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The Role of Universities in Research and Development and Technical Services(R & D & TS) in Korea

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Abstract

Abundant hard-working and well-educated human resources were the important sources of the spectacular economic success during the last decades. In contrast to the past sources of economic growth during the 1970's when labor and capital along with economies of scale were the dominant factors (the university has played an important role in the national economic success by supplying quality labour and intellectual talent.), the level of science, technological innovation and capital inputs will be of vital importance for future economic growth in Korea.

The balance of payments in technology transfer together with the current state of R & D activities has been reviewed and some of the issues and problems underlying the university system that tend to hinder research in collaboration with research institutes and industries have been outlined. Serious imbalance in the allocation of research funds among research sectors was identified as the most serious problem to be fixed. The importance of science and technology education in private universities for the enhancement of the national level of science and technology has been re-examined. Also research and development in engineering and technical services has been emphasized. In conclusion, ways to bolster the role of universities in the research environment in cooperation with industry and research institutes have been suggested.

1. Introduction

The unprecedented spectacular economic success of Korea in 1960's was primarily directed toward enhancement of national income ; abundant hard-working and well-educated human resources were the important sources of the economic success. Such resources will continue to be important in Korea's potential for growth in the future. Korea is now considered a 'newly industrialized country.' In the next decades, Korea's major goal is to

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make a smooth transition from a newly industrialized nation to an advanced society such as Japan, the United States, and the European countries. However, the prospects of the Korean economy are not all promising, considering a number of currently emerging issues, both internal and external. In contrast to the past sources of economic growth during the 1970's when labor and capital along with economies of scale were the dominant factors, the level of science, technological innovation and capital inputs will be of vital importance for future economic growth.

Up to now, the university has played an important role in the national economic success by supplying quality labour and intellectual talent. The fact is that most of the universities in Korea bave so emphasized liberal education('Humanities') that the basis of scientific research is somewhat fragile. Nonetheless, not much attention seems to have been paid to the enhancement of college education in science and engineering, or to the research environment at the level of national education policy. The role of the university in research activities involving industry and government supported research institutes should be re-examined. There are many problems in science and technology education in universities in Korea. However, the current government policy in R & D-the creation of new engineering institutions-may well only to exacerbate the problem. Perhaps, now is the time to reconsider educational policy in science and engineering and to foster the existing university system.

Until now, the primary emphasis has been put on industrial product development rather than on university-centered basic and applied research, mainly because product development is a matter of survival for industry and is directly related to national economic growth. Hence, necessary technologies need to be imported from overseas. However, the policy of technology imports has its own limitations, as all we know.

In the following remarks, I will review the balance of payments in technology transfer together with the current state of R & D activities ; I will then outline some of the issues and problems underlying the university system that tend to hinder research in collaboration with research institutes and industries in Korea. In conclusion, I will suggest ways to bolster the role of universities in the research environment in cooperation with industry and research institutes.

2. Economic Growth by Technology Imports.

Technology is an important asset ; it costs an enormous amount of money and time. Hence, it is an economic good that can be traded at the going market rate. In fact, technological know-how is the most expensive and highest value-added commodity of any of the technology intensive products available on the market. This is because a proprietary technology is a monopolistic good ; it will not be available in the world's technology-transfer market until it reaches a point of maturity in the view of the life-cycle of technology.

Since 1962 Korea has continuously and enthusiastically imported foreign technologies from industrialized countries all over the world. The importation of modern technology was necessary to continued economic growth at a time when the technology base was poor. The importing of technology was actually encouraged and supported during the 4th 5-year Economic Development Plan(1977-1981) and thereafter(9).

According to reports from KIRI(Korea Industrial Research Institutes, 1988) and KOSEF-(Korea Science and Engineering Foundation 1988), the recent trends of balance of payments in technology transfer are as follows(3,5) :

Table 1. Balance of Payments in Technology Transfer
(in millions dollars)

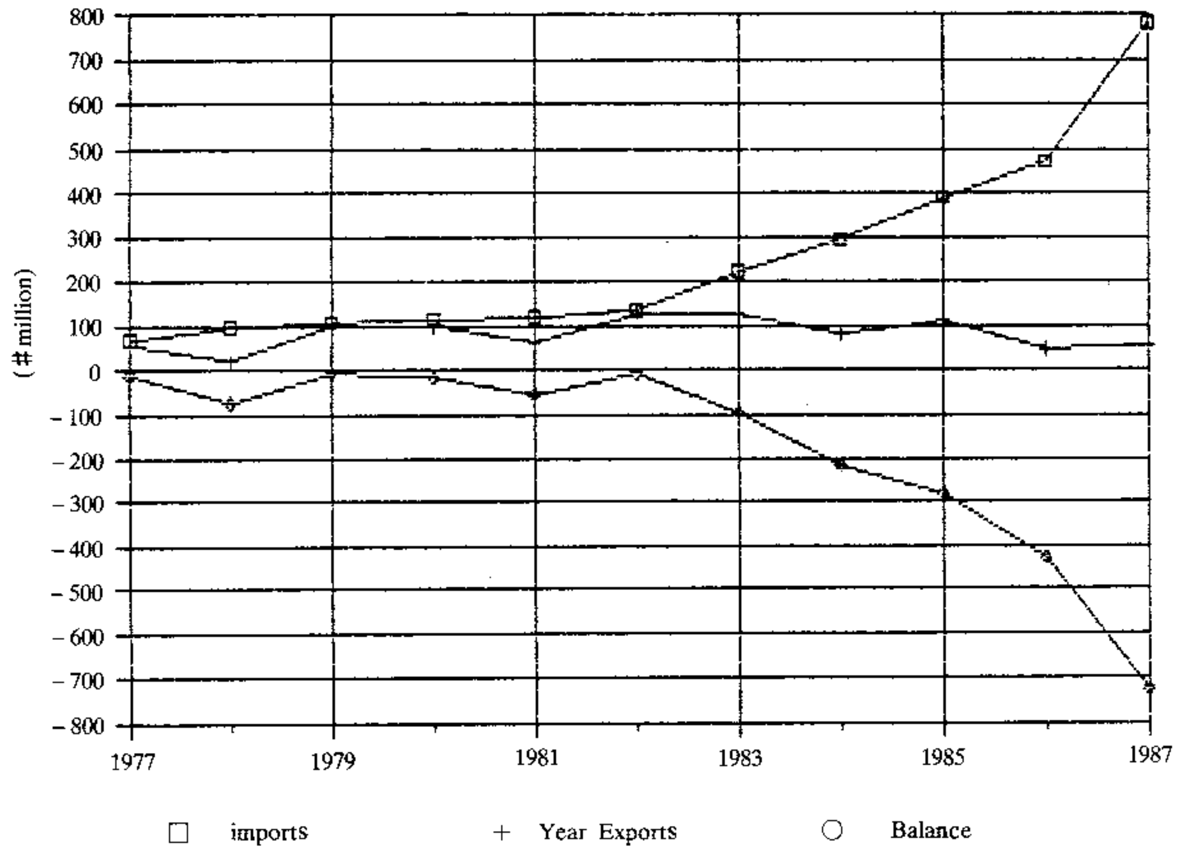
Year	Imporrs			Exports			Balance
	Manuf. Tech.	Engr. Service	Total	Manuf. Tech.	Engr. Service	Total	
1977	58	9	67	–	55	55	– 12
1978	85	10	95	–	20	20	– 75
1979	94	14	108	2	96	98	– 10
1980	107	9	116	6	93	99	– 17
1981	107	12	119	12	51	63	– 56
1982	116	20	136	18	109	127	– 9
1983	150	73	223	19	108	127	– 96
1984	213	82	295	17	63	80	– 215
1985	296	94	390	11	100	111	– 279
1986	411	63	474	12	36	48	– 426
1987	524	258	782	9	48	57	– 725
Total	2161	644	2805	106	779	885	– 1920
(83 – 87)	1594	570	2164	68	355	423	– 1741
(%)	74	89	77	64	46	48	91

By 1987 the total number of technologies imported from overseas had reached 4692, of which a little over half were imported during the period from 1983 to 1987. Korea paid about 2.2 billion dollars including royalties for patent and trademark and about 77 percent of this cost was incurred during this 5-year period, during which the restriction on technology imports was removed. More than half of the technologies were imported from Japan, and a quarter came from the United States. West Germany led the European countries by providing 250 cases. France exported 168 cases(3.6 percent of the total cases), and 164 cases were imported from Britain(3.5 percent ot the total technology transfers).

In terms of industrial categories, the machinery industry has carried the highest weight(1440 cases), followed by electric and electronic equipment industries(1071 cases), oil refining and chemical industies(908 cases), and the metal and metallurgical industry(452 cases). However, the number of technologies imported in 1987 for electric and electronic equipment industries outnumbered those of the machinery industry for the first time in history, indicating the need for modern technology in electric and electronic industries.

On the other hand, the amount of technology exports has decreased from $18.9 million since 1983. As a result, dependence on foreign technology is increasing(see Figure 1 ; Source : Reference 3). Korea is paying high prices for advanced technologies. It is never too late to increase investment in R & D in order to catch up with advanced foreign technologies. In order to use limited resources for R & D effectively, industy, university, and government efforts will require greater coordination. At the same time, it is important to establish a common ground for international cooperation with advanced countries, like Japan, and the U.S.A., through various research organizations which can share information, talent, and research facilities.

Figure 1. Balance of Payments in TechnologyTransfer



3. R & D Needs on Consulting and Engineering/Technical Service Area

According to the Industrial Research Institute Committee on the Definitions of Research (SRA Journal; Winter 1980, p 15), 'Research,' 'Development,' and 'Technical Services' are defined as follows:

Research is planned search or critical investigation aimed at discovery of new knowledge with the objective that such knowledge will be useful in developing new products/ processes/ services, or in bringing about a significant improvement in existing products, processes and services.

Development is the translation of research findings or other konwledge into a plan or design for new, modified, or improved products/ processes/ services, whether intended for sale or use. It includes the conceptual formulation, design and testing of products/ processes / services alternatives ; the construction of prototypes ; and the operation of initial scaled-down systems or pilot plants. It does not include routine or periodic alternatives to existing products, production lines, manufacturing processes, services, and other on-going operation, even though those alternatives may represnet improvements.

Technical Service is work performed by R & D personnel (usually requested by other areas of a company, such as manufacturing, marketing, or corporate management). It involves the application of existing technology to company problems in the existing business.

These definitions however, are apt to reflect the viewpoint of a person doing research mainly on hardware development, not necessarily that of a researcher whose major interests are on applied software products. I would like to recall the term "services." Engineering Service is ususally a system work required at the stage of implementation of the product development when the fruit of R & D is to be harvested. It is essentially a plant engineering technology. However, some of the products are neither hardware products nor plant-oriented products. In the information and knowledge industry, there are new products that are not very tangible, which yet, are very high value-added, knowledge-intensive products. They include computer software and ideas presented in a report. These ideas usually obtained through intensive research with conceptual computer modeling, could save millions of dollars that would otherwise have been wasted ; they are usually the subject of consulting. Since the idea can be obtained after processing and analyzing a great amount of data, and the methodology continuously evolves, basic research on this information technology also deserves special support from the government.

Recently, the Ministry of Science and Technology expressed the government's will to enhence software technology by increasing governmental support to software research. Currently, the governmental concept of software research seems to be restricted to basic softwares related to product development, such as semi-conductor technology and supermini computers, laser beam technologies, and ISDN techologies, etc. However, the concept of software should not be restricted only to hardware-related high-technologies. It should include applied high-technology softwares that are basic to consulting and engineering services. The software product would help decision makers at all levels of business. Eventually, it will stimulate and increase demand for the product of high technology hardware development. These include softwares for data processing and database management, applied softwares in the areas of optimal processing control of individual facilities, of decision support systems, or of planning and analysis.

Potential major trade partners of Korea in the technology export market would be less developed countries. They would need recent adaptable techonlogies and engineering experiences for their own economic and technology development ; the experiences of newly industrialized countries might be preferred to those of the more advanced countries'. And that would require a lot of consulting and engineering service technologies. The methodologies used for consulting and engineering services continuously evolve with advanced software and hardware technologies. Accordingly, R & D in these area will be essential to enhance the level of science and technology.

4. Current Status of Cooperative R & D Activities in Korea

At present, the scientific and technological level of Korea is far behind that of the advanced countries, and investment in R & D remains marginal. Currently, R & D activities in the public sector are being headed by research organizations, primarily National and Public Research Institutes, Government Supported Research Institutes, and Universities. There are 106 National and Public Research Institutes, 16 Government Supported Research Institutes [including Korea Advanced Institute of Science and Technology(KAIST)], and 351 University Research Institutes(including Research Laboratories in professional colleges). Not all of the National and Public Research Institutes are active in R & D, and the level of financial support by the government is different for each. Government Supported Research Institutes spend three to four times as much as national and Public Research Institutes, and they take the lead in projects for the National Research and Development Program(NRDP).

In the industrial sector, cooperative research is carried out through Research Associations, or in collaboration with either Government Supported Research Institutes or Universities(6). Large corporations have established their own research institutes, but many medium to small-sized firms fulfill their research needs through Research Associations for Industrial Technology. Recently however, the number of research institutes established by medium firms has increased. During 1988, eighty seven research institutions of medium sized firms were established. That totalled half of the 611 research institutions established by industries. Large corporations also participate in Research Associationa for their R & D needs, depending upon research subjects. The establishment of a Research Association by SamSung, GoldStar, and Hyundai for the development of the 4M－DRAM is a good example.

Universities have their own research organizations such as Korea University's Institute of Industrial Technology, The Research Institute for Basic Sciences, Electric Power, and

Table 2. Trends in Cooperative R & D Activities with Partners (Source : A Study on the cooperative R & D) activities by KAIST/KIRE, 1987, p. 84)

Year	Industries & Unversities			Industries & Research Institutes			Among Industries			Total Amount		
	Cases	Million		Cases	Million		Cases	Million		Cases	Million	
		Won	$		Won	$		Won	$		Won	$
1982	181	662	0.88	254	15087	20.1	5	255	0.34	440	16004	21.37
1983	106	523	0.65	321	17352	21.8	14	221	2.66	441	19996	25.13
1984	126	855	1.03	374	20774	25.1	25	1912	2.31	525	23541	28.45
1985	186	1868	2.09	432	25568	28.7	38	3468	3.89	656	30904	34.71
1986	207	2843	3.30	507	69488	80.6	46	4056	4.70	760	76387	88.67
Total	806	6751	7.97	1888	148269	176	128	11812	13.9	2822	166832	198.3
(%)	29	4	4	67	89	89	5	7	7	100	100	100

The Center for Advanced Materials Research at Seoul National University, or inter-university research institutes such as Inter-University Simiconductor Research Center(ISRC) in Seoul National University, etc. A recent survey conducted by Korea Industrial Research Institutes shows trends in cooperative R & D as in Table(2) :

As is shown in Table 2, cooperative R & D activities have increased rapidly since 1982, mainly due to the government's National Research and Development Program(NRDP). Although the number of R & D activities performed by industries and university linkage is higher than that among industries, the total amount of expenditures on R & D by industries and university linkages during the 5th 5-year plan is only about half that of industries. This reflects the fact that research opportunities were given to universities, but not the real research environment.

NRDP was initiated by the government during the 5th 5-year Economic and Society Development plan(1982 – 1986), encouraging the import of technology. During the 5th 5-year plan, $270 million was invested, and 2822 cases of R & D projects were carried out. And in 1987, or the $2.9 billion on total R & D spending, $131 million was invested for NRDP.

According to an administration white paper(6), Korea spent an estimated 3.8 billion dollars on R & D in 1988, and direct investment for strategically supported R & D projects under NRDP was about $152 million. $93 million came from government sources(an increase of 18% over the previous year's budget) and $49 million came from the private sector. The investment in NRDP will approach $290 million by 1992. Hovever, most

Table 3. Trends of R & D Cctivities under NRDP by Leading Research Institutes (Source : A Study on the cooperative R & D) activities by KAIST/KIRE, 1987, p. 209)(unit : $million, cases)

Leader	1982		1983		1984		1985	
	$	Cases	$	Cases	$	Cases	$	Cases
Gov. Supported Research Inst.	14.94 (40.9)	79	13.73 (61.6)	95	13.21 (60.7)	107	15.53 (54.6)	150
Industrial Research Inst.	0.42 (69.4)	2	6.83 (81.1)	16	1.86 (82.4)	6	4.67 (83.5)	23
Industrial Research Association	0.42 (61.4)	4	1.71 (56.1)	10	1.89 (64.8)	16	2.66 (67.7)	22
Universities	–	–	–	–	0.18 (35.6)	4	0.97 (55.0)	15
Total	15.78 (42.2)	85	22.27 (67.2)	121	17.14 (63.2)	133	23.83 (61.8)	210
Exchange Rate (Won/$)	748.8		795.5		827.4		890.2	

( ) represents % of research funds supported by Industry research projects under NRDP were carried out in collaboration with industries and government supported research institutes, rather than with universities(4) (Table 3).

These were distributed by research categories as follows :

Develpment of information technology ········· 18%
Advanced material science technology ········· 25%
Industrial technologies for the enhancement of market competition ········· 20%
Energy and resources conservation technologies ········· 14%
Technology needs for public sector projects to solve environmental and antipollution problems ········· 6%

Research and development expenditures in Korea reached a mere 1.99 percent of the GNP only in 1986 and increased to 2.12% in 1987, while more than two percent of the GNP has been devoted to R & D activities in most of the advanced countries since the early 1980's(1). According to "International Science and Technology Update ; 1987"(National Science Foundation), the U.S. and West Germany both had a 2.7 percent ratio in 1986 ; Japan's was 2.8 percent in 1985. In terms of absolute amount, the advanced countries spent between 10 and 100 billion dollars in 1985. The inadequacy of Korea's R & D expenditures thus becomes even more conspicuous.

Investment for R & D in universities in particular, is too meager to be effective, if we take into account the portion of Ph.D.'s in universities in the national science and technology community. This is apparent when we take a look at the distribution rates of total R & D expenditures among different sectors. In 1986 the total R & D expenditure of the nation was about $1.8 billion, which accounts for 1.99% of the total GNP of the year. Nineteen percent was supplied from the government and public sectors and 81% came from non-government sectors. It has been distributed among industries(67.1%), national and

Table 4. R & D Expenditures in Universities in the area of Science and Technology (Source : Major Indicators of Industrial Technology, KIRI, 1988)

	Korea (1986)	France (1983)	West G. (1985)	Japan (1986)	USA (1986)
Amount of investment (in $million)	190	1625	2530	6657	14200
(in comparison)	100	852	1327	3490	7445
% of researchers in universities	34	37	23	30	14
No of Students (in 1000)	1076	1144	1267	2122	12465
No. of Researchers in Univ.(in 10000)	16	34	30	121	113

public research institutes(3.9%), universities(10.8%), and non-profit research organizations(18.2%). The distribution rate for universities is higher in the United States(12.3%), Japan(13.3%), West Germany(14.2%), and France(15.8%). R & D expenditures in universities are compared in Table 4.

5. Difficulties in Performing Cooperative R & D with Universities.

Basic Research refers to investigation to gain knowledge for its own sake. Applied Research is investigation directed toward obtaining specific knowledge with commercial applications. Development is translation of techniques and scientific knowledge into concrete new products and processes.

There are problems in each of the research sectors of science and technology. Also there are several basic differences between research in the university and in industry. The university put emphasis on both basic and applied research, while industry emphasizes applied and developmental research. Applied research is the common ground where industry and the university can cooperate to their mutual benefit. However, the university is more interested in the basic research aspects, while industry is interested in the development aspects. Therefore, it is not easy to develop a cooperative projects between the two.

PROBLEMS IN COOPERATION WITH INDUSTRIES

Industries in general are in business to obtain a return on their investment. Hence it is very difficult to ask industries to provide funds for university research in isolation from their objectives of productivity. They might have their own research laboratories. But the primary responsibility of any industrial research laboratory is to insure that the corporation will remain successful in the future. The objectives of such research is new product development.

Industries under the pressure of competition turn increasingly to the importing of foreign technologies for their product development needs. Most industrial research laboratories in Korea are immature ; they immitate and assimilate imported technologies, but do not have much research experience in developing new products for themselves. In 1986, industry in Korea spent only about 1.35% of sales for R & D, which amounted to 1.2 billion dollars, compared to 2.3% in Japan, 3% in West Germany, and 3.5% in the U.S.A.. Korean industry spent 411 million dollars for technological imports(an estimated 30% increase from the previous year). That constitutes 34% of the total R & D expenditures of industry in Korea, which is high compared to the advanced countries, where ratios are in the range of 0.2% to 7%. This means that only two thirds of the total R & D expenditure of industry was put into the immitation and assimilation of imported technologies.

There is very little basic research in universities supported by industry. Industry does not believe that invention and new technolgy begin with basic research. However, industry is very much interested in innovation. Hence it iswilling to invest large amounts of money for research if a good return is anticipated. Industry tends also to engage in short-term projects, since technological obsolescence is the most important factor in determining the size of the budget and the periods of study. In one case that I know of, a corporation allocated more than a half million dollars to an engineering university for the development of artificial gem stones. The project was completed within two years.

Even after cooperative research projects are launched, actual cooperation during a research work is not a simple task. Usually it requires very close contact with company people in industry ; it is a time-consuming process what makes university professors reluctant to devote their time unless it is basic research. I have developed a decision support model for a company with several other coworkers. It is a computer model that finds the optimal product mix for a chemical company. It may be considered as a typical cooperative research and development work between university and industry in the area of applied software engineering. The first stage of the development was successful. and it is now under experiment. I learned in this R & D project that it is not easy to develop a cooperative R & D project with industry. Nobody wants to risk the responsibility for project failure. After all, it is typically the top manager who insists the development of the decision support model. Hence, the philosophy of the top manager seems to be the most important factor. So in order to promote cooperative R & D between industry and the university, it would be advisable to establish a department of R & D coordination in a corporate that could develop and evaluate cooperative research subjects, and could play the role of match-maker between industry and universities or between industry and research institutes. (Suppose a certain percent of the sales has to be spent on R & D, which would have to be mandated.)

Another thing that I learned in developing the kind of decision supporting computer model is the importance of interaction with personnel in the company. It is very important for research scientists or system analysts to understand the practice of the object system they want to model. Often there is a reluctance to share that kind of information. An individual cannot build a decision supporting system if he does not understand how the object system works. He has to have a chance to get along with the personnel who operate the system over a period of months or years. This cannot be accomplished simply by reading or by accident but has to be done by taking the initiative in arranging joint meetings, joint travel or joint projects with personnel in manufacturing, marketing, and other divisions in the company.

LACK OF GOVERNMENT SUPPORT TO SCHOOL OF SCIENCES AND ENGINEERING IN PRIVATE UNIVERSITIES

The problem of quality education in science and engineering is serious, especially at private universities which did not get any significant support from the government, although the nation benefited a great deal from the education they provided. According to the statistics in a report from the Ministry of Science and Technology, the university community reserves about 7,556 Ph.D's occupying about 80% of the total of 9,406 Ph.D's in science and technology in 1986. Of 7,556 Ph.D's 2,967 are in national universities, and 4,589 are in private universities. The total number of researchers in science and technology area holding the Ph.D in private universities is one and half times the number in national or public universities, and more than three times the number in government supported research institutes. As for the number of students, 74% of one million were educated at private universities in 1985 and about 37% were in science and engineering field(10). The proportions are similar in graduate schools. This shows the weight of private universities for the enhancement of the level of science and technology in Korea.

During the fiscal year 1986, the total R & D expenditures are reported at about $1.77 billion, of which $1 billion was spent on development, $473 million on applied research ($114 million was spent on strategic mission oriented applied research) and $294 million on basic research ; universities spent $190 million on which $50 million (3%) were supplied from government sources ($3.5 million were allocated to private universities.) How small a weight is given to the university by the government even in the field of basic research!

There are two primary sources of basic research funds : (1) the Basic Research Fund managed by the Korea Science and Engineering Foundation ; and (2) the Academic Research Enhancement Fund of the Ministry of Education. According to one report (Ref. 1, on p 117) in 1986, about 70% of the total available funds (about $72 million in 1986) went into the government funded research institutes, and 19% of that was allocated to the university ; 1% was for Industrial Research Associations ; and 8% was supplied to private industry. However, the government allocated only $3.5 million for R & D expenditures in private universities (Major Indicators of Industrial Technology, KIRI, 1988, p 86). There is a serious imbalance in the allocation of research funds among research sectors. This shows that there is no good national educational policy to enhance the quality of science and technology education and research environment in the university. Many of the research facilities are outdated, and many universities suffer from lack of laboratory space. As the success of KAIST demonstrates, governmental support of science and engineering colleges is essential for the enhancement of the overall science and technology level of a nation.

PROBLEMS IN THE UNIVERSITY SYSTEM

Many universities are undergraduate-oriented education systems, and they do not have a sufficient number of professors. National universities are in a better situation than private universities in terms of number of professors and instruction load. In national and public universities in 1985, the number of students per professor is 29.7 compared to 38.6 for private universities. Usually, professors at a private university have to teach a minimum of 3 courses a week. According to the 1986 yearbook of the Ministry of Education, however, approximately 60% of professors have to teach more than 4 courses.

The professors compete for research funds provided by the industry or research and science foundations. Once their research proposals are accepted and a research budget is allocated, they are managed officially by research organizations established in each university. A univisity research institute consists of several research divisions ; each division is usually composed of professors and their graduate students, technicians, postdoctoral fellows and administrators. These organizations are unstable, since the graduate students move in and out of the system (their primary concerns is to acquire a science and engineering degree, rather than to engage in research.) Getting a degree provides a student with exemption from military duties provided that he passes an examination. If we consider that enhancement of science and technology is an important part also of national defense, total exemption for students of graduate schools of science and engineering from military duties should be considered under certain conditions, so that the research effort shall not be interrupted. Government may set certain standards that a college should meet if it wants to have its students get the benefit of military service exemptions.

Many universities lack a strict administrative system that not only manages research funds, but also provides articulate administrative services. This is due, above all, to the relative lack of opportunities given to universities to perform research with sufficient funds to pay the overhead necessary to maintain a well established research administration system. It is due also to the tendency in academe to be adverse to bureaucracy. I learned that even at the Korea Advanced Institute of Science and Technology (KAIST), research activities are sometimes restricted by the bureaucracy surrounding fund management. An efficient administrative system is a necessity, however, if sizeable sums of research funds are to be efficiently managed in the future.

At any rate, it is no simple matter to carry out research projects under an undergraduate-oriented education system. The university system should be restructured toward graduate-oriented school system. Although most universities have their own graduate schools of engineering and science, many of them are feeble due to lack of professors and laboratory facilities(1). Being a graduate-oriented school means recruiting more professors for each department so that the instruction load of each professor can be reduced ; providing sufficient research laboratory space ; freeing professors from miscellaneous office work, unless it is research-related. Also, the library system should be revamped and expanded. Another important thing is to provide graduate sutdents with sufficient scholarship opportunities. Government should provide the same benefits that KAIST has enjoyed for more than a decade to every other engineering and science graduate school as long as the school meets certain standards. The marked academic succes of KAIST has stimulated enthusiasm for academic achievement in existing universitites. We may need many institutions like KAIST and the Korea Institute of Technology(KIT), which latter is projected as the undergraduate school of KAIST. Perhaps now is the right time to expand the same benefits to other universities and to stimulate academic competition in good faith among colleges of science and engineering. That is a sure way to improve the science and technology level of the nation and a way to fulfill the principle of equal opportunity in a democratic society. In order to finance the cost of restructuring existing colleges of science and engineering, the introduction of science and technology enhancement taxes should be considered.

In 1985, Inter University Semi-conductor Research Center was established at Seoul National University, and research activities began in october, 1988. The research center provides opportunities to share the expensive experimental facilities for basic semi-conductor research among member universities. This kind of joint research center among universities is desirable, since it avoids duplicate investments in research facilities that would require a large investment. I would recommand the establishment of similar research centers in other unversities according to research specialty as an additional means of enhancing R & D laboratory facilities in the university sector.

Genuine cooperative research among universities, industries and research institutes in Korea may be possible after the research system in the university is renovated.

Generally research in universities is tied intimately to its teaching function ; professors suffer from a heavy teaching load, peer counseling, and office work. Research in industry is tied to the eventual pay-off on investments. The total research experience of the university is typically limited to academic subjects ; since university faculty consider themselves as scholars, there is a tendency to be adverse to the commercialization of their knowledge. It is thus natural that university and industry interaction is minimal. Yet there are research scientists who accept their social obligation to facilitate the commercial application of their discoveries and to transfer knowledge gained from research experience to the field engineers.

There are many corporate managers who understand the responsibility of industry to society, but not to education. The university is the source of bright and able young people who will move into science and engineering and carry R & D forward in the future, both in the universitites and industry. Hence, industries have the responsibility for training and educating the research scientists of the future; this is a social responsibility. They may have to risk the failure by commissioning the university to carry out applied research projects.

Industry helps the university, and the university helps industry. Industry can help universities in terms of financial support of students or research projects of their interest. The university helps industry indirectly by providing the pool of educated people from which industry can draw employees. And the university can help directly by supporting studies of an interdisciplinary nature that provide a long-range vision of the critical leading technologies, and by advice on investment timings in critical new skill bases.

7. Concluding Remarks.

In the 2lst century, the state of their technology will distinguish the advanced countries of the world from the less developed ones and will separate the rich countries from the poor ones. Sustained economic growth is attained only by technological development and a balance of technology transfer with other nations, This can be accomplished by enhancing the level of investment in R & D and providing a R & D environment. In order for Korean industry to compete successfully in the world market and to sustain its economic growth through a self-reliant industrial structure in the future, the development of new basic and applied technology is essential. Korea, a resource-poor country, should develop an effective research and development system that can utilize the overall resources for R & D with maximum efficiency and create new technologies for national economic independence.

In order to set up an effective R & D system, the first priority should be to strengthen the university education system, since science and engineering education is the basis of all R & D. Science and engineering education at private universities, in particular, should get special support from the government. Private universities deserve special attention at present, because they have the greater portion of research potential, and the nation will need many more research scientists in the near future (74% of all students are educated at private universities.). Science and engineering education can be enhanced by inducing the university to restructure science and engineering colleges toward a graduate-oriented school system, such as KAIST.

The marked academic success of KAIST has stimulated enthusiasm for academic achievement in existing universities. Korea may need many institutions like KAIST. perhaps now is the right time to expand the benefits that KAIST has enjoyed for more than a decade to other universities and to stimulate academic competition in good faith among colleges of science and engineering. That is a sure way to improve the science and technology level of the nation as a whole, and a way to fulfill the principle of fairness of a democratic society by allowing equal opportunity to all eligible colleges.

Second, as a means to bolster the R & D system in the university according to each university's research specialty, establishment of research centers like ISRC at Seoul National

University at other university campuses should be encouraged and supported by the government.

At present, there is a strong tendency for industries to import technologies from overseas rather than to develop their own. The gap between Korea and advanced countries is likely to remain significant within the foreseeable future, unless R & D policies are set so as to ensure the effective utilization of existng R & D resources in universities, research institutes, and industry. In order to finance the aforementioned program for colleges of science and engineering, the imposition of technology enhancement tax should be considered.

Third, in order to promote cooperative work among universities, research institutes, and industries, the establishment of a research and development office might be considered ; such an office would match faculty members with research opportunities. It might be called the Office of Research and Development Coordination(ORDC). The main function of this office would be to develop research projects that are necessary to industry and to play the role of match-maker between industry and research teams in universities or research institutes by selecting appropriate persons to carry out projects. In addition, this office could form a research consortium for the collection of research funds from member companies or from research associations for the support of cooperative research into subjects developed by the ORDC.

Another function the ORDC would serve would be to establish a mutual exchange program whereby university professors and research personnel in industry and in public research institutes could exchange posts or parts of their mission for a year or two during sabbatical leaves. Of course this would require a high degree of selectivity based on mutual interest profiles. Professors would have to spend some of their time studying what is happening in industry. Industry and research institutes would have to give their staff time to find out what is going on in academe and in professional societies. Exchange programs and/or consulting agreements are sure ways to further cooperative research.

The methodologies used for consulting and engineering services no longer depend on experience only, but continuously evolve with advanced software and hardware technologies. R & D in these areas could make a significant contribution to the level of science and technology in Korea ; it also offers an appropriate inter-disciplinary forum for cooperation between the university and industry.

Lastly, it is essential to maintain close contact with overseas organizations whose level of technology is high and to establish cooperative research projects with them in order to learn and share information on advanced technoloies. However, unless the level of science and technology in Korea is comparable to that of these other countries, it will be difficult to maintain mutually beneficial relationships based on mutual respect.

NOTE : This paper reflects the personal views of the author. They are not necessarily those of Korea University. This view was presented at "Symposium on Industry-Public Research and Development Institute-University Linkages", sponsered by Japan Productivity Center, Tokyo, Japan, during February 20–24, 1989.

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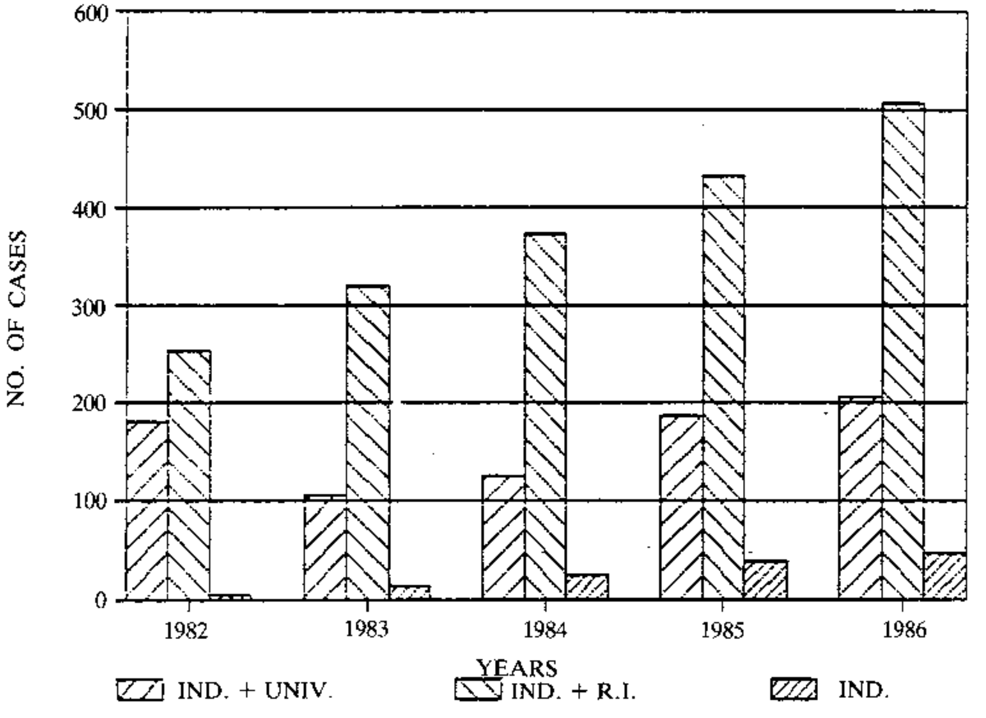
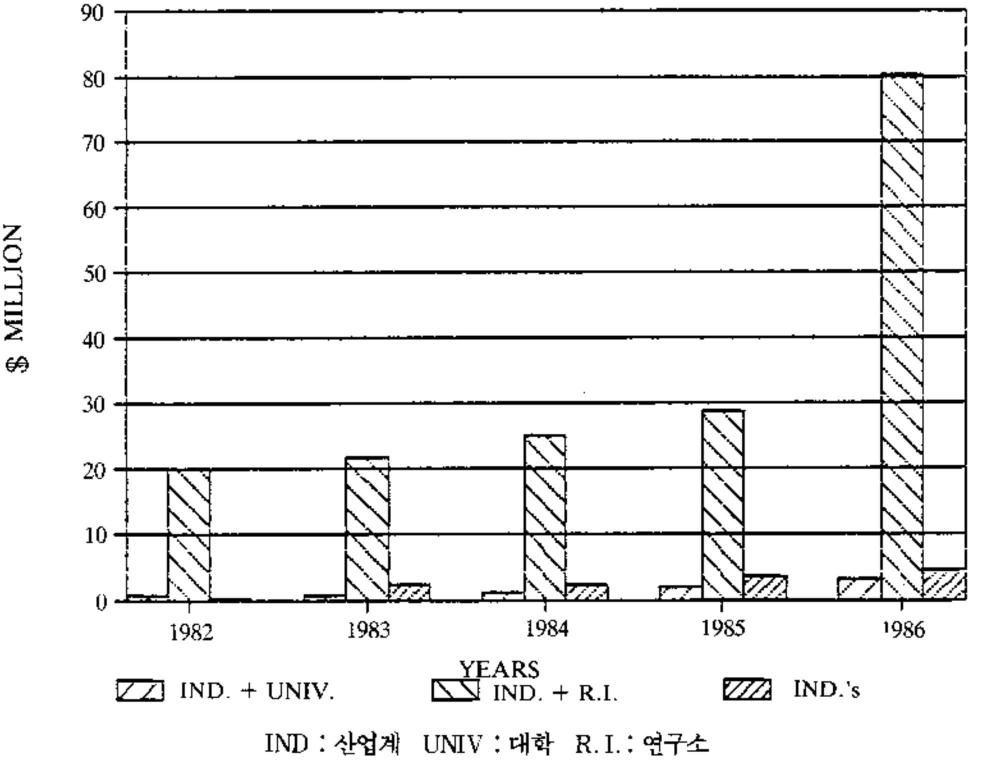
TRENDS IN COOPERATIVE R & D ACTIVITIES





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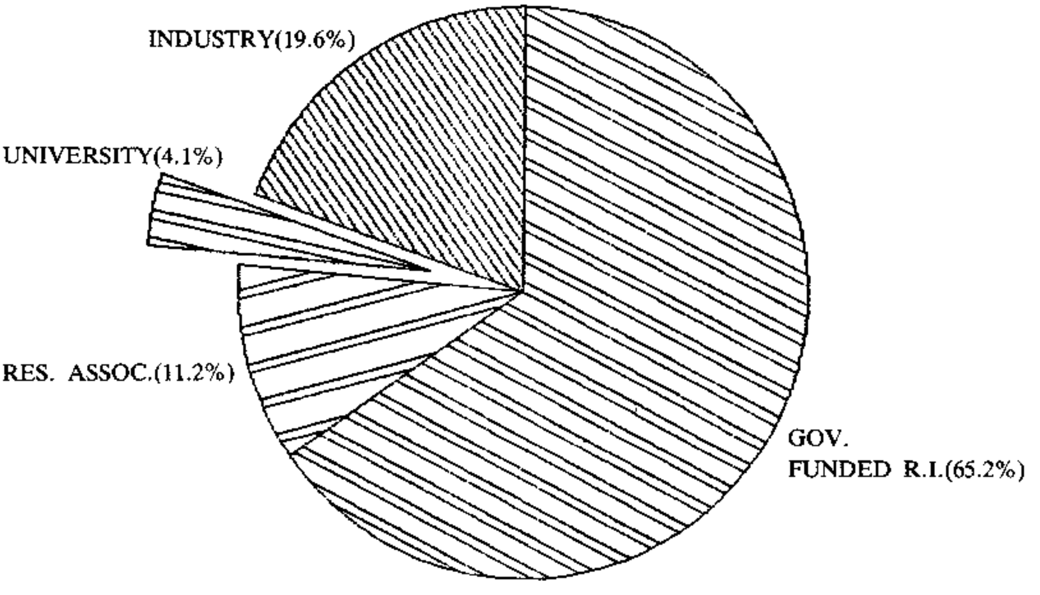
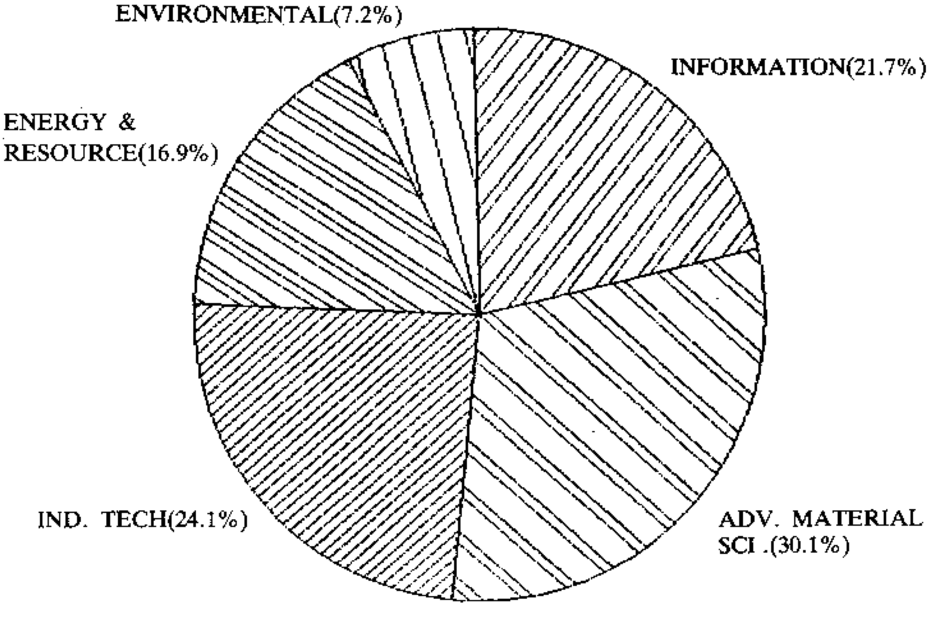
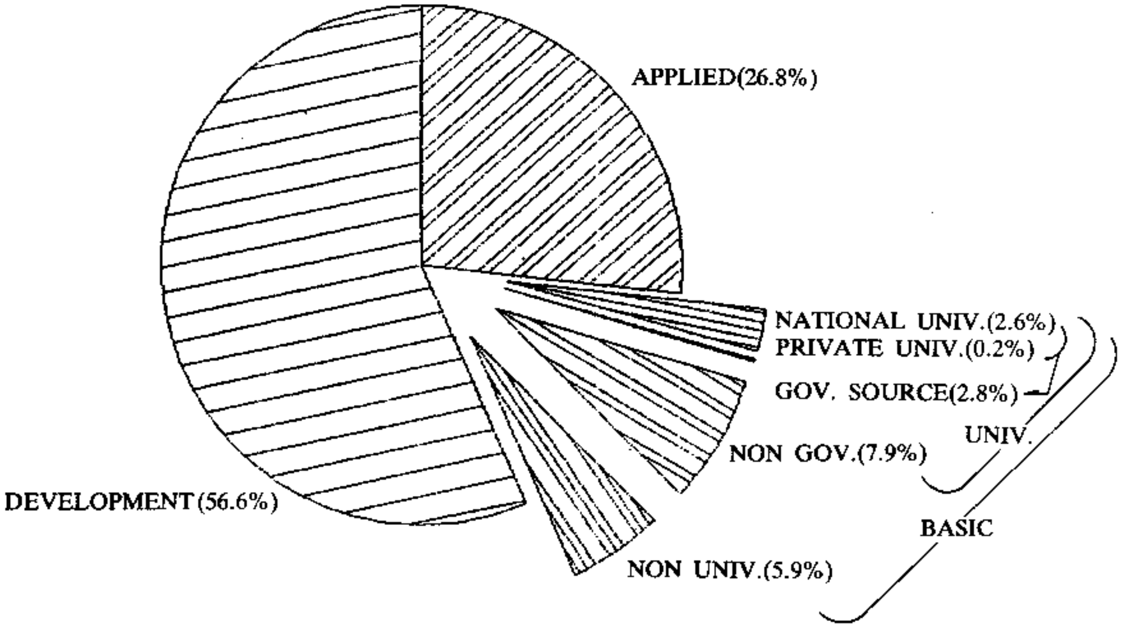
ALLOCATION OF NRDP FUNDS IN 1985
(TOTAL $24 MILLION)



DISTRIBUTION OF NRDP FUNDS BY RESEARCH CATEGORIES



EXPENDITURES FOR R & D ACTIVITY IN KOREA
(IN 1986)



DISTRIBUTION OF BASIC RESEARCH FUNDS
($72 MILLION IN 1986)