Korea's S&T Policy English Translation Project: Series 1

The 40-Year History of Science and Technology

Chapter 3. Establishment of National Research and Development System

Over the past half century, Korea has achieved remarkable economic growth. Among the major factors that have driven this growth, the development and innovation of science and technology is said to have made greatest contribution. For this reason, developing countries have shown growing interest in learning more about Korea's policy during the early phase of its economic growth.

Science and Technology Policy Institute (STEPI) aims to assist developing countries in their efforts to establish science and technology policy by translating policy materials related to Korea's past development of science and technology. For the first series of this project, we have translated some sections (1960s to 1980s) of The 40-Year History of Science and Technology, published by the Ministry of Science and Technology in 2008.

Ministry of Science, ICT and Future Planning

STEPI SCIENCE AND TECHNOLOGY POLICY INSTITUTE

Chapter 3. Establishment of National Research and Development System

Section 1. Promotion of Government-funded Research Institutes

1. Establishment of the Korea Institute of Science and Technology and Development of Government-funded Research Institutes

Established in 1966, the Korea Institute of Science and Technology (KIST) came into existence through the outstanding innovation system of Korean research institutions. Although most of KIST's operating budget consists of government funding, it was established as a special corporation rather than a government organization, and its researchers had traditionally enjoyed much better treatment and greater autonomy than public officials. Such preferential treatment for KIST researchers, despite poor government finances, was a strategic choice made with the aim of attracting highly skilled, well-educated scientific and technical personnel from overseas and encouraging them to settle down in Korea. While making numerous visits to various industrial sites across the country, KIST researchers made every effort to resolve the technical difficulties of Korean enterprises and played an intermediary role in the early stages of the establishment of many of Korea's industrial facilities by providing advice and guidance on plant operations. As mentioned previously, although it was a beneficiary of government funding, KIST was established as a special corporation, meaning that it possessed autonomy and independence in terms of its operations and was not tied to the framework of the government budget accounting system. This is an ingenious structure that was far ahead of its time. If it had been established as an institute subordinate to government audits or instructions, it would have been difficult for KIST to attract high-caliber scientists from overseas and offer them a flexible and dynamic environment conduct their work in. As it was, KIST was able to respond efficiently to the demand for industrial technology during the early stage of Korea's industrialization by supporting the introduction and improvement of technology as required by the economic development of the country. Based on the successes that its researchers achieved in resolving technical difficulties at the industrial sites of Korean enterprises, KIST grew to be known as a research institute that met the expectations of enterprises and the nation. In addition, the Korea Advanced Institute of Science, which was established in 1971 based on a separate law and with government funding as a graduate school offering science and technology programs, produced highly skilled scientific and technical personnel capable of meeting the demands of Korea's full-fledged industrialization.

Since the mid-1970s, Korea's industrial structure has become centered on the heavy and chemical industries. With technical demand having escalated accordingly, securing professional personnel with the technical expertise needed to support the country's five strategic industries—namely, the machinery, steel, shipbuilding, electronics, and chemical industries—emerged as a major challenge. However, the support system for Korean enterprises in place at the time was incapable of helping them resolve the technical problems they encountered. Therefore, it was necessary to strengthen the support system so that it could introduce and improve advanced technologies in each professional field at the government level. In this

regard, the success and achievements of KIST led to the expansion of government-funded research organizations in the 1970s, and KIST came to be regarded as a leading research institute and a model for the establishment of similar specialized research institutions. Enacted in 1973, 'the Support of Specific Research Institutes Act' promoted the establishment of specialized research institutes that receive government funding but are granted autonomy in terms of their research activities. In accordance with this act, many specialized research institutes in various sectors, including the chemical, machinery, and shipbuilding sectors, have been established, and the number of government-funded research organizations has increased in line with demand.

Meanwhile, the government has begun to recognize the need to supply land in order to effectively support the establishment of such government-funded research organizations. In 1973, it drew up the plan for and promoted the development of Daedeok Research and Academic City. By that time, the Korea Institute of Science and Technology, Korea Advanced Institute of Science, Korea Science Information Center, Korea Development Institute, Korea Institute for Defense Analyses, and Korea Atomic Energy Research Institute had been established within a research complex near Hongneungm in the eastern Seoul. The creation of this complex showed that it is possible for research institutes with different characteristics and functions to share research facilities, exchange knowledge, and build a system of mutual cooperation.

Some national research institutes were able to operate flexibly and give their researchers the freedom to work as they saw fit by casting off the rigid framework of other government organizations and public officials while transitioning to government-funded research organizations. In order to satisfy the growing demand for technology in each sector in line with the increasing pace of economic development and growth of the heavy and chemical industries, such government-funded research organizations expanded significantly. The specialized organizations established at this time include: the Korea Atomic Energy Research Institute, Korea Standards Research Institute, Korea Test Institute of Machinery and Metals, Korea Research Institute of Chemical Technology, Korea Radioactive Waste Agency, Korea Institute of Energy Research, Korea Institute of Resources Development, Korea Institute of Electronics Technology, Korea Electric Research and Testing Institute, Korea Telecommunication Research Institute, Korea Research Institute of Ships, Korea Science and Engineering Foundation, and the Ginseng Research Institute.

In the early 1980s, in order to facilitate and promote coordination among government departments and improve research efficiency, some government-funded research organizations took steps to better differentiate their functions or joined together to form larger organizations. However, inefficiencies caused by differences of opinion over technological development issues among public officials of the government ministries responsible for these institutes posed a problem. To resolve this, in October 1980, 16 government-funded research organizations under various government departments were integrated to form eight large-scale research institutes, which were then put under the management of the Ministry of Science and Technology.

As science and technology became increasingly specialized from the late 1980s to early 1990s, it was imperative for the nation to secure various fundamental and advanced technologies. Toward this end, several research organizations—the System Engineering Center (reorganized to form the System Engineering Research Institute in 1990), Genetic Engineering Research Center (reorganized to form the

Korea Research Institute of Bioscience and Biotechnology in 1995), Electronics and Telecommunications Research Institute, Korea Electrotechnology Research Institute, Ocean Research Institute, Korea Astronomy and Space Science Institute, Korea Base Science Institute (reorganized to form the Korea Basic Science Institute in 1994), Korea Aerospace Research Institute, and Korea Institute of Nuclear Safety—were launched as affiliate or independent organizations. In 1993, the Gwangju Institute of Science and Technology and Korea Research and Development Information Center were established as well. With the establishment of such a wide variety of specialized research institutes, some were, again, operated to meet the demand of related government departments. At the end of 1996, these government-funded research institutes were diversified under several government ministries, with 21 (including 8 affiliated organizations) under the Ministry of Science and Technology, 4 under the Ministry of Trade and Industry, 1 under the Ministry of Construction and Transportation, 1 under the Ministry of Agriculture, Forestry and Fisheries, 1 under the Ministry of Finance and Economy, 2 under the Ministry of Information and Communication, and 1 under the Ministry of Oceans.

2. Establishment of Competitive Environment and Introduction of Evaluation System for Government-funded Research Institutes

Even though some of the government-funded research organizations were integrated, their number continued to expand significantly. Since the 1980s, the number of corporate research institutes has increased particularly rapidly. The research institutes of large enterprises, which were equipped with the latest research equipment and staffed with experts in various areas of science and technology, began achieving remarkable technical innovations with the aim of allowing their products to gain a competitive edge in the global market. The research and development capabilities of universities were also enhanced over time. In the early stage of Korea's economic development, government-funded research organizations, almost exclusively, supplied the technologies that were needed. However, since the 1990s, government-funded research organizations, corporate research institutes, and universities have been competing to supply or develop the technologies we need. The emergence of this new environment triggered a major change in perspective within government circles concerning the role of government-funded research organizations. This new perspective included the recognition of the need for the policies governing such research organizations to be moved away from the usual one-sided policies of promotion and support to those that foster competition and depend on evaluations and assessments in order to determine support.

The Ministry of Science and Technology, which had played a pivotal role in fostering government-funded research organizations, was tasked with selecting such policies in consideration of the new science and technology environment. As part of this, it implemented a project-based system. Under this system, government funding for specialized research was allocated based on cost estimations, including labor costs, for each research project. However, researchers have since complained that, due to this system, they now spend more time securing research funds rather than actually conducting research. Still in place today as the basic funds allocation policy for government-funded research and development, this project-based system has resolved many of the former problems with the distribution of research funds, leading to increased rewards for performance and separate compensation for basic expenses, including labor costs.

Meanwhile, government-funded research organizations have been operated by the research councils installed under the Prime Minister's Office in accordance with the "Act on the Establishment, Operation

and Fostering of Government-funded Research Institutions, Etc.," promulgated on January 29, 1999. Some research institutes, including the Korea Advanced Institute of Science, Gwangju Institute of Science and Technology, Korea Atomic Energy Research Institute, Korea Institute of Nuclear Safety, Korea Cancer Center Hospital, Korea Science and Engineering Foundation, and Korea Institute of Science and Technology Evaluation and Planning, remained under the Ministry of Science and Technology, while the rest were placed under the jurisdiction of the Korea Research Council of Fundamental Science and Technology, Korea Research Council of Public Science and Technology, and Korea Research Council for Industrial Science and Technology, depending on their functions. However, since the reform of the administrative system in 2004 and the enactment of the "Act on the Establishment, Operation, and Fostering of Government-funded Science and Technology Research Institutes, Etc.," jurisdiction over these research institutes has been transferred back to the Ministry of Science and Technology. The policy goal of linking the role of government-funded research organizations more closely with Korea's science and technology strategy influenced this transfer of science and technology research councils to the jurisdiction of the Ministry of Science and Technology.

Under the research councils, government-funded research institutes are subjected to annual evaluations. The current "Act on the Establishment, Operation, and Fostering of Government-funded Science and Technology Research Institutes, Etc." requires that the research councils evaluate the research performance and management of the research institutes under their jurisdiction, and submit the results to the Minister of Science and Technology and Minister of Planning and Budget. In addition, Article 32, Clause 2 of the "Framework Act on Science and Technology," calls for the head of each central government organization to carry out evaluations of affiliated, government-funded research organizations, as prescribed by Presidential Decree, and submit the results to the National Science and Technology Council. Furthermore, Article 7, Clause 3 of the "Act on the Performance Evaluation and Management of National Research and Development Projects, Etc.," requires that the National Science and Technology Council assess the adequacy of performance goals and indices as well as the objectivity and fairness of the procedures and methods involved in the internal performance evaluations submitted by the heads of the central government organizations and research councils.

Section 2. Strengthening R&D Capacities of Universities

1. Increasing Opportunities for Students to Major in the Natural Sciences and Engineering: University Policies of the 1960s and 1970s

It was not until the Korean government started promoting the heavy and chemical industries in the 1970s that the demand for experts in science and technology, especially those with advanced degrees, skyrocketed. In the 1960s, nurturing skilled workers was critical in promoting the development of Korea's light industries, but after the government unveiled its plan to promote the heavy and chemical industries, the demand for professional scientists and engineers, along with related research and development (R&D), began to rise. In response, universities and colleges began working to expand the overall talent pool by increasing the enrollment of students in natural science and engineering majors and transforming their schools into specialized universities.

After this expansion, and in line with the growth of government-funded research institutes, professors and R&D specialists were in high demand. At that time, however, universities were unable to focus on R&D due to the poor state of their research facilities and lack of adequate academic programs, both of which are necessary for nurturing R&D experts with advanced degrees. So, they had no choice but to concentrate their efforts on educating undergraduate students. To address this issue, in 1971, the government decided to establish the Korea Advanced Institute of Science (KAIS), a specialized master's program designed to nurture professional scientists and engineers, instead of subsidizing and supporting universities and colleges.

2. Strengthening R&D Capacities of Universities: 1980s to 1990s

Due to the changes in Korea's industrial structure, technology integration in major industries, and the localization of products, the 1980s saw increasing demand for R&D specialists. Moreover, Korea's economic growth enabled universities to distribute their resources, which resulted in the gradual expansion of their R&D departments and the nurturing of talented students through the operation of graduate schools. In particular, since the early 1980s, various types of policies were developed by the Korea Science and Engineering Foundation (KOSEF) and Korea Research Foundation with the goal of promoting basic scientific research. These policies made significant contributions to the growth of R&D and the increase in research funding.

Strengthening the R&D capacities of universities in the 1980s promoted the growth of graduate schools and increased the production of domestic R&D specialists with advanced degrees. During this period, while existing universities gradually started to offer graduate programs of their own, KAIST (Korea Advanced Institute for Science and Technology) and Pohang University of Science and Technology in Korea, which were founded in 1981 and 1986, respectively, played major roles in fostering R&D specialists with advanced degrees.

Until the 1980s, university research laboratories had only conducted surveys and studied government policies. There were exceptions, of course, but it was not until the 1990s, when the government pushed forward its plans—the pioneering technology development program known as the "G7 Project"—to facilitate industrial-academic collaboration, that universities started becoming involved in R&D in earnest. As such movements started gaining momentum, the government's priorities shifted toward increasing graduate school enrollment, establishing science research centers (SRC) and engineering research centers (ERC), and increasing the number of research universities and graduate schools. In the late 1990s, a research project called the "21st Century Frontier R&D Program" was launched. This project subsequently led to an increase in research funding and faculty research participation, clearly showing that universities had become key players in R&D and that the shift had improved R&D performance. In particular, the Ministry of Education and Human Resources Development is continuously increasing funding for R&D related to the development of basic technology, which appears to have strengthened the research capacities of universities. Recently, natural science and engineering colleges have been including the publication records of their faculty members in their evaluation system, thereby promoting research within university laboratories.

As a result of such government policies, R&D funding increased significantly, growing from KRW 25.9 billion in 1980 to KRW 244.3 billion in 1990, and then jumping to KRW 1.5618 trillion in 2000. The beneficiaries of this funding were selected through fierce public competition, which facilitated the growth of quantitative indicators, including the increase in the number of SCI publications and researchers with master's and doctoral degrees.

These indicators show just how much universities strengthened their R&D capacities during the 1980s and 1990s. The number of people holding advanced degrees in the natural sciences and engineering increased five-fold in the 1980s and three-fold in the 1990s, with universities turning out 15,754 master's degree holders and 2,175 doctorate degree holders in 2000 (refer to chart below). Furthermore, the number of SCI publications surged from 236 in 1981 to 154,493 in 2000, growing at an annual rate of 22 percent over the course of two decades—the highest such growth rate in the world (the U.S., Japan, and Germany saw 1.9 percent, 4.8 percent, and 3.5 percent growth, respectively, in SCI publications during the same period). In the year 2000, 129,824, or 84 percent, of all SCI publications were published by universities. This shows that the R&D capacities of Korean universities had strengthened exponentially.

Table 2-3-1. Number of Advanced Degree Holders in the Natural Sciences and Engineering (1980-2000)

	Master's Degree Holders			Doctoral Degree Holders		
	Natural Science	Engineering	Total	Natural Science	Engineering	Total
1980	417	692	1,109	91	41	132
1990	1,489	3,872	5,361	240	456	696
2000	3,241	12,513	15,754	637	1,538	2,175

3. Searching for Means of Quantity Growth: 2000s

Despite the quantitative growth in the 1990s, it was suggested that the R&D capacities of universities should be strengthened in terms of their qualitative aspects as well. Although the annual growth rate of SCI publications was undoubtedly the highest in the world, the absolute number of publications ranked 16th in the world, which, in fact, accounts for only 3.9 percent of the total number of research papers published in the United States and 15.2 percent of those in Japan, as of 1998. The annual cost of tuition for one undergraduate student in Korea and the total number of SCI publications both lag far behind than those of other developed nations. In an effort to address this issue, the government launched the "BK21 (Brain Korea 21)" project in 1998. This project is designed to improve Korea's research environment and academic programs so that universities can focus on nurturing world-class science and engineering professionals and developing graduate programs that are recognized and admired around the world.

After the late 1990s, R&D policies became more focused on promoting intellectual property rights, interdisciplinary convergence research, and collaborations with the local economy and SMEs (small- and medium-sized enterprises) with the goal of achieving socioeconomic benefits. Some major undertakings in this regard include the regional research centers (RRC), national core research centers (NCRC), medical research centers (MRC), and business incubators. As a result, strengthening the R&D capacities of universities has not only made contributions to academic research, such as increasing the number of SCI

publications and citation indexes, but also led the development of industrial technology and satisfied the demand for local R&D.

Section 3. Development of Private R&D Activities

Over the last 40 years, economy has grown to become the 13th largest in the world in terms of GDP (USD 888 billion as of 2006) through compressed growth. Forming the foundation for this remarkable achievement was the expansion of R&D investment by enterprises since the 1980s.

R&D investment by private enterprises has exceeded that of the government sector since 1983, and currently accounts for 77 percent of the nation's total R&D investment (KRW 18.5642 trillion as of 2005). Compared to the R&D investment rates of private enterprises in the United States, France, the United Kingdom, and Germany, which stand at around 60 to 70 percent, the rate in Korea is relatively high. In addition, in 1998, the number of researchers working for private enterprises exceeded 50 percent of the total number of researchers in the country, and has continued to increase every year, now accounting for 64 percent. This rapid growth of the R&D activities of private enterprises in Korea has been fueled by the government's aggressive policies for the development of private R&D organizations.

According to laws, private R&D organizations in Korea can be divided largely into corporate research institutes, industrial technology research associations, and for-profit and non-profit research corporations. However, for-profit research corporations exist in name only, and the activities of industrial technology research associations and non-profit research corporations have become stagnant, despite their importance. Only corporate research institutes continue to grow, both quantitatively and qualitatively, and play pivotal roles in private R&D.

The growth and importance of corporate research institutes is largely attributable to the government's support policies. In 1981, the Korean government introduced an accreditation system for corporate research institutes, which served as a catalyst for the systematic growth of R&D by private enterprises. The comprehensive support programs launched by the government, including the various tax breaks, promoted the establishment of numerous corporate research institutes. Even though they experienced some ups and downs with the changing economic environment, these corporate research institutes continued their steady quantitative growth, eventually becoming responsible for the majority of R&D activities conducted by private enterprises.

The development trend of private R&D organizations shows that large corporations established the foundation for private enterprise R&D during the period from 1980 to 1985, when the accreditation system for corporate research institutes was first introduced. However, from 1985 to 1997, just before the foreign exchange crisis, the establishment of corporate research institutes by small- and medium-sized enterprises increased sharply, driven by the government's loosening of the requirements for such enterprises to establish corporate research institutes in 1985. Due to the foreign exchange crisis in 1997, R&D by private enterprises was temporarily suppressed. With the boom in the establishment of venture enterprises in the

2000s, however, the number of corporate research institutes formed by small- and medium-sized venture enterprises skyrocketed. Following the implementation of the reporting system for R&D service businesses in June 2007, private R&D organizations are now expected to enter a new phase of development.

1. Corporate Research Institutes

In the late 1970s, the government began aggressively supporting R&D by private enterprises. As Korea's economic growth stagnated due to the second oil crisis and the decline of construction in the Middle East, the government turned its focus toward securing its domestic capacity for technological innovation by supporting private enterprise R&D. In September 1978, by order of the president, manufacturers with annual revenues of over KRW 30 billion were selected to establish the country's first corporate research institutes. To this end, the Corporate R&D Center Establishment Promotion Council was set up in 1979, renamed the Corporate Technology R&D Center Association in 1980, and reorganized to create the Korea Industrial Technology Association (KOITA) in 1982. Since 1982, the establishment of corporate research institutes has been accelerated by specific R&D projects launched and promoted by KOITA. In 1981, the Ministry of Science and Technology revised the Technology Development Promotion Act to include corporate research institutes as participants in such specific R&D projects. In addition, the Enforcement Decree of said act set forth the conditions for the establishment of corporate research institutes and introduced the reporting and accreditation systems for such corporate research institutes, thereby promoting their establishment.

Following this, the government organized and implemented various support programs to promote R&D by private enterprises. Starting with the reserve fund for the technology development system in 1973, a variety of R&D promotion systems were introduced by 1981, including tax credits for research and development expenditures, local property tax exemptions for corporate research institutes, temporary special consumption tax rates for advanced technology goods, and income tax exemptions for foreign engineers.

In addition, tax exemptions for technology-related income, tax credits for investment in new technology commercialization projects, and tax credits for technology service businesses were revised and complemented, and tariff exemptions on goods for research purposes and tax exemptions for research samples were introduced in 1982.

Such revolutionary support programs were the first of their kind in the world, and allowed corporate research institutes to achieve record growth year after year. When the accreditation system was introduced in 1981, there were only 46 corporate research institutes. Following the full implementation of the support and management system, the number of corporate research institutes grew sharply, reaching 1,000 institutes by 1991, 2,000 by 1995, and over 3,000 by 1997.

Private enterprise R&D, which had been growing rapidly in line with Korea's economic growth, was hit hard by the foreign exchange crisis in 1997. The crisis forced many enterprises to carry out restructuring, including cuts to R&D investment, layoffs of researchers, and cancellations of planned R&D projects.

However, while R&D activity by large enterprises contracted, R&D activity by small- and medium-sized enterprises began to expand. Researchers who had been laid off due to the restructuring of large enterprises

began establishing their own small venture enterprises based on their cutting-edge technological expertise. This phenomenon triggered the establishment of research institutes by small- and medium-sized enterprises and venture enterprises in line with the policies for the development of venture enterprises prioritized and promoted by the Kim Dae-jung government.

From that time on, the number of corporate research institutes increased exponentially, reaching 5,000 by 2000 and exceeding 10,000 by September 2004. This explosive growth continued until the number of institutes surpassed 14,000 by July 2007.

The government's easing of the requirements for the establishment of corporate research institutes also contributed to this remarkable growth. Specifically, the requirement that the corporate research institutes of small- and medium-sized enterprises employ at least 10 researchers with bachelors of science degrees was relaxed to five such researchers in 1985, and the minimum qualifications for researchers of corporate research institutes of small- and medium-sized enterprises was lowered from bachelor's or higher degree holders to college graduates (with two years of experience) in 1994. In particular, for corporate research institutes of venture enterprises that had been established within the previous five years, the required number of researchers was reduced to two in 2001. This encouraged many startup venture enterprises to establish corporate research institutes, thereby laying the foundation for the future of R&D in Korea.

Table 2-3-2. Annual Establishment of Corporate Research Institutes

(Units: number of institutes)

Year / Enterprise Scale	1981	1983	1988	1993	1998	2003	2006	2007.6
SMEs, Venture Enterprises (Percentage, %)	-	9 (7.4)	322 (53.3)	1,113 (65.9)	2,960 (78.7)	8,927 (91.0)	12,398 (93.0)	13,542 (93.6)
Large Enterprises (Percentage, %)	53 (100)	113 (92.6)	282 (46.7)	577 (34.1)	800 (21.3)	883 (9.0)	926 (7.0)	932 (6.4)
Total	53	122	604	1,690	3,760	9,810	13,324	14,474

Source: KOITA

Table 2-3-3. Annual Establishment of Corporate Research Institutes

(Units: number of institutes, %)

Research Area / Enterprise Scale	Electrical and Electronics	Machinery	Chemicals and Biotech	Construction Engineering	Food	Oil	Others	Total
Large Enterprises	324 (34.8)	191 (20.5)	76 (8.1)	56 (8.1)	56 (6.0)	28 (3.0)	56 (6.0)	932 (100.0)
SMEs, Venture Enterprises	7,078 (52.3)	2,455 (18.1)	753 (5.6)	753 (5.6)	209 (1.5)	150 (1.1)	859 (6.3)	13,542 (100.0)
Total	7,402 (51.2)	2,646 (18.3)	829 (5.7)	829 (5.7)	265 (1.8)	178 (1.2)	915 (6.3)	14,474 (100.0)

Source: KOITA

However, despite this growth, the establishment of corporate research institutes faced a number of limitations. According to a survey of scientific and technological R&D activities conducted by the Ministry of Science and Technology, as of 2005, there were 154,306 researchers working at corporate research institutes, accounting for 65.7 percent of the total number of researchers. The survey also showed that 17.7 percent (10,261) of researchers with doctoral degrees (57,942), 63.1 percent (49,595) with master's degrees (76,579), and 96.9 percent (85,138) with bachelor's degrees (87,829) were working at corporate research institutes. In other words, the percentage of researchers with doctoral degrees working at corporate research institutes was significantly lower than that at public research institutes, including universities and government-funded research institutes. Therefore, it was pointed out that in order to increase the efficiency of R&D investment at the national level, an effective system of cooperation among corporate research institutes, on the one hand, and universities and public research institutes with excellent researchers, on the other, was urgently required.

The financial weakness of corporate research institutes was also pointed to as a problem. Approximately 7,351 corporate research institutes, accounting for about 50 percent of all corporate research institutes, employed two to five researchers each, and 48 percent (7,206) of corporate research institutes were small-scale institutes with a floor area of 100 square meters or less. In addition, the survey showed that while there were only 193 large-scale research institutes with over 100 researchers, very small research institutes with five or fewer researchers accounted for 50 percent of the total number of corporate research institutes.

Table 2-3-4. Distribution of Corporate Research Institutes by Number of Researchers (as of the end of June 2007)

(Units: number of institutes, %)

	2 to 5 Researchers	6 to 10 Researchers	11 to 30 Researchers	31 to 100 Researchers	101 to 300 Researchers	Over 300 Researchers	Total
Large Enterprises	2 (0.2)	103 (11.1)	377 (40.5)	277 (29.7)	113 (12.1)	60 (6.4)	932 (100.0)
SMEs, Venture Enterprises	7,349 (54.3)	4,163 (30.7)	1,695 (12.5)	315 (2.3)	20 (0.2)	- (0.0)	13,542 (100.0)
Total	7,351 (50.8)	4,266 (29.5)	2,072 (14.3)	592 (4.1)	133 (0.9)	60 (0.4)	14,474 (100.0)

Source: KOITA

Meanwhile, the high concentration of corporate research institutes in the capital area was identified as yet another problem. Such institutes located in the capital area, encompassing Seoul, Incheon, and Gyeonggi, numbered 10,052, accounting for 69.4 percent of the total number of corporate research institutes.

Table 2-3-5. History of Accreditation System for Corporate Research Institutes

September 1978	President recommended establishment of corporate research institutes for manufacturers with annual revenues of KRW 30 billion or more.
February 1979	Corporate R&D Center Establishment Promotion Council (later to become KOITA) established.
July 1981	Ministry of Science and Technology introduced reporting system for corporate research institutes.

October 1981	Ministry of Science and Technology accredited first 46 corporate research institutes, established foundation for the participation of corporate research institutes (Technology Development Promotion Act) in specific R&D projects, introduced local property tax exemptions for corporate research institutes, and implemented military service exemptions for researchers at corporate research institutes.
May 1982	Reporting requirement for the establishment of corporate research institutes introduced under the Enforcement Decree of the Technology Development Promotion Act.
July 1983	Number of corporate research institutes exceeded 100.
September 1983	Tariff exemptions on goods for research purposes implemented.
December 1985	Reporting requirement for researchers at small- and medium-sized corporate research institutes eased (five or more researchers with bachelors of science degrees).
January 1986	Foundation for the participation of corporate research institutes in industrial technology development projects established (Industrial Development Act).
March 1986	Ministry of Science and Technology implemented guidelines for the reporting, operation, and support of corporate research institutes.
April 1988	Number of corporate research institutes exceeded 500.
December 1989	Technology Development Promotion Act revised to introduce regulation on contracting out reporting and operation business for corporate research institutes.
November 1990	Reporting requirement for researchers of R&D-type, small- and medium-sized enterprise research institutes established by researchers of science and technology research organizations implemented (three or more researchers with bachelors of science degrees).
February 1991	KOITA took over and carried out reporting and operation business for corporate research institutes from the Ministry of Science and Technology.
April 1991	Number of corporate research institutes exceeded 1,000.
April 1993	Number of corporate research institutes exceeded 1,500.
May 1994	Researcher qualifications for small- and medium-sized enterprise research institutes eased. Restrictions regarding researcher qualifications for research institutes in the field of information processing and industrial design eased.
February 1995	Number of corporate research institutes exceeded 2,000.
December 1997	Number of corporate research institutes exceeded 3,000.
August 1998	Representatives of venture enterprise research institutes permitted to serve as researchers.
February 2000	Number of corporate research institutes exceeded 5,000.
July 2001	Reporting requirement for researchers of corporate research institutes of venture enterprises established within the previous five years eased (two or more researchers with bachelors of science degrees).
September 2004	Number of corporate research institutes exceeded 10,000.
July 2005	Requirement for researchers of corporate research institutes of large distribution enterprises eased to seven researchers or fewer.
October 2005	Requirement on independent space possessed by information processing enterprises regarding 30 square meters or less of area for exclusive eased.
December 2006	Number of corporate research institutes reached 13,324.
June 2007	Number of corporate research institutes reached 14,474.

2. Industrial Technology Research Association

Established in 1977, the Industrial Technology Research Association was created for the purpose of serving as a hub for mutual cooperation, consolidating the resources needed to resolve related issues, and disseminating the results of collaborations in technology development. It is an independent organization that is not influenced by individual enterprises and allows universities to join as members as a means of promoting industry-university cooperation. Such research associations have been established, in accordance with the Industrial Technology Research Association Promotion Act, and benefit from a range of support policies, including tax relief, financial support, priority purchasing, and participation in specific R&D projects. While research associations with poor R&D records have been expelled, as of the end of 2006, a total of 72 research associations are still active. Of these, 13 research associations are active in the field of machinery and metal, 24 in electrical and electronics, eight in software, three in chemical engineering, and 24 other fields.

Table 2-3-6. Status of the Industrial Technology Research Association (As of 2006)

(Units: number of associations, number of people)

Classification	Machinery and Metal	Electrical and Electronics	Software	Chemical Engineering	Others	Total
No. of Associations	13	24	8	3	24	72
No. of Association Members (Total)	393	613	302	69	511	1,888

Source: Ministry of Science and Technology

However, many of these associations are relatively inactive and require reorganization. As some associations with financial difficulties are unable to survive based on membership fees alone, it has been pointed out that government support is required.

Even though the most important role of these research associations is to organize and lead joint research projects between enterprises, they have been largely ineffective in this regard. Therefore, they have served merely as contract agencies when member enterprises apply for government research development projects.

However, a few research associations, including the Nano Technology Research Association, Korea Drug Research Association, and Korea Association of Robotics, are very active.

3. Non-profit Research organizations

Non-profit research organizations in the field of science and technology are established and operated in accordance with Article 32 of the Civil Code and the Act on the Establishment and Operation of Public-Service Corporations. As of 2003, a total of 22 non-profit corporations have been registered with the Ministry of Science and Technology. However, only four of them, including the Research Institute of Industrial Science and Technology, MOGAM Biotechnology Research Institute, Korea Interfacial Science

and Engineering Institute, and Korea Institute of Brain Science, have established dedicated research organizations for professional R&D activities. The other 18 non-profit corporations carry out only commissioned education and research support activities for research associations or medical institutes, conducting no practical R&D of their own. Some of them exist in name only, engaged in no activities whatsoever.

Research organizations of non-profit corporations, which can be established by both individuals and corporations, are permitted to operate independently and benefit from most forms of government support for industrial technology development.

On the other hand, contributions are not recognized as deductible expenses, and remaining assets must be returned to the national treasury or distributed free of charge to public corporations upon dissolution. Also, there are limitations in terms of investment in other corporations subject to credit management regulations. In addition, corporations are faced with the problem of the additional costs of maintaining independent organizations.

Table 2-3-7. Establishment of Research Organizations by Non-profit Corporations (As of 2003)

Classification	Corporation Name	Establishment Year	Main Research Area
1	Korea Science Foundation	1967	Support for the promotion of science and technology culture projects
2	Korean Institute of Chemical Engineers	1970	
3	Korea Research Association of Theoretical Physics and Chemistry	1978	Theoretical physics and chemistry research
4	Unam Geology Award Committee	1979	Support for the expenditures of research associations
5	MOGAM Biotechnology Research Institute	1984	Research on vaccines, new drugs, diagnostic reagents, etc.
6	Giheon Science Technology Foundation	1984	Research on vaccines, new drugs, diagnostic reagents, etc.
7	Korea Liver Foundation	1984	Support for the expenditures of science-related associations
8	Research Institute of Industrial Science and Technology	1987	Research on steel, new materials, and managerial economy
9	Korea Cancer Research Foundation	1988	Support for the research expenditures of medical scientists
10	Production Engineering Laboratory	1990	
11	Haedong Science Foundation	1991	Support for the research expenditures of electronics technology groups
12	Korean Cell Line Bank	1991	Support for medicine-related research expenditures

13	Korea Interfacial Science and Engineering Institute	1991	Research on interfacial engineering (environment, materials, and recycling)
14	Seokgok Observation and Science Research Institute	1995	
15	Korea Transplantation Genetics Research Foundation	1995	Support for medicine-related research expenditures
16	Dongchon Science Research Foundation	1996	
17	Korea Brain Science Laboratory	1996	Research on neuroscience, medical science, and tao science
18	Hantan Foundation	1996	Support for the research expenditures of related associations in Korea
19	Korea Instrumentation and Control Technology Training Institute	1997	Instrumentation and control technology training (commissioned)
20	Bongeun Foundation	1998	
21	Korea Institute of Brain Science	1999	Research on brain medicine, neural engineering, and psychology
22	Korea Polar Research Institute	2001	

4. Profit Research Corporations and R&D Service

The legal grounds for for-profit research corporations, whose sole purpose is the pursuit of profit, were provided by the revision of the Technology Development Promotion Act in 1991. However, unlike other private R&D organizations, for-profit research corporations received little attention, as no benefits for researchers, such as tax breaks or military service exemptions, were made available, leading them to remain as a nominal system. However, with the government's recent decision to promote R&D service businesses with characteristics similar to those of for-profit research corporations, as part of its policy for the development of the knowledge service industry, a turning point is expected to emerge. R&D service businesses exist within a knowledge-based service industry where the main agents of R&D, including industries, universities, and institutes, promote and support the creation and dissemination of science and technology knowledge by enhancing the productivity of research procedures and results, which has been the case in technologically advanced countries, including the United States and Japan, since the 1990s.

The Ministry of Science and Technology implemented a reporting system for R&D service businesses in May 29, 2007, in accordance with the Special Act on Support of Scientists and Engineers for Strengthening National Science and Technology Competitiveness (revised in December 2006). This was done as part of the government's policy for the development of the knowledge service industry. Based on this, by 2010, the Ministry of Science and Technology planned to employ 5,000 or more professionals by developing a total of 300 new R&D service enterprises. R&D service businesses are divided into R&D businesses that carry out R&D independently or on consignment in the field of science and engineering for the purpose of making profit and R&D support businesses that support R&D in the field of science and engineering by providing technology information, consulting, and testing and analysis for the purpose of making profit.

Table 2-3-8. Types of R&D Service Businesses Reported

Classification	Business Type Reported
R&D Business	R&D Business in Physics, Chemistry, and Biology
	R&D Business in Agriculture
	R&D Business in Engineering and Technology
	R&D Business in Other Natural Sciences
	Power of Convergence in Relation to Science and Engineering
R&D Support Business	R&D Consulting Specialist
	Technology Market Survey Specialist
	Patent Management Agency
	Technology Development Investment or Loan, and Technology Transaction Brokerage or Agency
	Material Component Testing Business
	Structure and Product Testing Business
	R&D Product Design Business
	Business Supplying Researchers and Education and Training

Currently, enterprises that have already reported R&D service businesses will be permitted to use technology information, professional research personnel, and research facilities and equipment owned by national and public research institutes, universities, and government-funded research organizations. They will also be allowed to participate in national R&D projects. In addition, various forms of support will be made available to corporate research institutes, including tax credits for R&D expenditures, and an alternative military service system for the personnel of R&D service businesses (Technical Research Personnel System) will be implemented. In order to create a foundation upon which R&D service businesses may grow, a professional research personnel support program designed to compensate R&D service businesses for some of the labor costs involved in hiring new researchers will be implemented.

The reporting requirements for R&D service businesses include having 10 or more science and engineering research personnel and an independent research facility, while R&D support businesses must have two or more science and engineering research personnel. In this regard, KOITA is commissioned to carry out the related reporting duties.

Section 4. Operation of National and Public Testing and Research Institutes

1. Establishment of National and Public Testing and Research Institutes in Korea

The initial concept of Research and development (R&D) in Korea was first conducted at national and public testing and research institutes. It is a significant contributions to introducing the idea of technological development in a country where there had been no signs of any technological advancement before its modernization. These testing and research institutes were divided largely into two main types of institutional units, referred to as national research institutes, which were agencies of the central government, and public research institutes, affiliated with local governments. Moreover, these institutes were categorized

as either testing institutes or research institutes based on their functions, and their staff and researchers were considered to be civil servants.

The very first of these testing and research institutes was the Railway Technology Institute, which was established in 1918 as a means of accelerating the construction and supporting the operation of railroads in Korea after the opening of the Gyeongin (Seoul-Incheon) Line in 1899. In the same year, the Office of Geological Survey was established, followed by the National Fisheries Research and Development Agency in 1921, the Forestry Experiment Station in 1922, and the Monopolized Research Center in 1937, all at the will of the Japanese imperial government. In 1947, after Korea regained its sovereignty from Japanese colonial rule, the National Animal Breeding Institute was established. In 1949, a couple of years later, several research institutes in areas related to primary industries were established, including the National Agricultural Products Inspection Center, National Raw Silk Inspection Center, and National Animal Quarantine Service. From 1954 to 1959, in the wake of the Korean War, the National Scientific, Criminal, and Investigation Laboratory was founded, along with the Horticultural Experimental Station, Veterinary Research Institute, Livestock Experiment Station, and National Nuclear Research Institute, all of which were devoted purely to R&D.

In the 1960s, there were 24 national testing and research institutes, but by the end of 1975, that number had grown to 75 as a result of establishment and merging of institutes during the 1960s and 70s. Since then, however, only six institutes have been established—five in the 1980s and one in the 1990s. The stagnant growth in the number of institutes brought the total number of institutes down to 60 by the end of 1996. As of 2005, there were 64 national testing and research institutes. In the early 1960s, over 75 percent of these institutes were active in areas related to primary industries, such as agriculture, forestry, and fisheries, but by the late 1990s, that proportion decreased to 62.5 percent. During the same period, natural science and engineering research institutes comprised 18.7 percent of all such institutes.

Through a series of expansions and reorganizations, some of these institutes became government-funded research institutions, which enabled them to be more actively engaged in R&D. For example, the Railway Technology Institute was reorganized into the Korea Railroad Research Institute; the Monopolized Research Center became the Korea Ginseng and Tobacco Research Institute; and the National Nuclear Research Institute changed into the Korea Atomic Energy Research Institute.

2. Movement of Researchers

After the 1960s, the Korean government took the lead in establishing government-funded research institutes, and by doing so, strengthened its R&D policies in order to better invest in and support these institutes. After the 1980s, both universities and businesses strengthened their R&D capacities, hence taking the reins from national research institutes.

The number of R&D specialists working at national testing and research institutes increased gradually every year; however, the proportion of these R&D specialists dropped significantly due to the surge in the number of R&D specialists at universities and businesses. In 1975, 72.7 percent, or 2,326 out of the total of 3,198 researchers, worked at national and public testing and research institutes. In the 1970s, however, that proportion slowly began to drop, reaching 30 percent in 1975. And it continued to drop, falling to six percent

in the 1980s, 3.4 percent in 1995, and 1.7 percent in 2005. In 1996, 8,733 researchers were working at government-funded research institutions, while only 4,148 were working at national research institutes. By 2005, there were only 3,950 researchers at national research institutes.

Table 2-3-9. Researchers per R&D Lab

(Unit: number of researchers)

	1967	1975	1985	1995	2005
Testing and Research Institutes	2,326	3,086	7,154	15,007	15,501
- National and Public Research Institutes	2,326	2,312	2,447	4,351	3,950
- Non-profit Research Institutes	-	774	4,707	10,656	11,551
Universities	599	4,534	14,935	44,683	64,895
Businesses	273	2,655	18,996	68,625	154,306
Total	3,198	10,275	41,085	128,315	234,702

3. Changes in R&D Investment

Until the mid-1960s, the majority of R&D investment had been concentrated in national and public testing and research institutes. The government budget for the improvement of research facilities and equipment increased from KRW 3.1 billion in 1967 to KRW 16.7 billion in 1975, KRW 48.8 billion in 1985, KRW 334.4 billion in 1995, and KRW 443.1 billion in 2005. However, with the significant increase in investment in the R&D laboratories of government-funded research institutes, universities, and businesses, the proportion of R&D investment in national and public testing and research institutes dropped from 85.4 percent of the total R&D expenses, which stood at KRW 3.7 billion, in 1967 to 39 percent in 1975, 42 percent in 1985, 4.8 percent in 1995, and 2.4 percent in 2005.

In 1996, researchers employed at government-funded research institutes were paid an annual average salary of KRW 161.673 million, while researchers at national research institutes earned an average of KRW 80.566 million. By 2005, the salary of researchers at government-funded research institutions had increased to an average of KRW 254.17 million, while that of researchers at national research institutes stood at only KRW 113.508 million. This considerable gap clearly shows that the R&D of national research institutes has grown to dwarf that of government-funded research institutions.

Table 2-3-10. R&D Expenditure per R&D Lab

(Units: millions of KRW [adjusted for inflation])

	1967	1975	1985	1995	2005
Testing and Research Institutes	3,152	28,139	280,246	1,766,713	3,192,887
- National and Public Research Institutes	3,152	16,679	48,845	334,428	443,131

- Non-profit Research Institutes	-	11,460	231,401	1,432,285	2,749,756
Universities	173	2,182	118,802	770,912	2,398,284
Businesses	368	12,342	751,025	6,902,981	18,564,243
Total	3,693	42,663	1,150,073	9,440,606	24,155,414

Section 5. Construction and Development of Daedeok Science Cluster

1. A mission to Establish a New Research complex : 1968 to 1977

The concept for Daedeok Science Town was first presented in the long-term comprehensive plan for science and technology development (1967-1986) that was established in 1968. This plan suggested the expansion of research facilities as a means of increasing the effectiveness of R&D and proposed the construction of a complex where research organizations and universities could gather together in one place. Based on this plan, in October 1970, the Ministry of Science and Technology commissioned the Presidential Committee on Economy and Science to conduct a survey and research project with the goal of drawing up a master plan for the construction of such a research and academic complex. In July 1971, the committee reported its results to the ministry. That survey and research report, which presented the basic framework and concept for Daedeok Science Town, played an intermediary role in the establishment of the research complex.

The year 1973 was the first year of the construction of Daedeok Science Town, as that was when the construction plan was finalized as a national plan. On January 17, 1973, during the president's annual inspection tour, the Ministry of Science and Technology presented the business plan for the establishment of technology research organizations in strategic industries and the construction of a second research complex. The president showed great interest in the construction of a second research complex and ordered that a detailed plan be drawn up. Later that year, on May 18, the report meeting for the construction plan (proposal) was held, with the president in attendance. The candidate sites for the research complex were: Daedeok, in Chungnam; Hwaseong, in Gyeonggi; and Cheongwon, in Chungbuk. Among these, Daedeok was selected as the location best suited for the construction of the complex, following which the president approved the designation of the research complex's construction plan as a national project.

With the introduction of the construction plan (proposal) for Daedeok Research and Academic City at the first General Science and Technology Council on July 27, 1973, the specific tasks of each ministry involved and how they would coordinate amongst themselves were formally established. On September 4, in accordance with Presidential Decree No. 6837, the Daedeok Research and Academic City Construction Committee (chaired by the vice minister of science and technology) was established in the form of an advisory body with the Ministry of Science and Technology. Subsequently, on November 30, the Ministry of Construction announced that it had designated the entire area of Daedeok Research and Academic City as a special education and research district, and the basic plan for the construction of the city was confirmed on December 21.

The construction of Daedeok Research and Academic City, which included streets and buildings, got underway in 1974. However, due to the economic depression caused by the first oil crisis, it became impossible to fund the construction of the city as originally planned, making it necessary to reduce the scale of the project. In addition, many argued that the construction plan should be revisited and discussed further, especially concerning the capital relocation process that had been initiated by Cheong Wa Dae (official residence of the Korean President) and the choice of Daedeok as the location. Amid such circumstances, the construction plan for Daedeok Research and Academic City was downsized, the project was renamed "Daedeok Science Town," and a stage-by-stage budget schedule was drawn up.

In addition, the responsibility for the construction of Daedeok Science Town was transferred to the Heavy and Chemical Industry Promotion Council, which, on June 3, 1976, made additional revisions to the new construction plans. In particular, the land area of Daedeok Science Town was increased by 300,000 *pyeong* (approximately 99 hectares) to accommodate the Korea Nuclear Fuel Development Institute, bringing the total area to 8.4 million *pyeong* (approximately 2,776 hectares). At the same time, the entire construction site was designated as an industrial base development zone, and on December 8, 1977, the Ministry of Construction announced its decision regarding the site for the construction and development of a research base in Daedeok.

2. Establishment of Daedeok Science Cluster: 1978 to 1992

Although the construction of Daedeok Science Town started in 1974, due to repeated revisions of related plans, actual development did not begin in earnest until 1978. In March 1978, the Korea Standards Research Institute moved into Daedeok Science Town, followed by the Korea Research Institute of Ships and Korea Research Institute of Chemical Technology in April and the Korea Radioactive Waste Agency and Chungnam National University in August. Following such public organizations, several private organizations, including the Ssangyong Research Center, Hanyang Chemical Research Center, and Lucky Research Center, started setting up in Daedeok Science Town in 1979. With the increase in the number of organizations moving into Daedeok Science Town, the Ministry of Science and Technology established the Daedeok Administration Office on March 10, 1979, and tasked it with ensuring that the construction of Daedeok Science Town was carried out efficiently.

With the dissolution of the Heavy and Chemical Industry Promotion Council in October 1979, the Ministry of Science and Technology took over the Daedeok Science Town construction project. Subsequently, on August 27, 1981, the Ministry of Construction announced the basic plan for the development of an industrial base in Daedeok, in accordance with the Industrial Base Development Promotion Act. This plan specifically provided for the rezoning of land for industrial purposes, as designated in 1977, and tentatively scheduled the development period as 1981 to 1990.

With the inauguration of the Fifth Republic of South Korea, the Ministry of Science and Technology called for a full-scale review of the Daedeok Science Town construction project. Based on the review, the ministry outlined the direction that the construction of Daedeok Science Town would take at the first Technology Promotion Council, which was held on April 27, 1984. The short-term plan aimed to create an R&D environment that would eliminate many of the inconveniences of everyday life so that the researchers could focus on their work, while the mid-term plan, for the period from 1984 to 1987, was to attract and establish

research institutes, universities, and culture and welfare facilities. The long-term plan, for 1988 and afterward, emphasized cooperation among research institutes, universities, and high-tech industries.

The decision to change the Daedeok Science Town construction project from a self-development project to a public development project was made at the 14th Economic Ministers Council, held on August 24, 1984. Accordingly, in May 1985, the Ministry of Construction announced that the Korea Land Development Corporation had been designated as the developer of the planned industrial base in Daedeok, thereby changing the basic plan for its development. The Korea Land Development Corporation initiated the first stage of the project in November 1985, and the second stage in May 1987. During the planning phase of the Daedeok Science Town construction project, Korea's first regulation system for land transactions was implemented, and the basic plan was revised several times in order to expand the research and education facilities.

When the entire area of Daedeok Science Town was selected to be the venue for the 1993 Expo in February 1989, the construction project for Daedeok Science Town was accelerated. In addition, at the first Science and Technology Promotion Conference, held on July 10, 1990, the Korea Land Development Corporation expressed that it would complete the construction project early, within only three years. Upon the launch of the committee responsible for the early completion of Daedeok Science Town (chaired by the minister of science and technology) following the announcement, national support for the construction project increased. The first stage of construction was completed in March 1991, and the second stage was wrapped up in November 1992. The completion ceremony for Daedeok Science Town was held on November 27, 1992. By that time, 33 organizations had already moved in, including three government organizations, 15 government-funded research organizations, four government-invested organizations, eight private research institutes, and three institutions of higher education.

3. Establishment of the Innovation Cluster: 1993 and Afterward

The number of organizations moving into Daedeok Science Town increasing rapidly upon its completion in November 1992, ensuring the effective management of the research cluser became a key issue. The construction of the complex had been governed by the Industrial Sites and Development Act; however, this act did not properly reflect the nature of Daedeok Science Cluster. For this reason, the Daedeok Science Cluster Management Act, which provided for the establishment of a management plan for the research cluster, classification of land use, and approval and cancellation of occupancy, was enacted in December 1993. Subsequently, in August 1994, the Daedeok Science Cluster Management Office was established and tasked with the management of the complex.

Meanwhile, in the 1990s, the government commenced the commercialization of the research results of government-funded research cluster and set out to establish a system of cooperation among industries, universities, and research institutes. Since September 1990, the Ministry of Science and Technology has been operating a startup support system for researchers, through which it promotes the application of newly developed technologies and provides three-year leaves of absence and unofficial funding within research institutes. In January 1994, the Cooperative Research and Development Promotion Act was enacted as a means of allowing the government to provide support for R&D expenditures and promoting the commercialization of R&D results by enterprises.

With the government's emphasis on collaboration among industries, universities, and research institutes, startups founded by researchers began to appear in Daedeok Science Town in the 1990s. For example, the Electronics and Telecommunications Research Institute supported researchers in their efforts to commercialize the R&D results of their assigned projects and launch venture enterprises based on such technology. In addition, the Korea Advanced Institute of Science and Technology, with the assistance of the Ministry of Science and Technology, established the New Technology Startup Support Group, which worked to support venture enterprises through various means, such as securing available space on campus for them to set up their operations, providing information on funding and management, and offering various services, including facilitating the sharing of research equipment and computers.

What actually triggered the transformation of Daedeok Science Cluster into a cradle for venture startups was the restructuring of government-funded research organizations following the economic crisis. Through this restructuring, researchers became increasingly interested in startups, and the government actively promoted support programs for venture enterprises. With the revision of the Daedeok Science Cluster Management Act in December 1999, production activities were permitted within the premises of Daedeok Science Cluster, occurring alongside its main research and education activities. This resolved the issue of the separation of research and production, which had been pointed to as one of the major problems of Daedeok Science Cluster.

On September 28, 2000, the proclamation ceremony for Daedeok Valley was held, announcing the goal of establishing Daedeok Science Cluster as a research complex for industries, universities, and research institutes. Daedeok Valley, which included Daedeok Science Cluster, Daejeon Scientific Industrial Cluster, the Third and Fourth Industrial Cluster Area of Daejeon City, Yuseong Special Tourist Zone, and Dunsan Government Town, was an innovation cluster covering R&D, production, and commercialization. Around the time of the Daedeok Valley proclamation ceremony, local governments and the private sector began ramping up their related activities. Daejeon City intensified its focus on attracting and supporting venture enterprises through the establishment of the Regulations Relating to the Development of and Support for Venture Enterprises Etc. in September 2000. As for the private sector, the Daedeok 21st Century, a meeting of venture entrepreneurs, was expanded in April 2001 to form the Daedeok Valley Venture Association, and Daedeok Net was launched in November 2000 to facilitate information exchange among organizations and enterprises in Daedeok Valley.

In 2003, the government began seeking means of providing greater support for Daedeok Science Cluster. Inaugurated in 2003, the Roh Moo-Hyun administration emphasized the establishment of a Northeast Asia R&D hub, which led to a debate on the formation of special R&D zones in conjunction with the 30th anniversary of Daedeok Science Cluster. A support policy for Daedeok Innopolis was introduced at a report meeting for major government projects in March 2004, and the Special Act on the Support of Daedeok Special Research and Development Zone, Etc. was enacted in January 2005. This act provided for the establishment of the R&D Special District Committee (chaired by the deputy prime minister of science and technology), approval for the establishment of research institute enterprises, special treatment for high-tech and foreign-invested enterprises, implementation of special district R&D projects, and the establishment of the Daedeok Innopolis Support Center. Based on such strong support from the government, Daedeok

Science Cluster has grown to become a full-fledged innovation cluster. As of October 2006, Daedeok Innopolis housed a total of 785 organizations, including 21 government-funded organizations, nine government-invested organizations, six education organizations, 13 public organizations, 13 support organizations, and 721 enterprises.

Section 6. R&D Collaboration among Industries, Universities, and Research Institutes

1. Types of Collaborations among Industries, Universities, and Research Institutes

The collaborations among industries, universities, and research institutes led by the government can be divided largely into three categories: collaborations on joint R&D, collaborations on education and support for skilled and talented personnel, and collaborations on technology transfers and support for startups.

Government departments are promoting collaborations among industries, universities, and research institutes for joint R&D through both long- and short-term R&D projects. Such projects include the 21st Frontier R&D Program of the Ministry of Science and Technology, Mid-term Base Technology Development Project, Next Generation New Technology Development Project, Common Core Technology Development Project, Regional Innovation System of the Ministry of Commerce, Industry, and Energy, Cooperative Consortium R&D Program of the Small and Medium Business Administration, Industrial-Academic Collaboration Support Project, and the Support Project for the Establishment of Corporate Research Institutes for Industrial-Academic-Research Institute Collaborations.

Collaborations among industries, universities, and research institutes for educating and nurturing skilled and talented personnel are supported by the government as a means of promoting training programs that combine theory and practical experience. Brain Korea 21 (BK21), a project launched by the Ministry of Education and Human Resources Development, is a typical example. Collaborative undertakings for technology transfers and support for startups include the Technology Transfer Promotion Business and business incubators that support the commercialization and transfer of R&D achievements.

2. Characteristics of Support Measures for Collaborations among Industries, Universities, and Research Institutes in Chronological Order

A timeline of the support measures for collaborations among industries, universities, and research institutes is provided in the chart (Table 2-3-11) below. The details are as follows.

First, during the 1960s, when nurturing skilled personnel was a central part of the government's policy, the Korean government focused on improving the capabilities of workers and securing sufficient manpower, as Korea's economy was concentrated in the labor-intensive, light industries.

Second, during the incubation stage of collaborations among industries, universities, and research institutes in the 1970s, specific measures for promoting the necessary linkages were still insufficient, but individual

government departments and agencies had started building the foundation for such collaboration. In 1972, the Korean government passed the Technology Development Promotion Act, which helped lay the basis for collaborative research projects among industries, universities, and research institutes.

Third, during the early stage of collaboration among industries, universities, and research institutes in the 1980s, the Korean government began supporting such partnerships in earnest through government-led R&D projects. As a result, about 60 percent of both the specific R&D projects of the Ministry of Science and Technology and industry-based technology development projects of the Ministry of Commerce, Industry and Energy were carried out through collaborations among industries, universities, and research institutes in 1982 and 1987, respectively.

Table 2-3-11. Changes in Government Policies to Support Collaboration among Industry, Academia, and Research Institutes

Period	Features	Details
1960s	Focused on nurturing skilled personnel	- Securing experts in science and technology; collaborative research projects between academia and industry that are focused on policies aiming to improve the skills of workers and secure sufficient manpower. - Newly enacted laws, including the Industrial Education Promotion Act, Professional Engineers Act, and Vocational Training Act.
1970s	Incubation stage of industrial-academic-research institute collaboration	- The changing roles of KIST as the key to joint R&D. - The Korean government enacted the Technology Development Promotion Act to encourage the development of purely Korean technology. - The government established research laboratories and planned to establish the Daedeok Science Complex.
1980s	Early stage of industrial-academic-research institute collaboration	- The government began supporting collaborations among industries, universities, and research institutes in earnest through national R&D projects. - The Industrial Technology Research Association Act was passed to enhance the support for joint R&D. - The government laid the foundation for strengthening collaboration among industries, universities, and research institutes with the establishment of the Korean Federation of Science and Technology Societies and Korea Basic Science Institute.
1990s	Developmental stage of industrial-academic-research institute collaboration	- Each department began pushing ahead with its own R&D projects. - Carrying forward a plan to establish local infrastructure in order to strengthen local innovation systems. - Encouraging the development of excellent technique research centers (ATC), regional cooperative studies centers (RRC), technology innovation centers (TIC), and Technoparks.
2000s	Developmental stage of innovative industrial-academic-	- Nurturing skilled and talented personnel and developing the technology needed by industries. - Calling for new types of collaboration among industry and academia, including open, integrated, and innovative linkages, to be created.

	research institute collaboration	- Creating an environment that values regional innovation clusters, operation of joint research programs between universities and industries, and spreading exemplary cases of industrial-academic collaboration.

References: Korea Industrial Technology Promotion Association, "Plan to Build Industry-Driven Innovative Networks," 2004

Fourth, in the 1990s, during the developmental stage of collaboration among industries, universities, and research institutes, each government department started pushing ahead with its own independent R&D project, and an official program was implemented to serve as an operation system that tied together industries, universities, and research institutes. Given the fact that businesses were incapable of leading technological development in South Korea, undertakings such as the excellent technique research centers (SRC, ERC, RRC) of KOSEF (Korea Science and Engineering Foundation), the technology innovation centers (TIC), and the technoparks of the Ministry of Commerce, Industry and Energy all encouraged research entities throughout the industry to pursue R&D achievements. In particular, the enactment of the Cooperative Research and Development Promotion Act in 1994 served as a signpost for industries, universities, and research institutes to work together, by including details of various types of support and aid, and induced increases in joint R&D investment.

Lastly, during the developmental stage of innovative industrial-academic collaboration in the 2000s, a reorganization of the system was induced in order to encourage new types of collaboration between academia and industry, nurture skilled and talented personnel, and develop technology so that industrial-academic collaborations would be able to meet the demands of industry. In addition, regional innovation clusters became an important factor in building an organic system of collaboration.

3. Collaboration Programs of the Korean Government

A. R&D Collaborations among Industries, Universities, and Research Institutes

The majority of government R&D projects are funded not only by both the public but also private sectors. The government provides up to 50 percent of project budgets to large companies and up to 80 percent to SMEs. Thus, the government's policies favor the development of technology-intensive SMEs and serve to strengthen the support for companies that lack the innovation and capabilities to develop new technology. Moreover, the government is currently assisting SMEs by cutting their engineering fees when they succeed in developing new technologies. In addition, the government allows SMEs to use, free of charge, technologies developed in research laboratories run by the government or universities.

The government has implemented several measures to promote joint R&D. The Ministry of Science and Technology has conducted specific R&D projects since 1982. Since the 1990s, these projects have served to expand the participation of private companies and universities by changing their support from small-scale research projects to collaborative research projects conducted among industries, universities, and research institutes. In particular, the National Research Laboratory (NRL), which was launched in 1999, focused on developing balanced partnerships among industries, universities, and research institutes, eventually making significant contributions to the expansion of the foundation for R&D and the

establishment of infrastructure for such partnerships. In addition, in 1994, the Ministry of Commerce, Industry and Energy began supporting the construction of university research parks in accordance with the Establishment of Industrial and Energy Technology Foundation Act, and worked to expand the Techno Complex. Moreover, since 1993, the Cooperative Consortium R&D Program, implemented by the Commerce-Industry Ministry, which is currently under the jurisdiction of the Small and Medium Business Administration, has promoted collaborations among industries, universities, and research institutes by helping SMEs address technological barriers and overcome the challenges involved in their production and manufacturing processes. It did so by permitting SMEs to use technologies developed in government- or university-operated research laboratories.

Some collaborative projects have been carried out through cooperation among different government departments. The Ministry of Education and Human Resources Development and Ministry of Commerce, Industry and Energy worked together to implement LINC (Leaders in Industry-University Cooperation) and the Leading TLO Program. Since 2004, the LINC project has been supporting universities in their efforts to boost collaboration with industries by designating a total of 13 universities as "industrial cooperative universities," including five industrial universities and eight universities from different regions. This project aims to develop programs that provide full support for critical equipment, technological development, and cultivation of highly capable students.

Table 2-3-12. Current State of Major Government-led Industrial-Academic-Research Institute Collaborations

Project Name	Responsible Department	Sponsored Universities	Details
LINC (Leaders in Industry-University Cooperation)	Ministry of Education and Human Resources Development, Ministry of Commerce, Industry and Energy	Universities (8) Industrial Universities (5)	- Reforming the system of universities located nearby industrial complexes so as to focus on collaboration with industries and providing them with full support, including critical equipment, technology development, and cultivation of excellent students. - Providing subsidy of KRW 2.5 billion to 6.5 billion to each university, and KRW 1.5 billion to 3 billion to each industrial university.
Leading TLO Program	Ministry of Education and Human Resources Development, Ministry of Commerce, Industry and Energy	Technology Licensing Office (TLO)	- Strengthening technology transfer capacity by supporting 28 promising, specially selected TLOs within universities and research laboratories in four major regions of Korea. - Supporting the operation of TLOs within regional technoparks. - Providing subsidy of KRW 200 million to 500 million to each TLO annually (including labor and direct costs).
Human Resource Training Project for Regional Innovation	Ministry of Commerce, Industry and Energy	Local Universities, The team in charge of collaborative	- Cultivating skilled personnel by supporting the joint R&D expenditures of local universities and industries (providing subsidy of KRW 100 million per year for up to three years).

		projects with universities	- Providing 30 to 50 percent of public funds to graduate student researchers.
Supporting Lab of Excellency	Ministry of Commerce, Industry and Energy	Universities	- Funding technology development projects carried out through collaborations between universities and industries with the goal of nurturing skilled personnel in industries with the potential to serve as future engines for economic growth. - Providing 50 graduate school laboratories with KRW 100 million in funding over four years.
Regional Innovation System	Ministry of Commerce, Industry and Energy	Industry-University-Research Institute Consortiums	- Establishing independent, local infrastructure, in accordance with regional characteristics, through innovation achieved by strengthening the network and collaboration among industries, universities, and research institutes
Technopark	Ministry of Commerce, Industry and Energy	Regional Technoparks (TP)	- Establishing technology innovation centers as a means of consolidating the research capacities of universities and industries within different regions (technology development, business incubation, support for equipment and facilities, pilot production etc.)
Regional Innovation Center	Ministry of Commerce, Industry and Energy	Universities and Research Laboratories	- Promoting regional innovation by providing full support for R&D, technology transfers, startups, equipment necessary for realizing regional strategies, and equipment in industries where South Korea shows strength. - Providing subsidy of KRW 700 million per center annually.
Facilitation of Technology Transfer and Commercialization	Ministry of Commerce, Industry and Energy	Universities, Research Laboratories, and SMEs	- Commercializing and transferring technology developed in both the private and public sector. - Technology Business Incubator (TBI), Research and Business Development (R&BD)
Joint Technology Development Consortium	Small and Medium Business Administration	Universities and Research Laboratories (SMEs)	- Overcoming the technological barriers and challenges of SMEs through joint technological development conducted among industries, universities, and research institutes. - Industrial-academic consortium (subsidy of KRW 43 billion for 210 universities), industrial-research consortium (subsidy of KRW 10 billion for 26 research institutes), Collaboration of Industry-University of Small and Medium Business Administration -University
Support for University-Industry Cooperation Centers	Small and Medium Business Administration	Universities (SMEs)	- Nurturing skilled personnel and excellent students and jointly developing the technologies needed by university laboratories and SMEs (subsidies limited to KRW 150 million for up to two years)

Establishment of Research Laboratories for Industry-University-Research Institute Collaboration	Small and Medium Business Administration	SMEs (Universities and Research Laboratories)	- Supporting the cost of establishing and operating SME research laboratories within universities and other research centers. - Subsidies limited to KRW 200 million for up to three years.

References: Office of Science and Technology Innovation, Mid-term Business Plan for R&D (2007 to 2011). "White Paper on Industry and University Cooperation," Korea Research Foundation, 2005.

According to the results of an analysis on the current state of joint research conducted by research entities as part of national R&D programs, the proportion of joint research conducted by industries, universities, and research institutes increased from 41.1 percent in 2005 to 42.4 percent in 2006, clearly showing an upward trend. Research conducted by all three of these entities together comprised the majority of joint research studies, followed by industrial-academic collaborations.

Looking at the chart below, which shows the extent to which businesses have participated in government-led R&D projects conducted by universities, it is quite evident that government investment has increased over the years. The participation rate of businesses increased from 17.7 percent in 1999 to 37.3 percent in 2004, representing a 19.6-percent increase. This increase was influenced largely by new projects, including the New University for Regional Innovation (NURI), and the establishment of new industrial cooperative universities in 2004. In terms of the types of businesses participating, from 1999 to 2004, the participation rate of both large and small companies increased by 11.7 percent, and the participation rate for SMEs rose by 7.3 percent.

Table 2-3-13. Trend of Company Participation in Government R&D Projects Carried Out by Universities (1999 to 2004)

(Units: KRW 100 million, %)

Type		1999	2000	2001	2002	2003	2004
Expenditures of Government R&D Projects Carried Out by Universities		6,089	7,092	10,826	10,609	11,141	13,233
Business Participation (Ratio, %)	Large Companies and SMEs	102 (1.7)	331 (4.7)	825 (7.6)	860 (8.1)	1,051 (9.1)	1,782 (13.4)
	Large Companies	104 (1.7)	238 (3.4)	140 (1.3)	206 (1.9)	194 (1.7)	298 (2.3)
	SMEs	874 (14.3)	1,323 (18.6)	1,557 (14.4)	1,898 (17.9)	1,940 (17.4)	2,857 (21.6)
	Total	1,080 (17.7)	1,892 (26.7)	2,522 (27.9)	2,964 (27.9)	3,149 (282.2)	4,937 (37.3)

References: Korea Institute of Science and Technology Evaluation and Planning (2000 to 2005), research and analysis data of the National R&D Program.

B. Laying the legal foundation

The Korean government has laid out justifiable reasons for establishing an institutional foundation for the promotion of collaboration among industries, universities, and research institutes based on some 30 pieces of legislation, including the Cooperative Research and Development Promotion Act, Technology Transfer Promotion Act, Act on the Support of Industrial Technology Research Cooperatives, and Promotion of Industrial Education and Industry-Academic Cooperation Act.

The enactment of the Technology Development Promotion Act in the 1970s helped established a basis for research projects conducted through the collaboration of industries, universities, and research institutes. Since 1982, following the implementation of the national R&D program, such collaboration among industries, universities, and research institutes began to show significant growth. The Technology Development Promotion Act laid out the rules for the use of intellectual property and R&D resources in order to promote collaboration among industries, universities, and research institutes. Therefore, the act provides for the sharing of R&D facilities and provision of preferential support for collaborative R&D projects and the dispatch of researchers to facilitate personnel exchanges. It also allows researchers to fill more than two posts. However, the provisions of the act are not legally binding, holding only declarative significance in terms of fundamental law, as government agencies have failed to come up with detailed implementation plans. Since the economic recession, the government has strengthened its measures for the promotion of collaboration among industries, universities, and research institutes. It has also promoted SMEs through the establishment of technology loans and assisted them with their technological development activities by enacting the Special Act on Innovation in Science and Technology.

Moreover, until the 1990s, the government's science and technology polices had favored R&D, thus encouraging increased R&D activities throughout the industry, while technology transfers received relatively little of the government's attention. Since the 1990s, however, government agencies began to realize the significance of technology transfers, leading them to initiate such projects. Furthermore, in 2000, after it passed the Technology Transfer Promotion Act (later renamed the Technology Transfer and Commercialization Promotion Act), the Korean government started differentiating these policies from other science and technology policies.

In 2003, implementation strategies and visions for new collaboration projects intended to meet the demands of regional customers were discussed as part of the government's plan to implement major government projects. Since the enactment of the Promotion of Industrial Education and Industry-Academic Cooperation Act (September 2003), the Ministry of Education and Human Resources Development has been actively encouraging policies designed to enable the establishment of university-industry cooperation centers at universities and support industrial cooperative universities.

Meanwhile, according to the measures established in 2005 by the Presidential Advisory Council for Science and Technology, which were designed to use government research institutes to strengthen the technological competitiveness of SMEs, these government research institutes suggested plans for promoting comprehensive technology programs through collaborations with innovative local groups, such as local universities, in order to meet the demands of local SMEs, including their demands for skilled workers and various types of manufacturing technologies.

C. Achievements of the Cooperative Research Center

Since 1990, excellent technique research centers (SRC, ERC) have been established by the Ministry of Science and Technology with the goal of initiating world-class research collaborations between industries, universities, and research institutes in various areas, developing fundamental technologies, and securing new, basic scientific knowledge by nurturing talented researchers at universities. These centers served as channels between the research projects conducted by universities and businesses and contributed to the expansion of joint research between industries and universities and the advancement of industrial technology through technology transfers. Moreover, they also helped overcome technological barriers and challenges and promoted the development and localization of state-of-the-art technology. Since 1995, regional research centers (RRC) have been working to develop local industries based on their specific regional characteristics and promote research at local universities by supplying highly skilled workers.

Technology innovation centers (TIC) were designed to encourage technological innovation by offering companies greater access to university research materials. These centers have been supported by the establishment of technology transfer centers, promotion of company projects, and collaborative research between universities and corporate R&D laboratories established near universities, all of which has enabled them to concentrate on the development of specialized technology. The University Industrial Technology Force (UNITEF) works to build mutual trust and expand networks and collaborations between universities and industries. It started with the objective of systematically supporting SMEs with their technology development efforts and providing skilled workers. In addition, UNITEF carried out projects aimed at addressing the technological barriers and challenges faced by SMEs, conducting technology evaluations of SMEs, and supporting product realization and validation.

D. Supporting Startups

Projects such as the Technology Business Incubator (TBI) of the Ministry of Commerce, Industry and Energy, the New Technology Startup Project of the Ministry of Science and Technology, the Startup Support Project of the Ministry of Information and Communication, and the business incubators of the Small and Medium Business Administration were all designed with the overarching objective of helping venture capital firms achieve success by making it easier for promising entrepreneurs and technology-intensive startups to gain access to and utilize research materials and resources owned by universities and research institutes.

In 1997, the government enacted the Act on Special Measures for the Promotion of Venture Businesses, which was limited to 10 years. Through this act, it hoped to increase industrial competitiveness and smooth the implementation of structural reforms by promoting the transition and establishment of venture capital firms. This legislation helped create a favorable environment for the establishment of new venture capital firms by allowing researchers and university professors to take leaves of absence of up to three years and hold additional positions at venture capital firms as either executives or staff members. In addition, funding systems were established to facilitate investment in venture capital firms or investment associations as a means of promoting the establishment of new venture capital firms. Moreover, this legislation made a significant contribution to enhancing the competitiveness of the venture industry and promoting the further

development of venture capital firms by establishing and implementing exceptional cases, including providing benefits for venture capital firms housed in business incubation centers, establishing laboratories for venture startups, offering tax deductions and exemptions, and operating the preferential guarantee systems of the Korea Technology Credit Guarantee Fund for venture capital firms.

E. Establishing Infrastructure

A technopark is a collaborative research complex where the R&D resources of industries, universities, and research institutes are integrated in order to maximize the development of technology-intensive industries and local technology through collaborations among industries, universities, and research institutes. The Ministry of Commerce, Industry and Energy established technoparks in an effort to enhance Korea's national competitiveness and invigorate the local economy through R&D, training programs, information exchange, business incubators, and pilot production. To successfully establish and operate the technoparks, the government passed the Special Act on Industrial Technology Complexes and established the necessary institutional foundation. The Ministry of Science and Technology and the Ministry of Construction and Transportation established science and industrial complexes that organically link living environments with their R&D, training, and industrial functions. Established in 1996 by the Ministry of Information and Communication, Media Valley is a complex that has integrated the production and distribution of multimedia R&D and additional facilities.