KNOWLEDGE SHARING PROGRAM

2011 Modularization of Korea's Development Experience:

Technical Engineering Education Model of Korea Polytechnic University (KPU)

2012

Ministry of Knowledge Economy

Korea Polytechnic Univerdity

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Technical Engineering Education Model of Korea Polytechnic University (KPU)

Title	Technical Engineering Education Model of Korea Polytechnic University (KPU)
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Research Management	Korea Development Institute (KDI) School of Public Policy and Management
Supported by	Ministry of Strategy and Finance (MOSF), Republic of Korea

Government Publications Registration Number 11-1051000-000234-01

ISBN 978-89-93695-79-3 94320

ISBN 978-89-93695-27-4 [SET 40]

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Preface

The study of Korea's economic and social transformation offers a unique opportunity to better understand the factors that drive development. Within one generation, Korea had transformed itself from a poor agrarian society to a modern industrial nation, a feat never seen before. What makes Korea's experience so unique is that its rapid economic development was relatively broad-based, meaning that the fruits of Korea's rapid growth were shared by many. The challenge of course is unlocking the secrets behind Korea's rapid and broad-based development, which can offer invaluable insights and lessons and knowledge that can be shared with the rest of the international community.

Recognizing this, the Korean Ministry of Strategy and Finance (MOSF) and the Korea Development Institute (KDI) launched the Knowledge Sharing Program (KSP) in 2004 to share Korea's development experience and to assist its developing country partners. The body of work presented in this volume is part of a greater initiative launched in 2007 to systemically research and document Korea's development experience and to deliver standardized content as case studies. The goal of this undertaking is to offer a deeper and wider understanding of Korea's development experience with the hope that Korea's past can offer lessons for developing countries in search of sustainable and broad-based development. This is a continuation of a multi-year undertaking to study and document Korea's development experience, and it builds on the 20 case studies completed in 2010. Here, we present 40 new studies that explore various development-oriented themes such as industrialization, energy, human capital development, government administration, Information and Communication Technology (ICT), agricultural development, land development and environment.

In presenting these new studies, I would like to take this opportunity to express my gratitude to all those involved in this great undertaking. It was through their hard work and commitment that made this possible. Foremost, I would like to thank the Ministry of Strategy and Finance for their encouragement and full support of this project. I especially would like to thank the KSP Executive Committee, composed of related ministries/departments, and the various Korean research institutes, for their involvement and the invaluable role they played in bringing this project together. I would also like to thank all the former public officials and senior practitioners for lending their time and keen insights and expertise in preparation of the case studies.

Indeed, the successful completion of the case studies was made possible by the dedication of the researchers from the public sector and academia involved in conducting the studies, which I believe will go a long way in advancing knowledge on not only Korea's own development but also development in general. Lastly, I would like to express my gratitude to Professor Joon-Kyung Kim for his stewardship of this enterprise, and to his team including Professor Jin Park at the KDI School of Public Policy and Management, for their hard work and dedication in successfully managing and completing this project.

As always, the views and opinions expressed by the authors in the body of work presented here do not necessary represent those of KDI School of Public Policy and Management.

May 2012

Oh-Seok Hyun

President

KDI School of Public Policy and Management

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Summary

Korea escaped poverty and accomplished marvelous economic development within only half a century and stands out as an unprecedented country in global society. Korea suffered from the Korean War immediately after liberation from Japanese imperialism and spent a long time in a dreadful poverty, but the country made the 'miracle of Han River' through the diligence of Koreans and the help of global society. Korea's GDP per capita was 79 dollars in 1960 -when the country was receiving aid from other countries- but, it grew to 17,175 dollars by 2009, a 23-fold increase-and the country has changed from a recipient country to a donor country.

In view of the process of economic growth of Korea during that half-century, the country has developed consecutively from growth focused on labor to growth centering on capital and scientific technologies. Of course, Korea introduced the technologies of advanced countries to secure and develop the technologies needed by industry, and has constantly accumulated technical skills to digest and improve those technologies. However, what lies at the core of economic development in Korea is the nurture of industrial technical manpower in stages following the demands of the times above all.

Because of this connection, this study introduces the routes of expansion and development and success stories in the nurture of excellent industrial technical manpower of Korea Polytechnic University, which was established in 1998 in order to advance the industrial technologies of Korea which have been the foundation for swift economic development for the last half-century; and, to nurture industrial technical manpower at the global level; and, to present an evaluation of such as well as implications for developing countries.

This study introduces the social and economic environments to effectively supply excellent industrial technical manpower following the development of technology-intensive high-tech industry in the 1980s and the 1990s, the directions of main policies of the government and the necessity of establishment of polytechnic universities in developing

countries, and clarifies how the establishment, directions of education and curriculum of Korea Polytechnic University have been expanded and developed as the basis for nurturing superior industrial technical manpower and industrial-educational cooperation.

Also, the implications for policy to realize the development of policies related to nurture of industrial technical manpower and the expansion of close connections in industrial-educational cooperation are presented through the research paper on the nurture of technical manpower through Korea Polytechnic University.

It is expected that successful policies for nurturing industrial technical manpower suitable to the reality of developing countries can be carried forward by utilizing these implications.

2011 Modularization of Korea's Development Experience
Technical Engineering Education Model of
Korea Polytechnic University (KPU)

Chapter 1

Background

1. Social/Economic/Industrial Technical Environment
2. Necessity of Nurture of Technical Manpower Tailored to the Field

Background

1. Social/Economic/Industrial Technical Environment

The success of the Korean economy is said to have been accomplished through the combination of well-educated and skilled labor, entrepreneurship without fear for adventures, high rate of savings and investment, a favorable trade environment and the ability of Koreans to plan ahead. This kind of assessment tells us that the basis for the economic development of Korea is the manufacturing industry. To that extent, the growth of the Korean economy is in line with the development of industrial technology.

In the early days of the Korean economy's industrialization, Korea relied totally on the introduction of technology from advanced countries and afterwards operated facilities introduced by other countries (the early 1960s through the late 1970s) and started to imitate simple technologies (the middle and late 1970s through the early 1990s) through accumulated know-how and retrogressive technology.

Then, in the process of digesting and absorbing such introduced technologies, Korea started to accumulate technical ability and to localize the introduced technologies or to improve performance and ultimately went through the process to reach the stage of creating new technologies (the early 1990s through the middle 2000s). In addition, in the early 1990s, Korea began to develop products earlier than advanced countries or to develop products superior in performance than the advanced technologies, such as the world's first 64M DRAM (1992), CDMA (1994) and so on.

1.1 The 1960s

Until the early 1960s, most Koreans lived in destitution and relied on agriculture. An obvious illustration is that in 1960, the national per capita income was 78 dollars and Korea was a typical economically underdeveloped country. Therefore, in the early and middle

1960s after the Korean War, Korea laid stress upon import substitution that reduces import through domestic production of products with the enormous aid of the U.S. and the UN like any other developing countries.

At that time, most factors for economic growth were due to population growth, and the Korean economy could not sustain itself without aid from foreign countries. A considerable import substitution was achieved through the construction of fertilizer plants, cement factories, textile mills and so on with the aid funds of foreign countries; but, almost all raw materials, parts, production facilities and so on relied on import.

The Korean government strived to overcome the economic backwardness from various angles and provided policies for education to take on the aspects of means needed to facilitate the industrialization of Korea. Since the 5-year economic development plan started to be pushed forward in 1962, the policies and investment for the nurture of manpower through related education began to be fulfilled in earnest.

The Korean industry pursuing import substitution met with difficulty as it reached the limits of growth due to the saturation of domestic market. Hence, the Korean government considered building an independent economic foundation by changing the strategy of industrialization from import substitution into an export-led strategy.

The Korean economy started to grow in earnest in 1962 when the country embarked on the promotion of industrialization whose core was an export-led growth strategy. The Economy Planning Board in charge of the role of locomotive for the economic growth of Korean style was established in 1961 and promoted the strategy of economic development through industrialization with the 'the 1st economic development plan for 5 years' in 1962, the following year.

The gist of the strategy of promotion of industrialization is to develop the pertinent industry by intensively fostering the items that can be exported and to expand the scope by reinvesting the funds earned by export into the related industries or the industries with high added values and, meanwhile, to make the virtuous cycle of creation of national wealth by advancing that in quality. Korea built factories with facilities introduced from foreign countries and produced light industry goods by utilizing cheap labor, and exported the goods overseas. The strategy of promotion of industrialization was to establish an independent economic foundation. This was the first moment for the Korean economy to make remarkable growth.

The important goal in the period of the First 5-year economic development plan was to secure enough engineers to nurture the light industry. Therefore, in this period, vocational high schools were expanded in quantity and enhanced in quality. The government established a plan for supply and demand of technical manpower as the first plan of the First 5-year technology promotion plan and did its best to supply manpower according to the plan. Back then, skilled manpower in the technical manpower sector was not only insufficient in quantity but also very low in quality, and thus it was an urgent task to nurture and secure skilled manpower in a short period of time.

The government exerted itself to solve the problem in three directions to cope with the ever-growing demand for technical manpower. First, it expanded the quantity of vocational (technical) high schools and strengthened industrial work experience in order to foster insufficient technicians. Second, it covered skilled manpower by promoting twinnings of technical high schools with enterprises, new establishment of vocational high schools affiliated with large companies, acquisition and operation of the existing technical high schools and so on. Third, it expanded vocational training to train industrial technical manpower in a short period of time. The government enacted the 'Vocational Training Act' in 1976 in order to expand job opportunities by increasing the labor productivity of simple labor manpower by letting them learn new functions or by having teenagers who do not enter college or the skilled manpower of low-level master proper techniques.

In the period of the Second 5-year economic development plan (1967 through 1971) in which industrialization was promoted in earnest, Korea discovered items that can be exported other than light industry goods, and thereby expanded export constantly. The country discovered items that can be produced through simple assembly such as black-and-white TVs, semiconductors and so on and promoted these items through joint-venture companies with foreign countries or companies with investment from foreign countries. Korea exported the products made there through OEM (original equipment manufacturing) and substituted import for the raw materials or intermediary goods for exported products and thereby increased the foreign-exchange earning rate and realized economic growth.

In the period of the Second 5-year economic development plan (1967 through 1971), the government increased the quorum of colleges of natural sciences or engineering and established the 'science technology education 5-year promotion plan (1967 through 1971)' which built additional technical schools and classes in order to make good a deficiency of scientific technicians and engineers.

a. To expand the quorum of colleges of natural sciences or engineering and to increase industrial, fisheries and marine schools or classes in order to redress the balance in the supply of technical manpower for each industrial sector.

b. To improve the policy for the uniform advancement of agriculture and industry by establishing industrial departments proper for the industrial demands of local communities in agricultural schools in industrial complexes and enlarging them annually.

c. To improve the operation of institutions training practical course teachers and strengthen on-the-job training and to thereby give better treatment in order to secure practical course professors and skill teachers and enhance their quality.

d. To improve and develop the curriculum and contents of education for them to adapt to the development of industry and to compile and issue the practical course textbooks that are insufficient.

e. To train and develop audiovisual teachers for the innovation of education methods.

f. To enact the order for standards of experiments and practices and to plan the efficiencies of facility investment through industrial-educational cooperation.

g. To annually increase the amount of state subsidies for expenses of facilities for experiments and practices and to thereby give subsidies also to private vocational schools.

h. To annually increase the amount of loan scholarship and to thereby expand the range of benefit.

Therefore, the vocational education in 1969 received heavy investments such as state subsidies for expenses of experiments and practices, expansion of facilities in technical schools and so on; so that it has been summarized as the 'industrialization education for the modernization of the country.'

From 1962 to 1971, the exports of Korea increased by 30% or more annually on average, and the manufacturing industry-which occupied only 22% of the entire export in 1962-accounted for 86% of the entire export by 1971. The leading industries in this period were light manufacturing industries based on low wages. Those that led export were the electronic assembly industry (such as electronic calculators, transistors and so on), the textile industry and simple manufactured goods such as bolts and nuts.

1.2 The 1970s

The export-led strategy kicked into high gear after the advancement of the industrial structure in the middle 1970s. In the early 1970s, the Korean growth strategy based on labor-intensive manufacturing industry was confronted with various difficult problems. First, the income elasticity of demands for light industry products was low, and thus the long-term prospect of light industry as a growth engine seemed gloomy.

The advanced industrial countries were entering into a cycle of low growth, and this caused a new flow of protectionism. Then, the exports of new developing countries such as Korea and Taiwan-in particular the textile industry and others-became the subject of voluntary restraints. In addition, there was pressure from the countries like Malaysia, Indonesia and India, which were latecomers to industrialization. The increase of real wages aggravated this competitive environment. Those were huge variables considering that the export-led growth of Korea was based on a cheap, redundant labor force. Moreover, oil prices hiked, and the Korean government tried to overcome the crisis by advancing the industrial structure from light industry into heavy chemical industry.

Therefore, the Korean government attempted the change into heavy chemical industry through the Third (1972 through 1976) and the Fourth (1977 through 1981) 5-year economic development plan. Since the 1970s, scientific technical manpower of a high level was in greater demand than engineers and technical experts in order to support the industrial growth following the development of heavy chemical industry, the policy for

scientific technical manpower in the 1970s made the basic goal to deliberately supply the manpower characterized for each industrial field and each level adapting to the economic development strategy which is the advancement of industrial structure through fostering the heavy chemical industry.

In particular, in the 1970s, Korea pushed ahead with the policy for classification of industrial schools and industrial-educational cooperation and thereby intensified vocational education. Recognizing that it was needed to have a mutual cooperation system in which schools supplement insufficient facilities for experiments and practices by utilizing new facilities of businesses, and businesses receive the supply of needed manpower from schools or have their manpower reeducated, the government exerted itself to build an industrial-educational cooperation system. In 1973, the Korean government revised the Industrial Education Promotion Act and thereby made it an obligation for the students of vocational schools to practice in industrial settings during a certain period. It also concretely stipulated the matters of cooperation of businesses in the enforcement decree of the same Act, and, in order to actively push on with these policies, newly established the Department of Industrial-Educational Cooperation and thereby had it take charge of the business of industrial-educational cooperation, plans for education of the heavy chemical industry, operation of the Central Industrial Education Council and so on.

In addition, the 3rd revision of curriculum was implemented in the same year, and this revision included the 'renovation of knowledge and technology education' as one of the basic policies of curriculum and presented the nurture of basic abilities, grasp of basic concepts, cultivation of judgment and creativity, reinforcement of education through industrial-educational cooperation and so on as the concrete matters for the realization of that.

The long-term plan for supply and demand for manpower and directions of policy (1971 through 1981) framed preparation for the era of heavy chemical industrialization in the 1980s, which became the basis for policies of manpower development. This plan: classified the types of scientific technical manpower into three groups such as scientific technicians, field technicians and vocational technicians; predicted the concrete supply and demand for scientific technical manpower for each major type of business and type of occupation according to the plan for construction of heavy chemical industry; and, suggested the direction of policies to supplement and develop the science and technology education and vocational training system.

At the same time, what was most emphasized in the development of scientific technical manpower was the expansion and characterization of colleges of natural sciences or engineering, and the government adjusted and expanded the quorum of 4-year-course colleges of natural sciences or engineering centering on the fields of machinery, electronics and chemical industry according to the plan for supply and demand for each type of occupation and nurtured characterized colleges in each region so that the colleges would contribute to the smooth supply of scientific technicians and development of local communities.

In addition, in 1974, the Korean government enacted and proclaimed the National Technology Qualification Act (enforced in 1975) and thereby obliged the graduates-to-be of technical schools take the technical qualification certificate examination; it also elevated their status and put forth efforts to secure the quality of technical manpower needed for the nurture of heavy chemical industry. In 1979, the government established technology classes in middle schools and conducted basic technical education starting from middle school courses and established the basis for technical education for the nurture of industrial technical manpower by supplementing the contents of technology subject of academic high schools.

In 1973, the government announced a strategy to invest about 9.6 billion dollars in 6 heavy industry fields such as steel, chemistry, nonferrous metals, mechanism, shipbuilding, electronics; this lead to, the upbringing of heavy chemical industries such as steel, automobile, ship, petro chemistry, machinery that started like this and went through a gestation period of 10 years and led the key industries and exported products of the Korean economy since the middle 1980s. In addition, the industrial structure was also converted from a labor-intensive industry into a technology and capital-intensive industry.

Like this, the promotion of heavy chemical industrialization was the most important industrial policy during the industrialization of Korea. Today Korea is the largest shipbuilder in the world, but until the middle 1970s, the Korean shipbuilding industry had an uncertain prospect for the future due to the absence of domestic technology. Also, the chance for the growth of the semiconductor industry, that now represents Korea together with the shipbuilding industry, was that the Korean government was encouraged by the marvelous growth of the electronics industry which was pointed out as one of the 6 strategic industries for the promotion of heavy chemical industry established the 'Semiconductor Technology Development Center' in 1975 with the aid of the UNDP and actively cooperated with enterprises as a policy for enhancement of electronics industry.

1.3 The 1980s

In the 1980s, the Korean government let the industrial and economic policies focus on ensuring the internal stability of the heavy chemical industry-which built the foundation in the 1970s-and also on securing the technical skills for the development of high-tech industry.

In the world outside Korea, the global dynamics of industrial competitiveness was reorganized, centering on the cutting -edge technologies starting with the advent of the microelectronics industry, and as technology protectionism accompanying this was intensified, the reorganization of industrial structure into technology- intensive industry was set as a new task. Hence, the industrial policy was also changed from a policy to foster individual industries into a policy to develop technologies, and restructuring was conducted into higher value-added businesses.

Before the 1980s, Korea mainly introduced and improved advanced technologies and applied them to industries; but, in the 1980s, the country made efforts to facilitate the key industries of Korea and technology intensification. It was widely recognized in Korea that it was necessary to conduct research and development and innovation of technologies to advance and localize the technologies in the key industries such as textile, petro chemistry, electronics, machinery, and shipbuilding, automobile and so on and to secure technical skills in the fields such as semiconductors, communication, and fine chemistry.

As the investment of the government in R&D was expanded and the inducements to accelerate private R&D activities were strengthened, private investment in R&D was also largely increased. Therefore, Korea started to gradually localize the technologies for which the country had been relied on advanced countries and, in some specific fields, the country also entered into the level of technology of advanced countries. As the weight of technical independence increased and advanced technologies were improved, cutting-edge products such as semiconductors, mobile phones, and LCDs (Liquid Crystal Displays) came to hold the place of the products leading export. As a result, the industrial structure was increasingly changed from capital-intensive industry into technology-intensive industry.

The policies for industrial education and science education in the 1980s can be characterized by the changes of industrial policies centering on high-tech industries through the adjustment of industrial structure, the emphasis on the basic science education, expansion of colleges of natural sciences or engineering for the nurture of technical manpower, the conversion of direction from the nurture of single-skilled workers to the nurture of multi-skilled workers, abandonment of the policies for classification of technical high schools, the drastic decrease of support for vocational high schools and so on. In 1982, the Korean government established and promoted a 'plan for scientific technical education (1983 through 1986)' together with the Fifth 5-year economic and social development plan and thereby exerted itself to expand the quantity and quality of scientists meeting the trend of advancement of industry, to solve the order imbalance of technical experts by the enhancement of quality, to improve the level of skills of skilled manpower and to make the climate for technical manpower to master technologies.

While the government underlined efficiency by concentrating investment on mechanical technical high schools and characterized technical high schools to satisfy the short-term demand for industrial manpower in the 1970s, it converted into policies to meet the long-term demand for manpower in the 1980s. In the 1980s, as the advancement of high-class scientific technicians and industrial structure for scientific technical manpower for ensuring the internal stability of heavy chemical industry and intensifying technologies of high-tech industry made rapid progress, the demand for scientific technical manpower equipped with expertise increased greatly. The government designated the fields with comparatively substantial conditions of research for each college or the fields needing special support following the regional distinct characteristics of colleges as the fields for characterization and established research institutes and afterwards invested the research funds in these research institutes intensively and thereby imposed large-scale joint research assignments.

In addition, it was made as a prerequisite to assign duties for technical high schools to raise only the basic abilities and adaptability and for businesses to teach the professional skills needed in the world of work. Thereby, the education of technical high schools was made not as a complete education but as a course of lifelong education; and, the goal of education was changed into an education that intensifies whole-person education-not focusing only on professional education.

The traditional industrial-educational cooperation was conducted by businesses giving financial support for nurturing skilled workers to high schools as a kind of tuition, and by high schools producing finished skilled workers for businesses, but the converted industrial-educational cooperation came to demand the division of educational activities by businesses and schools; it can be said that the foundation of the model for industrial-education cooperation of today was arranged.

1.4 The 1990s

In the 1990s, the rate of economic growth of Korea dropped due to the poor manufacturing industry-which is the driving force of industry-and the manufacturing industry also declined in importance in the entire industry. The Korean government made the strengthening of competitive edge of enterprises, the raise of social equity and balanced development, and the promotion of opening and internationalization and formation of the basis for reunification of North and South Korea the three major strategies with the 'new 5-year economic development plan' containing economy-invigorating policies, and made an endeavor to vitalize the depressed economy through plans for normalization of financial functions, tax reform, efficiencies of financial system and so on.

The electronics industry was the most magnified in the 1990s, and made eye-opening growth by developing products earlier than more advanced countries such as the world-first development of 64M DRAM (1992), the development of CDMA (1994) and so on, and starting development of products with superior performance than the advanced technologies.

The electronics industry of Korea emerged as the industry with the largest export since the 1980s, and grew to be the 6th-largest electronics industry in the world by 1992. In addition, the info-communications industry came to show an incredible growth on the basis of the electronics industry in the late 1990s. Since the financial crisis, the framework of industrial structure of the Korean economy started to be changed, and young venture entrepreneurs equipped with cutting-edge information and communication technologies started to rise as a new axis of the Korean economy.

Since the 1980s, the supply highly educated workers promptly increased, but, due to insufficient cutting-edge scientific technical manpower and insufficient skilled manpower especially in small and medium-sized manufacturing businesses, the economic and social phenomenon of a serious order imbalance of manpower occurred.

Since the late 1980s, the industrial world centering on small and medium-sized manufacturing businesses complained of the shortage of skilled manpower; in order to expand the supply of high-class technical manpower and raise the level of quality, the quorum of colleges of natural sciences or engineering of 4-year-course colleges and junior colleges was increased with the departments related to cutting-edge technologies as the center. In 1990, the government announced the 'measure for supply and demand of industrial manpower: the plan to overcome the manpower shortage in the manufacturing sector' interlinked with the demand of businesses for the expansion of skilled manpower.

This measure built additional technical high schools mainly among vocational high schools to expand the supply of skilled manpower and converted some general high schools into technical high schools, and also provided the opportunity for continuing education to the production workers of manufacturing businesses as one inducement to expedite the inflow of manpower into the manufacturing sector. In addition, the 1990s can be characterized by: the continuous intensification of the fields of industry and science such as the normalization of operation of industrial colleges and so on; smooth supply of skilled manpower; nurture of vocational high schools for the reduction of the overheated demand of the society for entering college; and the selective expansion of quorum of colleges for the supply of high-class technical manpower.

The Korean government implemented the policy to increase the quorum centering on the departments of natural sciences or engineering, induced colleges to characterize themselves and differentiate functions in education and research and selectively supported them following their performance. Also, at that time, it was decided to establish Korea Polytechnic University by the 'expanded meeting of economy ministers' as a part of the plan to improve the technical educational system.

As a result of these efforts, in the 1990s, Korea was successful in the nurture and production of high-class scientific technical manpower, but, as problems such as the order imbalance in quantity and quality of scientific technical manpower, unemployment crisis of students majoring in natural sciences or engineering, the phenomenon of students avoiding natural sciences or engineering that had been occurring since the late 1990s stood out, the limits of the policy for supply of manpower led by the government started to be magnified.

1.5 The 2000s (2000 through Now)

In the 2000s, as the knowledge-based economy in which knowledge leads the global economy as the largest factor of production was opened due to the revolution of information and communication technologies, the paradigm of technology and economy started to be dramatically changed. In addition, countries in the world devoted themselves to the creation of a new growth engine due to the advent of new cutting-edge technologies such as BT, NT, ET and so on, and thus the world entered into the era of global technology competition.

The core source for competition of countries and individuals moved from material resources to human resources that are the main agent of production and utilization of knowledge, following the historical environment of the society of a knowledge-based economy, and the demand for high-class human resources began to rise in quantity and in quality following the advent of new industries oriented to knowledge and information. As the fields leading growth moved from traditional manufacturing such as electronics, automobile, textile, steel to high-tech businesses such as information and communications, the nurture and supply of high-class scientific technical manpower that will play the main role in growth of new industries such as NT, BT, IT maintaining the competitive edge of traditional industries was required at the same time.

For this reason, the economic policies of Korea also began to require the creation of a new growth engine based on technological innovation and to convert into an innovation-led economy, and the efforts for the growth in quality of science and technology came to be made in the 2000s.

The Korean government enacted the 'Framework Act on Science and Technology' in 2001 in order to provide an institutional strategy that can comprehensively and systematically promote the science and technology policy that meets the knowledge- and information-oriented society of the 21st century and supports the innovation-led economic system, set the medium and long-term development goals in science and technology on the basis of the Act and established the basic plan for science and technology as the plan to accomplish the goals by stages.

As part of this flow, the Korean government established the 'basic plan for nurturing and support for manpower of natural sciences or engineering (2006 through 2010)' based on the 'Special Act for Support for Natural Sciences and Engineering for Strengthening National Scientific Technical Competitiveness' and thereby started to comprehensively adjust general policies related to the nurture and utilization of science and technology across government departments and began to promote the nurture and supply of high-class scientific technical manpower of new industries, at the same time satisfying the historical environment of a knowledge-based economy.

The government encouraged businesses to discover and nurture a new growth engine and to prioritize development of original technologies as a part of that. The businesses with top priority are the next-generation growth engine business promoted across government departments, the large-scale commercialization of national research and development that supports the tasks needing the promotion of commercialization, the 21st century frontier research and development that supports the development of the core original technologies and so on, and Korea is fostering the 6T industries through these businesses.

Table 1-1 | Comparison of Industrial Policies and Technical Changes (1962-2008)

	'62	'67	'72	'77	'82	'87	92~97	'02~'08
GOAL	· Construction of the basis for self-supporting economy · Start of industrialization	· Full-scale promotion of industrialization	· Advancement of industrial structure	· Realization of self-sustaining growth structure	· Price stabilization · Market economy function vitalization	· Balanced development of economy	· Economic and social advancement in the 21st century	· Dealing with the Knowledge and information oriented society · Conversion into the innovation-led economic system
Policies with overriding priority	· Expansion of social overhead capital · Import substitution of consumer goods	· Increase of export of light industry products · Import substitution of intermediary goods · Preparation of the basis for industrial advancement	· Nurture of heavy chemical industry and defends industry · Export of intermediary goods and facilities	· Technical advancement of heavy chemical industry · Enhancement of productivity through technical development	· Nurture of industry with compare advantage · Raise of competitiveness of industry and improvement of productivity · Conversion from the policy nurturing individual industry into the policy developing technologies	· Restructuring into the higher value-added business	· Science and technology of the level of 7 advanced countries · Development of high-tech industry	· Construction of society centering on science · Establishment of the national system for innovation of science technology
Strategic industry	· Fertilizer, cement and plywood, textile	· Synthetic textiles, textile chemistry and electrical instrument	· Steel, automobile, home appliances, shipbuilding and petro chemistry	· Steel (special steel), industrial electronic equipment, automobile and shipbuilding	· Machinery and electronics, parts	· Semiconductor, computers and Fine chemistry	· Semiconductor, cutting-edge home appliances, mobile phones and so on	· Telecommunication · Bio industry and so son

	'62	'67	'72	'77	'82	'87	92~97	'02~'08
Technical development strategies	· Introduction of appropriate technology	· Facilitation of introduction of advanced technologies	· Learning of operating technology of introduced technologies	· Digestion and absorption of advanced technologies	· Digestion and improvement of advanced technologies · Expansion of ability to develop independent technologies	· Acquisition of the technical level of advanced countries in specific fields	· Development of cutting-edge industrial technologies · Enhancement of performance of advanced technologies	· Discovery of technologies promising in the future · Development of core original technologies
Technical development activities and outcomes	· 60': Most of government R&D budget used by the government and research institutions · 70': Development into the industrial structure focusing on manufacturing industry (the ratio of manufacturing industry: 18.5% (1970)→24.1% (1978), insufficient R&D activities in private sector) · 76': 35% of total R&D investment borne by private sector 12 enterprise-affiliated research institutes in 1975			· 80': Unsatisfactory industrial-educational cooperation-255 college-affiliated research institutes in 1985, Research expenses per person of only 10 million won · 90': Increase of the number of patent applications (5,070 (1980)→25,820 (1990): Expansion of research ability of colleges (25.9 billion won (1980)→244.3 billion won(1990)			· 90': Improvement of ability of enterprises, Beginning of establishment of comprehensive research institutions of large enterprises and creationof technical development performances of a global level · 2000: Rapid increase of exports of technologies and rise in research outcomes such as patents, SCI papers and so on	

Table 1-2 | Comparison of Policies for Nurturing Industrial Technical Manpower (The 1960s-The 2000s)

	The 1960s-The 1970s	The 1980s	The 1990s	The 2000s
Development	· '62-'66: The 1st Manpower Development Plan for 5 Years · '67-'71: The 2nd Manpower Development Plan for 5 Years · '72-'76: The 3rd Manpower Development Plan for 5 Years · '77-'81: The 4th Manpower Development Plan for 5 Years	· '82-'86: The 5th Manpower Development Plan for 5 Years · '87-'91: The 6th Manpower Development Plan for 5 Years	· '92: The Plan for Manpower Policy Sector of the 7th Economic and Social Development Plan for 5 Years	· '01: National Basic Plan for Human Resources Development · Start of promoting manpower nurturing policies in the view of development of human resources
Directions of policy	· Conversion of the plentiful labor in cities and farm villages into industrial manpower on the basis of the plan for supply and demand of manpower conforming with the goals of economic growth	· Expansion of scientists in quality and quantity and construction of society respectingtechnology to form the climate for technical manpower to study technologies	· Solution of order imbalance of manpower due to the shortage of cutting-edge scientific technical manpower and skilled manpower focusing on SMEs in manufacturing industry	· Balance between regions/ Choice and focus
Core policies and nurture of industrial technical professional manpower	· Establishment of vocational high schools (agriculture, industry, commerce, fishery, etc) · Establishment of peculiar courses and special courses in technical high schools · Promotion of policies nurturing model high schools · Arrangement of high school textbooks for special purposes · Designation of high schools with special purposes · Promotion of characterization of technical high schools · Promotion of measures for equalization of high schools · Privileges for students of vocational high schools going on to colleges of the same areas	· Nurture of R&D manpower (upbringing of graduate schools of natural sciences or engineering) · Reorganization into characterized high schools and general high schools · Conversion of education of agricultural high schools into an educational system focusing on nurturing independent farmers	· Improvement of education of colleges of natural sciences or engineering · Strengthening of roles of junior colleges · Expansion of high-class scientific technical manpower · Improvement of vocational education for nurturing skilled manpower · Intensification of roles of vocational training Commencement of BK21 business · Strengthening of support for R&D activities of colleges (BK21 and support for excellent research centers) · Decision of establishment of Korea Polytechnic University at the 'expanded meeting of economy ministers' as a part of plans for improvement of technical educational system	· Promotion of the 2nd stage of BK21business · Promotion of the plan for nurturing basic studies · The business strengthening the innovative capabilityof local colleges for rearing the colleges (NURI) and the business for colleges centering on industrial-educational cooperation · Practicability of college education and core strategies · Nurture of manpower in industrial field · Characterization for each college

2. Necessity of Nurture of Technical Manpower Tailored to the Field

2.1 Significance of Industrial-Educational Cooperation in Industrial Technical Development

The policies for education and development of human resources of the past half-century in Korea have been established and implemented to satisfy the demand for manpower following the stage of industrial development. In the period of light industrialization, the educational system controlled by the state was settled, and in the period of heavy chemical industrialization, the generalization of secondary education and the expansion of vocational training were promoted. Afterwards, as the country pushed forward the policy for development of human resources oriented to demand of businesses and the characterization and internationalization of college education, the importance of industrial-educational cooperation came to be stressed.

The strong points of industrial-educational cooperation are that it supplements the capabilities of colleges and businesses, shares burdens and risks, and can utilize the performance efficiently at the same time. This cooperation model has been applied in advanced countries in various forms, and it is safe to say that in Korea, until the 1980s, the industrial-educational cooperation was very unsatisfactory and the level remained only as formal.

Korea keenly realized the necessity of industrial-educational cooperation and started to connect it with nurture of manpower since the 1990s. It can be said that it is because in the 1990s, the social and economic conditions for industrial-educational cooperation were satisfied and the social atmosphere for cooperation grew to maturity. The Korean government also felt acutely that there was a limit in simple formation of factory sites or input-based industrial policies and came to lay emphasis on the policy for industrial-educational cooperation as a new industrial policy centering on construction of substructure.

In particular, colleges have played the role of the main agent of innovation of industrial technologies or the supporter of industry, and for a long time, businesses and colleges have maintained their mutual cooperation. In addition, industrial colleges and Korea Polytechnic University can be called a representative case for planning the development of technologies through industrial-educational cooperation, the network for technical innovation and nurture of manpower tailored to the field.

Meanwhile, since this period, diverse attempts such as joint research for which colleges and enterprises are connected, reeducation for workers of businesses and so on were made. the 'Act for Acceleration of Technology Transfer,' 'the Act for Promotion of Industrial Education and Acceleration of Industrial-Educational Cooperation,' 'the Act for Acceleration of Vocational Education and Training' and so on also supported this institutionally. In addition, the government also came to support the nurture of manpower tailored to the filed through industrial-educational cooperation by making diverse supporting programs such as

'Technical Business Incubator.' 'the business of nurture of colleges centering on industrial-educational cooperation' and others.

2.2 Changes of Policy for Industrial-Educational Cooperation

The policy for industrial-educational cooperation of the Korean government has been changed in accordance with the stages of economic development in Korea as well as the characteristics of industrial development. The industrialization of Korea has passed through the stage of labor-intensive industrialization centering on light industry in the 1960s and the stage of capital-intensive industrialization centering on heavy chemical industry in the 1970s. It has developed into the stage of technology-intensive industrialization centering on heavy chemical industry and high-tech industry since the 1980s. The country started to be transformed into the new economy system of the era of deindustrialization since the 1990s.

Following these stages of development, the types of nurture of manpower were also different for each era. In the 1960s, the country concentrated on the nurture of skilled manpower, and in the 1970s and the 1980s, the nurture of technical experts was the urgent concern for policies. In the 1990s, the country shifted into a knowledge-based society, and great importance was attached to knowledge and technology, and the nurture of creative, intelligent manpower including scientific technicians was on the rise as the task of the times.

As the economic development was intensified, the weight of roles of science and technology got bigger. Though the industrial development was promoted on the basis of simple technologies in the 1960s, as time went by, the trend was changed for cutting-edge technologies and science to become the basis; and, for the demand for specialized technical manpower to increase at the same time. Therefore, the importance of development of human resources came to be brought into focus.

Table 1-3 | Industrial Characteristics Following the Stages of Development of Korean Economy

Category	1960s	1970s	1980s	1990s	2000s
Main industries	· Export-oriented light industry · Labor-intensive industry	· Export-oriented heavy chemical industry	· Technology-intensive heavy chemical industry · Some kinds of high-tech industry	· High-tech innovation-based industry · High-tech industry (selective strategic technology)	· Transfer to knowledge-based economy · Higher value-added business
Main talents	Technicians and skilled workers	Technical experts	Technical experts	Technical experts and scientists	New intellectuals
Macroeconomic policy	Arrangement of legal and institutional foundation for support for industrialization	Maximization of growth and increase of government involvement into the market	· Stabilization of macro-economy · Expansion of autonomy of the private sector and competition	· Liberalization of trade and direct investment by foreigners · Reform of financial market and economic restructuring	· Acceleration of direct investment by foreigners and transparency · Promotion of FTAs with foreign Countries
Educational policy	Legislation of compulsory education	· Increase of vocational training · Establishment of science technology education and research institution	Expansion of opportunities for higher education	Strengthening of lifelong educational system	· Innovation of development of human resources · College education meeting the demand of businesses

In the 1960s, the era of economic development centering on labor-intensive industry for export, the focus was on policies for nurturing manpower such as security of scientific technical manpower, enhancement of skills of workers, security of skilled manpower and so on; not much attention was paid to industrial-educational cooperation. However, as the related laws, the 'long-term comprehensive plan for development of scientific technologies (1967 through 1986),' 'the Third 5-year science technology promotion plan,' 'the Third manpower development plan' and so on were established, the basis for policies for industrial-educational cooperation started to be formed.

In 1963, the Act for Promotion of Industrial Education placed emphasis on the investment in facilities, subsidies for expenses for practice, an increase in professors and so on to ensure the internal stability of work experience. In 1968, the Act for Nurturing KIST arranged the basis for industrial-educational cooperation such as spread of new technologies. In addition, industrial-educational cooperation began to be pushed forward by conducting in-service training, training the skilled manpower meeting the demand of businesses and other organizations.

In the 1970s, Korea had a strategy to overcome the reliance on foreign countries for industrial technologies and to raise Korea's own ability to develop technologies. In 1972, the country enacted the Act for Promotion of Technology Development containing the support for industrial-educational cooperation. As the major industry was changed from light industry into heavy chemical industry in the 1970s, technicians that were the major talents in the old days were replaced with technical experts, and thus the impact of technologies on economic development also increased. This period can be seen as the quickening period of industrial-educational cooperation in which interests were concentrated on policies for technology research and development, and thereby research through industrial-educational cooperation was promoted.

In 1973, the 'Department of Industrial-Educational Cooperation' was newly established in the Ministry of Education, and it can be regarded that this was the time at which the government started to recognize the importance of industrial-educational cooperation. Since the 1980s, the time of enlightenment of industrial-educational cooperation got started, and research through industrial-educational cooperation came into the picture as an important task for national policies, and most technology development businesses were carried forward by industrial-educational cooperation. In addition, the research projects completed through industry-university-institute collaboration were facilitated actively and various efforts for information exchange and personal exchange were put forth.

Table 1-4 | Changes of Policies for Industrial-Educational Cooperation by Stages

Period	Characteristics of each period	Stage of policy	Main contents
1960s	Industry-university-institute collaboration research centering on nurture of manpower	Period of formation of foundation	· Focus on policies for nurturing manpower such as security of scientific technical manpower, enhancement of skill level of workers, security of skilled manpower and so on · Enactment of the 'Act for Promotion of Industrial Education, 'the 'Engineer Act,' the 'Vocational Training Act' and so on
1970s	Preparation of foundation for establishment of individual main agent of industry-university-institute	Quickening period	· Conversion of role of KIST as the core main agent of joint R&D · Enactment of the Technology Development Promotion Act for acceleration of development of Korea's own technologies · Establishment of the 5 major government-supported research institutions and so on
1980s	Period of full-scale progress of industry-university-institute collaboration research led by the government	Period of enlightenment	· Full-scale support through the national R&D business · Enactment of the Act for Nurturing Industrial Technical Research Union for the support of cooperative research · Construction of the foundation for strengthening of industry-university-institute collaboration
1990s	Period of intensification and expansion of government-led industry-university-institute R&D	Period of takeoff	· Independent and dispersive promotion of national R&D business by each department · Promotion of construction of regional foundation · Establishment of Techno Park, regional cooperative research centers and so on

Period	Characteristics of each period	Stage of policy	Main contents
2000s	Promotion of vitalization of industrial-educational cooperation centering on colleges	Period of maturity	· Establishment and intensification of industrial-educational cooperation groups of colleges · Inducement of education centering on users · Preferential support for the research tasks in the stage of commercialization · Acceleration of commercialization of R7D and strengthening of Technical Business Incubator function of colleges · Enactment of the 'Science Technology Basic Act,' the 'Act for Acceleration of Technology Transfer,' the 'Patent Act,' the 'Act for Acceleration of Industrial-educational Education and Cooperation,' the 'Basic Act for Development of Human Resources' and so on

Since the 1990s, the infrastructure for industry-university-institute collaboration was constructed in earnest and thus the research performed through industrial-educational cooperation emerged as the major task for policies. Also, the Korean government devoted itself to businesses laying the groundwork for the acceleration of industry- university-institute collaboration in the mid-1990s.

Since the 2000s, industrial-educational cooperation centering on colleges was vitalized. The government is maintaining the related systems and infrastructure so that voluntary cooperation can be made between the participants. It is also carrying forward the development of technology and nurture of technical manpower, meeting the demands of businesses in priority.

2.3 Necessity of Nurture of Technical Manpower Tailored to the Field

The changes to the Korean system of technical education for nurturing technical manpower are related to the development of Korean society. Since the 1960s, the system of nurture and education of technical manpower has changed and developed the policies for vocational technical education for the nurture and supply of the industrial technical manpower demanded following the stage of industrial development, and has changed the

related policies to train technical manpower that can forecast and lead the changes of the future industrial society.

In the 1960s, the goals of the 1st and 2nd economic development plans were the achievement of self-supporting economy and modernization of industrial structure, and thus the reorganization of the system of vocational education for the nurture of single-skilled workers was pushed forward. In the 1970s, as the industrial structure advanced and converted from a structure with the superiority of light industry into a structure with the superiority of heavy chemical industry, the characterization of technical high schools, establishment of the national system for technical qualification and the maintenance of the system of industrial-educational cooperation were implemented and thereby the system of industrial technical education was expanded.

The 1980s was a time of change in which the structural weak points in the process of pursuit of high growth of the government were derived and the strategy for quantitative high growth was converted into the strategy for qualitative advancement influenced by the global oil crisis, the higher-interest policy of advanced countries and so on. As Korea entered the stage of knowledge and information-intensive industrialization following the trend of advancement of industrial structure, the technical skills and the component ratio of manpower of advanced R&D positions and so on were arranged and expanded, and the system of nurture of high-class technical manpower was maintained. That is, the changes of the system of technical education in the 1980s were the realignment of technical high schools, new establishment of science high schools, new establishment and reorganization of open universities and increase of quorum of colleges for the nurture of high-class technical manpower in the field of high-tech industry.

At the beginning of the 1990s, due to the rapid advancement of industry, the conversion from a traditional materials economy into an information economy, the conversion from a centralistic domestic economy into a regionalized international economy and the conversion from a focus on single technology into a focus on hybrid technology were made. Therefore, it was time to cross the wall of technology and the wall of globalization for commercialization of cutting-edge technologies. The dramatic changes of industrial society accompanied great changes in the pattern of supply and demand for manpower in the industrial world, and thus the diversification, specialization and subdivision of demand for manpower together caused a number of changes also in the pattern of demand for technical manpower of the industrial world. In order to actively deal with these changes of demand for technical manpower in the industrial settings, the order imbalance of high-class technical manpower, the problems of the existing system for technical education and the age of limitless competition between countries, the necessity of strengthening of national competitive edge, adjustment of industrial structure and continuous investment came to the fore.

At that time, it was necessary to revitalize the industrial education that had produced groups of technical and skilled manpower playing the pivotal role for industry and to introduce a system for nurturing experts of middle standing with academic background

of bachelor's or higher degree in technologies that will lead technical innovation in industrial settings. It was required to reform the existing system of technical education and to reorganize into the structure of technical manpower the shape of an egg: with a strengthened 'waist' of high-class skilled manpower and technical manpower in the middle class in order to actively reflect the latest technical changes for the leap forward as an advanced industrial country which is true to the name. Hereupon, the necessity to construct the dual ladder industrial educational system seen in advanced countries heightened so that the industrial development could be led by settling the issues of the present technical educational system connecting academic high schools to colleges of natural sciences or engineering and introducing a new technical educational system connecting technical high schools to technical colleges.

The necessity of this dual ladder technical educational system came to the fore, and the development of a new model for nurturing professional technicians that could fundamentally reform Korean technical education became the calling of the times.

Back then, some argued that (5-year-course) technical special schools and the system of technical graduate schools should be introduced separately from the existing colleges and junior colleges and the educational system should be a dual ladder system and a law for industrial technical education should be enacted. Some others raised the point at issue in the aspect of educational theories that in that case, the schools would come to focus on training centering on learning of skills of specific occupational types rather than an education teaching general theories, knowledge and technologies, and the students would have less ability to adapt to the changes of structure of economy and industry. However, the Korean government viewed that in order to actively deal with the age of limitless competition between countries, it was inevitable to constantly invest in the strengthening of national competitiveness and adjustment of industrial structure. The final policy was determined to fix the current laws and ordinances related to education instead of enacting the 'Act for Industrial Technical Education' and to thereby greatly accept the demands of the industrial world within the system of education law.

In these changes to the domestic environment, it became necessary to enhance the quality of technical manpower in industrial settings through the nurture of practical professional technicians and to render services to the intensification of international competitiveness of manufacturing industry and to vitalize industrial and technical high schools and junior colleges that lagged behind.

In addition, it became necessary to double the effect of inducement of idle manpower and young unemployed manpower to the industry and to supplement the unsatisfactory performance in nurture of industrial technical manpower of the existing colleges of natural sciences or engineering and to introduce a new system of education through industrial-educational cooperation that makes systematic and efficient connections on the basis of deep trust between the main agents of industrial-educational cooperation and plentiful experiences in mutual cooperation for connected industrial-educational cooperation.

In general, in industrial technical education, the method of conducting a job analysis on related fields of businesses and approaching the development of curriculum through such analysis is important in order to meet the demands of businesses following short- and long-term changes, opening and internalization of industrial structure and technical innovation. In particular, it is important to satisfy the demands of the industrial world and to carry forward the policies for promotion of future-oriented technical education in setting the major departments and educational goals for nurturing technical manpower for SMEs.

The Korean government has recognized that it is important to match education and demands for industrial manpower in the process of economic development, and came to push on with the model of industrial technical university for the need to complete the system for education for technical manpower tailored to specific fields by conducting continuing education connecting the vocational educational institutions of the system of vocational education centering on technologies that nurtures technologists with technical logic and creative power of execution in order to supplement the existing technical educational system and to stretch to become an advanced industrial country.

2011 Modularization of Korea's Development Experience
Technical Engineering Education Model of
Korea Polytechnic University (KPU)

Chapter 2

Introduction

1. Background of Establishment of Korea Polytechnic University
2. Positioning and Directions of Characterization of Korea Polytechnic University
3. Process of Growth of Korea Polytechnic University

Introduction

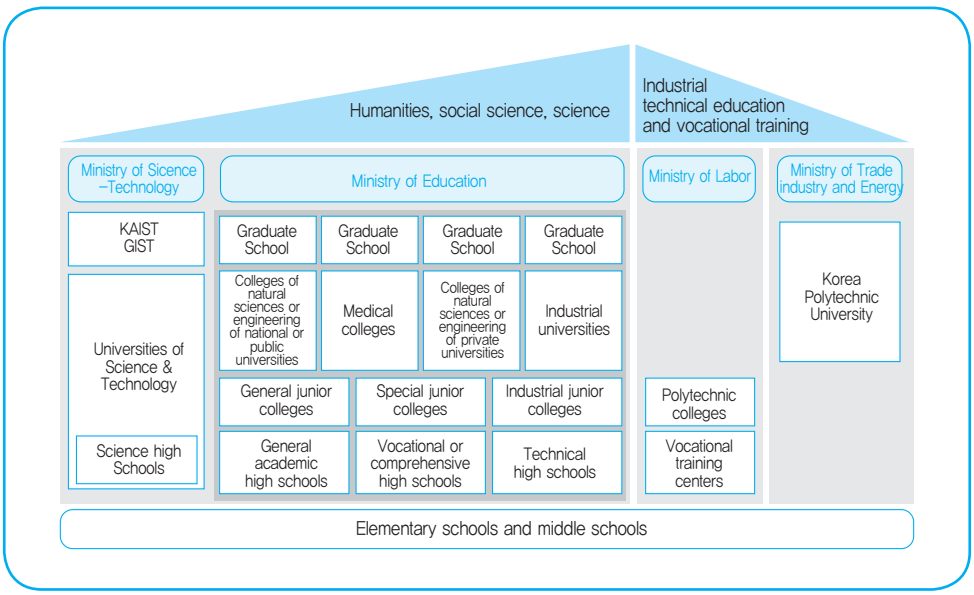
1. Background of Establishment of Korea Polytechnic University

1.1 Condition and Problems of Existing Industrial Technical Education

In Korea, the higher education system, with emphasis on natural sciences and engineering, was maintained centering on the Ministry of Education and the Ministry of Science-Technology, and the Ministry of Labor was operating polytechnic colleges and vocational training centers in charge of functions of vocational training and education. The Ministry of Trade Industry and Energy came to push on with the policy to newly establish "an industrial technical university," a new model for improvement of the technical education system, in which businesses nurture the professional technical manpower that businesses themselves need as a part of the sector of policy for education and manpower of the 5th seven-year economic social development plan.

However, at that time, the higher technical educational institutions such as junior colleges, open universities (industrial universities) and engineering colleges in Korea failed to flexibly operate the curriculum by reflecting the trend of technical changes and to actively deal with the acceptance of technical manpower by the industrial world due to the contents of education isolated from the field and could not characterize for each educational institution and each department because the education was conducted in the curriculum and contents of the same and uniform form.

Figure 2-1 | Structure Model of Higher Education of the 1990s



Likewise, the higher educational institutions of the 1990s in Korea such as technical high schools, junior colleges, industrial universities, and engineering colleges and so on failed to have systematic curricula and to reflect the demands of enterprises and thus faced difficulties in securing excellent students in the general trend of public opinion looking down on technicians.

The most important means in raising the competitiveness of industry are obviously the skilled and reliable technical manpower of the production field, and the manpower nurturing system should be developed in concert with the advancement of the industrial structure.

1.1.1 Engineering College

Since the 1980s, as the quorum of colleges was expanded, the total number of students almost doubled from 660,000 in the early 1980s to 1.04 million in the early 1990s. The number of graduates of colleges of natural sciences or engineering also increased a little together with the expansion of quorum of colleges. However, as the quorum of colleges was increased centering on colleges other than natural sciences or engineering, the ratio of all college graduates constantly decreased since 1980, and thus it caused the structural imbalance in manpower graduated from college.

In addition, the ratio of quorum of natural science departments accounted for only 40% of the total, and that of engineering departments accounted for only 19%, and the basic human resources for Korea to become a technical country was absolutely insufficient.

Table 2-1 | Progress of Graduates of Colleges of Natural Sciences or Engineering

Year	1970	1980	1985	1987	1990
Number of graduates	4,078	11,311	23,448	27,768	30,514
Ratio of students of natural science or engineering to all students	17.3%	22.7%	19.8%	18.6%	18.4%

Source: Educational Statistics Chronology of the Ministry of Education, annual reports

Back then, though the number of all students in engineering colleges increased, there was no change to the decrease in the ratio of graduates of colleges of natural sciences or engineering and the contents of education, and it was insufficient to deal with the demands of the industrial world. The industrial world viewed the fall in quality as the more serious issue, though the deficiency in quantity of high-class technical manpower was also a problem. The education of engineering colleges failed to reflect the rapid technical changes of the industrial world in its contents, and the industrial technical manpower form the educational institutions were not effectively absorbed to and utilized in the manufacturing industry. The problems of engineering colleges at that time can be summarized as follows:

First, insufficient professors

Second, insufficient educational budget

Third, old and insufficient equipments for experiments and practices

Fourth, absence of technical education

Fifth, inadequate industrial-educational cooperation

Also, in the aspect of educational policy, the demands of businesses such as recruitment of professors, expansion of facilities, strengthening of research functions and so on were a lower priority due to the policy basis of standardization for 1) the urgency of security of basic facilities of elementary and secondary education, 2) the appropriateness of balanced development between national and private colleges, and 3) the balanced development between colleges, regions and academic fields; consultation between related government departments was continuously put off.

In the aspect of technical education, due to the absence of practical education connected to businesses, most students only learned old or foreign theories in the 4-year-course curricula, and professors without experience in businesses were reforming the subjects. In addition, the negligence of basic education hindered the cultivation of students' practical abilities and the development of industrial technologies, and even curricula reflecting the technical changes of the times were not properly developed and operated.

In order to learn the field technologies that cannot be absorbed and digested in school education, the industrial-educational cooperation system is required above all, but, in many cases, enterprises and colleges fail to trust each other and to have systematic exchanges of professional manpower and thereby waste high-class brains. Enterprises preferred the introduction of foreign technologies and invitation of foreign technical experts that guarantee a minimum performance expecting only the results that can induce short-term profits. The systematic connection between industry and universities was not made. Therefore the professional manpower exchanges were not naturally conducted between industry and universities, and natural manpower and information exchanges between enterprises, professors and researchers were not performed.

In Korea, which lacks natural resources, the structural advancement of industry has to constantly pursue technology intensification and higher added value of the manufacturing industry inevitably. Thus, as the growth of technology-intensive industries stood out, the demand for professional and technical workers surged even more, and it was necessary to introduce the dual system of various shapes for the expansion in quality and quantity of industrial technologies with the reform of technical education that can solve the urgent problem of engineering colleges. It was also necessary to generally improve the existing technical educational system to plan the quality enhancement of technical education through mutual competition.

1.1.2 Industrial Universities (Open Universities)

Industrial universities were established and operated in order to grant the opportunities of continuing education to those who need education among the social manpower working in businesses and to nurture professional technicians with the ability to adapt to the industrial society by studying and polishing up expertise and technologies.

At that time, there were 8 industrial universities (5 national colleges and 3 private colleges) in Korea and among these the students studying engineering were about 3 thousand-accounting for 65%. The problems that the industrial universities of the 1990s faced can be summarized as follows:

First, operation of education isolated from the basic purpose of establishment

Second, incomplete system for nurturing teachers and irrational standards for qualification and quorum

Third, insufficient standards for facilities

Fourth, weakness of the system of selection of students and the school system

Fifth, insufficient characterization of curriculum

The main functions of industrial universities were to nurture technical manpower of middle standing, to expand the opportunities of members of society for continuing education and to conduct reeducation and supplementary education for businesses' workers. However, through the revision of school regulations and the ordinance for establishment of national schools, the chances for entrance to industrial universities for graduates of academic high schools were increased more than for workers, and the transfer of the junior college graduates that completed the curriculum which is different from the course of industrial universities for 2 years increased, and thereby the 4-year courses of industrial universities were in fact not normally operated.

The qualification of teachers of industrial universities was the same as the qualification of teachers of universities without any separate regulations, and mainly those with higher degrees without the experiences of work in the field needed for the characteristics of industrial universities were employed, and the characteristics of education of industrial universities were diluted and the industrial universities had a tendency to be like general universities.

In addition, the experiments and practices of industrial universities were introduced from the Sandwich System of the UK or the Dual System of Germany, and thus the 'ordinances for standards of equipments and facilities for experiments and practices' which are more intensified than those of general universities or junior colleges, but the standards for facilities of industrial universities were fixed together with the standards for junior colleges, and the industrial universities had only to focus on a more theoretical education.

In principle, industrial universities preferentially select, in order, those with various certificates, workers, and vocational high school graduates; but, in reality, a number of academic high school graduates entered industrial universities in many cases, and thus the industrial universities failed to play the role of a continuing educational institution for the members of society.

The entrance quorum system in industrial universities did not relate to the intent of expansion of opportunities for higher education actually, and limited the elastic supply of technical manpower (technical engineers) following the changes of industrial structure, and the departments and quorum were extremely restricted compared with junior colleges, and industrial universities lost the equity and equality of opportunity in the aspect of provision of opportunities for continuing education.

Back then, the shape of class and curriculum of industrial universities focused on flexibility and the convenience of learning with the operation of unsupervised learning and field trips, as opposed to classes where students attend in person and the operation of fixed date system and fixed time system for the classes where students attend in person. However, in reality, most classes were run as classes where students attend in person and there was no difference in the teaching methods from those of the existing general universities, and this provided the cause for demanding their conversion into the existing general universities.

In addition, the curricula of industrial universities were divided into special curriculum and bachelor curriculum, but the special curriculum was not actually conducted, and though the ratio of the subjects for general education and the subjects for major was about 20:80, the elasticity of contents focusing on the cultivation of work ability in the field ran short due to the curriculum focusing on theories more than technical education.

Likewise, it was urgent to grope for a plan for the original functions and roles of industrial universities that were operated in a somewhat distorted direction from the intent of establishment, and the necessity to reestablish the role as place for granting the opportunity of continuing education and lifelong education for the workers of businesses by differentiating the purpose of education, contents of education and so on of industrial universities from the other existing universities came to the fore.

1.1.3 Junior Colleges

Junior colleges are the vocational technical educational institutions connected with vocational high schools, and the name and personality were changed into such as vocational higher professional schools, professional schools and so on, and since 1979, the name has been unified as 'junior colleges.'

Junior colleges aim to nurture professionals of middle standing, but the meaning of the professionals of middle standing is not concretely clarified for each field of occupation; businesses and society also lacked recognition of junior colleges.

Since junior colleges were reformed in 1979, the quorum for humanities and social science departments was expanded by the changes of historical and social conditions, and thus the total number of students increased starting in 1986. However, the number of engineering graduates decreased or remained the same, but, as the shortage of technical manpower intensified in the 1980s, the number of engineering graduates increased again in the 1990s.

At that time, among the total 126 junior colleges, there were 49 engineering colleges (4 national colleges and 45 private colleges), 37 social practical work colleges, 31 health and nursing colleges, 7 agriculture and fisheries colleges and 2 art colleges. The employment rate of the graduates of engineering junior colleges soared starting in the mid-1980s, and in 1991, the employment of graduates of engineering junior colleges showed a drastic increase from the mid-1980s. However, the employment rate was not naturally increased by the demand of businesses or local communities. As the trend of high educational background and the demand for higher education increased, the establishment of junior colleges was suddenly facilitated by the national policy, and no sufficient preparation such as nurture of professors, development of curriculum, facilities of schools and so on was made. Thus, still then, junior colleges had not built the basis in the society and had many problems in the vocational education.

In addition, the contents of junior colleges imitated by scaling down the curriculum of 4-year-course universities with the education centering on theories-which is far isolated from the demands of industrial settings-and, though their teaching and learning methods had to sensitively cope with the technical development and demands of businesses and to be supplemented and reorganized with new technical innovations and contents, junior colleges had only courses nurturing semi-engineers, not technicians, and lost the function of the middle higher education institution.

Moreover, the professors with experiences in businesses meeting the purpose and functions of education of junior colleges ran short and the affiliated professor system by professional manpower of businesses was not sufficiently utilized. The teachers of junior colleges had no field experiences, completing only the colleges and graduate school courses centering on studies like the general colleges. Only a very limited number of professors had the experience of practical work in business and the system through which those with experiences were employed as professors of junior colleges was inadequate.

In the aspect of contents of education, most departments of junior colleges were operated by being isolated from the original purpose of education and the demands of the industrial world and imitating the 4-year-course universities, and due to the insufficient development and utilization of textbooks proper for the level of junior colleges, the same textbooks used in the 4-year-course universities were used at junior colleges. Meanwhile, the education term was short, the ratio of credit in the field of experiments and practices was low, and thus when the graduates were deployed into the workforce, they faced difficulties in performing work efficiently.

The urgent problems those junior colleges' nurturing and supplying the technicians of middle standing in charge of the core role in the industrial settings were as follows:

First, insufficient diversity and characterization of functions proper for the purpose of junior colleges

Second, improper educational conditions of junior colleges

Third, insufficient system for nurturing teachers

Fourth, insufficient development and operation of curriculum of junior colleges

Fifth, incomplete system connecting junior colleges with businesses

Junior colleges were thoughtlessly established without considering regional characteristics or demands, supply and demand of manpower, educational environment and so on, and the insufficiency of setting of clear standards for new establishment of junior colleges and system of evaluation and acknowledgement also hindered the development of junior colleges.

Further, in fact, the phenomenon of isolation was also rampant due to the uncertain establishment of ideology between junior colleges and businesses, the fall in credibility of businesses in the operation of curriculum centering on colleges and professors, the

avoidance of human exchanges between businesses for concerns of leakage of confidential information of industrial technologies, the value pursuit of enterprises focusing on short-term profit pursuit and so on.

Therefore, in order for junior colleges to efficiently nurture and supply the technicians needed by the industrial society by fulfilling their functions and roles, it was necessary to arrange an institutional strategy that could select students with a clear sense of purpose to become a professional from the beginning by considering the vocational aptitude and ability at the time of entrance. It was also highly necesary to establish the role of junior colleges as a comprehensive education connecting system that could grant the opportunities for continuing education that could effectively nurture technical manpower of middle standing.

1.1.4 Vocational Training Center

In Korea, the vocational training to grow work ability with technical education for idle manpower without skills was started in 1967 when the 'Basic Act for Vocational Training' was enacted. Starting then, about 700 vocational training institutions trained and produced about 1.60 million people by the early 1990s. The early vocational training the system and contents of vocational training of advanced countries due to the lack of experiences and knowledge and thereby good facilities and equipments for training were expanded and the vocational training centering on simple skills achieved a great outcome both in quality and quantity.

However, as the industrial society was converted from a labor-intensive structure into a technology-intensive structure, the demands for multi-skilled workers rapidly increased rather than the demands for single-skilled workers, but, the education period of most vocational training institutions was less than 1 year, and there was a limit in improving advanced skills following drastic technical changes. Hence, an attempt was made to expand the period of some training courses from 1 year to 2 years and to change the entrance requirements from middle school graduation into high school graduation and to thereby specialize the institutions. However, the contents of vocational training for skill education had no originality and were changed into similar directions of education as in junior colleges, and thereby the characteristics of vocational training were made vague. The trainees who completed the 2-year professional course also caused complications in school demanding the acknowledgement of an academic background which is the same as that of a junior college graduate.

Until then, the basic training course achieved the intended goal, but, most goals of other enhancement training, employment countermeasure training, retraining and so on were not accomplished due to careless development of programs or lack of preparation.

Vocational training inside companies operated for enterprises to nurture the manpower they needed for themselves also conducted formal skill education to get the exemption of the share of expenses for vocational training, and businesses avoided employing those who

completed the new nurture course rather than those who completed a worker-retraining course.

It was urgent to convert the system nurturing single-skilled workers centering on middle school graduates into a system nurturing multi-skilled workers centering on high school graduates to meet the rapid development of technologies and production methods for the efficient nurture of skilled manpower, and it was also necessary to develop various training courses and types of occupation for the nurture of professional manpower in cutting-edge types of occupation with new demands.

As in the above analysis of the problems of the existing institutions nurturing technical manpower such as engineering colleges, industrial universities, junior colleges and vocational training centers, the order imbalance of technical manpower in the nurture of industrial technical manpower in Korea in the 1990s was a result of the fact that the college-graduate high-class technical manpower in the traditional industrial technical fields was oversupplied due to inflexible technical education with focus on theories centering on engineering colleges, while the supply of technical manpower of middle standing centering on vocational training and technical high schools was inferior to that, and thus the system nurturing lower technical manpower came to be especially weak within the entire technical manpower structure.

This phenomenon was not only limited in Korea at that time, and was a general imbalance suffered by not only Japan but also the newly industrialized countries in Asia. In the case of Korea, it can be said that this phenomenon was overlapped by its cultural characteristics focusing on the value of university degrees and was raised as an especially serious issue.

1.2 Process of Establishment of Korea Polytechnic University

In the early 1990s, in Korea, the quantity and quality of demand for manpower were estranged from each other due to the educational system lacking the ability to cope with the process of rapid industrialization, and Korea was faced with serious shortages of manpower as the industry entered into a structural correction phase. This problem of order imbalance of industrial technical manpower can be categorized largely into three issues.

First, there was an oversupply of highly educated individuals, but there was shortage of high-class technical manpower in the special research and technology field, which is the pivot of industrial technical development.

Second, as the correction of industrial structure progressed, the relative employment instability such as the occurrence of unemployment in some declining industries increased, and there was an extreme shortage of production workers including technicians in some industries such as textile, nonferrous metals and so on.

Third, the issue of the level of quality of industrial manpower stood out as a difficulty in industrial development which is as big as the issue of quantity of supply and demand.

As such, the mix-up between the supply and demand of industrial manpower, the fall in the level of quality, and the relative instability of employment were troublesome obstacles to industrial development.

In order to settle these issues, it was demanded to satisfy the demand for continuing education and reeducation for technical manpower in the production field, and to improve the educational system so that it could involve a structural strategy that makes the technical education itself be able to flexibly cope with the demands of industry and the necessity of a new industrial technical educational system connected with technical high schools, junior colleges and technical colleges to ensure the internal stability of professional technical education centering on the field.

Back then, the Ministry of Commerce and Industry came to raise an issue in the nurture of industrial technical manpower of good quality and to propose a new technical educational system to the government with the industrial world as the center. The Ministry of Commerce and Industry was of the opinion that the shortage in quantity and insufficiency of quality of the industrial technical manpower at that time were serious, but that the industrial technical educational system focused on the quantitative nurture and expansion and had a limit in nurturing industrial technical manpower which is excellent in quality.

The Ministry of Commerce and Industry proposed the 'industrial technical education bill' in which the businesses nurture the technical manpower they need for themselves and the state grants an official degree to an academic ability of a certain level, and this bill oriented a structure that dualizes the educational system that had focused on study until then and thereby lets the existing educational system and the educational system centering on the technologies needed in the industrial settings stand together.

The Production Research Center under the Ministry of Commerce and Industry at that time pointed out that the then current educational system blocked the opportunity of higher education for skilled manpower and could not nurture the excellent technical manpower to the degree that the professional technical society demanded.

The Ministry of Education also acknowledged that the necessity of a new industrial technical educational system had a realistic validity with the same critical mind for the shortage in quantity and insufficiency in quality of industrial technical manpower, but at the same time was concerned that there would be conflict and friction between the new industrial technical educational system and the existing industrial technical educational system.

The persons related to education maintained that though the problem of quality of education of the existing engineering colleges also was being raised, it was impractical to newly establish technical colleges, and it was desirable to secure industrial manpower through the expansion of investment in the existing general colleges, open universities, a variety of vocational training and so on.

In particular, they argued that the main cause of the manpower shortage of the manufacturing industry was the weak charm for manpower such as the relatively disadvantageous working conditions of the manufacturing industry compared to the technical educational system. In addition, they stated their views that technical colleges came to concentrate on 'training' centering on learning the skills of specific types of occupation rather than 'education' teaching general theories, knowledge and technologies and there was a problem in the aspect of educational theories in that the students would be lacking the ability to adapt to the changes of economic industrial structures.

In November 1990, after these discussions between the Ministry of Commerce and Industry and the Ministry of Education, they finally agreed to revise the then-current laws and ordinances related to education so that technical colleges could be established not newly making the then-current Industrial Technical Education Act and to enact the 'Act for Nurturing Industrial Technical Education' for state and local governments to give the support needed to promote industrial technical education within the system of education law.

Afterwards, in March 1991, the Ministry of Commerce and Industry and KITECH jointly proposed the plan for improvement of the technical educational system, and in July 1994, the 'expanded meeting of economy ministers' decided to 'establish a trial industrial technical university' in the shape of industrial university as a part of the plan to improve the technical educational system in order to nurture high-class technical manpower based on theories and field experiences that meets the demands of the industrial world, and to add much to the enhancement of national technical competitive edge. They also came to study a model of trial industrial technical university; for the establishment of university of a new shape to induce the development through the reeducation of the existing field technologies and skilled manpower and the continuing education of the graduates of the vocational high schools such as technical high schools for the nurture of professional manpower with strong ability to adapt to the industrial settings.

As the revised bill of related laws and ordinances, which are the basis for the establishment of the industrial technical university, passed the Cabinet meeting in March 1995, the Ministry of Trade Industry and Energy (the former Ministry of Commerce and Industry) came to prepare detailed plans for the establishment of the industrial technical university and worked to revise the related laws and ordinances together with the Ministry of Education to let the industrial technical university aim to have the students learn the practical skills of the field since they are attending the university and be able to utilize the skills immediately after their graduation and make the workers in industrial settings who graduated from the technical colleges run by the technical education center of the KITECH, the training institute of Small & Business Corporation (SBC) and businesses be able to transfer to the industrial technical university as 3rd-year students.

As a result of 3 years of researching the model of the trial industrial technical university, the basic intent for establishment which is 'Established by the Government, Run by the

Private Sector' was confirmed, and a board of directors in which the government (the Ministry of Finance and Economy, the Ministry of Trade Industry and Energy, the Ministry of Education and the Ministry of Construction and Transportation) and the private sector (the industrial world, the academic world, the scientific technical world) jointly participate was made and thereby the 'Educational Foundation Korea Industrial Technical University' came to be established in December 1995.

Table 2-2 | Detailed progress of Establishment of Korea Polytechnic University

Category	Details
September 1991	A government-ruling party consultation to establish an industrial technical university by revision of the 'education law.' - A revised bill for education law was submitted to a regular session of the National Assembly as a legislation by Assembly members, but the bill was abandoned due to the opposition of junior colleges and the end of session of the 13th Assembly
May 1993	The plan to establish an industrial technical university was reflected to the 'new 5-year economic development plan.' - the 'Act for Industrial Technical University' was enacted, and it was decided to open the university in 1995.
January 1994	At the new economy meeting, the plan to enact the Act for Industrial Technical University was reported. - The Ministry of Education changed its position to the direction that the establishment of industrial technical university should be promoted within the system of education law.
June 1994	The final agreement was made to introduce the system of industrial technical university by fully revising the related laws and ordinances of open university with similar purpose of establishment and aim. - In July 1994, at the new economy meeting, the plan for establishment of industrial technical university was reported.
March 1995	The institutional foundation for establishment of industrial technical university was prepared by revising the 'regulations on establishment and operation of open university.'
May 1995	The Educational Reform Committee arranged the 'plan for education reform for establishment of the new educational system.' - The concept of new college which is an open educational system was embraced in the model industrial technical university.

The regulations on establishment and operation of Open University were revised so that the purpose of establishment of Korea Polytechnic University could be achieved with the Ministry of Education and thereby the foundation of establishment of Korea Polytechnic University as a regular educational institution established in the shape of Open University.

It was decided to let the Ministry of Trade, Industry and Energy establish and operate the model technical university jointly with the private sector in the shape of open university (educational foundation) by the Education Law according to the 'Act on Formation of Industrial and Energy Based Technologies' and to let the related government departments jointly form the working groups for establishment of technical university and maintain the related laws and ordinances; and, to promote details by placing the groups for promotion and planning of establishment of technical university at the KITECH in order to let the university take full charge of nurturing professional technical manpower with strong practical ability in the production field.

The location of the university was thought of as one of the important elements in implementing technical education centering on practical working in industrial-educational cooperation; the Sihwa Industrial Complex, which is the center of the largest area where SMEs are concentrated (with Banwol Industrial Complex, Bucheon Industrial Complex and Namdong Industrial Complex nearby), was selected after sufficiently reviewing the facts that there were many technical experts and technicians in production fields and the experts in industrial settings could be utilized as adjunct professors and appointed professors and it was easy for professors to teach students technologies in the field.

In December 1996, the construction of the school commenced with support from the government, and in December 1997, permission for establishment of the university (with 7 departments and 560 students) was obtained, and the university was named 'Korea Polytechnic University' to show that it was the only university teaching industrial technologies in Korea.

The university was opened in March 1998 with the ideology of the 'nurture of practical technologists with excellent ability to adapt to the field' through the education centering on practical work to secure the international technical competitiveness of businesses.

2. Positioning and Directions of Characterization of Korea Polytechnic University

2.1 Positioning of Korea Polytechnic University

In the 1990s, in view of the quantity of supply and demand of industrial manpower, in total amount, employment was stable and the unemployment rate was low. However, there was an extreme order imbalance for each industry, each type of occupation and academic background. In particular, the manufacturing industry was faced with the more serious technical manpower shortage. The main causes for this phenomenon in the institutional aspect of nurture of technical manpower are as follows.

First, the technical educational system nurturing industrial technical manpower in Korea had the regular curriculum of three stages of vocational high schools, junior colleges and engineering colleges (and graduate schools) and the curriculum for vocational training, but each stage of education was not a connected technical education conducted by stages following the level of technologies and skills, but rather an education which was not connected and in which technical education started newly from the time when the student entered the school of each educational stage. Hence, the point of time when technical education was started was later than that of advanced countries and there was a limit in continuously raising the technical level.

In addition, as a number of graduates of academic high schools entered engineering colleges whether or not they possess technical aptitude and ability, most students entering received a technical education centering on theories without the skill education which is the first stage of technical education, and thus they had low ability to adapt to industrial settings after graduation, avoided being employed in the manufacturing industry and were estranged from industrial settings more and more.

This can be said to be due to the single ladder educational system in which the educational system is excessively competitive and uniform, centering on degrees; and, the secondary curriculum and the higher curriculum were divided uniformly and the opportunities for continuing education toward the vocational educational system were limited.

Second, the curricula were not flexible enough to reflect the trend of technical changes, and the curricula were also isolated from the field and failed to actively deal with the demand for technical manpower of the industrial world. As the higher education institutions (engineering colleges, industrial colleges, junior colleges) taught students with the curriculum and contents in the same and uniform shape, the characterization of each educational institution and department was not conducted.

Likewise, in the 1990s, it was recognized as one of the serious problems that the technical educational institutions of Korea-such as vocational high schools, junior colleges, engineering colleges and so on-failed to meet the demands of enterprises in the aspect of contents of education and had an asymmetric structure between technical manpower and skilled manpower also in the aspect of supply of manpower.

Back then, Korea had to effectively construct the industrial structure proper for the international status and technical level and to establish a technical education system that could smoothly supply suitable industrial technical manpower to raise the international competitive edge of its industry.

In order to conduct structural removal of the obstacles to the inflow of manpower into the industrial technical manpower sector centering on production field technologies and to establish a system nurturing technical manpower that could harmoniously supply technical manpower for each field, skill level and skill with balance, the existing technical educational system had to be promptly reformed into a continuing educational system. This

was possible only by introducing the dualization of technical educational system such as the new establishment of technical universities of a new shape that was not absorbed by the basic technical educational system centering on engineering colleges, but was composed of a curriculum independently centering on practices and whose graduates' degrees are acknowledged as the same as those of the graduates of general colleges.

It became necessary to newly establish the technical universities that will take charge of the central role of the vocational technical educational system nurturing the high-class field technical manpower that will lead the technical development in the production fields after graduation by providing an education thoroughly centering on practices for the skilled manpower in the production fields, technical high school graduates and even some academic high school graduates with aptitude to technical sector.

2.1.1 Differences from Existing Industrial Education Institutions

The technologists that Korea Polytechnic University intends to nurture are different from the technicians nurtured by the existing junior colleges and the engineers produced by engineering colleges in the following ways:

Table 2-3 | Comparison of Functions of Educational Institutions

Category	Korea Polytechnic University	Engineering Colleges	Junior Colleges
Goals of Nurture of Technical Experts	Technologists that can take responsibility of production lines with ability, having both theory and practice	Research technicians that can design and develop centering on theories	Technicians with simple techniques that can manufacture parts
Fields of Employment	Jobs in production and technologies in industrial settings	Jobs of design and development	Jobs of simple skills in industrial settings
Main roles	Direction of production line work and management and supervision	Design and development	Management work crew units and design
Certificates	1st Class Engineer	1st Class Engineer	2nd Class Engineer and 1st Class Skilled Man

A technologist needed by SMEs is a concept which is different from technicians of the existing junior colleges and engineers of colleges of natural sciences or engineering.

At that time, junior colleges centered on theories and were on a different way from their original goals in nurturing manpower, and the nurturing of engineers by colleges of natural sciences or engineering was also an education focusing on theories and were nurturing engineers lacking the ability to be adapted to the field. Therefore, in reality, there was no technologist with the ability to develop production technologies by understanding the skills greatly needed by the field actually and applying the results of R&D to the present products and to thereby add value to products.

The abilities that a practical technical expert should have in industrial settings were: first, understanding of the basics of product design and interpretation at the level of production technologies and supplementation of the insufficiency of design; second, management of production process; third, framing of the statement of work of production field and management of production lines; fourth, review of the aspect of production technologies at the time of product development; fifth, management of cost of production and production management; and sixth, production assembly and inspection. However, the reality was that the technologists with these technical abilities were considerably few.

Table 2-4 | Positions and Roles of Technologists in the working process of Production Fields

(-: Main work,---: Peripheral work)

Category	Design and Development			Start	Production	Manufacturing	Inspection	Technology Sales
	Concept design	Engineering adaption design	Detail design	Pro-manufacturing	Manufacture, technology	Manufacturing	Testing	Engineering sales
Engineer	-	-	-	---	---	---		-
Technologist		---	---	---	-			---
Technician						-	-	---

Therefore, the technologists nurtured by Korea Polytechnic University must have the technologies to lead the field and to apply the results of research and development to actual products on the basis of the theoretical knowledge demanded by the field and to thereby increase the added value of products through enhancement of productivity, and thus the basic directions of education have the following distinct characteristics.

First, the system moves from centering on suppliers to centering on users. The common phenomenon of the existing college education was that it had conservatism due to the pride of being the best in study and thus had been consistent in the technical educational system

centering on suppliers that cannot easily deal with the changes of demand of technologies in industrial settings rapidly with the trend to make light of production technologies.

However, as society changes into hegemonies of technologies, the changes of technologies are so fast and if a country fails to cope with them rapidly, the country degenerates into a technically-underdeveloped country. Therefore it was needed to convert the basic directions of technical education from the traditional system centering on colleges, that is, suppliers, into the system centering on industrial settings that are the actual users of technologies. Whether to nurture technical experts of a field should be decided by knowing which technology to what extent the industrial settings need and which technology is saturated, but it was hard to tackle quickly and flexibly due to the uniform existing system of education law.

Second, the system moves from centering on theories to centering on experiments and practice. The educational system inclined toward only the education of theories due to the trend to make light of field technologies, and thus had been constant in the technical education isolated not only from the actual industrial settings but also from enterprises that are the actual users of technical manpower. Therefore, the discontent was that the users of technologies had been increased because the college graduates had to spend 3 to 4 years to grow the ability to be fit for the field.

Korea Polytechnic University places the essential point in the solution of these problems and focuses on substantially contributing to the industrial settings by converting the traditional educational system centering on theories into an educational system centering on experiments and practice and also by strengthening the system of industrial-educational cooperation.

For the method of education, Korea Polytechnic University avoided the education focusing on attendance for the method of class and let the students grow the ability to adapt to the field by conducting unsupervised learning which enables them to perform experiments, practices and selection, and completion of graduation projects for themselves centering on practices. The internship practice, that makes the circulation of field practice (in which students participate in the field with their own tasks to solve in the field in order to achieve the purpose of education), makes reeducation and employment possible.

In addition, the learning stages were organized centering on experiments and practice rather than on theories, and the University intended to let the 1st-year students conduct the practice of the 1st Class Skilled Man course, the 2nd-year students conduct 2nd Class Engineer practice, the 3rd-years conduct the 1st Class Engineer practice, and the 4th-years conduct overseas training and practice and thereby build a unique tradition that nurtures the sense of internalization at the same time.

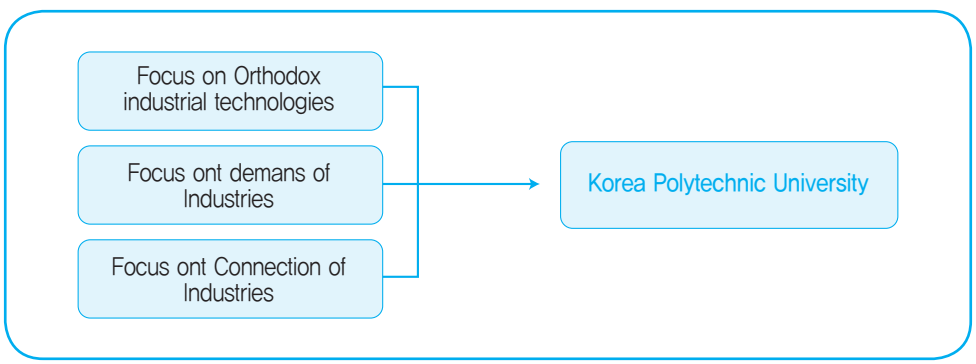
The University intended to liberalize the establishment of major departments and quorum for each department to be flexibly operated in order to be suited to the changes of demands of the industrial world for technologies and the purpose of nurturing technologists; and, to

revitalize the exchange of human and material resources between the production fields and the University through institutionalization of same so that businesses can jointly utilize the equipment for experiments and practices possessed by Korea Polytechnic University. In addition, the professors of the University will actively go in for settling the bottleneck technologies faced by enterprises for the promotion of industrial-educational cooperation and maximization of utilization of technologies and resources.

The University also intended to conduct technical directions including short-term curriculum commissioned from enterprises, commissioned research, joint research through industrial-educational cooperation and so on to supply and spread new technologies and technologies for manufacturing new products of rapidly changing industrial settings.

Through the differentiation of contents and pedagogies, the following plans for roles were considered in order to: resolve the order imbalance of industrial technical manpower, induce high school graduates to the vocational educational system, provide opportunities for lifelong education for technical manpower in production fields to thereby enhance the technical skills, and prevent the technical manpower from leaving the manufacturing industry and to push ahead with education centering on the technologies of production fields of the technical universities that will play the central role in the continuing technical educational system that induces the sound nurture of the lower technical manpower structure.

Figure 2-2 | Positioning of Roles of Korea Polytechnic University



2.1.2 Focus on Orthodox Industrial Technologies

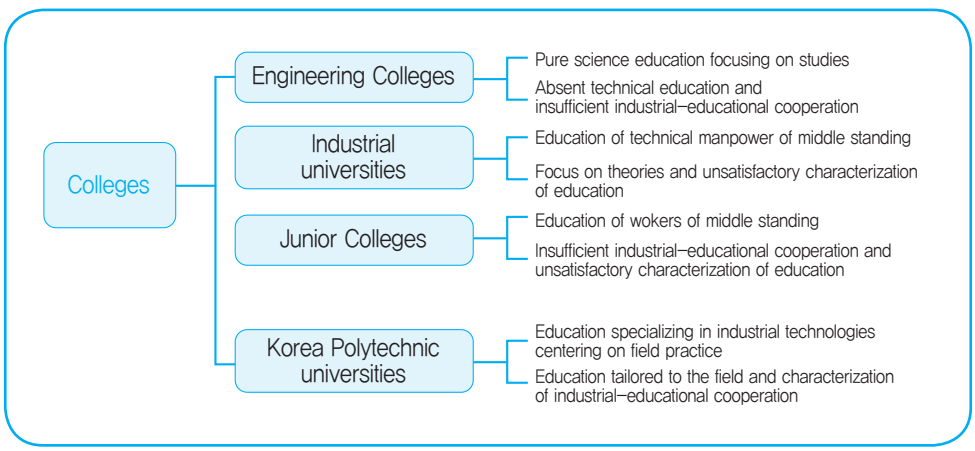
Korea Polytechnic University is oriented to the orthodox polytechnic university as a university at the center of regional industrial-educational cooperation, and strengthened the distributive education of the major field of technology connected with the industrial demand with the education centering on field placements.

Back then, Korean industry suffered not only from a shortage of technical skills but also from the order imbalance of industrial technical manpower being intensified in the field of

manufacturing industry, and the bottleneck phenomenon due to this stroke a serious blow to the entire productivity of the Korean economy and largely hindered the promotion of advancement of industrial structure. Korea was attempting an effective improvement of its educational system thorough technical high schools, junior colleges, engineering colleges and open universities for the nurture of industrial technical manpower, but it failed to accomplish its intended goal.

Korea Polytechnic University pursued a traditional industrial technical education that focuses on practices rather than the theories of traditional industrial technologies and actively deals with the actual technical demand of the industrial world in order to continuously absorb the demand for technical manpower following the advancement of industrial structure and to produce professional technical manpower.

Figure 2-3 | Comparison between the Existing Higher Technical Educational Institutions and Korea Polytechnic University



Korea Polytechnic University formed the curriculum centering on the field containing the present conditions, job analyses and demands of businesses through examinations through visits and interviews with businesses (1,420 persons) as the subject before opening the university and thereby decided the goals of learning and range of education. It developed the subject system chart and so on and had them verified by experts and businesses, and reexamined the demands of businesses for the characterization of majors for each department and development of curriculum three times after opening the university and thereby organized the curriculum reflecting the opinions of businesses.

In addition, it carried forward the formation and operation of the curriculum tailored to users through the examination of demands of businesses with the industrial-educational cooperation model, the operation of the credit system for project practice in enterprise fields of students, the development and instructions of bottleneck technology through the partner

company system, the approval system for establishment of research institute and research equipment in which an importance is attached to the results of joint use of enterprises, the performance evaluation system and promotion system for processors with importance placed on industrial-educational cooperation.

2.1.3 Focus on Demands of Industries

Korea Polytechnic University has to be the place of continuing education not only for academic high school graduates and technical high school graduates who received vocational training, but also for technical manpower who are working in the production fields. Therefore it pursued the formation and operation of school system considering, to the utmost, convenience for learners who work and study at the same time. Through this connection, it had itself be run openly through the provision of diverse school system programs.

Korea Polytechnic University placed emphasis on the nurture of new technical manpower through a regular technical educational system in the long term, and had itself be able to absorb the technical manpower produced in the lower technical educational system.

In order to build the educational system close to the field, centering on the demands of businesses, each department has nurtured the technical manpower that businesses can immediately utilize by selecting the characterized majors familiar to the field on the basis of the opinions collected from partner companies and so on, and composing the specialized subjects tailored to users corresponding to the characterization and managing the curriculum centering on the fields.

In addition, its operational purpose is different from the traditional system nurturing technical manpower, and it avoided the traditional inflexible system in details of operation such as formation of subject, qualification of teachers, operation of school system and so on and pursued voluntary and elastic operation to the utmost, and pushed on with the operation of the school system of each product field such as department of automobile, department of mechatronics, department of semiconductor and so on, reflecting the changes of industrial technologies as well as the classification for each technical field such as the traditional department of mechanical engineering, department of electronic engineering, department of electrical engineering, department of chemical engineering and so on in order to conduct practical technical education.

As the contents of subjects of Korea Polytechnic University aim to nurture professional technical manpower, it emphasized the education centering on practices, and it had to produce the technical manpower of middle standing that will lead the production fields and thus even more strengthen the general education needed for the cultivation of dispositions, in particular, the education of foreign languages. In addition, Korea Polytechnic University supplemented its system so that the manpower who had enough sense in the production fields through career in businesses and could adapt to the dramatic development of technologies

and had the theoretical basis to be able to develop technologies on one's own could be employed as teachers.

2.1.4 Focus on Connection of Industries

As the technical educational system centering on general engineering colleges inflexibly provided the technical education isolated from the demand of the production fields for technologies, the graduates lacked the ability to apply in the field and to develop and thus the time they spent adapting to the field after graduation was long. The waste of time for on-the-job training and double investment that the enterprises had to perform was a problem of the higher educational institutions within the existing system nurturing the industrial technical manpower.

Korea Polytechnic University oriented the technical education centering on production technologies and also the nurture of technical manpower that can be immediately inputted and applied to businesses and developed and operated the school system and curriculum that are needed by businesses with shortage of manpower, that is, that are directly related to industry. The distinct characteristics of curriculum of Korea Polytechnic University are as follows:

a. The first is the students to enter Korea Polytechnic University.

Korea Polytechnic University intended to prepare the soil to flexibly meet the rapid changes of technologies by providing the opportunity of substantial continuing education mainly to high school graduates with the craftsmanship as a technician and the desire to learn as the main students to enter Korea Polytechnic University, and to form the climate in which not only students of academic high schools but also excellent students of technical high schools can enter upon completing their studies and to thereby plan the early settlement of the so called dual system connecting technical high schools, junior colleges and technical colleges in order.

b. The second is the professors.

Korea Polytechnic University made those who have experiences in work at businesses as the professors of the university and the ability to teach technologies and let them nurture the students as practical technologists by connecting the rapidly changing field technologies and education.

c. The third is the teaching method.

The teaching method of Korea Polytechnic University rejects the education focusing on attendance and conducts education centering on practice and experiments, unsupervised learning that lets students select and complete their graduation projects and the internship practice that enables the cycle of: field practice→reeducation→employment. In this cycle, students participate in the field with the tasks to be solved in the field to achieve the purpose of education and it thereby lets students grow the ability to adapt to the field.

d. The fourth is the stages of learning.

The stages of learning are organized centering on experiments and practice rather than on theories. The 1st-year students are allowed to conduct the practice of the process for 1st class skilled man, the 2nd-year students are allowed to conduct the practice of the process for 2nd class engineer, the 3rd-years are allowed to conduct the practice of the process for 1st class engineer, and the 4th-years can grow the sense of internalization through overseas training and practice. This is the unique tradition of Korea Polytechnic University.

e. The fifth is the degrees.

Korea Polytechnic University grants professional technical degrees laying stress on qualifications and abilities, not like the degrees of society focusing on study, and thereby plan to convert the society centering on degrees into the society laying stress on qualifications and abilities.

f. The sixth is the departments and quorum.

The establishment of departments and the quorum of each department are liberalized to be operated flexibly to suit the changes of demands of the industrial world for technologies and the purpose to nurture technologists, but only the total quorum needs to obtain permission to prevent the over issue of degrees and to deal with the nurture of needed manpower.

g. The seventh is the promotion of industrial-educational cooperation.

For the advancement of industrial-educational cooperation and maximized utilization of technologies and resources, Korea Polytechnic University vitalized the exchange of human and material resources between the production fields and the university by making systems so that businesses can jointly utilize the tools and materials for experiments and practice possessed by the university and the professors of the university will actively settle the bottleneck technologies faced by enterprises.

2.2 Directions of Characterization of Korea Polytechnic University

2.2.1 Educational Ideology Differentiated from Those of the Existing Engineering Technical Educational Institutions

Korea Polytechnic University aimed to nurture the professional technical manpower in the industrial settings that will lead the future of Korean industry and technology and to give technical support to businesses and was established in the area of research support facilities of the Sihwa Industrial Complex in Siheung-si, Gyeonggi-do, which is the center of Banwol, Sihwa and Namdong National Industrial Complexes as the only one in Korea by the Korean government (the Ministry of Commerce, Industry and Energy) in 1998.

At that time, the fundamental problem of Korean industry and economy was judged to be the 'weakness of technical manpower in quality and quantity', and Korea Polytechnic University aimed to 'nurture the practical professional technical manpower.' Korea

Polytechnic University has a great ambition to construct a characterized technical university which is fundamentally differentiated from the existing engineering technical educational institutions that had the academic high school graduates enter engineering colleges and receive the education centering on theories isolated from the industrial settings and have much fear and avoidance to the field of enterprises and that lacked the adaptability of results of education to the field very much; and, that therefore produced high-class manpower lacking the ability to develop new products with market competitiveness. The educational ideology of Korea Polytechnic University is 'to nurture the practical technologists who exert themselves and think and manufacture, applying the logics of technologies to products through thoroughly digging into the logics of technologies and through experiments, practices, seminars, internship in enterprises and practices to manufacture the actual product models.'

Korea Polytechnic University chose "Creativity and Practice" as the school motto in order to accept the universal educational ideology and to nurture the creative and practical talents leading the knowledge-based society of the 21st century, and established the "realization of studies of positivistic method" by collecting the opinions of the members of university in 2002 so that it would be suitable to the founding spirit and characteristics of education of the university.

The educational ideology and directions of characterization of Korea Polytechnic University coincide with the universal purpose of higher education, which is 'Colleges aim to build character, and to teach and study the profound theories and application methods needed for the development of the country and human society and to do much toward the country and human society.' In addition, the purpose of college education is made of the two indices such as the 'right people' and the 'ideology of industrial-educational cooperation'. That is, the right people for the university are 'Creative and practical talents' and the ideology of industrial-educational ideology is the 'university coexisting and competing with enterprises.' These two indices of educational purpose are encapsulated in the school motto of 'Creativity and Practice.'

These founding ideology and educational purposes are connected to the educational purposes of each department, and the plans for the practice of those are constantly groped in all educational settings. The concrete educational purposes to achieve educational purposes and realize the founding ideology are 'Businesses as campus, campus as businesses,' 'University coexisting with enterprises' and 'University competing with enterprises.'

That is, the university is maintaining an organic cooperation system through the construction of the industrial-educational unified network such as vitalization of the partner company system and so on, in order to realize businesses as campus and campus as businesses, and has been reflecting the demands of businesses to the curriculum and pushing forward the characterization to the field close to regional industries in order to understand enterprises and to coexist with enterprises in the rapidly changing industrial society.

It is also leading businesses to realize the university is competing with enterprises and actively performing trusted research in the production technology fields and so on in order to increase the competitive edge of businesses.

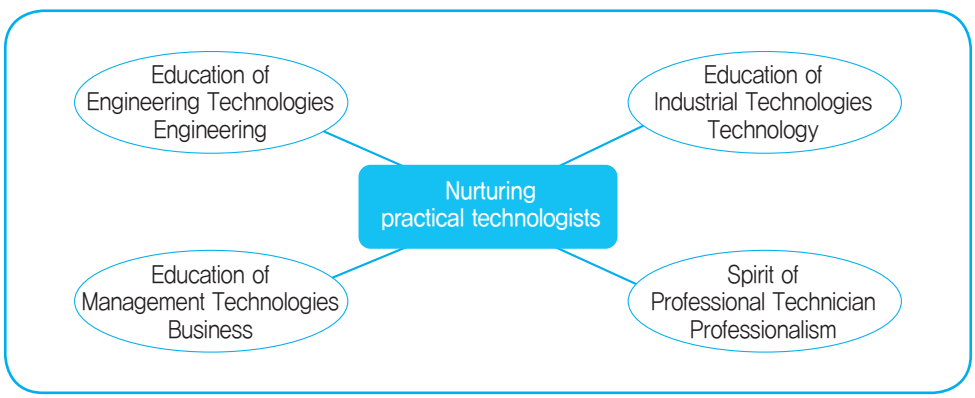
The directions of characterization are well shown in the founding ideology, educational purposes and so on. That is, the university is making an endeavor to build a partner company that will play the role of pivot of industrial-educational cooperation for the construction of the industrial technical information supporting system, always reflecting the demands of businesses in order to accomplish the educational purpose of 'Businesses as campus, campus as businesses.' It specialized the university into tailored education close to the field and the education for the nurture of high-class professional manpower to become the university coexisting with enterprises, and it is striving to construct the basis for R&D by strengthening the production technical research and so on to secure the cutting-edge research facilities and competitive edge in product development to become the university competing with enterprises.

2.2.2 Policy for Practical Operation of Academic Affairs

Following these educational ideologies, the policy for operation of academic affairs of Korea Polytechnic University is as follows:

First, it conducts education in which technicians and skilled workers mutually connect the ranges of time which are in total 8 to 10 years (3 years of technical high school, 2 to 3 years of practical work in the field, 3 to 4 years in Korea Polytechnic University and so on). Korea Polytechnic University aims to induce the practical education and training for development of new products continuously, even after graduation, and to thereby realize the lifelong education in which graduates facilitate their development in life as professional technicians.

Figure 2-4 | Core Contents of Industrial Technical Education



2.2.3 Realization of Systematic Education Connecting Industry and university

The education connecting industry and university is the vital force of accomplishment of educational purposes in the nurture of practical technicians, which is the aim of Korea Polytechnic University. It lets the top decision-making organization be composed jointly by industry and university and lets enterprises directly participate in the development of curriculum, and also lets enterprises be the center in evaluating graduates and thereby the demands of industry are reflected directly. In addition, it establishes facilities and equipment to be suitable to the request of enterprises and technical development and has the technical experts of the fields of enterprises (technical executives and master mechanics) directly participate in the education as adjunct professors. Moreover, it institutionalizes and executes industrial internship as a 'sandwich system' to train so that the theoretical education and experiments and practices in school will be applied to real-world industrial settings, and sends superior students for training overseas.

Further, Korea Polytechnic University appoints the persons in charge of education and training in school and enterprises and establishes and regularly operates the industry-university joint steering committee as an institutional strategy that can substantially take charge of the connection between industry and university. It has established and is administering the special education and training company that can connect university and enterprises as a mechanism connecting industry and university when needed. Also, the university is strongly carrying forwards international cooperation so that it can become a university of international level in a short period of time.

3. Process of Growth of Korea Polytechnic University

3.1 Period of Establishment

Since the opening of the university in 1998, Korea Polytechnic University has steadily developed in various difficult conditions at home and abroad. At the time of the university's opening, Korea suffered from a financial crisis, and thus construction costs were not fully secured due to fiscal austerity; construction was delayed. At the time of opening, only Building A and Building B of Engineering Hall were completed, and all lectures and administration businesses were conducted there. Permission for establishment of the university was also delayed and thus the university couldn't even properly publicize the entrance examination.

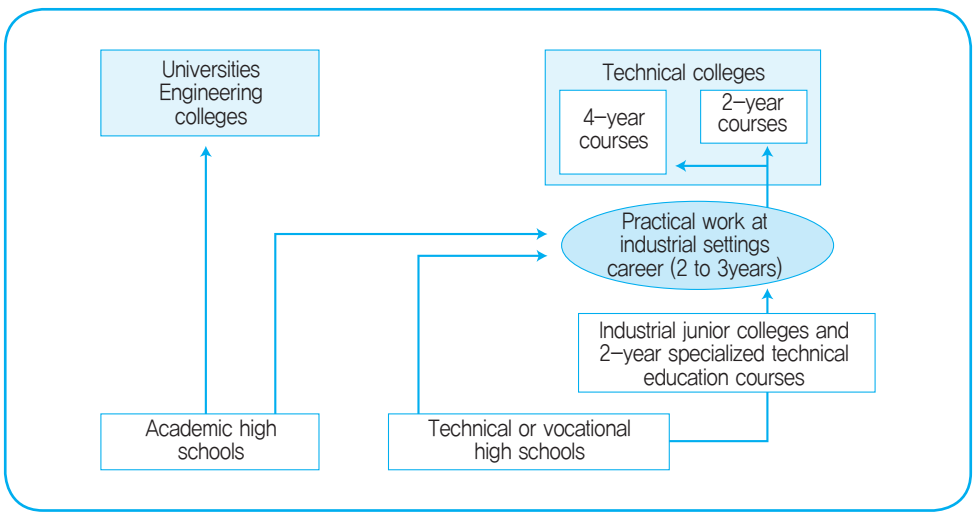
However, all the teaching staff and students gathered together to overcome these difficulties with the will to develop into the best engineering university, and afterwards, the educational environment was gradually improved.

In 1990, a general review was conducted for the educational methods following changes of conditions such as the decrease of technical high school graduates and fall in scholastic

ability. It was necessary to vitalize the technical education that had produced the technical and skilled manpower, which is the main axis of industry, and to introduce the system nurturing the professional manpower of middle standing with technical bachelor degrees or more that would lead the technical innovation in the industrial settings. Also, it was critical to introduce a new technical educational system to actively collect the latest technical changes and to thereby build the dual ladder technical educational system as in advanced countries so that it can lead the industrial development.

Korea Polytechnic University came to push on with the dual ladder educational system in the early stages in order to conduct continuing education by connecting the vocational educational institutions as the highest educational institution of the vocational educational system, centering on technologies that nurture technologists who possess technical logic and creative practical ability in order to supplement the existing technical educational system and to leap forward to become an advanced industrial country.

Figure 2-5 | Concept of Dual System



In addition, Korea Polytechnic University made preparations to take on an aspect of a university and to continuously develop by additionally purchasing the site for establishment of the Technical Business Incubator for industrial-educational cooperation in difficult financial situations and constructing educational facilities, and ensuring the internal stability of education and enacting various regulations.

3.2 Period of Growth

After the financial crisis, in the late of 1999, Korea started to overcome the difficulties to some degree and to recover international creditworthiness, and as the door to the enormous Chinese market was expanded, Korea came to feel the consciousness of the crisis together with the opportunity of new industrial growth. Therefore, in this period, Korea oriented itself toward an internally stable education in order to cope with and adapt to the external environment and started national investment to enter the knowledge-based society for the creation of new added values with more creative and practical education.

At that time, Korea came to face the period of growth in which the policies giving many changes and vitality to university organizations were starting to be promoted in order to deal with internal and external environmental changes. This period can be described as a period in which Korea Polytechnic University expanded and grew to accomplish the final purpose, which is to be the 'best prestigious university in industrial technologies.'

First, the professors vigorously conducted external cooperation and research activities, and through these activities, internal and external polices were actively pushed on with and thus the external awareness of the university was enhanced and visible outcomes started to appear across all the sectors of the university. This came to play the role of driving force for the university to develop.

3.3.1 Changes of Educational System

One of the most important changes of system in Korea Polytechnic University is the change from a 4-semester system into a 2-semester system. In the early days of establishment, the university chose the 4-semester system as a method to pursue the flexibility of allocation of subjects in which various experiments and practice subjects can be allotted and to attempt the technical major system for the higher graders who have completed the basic subjects when they were newer students, utilizing the characteristic of the 4-semester system through which it is easy to establish many subjects.

However, there was no solid basic education, and thus the intense learning effects in the short period of time were low, and students had to learn a great amount of content in a short time, and thus the degree of understanding of students decreased. Also, in reality, the engineering education that requires long-term patience and a lot of technical experience could not be sufficiently accomplished.

Therefore, Korea Polytechnic University changed the system into a 2-semester system centering on the learning by students themselves and on-the-spot experiences through partner companies by encouraging extracurricular activities not teaching many subjects in a short time. The university also changed the entrance screening system in order to secure the effectiveness of changes of educational system and to nurture high-class technical manpower and to thereby increase the competitive edge of businesses.

In order to provide high-level educational conditions to the students following these changes to the educational system, the professors actively participated in research activities through industrial-educational cooperation, and the students also participated in the projects through industrial-educational cooperation of the professors and thereby could cultivate practical technologies and creativity.

3.3.2 Expansion and Development of Industrial-Educational Cooperation

Another chance for Korea Polytechnic University to fulfill an eye-opening progress is the R&D by industrial-educational cooperation. In the early stage in 1998, the research funds per professor were only 6.60 million won, but, in 2001, the research funds per professor were 37.95 million won and ranked as No. 5, following KAIST and Seoul National University among the 4-year-course universities across the nation. This was an index that clearly shows the R&D capabilities of Korea Polytechnic University.

Since 2000, in order to more smoothly promote industrial-educational cooperation, the university set up the industrial technology CEO course and the CEO informatization course for which the CEOs of nearby businesses were invited, and pushed forward work agreements and academic exchanges with distinguished institutions in Korea. It also expanded the partner companies which are the largest driver of industrial-educational cooperation and ensured the internal stability of operation, and thus the university came to enjoy the outcome of today.

In the early stage, the professors visited the enterprises in Ansan and Sihwa Industrial Complexes to conduct development tasks in industrial-educational cooperation, but recently, increasingly many businesses in nearby industrial complexes or partner companies are requesting industrial-educational cooperation. In addition, it was also a fruit of industrial-educational cooperation that Korea Polytechnic University could actively participate in government businesses together with partner companies, and the scholarship supported by partner companies also played an important role in increasing the ratio of receiving scholarship to an epoch-making extent.

Afterwards, the university established the Industrial-Educational Cooperation Center for the more positive industrial-educational cooperation and also established two research institutes (Nano-TIC, Siheung Environmental Technology Development Center) and two affiliates (Remote Technology Support Center, Technical Business Incubator).

3.3 Period of Takeoff

The outcome of the period from the late 2000s until now is the arrangement of the system of a new concept integrating the educational system and industrial-educational cooperation through the Techno Innovation Park above all. In order to systematically support the technical development of SMEs in nearby industrial complexes, Korea Polytechnic

University came to conduct an industrial-educational cooperation business of a new concept in which professors, students and technical manpower of enterprises participate and conduct R&D in the same space, and Techno Innovation Park (TIP) was built in Korea Polytechnic University. Inside TIP, an individual Engineering House, a dormitory which is open for 24 hours for the industrial-educational cooperation researches, a guesthouse and so on are located, and thereby are increasing the efficiency of research activities.

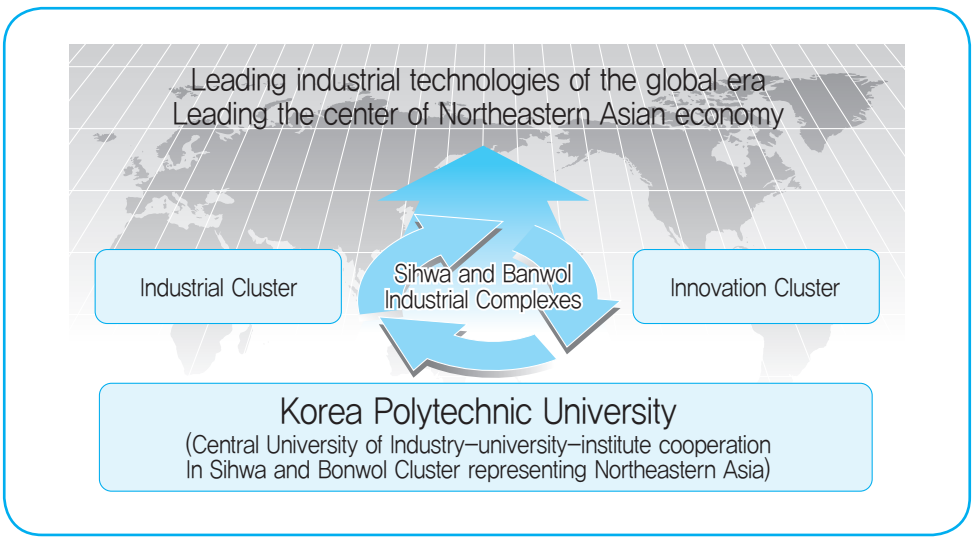
Thanks to the activities of the Engineering House, the results of industrial-educational cooperation came to increase to a great extent, and students are making many results of industrial-educational cooperation and employment through on-the-spot experiences.

The university is intensifying international exchanges with famous universities in the world by establishing the international cooperation team, and thereby is providing broad opportunities for education to students.

Korea Polytechnic University aims to nurture the practical professional technical manpower with superior ability to adapt to industrial settings, and has been promoting by establishing the following directions of development in order to grow as a global professional technical educational institution by playing the role of the highest university of the vocational technical educational institutions realizing the ideology of lifelong education of technicians as a demonstration institution that develops the dual ladder national technical educational system.

Korea Polytechnic University orients itself to the traditional identity of ‘polytechnic university’ and the university characterized for industrial-educational cooperation and pushes ahead Industrial Park in which enterprises, professors and students are mixed together on-campus, and has the ‘top university in the (industrial-educational cooperation) cluster in Northeast Asia’ as the vision for development on the basis of the Sihwa and Banwol Innovation Cluster.

Figure 2-6 | Vision of Medium and Long-term Development of Korea Polytechnic University



The characterization program of the 'new industrial-educational unified engineering education' is the core process of practice of the medium and long-term development plan of Korea Polytechnic University, and this program is a practical task that can materialize the three major tasks of the medium and long-term development plan of the university (nurture of creative professional talents, materialization of the industrial-educational cooperation system and the university centering on users).

In order to build the software infrastructure of this characterization program of Korea Polytechnic University, it is implementing the Engineering House system in which the partner companies participate and develop the technologies of commercialization together, and TIP was completed in January 2007 for the construction of hardware infrastructure.

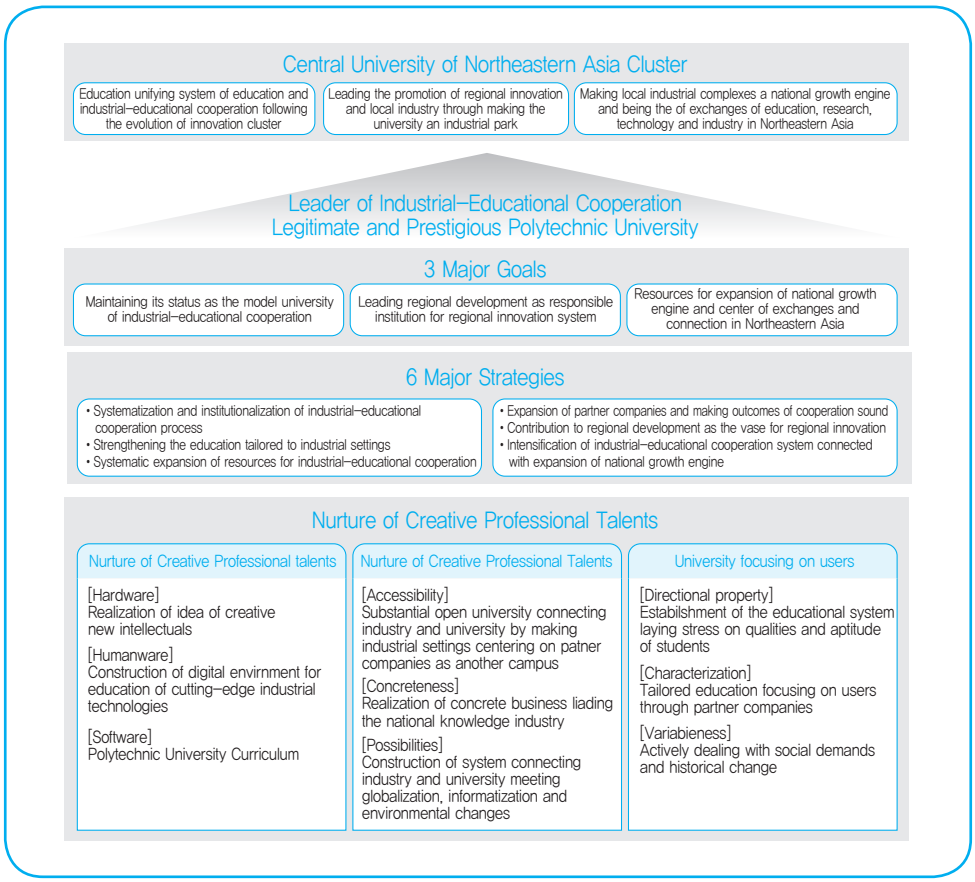
The university is attempting the development into the central university of the cluster of Northeast Asia by leading the technical innovation of the industrial complex cluster participating in the innovation cluster business of Sihwa and Banwol regions.

Korea Polytechnic University is opening a new paradigm of engineering education centering on the field by increasing the degree of completion of the original polytechnic course through the characterization program of the new industrial-educational unified engineering education program and establishing the practical educational system.

In addition, it has the vision to strengthen the ability of international industrial-educational cooperation as the central university of the regional technical innovation cluster following the flow of internationalization and to develop into a central university of nurture of manpower with international industrial-educational cooperation that intensifies the

ability of international technical cooperation of SMEs through the nurture of professional engineers with international practical work ability.

Figure 2-7 | Roadmap of Medium and Long-term Development of Korea Polytechnic University



The educational system with industrial-educational cooperation of Korea Polytechnic University will improve the ability to provide the tailored new engineering manpower with the ability in the field to businesses, and the nurture of future-oriented manpower based on technology convergence will enable the university to play the role of the center of the industrial technical cluster of Northeast Asia by providing the basis for national growth engine and supporting the strengthening of competitive edge of the SMEs in the Sihwa and Banwol National Industrial Complexes.

This characterization of the basis for the new industrial-educational unified engineering educational system of Korea Polytechnic University in which enterprises, students and

the university participate together for the single goal of the 'development of industrial technologies of Republic of Korea' is expected to enable Korea Polytechnic University to grow as the central university of the industrial technical cluster of Northeast Asia by playing the role of achieving the goals of characterization of the university intending to construct the supporting system for local SMEs and to constantly push ahead with the nurture of professional manpower and also by nurturing the manpower with creative and international ability in the global era of the 21st century.

2011 Modularization of Korea's Development Experience
Technical Engineering Education Model of
Korea Polytechnic University (KPU)

Chapter 3

Implementation

1. Academic System Nurturing Technical Manpower Tailored to Industrial Settings
2. Characterization of Industrial-Educational Cooperation of Korea Polytechnic University
3. Core Model of Industrial-Educational Cooperation of Korea Polytechnic University

Implementation

Korea Polytechnic University has constantly developed the tailored educational system in which businesses directly participate in order to meet the demands of SMEs for nurturing manpower for the field.

As a result, the university is running the Engineering House in which professors, students and enterprises conduct education, research and industrial-educational cooperation in the same space, and the university has started the industrial-educational unified nurture of new engineering manpower on the basis of that.

As the TIP was completed and the internal stability of educational system for nurturing industrial technical manpower tailored to the field based on Engineering House is ensured, the university has enhanced the technical skills of local businesses and has dealt with the demand for manpower needed for that. In particular, the university has built the system of Engineering House based on technology convergence that will be needed for local businesses from now on and has nurtured future-oriented talents by educating through developing related educational content.

In addition, Korea Polytechnic University has grasped international technical changes and nurtured the technical manpower with the ability to push ahead with technical cooperation with diverse foreign institutions so that SMEs can carry forward the internationalization of technologies following the globalization of industry.

1. Academic System Nurturing Technical Manpower Tailored to Industrial Settings

Korea Polytechnic is constructing the industrial-educational unified professor-student-business cooperation system for making use of the location at the center of Banwol, Sihwa and Namdong National Industrial Complexes. In the professor sector, the university

mitigates the system of obligatory class hours and motivates the professors for industrial-educational cooperation through evaluation of results of industrial-educational cooperation and special treatment in personnel matters. In the student sector, the university boosts the outcomes of close connections between education and employment ultimately by executing curricula that are closely related to industrial settings such as the system of obligatory credit for field practice, the system of graduation project and so on, the formation of tailored curriculum meeting the demand of the field of enterprises and so on. Businesses have the cooperation system such as education of officers and employees, joint development of technologies, adjunct professor activities, and evaluation of students in field practice, donation of scholarship of partner companies, employment of excellent manpower and so on by participating in partner companies.

Korea Polytechnic University is strengthening the characterization of education for the nurture of technical manpower tailored to industrial settings on the basis of this industrial-educational cooperation system, and has introduced the 'characterized major system' since the curriculum of the year 2000 under the purpose of establishment of the 'nurture of high-class technical manpower with broad knowledge and practical ability on the basis of theories and field trips that can accord with the demands of the rapidly changing industrial world' and has completed the 'curriculum tailored to users' through the reorganization of the 2nd curriculum in October 2000 and has been applying it since 2001.

The university has the 11 undergraduate departments (machinery, machine design, mechatronics, electronics, computer, game, new materials, life chemistry, industrial design, e-business, and nano-optical) specialized into the engineering and supporting service departments, the Graduate School of Industrial Technology & Management and the Graduate School of Knowledge-based Technology & Energy as the educational basis. The university has secured professors with work experience of 5 years or longer in business, engineers working in businesses and adjunct professors with the qualification of researchers of research institutes such as Engineering House and so on as the manpower supporting R&D.

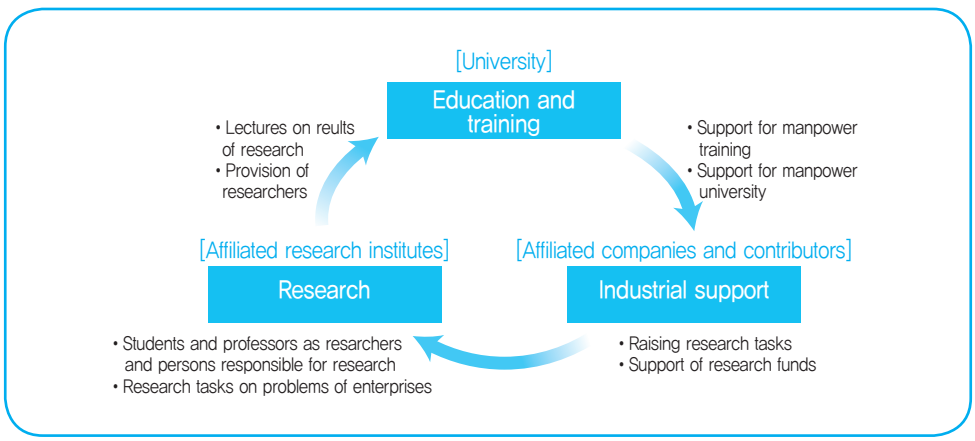
1.1 Characterization of Education through Industrial-Educational Cooperation

The plans for characterization of education of Korea Polytechnic University are largely 1) unified education connecting industry-university-institute, 2) strengthening of computer education that can lead the era of informatization, 3) intensification of foreign language education for globalization and advancement of technologies, 4) promotion of the system of technical specialist in enterprises after graduation, 5) training of cutting-edge technologies and development of textbooks by professors and 6) operation of characterized academic system.

First, the unified education connecting Industry-University-Institute:

It is the education in which universities, enterprises and institutes participate together and conduct research by selecting the subject of research and share and put the results to practical use and train the professional technical skills and manpower of universities and institutes in the early stage.

Figure 3-1 | Education through Industry-University-Institute Collaboration of Korea Polytechnic University



Second, strengthening of computer education that can lead the informatization era:

It is the education that intensifies computer education and thereby strengthens the ability to utilize ICT in the field in the early stage in order to deal with the rapidly changing flow of industrial technologies and to nurture the quality technical manpower through putting ICT into the manufacturing industry.

Third, strengthening of foreign language education for globalization and advancement of technologies:

It is the education that teaches foreign languages in 2 stages and conducts the education of practical conversation mainly for lower graders and strengthens the education of Technical Spec and Technical Writing for higher graders. It establishes language labs with multimedia and nurtures global technical talents that can support the advance of the industrial world based on regions and the business of global companies with the industrial world within the region through making the passage of language tests such as TOEIC an obligation as the requisite for graduation.

Fourth, promotion of the system of enterprise technical specialist after graduation:

It is the education that grants the qualification of 'enterprise technical specialist' which is similar to the medical specialist in hospitals to those who go through the kind of 'resident' course in which the students are employed by businesses on the basis of their ability

accumulated through basics, major, enterprise internship and the system of graduation project during university years and thereby experience the process of the design for new products and manufacturing process, manufacture, production and commercialization under the directions of the academic adviser.

Fifth, training of cutting-edge technologies and development of textbooks by professors:

It is the education that collects the data about curriculum of theories, experiments and practice, internship, the system of graduation project and so on through the training in cutting-edge industrial settings of each major field and the fields of practical education at home and abroad (Fachhochschule in Germany, Polytechnic University of Japan, the sandwich system of the U.K. and so on) and that makes trial textbooks and uses them.

In order to run these curricula, the university is operating an academic system which is different from those of general universities and open universities (industrial universities).

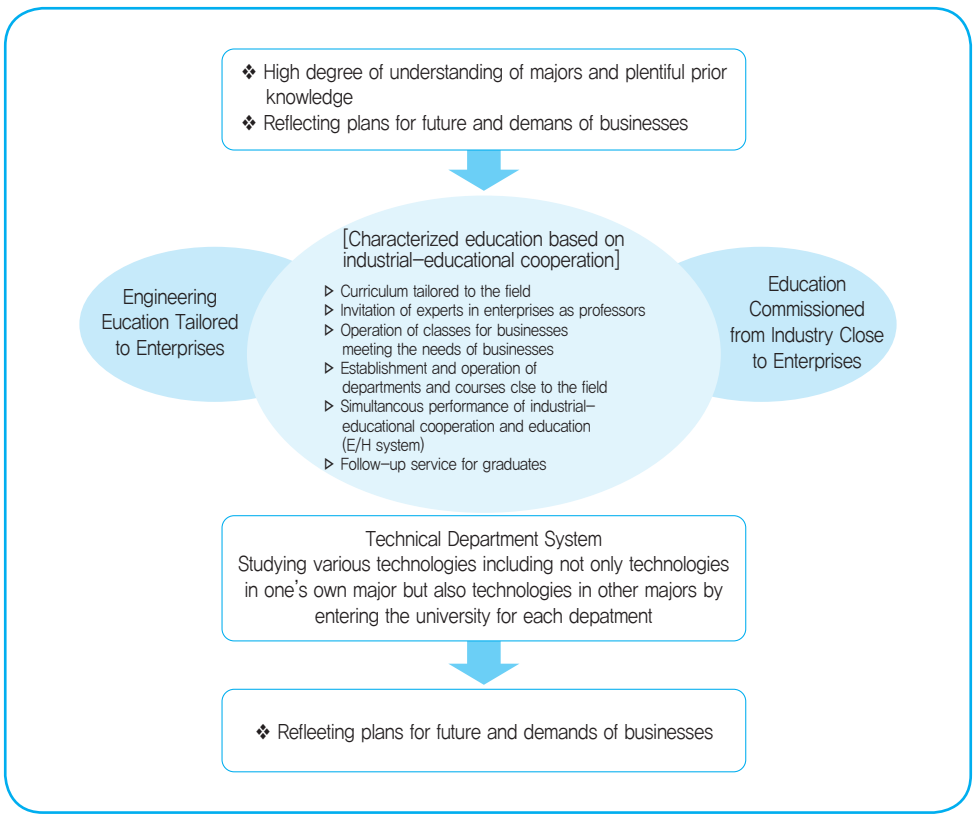
- Selection of students: Selection through student records, interviews and so on without reflecting the scholastic ability tests with technical high school graduates and those with careers in businesses
- 2- to 4-semester system: Introduction of the 4-semester system in order to minimize the loss of classes and the number of subjects completed per semester and to thereby concentrate the curriculum
- Utilization of professors with experiences in businesses: Employment of experts in each field with work experience in businesses and realization of the ideology of practical education
- Module curriculum on demand: Operation of learning programs in the shape of module (group of related technologies) following the orders of businesses
- Assistance for start-up with technologies by professors and students: Establishment of subjects related to start-up and support for start-up of tasks of graduation project for the technical start-up (venture companies) of professors and students to be possible

Korea Polytechnic University has presented the vision of “the best prestigious industrial technical University” since its opening and has developed as the central university for industrial-educational cooperation through the efforts to build the basis for industrial-educational cooperation.

The university has officially launched the partner company system as the system for organic and lasting industrial-educational cooperation with local businesses, and now has about 3,500 partner companies. The partner companies have been playing the core role for the composition of the educational system by participating in Engineering House. The university has oriented the curriculum tailored to users through reflecting the demands of businesses by examining it every year on the basis of industrial-educational cooperation and at the same time conducting an active job analysis.

Korea Polytechnic University has continuously developed and ensured the internal stability of diverse curricula centering on the field such as project practice, project research, graduation research, creative engineering education and so on.

Figure 3-2 | Model of Technical Department System of Korea Polytechnic University



1.2 Development and Operation of Curriculum Tailored to Businesses

1.2.1 Background of Introduction

a. Introduction of curriculum tailored to businesses:

- Consideration of the industrial structure and directions of development of local communities and progressive acceptance of the opinions of businesses and related institutions

- Deliberation of the plan to accept the hybrid technology not bound to the classical framework of studies

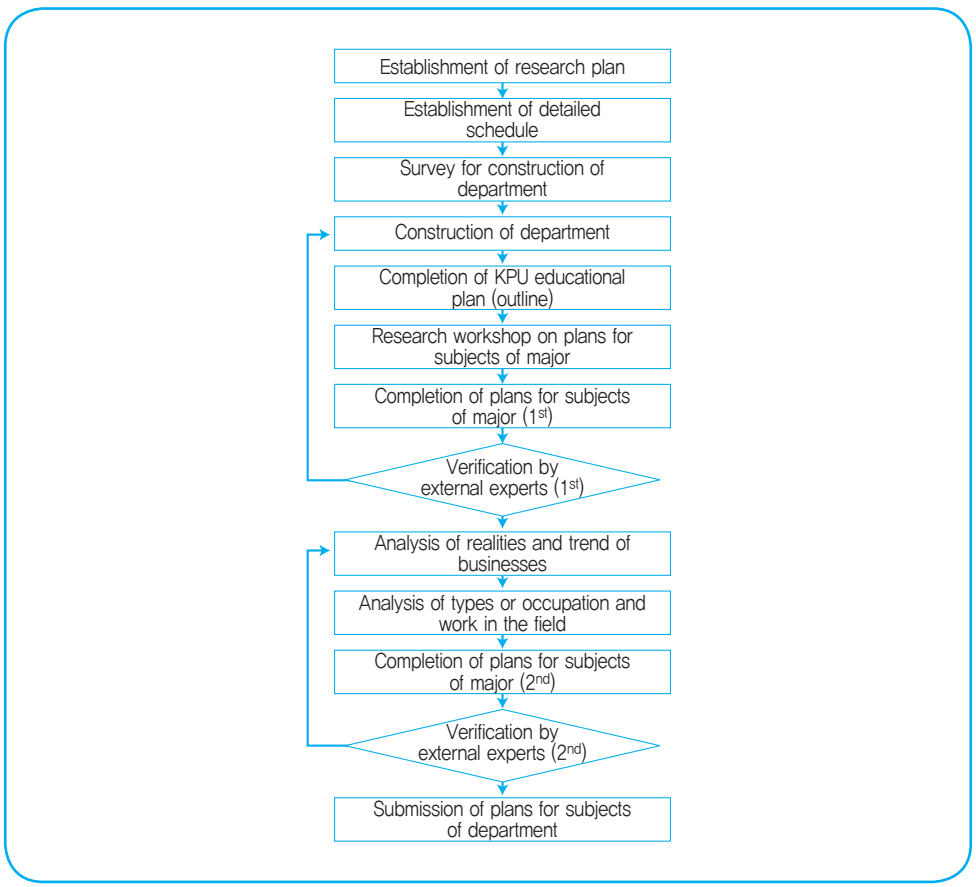
- Reception of not only the subjects of academic areas but also the subjects based on experiential technologies

b. Introduction of the major curriculum for each industrial technology:

- Necessity of concentration of the range of subjects demanded by businesses together with presentation of various subjects
- Presentation of the subject that can complete the major technology in one range and easy grasp of the connection of technologies between subjects
- Presentation of the standard completion model needed for completion of the pertinent major

1.2.2 Order of Development of Curriculum

Figure 3-3 | Order of Development of Curriculum Tailored to Businesses



1.3 Strengthening of Connection between Industry and University and Distributive Education

1.3.1 Field Practice

a. Definitions:

- Technical practice in the field in which students conduct practice of application of technologies in person, in industrial settings, to put the technologies they learned in school into the industrial settings

b. Purposes:

- To apply the learned technologies in the field and to thereby let the students master the technologies and know which technology he or she lacks
- To cultivate the ability to apply the learned technologies in the field
- To create opportunities to learn new technologies of the industrial settings
- It is the period of preliminary examination of graduation projects conducted in the 1st and 2nd semester of the 4th year

c. Goals:

- To let students experience theories and practical work about their major field
- To cultivate the ability to grasp and analyze the problems occurring in the field of businesses and to solve them academically

Table 3-1 | Methods of Performance of Field Practice

Semester	Professors, students, enterprises	
4th semester of 3rd year	① Request for field practice (professor→enterprise) ② Notification of whether field practice is possible or not (professor←enterprise) ③ Display of list of enterprises (professor→student) ④ Selection of enterprise after interview (professor←student) ⑤ Consultation on contents of practice/decision on enterprise (professor←student) ⑥ Notification of field practice (professor→enterprise) ⑦ Reply of agreement (professor←enterprise) ⑧ Notification of decision on enterprise (professor→student)	
1st semester of 4th year	⑨ Report to enterprise /consultation on work (student→enterprise) ⑩ Submission of the plan for practice (professor←student) ⑪ Consultation on modification of plan (professor→student) ⑫ Consultation on modification (student↔enterprise) ⑬ Resubmission of the plan for practice (professor←student) ⑭ Submission of daily report (professor←student) ⑮ Submission of interim report (when half has passed) (professor←student) ⑯ Submission of final report (professor←student) ⑰ Evaluation by enterprise (professor←enterprise) ⑱ Official document of appreciation (professor→enterprise)	
	※ Furnishing of report ※ Introduction of recall system	※Ratio of evaluation Report 70% Evaluation by enterprise: 30%

1.3.2 Graduation Project

a. Definitions

- Making and presentation of a product suited to one's major field in order to apply the field technologies learned at the university and through field practice and to thereby establish the technologies as one's own.

b. Purposes

- To let students directly perform the entire process from discovery of tasks and design through completion of trial product on the basis of the knowledge learned until the 3rd year and experiential technologies earned in the field practice.
- To comprehensively realize the learned technologies and to cultivate practical technologies.

c. Methods of performance

- Graduation projects are selected by the students together with the adviser first and the tasks are selected by the Committee Directing Graduation Project by the announced standards.
- Students frame the daily report on their graduation project every day and obtain the confirmation of their professors.
- Students plan to share technologies through seminars in teams frequently during the performance of graduation project.
- When the graduation project is completed, the final presentation is held, and the Committee Directing Graduation Project makes the final evaluation on graduation projects. The main elements of evaluation are the agreement of contents with the name of graduation project, practicality, the degree of learning the technologies and so on, and a grade is granted by calculating the total points by placing weighted value on each item.

2. Characterization of Industrial-Educational Cooperation of Korea Polytechnic University

2.1 Promotion of Program of Characterization of Industrial-Educational Cooperation Following Regional Backgrounds

Many of the types of businesses in the West Coastal industrial complex areas where Korea Polytechnic University is located are machinery, metals and chemistry, and in particular, businesses related to production such as molding, casting, heat treatment, surface treatment and so on-types of businesses causing environmental pollution-are concentrated. It can be said that it is desirable to support the research and technologies of production basis technology, production automation technology and so on with focus on the field rather than the research function oriented to cutting-edge technologies of nearby other universities for the actual technical support for the businesses in neighboring in trial complexes that are SMEs.

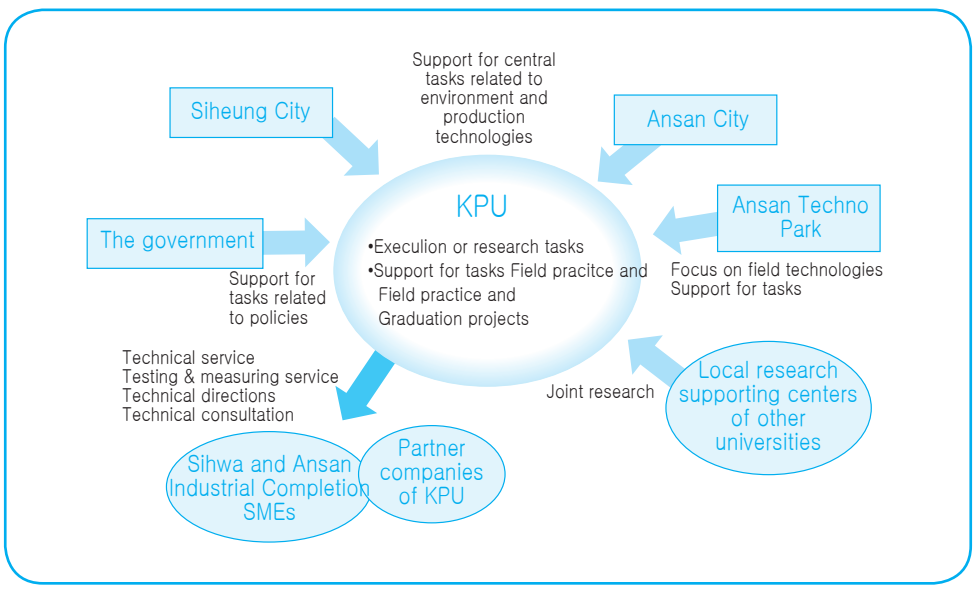
Sihwa Seawall, near the industrial complex where the university is located, is being ceaselessly polluted due to the types of business in the industrial complex and is thereby checking the surrounding living environment and the government and local governments were bent on the countermeasures. It was necessary to strengthen the cooperation system with the government and local governments through aggressive supporting activities such as countermeasures for pollution of Sihwa Lake, removal of the cause of environmental pollution of businesses in the industrial complexes.

In addition, as the internal factors of Korea Polytechnic University, it was necessary to develop and support various businesses of technical support such as technical directions,

consultation and so on for the vitalization of partner company system and to conduct an organic industrial-educational cooperation program such as cooperation with the field practice of students, support for start-up of graduates and so on. In view of the intent of establishment of Korea Polytechnic University reflecting the role to support SMEs, it can be said that it was necessary to intensify the tie with local businesses in industrial complexes through supporting systematic services such as the experiments, measuring using the equipment the university possesses and so on for the university to settle down.

Finally, the program of characterization of industrial-educational cooperation of Korea Polytechnic University was needed for the enhancement of the ability of research of the professors of the university and for the lasting development such as joint research with local businesses and so on.

Figure 3-4 | Role of Korea Polytechnic University in Industrial-Educational Cooperation



2.2 Directions and Program of Characterization of Industrial-Educational Cooperation

Korea Polytechnic University has put forth great efforts to realize the ideology of industrial-educational cooperation and the founding ideology of positivistic method as it stretched itself as the central university for industrial-educational cooperation, and has strengthened the system supporting local businesses by developing research on university education and enterprise activities into industrial-educational cooperation in order to specialize itself for the materialization and systematization of the efforts.

As the basic policies for this, first, the university is sharing roles with the nearby universities supporting cutting-edge technologies and is substantially supporting the businesses in the industrial complexes of the type of SMEs appropriate to the characteristics of Korea Polytechnic University for the intensive backup for the research and technologies of the field of bottleneck technologies, centering on the SMEs in the industrial complexes.

Second, the university has been pushing forward a program of industrial-educational cooperation by cooperating with the government for the technical field which is the most urgently needed by the local SMEs such as the field of production basis technology, the field of automation and so on in order to specialize its function of support for research and technologies for each field, and is promoting an industrial-educational cooperation program for the field of environmental technologies, close measuring, the field of test and inspection services and so on by working together with local governments.

Third, the university is discovering and promoting the business of technical support for the vitalization and settlement of the partner company system by unifying the system supporting the university's businesses and conducting joint research with enterprises, and is developing constant supporting plans so that the business can be institutionally settled for the partner companies to actually feel the effects of support.

The system of characterization of industrial-educational cooperation of Korea Polytechnic University aims to add much to the improvement of national technical competitive edge by nurturing professional technicians and technical experts of middle standing with strong ability to adapt to the field needed by the industrial world.

Therefore, Korea Polytechnic University has established and is running the system of characterization of industrial-educational cooperation, differentiated from other universities as follows:

- The university has the system to give better treatment to those who have worked in the industrial settings for 5 years or longer and to calculate the career in industrial settings when employing professors; and, the system to make the ratio of industrial-educational cooperation results as 50% or more in the evaluation of performance such as that for promotion of professors and so on and the performance-related pay system.
- The university is administering the systems such as the formation of subjects tailored to users reflecting the results of research on demands through partner companies and so on, obligatory credit for practice in industrial settings, a system to give credit for participation in project researches, obligatory submission of graduation project, operation of the class for education commissioned to businesses and so on.
- The university has introduced the concept of Engineering House as a differential infrastructure system of industrial-educational cooperation. E/H (Engineering House) means to let all the research institutes, laboratories and university equipment be used by professors, enterprises and students as the space for joint research and education.

One of the main institutions of Korea Polytechnic University characterizing industrial-educational cooperation is the process establishing the vision, making medium and long-term plans, collecting the opinions of members and concentrating the ability of promotion.

Table 3-2 | System for Characterization of Industrial-Educational Cooperation

Sector	Main outcomes
Partner company system	○ System of professor in exclusive charge, ○ Discount of 50% for experimental equipments, ○ Better treatment for workers applying for entrance, ○ Directions and development of technologies and so on ○ The meeting for transfer and exchange of technologies, ○ Scholarship of partner companies and participation in E/H
Employment of professors	○ Full-time teachers: Those with 5 years' or more work experience, calculation of career in industrial settings and results of performance of tasks in industrial-educational cooperation ○ Adjunct teachers: Those with field technologies in businesses
Evaluation of achievements of professors	○ Mitigation of application of the system of responsible class hours ○ Importance on the operation of partner companies with results of research tasks in industrial-educational cooperation, overhead incentives and so on
Educational system	○ Formation of subjects tailored to industrial-educational cooperation (research on demands), ○ Obligatory credit for field practice (8 credits) ○ Participation in the tasks of industrial-educational cooperation (1 credit per semester), ○ Obligatory submission of graduation projects in industrial-educational cooperation ○ Operation of the class for workers commissioned from the field, ○ Technical reeducation for workers and follow-up services for graduates ○ Formation and operation of the E/H curriculum, ○ ITP
E/H systems	○ Utilization of the research institutes, laboratories, personal research centers of professors and so on as the infrastructure for technical innovation and commercialization in industrial-educational cooperation
Online industrial-educational cooperation	○ Provision of the latest technical information, policy information and so on at the Website of the university

Sector	Main outcomes
Vision and consensus	○ Establishment and implementation of the medium- and long-term development plan for characterization of the university in industrial-educational cooperation, ○ Establishment and execution of the medium- and long-term development plan for each department, ○ Workshops for all the teaching staff and so on

2.3 Infrastructure of Industrial-Educational Cooperation for Realization of New Industrial-Educational Unified Engineering Education

2.3.1 Techno Innovation Park (TIP)

Techno Innovation Park means the supporting space and system (Engineering House, dorms and convenient facilities) to build the industrial-educational cooperation network by considering the strategic industry of each region and the strategy of nurture of the regional industries of Korea and to nurture manpower through industrial-educational cooperation.

TIP is a cutting-edge complex for industrial-educational cooperation and technical innovation established to strengthen the function of industrial-educational cooperation of Korea Polytechnic University and to realize the education focusing on the field by connecting itself to the dorm with E/H, which is the core space for industrial-educational cooperation, as the center and letting the technical development of SMEs and the engineering education be conducted for 24 hours a day.

a. The main functions of TIP are as follows:

- Construction and operation of the network for the expansion of exchanges between enterprises and the university.
- Support for commercialization, technical development, high-class manpower and equipments of SMEs centering on "Engineering House," which is the space for joint research of enterprises and the university.
- Learning close to the field for 24 hours a day by the participation of students in the joint research projects of departments of the university and enterprises such as graduation projects, project practices, project research and so on as the education in industrial-educational cooperation.

2.3.2 Technical Business Incubator (TBI)

The functions of TBI of Korea Polytechnic University are support for spaces, technologies and patents of enterprises, support for manufacture of trial products, management

consulting, support for publicity, financing, mediation and support for consulting and seminars on general management of start-ups for the effective support for those preparing start-ups and those newly beginning start-ups on the basis of the knowledge, technologies and information possessed by the university.

Currently, there are 23 enterprises located in TBI, and they have 139 employees and are achieving gross sales of 14.7 billion won.

Those enterprises in Korea Polytechnic University's TBI are receiving not only the technical support needed for start-up but also the support for entire technical operations such as operation of enterprises, management, accounting, marketing and so on needed to grow further.

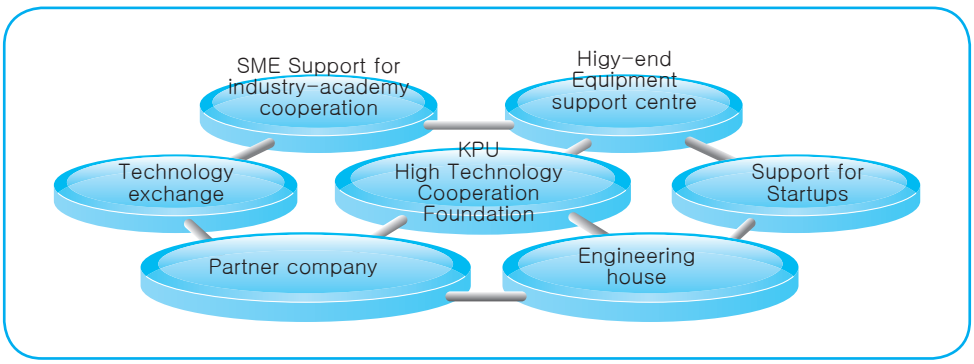
This support from TBI has produced 31 robust technical enterprises to date, and TBI is being evaluated as having played the role of a huge support for the growth of start-ups through the organic connection between professors, students and enterprises.

2.3.3 High Technology Cooperation Foundation

Korea Polytechnic University is not only running diverse industrial-educational cooperation programs for the technical innovation of Sihwa and Banwol Industrial Complexes but also has established and is administering the High Technology Cooperation Foundation to actively cope with rapid technical changes and to support practical high-class technical manpower and enterprises.

The High Technology Cooperation Foundation has been fulfilling a variety of businesses of education in industrial-educational cooperation and support for enterprises in order to double the values of industrial-educational cooperation and to emerge as the central university in international industrial-educational cooperation; its vision is leading industrial-educational cooperation at a global level.

Figure 3-5 | Directions of Operation of High Technology Cooperation Foundation



2.3.4 Siheung Environmental Technology Development Center

The Sihwa Banwol region, located along the western coast, has about 8,000 enterprises located there, and among these enterprises, about 2,000 enterprises are emitting air pollutants. The residents living near the industrial complex are directly or indirectly exposed to bad smells and various pollutants because mainly westerlies or southeaster winds blow along the coastal areas.

Siheung Environmental Technology Development Center was established by being designated by the Ministry of Environment in July 2000 according to the provisions of the Act on Environmental Technology Development and Support in order to create a pleasant environment and to solve the substantial problem of bad smells as the pivot for solutions to these regional environmental issues. The center has composed and is operating a consortium that can settle the demands of residents and environmental issues for itself with the system of cooperation between enterprises, research institutes, civic groups and local governments with Korea Polytechnic University as the supervisor.

Siheung Environmental Technology Development Center was established for the purpose of solving the environmental problems of the Sihwa Banwol region and to develop, disseminate and spread environmental technologies and the latest fusion cutting-edge technologies through the construction of the cooperation system between industry, university, institute, government and residents. Afterwards, the center has been in charge of environmental policies, environmental technologies, execution of polls on environment, plans of solution of environmental problems, nurture of manpower specializing in environmental technologies, environmental industries related to the solution of the issue of bad smells and nurture of environmental venture companies by composing a consortium with KITECH, Korea Testing Laboratory, Korea Institute of Energy Research and so on, and is conducting the environmental influence evaluation and the designation and evaluation of new technologies as an official environment analyzing institution.

Up until now, the center has been conducting research on environmental policies for the solution of current issues within the Sihwa Banwol region, the Environmental Home Doctor for each enterprise, the examination and support of environmental facilities of enterprises and solution to difficulties for the SMEs lacking the ability to manage environment and letting enterprises properly treat and reduce environmental pollution in the course of production activities so that the competitive edge of the enterprises can be cultivated, thereby rendering services to the economic benefits following the improvement of air pollution of enterprises and the social development following the improvement of environment of the region.

2.3.5 Korea-Russia Industrial Technical Cooperation Center

The Korea-Russia Industrial Technical Cooperation Center was established in 2004 when the competitive edge of products was threatened due to global deindustrialization following the leak of domestic production technologies and transfer of production facilities to prevent deindustrialization, and to maximize the international competitiveness by playing the role of a medium putting the cutting-edge basis technologies of former Soviet Union regions such as Russia, CIS and so on into the commercialization of Korean enterprises.

The center has been systematically collecting and analyzing the industrial technical information of Korea, Russia and CIS by constructing the industry-university-institute cooperation system inside the engineering complex and thereby striving for efficient industrial technical cooperation with Russia and CIS.

Since 2005, the center has been conducting support for systematic introduction of technologies such as the support for network for technical cooperation between the partner companies and Eurasia, consulting for international technical cooperation and so on through the support of the business of nurture of central universities in industrial-educational cooperation, which is supervised by the Ministry of Commerce, Industry and Energy and the Ministry of Education. In addition, the center is providing the technical information desired by enterprises by systematically building the technology DB in connection with the local offices in the Eurasia region including Moscow and Central Asia and is supporting the construction of a systematic cooperation system to the stage of commercialization of introduced technologies such as joint technical development, transfer of technologies and so on through the technology briefing sessions and dispatch of cooperation groups.

3. Core Model of Industrial-Educational Cooperation of Korea Polytechnic University

3.1 EH: Engineering House

3.1.1 Concept

Engineering House is the system in which the nurture of practical technical manpower and joint research of businesses are done together by conducting the development of technologies of businesses and the educational activities of university in the same space inside the university.

Korea Polytechnic University has introduced an industrial-educational unified research and educational system that produces practical technical manpower under the smooth connection and cooperation between enterprises, university and research institutes by way of showing an example since the 2nd semester in 2003 to strengthen the on-the-spot experience education of undergraduate education, and this is Engineering House.

The Engineering House system opens all the laboratory facilities, research centers and cooperative research institutes excluding the basic laboratories of the university and lets researchers of enterprises, professors and students jointly participate in the technical innovation and development of products of enterprises. It has the advantage that enterprises can maximize product-development performance and the university can cultivate practical research abilities and strengthen the education centering on the field.

The existing college education system is conducted by dividing the education of theories and practice over the 4 school years, but the Engineering House educational system is a new system that lets the undergraduate 1st- and 2nd-year students receive basic major education and the 3rd- and 4th-year students receive detailed major education centering on the field, similar to graduate school courses.

Engineering House, viewed as a spatial and substantial concept, is complexly naming the educational centers for the detailed majors that the undergraduate 3rd- and 4th-year students of each department should learn intensively and the future-oriented cooperative research institutes. In particular, at least one enterprise must participate in Engineering House, and two to three responsible professors and participating professors operate one Engineering House together.

3.1.2 Necessity of New Engineering Education through EH

The existing education of engineering colleges in Korea centers on graduate schools, large enterprises and theories, and it was required to introduce an industrial-educational unified educational system to effectively deal with the supply of technical manpower needed for technical innovation and expansion of foundation for development of SMEs.

Therefore, a system of engineering education of a new concept was needed, and the 'education and R&D system harmonizing enterprises in universities' such as Engineering House is being evaluated as a good alternative.

Engineering House is an education based on a new concept in which the development of products of enterprises and education of students are conducted at the same time in the same space inside university, and the education is conducted following the curriculum of Engineering House, and at the same time the cooperative research institutes inside Engineering House where the development of products of enterprises is conducted are contributing much to the education of practical work in the field.

As a result of active industrial-educational cooperation, Korea Polytechnic University achieved the outcome that the scholarship of partner companies has increased constantly since 2004 and was connected to employment. This is a good indicator of much interest and participation of enterprises in the Engineering House educational system, and it is letting the structure of virtuous cycle in which the employments of graduates and support for enrolled students are increased thanks to the active participation and support of enterprises and at the same time producing excellent students.

Figure 3-6 | Necessity of New Engineering Education through EH

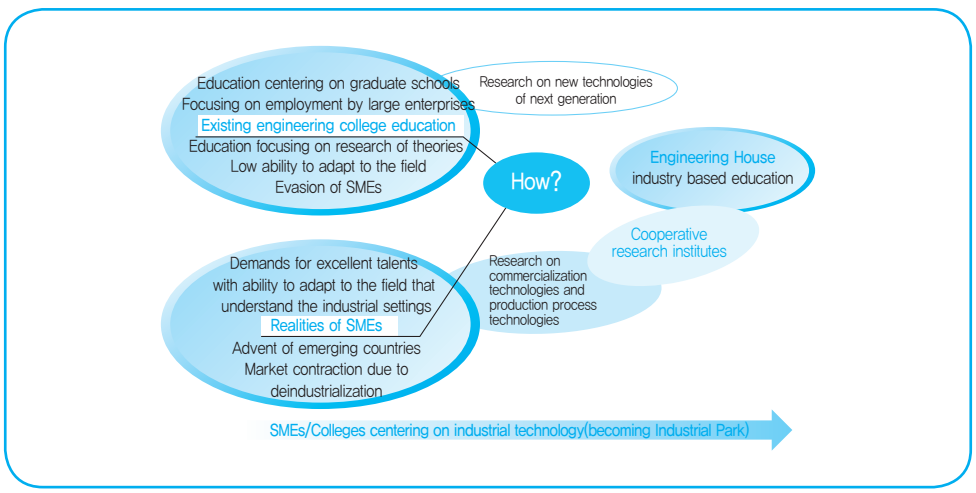
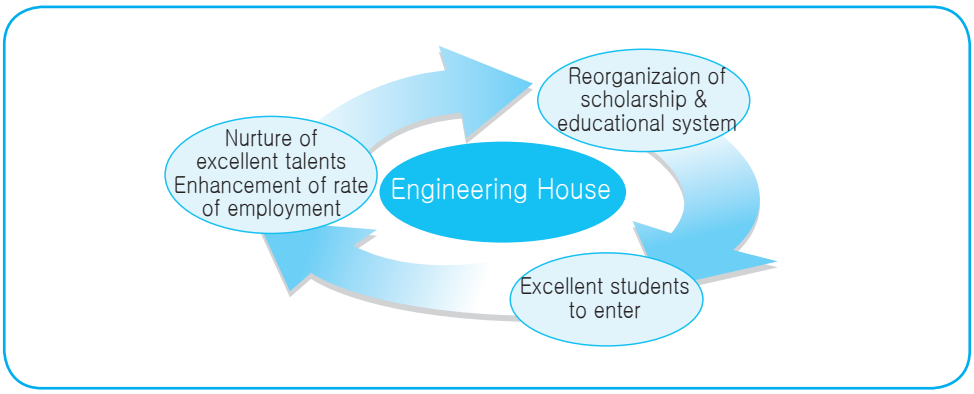


Figure 3-7 | Virtuous Cycle Structure of Increase of Rate of Employment and Inducement of Excellent Students through EH



3.1.3 EH Promotion system

Engineering House was introduced following the demands for manpower with ability for work in the field without need for reeducation by SMEs for the university to produce professional technical manpower with on-the-spot experiences that received the education centering on practical technologies for SMEs, and the direction of promotion of Engineering House are as follows:

The first is to realize a model of industry-university-institute collaboration of a new shape.

The second is to form a substantial research environment that can actively deal with the flow of industry.

The third is to form an educational environment of a new concept for nurturing the high-class engineers needed by enterprises.

The fourth is to form the optimum industrial environment to maximize the industrial-educational cooperation activities of enterprises.

The fifth is to form a space where students and enterprises are organically connected with each other 24 hours a day.

The sixth is to present a typical model of several buildings for the same purpose that will be built from now on at home and abroad as an ideal model of industry-university-institute collaboration.

The seventh is to grant a new symbolism to the campus with the overall harmony with campus and to emerge as the leader of the era of the west coast.

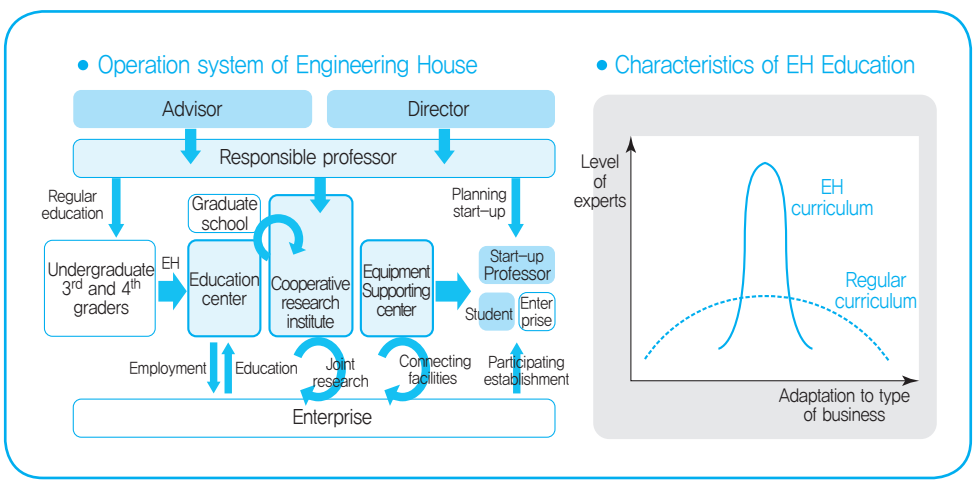
The basic strategy for promotion of Engineering House has the partner company system and Sihwa Banwol Innovation Cluster as the institutional and environmental foundation, and

the experiences of development of the curriculum tailored to users that Korea Polytechnic University has conducted steadily as the educational foundation and thereby carries forward the 'realization of the new industrial-educational unified engineering education based on Engineering House.'

As the organization to operate and promote Engineering House, the Engineering House Deliberation and Evaluation Committee is made with the EH Team inside the industrial-educational cooperation groups of Korea Polytechnic University as the center to plan and push ahead with the research and development of bottleneck technologies of enterprises, the support for enterprise R&D networks and the plan to utilize the research infrastructure of industrial-educational cooperation. Organic cooperation systems with the already-composed Engineering House of Korea Polytechnic University was constructed in order to present and push forward the model to strengthen the middle and long-term research capability of the SMEs inside Banwol and Sihwa.

Korea Polytechnic University is running the EH Team to support the EH system and is thereby handling everything that has to do with the business and supporting the operation, and is leading research on demands and execution of tasks through individual Engineering Houses.

Figure 3-8 | EH Operation System and Characteristics of EH Education



3.1.4 EH Educational System and Model

The educational system of Engineering House has improved the existing educational method that is conducted by dividing the education of theories and practice systematized over the 4 school years and is being operated as an educational system in which the undergraduate 1st- and 2nd-year students receive the basic major education and the 3rd- and 4th-year students receive a detailed major education, similar to the curriculum of graduate schools.

The environment in which the participating students can always study in the research space of advisers similar to existing graduate school courses is formed, and the system is composed of the 'Engineering House' system of the concept of educational space for the undergraduate 3rd- and 4th-year students and the 'Industrial-based learning' operation model in which students can always have on-the-spot experience.

a. Industrial-Based Learning

- The system of cooperative research institute was introduced as a method to vitalize the industry-university-institute collaboration by smoothly connecting enterprises and university.
- The cooperative research institutes let several enterprises connected to the detailed majors of professors be constantly connected, and also conducts the R&D for product development.
- In the R&D for product development, the system in which the undergraduate students participate and study is constructed and on-the-spot experience is conducted by frequently connecting with the participating enterprises.

Figure 3-9 | Based Learning of EH

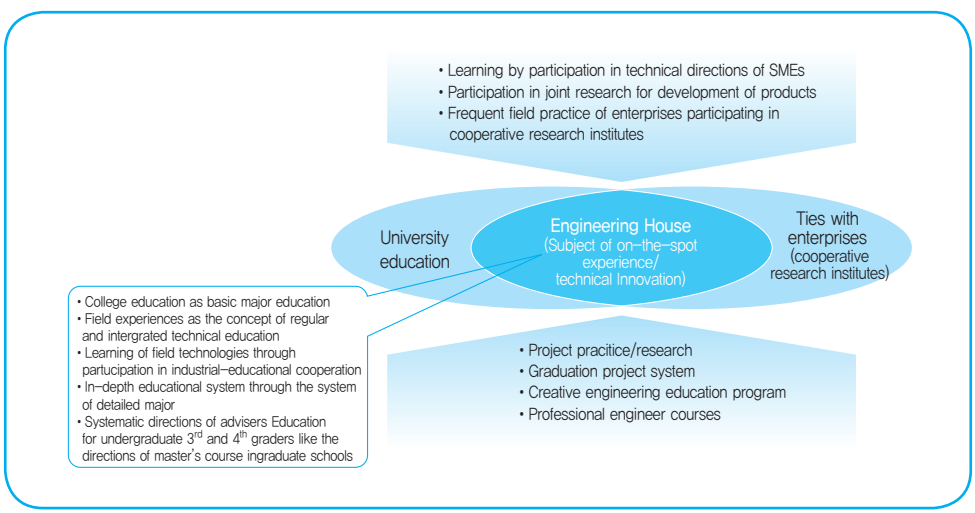


Table 3-3 | Characteristics of EH Education Model

Name		Contents
Inputted elements (Strategy for construction of infrastructure)	Space for education and research	- The new engineering educational system secures the educational space of the undergraduate 3rd- and 4th-year students, called 'Engineering House'. - The 'space of cooperative research institutes' that comes under the space for research is secured in order to secure the foundation for connection with enterprises.
	Facilities for Industrial based learning	- Security of educational facilities and research facilities to secure the foundation for connection with enterprises - Each professor in charge of the university maintains constant connection with enterprises with the sense of duty for basic research such as the projects of enterprises, the projects of the government and so on.
Curriculum	Years 1 and 2	- The basic major education/education of liberal arts, which are the same as the current educational system
	Years 3 and 4	- Execution by integrating the regular curriculum and the curriculum of companies inside the university. However, the students who do not choose the Engineering House educational system receive the education of the current educational system. - The students who choose the Engineering House education receive the education of required subjects and optional subjects and at the same time conduct additional Industrial-based learning inside Engineering House. - All the students who choose the Engineering House educational system have to enter the dorm in principle. - The students who choose the Engineering House educational system receive the credits of project practice, project research, graduation project and so on through the additional curriculum.

Name		Contents
Curriculum	General contents of learning	- Regular, continuous and integrated practice at the field of enterprises - Process of solution of bottleneck technologies of enterprises - Technical directions of enterprises/ learning by participating in projects - Education to enhance the ability as a system engineer through case study - Education through the senior members of company inside the university - Seminars - Exchange seminars between Engineering Houses - Technical educational courses in which the engineers who graduated from the university participate - Execution of the education inviting figures of enterprises and other educational institutions and so on

b. Educational Model centering on the field based on EH

Table 3-4 | Education Model Centering on the Field based on EH

Educational Model	Contents
Learning by participating in development of products	○ Related subjects: Industrial-educational cooperation practice (tentative name) ○ Participation in the research tasks conducted by the cooperative research institutes of Engineering House ○ Details of participation - Market research, examination on trends of research, research on related technologies and analyses - Schedule of examination and analysis, schedule of execution of tasks, schedule of analysis of results and so on ○ Schedule management - Participation in design, manufacture and execution of research - Analysis and evaluation of characteristics of results and so on ○ Methods of execution - Presentation at seminars in which advisers and experts in companies inside the university participate once a week - Framing and check of practice reports for the records of details of daily work ▲ Framing and submission of the comprehensive practice report for the comprehensive evaluation
Learning by case study	○ Related subjects: Industrial-educational cooperation practice (tentative name) and the subjects established on Engineering House's own ○ Operation by participation in technical directions of enterprises conducted by cooperative research or in the shape of the subjects established on Engineering House's own ○ Methods of execution - Deduction of plans for solution of problems by selecting 4 to 5 cases in total - Problem analysis, presentation of plans to solve problems, application, analysis of results and so on - Presentation at seminars in which advisers and experts in company inside the university participate - Framing and check of practice reports for records of details of daily work (Omitted in the case of the subjects established on Engineering House's own) ▲ Framing and submission of a series of reports covering the examinations for each case and analysis of results

Educational Model	Contents
Learning for inspiration of founder spirit	○ Related subjects: Operation of common subjects of Engineering House ○ Active utilization of outside experts as a prior education program for foundation ○ Recommendation of operation of curriculum in the shape of mock foundation in which actual cases of foundation are selected and analyzed
Learning by inviting experts	○ Related subjects: The subjects under joint operation of Engineering House, the subjects established on Engineering House's own and industrial-educational cooperation practice ○ Subjects of education - Experts inside companies in cooperative research institutes-Experts in outside colleges, research institutes and so on - Utilization of retired experts at home and abroad and so on ○ Recommendation of operation of educator pool system: A manpower pool system composed of 4 to 5 people (team teaching system) - Learning, by seminars, the theories of new technologies - Case study for solution-planning and so on ▲ Execution of mid-term evaluation and final evaluation
On-the-spot study	○ Related subjects: Industrial-educational cooperation practice (tentative name) ○ Learning of the process and related technologies in the actual industrial settings by visiting the enterprises related to the themes of the industrial-educational cooperation practice ○ Methods of execution - Field trip ▲ Framing and submission of the field trip report
Learning by graduation projects	○ Related subjects: Industrial-educational cooperation practice (tentative name) ○ Methods of execution - Equivalent to the graduation projects of the regular courses, but centers on the development of new products and actively recommends the performance of a patent application.

Source: KIET(2007)

3.1.5 Promotion Stages and Progress of EH

Engineering House did not secure a separate space in the foundation stage and was started by dividing some laboratory space allotted to departments, and the government support such as the industry-university-institute consortium, the industrial-educational cooperation division business and so on was started. Afterwards, it passed through the stages of model and operation, and the excellent modeling of Engineering House was discovered and the institutional support was settled.

Table 3-5 | Promotion of E/H by Stages

Table	Period	Contents of promotion
Stage of formation of basis	2003-2004	○ Establishment of concept of EH and supporting policies ○ Introduction and application of EH system by utilizing the practical rooms of departments
Stage of trial operation	2005-2006	○ Security of an independent separate space and execution of trial operation ○ Execution of institutional support for industrial-educational cooperation activities and education
Stage of settlement of operation	2007-2009	○ Settlement of the new engineering educational system due to the completion of TIP ○ Development and operation of the system evaluating and operating EH
Stage of expansion and development	2010-2013	○ Expansion and development of the new engineering educational system through EH subject and certification system ○ Spread of the successful operation model through the expansion and evaluation of EH

Currently, Korea Polytechnic University has established the industrial-educational cooperation system based on EH in order to expand and vitalize EH, and is expanding and managing EH in order to strengthen the technical innovation and in-service training of partner companies. Also, the university is inducing the vitalization of establishment of EH that can support green growth and IT fusion technologies that are newly demanded following the technical demands of enterprises inside the Sihwa and Banwol Industrial Complexes, which is the local industrial complex and the market environment.

Table 3-6 | Participation in EH

Year	Number of EH	Number of participating professors	Number of participating enterprises	Number of participating students	Number of participating researchers of enterprises
2007	37	89	97	215	116
2008	41	95	136	299	119
2009	45	96	165	405	142

For EH subjects, the university is systematizing the university's own educational programs, seminars, practices and so on conducted for the participating students in the individual EH through the 1st year business and thereby is running EH subjects as a trial and converting them into regular subjects. The university is also developing various practical textbooks following the grant of credits in EH subjects and conducting the intensified technical education utilizing them, and thereby is strengthening the EH educational system, and nurturing enterprise-friendly practical talents needed by enterprises by cultivating the ability to adapt to the field and to perform projects through EH subjects.

In order to overcome the difficulties in pushing on with EH in this way, it was necessary to reflect the demands of all members of EH, such as the participating professors, the professors in the field of enterprises, students and so on for the promotion of EH subjects to be regular subjects and to design the subject by considering the requisites for graduation, the terms desired for bachelors and so on. In this connection, the university has been forming the consensus for the plans for promotion of EH subjects and the plans for operation of EH through the EH meeting and the surveys targeting the professors and students participating in EH.

In June 2009, the university did a survey targeting the professors and students participating in EH and held a meeting for the plans for operation of EH subjects on the basis of survey results, and the respondents favored 33 out of 45 EH subjects (73%) and hoped that the EH subjects would be opened always during the semester and vacation. Many respondents said that it was proper to allot 2 credits for each EH subject.

The university is establishing the final plan for operation such as the method of opening EH subject, type of operation of classes, acknowledgement of class hours, number of students attending and so on jointly with the academic affairs office, and is conducting a public hearing for the professors participating in EH and is establishing the 'EH subjects' as a group for project practice among the regular subjects in the year 2010, and is reflecting on the academic system by holding the academic affairs committee in November, 2009.

3.1.6 Outcomes of EH Promotion

The Engineering House system is an industrial-educational cooperation system mixing the development of new products of enterprises and practical education and Korea's first model for new industrial-educational cooperation in which professors, enterprises and students can jointly conduct education, R&D and industrial-educational cooperation activities in the space of EH. EH is creating the effects of not only the technical development of enterprises but also the nurture of tailored talents for enterprises and increase of employment by letting enterprises, professors and students conduct joint research and education together.

As a model for strengthening of industrial-educational cooperation for the acceleration of innovation of industrial complexes, the EH model is presenting the R&D model based on the research institutes in industrial-educational cooperation for intensification of the innovative research capability and system of the Sihwa and Banwol National Industrial Complexes, which is the largest region where SMEs are concentrated, and is acknowledged as a successful industrial-educational cooperation system.

In general, EH is evaluated as having created the effects that external experts, the EH field professors and so on jointly participated in the education for students, and thereby provided education in the practical technologies in the field of enterprises to the undergraduate 3rd- and 4th-year students through the operation of regular EH subjects.

EH strengthens the tailored field practice education that can raise the ability to adapt to real industrial settings and develop the ability to intensify the learning of knowledge in major and technologies by applying and utilizing the theories learned through EH to the field of EH and, in particular, provides education that lets the students participate not only in seminars on the latest technical trends but also actual projects with enterprises, and thereby EH nurtures the talents tailored to enterprises and is expected to have the students employed by good companies.

The direct outcomes through EH are as follows:

First, the university reflected the demands following the changes of technologies needed by businesses swiftly and flexibly, and thereby conducted research on demands targeting about 50 EHs and selected 11 EHs, and developed and operated the EH subjects to nurture talents focusing on practical work.

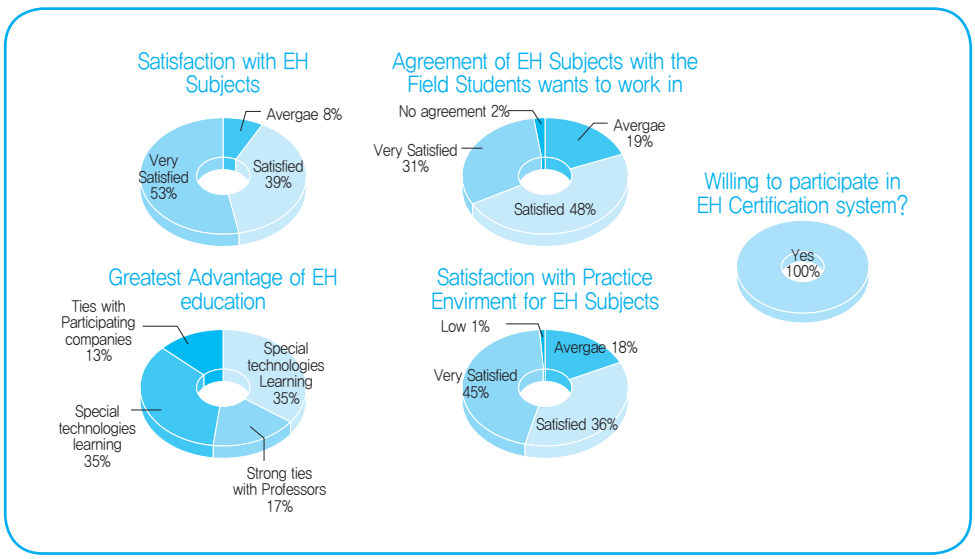
Second, through that, the university and experts in businesses jointly intensified enterprise-based learning, and therefore the quality of education was improved and the number of students participating in EH increased.

Third, the university held special lectures inviting more external experts when managing EH subjects and had 15 or more students participate in the lectures, and thereby provided opportunities to listen to the lectures not only to the undergraduate students participating in EH but also to undergraduate students with other majors who are interested in EH technologies. Hence, the university raised the effects of intensified learning on fusion technologies and majors in engineering education.

The university accomplished the expansion of opportunities of the participating undergraduate students to take part in education and the increase of satisfaction by applying the EH subjects to the academic system of the university so that the systematic management and educational feedback through the operation of EH subjects in 2010 can be conducted through the EH system.

A survey says that 100% of the students are willing to take part in the EH certification system if it will be executed from now on, and thus the university is trying to expand and develop the EH system into a new engineering educational model by intensifying the curriculum tailored to the filed through the EH subjects and connecting the EH system to employment from now on through the introduction of the EH certification system.

Figure 3-10 | Statistics of Survey Targeting Students Participating in EH Subjects



The university developed various practical textbooks following the grant of credits in EH subjects and conducted the technical intensified education using that as a success factor for the EH subjects, and thereby the university added much to the strengthening of the EH educational system and enhancement of the quality of education. Analysis reveals that the university selected the sustainable subjects and the subjects to be abolished through the assessment on the EH subjects every year and developed and conducted the new EH curricula on the basis of prior examinations, and therefore the EH subjects were made regular subjects and the number of participating students and indices of industrial-educational cooperation increased.

From now on, it is necessary to drive forward the EH system as a successful new education model in industrial-educational cooperation through positive publicity activities

in the EH system, subjects and so on to induce the settlement of the operational system of EH subjects and to improve the system of evaluation and support through which the enterprises, professors and students participating in EH can grow ceaselessly.

In addition, it is necessary to conduct constructive publicity activities including the publication of brochures related to the EH certification system for the utility of the EH certification system in order to plan the enhancement of technical manpower in quality through the introduction of the EH certification system and to further the establishment of the certification system through conducting satisfaction research every year targeting the students who have obtained the certification and the enterprises employing the students.

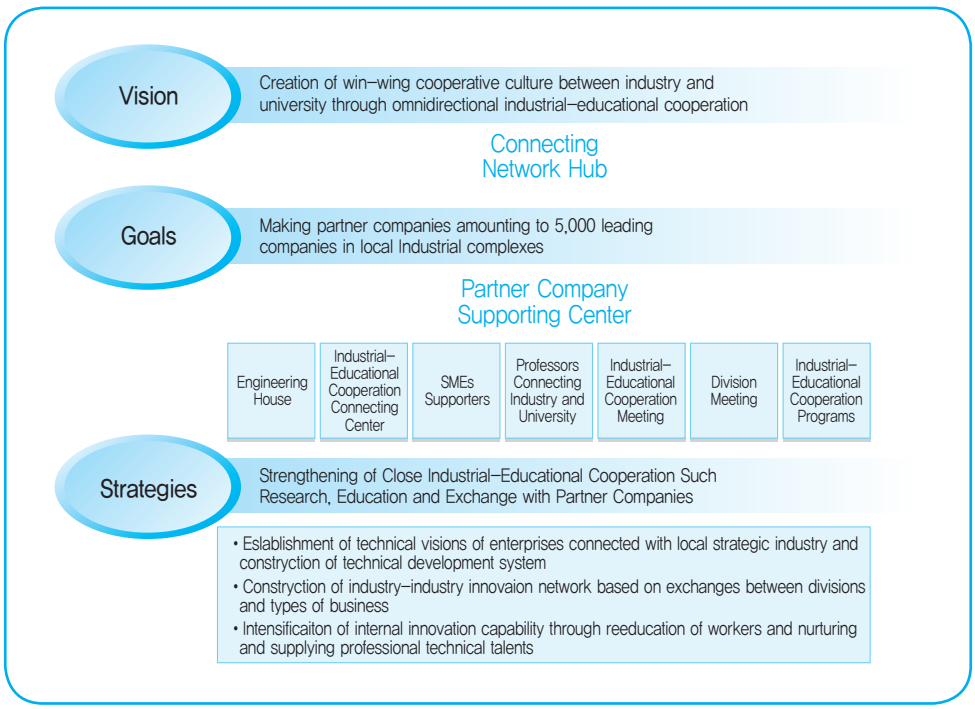
It is planned to cultivate the ability to adapt to the field and to perform projects by giving motivation to learn to the undergraduate students taking part in EH through issuing certificates with the evaluation of listening to EH subjects, participation in projects, grades and so on, to improve the quality of employment by triggering enterprises' will to employ through nurturing the enterprise-friendly practical talents needed by enterprises and to emerge as a successful model for industrial-educational cooperation at home and abroad by constructing the certification system tailored to the demands of enterprises reflecting the demands of the enterprises participating in EH and the systematic certification management system.

3.2 Partner Company System

3.2.1 Concept and Vision

The partner company system presents the system of a companion-like innovation program in which the university and enterprises mutually share human and material resources on the basis of tailored cooperation on education and research. In this system, the university completes the education centering on users and enterprises create profits by planning the improvement of technical competitive edge. The partner company system is an industrial-educational cooperation system of a new concept that was originated by Korea Polytechnic University and is a new paradigm of industrial-educational cooperation, spread across the nation.

Figure 3-11 | Visions of Partner Company System



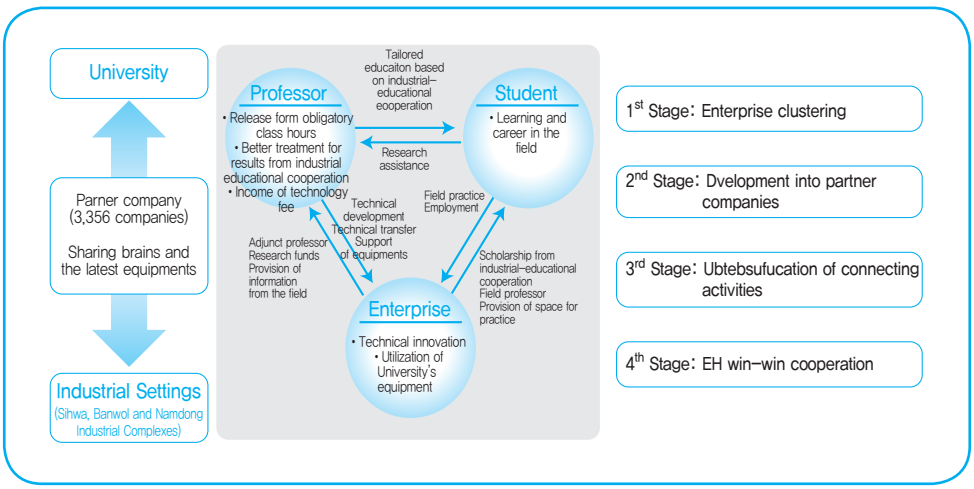
Korea Polytechnic University was established in the industrial complex as a university for industrial-educational cooperation in order for industry and the university to cooperate and thereby to increase the technical competitiveness and nurture the excellent technical manpower needed by enterprises. About 90% of the enterprises in the industrial complex where the university is located are SMEs with sales of less than 10 billion won and 50 or fewer employees, and it is urgent to secure superior manpower for the development of products, development of technologies and so on through industrial-educational cooperation.

In order to settle the issues of the businesses and environment of the local industrial complex, the university came to push forward the partner company system, which is an industrial-educational cooperation system with a unified network in which professors and students of university and local enterprises participate together, and has been carrying forward diverse cooperative businesses such as organic exchanges of information, joint technical development and so on between small and medium-sized businesses and the university.

3.2.2 Operating System of Partner Company System

The win-win cooperation synergy between industry and university is being maximized through the system strengthening cooperation by stages of the partner company system, and this is entering a virtuous cycle through the nurture and supply of professional technical manpower with the capability in the field.

Figure 3-12 | Operation System of Partner Company System



First, the construction stage (starting of relationship): Enterprise clustering

- As a stage of invitation of partner companies, introduction of the partner company system by the university and publicity of plans for operation to enterprises
- External proclamation of official activities such as the welcoming ceremony for partner companies, division meetings and so on

Second, the operation stage (formation of trust): Development into partner companies

- Intensification of the ties between professors and enterprises through the partner company meetings for each type of business
- Beginning of directly related activities for the fields of demands of enterprises through advisers
- Operation focusing on the one-way connecting support from the university to enterprises such as technical direction, reeducation of workers, seminars for new technologies, support for utilization of equipments and so on

Third, the utilization stage (deepening of relationship): Strengthening of connecting activities

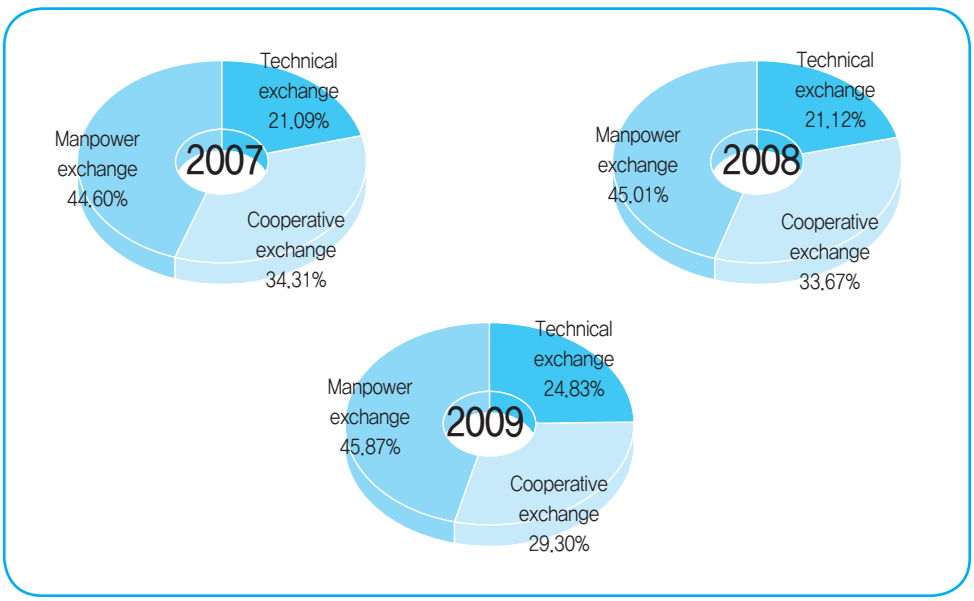
- A stage of concrete two-way cooperation between the university and enterprises through the systematization of the system of operation of partner companies
- Full-scale participation of enterprises in the nurture of manpower such as provision of field practice, support for partner company scholarship and so on

Fourth, increase of outcomes (the stage of completion): EH win-win cooperation

- The cooperation and win-win development between the university and enterprises across the full virtuous cycle of technical innovation with the partner companies as the basis
- Creation of profits such as the technical transfer, commercialization, inducement of investment, establishment of technical holding company and so on through close mutual connection

The types of industrial-educational cooperation programs can be divided largely three types: technical exchanges, manpower exchanges and exchanges and cooperation. The most common type among industrial-educational cooperation programs between Korea Polytechnic University and its partner companies was manpower exchanges. It can be viewed that the demand for manpower with capability in the field needed by enterprises is high through the characteristics of the academic system for nurturing technical manpower of the university such as the field internship, practice system and so on.

Figure 3-13 | Distribution of Types of Industrial-Educational Cooperation between Korea Polytechnic University and Partner Companies



The university views professors with career expertise in business, public institutions, research institutes of large enterprises and so on as the optimum professors, closely supporting the partner companies one to one and thereby provides the consulting with site visit through the 'diagnosis card for partner companies', and the partner companies participate in the construction of the network between partner companies by operating the self-regulating meeting of partner companies, strengthening exchanges and cooperation and so on.

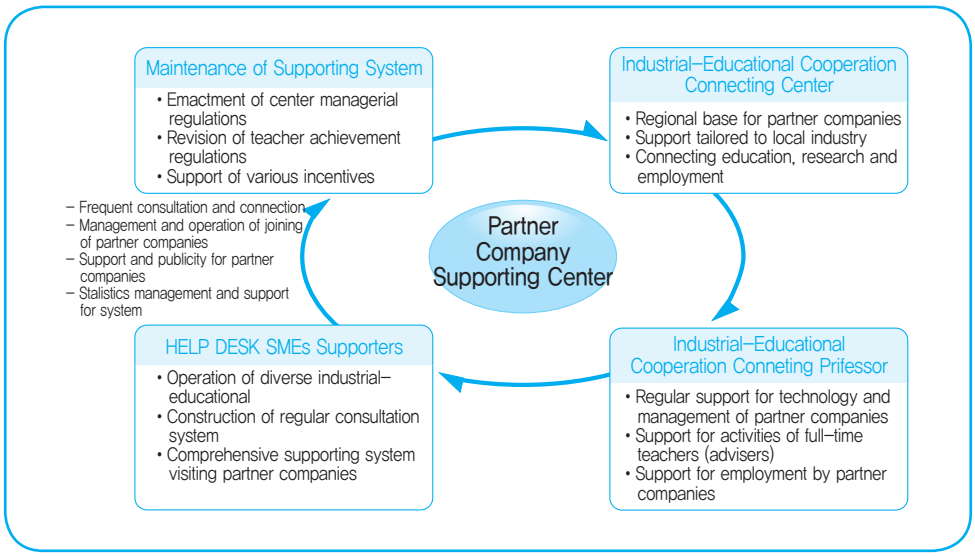
The partner company system has the vision of creating a win-win cooperative culture through omni-directional industrial-educational cooperation, and the number of businesses that have joined as partner companies increased to 3,465 through the operation of the business link program of the Bucheon Industrial-Educational Cooperation Connecting Center established in the 1st year and the establishment of the Guro Industrial-Educational Cooperation Connecting Center.

Category	Partnership	Membership	Remarks
Number of partner companies	987	2,478	As of March 2010

Korea Polytechnic University is managing and supporting the partner company system with the Partner Company Supporting Center, and has been systematically connecting and supporting the advisers and partner companies. The Partner Company Supporting Center was established in the 1st year for the expansion and specialization of the organization of which the center takes exclusive charge, and has been maximizing the ability of industrial-educational cooperation of full-time professors through expanding the areas of activities of the center, and strengthening its supporting ability through supplementing the personnel.

The university is vitalizing industrial-educational cooperation through recruiting the professional supporting manpower for the strengthening of support for enterprises and is expanding the areas of activities and strengthening the supporting ability of the Partner Company Supporting Center.

Figure 3-14 | Comprehensive Strategy Supporting Partner Companies of Korea Polytechnic University

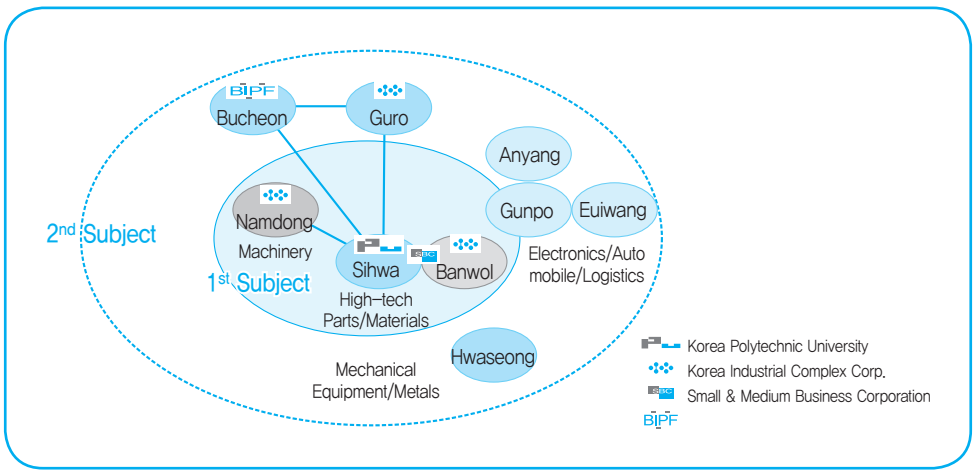


The Partner Company Supporting Center was established in the 1st year for the expansion and specialization of the organization of which the center takes exclusive charge, and has been maximizing the ability of industrial-educational cooperation of the full-time professors through expanding the areas of activities of the center and strengthening its supporting ability by supplementing personnel. The center is also doing much toward the increase of outcomes of technical innovation through expanding partner companies and developing the programs supporting superior partner companies.

The university is driving forward the expansion of partner companies to 5,000 memberships and 1,500 partnerships on the basis of making the systematic function connecting business commercialization and supporting programs a package in order to discover new enterprises and to raise the convenience of support for enterprises by establishing the organizations in exclusive charge such as the Partner Company Supporting Center.

In addition, the university is supporting the Sihwa, Banwol and Namdong Industrial Complexes, where the university is located, as the regions for direct support; and, the Bucheon and Guro Industrial Complexes, where no 4-year-course engineering college is located, by establishing the Industrial-Educational Cooperation Connecting Center.

Figure 3-15 | Industrial-Educational Cooperation Connecting Center



Korea Polytechnic University is providing a one-stop technical management consultation service to its partner companies to closely support the SMEs in Banwol and Sihwa Industrial Complexes where SMEs are concentrated through technical direction, management consulting, patent consultation and so on. As the policies supporting SMEs focus on the bottleneck technologies in the field through this service, the university has been conducting one-to-one tailored supporting measures needed for all processes from the development of products through entry into the market as the countermeasure for the absence of plans to solve the problems occurring in the actual operation.

Korea Polytechnic University is supporting increased satisfaction of its partner companies and stable operation of the Connecting Center through supplementation and utilization of experts with capabilities in the field as professors by establishing the industrial-educational cooperation connecting professor system, and is facilitating the cooperation in the areas with which the employees in exclusive charge and the professors connecting the industrial-educational cooperation among the diverse industrial-educational cooperation programs so that member companies can be advanced into partner companies, and is also developing cooperative activities of partner companies to a variety of fields such as technology, employment and education.

3.2.3 Outcomes of Partner Company System

Since the launch of the partner company system in February 2002, the number of partner companies of Korea Polytechnic University has increased from 1,000 companies in May 2002 to about 3,500 companies at present.

The university is showing outcomes such as business incubation, special lectures for the CEOs of its partner companies, special courses for CEOs of SMEs, operation of TIP, classes

for workers commissioned from businesses, availability of equipment for experiments and research, attraction of scholarships from its partner companies and so on together with the constant expansion of technical development and results of direction in industrial-educational cooperation.

Korea Polytechnic University opened Techno Innovation Park (TIP) in March 2007. In TIP, the university (professors and students) and the participating enterprises (researchers) jointly conduct new development projects for the nurture of technical talents (education) and promising cutting-edge technologies on the basis of the cooperation between the university and enterprises.

Enterprises' researchers participate as field professors and thereby transfer technologies to the university's students and receive consultation on technical development from the professors.

Table 3-7 | Outcomes of Industrial-Educational Cooperation Centering on Partner Companies

Sector	Outcomes of industrial-educational cooperation
Number of partner companies	○ Launch of the partner company system in February 2002 ○ 1000 companies in May 2002 ○ About 3,000 companies as of 2011
Business incubation	○ Business incubation for 20 companies through the Technical Business Incubator (2007)
Operation of the courses of industrial technologies for CEOs (ITP)	○ 748 CEOs for 14 terms since 2002
Education for workers commissioned from businesses	○ Commissioned education for 539 workers as of 2007
Nurture and reeducation for workers of businesses	○ 327 workers in 2001; 5,439 workers in 2002; 2,463 workers in 2003; 3,301 workers in 2004; 2,166 workers in 2005; and 2,483 workers in 2006
Technical development and directions	○ Support through the research centers in industrial-educational cooperation, cooperative research centers, TRITAS, consortiums of industrial and university and so on
Special lectures for CEOs of partner companies	○ 9 lectures in 4 departments in 2005 ○ 11 lectures in 4 departments in 2006
Participation in students' graduation researches	○ 97 cases in 2001, 134 cases in 2002, 138 cases in 2003, 161 cases in 2004, 226 cases in 2005 and 348 cases in 2006
Participation as adjunct professors	○ 222 persons, including engineers of enterprises and so on

Sector	Outcomes of industrial-educational cooperation
Participation in field practice of students	○ About 10,000 persons in 7,000 companies
Others	○ Scholarship of partner companies, opening of equipments for experiments and researches and so on

Table 3-8 | Results of Professors Connecting Industrial-Educational Cooperation in the 2nd Year

Items	Number of enterprises consulted	Number of cases of consultation	Technical directions	Connection with technical development tasks	Financial connections
Results	109	195	12 cases	10 cases (878,000,000 won in total)	1 case (200 million)

Korea Polytechnic University held the meeting of division representatives of its partner companies for the 10th anniversary of establishment of the partner company system, and awarded prizes to the partner companies and the teachers that had excelled at industrial-educational cooperation through the 10th anniversary ceremony. The university is thereby publicizing, spreading and propelling the partner company system.

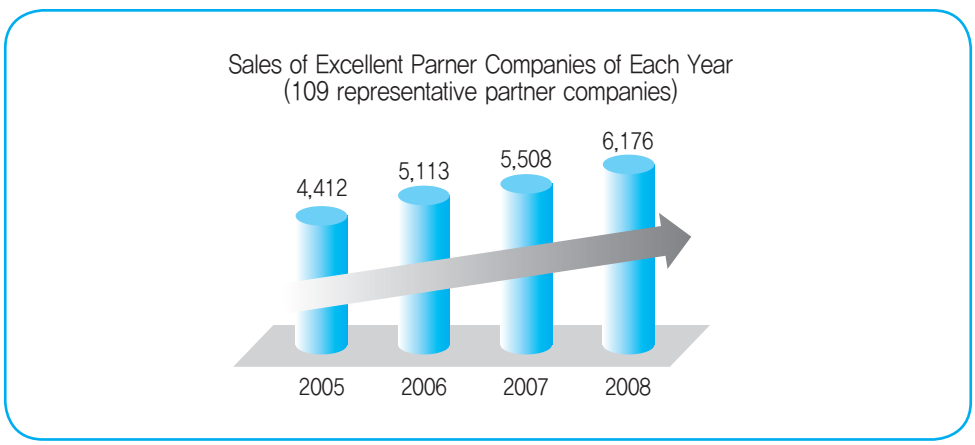
In general, the university is assessed to have systematized the system classifying the types of industrial-educational cooperation through the construction of the comprehensive supporting system for partner companies and to have provided the tailored services through analyzing the correlations between the types of cooperation, and to have prepared the basis for promotion of industrial-educational cooperation through establishing the Partner Company Supporting Center and building the systematic supporting system of the employees in exclusive charge for the fields that can be dealt with other than the technical fields needing the expertise of professors.

The university conducted the basic analysis on the demands for consulting of its partner companies through research on satisfaction with the industrial-educational cooperation and demands for consulting of its partner companies, and constructed the more systematic and aggressive basis for discovery of potential demands of enterprises and industrial-educational cooperation by developing the model for selection of priority of consulting. It can be said that the university could increase the number of partner companies per full-time teacher and contribute to the promotion of industrial-educational cooperation by expanding the range of technical support, including equipment use, by extending the work areas of the supplemented professors connecting industrial-educational cooperation.

The concrete outcomes are that the university substantially helped its partner companies through the establishment and promotion of a comprehensive supporting strategy centering on the Partner Company Supporting Center and the Industrial-Educational Cooperation Connecting Centers in Guro and Bucheon that were established as a business of nurture of the central university in industrial-educational cooperation and maximized the capability for industrial-educational cooperation of the university with efficient support for advisers.

In addition, the university is evaluated to have expedited cooperation in the areas for which the employees were in exclusive charge and the professors connecting industrial-educational cooperation can deal with, and also developed the activities of cooperation with partner companies into diverse fields such as technology, employment, and education in running a variety of industrial-educational cooperation programs so that the member companies could be developed into partner companies. The university is also evaluated to have induced its partner companies to cope with the trend of increase of its graduates by expanding its partner companies in quantity, built the system that can raise the performances of industrial-educational cooperation through the analysis of types of enterprises and given a boost to the outcomes of support for enterprises through construction of a differentiated supporting system by developing the system of partner companies with membership and partner companies with partnership.

Figure 3-16 | Sales Growth Rate of Excellent Partner Companies of Each Year



Korea Polytechnic University is planning to increase the participation of enterprises by continuing and strengthening the publicity activities on the partner company system and to maximize the results of industrial-educational cooperation through the tailored services of advisers for the companies with partnership participating in the system to a high degree.

Moreover, the university is forming a scheme to extend the range of work of the professors connecting industrial-educational cooperation (2 professors in the university and 2 professors

in the Industrial-Educational Cooperation Connecting Center) supplemented to take exclusive charge of the work supporting partner companies, to expand the range of support by completing a systematic and effective supporting system for the companies with membership on the basis of close cooperation and to thereby increase the number of partner companies per full-time teacher and propel industrial-educational cooperation. The university is also forming a plan to discover the potential demands of enterprises in specialized areas and to construct a specialized basis for industrial-educational cooperation through the operation of system utilizing the Website for comprehensive support for partner companies in the long term by subdividing and developing the model for selection of priority for each type of business, to operate the tailored industrial-educational cooperation service through the analysis of correlation between the types of cooperation and to thereby develop the partner company system into an efficient supporting system for promotion of industrial-educational cooperation.

3.3 Industrial-Educational Cooperation Connecting Center

3.3.1 Concept

The outcomes of industrial-educational cooperation are concentrated in the Sihwa, Banwol and Namdong Industrial Complexes where Korea Polytechnic University is located. The rate of partner companies in those Industrial Complexes is 33.6%, the rate of employment to partner companies there is 51.2% (as of 2007) and the rate of performance of technical development tasks in industrial-educational cooperation and technical directions there is 39.5%. However, though the partner companies in the capital area excluding the Sihwa, Banwol and Namdong Industrial Complexes number 1,961 in total and account for 59.5%, the region remained relatively weak in industrial-educational cooperation.

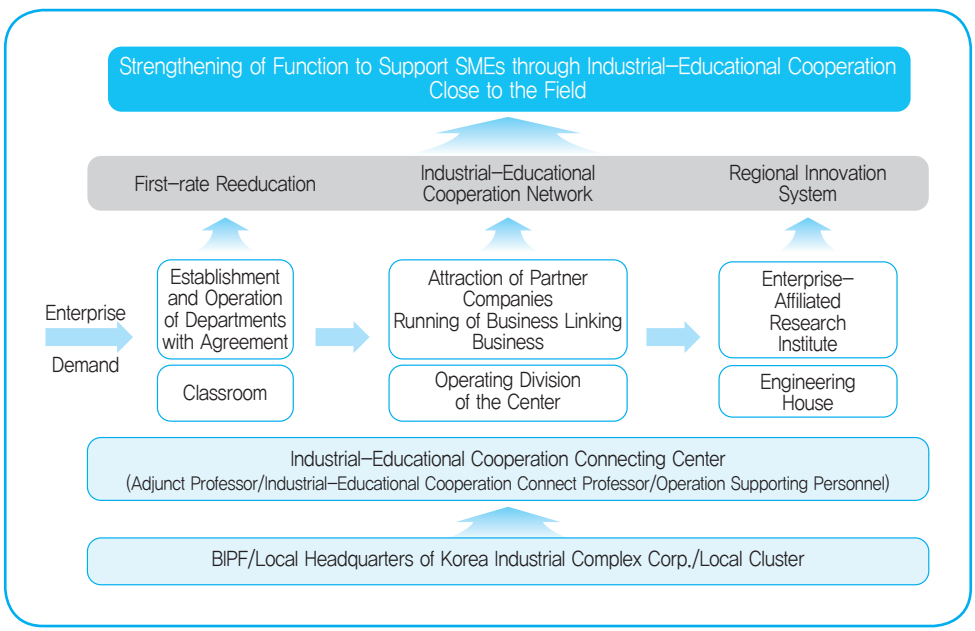
In particular, the Bucheon, Guro and Hwaseong regions with the southwestern industrial complexes in capital area where enterprises are concentrated have 439 partner companies (13.3%) and the rate of employment to partner companies of 11.4% (as of 2007). The Bucheon Industrial Complex (with 8,507 companies) is a region where SMEs are accumulated centering on the businesses related to electricity and electronics, automation devices and chemical products; an EH is now established there and the region is playing the role of the basis for constructive industrial-educational cooperation activities. The department of mechatronics engineering of Korea Polytechnic University is running a class for workers commissioned from businesses there. Seoul Digital Industrial Complex (Guro, with 8,416 companies) is a region with concentrated SMEs which is rapidly transforming itself into a cutting-edge urban industrial complex as it recently successfully attracted higher value-added industries and information knowledge industries, and there are a number of partner companies (173 companies) located and lively industrial-educational cooperation activities are being undertaken there centering on the fields of IT and design.

In the Bucheon Industrial Complex and the Seoul Digital Industrial Complex (Guro), there are a number of demands for the strengthening of research capabilities through

connecting industry and university, manpower exchanges between industry and university and so on, but, there is no 4-year-course engineering college that can provide the basis for industrial-educational cooperation within the region. Considering this, the industrial-educational cooperation including joint technical development between industry and university is frequently conducted in the Bucheon and Guro regions, and many graduates of Korea Polytechnic University are working there. Bucheon and Guro are specialized for robotics, mechatronics, IT industry and so on and it is expected for active cooperation. It is necessary to secure the regional basis in Bucheon and Guro to deal with demands for industrial-educational cooperation close to the field in the regions and to support the reeducation of manpower and technical development by partner companies focusing on the departments of the university characterized for the characteristics of the types of business in the regions.

Korea Polytechnic University constructed the infrastructure supporting industrial-educational cooperation in the southwestern industrial complexes of the capital area in order to expand and strengthen the function supporting SMEs based on industrial-educational cooperation pursued by the university, and presented new types of industrial-educational cooperation by administering programs supporting the education, research and commercialization demanded by enterprises.

Figure 3-17 | Concept of Promotion of Industrial-Educational Cooperation Connecting Center



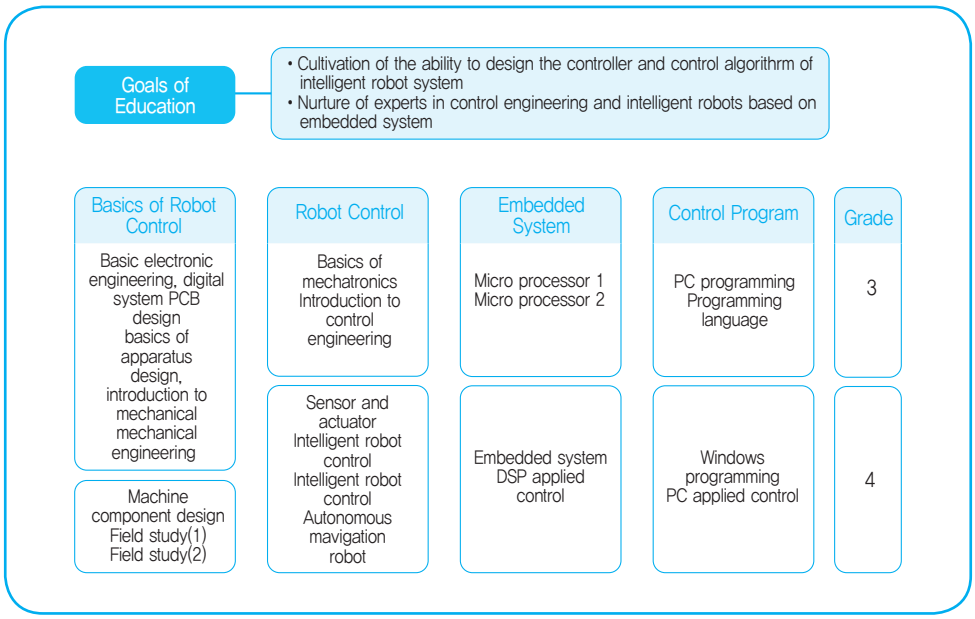
3.3.2 Operation of Industrial-Educational Cooperation Connecting Center

In order to push on with the Industrial-Educational Cooperation Connecting Center, Korea Polytechnic University established the basis for cooperation with the institutions supporting enterprises within the Bucheon region, and has constructed and is operating the Industrial-Educational Cooperation Connecting Center through securing new spaces by expanding the spaces of the supporting institutions in Bucheon, in which EH is established and operates.

The university has been tailoring the curriculum to each field through the connection between the main types of business and technical fields of Bucheon, which is a connected region, and the characterized departments of the university, and producing industrial-educational convergence talents that can satisfy the demands of regional partner companies through opening and managing the department with agreement. The university is also initiating field practice and graduation project activities with agreement between the EH and the research institute affiliated with enterprises and thereby completing the practical in-service training.

The department with agreement is utilizing the EH and research basis facilities within the Connecting Center as the facilities for practice and leading the enterprises participating in the process of education to participate in the programs supporting industrial-educational cooperation. The Department of Robot Control Engineering has been operated for element technologies such as embedded systems, sensors and actuators, design of servo drivers, basics of robots and so on, focusing on nurturing creative professional technical manpower with abilities both in theories and practices on the basis of the control engineering which is the essential theory for robot control.

Figure 3-18 | Operation of Education Tailored to the Field of Industrial-Educational Cooperation Connecting Center



3.3.3 Outcomes of Industrial-Educational Cooperation Connecting Center

The Industrial-Educational Cooperation Connecting Center is an industrial-educational Cooperation model that provides a variety of industrial-educational cooperation services to the businesses located in the Bucheon and Guro regions where no 4-year engineering college is located. The Bucheon Industrial-Educational Cooperation Connecting Center secured and built the space for the center on the basis of cooperation with the local governments and local institutions supporting enterprises such as Bucheon City, BIPF, Bucheon Venture Association and so on, and established the departments with agreement and EH, and induced vitalization by allocating a certain ratio of the enterprises that are the subject of the programs supporting partner companies such as the industrial-educational cooperation meeting, technical development and directions and so on to the enterprises in the connected regions.

The center is thereby successfully running diverse programs supporting industrial-educational cooperation such as technical development and directions, support for design and marketing, the industrial-educational cooperation meeting, the field practice connecting with enterprises and so on, and the center's 357 partner companies (10.3% of all the partner companies of Korea Polytechnic University) as of March 2010.

In addition, the professors in charge of the enterprises participating in internship are taking charge of periodical consultation and management of the students in internship and providing technical advices for work to the enterprises and thereby are increasing the degree of completion in understanding and learning of practical work in enterprises of interns and directing the interns so that they can ultimately be employed by the enterprises.

Korea Polytechnic University is driving forward the expansion of support for the Bucheon Industrial-Educational Cooperation Connecting Center and the establishment of the master's course in graduate school in the year of 2011, and it is planning to manage the educational system focusing on the field meeting the demand of the field through the research on demands for subjects and to strengthen the function to support enterprises.

2011 Modularization of Korea's Development Experience
Technical Engineering Education Model of
Korea Polytechnic University (KPU)

Chapter 4

Evaluation

1. Economic, Industrial and Technical Outcomes
2. Outcomes of Education Tailored to Industrial Settings·
3. Outcomes of Construction of Basis for Research and Technical Development Jointly by Industry and University
4. Outcomes of Overseas Cooperation

Evaluation

1. Economic, Industrial and Technical Outcomes

Korea Polytechnic University has done its best to develop new technologies that could be used in industrial settings since its establishment. The university has constructed a close cooperation system with not only the nearby Sihwa and Ansan Industrial Complexes but also the manufacturers in all industrial fields, and is being assessed as having been forming an almost perfect industrial-educational cooperation system that cannot be found in other industrial universities.

In March 2001, Korea Polytechnic University made an agreement with Korea Industrial Complex Corporation to mutually and closely cooperate with each other for the construction of a comprehensive supporting system for strengthening of the competitive edge of the enterprises located in industrial complexes, and also agreed not only to grasp and solve the difficulties of enterprises in industrial complexes in relation to the computerization, if there are any, but also to conduct the transfer of the technologies the university possesses to the industrial world, the provision of information to and joint execution of the business of business incubator, support for informatization of the enterprises in industrial complexes for the construction of digital industrial complexes, the joint opening of various curricula and seminars and so on. They built a mutually beneficial cooperation system in which the professors of the university provide practical technical directions to the enterprises in industrial complexes on the basis of the new technologies and information they possess and the industrial complexes direct the enterprises in them to join as the partner companies of the university and to support the scholarship and field practice for the students of the university.

In addition, Korea Polytechnic University has constructed a close external cooperation system, especially with SMEs and venture companies for its location in the Sihwa Industrial Complex where mainly small and medium-sized manufacturers are located. The university

not only has directly established the cooperation system with its partner companies amounting to about 3,000 enterprises, but also the joint supporting plan for SMEs and venture companies by closely connecting with Small & Medium Business Administration, Korea Intellectual Property Office, KOTRA, Korea Industrial Complex Corp., Korea Electronics Technology Institute and so on.

Korea Polytechnic University came to be able to produce practical engineers that can be deployed to the field directly upon graduation and adapt to the field in the shortest period of time beyond the strengthening of classes with experiments and practices, and enterprises came to be able to participate in the practical learning of the university and to educate the students suitable to the enterprises themselves. That is, the university and enterprises came to be able to build a strengthened network by being reconciled.

Enterprises are developing by receiving the support of the infrastructure such as technical support, use of equipment, needed manpower and so on and by sharing information and technologies with Korea Polytechnic University as the pivot of the technical innovation cluster.

In particular, Engineering House can enable undergraduate students to have ability in detailed majors, like graduate students, by being able to educate them by dividing the majors of undergraduate courses comprehensively, and is seen to have played a role as an educational system which is also strong on historical changes by applying the flow of industry through the changes of EH, though it is hard to decide to continue or abolish departments of the university.

Thanks to Korea Polytechnic University, SMEs can not only minimize the cost for reeducation by being able to employ those who already have experienced the creative educational system based on practical technologies but also solidify the technical basis of SMEs themselves with weak basis for product development and research.

In addition, the university has rendered services to change the western coastal areas into a basis for international exchanges by utilizing the characteristics of the industrial complexes exporting to China and by transforming the western coastal areas reaching the Songdo Special Zone into international industrial cities and cities of technical innovation.

Moreover, the university has been a catalyst for the technical innovation of local businesses by having the ability in information and theoretical basis of the university and the field technologies and difficulties of enterprises to be connected to each other through the industrial-educational cooperation models of Korea Polytechnic University, such as partner companies, Engineering House and so on and the joint research of enterprises and the university. The university has also provided the opportunity of technical innovation to local businesses by enabling SMEs that concentrate their technical skills on traditional industries to see the technical trend of the world at any time.

2. Outcomes of Education Tailored to Industrial Settings

Korea Polytechnic University is firmly maintaining its legitimacy and identity as a polytechnic university and has achieved a 100% rate of employment among its graduates 6 years in a row since its opening in 1998. This can be explained as the outcome of the educational system characterized for industrial-educational cooperation such as the curriculum tailored to demands, project practices, graduation project system, and partner company system.

Since its opening, Korea Polytechnic University has established the medium and long-term development plan through 2007, which is the 10th anniversary of its opening, for the establishment of a new model for engineering education and the process of practice focusing on the presentation of visions for the university's development and leadership of the president of the university. The university has undergone the decision making process where the opinions of the members of the university such as the teaching staff, students and businesses such as its partner companies are unified, and the decided matters were promptly pushed forward.

In particular, the partner company system of Korea Polytechnic University is a system that practices the industrial-educational cooperation of the 'university as the laboratory for enterprises, the field of enterprises as the campus for the university.' The Sihwa and Banwol National Industrial Complexes where the university is located is the largest region in Korea where SMEs are concentrated, and needs the infrastructure of support of professional technologies and manpower. Through this connection, Korea Polytechnic University came to invent and construct the partner company system as a practical industrial-educational cooperation system in which enterprises receive the support of technologies, equipment and manpower from the university and the university utilizes enterprises as the place for the education tailored to the field and the employed.

The main factors by which Korea Polytechnic University has succeeded as the central university in industrial-educational cooperation in the region are the fact that the university visited the field of industrial-educational cooperation, the maintenance of the identity of the university oriented to the authentic polytechnic university, establishment of the medium- and long-term plan under the presentation of visions and leadership of the president of the university, the concentration of the practical capability of all the members and so on.

The concrete success models of industrial-educational cooperation are the formation and operation of the curriculum tailored to users through the research on demands of businesses, development and directions of bottleneck technologies through the partner company system, the research institute attaching importance to the results of joint use with enterprises, the system of approval for establishment of equipments for research, the system of evaluation of achievements of professors laying stress on industrial-educational cooperation, the promotion system and so on.

Korea Polytechnic University, which was established 13 years ago, had the 5th largest research cost per professor on the basis of the performances of the education, research and industrial-educational cooperation in the meantime, and was selected as the 'best university in industrial-educational cooperation' by the Ministry of Education & Human Resources Development in 2001, as the 'excellent university in educational reform' in 2002, and as the 'best university' in the national comprehensive evaluation of universities in 2002. In addition, in 2003, the university was selected as the excellent university in characterization with the 'construction of the engineering educational system through enterprise clustering' in the evaluation of financial support for excellent universities in characterization conducted by the Ministry, and in 2004, the university was selected as the 'central university in industrial-educational cooperation' and the 'excellent university in characterization' by the Ministry of Commerce, Industry and Energy and the Ministry of Education & Human Resources Development and as the best university in the 'evaluation of the field of mechanical engineering' conducted by Korea Council for University Education. Moreover, the university was selected as the 'excellent university in characterization' in 2004 through 2007, and took the 8th place in the financial and results-based level of private universities as evaluated by the Korea Foundation for the Promotion of Private Schools.

Korea Polytechnic University established the 2nd medium and long-term development plan in December 2002 on the basis of the assessment of outcomes of the 1st medium and long-term plan, and has been practicing its takeoff in earnest since 2003. The 2nd medium and long-term development plan (2003 through 2007) made the best prestigious university in industrial technologies by 2007 as the vision, and established its development goals as the university focusing on users, the university of industrial-educational cooperation that coexists and competes with enterprises through industrial-educational cooperation, nurture of creative and practical talents and so on, and the university pushed on with the plan.

At the same time, the core policy is to newly establish and practice the 'new development model for industrial-educational cooperation of Korea Polytechnic University' on the basis of the evaluation on the industrial-educational cooperation model and operational outcomes of the university until now, and the main strategy for promotion can be said to be the characterized curriculum of the education focusing on field practice and practical technologies.

In order to build the educational system close to the field centering on users, each department of the university selected the field-friendly characterized majors on the basis of the opinions collected from the partner companies and so on and composed the characterized subjects tailored to users corresponding to characterization and at the same time operated the curriculum focusing on the field, and thereby achieved a rate of employment of 100% for 9 consecutive years by nurturing the technical manpower that can be utilized by businesses immediately.

Table 4-1 | Outcomes of Education Centering on Industrial Settings

Sector	Main outcomes
System of characterized major for each department	○ Plan for characterization of major for each department and appointment of professors for characterized majors
Curriculum tailored to users	○ Decision of the curriculum of 1st stage before the opening of the university in 1998 ○ Implementation of curriculum tailored to users of 2nd stage in 2000 ○ Reorganization of curriculum reflecting the research on demands every year
Engineering House	○ Planning of the business of the plaza for technical education in industrial-educational cooperation in 2002 ○ Construction of the comprehensive Engineering House in 2004 ○ Starting of construction of the plaza for technical education in industrial-educational cooperation in 2005 ○ Completion of the plaza for technical education in industrial-educational cooperation in 2006
Project practice of students	○ 956 students in 2001; 1,596 students in 2002; 1,519 students in 2003; 1,887 students in 2004; 2,140 students in 2005 and 1,667 students in 2006
Project research	○ 116 students in 2002; 110 students in 2003; 77 students in 2004; 81 students in 2005 and 148 students in 2006
Graduation project research	○ 97 cases in 2001; 134 cases in 2002; 138 cases in 2003; 161 cases in 2004; 226 cases in 2005 and 348 cases in 2006
Expansion of the ratio of practices	○ Expansion of the ratio of the subjects with experiments and practices to about 40%
Rate of employment	○ 100% for six consecutive years, 2002 through 2007

3. Outcomes of Construction of Basis for Research and Technical Development Jointly by Industry and University

Korea Polytechnic University opened 31 cooperative research institutes, utilized 222 adjunct professors focusing on engineers working in businesses for lectures and researches and conducted the lectures for the workers in businesses in 11 departments for the joint research by industry and university.

Table 4-2 | Research Centers Related to Main Industrial-Educational Cooperation

Research centers	Date of establishment
Technical Business Incubator	August, 1999
Superprecision Processing TIC	January, 2001
College of Technical Directions for SMEs	April, 2000
Siheung Environmental Technology Development Center	July, 2000
Remote Technical Support Center	March, 2001
IT Graduate School	February, 2001
Consortium of Industry, University and Institute	May, 2001
Supporting Center for Development of Assembly Inspection Equipments	January, 2003
Superprecision Optics Cluster	April, 2003

There are about 30 cooperative research centers other than the above research centers, and the university is oriented to 1 research center per professor. The results of R&D and technical directions of full-time teachers utilizing the research institutes in industrial-educational cooperation and so on largely increased every year, and the research cost per professor of the university achieved the level of No. 2, among all universities in Korea.

Table 4-3 | Results of R&D and Technical Directions

(Unit: case, one million won)

Category	2001		2002		2003		2004		2005		2006	
Category	Tasks	Amount	Tasks	Amount	Tasks	Amount	Tasks	Amount	Tasks	Amount	Tasks	Amount
R&D	76	4,242	83	4,209	147	13,138	258	26,747	281	31,532	347	34,181
Technical directions	19	0.47	24	0.48	27	0.56	16	42	56	114	-	

4. Outcomes of Overseas Cooperation

The industrial technical university model is being assessed as a success case for the nurture of technical manpower in developing countries still weak in the aspect of the nurture of industrial technical manpower that served as the foundation for the experiences of rapid economic development of Korea, and the businesses for globalization of the model such as the informatization of education, spread of the industrial-educational cooperation model, establishment of industrial technical university and so on are being promoted.

Currently, many colleges and universities at home and abroad are visiting Korea Polytechnic University to benchmark the characterized educational system based on industrial-educational cooperation of the university, and the university is receiving the requests for the establishment of the industrial technical university model from overseas, and various cooperation programs are being promoted for the development of education in industrial-educational cooperation in foreign countries.

Table 4-4 | Countries Requesting the Industrial Technical University Model

Country	Institution	Business (name)
Algeria	MATET	Algeria Cutting-Edge Technology Africa Center (CATICTA)
Algeria	* The Ministry of Land Development and Environment of Algeria	
Laos	MoE	Establishment of Laos Polytechnic University
Laos	* The Ministry of Education of Laos	
Brazil	SENAI	Establishment of Brazil Polytechnic University
Brazil	* The Vocational Training Center of Brazil	
Paraguay	World-OKTA (Paraguay)	Establishment of Paraguay Polytechnic University
Indonesia	UI	Establishment of TIP (Techno Innovation Park) of Indonesia

In addition, a variety of consultations are being conducted for the informatization of industrial technical education with the government departments and educational institutions of Africa, the Middle East, Asia and Central and South America.

Table 4-5 | Cooperation in Informatization of Industrial Technical Education

Country	Institution	Business (name)
Algeria	INTTIC	Plan of Building INTTIC e-Learning center
Algeria	* Institute National Des Telecommunications et Des Technololgies DeL'information et de la Communication	
Tunisia	Manouba	Cyber education center and e-campus system at Manouba
Morocco	USMBA	Establishment of a Multimedia&e-Learning Center to improve employability
Morocco	* University of Sidi Mohamed Ben Abdellah	
Tanzania	UDSM	Establishment of Multimedia Center to Enhance e-Learning

Country	Institution	Business (name)
Tanzania	* University of Dar Es Salaam	
The Azerbaijani Republic	ATU	Education Network for Azerbaijan Technical University (AzTU)
The Azerbaijani Republic	* Azerbaijan Technical University (AzTU)	
Uzbekistan	NUUz	The Establishment of Smart University System for the National University of Uzbekistan
Uzbekistan	* National University of Uzbekistan (Nuuz)	
Indonesia	UI	Plan of Building University of Indonesia e-Leaning Center
Indonesia	* University of Indonesia	
Laos	Laos National University	Establishment and Operation of the Industrial Technical e-Learning Center

Korea Polytechnic University is administering not only the educational system and infrastructure but also the training course for industrial technical teachers for students from foreign countries for the industrial technical development of developing countries.

The training course is made of the Korean language course for 1 year (or one and a half year) and the undergraduate course (transfer course) for 2 years, and is a curriculum of 3 years in total. The subjects for the nurture of industrial technical teachers are the introduction to pedagogy, educational psychology, educational methodology and educational engineering methodology, and other than that, the curriculum tailored to the field such as project practice, research graduation project and so on are being conducted focusing on the industrial technical educational programs centering on the field of industrial-educational cooperation and thereby the university has been supporting the nurture of practical technical professional manpower of developing countries.

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Chapter 5

Implications

1. Directions of Education for Technical Manpower Based on Industrial-Educational Cooperation
2. Directions of Industrial-Educational Cooperation for Industrial Development
3. Plans to Effectively Spread Education through Industrial-Educational Cooperation

Implications

1. Directions of Education for Technical Manpower Based on Industrial-Educational Cooperation

The changes of technical educational system for nurturing technical manpower of Korea are related to the development of Korean society. Since the 1960s, the educational system for nurturing technical manpower has changed and developed the policies for vocational technical education in a timely manner to nurture and supply the industrial technical manpower demanded following the stages of industrial development, and also has transformed the related policies for the nurture of technical manpower that can forecast and lead the changes of the industrial society of the future.

In the current knowledge-based society of the 21st century, the role of colleges for the nurture of technical manpower is being more emphasized. In the knowledge-based society, it is more important than anything to establish technical skills in advance, and as the technical manpower with expertise is recognized anew as an agent to increase the national competitive edge more than other production factors such as labor, capital and so on, the demands for the role of university as the core main agent of creation, transmission and spread of knowledge are increasing more and more as opposed to the previous role as the center of knowledge transmission.

The emergence of the theory of role of college education in the nurture of technical manpower proves that the current college education fails to properly provide the manpower meeting the demands of industrial settings. The largest problem of the engineering manpower nurtured up until now can be said to be the shortage of ability to apply to practical work, and in order to improve the problem, it is necessary to spread the educational plan for the nurture of practical professional technical manpower such as formation of curriculum focusing on the field, replacement of the paper with the results of performance of projects and so on rather than an education centering on lectures.

As the technical development of the industrial settings gets faster, a systematic institutional support system should be prepared not only to intensify industrial technical competitiveness but also to nurture the good technical manpower that has what it takes. A flexible social and economic system that enables the construction of the system nurturing elastic technical human resources, smooth movement of technical manpower between sectors and the increase of utilization is needed.

As it is newly evaluated that one of the important sources of the competitive advantage between countries is the accumulation of industries, efforts to sharpen the competitive edge by utilizing the advantage of location in a specific region and accumulating the related technical human resources are being put forth. The reason why industrial accumulation and human resources development at the regional level is of consequence is that proximity in the geographical, cultural and institutional meaning provides the benefits in the specialty and relationship of the region that is hard to connect at a long range, information, incentive and other productivity. Hence, the promotion has been broadly conducted at a national level to enjoy the effects of organic nurture of technical manpower between industry and university in localized areas.

One of the weighty reasons why the main advanced industrial countries in the world came to possess a global competitive edge today can be said to be that they made the efforts at a regional level to construct the basis for industrial development formed in local areas and to nurture and utilize industrial manpower. Korean industry is sensitive to market situations or changes of economy and has structural issues that are difficult to fundamentally settle, but, the most basic issue can be said to be the insufficiency of technical human resources of good quality needed for industry.

The absence of professional technical manpower in industrial settings leads to the decline in quality of products and productivity, and this finally causes the fall of quality of finished products with production of inferior goods, and thereby hinders the development of industry itself by weakening the competitiveness of products and bringing direct losses such as the drop in sales of enterprises. That is, the deficiency of skilled and technical manpower needed by enterprises brings the enfeeblement of market competitiveness, and the enfeeblement of market competitiveness causes the reduction of sales and leads to the shortage of funds, which is a vicious circle. In order to break from the continuity of this vicious circle, it is necessary to improve the ability and technologies of technical manpower and to nurture strategic industrial technical manpower at a national level.

In particular, the nurture of local industrial manpower not only settles the issue of manpower but also improves technical skills of enterprises, and, further, begins to cut the vicious circle in Korean industry. It is very important to build an organic cooperation system between university, businesses and related main agents and the infrastructure for nurturing technical manpower in order to ceaselessly nurture the industrial talents in the medium and long term at a regional level. Local technical manpower can be nurtured through the construction of an efficient industrial-educational cooperation, and it is necessary to

support diverse technical educational programs so that substantial industrial-educational cooperation focusing not on the existing suppliers (schools) but on the businesses (users).

It can be said that it is necessary for colleges to arrange a system nurturing technical manpower that can induce the advancement of local industrial structures, to conduct field practices together with theoretical education for the technical specialization of manpower produced by colleges, to connect with industrial settings so that the technologies produced can be commercialized, and to build the system nurturing technical manpower in which research, education and technical development can be performed simultaneously.

Korea Polytechnic University can be said to have tried to improve the quality of technical manpower in industrial settings by nurturing and producing practical professional technicians in the changes of environment at home and abroad, to have rendered services to the strengthening of international competitive edge of manufacturing industry and facilitated the vitalization and development of technical education which fell behind, to have doubled the effects to induce the idle manpower and the young unemployed to become involved in industries, and to have developed the industrial-educational cooperation into a systematic and efficient connecting system on the basis of the deep trust between industry and university and plenty of experiences in mutual cooperation.

The success factors of the nurture of technical manpower through Korea Polytechnic University can be said to be the formation of consensus by and between the local main agents such as the university, businesses and so on, the efforts for nurturing professional manpower with a more planned medium- and long-term view and positive attitude and the continuous endeavor of the Korean government and local governments to make the point of mutual contact constantly.

The partner company system and the Engineering House system of Korea Polytechnic University is being evaluated as a successful model of education through industrial-educational cooperation, and the developing countries lacking resources may consider the introduction of this model of education through industrial-educational cooperation.

But, considering that realistic conditions such as security of sufficient finance and so on should be first settled in order to introduce the model of Korea Polytechnic University as a regular curriculum, it may be considered to reform the current educational system of vocational training centers and to push ahead with education tailored to the field and to expand its implementation by stages even if it is not a regular curriculum.

For this purpose, it is necessary to select the key industries of developing countries, to analyze the industrial demand with the existing technical educational institutions, workers for businesses, skilled workers in the field and so on as the subject and to design a new technical curriculum to provide the opportunity for continuing education to skilled workers in the field.

On the basis of that, it will be possible to actively utilize the infrastructure such as the space for education and research and so on of the existing educational institutions such

as the current vocational training centers and so on and to operate the curriculum tailored to the field by stages such as industrial-based learning, learning through participation in commercialization and development, case study, learning by inspiring entrepreneurship, learning by inviting experts, having field trips and so on.

It is thought that the proper implementation of the partner company system and Engineering House system of Korea Polytechnic University for the environment of developing countries will be able to guarantee the opportunity for continuing education to workers in technical posts in industrial settings and to greatly contribute to the development of industrial technologies of the whole nation by matching industrial demand, which is important in national economic development, and supply of practical professional technical manpower.

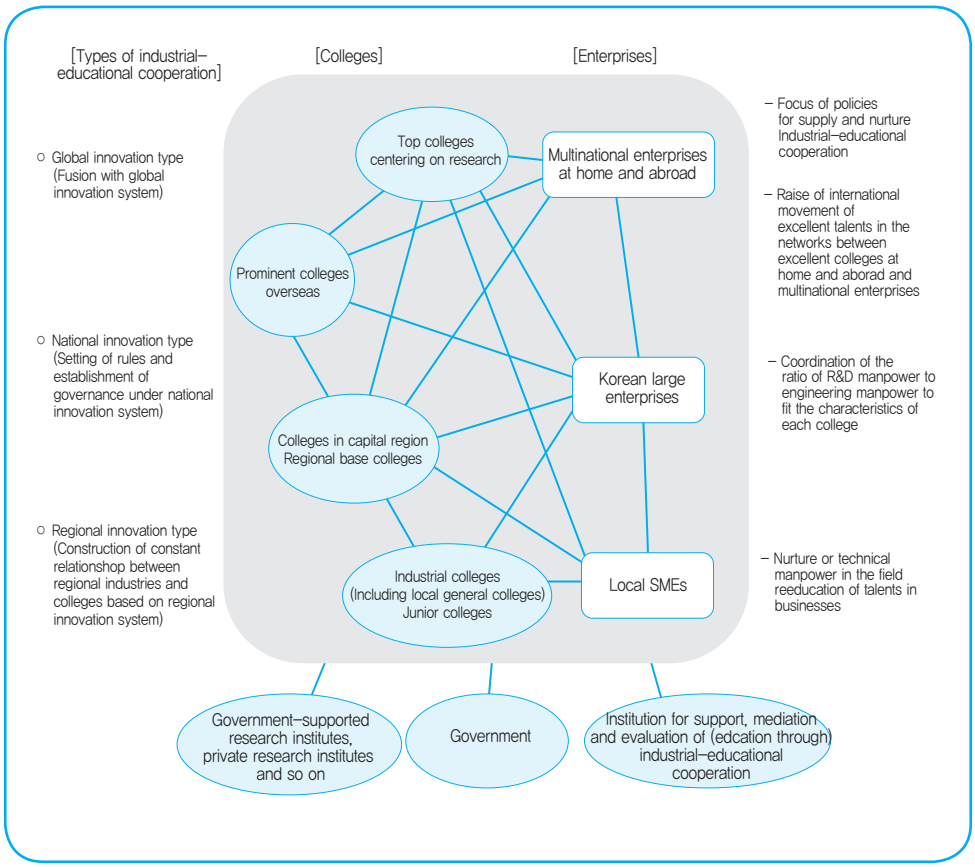
2. Directions of Industrial-Educational Cooperation for Industrial Development

For the past half century, Korea's policies of education and human resource development have been established and implemented to satisfy the demands for manpower following the stages of industrial development. In the period of light industrialization, the educational system controlled by the state was settled, and in the period of heavy chemical industrialization, the generalization of secondary education and expansion of vocational training were pushed forward; these policies are being evaluated as having been very favorite effective.

The manpower nurturing system through industrial-educational cooperation should be constructed in a unique shape which is suitable to the pertinent country's stage of economic development, industrial structure, and system of technical innovation, as well as competitiveness of colleges, social and cultural environment and so on. As the construction of the manpower nurturing system through industrial-educational cooperation that can lead the industrial innovation in harmony with the global environment is connected to the characterization of colleges, the efforts in policies such as presentation of directions by the government and so on are required.

The cases of the 'national innovation type' and the 'regional innovation type' are overlapped in considerable parts in that the various types of industrial-educational cooperation are connected with each other within the multiple manpower nurturing system through industrial-educational cooperation and, in particular, that the regional innovation system is recognized not as a subordinate component of the national innovation system but rather as a means to achieve national innovation.

Figure 5-1 | Types of Manpower Nutrition through Industrial Educational Cooperation and Focus of Supply and Demand Policies



Source: KIET (2006)

The manpower nurtured through industrial-educational cooperation of the global innovation type holds a high rank within the multiple manpower nurturing system through industrial-educational cooperation, and its core is the strategy for manpower nurturing connecting R&D and HRD. For manpower nurtured through industrial-educational cooperation of the global innovation type, first, the systems and environment should be formed so that some colleges can be developed into leading colleges centering on research in the world and the policies that can increase the international movement and utilization of talents should be considered.

In order to construct the manpower nurturing system through industrial-educational cooperation of the national innovation type, it is necessary to pursue the strategies of structural dimensions such as the setting of regulations, establishment of governance, establishment of proper supporting institutions and so on. For the manpower nurturing

through industrial-educational cooperation of the regional innovation type, the enhancement of constant cooperation between regional industry and colleges is necessary so that the nurture of technical manpower in the field, reeducation of manpower in businesses, nurture of manpower through development of bottleneck technologies in the field and so on can be effectively conducted.

In particular, as the importance of the regional innovation system is enhanced with the advancement of globalization, the regional innovation system is being recognized as a substantial subject that achieves national innovation now.

The Korean government has carried forward industrial-educational cooperation as a means of creation of new industry, creation of employment and vitalization of economy in the viewpoint of national innovation system, and the viewpoint is expanded to the regional innovation system, and the government has recently been intensively nurturing the colleges centering on industrial-educational cooperation to which the model of Korea Polytechnic University is applied nationwide, so that local colleges and industries can grow together.

As the cases in which a subsidiary company of a global enterprise played a core role in regional economic growth, the efforts to attract the higher value-added activities of global enterprises centering on the regional innovation system are more active. In addition, as the boundaries between countries become vague, some enterprises that have grown on regional bases are making inroads into the world.

Moreover, though only in a few cases, some venture companies that have cultivated the innovation ability in local areas have advanced into the world in relation to global enterprises. In this trend, the role of colleges is more emphasized.

Therefore, though the regional innovation system itself places a great deal of weight on the policies for the advancement of regional industries, in reality, most enterprises of middle standing and SMEs based on regions are failing to move on to the stage of possessing innovation ability and are staying in the stage of accepting technologies.

Considering this reality, the business of manpower nurturing through industrial-educational cooperation of the 'regional innovation type' is needed to be an industrial-educational cooperation that adds much to the raise of vitality of limited regional industries with the innovation of regional strategic industries.

In this case, colleges are in charge of nurture of technical manpower in the field, reeducation of manpower of businesses, lifelong education and so on, and the nurture of manpower through the joint research of industry and university is conducted through the promotion of development of bottleneck technologies in the field targeting SMEs. Practically, the innovation ability of regional colleges is considerably limited, and the regional economic development by industrial-educational cooperation has restrictions in many cases.

In many cases there are exaggerations of the expectations that the bases of research and development will be accumulated centering on colleges and the production activities will be accumulated through this and thereby the regional employment will be created. The reason is that though research is conducted in colleges, the production activities of enterprises can get started any place abroad as the movement of production facilities overseas spreads. However, the vitalization of industrial-educational cooperation through regional innovation has increased the possibility that enterprises can advance into the world on regional bases, and the possibility that the enterprises of the world can start production where labor cost, transportation cost, materials and so on are the cheapest. The industrial-educational cooperation of the regional innovation type should actively utilize this.

The directions of composition of the manpower nurturing system through industrial-educational cooperation in the era of opening and the policies of manpower nurturing through industrial-educational cooperation of each type can be summarized as follows. The expansion of operation of tailored curriculum can be called the core in the manpower nurturing through industrial-educational cooperation of regional innovation type. The regional innovation system is now recognized not as a component of national innovation system but as a means to achieve national innovation. In this case, it is necessary to develop various shapes of strategies for manpower nurturing through industrial-educational cooperation reflecting regional distinct characteristics.

Table 5-1 | Comparison of Systems and Policies among the Manpower Nutrition through Industrial Educational Cooperation

Category	Global Innovation Type	National Innovation Type	Regional Innovation Type
Subject of promotion	Leading graduate schools Global enterprises National strategic industries (enterprises) Central (local) government	Base colleges nationwide (graduate schools) Most industries (enterprises) Central (local) government	Regional base colleges Regional enterprises Local government
Manpower nurturing through industrial-educational cooperation (Focused shape)	Industrial-educational joint research	Education through industrial-educational cooperation and industrial-educational joint research	Education through industrial-educational cooperation
Research vs Education	Centering on graduate schools and research	Research and education together	Centering on undergraduate education
Nurture of manpower	Nurture of global high-class talents Internationalization of education	Co-op education including internship Tailored education	Tailored curriculum Co-op education including internship
Industries and enterprises	National strategic industries and global enterprises	Most industries and enterprises	Regional innovation enterprises and enterprises
Related policies and systems	○ Rise in international movement of talents ○ Distribution system of information of overseas manpower	○ Engineering education certification system ○ Institutions for mediation and research of co-op education ○ Consultative body for development of human resources for each industry	(Consultative body for development of human resources for each region)

Source: KIET (2007)

A tailored curriculum operates in all types, but it occupies an important position basically in the manpower nurturing system through industrial-educational cooperation of national innovation and regional innovation, and the trend is that some within the industrial world started to discuss the operation of tailored curricula and now the enterprises that establish tailored curricula are rapidly increasing.

Some argue that it is a plan of businesses to save themselves that they prefer tailored education because they feel desperate that they have to solve the problems for themselves because there is no solution at the national level for the procurement of manpower with ability for the major practical work needed by businesses.

However, some tailored education carries the possibility to distort the contents of college education or to disturb the labor market. In the operation of tailored curriculum, businesses have the status of monopolist, and therefore can cause the harmful effects of monophony in the labor market. The graduates that receive an education in narrow fields have low bargaining power. Unless a pertinent company employs them, their knowledge and skills become useless, and it is hard for them to move to another company even after employment. Because of this, their job mobility is low.

In addition, also from the viewpoint of colleges, tailored education aiming for training in narrow fields replacing the colleges inside companies or OJT can cause problems in the aspect of education. In particular, colleges are hit if the contract with enterprises does not continue for a certain period of time. In order to reduce these harmful effects, the Korean government is recommending using the existing departments and curriculum.

Therefore, unlike the colleges with the top priority of raising rate of employment, the leading colleges centering on research and belonging to the global innovation type should be prudent in establishment of the course.

It can be also considered to operate the tailored curriculum by a consortium of some colleges or enterprises in a certain region. In addition, the establishment of a tailored curriculum by forming an enterprise consortium through the mediation of the consultative body for development of human resources for each industry can be considered. The consultative body for development of human resources for each industry is an institution to enhance mainly the education and training of workers in the same industry, but it can collect, analyze and spread the information on the supply and nurture of manpower of the same industry.

Another factor is that in Korea, one of the important purposes for the enterprises of traditional manufacturing to operate an internship program, is to raise their image, and internship is not often operated centering on the needs of enterprises. Therefore, the actual effects of education through industrial-educational cooperation are not being achieved.

Internship is also failing to properly function as a path of employment of excellent talents, and is staying as a program for one-time experience. Repetitive education oriented to expertise should be conducted to expect the substantial outcomes of the internship.

In order for the internship in budding stage to reach a full-scale stage, it is necessary to construct the needed infrastructure. It is desirable to increase the capability of each college for the vitalization of co-op education or internship and to establish non-profit institutions and to let them take charge of development or mediation of programs of internship or co-op education.

The 'co-op education mediation and research institution (tentative name)' can efficiently develop studies and spread education programs through industrial-educational cooperation. This system makes it possible to coordinate and prevent the overlapping investments of colleges for development of programs and can bring the 'economy of scale' that cannot be accomplished easily with only the individual efforts of colleges. It is desirable to let this institution receive the support of the consultative body for development of human resources for each industry.

As mentioned above, the consultative body for each industry is an institution that deals with the issues of development of human resources with enterprises as the center, and thus enterprises are bound to have more interests in the education of their workers. If internship becomes a part of curriculum of colleges in some colleges such as engineering colleges and so on, an institution closely related to colleges is more appropriate than an institution based on the industrial world in order to systematically promote internship.

Therefore, an institution with full authority should be established for the epochal development of co-op education, and it is efficient for the organizations based on the industrial world such as the consultative body for development of human resources for each industry and so on to collect and analyze the information of the industrial world and to deliver the information systematically to the upper institutions.

Universities have played the roles of the main agent of innovation of industrial technologies and the supporter of industry, and for a long time, businesses and colleges have maintained cooperation. Industrial universities and Korea Polytechnic University can be called a representative case of the planning of technical development and technical innovation network through industrial-educational cooperation and the nurture of manpower tailored to the field.

In general, the types of cooperation are sometimes classified by the purpose of pursuit of industrial-educational cooperation such as education, technical development and so on and are other times classified centering on the main agents participating in the cooperation such as colleges, research institutes and so on; the units of participation. For the countries that have to plan industrial development based on technical skills, it is very essential to build a cooperation system for the technical innovation and commercialization of developed technologies in the real world.

The positive effects through the industry-university-institute cooperation are, in general, the effects of mutual learning, human exchanges, transfer of tacit knowledge and codified knowledge, a synergy effect through the formation of local networks, expansion of the

possibility of access to new knowledge of enterprises and so on. In particular, the process of industry-university-institute joint R&D, which can be called the most representative form of industry-university-institute cooperation, is evaluated to enable the economy of scale and range and to have the effects such as the expansion of investment and efficiency of R&D.

However, it does not mean that all sorts of industry-university-institute cooperation can obtain these positive effects by themselves. Industry-university-institute cooperation should be faithful to its principle to spread and share knowledge and technologies. The principle should precede any visible "activities" and can be said to be the "approach" on the cooperation. That is, the progressive will of related parties to participate is needed, and the precondition is the observance of the principle of operation such as farseeing intelligence, flexibility, excellence in quality, sufficiency in quantity, symbiosis, progress, actuality, continuity, equality, harmony and so on.

Industrial-educational cooperation can facilitate technical innovation and obtain a synergy effect through the connection between universities and businesses. Industrial-educational cooperation is emphasized at a regional level because it can maximize the effects of human, material and technical potential of the region not at an individual level but through cooperative activities and thereby accelerate the vitalization of regional economy and indigenous development.

To sum it up, attempts for industry-university-institute cooperation at a regional level are being conducted, but, the main agents still lack trust between them and are failing to have a systematic and efficient connecting system due to shortage of experiences in cooperation. Therefore, the participating main agents need to form a consensus with each other and to have a more planned and medium and long-term view and an aggressive attitude. In addition, the efforts to make the points of mutual contact ceaselessly and the efforts of the government and local governments that can support those efforts are needed.

In order for each main agent to increase the efficiency of cooperation for the effective execution of industry-university-institute cooperation, it can be discussed to regulate the personality and role so that each main agent can display its own capability to some extent.

What is of primary importance is the role of colleges. Colleges should make more positive endeavor to nurture and supply the technical manpower needed by enterprises. Also, it is necessary to put forth efforts to improve the structure of colleges and to discover a new educational model such as the introduction of incentive for which superior manpower of colleges can progressively participate in industrial-educational cooperation programs such as joint research with enterprises.

In this connection, the industrial-educational cooperation system of Korea Polytechnic University is being evaluated as having vitalized the local industry and successfully nurtured and supplied the professional technical manpower with capability in the field needed by the region. Engineering House, the partner company system, system of credits for field practice, diverse programs supporting enterprises, support for infrastructure and so on are becoming the model of a new college innovation and industrial-educational cooperation.

However, the role of colleges in regional technical innovation can work in a different way depending on the culture of colleges or the environment and specialty of the region where the colleges are located and the industrial-educational cooperation system also can show various shapes following the region and the time.

Enterprises should be able to raise the recognition of industrial-educational cooperation and to participate in the cooperation system in a more progressive position. They should be able to increase their technical ability through cooperation, and to maximize the effects of cooperation by setting appropriate items for technical development. Problems occur when an enterprise discovers that their new technology was already developed elsewhere; they must postpone the entry into the market due to inexperienced management or they an excessive conviction on their technology going back a long way.

Therefore, it can be said that enterprises need to broaden the range of knowledge needed for management activities such as the proper understanding of technical markets and future technologies, intellectual property rights and so on and to secure the competitive edge through the introduction of a creative technical management system.

Meanwhile, the central government and local governments need to establish an institutional support system for the industry-university-institute cooperation system to be implemented efficiently and to expand the financial support even more. Also, they should suggest the next-generation growth engine and technology roadmap (TRM) and thereby continuously present a vision of the future through the policies for industrial development of the country.

As the globalization progressed, the importance of the regional innovation system among the directions of nurture of manpower through industrial-educational cooperation began to stand out. The industrial-educational cooperation model of Korea Polytechnic University that has driven forward the nurture of manpower through industrial-educational cooperation focusing on the enterprises of middle standing and SMEs is a good case. Most enterprises of middle standing and SMEs based in local areas are failing to step forward to the stage to possess innovative ability and remaining in the stage of technology acceptance. Considering this phenomenon, the business of nurture of manpower through industrial-educational cooperation of 'regional innovation' should render services to the innovation of the strategic business of each region and the increase of vitality of limited local industries.

3. Plans to Effectively Spread Education through Industrial-Educational Cooperation

In view of the nurture of professional technical manpower that will lead industrial innovation and the mutual development of enterprises and colleges, the biggest issue of current college education lies in the system of colleges nurturing manpower in a way that is isolated from the demands of industrial settings for manpower. As the demands of industrial settings for manpower and colleges' nurture of manpower fail to be connected with each

other organically and the order imbalance of manpower sets in, colleges and enterprises are both suffering from difficulties in possessing competitive edge.

A system connecting the demands of industrial settings for manpower and the nurture of manpower of colleges should be constructed for the self-sustainable and constant development of colleges and intensification of industrial competitiveness. That is, the increase of industrial competitive edge and solution of youth unemployment are possible only when a system of organic cooperation between colleges and enterprises is built and the nurture of manpower of colleges can efficiently satisfy the demands of industrial settings for manpower.

However, despite this, industrial-educational cooperation between engineering colleges and enterprises is not lively yet and its general outcomes are poor, and it can be said that colleges are failing to efficiently nurture manpower.

Colleges and enterprises agree that the largest issue in the education of engineering colleges of Korea is that college education is not reaching the field because colleges are estranged from industrial settings. But, colleges recognize its seriousness much less than enterprises. That is, though the expectations of enterprises and colleges for the role of the education of colleges of natural sciences or engineering are similar, enterprises – unlike colleges-have deep dissatisfaction with the actual contribution of college education, and they have considerable dissatisfaction with the increasingly deficient education of majors.

In order for the education of colleges of natural sciences or engineering to satisfy the demands of industrial settings for manpower, firstly this difference in recognition between enterprises and colleges should be settled. Enterprises and colleges should be able to understand each others' demands through constant exchanges. However, the channel for cooperation between enterprises and colleges is not properly built, and thus the exchanges between enterprises and colleges are not vitalized; as a result, it can be said that in reality it is hard to bring the colleges of natural sciences or engineering closer to the field.

In order to have the education of colleges of natural sciences or engineering get closer to the field, it is important to nurture manpower through industrial-educational cooperation, but, the industrial-educational cooperation programs close to the field are not being vivaciously executed in colleges of natural sciences or engineering. Among the industrial-educational cooperation programs, only the industrial-educational joint R&D and internship are being relatively briskly conducted, and other programs have low rates of execution; in addition, enterprises are almost excluded from the reorganization of curriculum. This can be called the limit of nurture of industrial technical manpower of the current higher educational institutions.

In addition, there is a huge deviation in the participation of colleges of natural sciences or engineering in the industrial-educational cooperation programs, and the deviation is generally consistent. By and large, industrial universities are more constructive in industrial-educational cooperation programs than colleges. The industrial-educational cooperation

programs are not being actively performed in colleges of natural sciences or engineering, and even the programs being implemented are evaluated as generally unsatisfactory. Industrial-educational cooperation programs such as internships are analyzed to have great effects to increase the rate of employment of college graduates, but, their contents are mostly insufficient, and it is pointed out that they need to ensure internal stability. Although the industrial-educational cooperation programs being executed are being rated low, both enterprises and colleges are all agreeing on the necessity of expansion of industrial-educational cooperation programs.

In order for industrial-educational cooperation to be vitalized and to achieve the desired results, the voluntary and progressive participation of colleges and enterprises is required; and for this, it should be possible for colleges and enterprises to enjoy substantial benefits through industrial-educational cooperation. That is, the virtuous circle in which colleges increase the competitiveness of enterprises by meeting the demands for manpower of industrial settings, and enterprises increase the competitive edge of colleges through investment in the nurture of manpower of colleges, should be settled through industrial-educational cooperation.

In order for industrial-educational cooperation programs to be established in colleges, firstly, the channel for cooperation between colleges and enterprises should be built, and this is especially effective when conducted in industrial units collectively. That is, the demands for manpower and the nurture and supply of manpower should be organic in one framework by letting the demands for manpower that are peculiar to the pertinent industry and are shared by the enterprises of the pertinent industry and analyzed through a consultative group in industrial unit while having colleges and enterprises participate in the industrial-educational cooperation programs as partners of development of human resources in industrial units.

Industrial-educational cooperation programs should be extended and made more substantial in order to increase the efficiency of nurture of manpower of colleges through industrial-educational cooperation. Colleges need to characterize their function to nurture manpower by considering the educational purposes, conditions and so on of themselves and to institutionalize and set the industrial-educational cooperation programs suitable to the characteristics of each college.

It is expected that effective industrial-educational cooperation programs would be different depending on the types of characterization of each college-such as colleges focusing on research, colleges centering on undergraduates or colleges characterized for the field-and accordingly it is necessary to develop and administer the programs to accord with the function nurturing manpower of each college. In particular, each program should be able to substantially satisfy the needs of enterprises to facilitate the participation of enterprises and arrange industrial-educational cooperation.

In addition, the direct participation of enterprises in the nurture of manpower of colleges should be extended. The demands for manpower of industrial settings should be reflected

to the curriculum of colleges by institutionalizing the participation of enterprises in the composition of college curricula. It is necessary to strengthen the connection between college education and the field by expanding the human exchanges between enterprises and colleges and to cultivate the creative ability to solve problems and to adapt to the field through that. The institutional support of the government, local governments and so on for the enterprises and colleges participating in the industrial-educational cooperation programs is also of importance.

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ISBN 978-89-93695-79-3

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