Direction for Technological Self-Reliance

–Korean Approaches

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Introduction

The prospects today for developing countries to enter into industrialization are not so evident ; nor can it be taken for granted that latecomers have the advantage. On the contrary, strenuous efforts are required to build up the capacity for embarking upon industrializ ation. Elimination of the obstacles to industrialization is a long-term affair which ideally should precede the industrialization process. If one were to try to accomplish the process all at once, the task would be formidable, or even impossible. Thus, a step-by-step approach should be taken to create the capacity for industrialization. In the process, one could capitalize on the advantages of being a "latecomer".

In any approach to industrialization in a developing country, great care must be taken in selecting the fields to be developed, along with deciding upon the extent of industrializ ation. These decisions must be based on a clear understanding of the country's potential and the constraints to which it is subjected. A country richly endowed with the natural resources necessary for industrialization may use a different approach from a country rich in human resources but possessing few natural resources.

To properly chart the path to industrializ ation requires consideration of numerous socio-political, cultural, and economic factors. The case of Korea is cited in this paper as an example. Korea opted for the development of light, labor-intensive industries by absorbing the labor force from the primary sector. However, the demand for industrial products in the primary sector was insufficient making it necessary to look outward for capital, markets, and technology. Korea, therefore, did not choose to develop industry by pursuing import-substitution followed by export-promotion policies. Rather the were undertaken almost simultaneously, particularly when the First Five-Year Economic Development Plan

went into effect.

The apparent success of this bold approach has been attributed to several factors : ① Amenability to training and the absorptive capacity of the labor force in dealing with relatively sophisticated technologies ; ② Close trade relations with the U.S.A. and Japan, the two largest markets : ③ Full exploitation of the technical advantage of being a latecomer to industrialization ; and ④ The capacity to adapt to the international economic environment, which was actively suppoted by the Government through the creation of a favorable investment climate for foreigners.

The most conspicuous constraints for the rapid industrialization scheme were the deficiencies in the social overhead sectors. Because the infrastructure for industrial development was poor, the Government placed great emphasis on quick and decisive action to construct roads, ports, and communications and other facilities essential to development, including expanding existing facilities for technical education. About 50 percent of the total foreign capital induced was spent for these facilities, on top of over 70 percent of the total public loan funds from overseas.

The First Five-Year Economic Development Plan (1962-1966) called for selective industrialization on the one hand, and the establishment of social infrastructures on the other, allowing the national economy to find its proper berth. Such industries as power, cement, fertilizer, and coal mining were among the targets selected by the Government. Light industries such as textile, plywood and consumer goods evolved largely by private entrepreneurs who saw viable domestic markets for those products.

The Second Five-Year Economic Development Plan(1967-1971) pushed forward the continued expansion of basic chemicals, petro-chemicals, and the iron and steel industries. Growth momentum was eatablished through these sectors so as to make their dynamism felt throughout the Korean industrial sector. These industries are highly capital intensive by nature and thus require a huge infrastructure which has to be supported by the Government. They would not necessarily develop sufficient linkage effects directly, but they are essential to the foundation upon which high linkage industries can be established. One pressing problem in developing these leading was whether or not they could be operated at, or at least near, full capacity, The leverage was found to be extremely small, because the capital needed for these industries, most of which originated from abroad, was much higher than that required in advanced countries. This hard fact of life heavily influenced the design of every industrial project.

The Third Five-Year Economic Development Plan(1972-1976) more or less followed the same direction of industrialization. Greater economies of scale were needed, along with the development of agriculture and social services, to capitalize on the previous experiences of advanced countries as well as Korea, and thus maximize the advantages of the latecomers. This orientation necessitated the introduction of newer and higher level technologies of a magnitude never before experienced. It was an irreversible decision and an answer to the issue of survival or extinction in an ever-stiffening international competition.

The technological development of any country usually starts with the importation of advanced foreign technology and proceeds—through development of domestic variants of

this imported technology–to the final goal of technological self-reliance. However, little can be expected from imported technilogy in the absence of the capability to modify and improve it for domestic applications. Therefore, to achieve viable results from the technology ransfer, corresponding efforts must be made in assimilation and adaptation.

With these thoughts in mind, this paper will try to relate the role of technology to Korea's experiences. More attention will be given to the role of technology at the national level, not because I believe in highly centraliz ed system, but because of the impact it can have at the national level. The Goverment has a crucial role to play during various stages of industrialization and the choice of technologies to achieve these goals.

Macro / Micro Linkages for Science and Technology Development

In developing countries, technology has come to be viewed as one of the most important means of achieving national progress. Given this, I am going to discuss here the role that science and technology have played in Korea's development. Particular attention will be focused on the use of high technology, as this was the path chosen by Korea in its press to industrialization and to evolve into an outward-oriented economy. While less sophisticated technologies can surely serve the needs of some aspects of national development, it was determined that the high technology path would afford Korea the most option in attaining is development goals. The decision to choose the high technology path resulted from the realization that the problems which burden a developing country require a bold and innovative strategy for their elimination. The Korean Government formulated intensive policies and strategies for the development of science and technology with many innovative support measures. The major elements of the policy guidelines for the 1970's were the :

1. provision of a solid foundation for scientific and technological growth ;
2. Strategic development technology ; and
3. Creation of a favorable climate for science and technology.

This was followed by concrete planning for the most efficient execution of these policies, under which a three-pronged approach was adopted emphasizing manpower development at various levels, accelerated introduction of foreign advanced technologies, and stimulation of domestic R&D activities. To this end, the implementation plan was formulated in consideration of both institutional and legal factors.

The institutional framework of this approach was somewhat daring. It included the establishment of : ① the Ministry of Science and Technology(MOST) in 1967 as the central Government policy making, planning, coordinating and promotional body ; ② the Korea Institute of Science and Technology(under the KIST Assistance Act) in 1966 as an autonomous multi-disciplinary industrial research institute ; and ③ the Korea Advanced Institute of Science(KAIS) in addition to existing universities and colleges, to be a mission-oriented post-graduate school in selected fields of applied sciences and engineering. KAIS was to be an autonomous institution, receiving financial support chiefly from the Ministry of Science and Technology. Its function was to educate a sufficient number of high calibre scientists and engineers to meet the emerging

needs of Korean industry. Finally, many vocational training institutes and high schools were established to meet the rapidly rising–almost explosive–demand for skilled workers and technicians.

In recognition of the need for an institution to bridge academia and industry, the traditional and the contemporary, and the domestic and the foreign, the concept of an intermediary agent was introduced. Accordingly, Korea first established an independent, multi-disciplinary industrial research institute(KIST). Next came about the reinforcement of an information clearing house for industrial research, followed by the establishment of quality control and instrument calibration service centers as short-term measures in selected fields of industry. As a long term measure, the Korea Standard Research Institute(KSRI) was organized to support industry.

The Korea Institute of Science and Technology (KIST) was created to bolster the industrial sector, particularly in those areas where the national economic development plan emphasized the elimination of bottlenecks hindering further growth. This institute was established, through special legislation, as a multi-disciplinary contract research organiz ation to make researchers aware of the marketing of technologies. In the realm of R&D, KIST was intended to make researchers problem-oriented and to impress the underwriters of such R&D with the importance of the implementation of the R&D results.

As industry grew, technological requirements increased in level and diversity. As a result laboratories, such as those in shipbuilding, petrochemicals, electronics, telecommunications, machinery and energy, which existed as integral parts of the institute, were no longer able to render sufficient technical support to industries growing at such a rapid rate. Independent research organizations specific to each industry and problem area became necessary. In order to address this formidable task, the Government made use of existing small laboratories at KIST as seeds, and spun them off from the mother institute. Thus, they inherited not only accumulated experience but a workable management philosophy and a system all too often missing in a new organization.

In order to operate these institutes effectively, the Daeduk Science Town established to house research organizations, both public and private, as well as higher educational institions. Daeduk Science Town is an intellectual complex designed to contribute to the development of science and technology. It is expected that the Science Town will develop as the cradle of Korea's burgeoning science and technology, eventually acting as the center of national excellence.

Although there are several devices for inducing industries to carry out R&D, the most essential is providing soft capital for technology development, due to industry's limited fund resources.

In this respect, I will expand on Korean examples : the Korea Technology Advancement Corportion(K-TAC), Korea Technology Development Corporation(KTDC), Korea Development Investment Corporation(KDIC) and Korea Technology Finance Corporation (KTFC).

In 1974, K-TAC was organized to carry out the commercialization of R&D results of KIST. The paid-in capital of K-TAC was US$4.7 million, of which KAIST holds 51% control, with the remaining 49% divided among other sources. Currently, K-TAC has

8 subsidiary companies with a total investment of US$1.4 million. It will add 6 more subsidiaries in 1987.

KTDC was established in 1981 as an autonomous public enterprise. To promote the R&D projects of industry which inherently involve substantial risks coupled with expected high returns, KTDC is willing to share both the risk of failure as well as the benefits of success. To this end, the corporation offers three different types of financial support ; long-term loans, conditional loans and equity investments. The major activities of KTDC include support for all aspects of the introduction, improvement and adaptation of advanced technology, particularly semi-developed technology from abroad, the commercialization of R&D results, the development of new products and processes, and the support of plant engineering services. KTDC also provides special services in the area of technical advice, feasibility studies for R&D activities, technology transfer and management. The local currency resources are composed of ₩26.8 billion in paid-in capital, ₩66.5 billion in technology development financing debentures and ₩11.0 billion in Government loans. Foreign exchange resources were obtained from first and second IBRD loans in the amount of US$44 million and US$ 12 million, respectively. Of the total funds approved during 1985, 37% were approved for 77 projects of the metal and machinery industry, 30% for 61 projects of the electric and electronics industry, and 33% for 50 projects of the chemical and other industries. The breakdown of projects showed that 86% of the total amount was provided for R&D activities and the commercialization of R&D results, 12% for technology imports and training, and 2% for the purchase of R&D equipment.

In another case, KDIC was incorporated in December of 1982 by the seven Seoul-based short-term finance companies in Korea. As a limited liability venture capital company, KDIC is designed to foster and strengthen the technology oriented small and medium industries in Korea through equity investment and / or equity-type investment. In addition to the provision of financial support, KDIC expects to support the management of its portfolio companies through its participation on the Board of Directors of these companies, as well as through the provision of business advisory services. The paid-in capital of US$ 12.0 million was contributed not only the seven short-term finance companies in Seoul, but also international or forgign business organiz ations such as the International Finance Corporation(IFC), Asian Development Bank(ADB), German Finance Company for Investments in Developing Countries(DEG), American Can Company, Credit Agrico(UEI, France), Japan Associated Finance Co. (JAFCO) and Westinghouse Electric Co., U.S.A. Since the establishment of KDIC, 98 projects have been invested in. The investments include common stocks, preferred stocks as minority shareholders, convertible debentures and debentures with warrants. As of the end of June, 1986, the portfolio of KDIC by industrial classification was as follows : 32% for 38 electronics projects, 14.4% for 11 metal fabrication 14.6% for 7 non-metallic mineral products projects ; 13.2% for 18 food projects and 2.3% for 2 miscellaneous projects. KDIC purchases debentures and makes short-term loan for working capital only to its portfolio companies.

Lastly, KTFC was established in October

of 1984 by the Korea Development Bank as a venture capital company. Its initial capitaliz ation was $10 billion(US$12 million). Currently, the paid-in capital of KTFC is twice that amount. During 1985, KTFC approved 71 projects of 58 firms and supplied funds equivalent to ₩21.3 billion in the form of equity investments, acquisition debentures, credit loans and conventional loans. The financial support during the year consisted of 24% to R&D activities, 45% to the initial commercialization of new technology, and 31 % to improvements in the manufacturing processe. To meet the urgent need of industry for manpower trained to handle high level technology, the Korea Advanced Institute of Science (KAIS) and the Changwon Technicians Collage were established. KAIS provides post-graduate programs in applied science and engineering in selected fields. This institution is trying to contribute a "center of relevance" to the nation's economic development rather than merely creating a "center of excellence" in academic pursuits. The Changwon Technicians College was established to guarantee a new social status based on professional pride in the skilled worker's career. This institution makes it possible for a skilled worker to become a master foreman through education in the necessary theoretical background and administrative skills, and later to become a manager of supervisor with the same social standing as a regular college graduate.

In the early 1970's, the growth of Korea's economy surpassed that of a semi-developed country and approached that of an industrializ ed nation. As a result, nurturing the potential of science and technology became an immediate need. The trend at this stage of development is naturally to turn an eye to the development of basic science. Until-recently, the Government. led the development of industrial technology. Many industrial research institutes were established and operated under the strong support of the Government. By the mid-1970's, the conditions for technology development in the private industrial sector were vastly improved, with private industry's capabilities being greatly escalated.

Research activities for basic sciences had to be supported on a national scale as the source for industrial technology. The support of basic research activities in universities and the establishment of the Korean Science and Engineering Foundation were a step forward in strengthening basic research field. In addition, systematic and mutual cooperation between government, universities, industry and research institutes was recognized as a necessity. While enterprises in industry encouraged to finance their own R&D activities through the law for the Promotion of Technology Development, those lacking in their own facilities and research personnel are induced to consign R&D tasks to "Specialized research institutes" either entirely or on a cooperative basis. In addition to this method of promoting cooperation between industry and academia, plans have been drawn up to establish an integrated research system to include basic, applied and development research.

The Government also finances R&D activites jointly with private enterprise. The benefits of these joint research ventures naturally accrue to the enterprises involved, and have led to the creation of a number of laboratories financed jointly by private enterprise and the Government. Future government policy must focus on securing funds and research personnel for these institutions. As previously stated the

lack of investment in R&D is one of the constrainst to technology development, particularly in the private sector. Even enterprises with money for technology development may not know which organization might be best able to solve their technological problems. On the other hand, even if a research institute has developed a promising technology, it is not always an easy task to find the appropriate client for it. An intermediary to bridge academia and industry with sufficient funding capacity might offer a ready solution to these problems. It is suggested here that a specially equipped financial institution could act as such an intermediary. Industry, a research institution and a financial intermediary could form a tripartite system of cooperation to aid technology development. To create this tripartite system, a financial institution which will play an effective intermediary function must be located.

The Ministry of Science and Technology spearheaded the enactment of several very important laws for the development fo science and technology. They include : The Law for the Promotion of Technology Development of 1972, to provide fiscal and financial incentives to private industry for technology development ; The Engineering Services Promotion Law of 1973, to promote local engineering firms by assuring markets and performance standards ; The Assistance Law for Designated Research Organizations of 1973, to furnish legal, financial and fiscal incentives for research instites in specialized fields emphasized by the Gvernment and private industry ; and, The Law for the Korea Science and Engineering Foundation of 1976, to provide a legal basis for the establishment of the Foundation to act as the primary agent for strengthening research in basic and applied science and engineering. The foundation centers around universities and facilitates the rapid application of science and engineering to fit national needs.

Among these measures, I shall draw special attention to the Law for the Promotion of Technology Development of 1972. The law was passed to encourage the private sector to adapt and improve imported technoloy, and to develop domestic technology through the R&D activities of government-subsidized laboratories. Subsequently, various tax and financial incentives have been provided. As a result, an ever-increasing number of enterprises have been allocating funds for R&D projects, and long-term low interest loans have been granted to those enterprises seeking to utilize newly developed thechnologies for commercial purposes. Encouraged by this government policy, many firms in the private sector are now showing a keen interest in establishing their own laboratories and equipping them with the necessary facilities and qualified staff.

The Government took a follow-up step in 1977 by amending the aforementioned Law to : ① extend the tax and financial incentives to a wider range of industries, while making R&D activities mandatory for strategic industries ; ② take protective measures to create demand for products embodying newly developed domestic technologies ; and ③ organiz e the industrial Technologies Research to search for solution to the problems facing small and medium enterprises and provide

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them with guidance in technology development.

Future Development Strategy

Considering that industrialization had to be established almost from scratch, a huge stimulus needed to implement the process. Accordingly, a leading sector was chosen to provide the impetus for launching industrializ ation, and rapid economic growth was achieved through the concentration of support in this sector. I have already noted these leading industries in the course of discussing the effects of long-range economic planning in Korea. It can be recalled that most of these industries require large, capital intensive facilities to produce raw materials or semiprocessed materials with comparatively low added-value.

Relying on a leading sector of this kind makes it necessary to attach great importance to the economic unit. That is, it becomes necessary to think in terms of economies of scale not only from an economic but also from a technical point of view. Therefore, once these industries achieved great relative importance within an industrial structure, growth came to hinge on expansion. This expansion leads to a vicious spiral of an ever-expanding scale as the condition for maintaining the industrial system and its high-level growth. The problem arises over whether this momentum can be maintained endlessly. In any case, this kind of growth has many unwanted side effects.

The obstacles to pursuing this type of development are formidable. First, it ultimately demands a very large-scale industrial system which can be maintained only at the cost of chronic instability, considering the nearly total dependence on foreign countries for needed raw materials and energy. This demand in turn implies many serious problems related to the tremendous infrastructure needed, the building of transportation networks, environmental management and the resultant unnecessary competition in the international markets. Once a country has reached the take-off stage in its development, some kind of boost may be necessary to ensure that the momentum of development is maintained. However, it is equally imperative that the industrializ ation prcess be put back on a normal trak as soon as possible. To this end, a unique industrial structure and direction for the industrialization process must be established on the basis of the actual conditions in a given country.

In view Korea's conditions, it would seem that what is needed is not the blind pursuit of an ever-increasing scale. Instead, the industrial structure should stress the manufacture of products with a high added-value stemming from the asset of high quality labor force combined with sparing use of natural resources and energy. In this way, it wil be possible to develop strategically specialized industries which emphasize technology and brain-power. If kept small in scale, they may not be hampered by huge infrastructures wich in turn require immense capital investments. Thus, it should be possible to achieve stable prosperity while avoiding unnecessary competition in the international division of labor.

In making this point, it is not may intention to minimize the significance of large-scale industries. Rather, the development of these basic industries should be pursued with some restraint in order to free the resources necessary to support the minimum demands of the more specialized industries which produce high value-added products. After all, ensuring

a stable supply of major raw materials and semi-processed products is a prerequisite for a final product which will successfully compete in international markets. In other words, basic industries must be developed as a foundation for industrialization, but the scale and in terms of the specific goals being pursued. Moreover, it is necessary to achieve a balance between quantitative and qualitative production as well as between facilities and technology.

It is, therefore, quite evident that, in a country like Korea with its limited territory, scarce natural resources and high population density, it is skill and brainpower which provide the base for national development. Consequently, while we are laboring to foster the needed manpower, we must also search for a technological development strategy to employ this superior manpower within an industrial structure which makes the most of technology and brainpower. To place emphasis exclusively on those industries which require a huge infrastructure would result in prevailing instability with the concomitant loss of the opportunity to join the ranks of developed countries. Taking this perspective, it is clear that our efforts must be bent toward achieving that "small but advanced" type of development which is exemplified by such European countries as Switzerland, Belgium, the Netherlands, Denmark and Sweden.

To realize the technology-intensive industrial structure, we can see that it is necessary to ; ① foster the development of strategically specializ ed industries ; ② optimize the social and industrial system ; and ③ promote the quest for a high technology society. As was pointed out earlier, strategically specialized industries will have to be characterized by a propensity to economize resources and create employment opportunities, while requiring minimal capital investment and producing little environmental pollution. Furthermore, a country has to minimize its spending on social overhead to compete successfully with fully indutrialized and resource-rich nations. For this reason, optimization of the social and industrial systems is a very important strategic goal.

As is evident, Korea has made many achievements in a short period of time over the past quarter century. During the first three Five-Year Economic Development Plan period (1962-1977), the GNP growth rate averaged 10 per cent per annum in real terms, with exports, which consisted of more than 90% manufactured goods, reaching the level of US$ 10 billion in 1977, from $55 million in 1962 . On the other hand, because of this rapidity of growth, there are areas in which the growth is superficial and only quantitative. Efforts must be devoted to those areas to provide assistance and to close the gap between quantity quality.

Viewing Korea's economic development from such a vantage point, one can reflect on the goals and policies of science and technology development and how they were implemented thus far. In order to join the ranks of industrially advanced countries, Korea needs to redefine its goals, formulate new strategies, and chart a new course with respect to technological and industrial development. Ways must be found to break away from the conventional macro-growth pattern towards micro-substantiality. More serious attention must be given to long-range problems. These future-oriented, long-term problems obviously cannot be undertaken by a few individuals or by a limited number of institutions. Con-

certed, organized and systematic efforts are called for on a national scale, with all sectors-government, industry and academia-participating. Conversely, these national-scale tasks must have a nucleus on which other capabilities and talents are to be assembled. The Korea Institute of Science and Technology for instance, could very well serve the role of the nucleus because of its diverse experience in technology development and project management. Since the solutions to these problems require long lead times, investment and preparations must be made as early and promptly as possible. Determining priorities among tasks must be accomplished with long-range global targets in mind. The following suggests a hierarchy of considerations for future national-scale projects :

First, efforts which increase competitiveness in the international market to ameliorate the present industrial structure in the direction of producing goods and services high in added-value with minimum use of resources ;

Second, areas which will precede and lead others and exert far-reaching effors on them

Third, efforts which require high risk, high cost and long duration, hence, not being able to be undertaken by industry alone, e.g., energy, resources, the environment, etc. ;

Fourth, areas which will provide the nation with a unique industrial and economic position internationally ;

Fifth, areas which will serve as the base for nationally strategic industries, e.g., microelectronics and new materials development ; and

Sixth, efforts of a techno-economic character for community development.

Along with these guidelines, KIST established detailed criteria for selecting future-oriented research areas and formulating the long-term development plans.

One area of paramount importance which meets the suggested criteria is materials research, including development and localization. Materials technology constitutes the base of the machinery industry and other specialized industries such as defense, electronics, and energy. Furthermore, innovative materials technology will provide the break-through to induce new products or new industries. In other words, it will contribute to the innovation of technology and advancement of industry. Materials technology largely consists of process "know-how", which is well-protected by the countries which possess it. Also, due to the recent trends of protectionism and nationalism on the export of technologies and resources, access to "know-how" by means of purchases or licenses is becoming increasingly difficult. Even if the technology were acquired, assimilation and adaptation to Korean needs will be difficult without the extensive experience of working with it. For this reason, research and development in this area on a national scale is indispensable and urgent.

One other area of national importance is that of fine chemicals. This is particularly important as Korea possesses most of the needed raw materials and intermediates, which are now domestically produced. Some indigenous mineral resources include fluorspar and silicates, which could be used for manufacturing fine chemicals. Other rationales for the development of fine chemicals include their high value-addedness and Korea's accumulated experience in chemistry and chemical engineering. There are other areas in which Korea

must step up development efforts for reasons similar to those illustrated. Among them are information technologies including optoelectronics, communication and computer engineering, echatronics, biotechnology, the broad and interdisciplinary areas of software science and engineering, energry development, environment management, safety, and land utilization.

Looking at the situation from another angle, science and technology, especially technology based on science developed during the second half of this century, has exerted a great global impact on mankind, resulting in the apex of the so-called "industrialized society", this impact has become greater and greater in recent years, leading to a societal transition that is often compared with the Industrial Revolution. Such a societal change due to recent, rapid technological progress will transform our present society into postindustrial or information society.

As can be easily observed, advanced countries are now tending to switch their industry-oriented development strategies to information-oriented ones. Developing countries are bound to be affected by this trend, and thus are required to turn their eyes toward a new information-oriented development strategy in the foreseeable future. In order to meet this demand, they have to seek and adopt the basic concept of an information-oriented society. The first step towards this new concept is to establish a system for the settlement of an information-oriented society. The following seven factors might be essential to the pursuance of an information-oriented society in light of the computerization process :

- The establishment of a computerized administrative system such as an office automation system ;
- The development and utilization of a managerial information system ;
- The formation of a nation-wide information network ;
- The systemization of a distribution structure ;
- A systematic approach for social development, such as the development of a traffic control system, improvements in communication systems, pollution prevention and restriction system, etc. ;
- Computer-oriented education ; and
- Popularization of computer uses to create a computer-minded society.

Among the preceding items, the most pressing demands for the nation will be in the computerization of administrative systems and the utilization of managerial information. These are to be developed in parallel with the establishment of nation-wide information network. The following priority should include, based on the fore-going target, the development traffic control systems, the improvement of communication system, the prevention and restriction of pollution, and the systemization of a distribution structure. All of these are oriented towards series of new social developments. These tasks should then be followard by computer-oriented education and the popular uses of computer facilites in the face of entering into an information-oriented society in a real sense.

With all these changes in mind, one can foresee the increasing importance of the " management of technological change". In the coming days of great societal change, individuals will be required to possess knowledge of new technologies, whether sophisticated or not. Hence, the managers, either at the national or industrial firm level, should bear in

mind the application of proper technologies for the changing circumstances.

Concluding Remarks

First, for developing countries, which in most cases suffer from the vicious cycle of underdevelopment of many kinds, especially economic, it is imperative to have some lead sectors pursued with a daring mix of technologies and entrepreneurship to break through the inertia of underdevelopment.

Second, planners in many developing countries have taken industrialization to mean " economic development". Less significance has, however, been placed upon the need for industrial research in countries where industrializ ation has been chosen as the economy's prime mover. The importance of industrial research has only very recently been recognized not only for its supportive role in economic development, but also-and perhaps more importantly-in producing the framework for the formulation of economic development strategies.

Third, massive efforts to mobilize domestic talent and bring it to bear on the problems at the grass-roots level, be they agricultural or industrial, are not only desirable but essential to realize national industrialization goals.

Fourth, developing countries should not be swayed by the prevalent notion that their generation of technology is not economical, if not impossible. On the contrary, there is a vast scope and an absolute need in developing countries for the generation of technologies by those countries themselves, or perhaps in collaboration with countries where there are enlightened governments and people.

To accomplish this requires the right people more than anything else, as they are the only ones who can change the methods and the milieu. Lastly, I would like to emphasize that developing countries have to prepared to face the upcoming challenges in an information society. As John K. Galbraith asserts, the future society is one in which science and technology will determine the direction of socio-economic changes. The speed of such a societal change is accelerating and the area of impact broadening, while the nature of change is even more sophisticated.

The development success stories we have witnessed in the last century are distinctly limited in number and it behooves us to think of something daring and innovative in approach if we are to leap the gulf which separates the developed from the underdeveloped, the rich from the poor, the urban from the rural, the industrial from agricultural, and mental labor from manual. In striving toward its national development goals, Korea has recorded substantial achievement.

Through a series of trial and error, Korea has succeeded in providing qualified technical manpower, in improving national scientific and technical capabilities, in innovating administrative and support systems, and in increasing as well as focusing on R&D investment.

These total science and technology efforts were intended to effect a structural change in the economy from a simpl, labor-intensive to a more technology-intensive structure, and later to the development of a brain-intensive one. In other words, Korea's efforts have been directed toward accelerating the transition of the role of science and technology from one of supporting national economic development to one of directing this development toward the establishment of a technologically self-reliant society.