti.go.jp/policy/business_infra/saisei-hou.html)	産業活性再生特別措置法
Industrial Science and Technology Commission (AIST)	Kogyo gijutsu kyogikai (AIST)	工業技術協議会（工業技術院）
Industrial Science and Technology System	Sangyo kagaku gijutsu kenkyu kaihatsu seido	産業科学技術研究開発制度
Industrial Structure Council	Sangyo kozo shingikai	産業構造審議会
Industrial Structure Research Committee	Sangyo kozo chosakai	産業構造調査会
Industrial Structural Reform and Employment Measures Headquarters	Sangyo kozo tenkan koyo taisaku honbu	産業構造転換雇用対策本部
Industrial Structure Improvement Fund	Sangyo kiban seibi kikin (http://www.isif.go.jp/english/index.html)	産業基盤整備基金
Industrial Technology Agency	Kogyo gijutsu cho	工業技術庁
Industrial Technology Commission (Office of the Prime minister)	Sangyo gijutsu kyogikai (Sorihu)	産業技術協議会（総理府）
Industrial Technology Council (MITI)	Sangyo gijutsu shingikai (MITI) (http://www.miti.go.jp/report/committee/index.html)	産業技術審議会（通産省）
Industrial Technology Development Plan	Sangyo gijutsu kaihatsu keikaku	産業技術開発計画
Industrial Technology Research Institute	Sangyo gijutsu sogo kenkyujo	産業技術総合研究所
Industry Competitiveness Council	Sangyo kyosoryoku kaigi	産業競争力会議
Institute of Physical and Chemical Research (Riken)	Rikagaku kenkyujo	理化学研究所
Intellectual assets	Chiteki shisan	知的資産
Intellectual social infrastructure	Chiteki shakai shihon	知的社会資本
IT Strategy Council	IT senryaku kaigi	IT 戦略会議
Japanese Accreditation Board for Engineering Education	Nihon gijutsusha kyoiku nintei kiko	日本技術者教育認定機構
Japan Federation of Economic Organizations	Keizai dantai rengo kai (Keidanren)	経済団体連合会(経団連)
Japan Industrial Technology Association	Nihon sangyogijutsu shinko kyokai (http://www.jita.or.jp/)	日本産業技術振興協会
Japan Science and Technology Cooperation	Kagaku gijutsu shinko jigyodan (http://www.jst.go.jp/)	科学技術振興事業団

Japan Society for the Promotion of Science	Gakujutsu shinko kai (Gakushin) (http://www.jsps.go.jp/e-home.htm)	学術振興会（学振）
Joint Research	Kyodo kenkyu	共同研究
Large Scale Industrial Research and Development System (Big project)	Ogata kogyo gijutsu kenkyu kaihatsu (O puro)	大型工業技術研究開発 (大プロ)
Law for Consolidating Research and Development System Relating to Industrial Technology (No.160)	Sangyo gijutsu ni kansuru kenkyu kaihatsu taisei no seibi to ni kansuru houritsu	産業技術に関する研究開発体制の整備等に関する法律
Law for Establishing Cabinet Office (No.89)	Naikakufu sechi ho	内閣府設置法
Law for Establishing Ministry of Education (No.146)	Monbusho sechi ho	文部省設置法
Law for Establishing National Schools (No.150)	Kokuritsu gakko sechi ho	国立学校設置法
Law for Facilitating the Creation of New Business (No.101)	Chushokigyo toshi ikusei kabushikigaisha ho	中小企業投資育成株式会社法
Law for Promoting Research Cooperation (No.57)	Kenkyu koryu sokushin ho	研究交流促進法
Law for Promoting University-Industry Technology Transfer (Law on TLOs) (No.52)	Daigakuto gijutsu iten sokushin ho	大学等技術移転促進法
Law for Reinforcing Industrial Technology (No.44)	Sangyo gijutsuryoku kyoka ho (http://www.miti.go.jp/kohosys/topics/00000087/index.html)	産業技術力強化法
Law for Straightening R&D System for Industrial Technology (No.33)	Sangyogijutsu ni kansuru kenkyu kaihatsu taisei no seibi ni kansuru horitsu	産業技術に関する研究開発体制の整備に関する法律
Law on Industrial Technology Research Association (No.81)	Kokogyo gijutsu kenkyu kumiai ho	鉱工業技術研究組合法
Law on the Standardization (No.185)	Kogyo hyojunka ho	工業標準化法
Subsidy for Industrial Technology Commissioned Experimental Research	Juyo kokogyo gijutsu shiken kenkyu itakuhi	重要鉱工業技術試験研究委託費
Measuring control	Keisoku kanri	計測管理
Ministry of Agriculture & Commerce	No shomu sho	農商務省
Ministry of Commerce & Industry	Shoko sho	商工省
MITI Testing Laboratory	Tsusan kensajo	通産検査所
Nation Based on Creation of Science and Technology	Kagaku gijtsu sozo rikkoku	科学技術創造立国
Nation Based on Science and Technology	Kagaku gijtsu rikkoku	科学技術立国
National Institute for Advanced Interdisciplinary Research	Sangyo gijutsu yugoryoiki kenkyujo (http://www.aist.go.jp/NAIR/nair_e.html)	産業技術融合領域研究所
National Institute of Technology and Evaluation	Seihin gijutsu hyoka senta http://www.nite.go.jp/index-e.htm	製品技術評価センター
National Property Law (No.73)	Kokuyu zaisan ho	国有財産法
National Research and Development Programs for Medical and Welfare Apparatus	Iryofukushikiki gijutsu kenkyu kaihatsu seido	医療福祉機器技術研究開発制度
National Schools Special Public Finance Law (No.55)	Kokuritsu gakko tokubetsu kaikei ho	国立学校特別会計法

National Strategies for Industrial Technology	Sangyo gijutsu senryaku http://www.meti.go.jp/english/report/data/gNSIT01e.html	産業技術戦略
New Energy Development Organization (NEDO)	Shin energi sogo kaihatsu kiko	新エネルギー総合開発機構
New Energy and Industrial Technology Development Organization	Shin energi sangyo gijutsu sogo kaihatsu kiko	新エネルギー・産業技術総合開発機構
New Energy Technology R&D System (Sunshine project)	Shin energi gijutsu kenkyukaihatsu keikaku (sunshine keikaku)	新エネルギー技術研究開発計画 (サンシャイン計画)
Next Generation Industrial Technology Infrastructure R&D System (Next generation)	Jisedai sangyo kiban gijutsu kenkyu kaihatsu (Jisedai)	次世代産業基盤技術研究開発 (次世代)
Office	Shitsu	室
Office for the Promotion of University-Industry Cooperation	Daigakuto renkei suishin shitsu	大学等連携推進室
Office of Science and Technology Basic Plan	Kagaku gijutu kihon keikaku shitsu	科学技術基本計画室
Patent Distribution Adviser	Tokkyo ryutsu adviser	特許流通アドバイサー
Patent Law (No.121)	Tokkyo ho	特許法
Program to Support 10'000 Post-docs	Posuto dokuta to 10'000 nin shien keikaku	ポストドクター等１万人支援計画
Public Finance Law (No.34)	Zaisei ho	財政法
Public cooperation	Tokushu hojin	特殊法人
Public utilities cooperation	Koeki hojin (http://www.toyama-u.ac.jp/~furuta/pub-enterp.html)	公益法人
R&D Officer	Kenkyu kaihatsu kan	研究開発官
Research Association	Kenkyu kumiai	研究組合
Research Laboratory	Kenkyujo	研究所
Research Institute	Kenkyujo	研究所
Science Council	Gakujutsu shingi kai	学術審議会
Science Council of Japan	Nihon gakujutsu kaigi	日本学術会議
Science and International Affairs Bureau	Gakujutsu kokusai kyoku	学術国際局
Science and Technology Basic Law (No.130)	Kagaku gijutsu kihon ho	科学技術基本法
Science based industry	Kagaku shugi kougyo	科学主義工業
Small and Medium-size Business Innovation Research System (Japanese Small Business Innovation Research Program: SBIR)	Chushokigyo gijutsu kakushin seido	中小企業技術革新制度
SME Investing and Promoting Company	Chushokigyo toshi ikusei kabushiki gaisha	中小企業投資育成株式会社
Special Committee for Basic Plan at the Council for Science and Technology	Kagaku gijutsu kaigi kihon keikaku tokubetsu kaigo	科学技術会議基本計画特別会合
Special Corporation	Tokushu hojin	特殊法人
Special Law on the Public Servants in Education (No.1)	Kyoiku komuin tokurei ho	教育公務員特例法
Strategy Planning Office	Senryaku kikaku shitsu	戦略企画室

Subsidies for Development System	Kogyoka shiken hojokin seido	工業化試験補助金制度
Sunshine Project	Sunshine keikaku	サンシャイン計画
Supplementary budget	Hosei yosan	補正予算
System	Seido	制度
System for Promotion of Coordinated and Creative Science and Technology	Sozo kagakugijutsu suishin seido	創造科学技術推進制度
Technology and Evaluation Infrastructure Institute	Seihin hyoka gijutsu kiban kiko (http://www.nite.go.jp/index-e.htm)	製品評価技術基盤機構
The Government of Japan's Reorganization and Reform Plan	Chuo shocho to kaikaku (http://www.chusho.miti.go.jp/)	中央省庁等改革
Three-Year Programme for Promoting Deregulation as Revised	Kisei kanwa suishin 3 kanen keikaku (kaisei) http://www.somucho.go.jp/gyoukan/kanri/990422b.htm#e02	規制緩和推進 3 ヵ年計画（改正）
University Council	Daigaku shingikai	大学審議会
Use of rights for defensive purposes	Boei tokkyo	防衛特許