

Survey of Trends in the Development of Science and Technology Parks

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In recent years there has been a high level of interest worldwide in creating social systems which will encourage continuous technological innovation. This is due to the urgency in all countries to establish new regional economies with autonomus competitiveness, secure employment and rectify the disparity between regions as we search for a new, post-cold war international order and experience the global development of economic activity.

We are now strongly aware that, in order to bring about continuous technological innovation, it is important to create a framework as one kind of social system through a multitude of development and organized links of such development with the flow starting from the science and technology institutes and moving downstream, such as from basic research to applied research and developmental research, and the commercialization and industrialization of the results of that research.

In fact, the heightening of competition due to the globalization of economic activity and technological reform has altered social demands, particularly in industrialized nations, to the development of industrial development bases with research and development functions instead of the development of industrial estates simply as production bases. Especially in Japan, where the hollowing out of industry is feared, the role of the domestic production bases of major companies, which have long promoted regional development, is no longer that of mere production bases for low-value added products, forcing them to change tack to industrial bases with new functions.

Meanwhile, part of the incubators, devised as institutes to produce venture companies and employment opportunities in the United States at the end of the 1970's, were fortified in the 1980's through links with universities and succeeded in creating new development bases for cutting-edge industries and bringing about a gradual evolution in their form. As a result, these types of incubators which acted as institutes for the creation of cutting-edge technology through technology transfers from universities, again find themselves the center of attention in the 1990's. Today, the diversification of incubators around the world is being pushed ahead at a rapid pace. These can be broadly divided into three types according to objective - employment creating, industrial structure change and cutting-edge technology industry creating - although their format in development and management is extremely varied depending on their objective and function, and they differ according to country or region.

Given these present circumstances, this report labels this multitude of industrial development bases focusing on incubators "science and technology parks", studies their real state of affairs across a broad international and domestic spectrum, analyzes and assesses their type by function and the development objectives and management format of each base, and by taking them as "a social system to maintain continuous technological innovation", aims to contribute to policy formulation for science and technology institute establishment for the economic development of the country and the region and for new methods of using science and technology resources.

This report also makes proposals for the first time regarding the type by function of "science and technology parks" as the industrial development bases that are being vigorously developed in recent years, not only in advanced industrialized nations but also in developing countries. The first objective in doing so is to clarify an indicator to show the type of bases that should be developed when developing "science and technology social infrastructure", according to the location of accumulated science and technology resources or the level of economic development, for the efficient promotion of "technological innovation" in regional areas. Another objective is to clarify the functional differences of

"science and technology social infrastructure" for technological innovation, particularly between regions of European nations, the United States and Japan, by creating a common typing criteria, and find a direction for the study of new systems for international cooperation relating to science and technology resources.

Summary

Chapter 1 Background and Objectives

Progress in the globalization of economic activities is spurring on the dispersion across the globe of company production bases, as well as starting to accelerate the search for new business development towards strategic positioning of research and development bases. There are demands for the establishment of new regional promotion policies aiming for the improvement of intellectual productivity within the framework of the globalization of economic activities, particularly in advanced industrialized regions in which areas that have functioned as industrial production bases are now changing from mere production bases to research and development bases.

Aiming for a country format with multi-polar dispersion, Japan is making enormous changes in its policies for the promotion of regional economies in order to develop the regional economy and gain qualitative improvement in regional living, switching from "regional economic development through attracting investment and centered on production infrastructure" to "intra-regional economic development focusing on the establishment of research and development infrastructure to revitalize innovation". Here there are calls for the forging of a social system that will create new industry through regional technological innovation, with a broad-based awareness of the importance in terms of policy of not only the use of existing science and technology resources, but also their development and stockpiling.

Until now, a very limited number of institutes, including higher education institutes have undertaken research and technology development. Nevertheless, recent years have seen the brisk development of new science and technology institutes and bases for research (including basic research) and technology development, or for the industrialization and commercialization of the fruits of such research. This also means that a diverse range of management set-ups for these new science and technology institutes and bases and management methods have been created, and that these roles and function must be assessed anew. There is also the need to investigate the development and operation of these institutes for which so much is expected in terms of their effective functioning as tools in regional economic development.

The aim of this study is to comprehensively ascertain and assess the current state of a variety of overseas and domestic industrial development bases, which have taken on the functions of research and technology development in recent years, and in doing so, seek out the role of the diversifying science and technology institutions as social infrastructure, as well as searching for direction for new social systems that will encourage technological innovation that include these roles. The focus of this study is primarily on the science and technology parks (S&T parks) which, of the industrial development bases, particularly aim from the industrialization of science and technology outputs, as it newly types S&T parks from their differing composition of elemental infrastructure, studies the state of development of S&T parks in Japan based on these types, and analyzes and assesses them mainly from the perspectives of management of research technology development and the industrialization of the same. Analysis and assessment of overseas examples were also conducted to bring to light the characteristics of Japan's technological innovation system, and comparative studies made. Looking to the forging of a social system that will encourage continuous technological innovation, the report also puts forward proposals for the new development of regional technology policy by clarifying the role of S&T parks and their feasibility, and related issues in Japan.

Chapter 2 The Role of Science and Technology Parks

(1) The Process of the Emergence of Science and Technology Parks

By creating more sophisticated industrial activity, and function in the more efficient transfer to the industrial sector of science and technology seeds developed at universities and public research institutes, the industrial parks that were devised as production based in the United States in the 1950's, transformed into research parks in the 1960's in the United States, evolving in content further in the 1970's in the United Kingdom to science parks. With the arrival of the 1980's, the evolution continued when so-called "incubators" aiming to create industry were introduced into science parks and research parks, after which industrial parks as production bases became industrial development parks (S&T parks) with a clear awareness of innovation.

As of 1992, 3269 industrial parks, including those in the planning stages, had been developed in Japan. Needless to say, these acted as industrial infrastructure and contributed to Japan's economic growth. Nonetheless, as of the 1980's, these Japanese industrial parks also transformed themselves from inside from simple production bases for large quantities of materials to production bases for more sophisticated, high value added products by not only developing a more sophisticated industrial structure, but also through the promotion of a high level of knowledge intensive production bases. This type of evolution contrasts with that of industrial parks as seen in Europe and the United States which have mainly been prompted externally, with the clear objective of the practical use of science and technology seeds developed at universities and research institutes, that is, with those developed with a clear idea of their nature as industrial development bases.

(2) Regional Economic Development and Regional Science and Technology Policy

Japan is already in a period of transition from the up-till-now investment-drawing style of regional economic development to intra-regional economic development. The history of regional science and technology policy which has clear objectives for the stimulation of regional industries and the intra-regional development of industry, however, is only short. Needless to say the ultimate goal of intra-regional economic development is the continuous growth of industry and the economy through technological innovation. To this end, there is the need for comprehensive policy development which will encourage all technological innovation from the promotion of research and technology development within the regions, to the industrial application of the fruits of those efforts. While S&T parks may function as new industrial science and technology bases that link science and technology and industry and that are effective means of intra-regional economic development, this will require the development of S&T parks appropriate to each region in terms of regional industry and science and technology resource stockpiles, as well as effective management.

Chapter 3 Definition of Science and Technology Parks

(1) The Definition of Overseas Science and Technology Parks

Although a variety of formats has been developed for S&T parks in Europe and the United States, some countries do have clear definitions. There are strict definitions of "science park" as determined by the United Kingdom Science Park Association (UKSPA) in UK and the International Association for Science Parks (IASP), of "research parks" in the United States as prescribed by the Association of Universities Related to Research Parks (AURRP), for "innovation centers" in Germany as stipulated by the Association for Technology and Business Incubation Center (ADT), and for incubators in the United States as prescribed by the National Business Incubation Association (NBIA). Accordingly, when formally naming S&T parks, public institutes in Europe and the United States in principle do not use names that are defined and in use in other nations. It is unfortunate that these words are so easily misused in Japan. The definitions used in this study have been made with reference to the following definitions used in other countries.

(2) Classification of Science and Technology Parks

While relying heavily on the industrial and economic structures of each country, the world's S&T parks have been developed, and have spread, with individual goals in mind. This indicates the absence even now of internationally accepted definitions for S&T parks. As

such, we created 3 types and 12 classifications of S&T parks from 15 combinations of four elemental infrastructures that have been developed in the process of the evolution of industrial development bases (parks, research facilities and institutes, exchange facilities and institutes, and incubators), using a method that removes meaningless combinations.

Those four infrastructures denote the following. Park – “sufficient land or buildings with good quality environmental conditions for companies and research institutes to take up residence and conduct research and technology development”. Research facilities and institutes – “universities and other institutes of higher education, national and public research institutes, and private and third sector research institutes”. Exchange facilities and institutes – “facilities and institutes which conduct a variety of services, including research exchanges, training and information provision, in order to support research and technology development and industrial activities”. Incubator – “facilities and institutes which conduct a variety of specialist services for individuals and groups starting new businesses and companies which have just been established to support industry creation and provide business and technological support”.

(3) Survey of Japan’s Science and Technology Parks and their Definition

A preliminary survey was conducted through liaison with the bureau in charge of science and technology in each prefecture regarding industrial development bases focusing on research and development, concentrated bases for research and development to promote technology innovation, and industrialization support bases. After primary screening, a survey in questionnaire form was conducted on 137 science and technology institutes and bases regarding research and technology development functions and support functions for these, training and exchange functions and support functions for these, and incubator functions.

The results allowed us to define and classify the following 3 types of S&T parks in Japan by their difference in functions.

(a) Innovation centers: these have an incubation facility to support the establishment of industries, and may also have facilities and institutes for research and exchange. They do not, however, have parks to allow established companies to expand their business activities, including production activities at the same location, or to allow the new introduction of external research institutes. They could be described as metropolitan industrial development bases, conducting research and technology development in close conjunction with nearby universities, public research institutes and institutes of higher education and research, and aiming for intra-regional economic development through the industrial application of science and technology resources.

(b) Science parks: these have both incubation facilities to support new business development, and other major facilities within the park. With a relatively large area and, of course, space for a concentration of research institutes and research and development-oriented businesses, they also have room for companies passed the incubator stage who want to expand their business, and are large-scale parks which could be described as industrial development bases in outer lying areas. Many have been constructed in the vicinity of universities and areas with a concentration of research institutes, and, by implementing research and technology development in conjunction with universities and other institutes of higher education and research, aim to apply those results to industry as well as actively promote technology innovation in existing companies. Although their basic objective is intra-regional economic development, they also function effectively in bringing in industry from outside the region.

(c) R&D parks: Research housing complex constructed to bring together research facilities and institutes such as private sector research institutes, universities and public research institutes, but without incubation facilities for the application to industry of science and technology resources. Naturally the location and infrastructure provided is different to that of industrial parks. Access to city functions is important, as is access to transportation, the residential environment, the living environment and the natural environment. The placement of social foundations to support human intellectual productivity is one key. Some R&D parks

do not have research exchange functions and some do. This research exchange function improves the regional capability in research and development, and also entices research and development-oriented companies in from outside. Both types basically have been developed as tools for bringing in industries for regional economic development, rather than as institutes and bases for intra-regional economic development.

By applying the above definitions to the results of the preliminary survey and questionnaire, we found that as of March 1994, there were 111 S&T parks across Japan, including those in the planning stages. Of those, 46 (41%) were R&D parks, 36 (33%) were science parks, and 29 (26%) were innovations centers.

Chapter 4 Trends in the Establishment of Science and Technology Parks and their Objectives

(1) Establishment Trends

Estimates put the number of S&T parks around the world at approximately 1200, with differing names according to the country or the region; research parks (United States), science parks (UK), innovation centers (Germany) and high technology and industry development districts (China). As of March 1994, 70 S&T parks, of the three basic different types, had been established in Japan.

(2) Objective of Establishment

In Germany and UK the overwhelming majority have been established for the creation of high-tech industries. In Japan, however, a large proportion (69%), even innovation centers, have been established to support existing small and medium enterprises (SMEs), with more science parks established to bring in high-tech industries (58%) and support SMEs (53%), and R&D parks established to bring in high-tech industries (72%).

There are also 45 incubators which have been positioned and are managed in innovation centers (26 fully established as of March 1994) and science parks (19). Of these, less than half (38%) of the innovation centers and science parks answered that their objective was full-fledged incubation that sought to apply science and technology resources to industry.

In order that S&T parks become effective alternatives to industrial parks in developing intra-regional economies, efforts need to be made to develop a variety of S&T parks in line with the economic circumstances and state of stockpiling of science and technology resources in each region.

Chapter 5 Current Situation Regarding Science and Technology Parks

(1) Personnel Mobility and Research Exchanges

There is virtually no researcher secondment or dispatch, or research exchanges conducted within the S&T parks or with external institutes, and although there are regional facilities for research exchanges and joint research, there is no framework as a system for industrial application of science and technology resources through links between universities and public research institutes and industry.

(2) Research and Development Support Function

Although there is a strong awareness at both innovation centers and science parks of the importance of the research and development support function, this is due to the recognition that this function is absolutely essential to the full functioning of the incubators. The support, however, predominantly takes the form of locations, facilities and other tangibles, with almost no dispatch of researchers, research guidance, promotion of joint research and other personnel support.

(3) Management Bodies and Operating Expenses

Many of the innovation centers, science parks and R&D parks with exchange functions are managed by third sector companies or public foundations, while a large proportion of R&D parks without exchange functions are managed by prefectural or other local government bodies. Around half of the total revenue for operating expenses for S&T park managing bodies is supplied by local government subsidies (31%) and real estate leasing fees (20%).

Chapter 6 Present State of Incubators in Science and Technology Parks

(1) Establishment Trends

Incubators started to emerge in Japan from 1989, with 45 established nationwide as of March 1994. Of all S&T parks established to this point, 64% have incubator facilities. In contrast, a downward trend is seen in S&T parks in the planning stages for future construction, with only 49% of these expected to include incubator facilities. This may be due to not only the difficulty of operating incubators, but also the lack of entrepreneurs, the difficulty of procuring science and technology resources and the inability to judge the function of incubators and their economic effect in intra-regional economic development.

(2) Tenants

Preferred tenants in Japan are companies that have just been established, and existing SMEs that are trying to enter a new field. Only a very small number of incubators actively seek to bring in entrepreneurs trying to establish a new company. Rather than function to give birth to new businesses, Japanese incubators nurture nascent industries and use them in the development of new business for mature. There is a vast difference in both function and objective with the European- and American-style incubators which have the assumption that entrepreneurs will become tenants to begin new businesses.

(3) Tenancy Limitations

In principle, the maximum tenancy is three years in 56% of parks, with 24% having a maximum period of five years. Only one incubator provides assistance with transfer locations for tenant businesses.

(4) Characteristics of Tenancy Rate

Incubator tenancy rates tend to rise with the presence of active research exchange programs, and the number of services provided to tenant companies. Particular note should be made of the fact that research exchange activities and the provision of services are becoming essential conditions for tenants.

(5) Services

Although specialist services including consultancy services such as business establishment, finance and technology, and financial services such as venture capital and subsidies are generally provided in Europe and the United States (48 - 94%), in Japan only technical support (73%) and assistance (52%) are provided in more than 50% of facilities, and little use is made of external institutes. There is a particular dearth of detailed financial policy corresponding to newly started businesses and the various stages of growth in business. Many tenant businesses (67%) have their head office outside the incubator, and quite a number (65%) of businesses also take up tenancy some three or more years after establishment. As is evident from these figures, many incubators merely provide a site for already established companies, rather than supporting new businesses.

Chapter 7 Conclusions and Observations

(1) The Development of Various S&T Parks with Different Functions

S&T parks can be broadly classified into three types - innovation centers, science parks and R&D parks. Not only can they become effective alternatives to industrial parks in intra-regional economic development, but they may also be social bases of great importance in

promoting the establishment of science and technology institutions for research and technology development to further improve intellectual productivity in Japan which already has the course of fundamentals in place for productivity improvements.

(2) Development of Incubators with Clear Objectives and the Development of Management Systems for Them

A characteristic of incubators in Japan would be that many of them strive to create cutting-edge technology companies with the emphasis on research and technology development. Japan is lagging behind in relation to the development of incubators, however, and prior to beginning the development of "technology incubators" for the creation of cutting-edge technology industries, said to be the most difficult to develop, manage and operate, we should first actively introduce the more easily managed and operated employment-generating and industry structure converting types, for the sake of studying basic incubation measures.

Furthermore, as many companies taking up tenancy in Japan's incubators are "existing SMEs" which are seeking to move into new fields, supporting such activities has become the central function of the incubators. Should the establishment objective of incubators be to support the running and technological aspects of existing businesses rather than providing support for the foundation of businesses, then incubators should also take on more detailed functions in line with the needs of the regional industrial society instead of having a nationwide, broad agenda of creating leading-edge technology industries.

While it is important to promote research and development, nurture entrepreneurs and create new industries in encouraging intra-regional economic development, it would be highly desirable if, prior to this, Japanese-style incubators could be developed in line with the industrial and economic circumstances of each region, including employment-generating and industrial structure altering types. Naturally development of region-specific operating know-how would be required in order to do so, as would locating entrepreneurs and creating a system to develop them, and the assigning of incubator managers who can conduct overall management, assessment and practical application.

(3) Issues in Bases Established as Innovation Systems

Since the 1990's there has been a gradual shift offshore of production bases, primarily of sectors in debt, in conjunction with the globalization of the Japanese economy. This has led to predictions that the domestic production bases of Japanese industry will be forced to change their qualitative functions from being simply material production bases, to knowledge intensive production bases specializing in high value added products, and again to intellectual production bases for research and technology development. For local authorities, such changes in circumstances signify the need for systematic establishment of social bases for the effective implementation of research and technology development to encourage intra-regional technology innovation, whether industries are brought in from outside for regional economic development, or whether new industries are nurtured within the region.

Meanwhile, as technological innovation has been accelerated and become more select in recent years, even the SMEs developed within the region have had no choice but to move further upstream to basic research. At the same time, this also means that the role of administrative organizations, which have conventionally provided support for industrial activities at the upper end of the scale, that is the research and technology development part of industrial activities, have conversely been forced further downstream to broaden the recipients of their support. One would say, however, that the development of S&T parks and incubators in Japan has seen the establishment of many receptacle facilities, lacking in planning that would allow mutual, organic linking of functions as a social system for the creation of innovation. This necessitates the urgent implementation of the development of a social system for continuous technological innovation, with establishment of the following methods for physical infrastructure the minimum requirement. It will be necessary to: 1) strictly ascertain and assess the levels of stored science and technology resources in each region; 2) ascertain the science and technology needs from the industrial and living aspects

of the regions; 3) having done so, craft and put in place a social base as a social system for comprehensive knowledge production to realize a flow from basic research to technology development and their commercialization and industrialization.

(4) Organizational and Systemic Issues as Innovation Systems

In contrast to the relatively smooth establishment in Japan of physical aspects of supporting technological innovation, such as research and technology development facilities and institutes, it must be said that the country is lagging behind considerably compared to European and American society in terms of the intangible aspects (social systems) of stimulating and accelerating technological innovation.

The first issue is the difficulty of capital procurement for industries from the time of establishment, through their nascent period and even in the growth period. This is because there are almost no financial systems in Japan to support company creation from the establishment stage through the growth period, unlike the micro loan system for the establishment stage (US), the public capital system for seed capital for industries in their early stages (US and Europe), socially approved angel funds approved by society (US and Europe), over-the-counter measures which allow capital procurement prior to the release of shares on the stock exchange (US) and other financial systems to provide funds for company growth which are in place at every stage in Europe and the United States.

The second problem is the absolute insufficiency of exceptional entrepreneurs. This is clearly due to the minute number of entrepreneurs from universities and institutes of higher research in comparison with those coming from major companies in Japanese society.

This means that although 43% of the 640,000 full-time researchers in Japan (fiscal 1994) work at research institutes and universities, we can only hope for new spin offs from research institutes and universities if we are to expect technological innovation by venture companies in the area of leading technology . To this point, however, no incentives have been sufficient to encourage spins offs as entrepreneurs from researchers and technicians particularly in universities and research institutes. The background circumstances to this are very complex. With this firmly in mind, it will be necessary to begin crafting a new framework for a joint industry-academia system which focuses on incubation, including a review of the social role and function of universities themselves, in order to entice spin offs from universities and research institutes.