KOREA'S STRATEGY FOR LEADERSHIP IN RESEARCH AND DEVELOPMENT

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FOREWORD

The Republic of Korea (Korea) is one of the United States' most significant trading partners and a growing economic ally. It is the world's largest producer of dynamic random-access memory (DRAM) chips and among the top manufacturers of ships, consumer electronics, and automobiles. In recent years, the annual growth in Korea's gross domestic product (GDP) has remained high, at between 5 and 8 percent, and by 1995 the per capita GDP was $9,990, more than $1,500 higher than in 1994; in 1996, the per capita GDP reached $10,600. Much of Korea's past growth has been achieved through investment in large-scale facilities, development of infrastructure, and aggressive acquisition of the most advanced technology available in the global marketplace. In the process, the Koreans have developed a range of sophisticated procedures for transferring technology, some of which may provide insights into practices of other developing countries.

The continuation of Korea's high economic growth will increasingly depend on technological innovations produced within Korea. As a result, the government is placing great emphasis on stimulating indigenous technical advances and on a business climate more conducive to innovation. In 1996, the government spent $1.1 billion on nondefense research and development (R&D), a 15 percent increase over 1995.

Korean industry also continues to place great emphasis on technical advances. Despite slower economic growth in 1996, the Korean Industrial Technology Association (KITA) issued an extremely optimistic 1997 forecast for R&D spending and other R&D indicators. Nearly 80 percent of KITA members responding to a survey believed company R&D expenditures would increase, compared with just less than 30 percent of U.S. respondents in a similar survey by the Industrial Research Institute. Similarly, more than 70 percent of KITA respondents forecast increases in the number of R&D professionals, compared with about 15 percent of their U.S. counterparts.

This report, "Korea's Strategy for Leadership in Research and Development," is part of a series published by the Office of Technology Policy on Asian science and technology infrastructure and strategies for technological innovation. Our research suggests the following observations:

- Korea employs a wide variety of methods of technology transfer, ranging from licensing and stock purchases to academic exchanges and research databases.

- The majority of technology being transferred to Korea is absorbed by the top chaebols (conglomerates).

- Korea is determined to upgrade its technological infrastructure and improve its competitiveness by implementing a systematic, integrated globalization strategy that harnesses the strengths of business, academia, media, and government.

- Korea continues to engender admiration from U.S. business, given its achievements since the Korean War, and caution due to the lack of transparency in its business practices.

INTRODUCTION

> Expanding technology investment and cooperation with U.S. companies is an urgent objective of the current government. While our business community has lost its dominant position in light textiles and consumer goods, the electronic, heavy manufacturing, and chemical industries are booming and aggressively seeking to make their technologies more competitive.
>
> *– H. K. Kim, Korean government official, 1996*

Korea is rapidly developing its own industrial infrastructure to ensure its competitiveness and continued growth in the global marketplace. A key component of this infrastructure development is the assimilation of technology and management techniques developed by more industrialized nations, especially the United States. Together, the public and private sectors of Korea have focused strategically on competitiveness through increased technological self-sufficiency and identification of new sources of technology. The Korean globalization strategy takes advantage of all opportunities to improve its technological infrastructure and global competitiveness. This report explains the methods of technology transfer employed by Korea's public and private sectors.

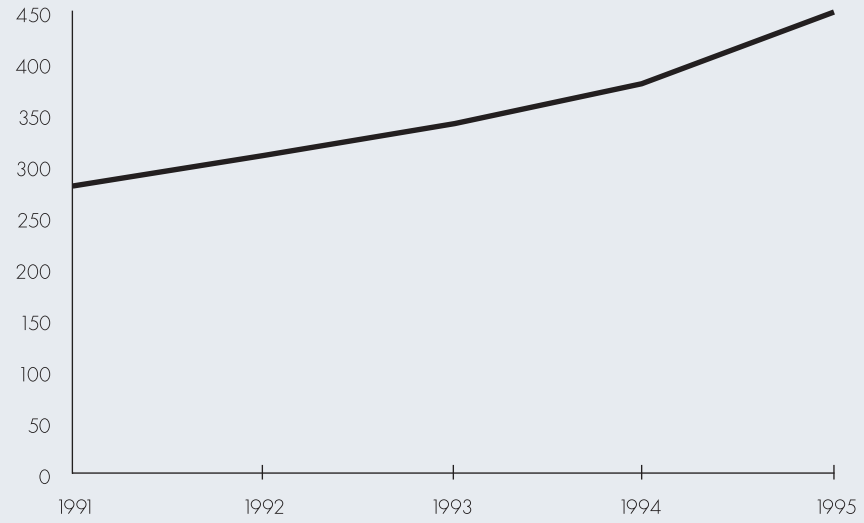
Economic Background

During the past 20 years, Korea has enjoyed a steadily increasing standard of living as its economic strength has grown. The rapid growth of the 1970s and early 1980s, propelled by the government-led development strategy, was tempered by a slowdown in the late 1980s. This lag mirrored a variety of socioeconomic changes taking place in Korea, including further democratization of the political process and pent-up demand among its consumers. The serious problems—a deficit in the current account balance, 10 percent inflation, and a dropping GDP growth rate—have steadily improved during the first half of the 1990s. In 1995, with a population of 45 million, Korea had a GDP of $447.6 billion, or a per capita GDP of $9,990 (figures 1 and 2).

During the past 20 years, Korea has enjoyed a steadily increasing standard of living as its economic strength has grown.

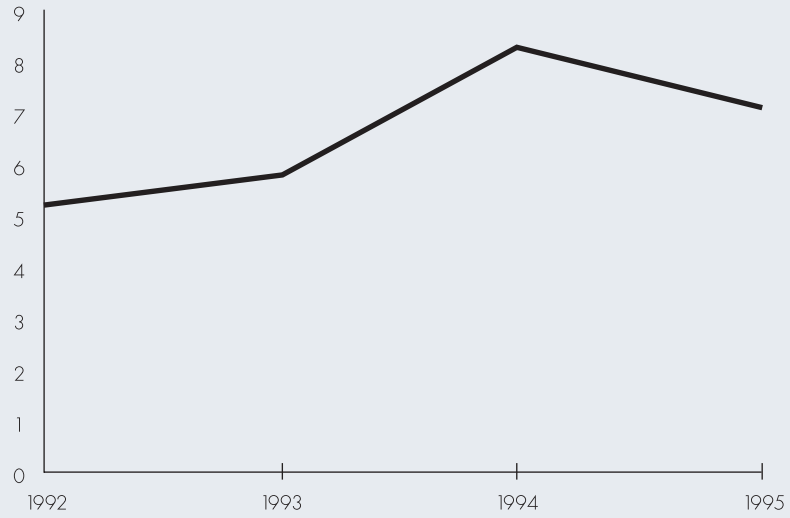
While the GDP and wage rates continue to rise (wage rates have grown 14.5 percent since 1994), inflation has remained steady at 6 percent. And between 1979 and 1995, Korea's manufacturing output increased by an annual average of 9.9 percent. Even Korea's foreign debt remains low, at $60.5 million (1995). These consistently positive economic indicators,

Figure 1. Korea's GDP, 1990 to 1995 (billions of dollars)



Source: U.S. Department of Commerce, 1996

Figure 2. Korea's Annual per Capita GDP Growth Rate, 1992 to 1995 (percent)



Source: U.S. Department of Commerce, 1996

crowned by a relatively flat inflation rate, reflect both the increasing standard of living in Korea and economic stability.

However, while many of the economic indicators paint a pretty picture, some of the underlying factors are putting pressure on the Korean economy, including its trade deficit, which totaled $2 billion in 1995, and the rising wage rates that are boding so well for the individual Korean worker. These high wage rates are one cause of the decline in Korea's share of the light industry manufacturing market.

Highlights of Korea's Industrial Development

Korea's industrial and competitive development has advanced through well-defined stages to reach its present position. This progression reflects the development of Korea's industrial economy in general and the development of its competitive advantages in particular.

Korea has already left behind its first competitive development stage, generally referred to as the factor-driven stage. During this period (the 1960s and 1970s), Korea's key competitive advantages were its abundant and inexpensive labor and its ability to acquire technology through the purchase and imitation of foreign capital goods. Korea capitalized on these competitive advantages by expanding its export-oriented light industry, investing in large-scale production facilities, and improving its process technology. At this time, the government began taking a leadership role in the development of Korea's technological competitiveness by establishing its scientific institutions and providing the foundation for its scientific infrastructure. The government also launched national R&D programs for civilian technology to promote the assimilation of imported foreign technology.

Korea capitalized on these competitive advantages by expanding its export-oriented light industry.

Korea then progressed into its investment-driven stage (the 1980s and early 1990s), during which it concentrated on acquiring and assimilating the most advanced technology available in the global marketplace. Korea's improved manufacturing capability became a competitive advantage, enabling it to expand its technology-intensive industries and increase its R&D capacity.

The investment-driven stage has been characterized by a pragmatic, integrated strategy that harnesses the strengths of the private sector, academia, and government. Together, the public and private sectors of Korea have strategically focused on competitiveness through increased

technological self-sufficiency, identification of new sources of technology in such places as Russia and China, development of new products from technological sources other than traditional suppliers, and increased foreign investment by Korean firms, especially in Southeast Asia, the United States, and Europe. Technology transfer and assimilation have formed the basis of the Korean competitive infrastructure.

Korea continues to parlay its dominance as a processor rather than an innovator and is still gathering and assimilating knowledge from outside sources to build technological strength.

The Korean government has retained its leadership role, channeling limited capital into specific industries, promoting risk taking, protecting its domestic markets to encourage the entry of national firms and the construction of efficient facilities, stimulating and influencing the acquisition of foreign technology, and encouraging exports. The government continues to encourage local industries to expand their investments in R&D through such incentives as accelerated depreciation allowances, investment tax credits, deferral of income tax payments, and duty-free import of selected capital goods. The government is also involved with business development in support of strategic industries and has significantly boosted R&D spending to develop key technologies and thus increase global competitiveness. A notable example is the planned investment of $27.25 million in the research and design of High-Definition Television (HDTV) technology.

The Korean government is also active in creating and promoting a climate for science and technology (S&T) within its society to help the transition to the innovation-driven stage. With the cooperation of the academic, industrial, and media communities, the government has initiated a nationwide science movement whose main objective is to "create an environment in which the general public can apply scientific principles to daily living with a spirit of rationality, efficiency, and creativity" (USG DOC.#SM95-10004). This type of nationwide public support for science and education has provided a strong foundation for individual and community support for technological infrastructure development.

The Korean government has placed a high priority on developing indigenous technological capabilities and creating a world-class industrial infrastructure by 2001. It has recognized that economies with a strong domestic infrastructure in terms of technological assets and capabilities are better equipped for global competition and that those without such an infrastructure must utilize other advantages to create incentives for the technology to come to them. Korea continues to parlay its dominance as a processor rather than an innovator and is still gathering and assimilating knowledge from outside sources to build technological strength.

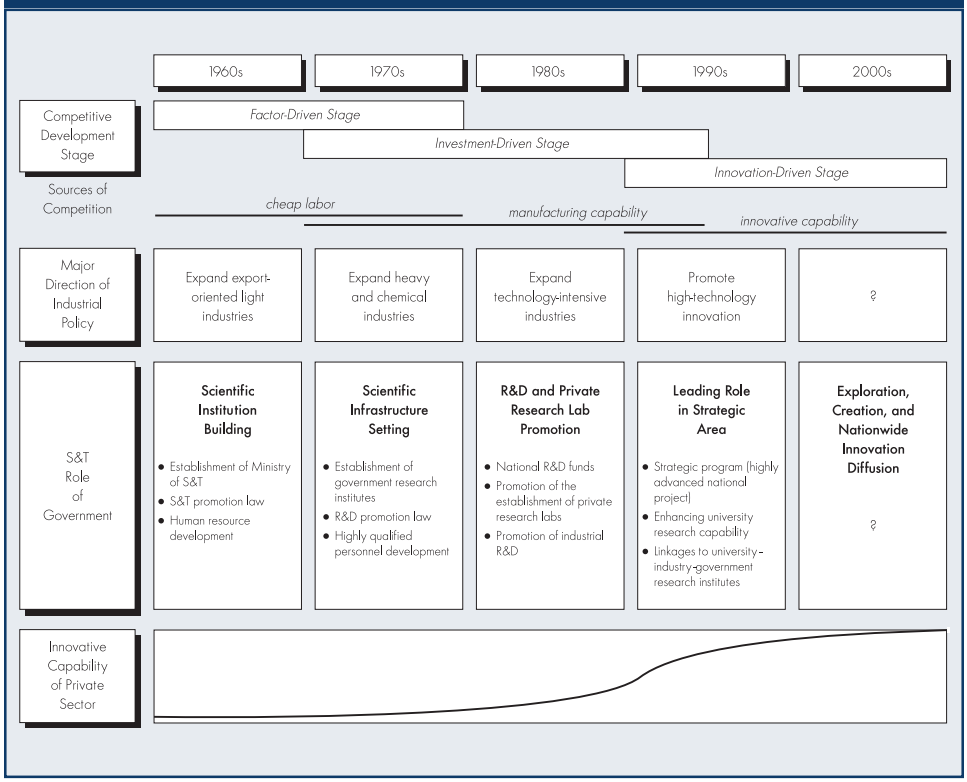
The Korean government and the chaebols have worked both independently and together to make up for the shortcomings of their technological infrastructure and are focusing on obtaining foreign technology from industrialized nations through direct and indirect methods.

Korea is slowly making the transition from the investment-driven stage to the innovation-driven stage, in which its major source of competitive advantage will be its capability for innovation. This transition is fraught with challenges, the most difficult being the generation of high rates of technological innovation. Many of the chaebols are already competing in the sophisticated global market, and consequently, Korea is undergoing structural changes that favor high-value-added industries. Leading chaebols such as Samsung, LG, Hyundai, and Daewoo are positioned at the forefront of their industries and are in the process of globalizing their R&D centers to develop state-of-the-art technologies. But although these chaebols have begun to support technological innovation, the Korean government's national system of innovation is still weak in its creation of scientific knowledge and technology. The question remains, How will Korea, while still working to build its technological infrastructure, obtain enough technology to ignite indigenous innovation?

Continuing Obstacles

Korea's bureaucratic approach to managing foreign investment is incompatible with the needs of many foreign firms, particularly U.S. firms. Many companies are wary of Korean business practices and continue to raise questions about Korea's respect for intellectual property rights, its limited market access for goods and services, its labor and wages, and the compatibility of management styles and goals. Korea maintains restrictions on foreign ownership including case-by-case approval for foreign investment. The terms of trade and the openness of the Korean market are a source of friction with the United States. U.S. firms have concerns related to accessing technology in Korea and purchasing Korean firms. Business deals, according to U.S. firms, have suffered from serious bureaucratic limitations, and many U.S. firms are simply staying away, not convinced that they are dealing with Korean companies on a level playing field. Korean firms and the Korean government are making steady progress but are still learning how to engage in business and technology transfer so that a net positive result is ensured for both parties (figure 3).

Figure 3. Evolution of the Korean Government's S&T Role



Conclusion

Together, the public and private sectors of Korea have strategically focused on competitiveness through increased technological self-sufficiency and identification of new sources of technology.

Together, the public and private sectors of Korea have strategically focused on competitiveness through increased technological self-sufficiency and identification of new sources of technology. This report will focus on the opportunities for technology transfer and the methods Korea uses to obtain cutting-edge technology. The following is a discussion of a full range of technology transfer methods, from direct purchases of patents to the more subtle method of academic exchange of scientists and engineers, all of which are employed by the chaebols and the government.

Leading Sources for Technology Transfer

In its drive to build its technological infrastructure, Korea has acquired and assimilated technology from a number of more advanced countries. Recently, the United States has been the most favored partner for strategic industrial cooperation. In 1994, technology imports into Korea from the United States rose 21.3 percent, from 122 cases to 148 cases; technology imports from Japan dropped 18.2 percent, from 137 cases to 112 cases. The Ministry of Trade, Industry, and Energy (MOTIE) and the Ministry of Science and Technology (MOST) have established policies to engage U.S. companies in broad-based programs of technology cooperation with Korean firms, taking advantage of any opportunity to improve Korea's technological infrastructure and global competitiveness. Information gathered from Korean newspapers over the past two years shows the following numbers of press reports that mention a specific country in the context of technology transfer or plans for technology cooperation: United States, 62; Russia and Japan, 13; China, 4; Australia and Germany, 3; and Canada, England, France, Israel, Netherlands, Sweden, and Ukraine, 1 each.

In its drive to build its technological infrastructure, Korea has acquired and assimilated technology from a number of more advanced countries.

Korea's shift from other Asian-Pacific countries toward the United States as its preferred source of technology is also evidenced in data reported in the Korean press on MOST's "brainpool" program—a program developed to recruit foreign (especially Korean-American) scientists. Combined data for the first two groups of scientists selected in a worldwide recruitment drive in 1994 and in a separate program in Japan by the Korea Institute of Science and Technology (KIST) show that 35 scientists came from the United States, 12 from Japan, 9 from Russia, and 7 from the People's Republic of China (China). Two scientists from Canada and one each from Australia and Sweden were selected. As with the data from press reports, the United States is the preferred source by a large margin.

Korea favors the United States for a variety of reasons. In general, U.S. companies are looking for capital to expand operations and new markets for their products, while the Koreans are looking for technology to both enhance their economic growth and develop indigenous technologies. Korean firms remain committed to competing on a global scale and view cooperation with the United States primarily as a means to acquire needed technologies.

In addition to looking to the United States and other advanced nations, Korean companies are pursuing available technology in less obvious

places, for example, the Newly Independent States and China. These nations offer a high level of education, a strong background in basic R&D, low prices for patented technology, and low labor rates. China, in particular, offers its geographic location, which facilitates the flow of products and people, and cultural similarities, which ease business communication.

Korean Policy to Develop Advanced Technology: The Highly Advanced National (HAN) Projects

As part of its globalization strategy, the Korean government developed a plan to select and develop strategic industrial technology requiring nationwide R&D investment (figure 4). This plan, called the highly advanced national (HAN) projects, develops and assimilates core technologies in strategic areas where Korea will have the capacity and capability to compete on the level of more advanced countries by 2001. Korea cannot upgrade its capacity in every industry to the level of all highly advanced nations, but it intends to build and maintain its competitiveness in selected industries by concentrating its limited R&D resources.

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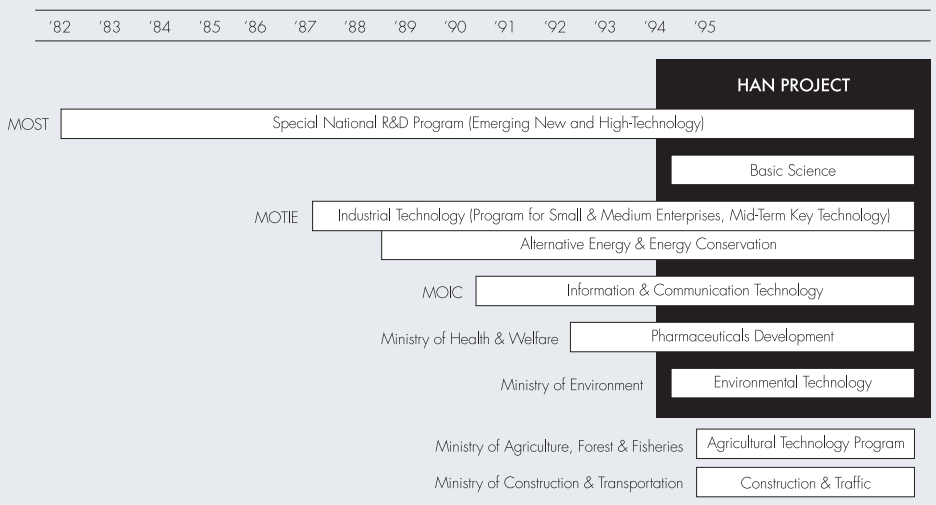
A HAN project is a large-scale R&D project carried out through joint investment by the government and the chaebols under a long-term project management system, which is supported by interministerial cooperation and coordination. Various R&D actors—such as universities, industries, and government-supported research institutes—participate in each project. For the areas where domestic R&D capacity is lacking, international cooperation is actively pursued.

The Korean government created two categories of HAN projects. The first category, "product technology development projects," concerns technologies for specific high-technology products that may have a substantial share in the world market. The second category, "fundamental technology development projects," concerns core technologies that are absolutely necessary to advance the economy, society, and human life.

Some of the technologies targeted by the HAN projects are aerospace, automobiles, bioengineering, communications, computers, electronics, environment, machinery and metals, medical equipment, nuclear power, and semiconductors. It is under the auspices of these projects that inter-

Figure 4. The Korean Government's National R&D Program



national cooperation and technology transfer are currently being pursued.

Korean firms regularly send researchers and technicians to aircraft manufacturers in the United States to expose them to advanced aerospace technology.

Methods of Technology Transfer

Development of advanced communication and information technologies has led to an unprecedented amount of technology transfer and cooperation through nontraditional avenues or informal relationships. Methods of indirect technology transfer are becoming more sophisticated in today's marketplace. The Korean government has successfully organized and implemented a variety of methods to assimilate and acquire technology: direct overseas involvement, international cooperation, cooperation between Korean and foreign companies, foreign patents, employing foreign nationals, and foreign databases.

All of the primary Korean chaebols are actively setting up overseas subsidiaries.

Direct Overseas Involvement

The Bank of Korea reported in July 1996 that Korean overseas direct investment amounted to $2.5 billion for 700 projects in the first five months of 1996. The number of approved overseas direct investment projects increased by 24 cases from the same period of 1995, and the total investment amount surged by $950 million.

Overseas Technical Training

Korean companies regularly send employees abroad for on-site training at overseas companies. This practice exposes Korean technicians to the technology, operations, and practices of a foreign company; it also exposes the foreign company to Korean business practices and cultural nuances. This exposure furthers the globalization strategy of Korean companies and U.S. companies as they build relationships and increase their understanding of one another.

Korean newspapers have discussed a number of examples of overseas technical training, most recently in the aerospace industry. As the U.S.-Korean relationship in the aerospace industry develops, Korean firms regularly send researchers and technicians to aircraft manufacturers in the United States to expose them to advanced aerospace technology. For example, Korean Air sent six employees to participate in the Boeing Company's 777 aircraft project in order to accumulate manufacturing design experience. In another instance, Samsung Aerospace sent 60 employees to the United States for technical training, and Halla Heavy Industries sent an 8-person technology training team to study satellite technology.

Overseas technical training is also prevalent in the Korean oil refinery industry. Yukong Ltd., Korea's largest oil refiner, will reportedly increase the proportion of its employees trained abroad to more than 10 percent of its workforce by 2000. As part of its globalization strategy, Yukong sent 80 employees to various parts of the world for long-term training during 1996.

Establishing Overseas Subsidiaries

Building sales, production, and R&D subsidiaries is central to any expansion strategy of a multinational company, and Korean companies are no exception. As of 1996, LG Electronics alone had sales subsidiaries on five continents, branch offices on six continents, and nine regional operations centers in Europe, North America, Asia, and the Middle East. This type of presence lends itself to technology transfer, especially in production facilities and research centers, through exposure to the technological trends of the countries in which they are located. The technology they build on or develop is incorporated back into the production or development systems of the worldwide operations of the LG Group.

All of the primary Korean chaebols are actively setting up overseas subsidiaries in an effort to claim markets and take advantage of both lower production costs and local technical expertise. Samsung Electronics spent $1 million to set up Image Quest Technology in Silicon Valley (Santa Clara, California). Image Quest Technology was built to research and design thin-film technology (TFT) for liquid crystal displays (LCDs) and is staffed primarily by local hires. Samsung invested in a region of the world where it believed it could find the best researchers for the task at hand. Korean newspapers also reported that Samsung Electronics and another U.S. company jointly developed two state-of-the-art digital signal processing semiconductors. To ease the development of this technology, Samsung established a branch office in the United States.

Korean export manufacturers greatly expanded these overseas R&D activities in 1995, with budget increases of up to 200 percent.

Hyundai Electronics' subsidiaries are also active in the development and assimilation of advanced technology. Hyundai developed a 10.4-inch TFT LCD at one of its U.S. branches and brought the technology to Korea for manufacturing. Hyundai Electronics has also set up centers in San Jose, California; Boston, Massachusetts; and Taipei, Taiwan, for the design of application-specific integrated circuits (ASICs).

The Korean press also reports that the Korean heavy machinery and oil refinery industries, as well as factory automation companies, are taking advantage of their geographic location in nations with advanced technology. One newspaper reported that Posco's new subsidiary in Maryland,

The Korean government is supporting, both verbally and fiscally, the establishment of S&T forums.

Posco International Corporation, would use its position to engage in technical information gathering.

Overseas Research Centers

The most common motivations for global research and development centers are the following:

- To monitor foreign technological developments
- To acquire or generate new technology
- To maximize use of specialized skills in a host country
- To support the needs of foreign production operations and the parent company

By spreading production, product development, and research components around the globe, multinational corporations can reduce the cost and risk of technological innovation. Korean companies in particular relieve the serious problem of limited R&D capacity and labor force.

Many research centers established by the Korean government and chaebols are located in more advanced nations, such as the United States and Japan, and are thus able to both obtain newly developed technology and employ experienced local scientists. Others are located in less developed nations, such as Russia and China, and help the parent company to better understand these rapidly changing markets and to take advantage of the skills of highly educated researchers and designers. By employing foreign nationals at their research centers, Korean manufacturers are attempting to accelerate the globalization of R&D by hiring the technological know-how. The cost of building and operating these centers is offset by the information about markets and technology that is gathered.

Korean export manufacturers greatly expanded these overseas R&D activities in 1995, with budget increases of up to 200 percent. The major Korean-owned, U.S.-based research facilities include Samsung Electronics' San Jose Research Institute (85 employees); LG Electronics San Jose Research Institute (10 employees); LG North American Operations in Chicago, Illinois (15 employees); Hyundai Electronics' SEMR Research Institute in San Jose (29 employees); and LG Semicon in San Diego, California, with 60 people conducting semiconductor technology surveys. Samsung Electronics plans to build a research center in Tsurumi, Japan, at a cost of $125 million. It will employ Japanese scientists and

technicians for R&D in electronics technology. Both Samsung Electronics and Samsung Aerospace have set up research centers in Russia to capitalize on Russian expertise in the basic sciences.

Daewoo's divisions also have been active in establishing overseas R&D centers. Daewoo Electronics is setting up a worldwide research network that includes 12 R&D centers in eight foreign countries. The Korean press reports that Daewoo Heavy Industries is building an aerospace research center in Russia and that Daewoo Motor Company plans to build R&D centers in the United States, Germany, and England to obtain advanced automotive technologies that manufacturers in advanced countries are reluctant to transfer to foreign competitors.

Further, MOST, in addition to the three centers it already operates in Russia, intends to build eight joint R&D centers abroad: two each in Australia, China, England, and Russia. These centers represent an expansion of Korea's "S&T cooperation diplomacy" and are part of MOST's plan "to develop economically useful technology through strategic cooperative research with the major advanced nations" (USG DOC.#SM95-10004).

International Cooperation

Countries cooperate on a variety of levels, often with the stated purpose being to transfer technology. For example, international cooperation trends indicate that governments are willing to share highly advanced environmental cleanup and protection technology that will benefit the public good. Some of this technology may then be transferred to other commercially viable production processes. Forums, foundations, and academic exchanges have the primary goal of increasing the public good, but technology transfer or cooperation is often an accompanying positive outcome.

International Forums and Foundations

The Korean government is supporting, both verbally and fiscally, the establishment of S&T forums to act as a corridor between Korea's commercial S&T establishment and U.S. high-technology companies to facilitate the transfer of U.S. technology. The role of both the forums and the foundations is to remedy Korea's weakness in key industrial sectors by creating opportunities to interface with scientists working with specific U.S. technologies. These forums and foundations facilitate Korea's

globalization plan by exposing foreign companies and individuals to Korean business practices and foci.

In May 1994, the second Korea-U.S. Science and Technology Forum was held in Washington, D.C. The forum had three stated goals:

- To cooperate to advance national R&D proposals
- To promote joint research in basic sciences and in commercializing the results
- To develop a plan for U.S.-Korean cooperation in advanced industrial technology

Centers of Excellence operated by leading foreign institutes provide Korean researchers with opportunities to work with internationally accomplished scientists and excellent equipment.

The Korean press reported that the forum provided a "technology network room" designed to build an informal cooperation network to promote the exchange of data, human resources, and technology in order to strengthen S&T cooperation among industry, academia, and research institutes on an international scale.

The third Korea-U.S. Science and Technology Forum, held in Washington, D.C., in December 1995, had four goals:

- To promote scientific and technological interaction
- To explore desirable areas and means of cooperation
- To assist scientists and engineers in forming networks for collaboration
- To deepen mutual understanding of institutions, practices, and policy environments

The focus of the forum series is to promote continued international S&T cooperation between the United States and Korea. The most recent forum sponsored by the Korean government took place in June 1996 in Washington, D.C., and centered on marine S&T. The centerpiece of the forum was the Korean government's announcement that it intends to create a cabinet-level Ministry of Ocean and Fisheries. The U.S. private sector, as well as government officials from both countries, participated.

Additionally, Korea sponsors "technomarts," five-day events that feature seminars, technology presentations, and one-on-one business

negotiations. The Korean press reported that Korean companies participated in a series of eight technomarts in 1995 with the purpose of acquiring technology from foreign firms. One example is Techplaza, an annual technology exchange sponsored by the Korea Trade-Investment Promotion Agency (KOTRA). The largest technomart to date was held in Taejon, Korea, in May 1995 and was cohosted by MOTIE, the Korea Institute of Industry and Technology Information (KINITI), and KOTRA for the Asia-Pacific Economic Cooperation (APEC). More than 100 companies participated, with at least 50 foreign companies, including representatives from the United States. The press also reported that the relevant agencies are also discussing the establishment of a permanent technomart in Korea to build an information distribution system for technology transfers between companies and related institutions.

In 1994, the Federation of Korean Industries established the Korea-United States Foundation for Industry and Technology Cooperation (KUFIT), whose mission is to hasten Korea's technical and industrial collaboration with other nations, thus further improving the international competitiveness of Korean companies. KUFIT seeks joint-venture projects with U.S. firms to facilitate technology transfer to Korea. The areas of cooperation include semiconductors, computers, machinery, aerospace, telecommunications, medical equipment, and environmental protection. KUFIT expects to have $35 million in public and private sector funding by 1997 that will be used to improve the productivity of small and medium-sized firms and to support technology imports, joint ventures, and strategic alliances.

Centers of Excellence

Centers of Excellence operated by leading foreign institutes provide Korean researchers with opportunities to work with internationally accomplished scientists and excellent equipment. MOST is encouraging the Asia-Pacific Theoretical Physics Center and France's Pasteur Research Institute to create centers in Korea to help the Koreans catch up with the more advanced countries in S&T. A program outlined by the KIST director called for establishing Centers of Excellence as a means of attracting first-rate scientists from more advanced nations, particularly the United States, to Korea. One Korean press source reported that the Seoul campus of the Korea Advanced Institute of Science and Technology (KAIST) will host another Center of Excellence, with a dozen Nobel Prize winners invited to teach and conduct R&D activities.

Cooperative agreements between Korean and foreign firms have long been a source of infrastructure and commercial technology for Korea.

Academic Exchanges

Academic exchanges are common in every field of study and almost every country. Korea is no exception, and Korean students and researchers are often sent abroad to acquire advanced degrees or study specific fields of knowledge. For Korea, however, there is a greater sense of national purpose to these exchanges than for many other countries.

MOST has expanded the number of Korean nationals sent overseas by the government to obtain Ph.D.s from 182 in 1994 to 250 in 1995. In addition, the government planned to fund approximately 460 researchers sent to foreign institutes through the end of calendar year 1995. One newspaper called for a further increase in the number of Korean students given scholarships to study abroad in an effort to obtain advanced foreign technology. It has been reported that the Korean Science Foundation is stepping up S&T exchanges with German academic institutions and has signed memorandums of understanding with the German Academic Exchange Agency and the Alexander von Humboldt Foundation to expand S&T exchanges. The agreements call for exchanging 10 students each year from both countries in master's and doctorate-level programs, which the paper said is expected to greatly strengthen the research capabilities of Korean scientific and technical personnel.

Technical Links with Foreign Universities

The chaebols form international industrial-academic cooperative associations with foreign universities to do joint research in advanced technology. Expanding links with foreign universities allows the chaebols to improve their industrial capabilities faster, incorporating highly trained personnel who have professional connections to research institutions.

LG Electronics has reportedly put together a $10 million joint research cooperative structure that involves 32 foreign universities, including the Massachusetts Institute of Technology, Stanford University, and Purdue University. Samsung Electronics is carrying out joint international R&D projects in memory semiconductors with Stanford University, the University of Texas, and the University of Arizona; in nonmemory semiconductors with the University of Illinois; and in LCDs with Kent State University.

There are a number of benefits to be gained from cooperation with foreign academic research institutions. The Electronics and Telecommunications Research Institute (ETRI) teamed up with Stanford University for the joint development of an operating system for an indigenous Korean multimedia workstation. Cooperation with Stanford University began in

1991 and includes special technical training and performance test training for ETRI personnel. When the program is completed, ETRI will transfer the related technologies to Samsung, LG, Hyundai, and Daewoo for commercialization.

Cooperation Between Korean and Foreign Companies

Cooperative agreements between Korean and foreign firms have long been a source of infrastructure and commercial technology for Korea. The chaebols generally bring cash, production process experience, and access to new markets with them to the negotiating table; foreign firms generally bring the necessary technology. Strategic technical alliances with other world market leaders allow the chaebols to penetrate new markets faster and give them access to a broader range of cutting-edge technology. LG Electronics has forged a number of these cooperative relationships, specifically with Motorola to develop ASIC technology, with Xerox for Power PC research, and with Philips for video CDs. LG Electronics was credited with having lined up comprehensive, cooperative relationships with companies in the United States and other nations for multimedia equipment and software, two areas that LG has targeted for development. In Chicago, LG and the Zenith Electronics Corporation have been working since 1990 on cable modem design and concepts for next-generation multimedia set-top boxes. These cooperative efforts have enabled Korean firms to move rapidly onto the world stage, with LG leading the way in the multimedia market.

Strategic Cooperation

Strategic cooperation is the process of identifying gaps in indigenous technologies, seeking out the technology, and then engaging the owner of the technology in a cooperative relationship that results in the transfer of the technology. Korea may provide any number of incentives for technology transfer, including funding commercialization, providing plants and equipment, contributing other technology, or facilitating local market access. For example, Russian and Chinese companies can provide Korean firms with strong basic scientific research, and Korean firms can help the Russians and Chinese turn that knowledge into commercial products. However, some foreign firms in Korea have filed complaints because it was not clear to them that technology transfer was part of the cooperative agreement. Korea has had a questionable reputation in the past with respect to honoring contracts, especially those related to intellectual property rights. And while the Korean government has recently taken steps to improve the situation, foreign firms must weigh the cost of fully

protecting themselves against the potential benefit of doing business with Korean companies.

The Korean government is often involved at different levels of the strategic cooperation process, specifically in identifying weaknesses in the indigenous S&T structure, finding foreign companies willing to transfer their technology for commercial purposes, and subsidizing the actual transfer. The Korean press reports that MOTIE's "Plan to Strengthen Cooperation with Technologically Advanced Foreign Countries" specifies which technologies are desired from companies worldwide through cooperative systems. The Korean government's Small and Medium Business Promotion Corporation is helping transfer U.S. electronic and computer technologies to Korean firms by acting as an intermediary for Silicon Valley-based U.S. companies looking for overseas partners. This corporation receives half a dozen referrals per month through a U.S. organization specializing in technology evaluation and technology transfer concerning U.S. firms seeking cooperation on specific projects. Other types of government aid targeted at facilitating technological cooperation include MOTIE's allotment of $750,000 to support joint research with Japanese companies and another $200,000 for basic industrial technological cooperation with Japan.

Joint International R&D

Strategic cooperation can also include participation in joint international research. Because the initial focus of this research is precompetitive, companies are reportedly more willing to share their technology. Korea's expansion of these types of international projects indicates their success. In fact, Korea's National S&T Advisory Council recently argued that not enough of the funds set aside for basic industrial technology development were being allotted for joint international R&D cooperation. The council called on the government to devise a special support plan to promote joint involvement by Korean industrial, academic, and research institutions in international high-technology research.

Korean firms have been actively involved in acquiring patent portfolios from U.S. patent brokers.

MOST's Science and Technology Policy Institute (STEPI) is planning to create cooperative foundation joint institutes with 10 developed countries by 2004 to enable Korea to build a system of international research data and personnel exchange for globalization in S&T. In the long run, the institutes will also engage in international R&D projects in such fields as environment, energy, natural resources, and hygiene and expand international education and training programs.

Other examples of MOST's efforts in joint international R&D include providing $8.1 million in subsidies in 1995 to support joint research and technical cooperation with foreign companies; ETRI signing international joint research contracts with SRI International and Syracuse University for technology relating to a super-high-speed data communications network; and the Korean government's Systems Engineering Research Institute (SERI) and Korea Computer signing a research contract with the Tandem Corporation.

Foreign Patents

During 1995 and the first half of 1996, Korean companies made between 8 and 10 full acquisitions of, or minority equity investments in, foreign firms.

Low-Cost Patents

The end of the Cold War and the opening of the Russian market have been a boon to many international manufacturers in search of basic research and patents at low prices relative to the global market. Korean firms and research institutes have been taking advantage of this situation by obtaining needed technology via the purchase of Russian patents. The Russian Office of Patent Administration reported in early 1994 that since October 1993, 41 Korean companies had applied to transfer 365 patented Russian technologies. The Korean firms involved included 22 chaebols, 14 small and medium businesses, and 5 research institutes, including the Korea Atomic Energy Research Institute. There were 157 applications in electricity and electronics, 143 in chemistry, 31 in machinery and metals, and 34 others. In July 1994, the Russian Office of Patent Administration announced that a survey team comprising representatives of the Korean government and private industry, sent to Russia in June 1994, had arranged to transfer 37 high-technology patents. The team had reportedly been able to negotiate deals on 24 of the 32 technologies it originally sought, plus 13 other technologies discussed on site.

On the other side of the world, Korean firms have been actively involved in acquiring patent portfolios from U.S. patent brokers. This profusion of patent acquisition, in both the East and the West, has recently led to the rise of sophisticated patent departments within many of the chaebols.

Investments in Foreign Firms

In July 1995, building on a 20-year relationship, LG Electronics purchased 57.7 percent of the stock of Zenith Electronics Corporation. The stock purchase was instigated by a number of factors, not the least of which was Zenith's need for a cash infusion and access to new markets. LG Electronics has a strong multimedia focus, and access to Zenith's patented HDTV technology will be highly beneficial. With this technology,

Among the leading figures in Korea's aerospace industry are many who have worked on advanced aviation projects in the United States.

LG Electronics hopes to dominate the potentially huge HDTV market through licensing agreements.

LG is certainly not the only Korean firm to gain control of a company for the purpose of obtaining patented technology. During 1995 and the first half of 1996, Korean companies made between 8 and 10 full acquisitions of, or minority equity investments in, foreign firms. In 1993, Samsung acquired Harris Microwave Semiconductor, a major U.S. optical semiconductor manufacturer. Samsung bought the firm to secure a world-class technological capability in nonmemory semiconductors, which it lacked. Eight months later, Samsung was producing gallium arsenide chips at its new subsidiary, renamed Samsung Microwave Semiconductor. Samsung succeeded in converting the chips from military applications to commercial use in mobile communications and high-speed computers, applications for which Samsung's silicon-based chips are not well suited. Samsung expected to save $7 million annually in import costs ($2 million more than it paid for Harris) and to increase its competitiveness in communications equipment worldwide.

Hyundai Electronics' purchase of controlling stock and management rights in the U.S. firm Maxtor, the world's fifth-largest producer of computer hard disk drives (HDDs), enabled it to obtain "accumulated technology" and patents on HDD components. The deal also gave Hyundai ASIC technology, in which Korean firms were reportedly weak. According to press reports, before the sale Samsung Electronics was the only Korean manufacturer of HDDs; other companies had abandoned their projects because of technical difficulties. Hyundai also obtained technology to build a laser disk data retrieval mechanism, which would have been difficult for it to develop alone because of its lack of technological capability.

Hyundai Electronics invested $340 million to acquire NCR's Microelectronics Products Division (renamed Symbios Logic), the nonmemory semiconductor division of AT&T Global Information Systems. This purchase is significant not only because it was the largest single overseas acquisition by any Korean firm at that time but, more important, because it secured a base of operations abroad for Hyundai to jump into the high-value-added sector of nonmemory semiconductors. The Korean press reported that the contract gave Hyundai rights to Symbios Logic's 690 patents and trademarks.

Employing Foreign Nationals

The chaebols favor hiring foreign experts for Korean operations as an indirect method of technology transfer. It is recommended by Korean government experts, facilitated by official and semiofficial Korean organizations, and widely practiced in Korean industries. The Korean press has reported that the government will match funds spent by companies recruiting and employing high-level foreign personnel. These funds include salary incentives for qualified and accomplished foreign personnel at rates well above international standards. The director of KIST proposed that foreign experts be used to evaluate Korea's research institutes in order to raise their technical standards and that a special fund be established to hire foreign researchers for extended periods to develop Korea's S&T infrastructure.

Among the leading figures in Korea's aerospace industry are many who have worked on advanced aviation projects in the United States. Technicians working in U.S. production plants are carefully selected by Korean firms for their experience. Korean newspapers reported that Samsung Aerospace recruited 140 foreign aeronautical specialists, 40 from the United States and the remainder from Russia and Ukraine. A Samsung mission that visited the United States in June 1993 was able to recruit 16 general managers of design, 9 group leaders, and 5 senior technicians. Korean companies periodically take out full-page ads in Silicon Valley newspapers to recruit engineers and have been able to scout out talented personnel.

MOST announced plans to hire as regular employees in its research institutes foreign scientists and technicians who are not expatriate or émigré Koreans, as one link in its program to raise the level of specialized research done in Korea. Some 20 such foreigners were to be hired in the second half of 1995, and this number is expected to increase annually.

For the high-technology industries in more advanced nations, this practice raises concerns about the protection of intellectual property rights and proprietary information. Both the United States and Japan have taken issue with Korea over real and perceived illegal acquisition of technology, and U.S. companies claim that they have lost revenue in licensing royalties to Korean firms.

Korea's government and industry operate systems to identify potential qualified employees who their would-be sponsors believe are in a position to transfer advanced technology and who, because of their ethnicity, are predisposed to accept offers to contribute their knowledge to Korea.

The Korean press reported that MOST is operating a system to recruit scientists and technicians, drawing from the 40,000 ethnic Koreans working overseas in S&T fields, a third of whom are affiliated with the General Federation of Korean Science and Technology Organizations. The purpose of this "brainpool" is to provide incentives for "overseas Koreans and other foreign scientists" to help Korea "acquire at an early date the newest science, technology, and know-how in the R&D stages in advanced countries" (USG DOC.#SM95-10004). Part of the incentive program stipulates that leading foreign scientists with five years' post-doctoral experience abroad will be given airfare and a salary higher than what they currently receive if they serve a minimum of six months at a Korean S&T facility. Offers were made to 57 foreign specialists during the program's first year. The majority had Korean surnames and lived in the United States. MOST increased its funding for the brainpool program in 1995 from $2.5 million to $3.375 million to pay for an increase in recruitment to more than 100 foreigners and overseas Koreans.

KIST reportedly runs its own brainpool targeting Japanese S&T personnel, 12 of whom were hired in 1994 during the program's first year of operation. In addition, at least one private Korean corporation is carrying out a similar brainpool program. Samsung Electronics recruited 150 Ph.D.s in 1994, mostly high-level personnel residing overseas. The company was to be assisted by the Samsung Group's Talented Personnel Development Research Institute, which uses a database to collect information on researchers worldwide by field so that the company can hire the expertise it needs in a timely manner. At present, the database holds information on more than 1,000 overseas scientists and engineers.

Box 1. Invitation to Apply for Employment in a Brainpool of High Level Overseas Scientists: *ROK Newspaper* Advertisement, February 1994

The General Federation of Korean Science and Technology Organizations, in accordance with the Government's (Ministry of Science and Technology's) plan to employ high level S&T personnel (a brainpool system), invites superior overseas scientists and technicians to South Korea for work in research and development, in order to achieve the supreme national task of helping South Korea enter the ranks of scientifically and technologically advanced countries by the 2000's. We hope for your wide participation.

1. Goals. To strengthen national competitiveness in keeping with the trend toward a global, worldwide, information society, we seek to employ superior overseas ethnic Korean and foreign scientists and technicians locally in domestic research and development, to contribute toward South Korea's entry into the ranks of scientifically and technologically advanced countries by the 2000's.

2. Fields. All fields of science and technology which are the objects of national strategic development, including: basic fields (basic research, measurement, standards, astronomy); machinery and materials (machinery, ships, aviation, space, materials); electrical and electronic (electricity, power, electronics, computers, communications, optical technology); chemical engineering and biological (chemistry, chemical engineering, biology, agriculture and fishing, sanitation); resources and oceanographic (resources, oceanography, environment, construction); energy (atomic power).

3. Positions to Be Filled. 100 or fewer.

4. Personnel Sought. (a) Ethnic Koreans and foreign scientists and technicians with five years or more experience working overseas from the time they receive a Ph.D. (b) Ethnic Korean and foreign scientists and technicians who possess excellent, world class R&D accomplishment or know-how, regardless of their degree or experience, as determined by the selection committee.

5. Period of Employment. (a) Between six months and two years (less than six months is also possible, as determined by the selection committee). (b) There is also a possibility of extending the employment period beyond two years (as determined by the

evaluation committee).

6. Support and Expenses. (a) Expenses incurred entering and leaving the country (airfare and personal expenses, etc.). (b) Costs in country (automobile and other support depending on one's experience; salary on a level higher than the compensation received in one's own country, to be decided by the selection committee).

7. Institutions of Employment. (a) Government funded research labs (institutes). (b) National and private research labs. (c) Universities (except ERC [Engineering Research Centers] and SRC [Science Research Centers]).

8. Methods of Employment. Conduct joint research as part of an existing or new R&D team, with the possibility of concurrently giving lectures in one's specialty, and making presentations in various types of academic meetings and seminars.

9. Evaluation. The scientists and technicians who are hired will have their research results evaluated from the perspective of the type of employment at six month intervals by the Evaluation Committee. (If found "unsuitable" support will be discontinued and that part of the support paid will be recovered from the institution where the person is employed.)

10. Application Period. 14 February to 10 March (for the first half of the year). Remaining personnel look for a later notice in the second half of the year.

11. Documents to Submit. (a) Application for employment with the brainpool (in a form determined by the individual)—1 copy. (b) Statement of plans (to be drawn up by institution applying)—1 copy. (c) Written introduction from the institution applying—1 copy.

12. Information Office. General Federation of Korean Science and Technology Organizations

13. Miscellaneous. (a) Materials received will not be returned. (b) Please address detailed inquiries to the General Federation of Korean Science and Technology Organizations.

Director
General Federation of Korean Science and Technology Organizations

A new automated machine translation system has been developed by the Korea Research and Development Information Center (KORDIC).

Foreign Databases

The Korean government ensures that its researchers have access to the most respected S&T databases available for design and R&D purposes. These databases, which are generally focused on basic R&D, facilitate the accumulation of technological know-how.

KINITI spent $7.5 million upgrading its KINITI-IR (Information Retrieval) system, a nationwide data network that provides on-line access to information on advanced industrial technology in foreign and domestic databases. The network provides industrial, scientific, and technological data from foreign and domestic sources that Korean industry finds necessary for R&D and technical development. Subscribers can access eight foreign databases holding some 18 million items from a plethora of sources.

KINITI has also linked up with two more international data services, including the Scientific and Technical Information Network (STN) operated by U.S., German, and Japanese companies. The use of these databases prompted one Korean newspaper to comment that Korean database users could now obtain high-quality S&T data inexpensively.

SERI has arranged through its Korea Research Environment Open Network (KREONet) to sign up with the research data network EuropaNet, operated by the European R&D information center Dante. The link will provide Korean researchers with easy access to the most up-to-date S&T information available in Europe. One SERI official called the system a "magic box" for Korean S&T development.

A new automated machine translation system has been developed by the Korea Research and Development Information Center (KORDIC), an agency affiliated with KIST that enables Korean researchers to use hangul-based queries to access the JOIS (JST Online Information System), a database of the Japan Science and Technology Corporation. Plans reportedly call for expanding services to other leading Japanese database services and English-based services.

Databases have gained increased importance over the past several years because of the rapid commercialization of the World Wide Web. Governments have recognized that databases have a wealth of information from which domestic companies can benefit. More important, international companies would also be able to have access to the databases via the

The Korean government and the chaebols have recognized that the databases are an excellent and inexpensive source of technological information.

Internet, thus greatly reducing the costs of information acquisition. Korea plans to invest $700 million in this technology.

In sum, the Korean government and the chaebols have recognized that the databases are an excellent and inexpensive source of technological information. Capitalizing on these databases has allowed the Korean government to acquire considerable S&T information within a limited time.

KOTRA, the Korean government-run organization with 82 overseas trade offices chartered to facilitate the export of Korean products, is also involved in promoting technology transfer. It has initiated a new plan to provide concentrated support to small and medium-sized Korean companies, particularly those that are technology intensive. This support would include providing information on competing products.

Korea has been successful with technology transfer methods and an integrated globalization strategy in its preliminary competitive development stages.

Conclusion

Korea has developed and implemented a systematic, integrated globalization strategy that harnesses the strengths of its private sector, academia, and government. The country has proved its technology transfer and production expertise and more recently has shown its incipient innovation capabilities. A notable example is the improvement of assimilated foreign technology, specifically the 4-megabit DRAM technology transferred to Korea in the early 1980s. The chaebols improved and built upon the original chip, creating a faster, higher-memory 16-megabit DRAM chip that was then marketed to the United States. In addition, Korea is transferring technology as it moves its production overseas to lower its manufacturing costs. Korean production facilities are operating in India, Southeast Asia, Mexico, China, and, in a few cases, the United States.

Korea has been successful with technology transfer methods and an integrated globalization strategy in its preliminary competitive development stages. Its strategy has been so successful that a number of developing countries have called on Korea to share its economic development experience and intermediate technology with them rather than asking for direct monetary aid.

It is clear that technology cooperation and transfer methods should increase access to technology for all participating parties, thus creating an incentive for open cooperation. However, there continue to be calls for the Korean government to liberalize the investment environment so that foreign firms may enter the Korean market without bureaucratic barriers. The United States has complained about Korean government control of the business negotiation process and the foreign investment approval process, both of which have been publicly revamped but in practice remain much the same. U.S. businesses are concerned that the Korean government's orientation is more national than international, in stark contrast to the global activities of the chaebols. U.S. companies expect to be equal partners in any international cooperative ventures, and they expect a demonstrable return for their willingness to share resources, including protection of their intellectual property rights. These are all factors that U.S. companies must weigh against the benefits of tapping Korean markets and sources of capital.

Despite these problems and complaints, this integrated national development strategy has enabled Korea to advance its technological infrastructure more rapidly than previously thought possible. Rapid and strong development coupled with a consistent industrial focus has provided the means for achieving not only its international competitiveness goals, but also its international political aspirations. Korea was granted full mem-