National Industrial Technology Strategies and Japan's Innovation System

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1. National Industrial Technology Strategies

In December last year, the first compilation of a National Industrial Technology Strategy was released. This report contains the results of investigations that were conducted at high-level investigative sessions by industry, government, and academic leaders thinking about strengthening the industrial technological capabilities of the Japanese economy. Recognizing that the key to the Japanese economy's robust development in the 21st century lies in increasing the technological competitiveness of Japanese businesses and the promotion of innovation, the investigations were indicated by the Industrial Competitiveness Council, a body spearheaded by Prime Minister Obuchi Keizo.

The Strategy explains the strategic importance of national research and development investment in industrial technologies and of shifting the focus of the innovation system away from a catch-up mentality toward a frontier-oriented approach. Especially with regard to innovation system reforms, it addresses the role to be played by industry, academia, and the national government, and describes the issues that need to be tackled. It is a breakthrough plan in that it makes proposals regarding the entire Japanese innovation system, stressing the importance of mutually complementary relationships in that system. (Diagram 1)

The Strategy's specific policies can be divided into four categories. First is the "realization of genuine industry-government-academic tie-ups that result in technological innovations." It is often said that uncoordinated research activities undertaken by industry, government, and academia and the lack of reciprocal interaction among these sectors are the weak points of the Japanese innovation system, but there is an abundance of policies aimed at supporting tie-ups. It is especially important that the research findings of universities and national research institutions are applied in industry. The Strategy proposes support for technology licensing organizations (TLOs), which promote private technology transfers from universities, the granting of academic discounts on patent fees for universities and university professors, and the resolution of the problems involving people who hold concurrent posts as national university professors and private businesspeople, made famous by Nakatani Iwao, a former Hitotsubashi University professor who resigned to become an outside director of Sony Co.

TLOs are patent departments at universities set up under the Law Promoting Technology Transfer from Universities to Industry enacted in May 1998. Specifically, they are responsible for applying for patents for research findings from universities and preserving the rights of the parties involved in that research, conducting licensing of research findings to businesses, and holding seminars to publicize research findings. TLOs have been established at universities based on the Bayh-Dole Act enacted in the US in 1980, and today they can be found at 130 universities. In Japan, as of February 2000, organizations at 10 universities have received government approval, and low-interest loan systems and patent fee reduction measures are being established for approved organizations. TLOs are expected to further invigorate tie-ups between industry and academia.

The second category is the "promotion of reforms aimed to make universities internationally competitive." As can be seen in the large role played by Stanford University in the high-tech capital of the Silicon Valley, it is clearly of the utmost importance that university research be re-energized if industrial technological competitiveness is to be improved. Thus expectations for universities are high in terms of improving industrial technological competitiveness, but Japanese universities are lagging remarkably behind in terms of institutions such as incentive systems for researchers and their information infrastructures. All activities at universities, from the creation of new departments to the appointment of professors, are highly regulated, and it would be difficult to say that Japanese universities are suitable for the task of serving as wellsprings of innovation. Specific proposals for university reform include environmental improvements to facilitate the independent and dynamic establishment of departments and sections, and the active use of funding from multiple government agencies.

The infrastructure for information networks and research facilities is also lagging behind. At national universities, upgrades to the information infrastructure, such as information devices and the Internet environment, have been late in coming. For example, there have been stories about it taking as long as a month for new professors at certain national universities to be assigned e-mail addresses. Also, research facilities are becoming so worn out that they seem to be about ten years behind when compared to private research institutions. As is stated in the National Industrial Technology Strategy, if the industrial competitiveness of Japan is to be improved, it

Diagram 1

Outline of the National Industrial Technology Strategy

Current conditions

- The productivity of the Japanese economy began falling in the late 1980s, and has fallen beneath the OECD average.
- There was fierce cost competition with the newly industrialized countries primarily in Asia during the era of high competition. The United States and the developed nations of Europe have caught up with the production technologies in which Japan once held the competitive advantage, and there is fierce competition to differentiate products and provide added value.

A reduction in industrial technology capability is not typically a factor in the decline of corporate revenues, but rather a warning that the socioeconomic foundation that sustains everyday economic life is in danger.

"Industrial technology" is the dynamic force that drives our economy.

« Japan's Isolation »

- Japan plays a relatively small advisory role in terms of intellectual property rights and standardization in advanced fields such as information and communications.
- The number of start-ups resulting from university research and the number of venture businesses taking the lead in technological innovation is small compared to the U.S.
- Private companies tend to approach overseas rather than domestic research institutions when searching for a joint research partner or for an institution to do research for them.

Need to Reform the Technological Innovation System

« The U.S. Technological Innovation System »

- Strategic efforts since the mid-1980s to make greater competitiveness an explicit policy goal.
- Technological innovation system functions through new industry-academic-government tie-ups, such as the outsourcing of research to universities, and through venture businesses.
- Semiconductor and automobile sectors have regained their international competitiveness. The U.S. holds an overwhelming competitive advantage in innovative fields such as information, communications and biotechnology.

Direction of Industrial Technology Policies for the 21st Century

Change Focus of Technological Innovation System from Catch-Up to Frontier Creativity

3 Failures

(1) Failure to change the problems inherent in a vertical administration, and the inflexibility of the government.
(2) Failure to develop "self-sufficiency" in industry.
(3) Failure to change the inflexibility of the university system.

4 Goals

(1) Achieve meaningful industry-academic-government tie-ups that result in technological innovations.
(2) Promote reforms aimed at making universities internationally competitive.
(3) Cultivate highly creative researchers and engineers.
(4) Rebuild flexible government institutions that can adapt to worldwide trends in technological innovation.

Strategic Prioritization of Government R&D Investment in Industrial Technology

< Recognize Problems >
Now that the steady rise in the economy has ended, eliminate across-the-board equal allocation of resources and highlight strategic resource allocation in a more competitive environment.
< Principles of Prioritization >
(1) R&D investments that focus on social needs involving market creation.
(2) R&D investment in nascent technology that is innovative and fundamental.
(3) Investment in intellectual fundamentals, the basis of industrial technology developments.

Industrial Technology Strategy by Sector

Biotechnology
Information and Communications
Machines
Chemistry
Energy
Medicine / Welfare
Materials
Environment
Textiles, etc

Goal 1: Achieve significant industry-academic-government tie-ups that result in technological innovations

- Create an environment for using outside funding in national universities, such as a trust accounting system, and establish the same system in public schools.
- Promote joint research that matches the needs of industry to the nascent technology of universities and national research institutions.
- Establish local joint research centers to facilitate industry-academic-government tie-ups.
- Reform of national research institutions to make them attractive partners.
- Promote programs that allow national university professors and national institute researchers to work part-time in businesses.
- Promote programs that allow private company staff to work part-time in public universities and public experimental research institutions.
- Establish measures allowing TLOs to use nationally owned facilities within national universities without charge and establish procedures for assigning national patents to TLOs.
- Reduce patent fees for universities and individual professors (academic discount).-

Goal 2: Promote reforms aimed at making universities internationally competitive

- Implement autonomous university management (promote individuality).
- Create an environment in which academic departments and programs are managed autonomously and dynamically.
- Make active use of multifaceted funding from various government agencies.
- Improve the research infrastructure at universities.

Goal 3: Cultivate highly creative researchers and engineers

- Form a market for researchers by instituting such systems as a tenure system and a fixed-term employment system.
- Build institutions that offer young post-doctorate researchers a desirable research environment.
- Keep researchers active in a variety of fields including planning, management and assessment.
- Create a lifelong-learning system for engineers by establishing an accreditation system.
- Expand the educational system so that students from the elementary school level up are taught how to build things.
- Promote English language and information technology education, as well as education that cultivates an entrepreneurial spirit.
- Promote hands-on business research by educators and research in educational fields among researchers and engineers.

Goal 4: Rebuild flexible government institutions that can adapt to worldwide trends in technological innovation

- Organize and manage the Council on Arts and Science & Technology, which ensures adequate tie-ups between government agencies and among industry, academic, and government institutions.
- Give sufficient priority to industrial technology policies in developing basic plans for science and technology.
- Strategically strengthen the functions of policy-implementing institutions.
- Create schemes for assisting individuals such as university professors.
- Create a scheme wherein the government provides assistance to companies which, having themselves borne the risks and costs of research and development, are in the final stages of applied research.
- Maintain speed, transparency, and competitiveness and build a flexible budget processing and management system that looks at the entire research process by applying an appropriate assessment system, such as a peer review system.
- Make strategic use of an intellectual property rights system, strategically promote standardization, and improve the intellectual base.
- Facilitate the acquisition and use of patents through such means as reducing patent fees for small and medium-sized venture businesses.

is essential to undertake reforms aimed at creating internationally competitive universities. This does not mean merely extending reforms that have been undertaken thus far, but undertaking reforms on the basis of liberal ideas that are not constrained by the systems or budgets that apply to the university's activities.

The third category is the "training of highly creative researchers and engineers." For example, the academic career path at Japanese universities generally follows a seniority-based system within each research laboratory, where appointment and promotion processes are inflexible. Such a system prevents competition for results among researchers, and hinders their ability to attract top-rate personnel from private research institutions and other external organizations. Consequently, the National Industrial Technology Strategy proposes the active use of contractual hiring or the introduction of a tenure system through a public application process under which candidates are selected by independent judgement on the part of the university or by impartial external evaluation.

Also, from the perspective of building a life-long learning system to improve the skills of engineers, internationally adopted systems should be established, such as the introduction of an accreditation system for engineers and the improvement of the current technical consulting system. Further, the Strategy makes broad proposals for encouraging student internship programs in order to develop human resources in the manufacturing sector that can sustain the technology revolution, and expanding education to teach creativity and the entrepreneurial spirit starting in elementary and junior high school.

The fourth category is "the reconstruction of flexible government systems that can meet global trends toward technological revolution." It proposes that lessons be learned from the lack of coordinated, strategic investments by the various ministries in planning and implementing industrial technology policies, and suggests that the ministries need to cooperate, take a comprehensive view of the overall technological system, from the creation of technologies to their market development, and engage in strategic policy development. To achieve these goals, it is expected that the Council on Arts and Science & Technology that is to be established with the ministerial and agency revisions in 2001 will be put to use in drafting a strategic industrial technology strategy plan with the cooperation of all the ministries as well as between the government, industry, and academic sectors.

It is also important to introduce a system for evaluating government investments in research and development. The United Kingdom and Australia, for example, have established technology evaluation systems whereby the results of evaluations conducted on technology and development projects influence the planning and budgetary allotments of new projects. A developed system such as this does not exist in Japan. The Ministry of International Trade and Industry has established technology evaluation guidelines, and is now beginning to evaluate projects based on those guidelines, but there is still inadequate feedback of those evaluation results to new project planning. Revisions to this process are now underway.

2. The Debate over a National Innovation System (NIS) in the OECD

The National Industrial Technology Strategy contains proposals regarding specific policies for improving the entire Japanese innovation system by strengthening industry-government-academic tie-ups, while the OECD is also comparing the "national innovation systems" under which universities, national research institutions, and industries work together organically to produce innovations for the nation as a whole.

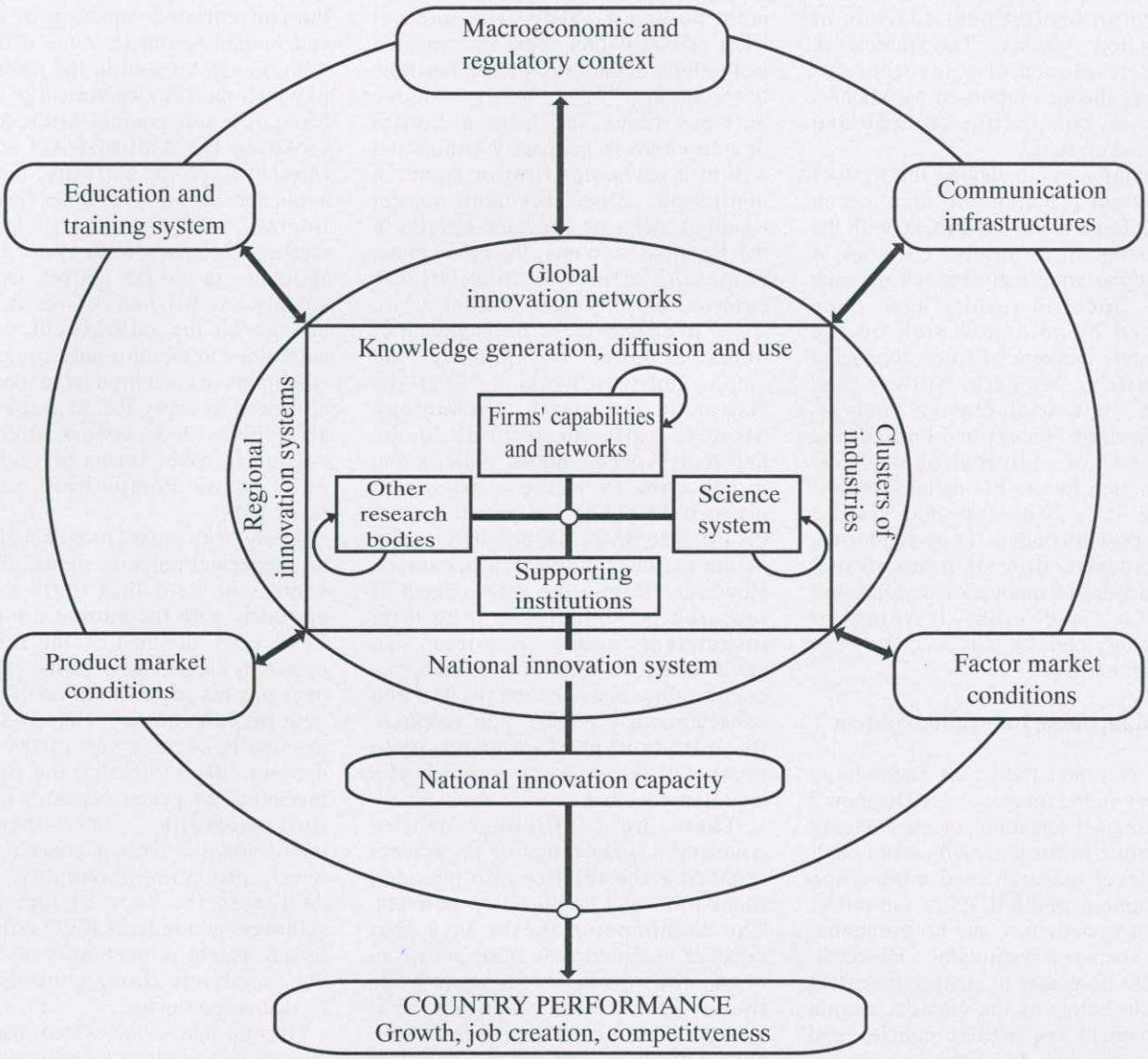
The debate over NIS was started in the late 1980s, led by professor Richard Nelson of Yale University, and an international comparative project was begun by a cooperative team comprised of Japanese, American, and European researchers. The findings were published in 1993 as a book entitled *National Innovation Systems*, which, while informative in terms of providing a history of each country's technology policies, provided neither a comparative analysis based on a common framework nor an adequate comparison of the systems in each country.

The OECD's NIS project started out as an international comparison of innovation systems using a common framework that was undertaken by the OECD Committee for Scientific and Technological Policy (CSTP) in their efforts to apply the results of academic research. A sample NIS analytical framework is shown in Diagram 2. It sets the focus on the revitalization of activities and tie-ups between private enterprises, other research bodies including the science system, comprised of such advanced reserch institutions as universities, and national research institutions, and their supporting institutions. Tie-ups between these institutions at the global, national, and regional levels lead to the formation of industry clusters and constitute a nation's innovation capacity. This innovation system is a multi-layered framework that is influenced by the existing macro-economic environment, the educational system, conditions of competition in the product and factor markets, and the information communications infra-structure. (Diagram 2)

The limits of traditional neoclassical microeconomics and new developments in economics provide the theoretical background of the framework for this kind of national innovation system. That is, according to neoclassical microeconomics, government intervention in private R&D is justified by the fact that without it the level of investment would be too small to be effective since

Diagram 2

Conceptual diagram of a national innovation system



Source: Managing National Innovation Systems, 1999, OECD, Paris.

the public rate of return will be larger than the private rate of return on R&D investment. The political implication is that government financial subsidies to private R&D activities will help maintain an optimal level of R&D investment. Because of this theory, discussions and investigations of only a very few policy tools, such as subsidies or tax breaks for R&D, have been conducted.

Nonetheless, recent developments in the field of economics have yielded broader analyses of technology policies. For example, the endogenous economic growth theory of Stanford University professor Paul Romer, et al., focuses on technology spillovers between firms, and theorizes that promoting technology transfers between firms and among the industrial, public, and academic sectors makes it possible to achieve long-term growth by increasing productivity. Also, neoclassical microeconomic theory treats the firm's production activities as a black box, but developments in institutional economics, which analyzes the effects of the firm's organizational structure or

human resource management on its business activities, has opened the door toward an institutional analysis of innovation systems. The framework being developed also incorporates business theories espoused by Michael Porter on competitive strategy and industrial clusters.

In addition to conducting this kind of theoretical research and creating an overall framework, the OECD, with the cooperation of its member countries, is conducting empirical research on each issue. Specific results have been attained by joint research on the innovative network of firms conducted by Austria, Denmark, Norway, and Spain, industrial cluster analysis performed by Norway and Finland, and analysis of international R&D cooperation by the EU nations. In the future it is expected that similar analyses will continue to be conducted, the understanding of international comparisons of innovation systems will increase, and cross learning of technology policies will occur between member nations.

3. The Japanese Innovation System

The National Industrial Technology Strategy in the framework in Diagram 2 has attracted attention for encouraging innovative firms, universities and other high-level research institutions, and government institutions to undertake innovative activities, and for promoting tie-ups between institutions. However, it is also necessary to analyze the effect of such factors as the macroeconomic environment, competition policies, and human resource development policies. Though the National Industrial Technology Strategy only touches on them briefly, intellectual property rights policies and standardization policies are closely related to the innovation system and investigations of innovation policies need to include studies on the form these policies should take.

For example, in considering what labor policies should look like in terms of promoting innovation, how should the trade-off between human resource liquidity and human capital development be approached? The internal labor market within firms and research institutions is the crux of the Japanese labor market. Few employees move between firms and human capital development is primarily conducted within a particular firm or research institution. Since this labor market rigidity is delaying structural reforms in the Japanese economy, the government is making efforts to stimulate the external employment market while trying to engage in the development of human capital to improve the employability of workers. Even the National Industrial Technology Strategy calls for reforms to the university system and for policies that promote the exchange of personnel between the public and private sectors for the sake of facilitating the liquidity of the market for research personnel. However, because the development of research personnel is a long-term investment and requires an environment in which researchers can comfortably ensconce themselves and conscientiously pursue their research, the introduction of an excessively competitive market could be counterproductive.

There are conflicting theories covering a wide range of arguments regarding the relationship between innovation and competition policies. The Schumpeter thesis says that creative destruction is born out of an oligopolistic market environment while the Arrow effect suggests that competition promotes innovation. Which theory is correct may depend on the nature of the innovation. A comparison of the two major 21st-century technologies, information technology and biotechnology, is instructive. In the field of information technology, as is evident in Internet ventures, a structure has emerged in which innovative creations occur as a result of the promotion of competition. In the field of biotechnology, however, the analysis of the human genome and genetic function analysis requires the processing of enormous amounts of genetic information, thereby making the concentrated injection of capital and human resources more effective. Also, as can be seen in the recent case in which the US Department of Justice brought a suit against Microsoft for violating the Antitrust Act with its Internet Explorer software, there are applicable examples in other fields (the Internet browser market) where the market dominance, such as that held by Windows in the OS market, has been solidly established. Thus it is not enough for the antitrust enforcement authorities to monitor only competition conditions in each product market; they also need to apply the Antitrust Act to all fields with a network effect, and engage in other forms of reviewing policies on competition through innovation.

Finally, with regard to the relationship to intellectual property rights, there are some who feel that there may be problems with the current pro-patent. Especially in the US, the range of patents is expanding, creating problems over patents of business methods and genetic information that is sure to eventually become part of the public domain. By protecting the rights of inventors, the patent system is a policy for promoting investment in innovation, but there is concern that in overly protecting monopoly, it also decreases the pace of technology spillovers and reduces R&D efficiency. Strong patent protection is necessary, but excessively strong protection may be counterproductive.

Thus an innovation system has to be constructed in close coordination with the overall economic system. Many problems exist in the Japanese innovation system, but it is important that further analyses be conducted on its relationships with each economic system and that an improved system be developed. JJTI

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