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TECHNOLOGY MANPOWER SUPPLY SYSTEMS IN EDUCATION IN KOREA AND INTERNATIONAL COMPARISON

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I. INTRODUCTION

The rapid growth of the Korean economy during the last thirty years can be largerly attributed to Korea's well educated and trained manpower. The Korean economy has been heavily dependent upon exports, and the remarkable export growth was in turn heavily dependent upon Korea's abundant and skilled human resources. However, the education system has failed to match the supply of educated manpower with rapidly changing industrial demand. Business firms face a severe shortage of technicians and high-tech engineers. This is because the government has failed to make sufficient investment in education in the vocational high school, junior college, university and college, graduate school and vocational training institute levels, and also because the major burden of higher education costs have been left to the private sector. Most universities in Korea are privately run, under strict controls by the government, but the government provides almost no financial support to these private schools. As a result, according to some indicators, the quality of education has been deteriorating in higher education in general and in engineering schools in particular.

Many college graduates face unemployment. For example, in recent years, 50 percent of college graduates were still unemployed two months after graduation.

The speed of the development of the Korean economy in the 1990s is heavily dependent upon the development of both technology and technology manpower. This paper describes enrollment and advancement ratios by the levels of education in section II, and stock and supply of science and technology manpower in section III. And in section IV we will turn our attention to ways to improve Korea's technology manpower development systems and in section V to mid-term plan to counter the technological manpower shortage. Finally in section VI we shall take a look at the subsidy schemes for the higher educational institutions and the engineering school.

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II. ENROLLMENT AND ADVANCEMENT RATIOS BY LEVEL OF EDUCATION

The enrollment ratio in higher Educational Institutions in Korea is one of the highest in the world as shown in Table 1. Since 1975 the advancement ratios of middle and high school graduates have been rapidly increasing and in 1988 thirty five percent of high school graduates advanced to higher educational institutions (see Table 2).

Only 36.2 percent of middle school graduates went to vocational high schools whose grauates have a 79.6 percent employment rate while 63.8 percent went to general high schools. About a half of the graduates of the general high schools were able to enter higher educational institutions. 69.4 percent went to universities and colleges (four years); 27.4 percent to the junior colleges (mostly two years) which offer mainly vocational courses while only 19.5 percent of the general high school graduates found jobs. The most worrisome figure is the low employment rate of 50.6 percent of university and college graduates two months after graduation which is one causes of the serious scocial unrest (see Table 3).

Table 4 shows the labor supply by level of education. The non-entrants to the higher schooling by the graduates of the middle school or below it have been declin-

[**Table 1**] Enrollment Ratio by Level of Education in Selected Countries

(unit: %)

	Year	Elementary Education	Secondary Education	High Education
Korea	1986	100	92	36.8
U.K.	1982	101	86	20.3(1983)
Japan	1984	100	95	29.6
France	1983	108	90	26.8
U.S.A.	1984	101	95	57.3
U.S.S.R.	1984	106	100	21.4

Source: UNESCO, Statistical Yearbook, 1986.

[**Table 2**] Advance Rate of Graduates to Higher School Level

(unit: %)

	Primary School graduates	Middle School graduates	High School graduates	University graduates
1970	66.1	70.1	26.9	4.6
1975	77.2	74.7	25.8	6.5
1980	95.8	84.5	27.2	12.2
1985	99.2	90.7	36.4	10.4
1988	99.5	93.5	35.0	7.4

Source: Ministry of Education, Statistical Yearbook, 1970-1988.

[**Table 3**] Advance and Employment Rates of Graduates of Each Level of Schools (1988)[1]

(unit: %)

Schools	Application ratio	Advance ratio	Employment ratio
Primary School Graduates		99.5	
Middle School Graduates		93.5	
To General High School		63.8	
Vocational High School		36.2	
General High School Graduates	83.7	50.2	19.5[2]
Vocational High School Graduates	22.1	10.2	79.6
Out of General High School Graduates who advanced to			
Univ. and Colleges		69.4	
Junior Colleges		27.4	
Other Schools		3.2	
Univ. and College Graduates		7.4	50.6
Junior College Graduates		7.6	76.3
Graduate School Graduates		8.9	78.7

Source: Ministry of Education, Statistical Yearbook, 1988.

Note (1) April 1, 1988.

(2) The 41% of the employed High School graduates entered the manufacturing sector.

[**Table 4**] Labor Supply by Level of Education-Nonentrants to Higher Schooling by the Level of Education

(unit: 1,000 persons, %)

	1972-76 average	1986	1988
Middle School or Below	371(63.0%)	83(11.8%)	72(8.4%)
High School	177(30.1)	425(60.4)	446(60.7)
(General)	NA	180(25.6)	212(28.8)
(Vocational)	NA	245(34.8)	234(31.8)
Junior College	10(1.7)	69(9.8)	77(10.5)
Univ. and Colleges	31(5.3)	127(18.0)	150(20.4)
Total	589(100.0)	704(100.0)	735(100.0)

Source: Ministry of Education, Statistical Yearbook, 1972-1988.

ing rapidly whereas non-entrants to the hihger schooling among the general high school and university and college graduates have been rapidly increasing. The latter faces a difficult time finding employment. Thus Korea urgently needs to expand vocational education and training programs.

III. STOCK AND SUPPLY OF SCIENCE AND TECHNOLOGY MANPOWER[1]

Science and Technology manpower includes: scientists, engineers and technicians. In 1983, there were 51,610 scientists, engineers and technicians[2] engaged in Research and Experimental Development in Korea, 8.8 percent of the Japanese number (see Table 5).

Table 6 shows scientists and technology manpower engaged in industries and research institutes by education level in Korea and Japan in 1980 and 1985.

The total science and technology manpower in Korea is about one tenth of that of Japan in the all education levels. However, the distribution of manpower in the diffierent levels of education in Korea in 1985 is very similar to that of Japan in 1980.

The R&D manpower in science and technology in Korea in 1986 is 11.3 persons per 10,000 persons. This is in sharp contrast with 33 persons in the U.S. (1985), 31 persons in Japan (1985), 19 persons in West Germany (1981), and 18 persons (1984) in France.

A comparison of the ratios of science and engineering majors in the higher educational institutions in Korea, Japan, and Taiwan shows that Korea's ratio compares favorably with the ratios found in Japan and Taiwan. For example, in 1988

[**Table 5**] Number of Scientists, Engineers and Technicians Engaged in Research and Experimental Development

(unit: persons)

	Total	Scientists and Engineers	Technicians
Japan (1983)	589.471	496,145	93,326
Japan (1984)	628,686	531,612	97,074
W. Germ. (1981)	243,680	128,162	115,518
France (1979)	230,766	72,889	157,877
U.K. (1978)	163,100	86,500	76,600
U.S.A. (1983)	NA	728,600	NA
Korea (1983)	51,610	32,117	19,493

Source: UN, Statistical Yearbook, 1985/1986.
UNESCO, Statiscal Yearbook, 1985/1986.

[1]Technology manpower means engineers and technicians. Sometimes engineers are divided into engineers and technologists who are less skilled than general engineers.

[2]Scientists and engineers are those who have completed education at the third level leading to an academic degree or those with training equivalent to the above. And technicians are those who have completed the second stage of the second level education or those with training equivalent to the above. Medical doctors and related workers are not considered here to be scientist and technicians although they may perform medical research.

[**Table 6**] Science and Technology Manpower of Graduates of Each Education Level in Industries and Research Institutes

(unit: 1,000 persons, %)

	Total	High School or below	Junior College	Univ. & College, Graduate School
Korea				
1980	98.9	40.2	10.2	48.7
	(100.0)	(40.7)	(10.1)	(49.2)
1985	149.5	61.4	20.3	67.8
	(100.0)	(41.0)	(13.6)	(45.4)
Japan				
1980	1,005.4	409.3	131.9	464.2
	(100.0)	(40.7)	(13.1)	(46.2)
1985	1,575.0	NA	NA	NA

Source: KAIST, Long-term demand prospects toward 21st century for the science and technology manpower, 1989.3.

in Korea 30.7 percent of university students were natural science or engineering majors (6.3 percent natural science, 24.4 percent engineering); while in Japan, 23.3 percent were natural science or engineering majors (2.8 percent natural science, 20.5 percent engineering); and finally in Taiwan, 37.8 percent were natural science or engineering majors (8.5 percent natural science, 29.3 percent engineering). The Korean ratios are much lower than those of Taiwn, but higher than the Japanese ratios. Especially the ratio of engineering students in Taiwan is higher by nine perentage points than the ratio in Korea (see Table 7, 8 and 9).

The next chapters will examine in detail the supply of engineers and technicians.

[**Table 7**] Total Enrollment, Engineering and Natural Science Students in Higher Educational Institutions in Korea (1988)

(unit: persons, %)

	Total Enrollment	Engineering Students
MA, Ph.D. Courses	75,117	12,463 (16.6%)
MA	63,254	10,334 (16.3)
Ph.D.	11,863	2,129 (17.9)
Univ. & College	1,003,648	216,449 (21.6)
Junior College (2, 3 yrs)	266,844	105,754 (39.6)
Total	1,420,726	347,129 (24.4)
		Natural Science field(1)
		89,278 (6.3%)

Source: Ministry of Education, Statistical Yearbook, 1988.

Note (1) Natural Science excludes Engineering, Medical and Pharmacy, Agriculture and Forestry, and Fishery and Marine.

[**Table 8**] Total Enrollment, Engineering and Natural Science Students in Taiwan (1988-89 School Year)

(unit: persons, %)

	Total Enrollment	Engineering Students
MA, Ph.D. Course	17,341	5,639 (32.5%)
MA	14,119	4,391 (31.1)
Ph.D.	3,222	1,237 (38.4)
Univ. & College	207,479	35,894 (17.3)
Junior College (2 yr)	72,541	36,416 (50.2)
Junior College (3 yr)	29,834	3,878 (13.0)
Junior College (5 yr)(1)	67,734	33,528 (49.5)
Total	394,929	115,548 (29.3)
		Natural Science field(2)
		42,189 (8.5%)

Source: Ministry of Education, Educational Statistic of the Republic or China, 1989.

Note (1) Junior College (5 yr) has 3 year high school and 2 year Junior College Course. Thus the figures include only the 4th and 5th grade students.

(2) Natural science includes Mathematics and Computer Science, Craft & Industry, and Architecture and Townplanning.

[**Table 9**] Total Enrollment, Engineering and Natural Science Students in Japan 1988(1)

(unit: persons, %)

	Total Enrollment	Engineering Students
MA, Ph.D. Course	82,476	29,167 (35.4%)
MA	56,596	25,528 (45.1)
Ph.D.	25,880	3,639 (14.1)
Univ. & College	1,861,306	368,207 (19.8)
College of Technology(2)	52,000	52,000 (100.0)
Junior College	444,808	23,412 (5.3)
Total	2,440,590	501,953 (20.5)
		Natural Science field(2)
		67,747 (2.8%)

Source: Statistics Bureau, Japan Statistical Yearbook, 1989.

Note (1) Special Tranining Schools and Miscellaneous Schools are excluded.

(2) The number here includes only those at the college level in 1989: the last two years students of five-year colleges of technology and also those in national schools for training engineering teachers.

IV. CHANGES NEEDED IN THE EDUCATIONAL SYSTEM TO PRODUCE TECHNICIANS AND ENGINEERS

1. Industrial High Schools

The supply of technicians and technical manpower in the high-tech fields is far short of industrial demand since the supply system is very rigid compared to the rapid changes that have occurred in the industrial structure. On the other hand the employment rates of recent graduates of universities and colleges (henceforth called universities) are below 50 percent in general and are becoming worse-inflaming severe social unrest.

According to the survey of 4074 small-and medium-size firms (henceforth called SMFs) on the availability of technical manpower by the SMF cooperative Association in 1989, the shortage rate of the technological manpower is 29.3 percent and that of the technicians 15.2 percent.[3] The shortage has arisen because: first, a lack of adequate numbers of industrial high schools (H.S.s) and industrial departments of the junior colleges; second, a lack of adequate vocational training by the training institutes and within-plant vocational training; third, the number and size of SMFs has been increasing rapidly in recent years; fourth, a decline in the number of the agricultural workers moving into the urban workforce causing increasing demand for the graduates of vocational H.S.s; fifth, firms have been moving from production of low value added goods, to production of high value added goods because of the large won appreciation and the rapid rise in wages. Thus firms are seeking more skilled workers instead of unskilled workers. Sixth, technological workers prefer to work for larger business.

The number of graduates of the general H.S.s increased 74 percent from 1978 to 1988 whereas that of the vocational H.S.s increased 37 percent in the same period and that of the industrial H.S.s declined in the period, 1980 to 1988. Furthermore, the ratio of the enrolled students of the vocational H.S.s to those of all H.S.s continuosly decreased from 60 percent in 1975 to 45 percent and 36.6 percent in 1980 and 1988. Since 1987 the absolute number of vocational high H.S.s has been below that of 1986 (see Table 10). This is surprising considering the fact that the employment rate of the vocational H.S. graduates has been improving significantly from 58.3 percent in 1981 to 61.2 percent, 78.5 percent, 82.1 percent in 1986, 1988 and 1989 respectively which are much higher than those of the university graduates. On top of this the employment rate of the industrial H.S. graduates has been increasing steadily from 69.7 percent in 1980 to 93.3 percent in 1988 which are even higher than that of the vocational H.S.s (see Table 11).

[3]Technological manpower used here includes technologists, grade 1 engineers, grade 2 engineers, and graduates of engineering colleges or above. Technicians mean chief technicians, grade 1 technicians, grade 2 technicians, assistant technicians and graduates of technical high schools.

[**Table 10**] Number of Students in the General and Vocational High Schools

(unit: 1,000 persons, %)

	1978	1980	1982	1984	1986	1988
General	840	933	1,069	1,200	1,345	1,458
	(57.7)	(55.0)	(55.6)	(57.4)	(59.5)	(63.4)
Vocational	615	764	853	892	917	843
	(42.3)	(45.0)	(44.4)	(42.6)	(40.5)	(36.6)
Total	1,455	1,697	1,922	2,092	2,262	2,301
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Source: Ministry of Education, Statistical Yearbook, 1978-1980.

[**Table 11**] Number of Students in the Industrial High Schools and the Employment Rates

(unit: persons, %)

	1980	1984	1986	1988
Number	200,367	200,794	202,730	197,731
Employment rates[1](%)	69.7	75.8	81.7	93.3

Source: Ministry of Education, Statistical yearbook, 1980-1988.

Note (1) Employment rates, as of April 1 each year, of graduates of February of the same year.

One of the main economic reasons for the decrease in the number of students of vocational and industrial H.S. is the large wage gap between the H.S. graduates wages and the university graduates wages in spite of the high employment rates of the vocational H.S. graduates. The second reason for the decrease in the number of industrial H.S. students is that the government did not invest much in the industrial H.S.s and the private sector also avoided large investments in the high-cost industrial H.S.s. If the facility costs in the commercial H.S.s is 100, the facility costs in the industrial H.S.s is 643. Thus a significant increase in the numbers of industrial H.S.s seems to be very difficult without large investments by the public sector. The facilities for experiments in vocational H.S.s met only 55.4 percent of the requirements set by the ministry of Education in 1989. The ratio of students of private industrial H.S.s to total students in the industrial H.S.s is 49 percent, while that of the students of private commercial H.S.s to total students in the commercial H.S.s is 78 percent.

In Taiwan to weights of vocational and industrial H.S. education is conspicuously higher in Korea. In Korea the ratio of vocational H.S. students to total H.S. students is 36.6 percent, and the proportions of industrial H.S. students in vocational H.S. school students is 23.5 percent in 1988. On the other hand in Taiwan the ratio of vocational H.S. students is 71 percent and the proportion of industrial H.S. students in vocational H.S. students is 47.2 percent (see Tables 12 and 13). In Japan the ratio of vocational H.S. students is 26.4 percent and the proportion of the industrial H.S. students in vocational H.S. students is 34.7 percent in 1988.

The lack of investment in vocational high schools brought forth the keen com-

[**Table 12**] Composition of Students in the Senior Secondary Education in Taiwan (1988-89 SY)

(unit: persons, %)

	No. of Students (%)
General	208,994 (29)
Vocational	514,872 (71)
(Industrial)	(243,124)(33.6)
Total	723,866 (100)

Source: Ministry of Education, Educational Statistics of the Republic of China, 1989

[**Table 13**] Composition of Students in the Vocational High School in Taiwan

(unit: %)

Total	Industry	Commerce	Agriculture	Home Econ. Nursing, Oth.
100.0	47.2	33.5	4.4	14.9

Source: Ministry of Education, Educational statistics of the Republic of China 1989.

petition of 4 to 1 in the entrance examinations for the universities and colleges. Only 24.9 percent of the applicants were able to enter universities and colleges (4 years) and 14.3 percent could enter junior colleges in 1988. Most of the rest were waiting for another try.

According to the February 1990 Korea Chamber of Commerce and Industry survey of 1,753 firms on the wage structure of 1989, the wage gap between new university graduates and H.S. graduates with four year work experience at the same firms has disappeared finally due to the rapid increase in wages of the graduates of the secondary educational institutions. Therefore, if the government invests large amounts of resources by itself into the vocational and industrial H.S.s, and provides appropriate incentives to the private sector for inducing large investments in them, the supply of technicians from the H.S.s can be significantly increased.

The government announed that vocational classes will be combined within the general H.S.s in 1990. It seems to be more desirable than the government plans to make vocational H.S.s annexed to existing H.S.s as in Taiwan and to set up new independant vocational and especially industrial H.S.s. The reason is that the vocational classes will have lower morale if they sit next to the general classes preparing for the college entrance examinations than if the vocational classes are placed in different buildings with proper facilities and equipments.

2. Engineering Junior Colleges

The slow growth of the junior colleges relative to the universities and colleges is one of the causes of the lack of the technological manpower experienced by small- and medium-sized industries. The number of the enrolled students in the univer-

sities and colleges increased 2.5 times in the period, 1980 to 1988 whereas that of students in the junior colleges increased 1.6 times (see Table 14).

The composition of the junior college students by major fields and the employment rates of all junior college graduates and industrial junior colleges are shown in Table 15 and 16. About 40 percent of the students belongs to the engineering schools. In Taiwan about 43 percent of junior college students are majoring in engineering (see Table 8).

The employment rates of the graduates of the junior colleges have been far higher than those of the universities and colleges. Especially the engineering junior col-

[**Table 14**] Number of Students in the Higher Education(1) (1988)

	Junior College(2)	Univ. and College	Graduate School
1970	33,353	146,414	6,640
1975	62,866	208,986	13,870
1980	165,051	403,989	33,939
1985	242,117	931,884	68,178
1988	266,844	1,003,648	75,117

Source: Ministry of Education, Statistical Year Book, 1970-1988.
Note (1) Teachers College and Miscellaneous Schools are excluded.
(2) Junior Colleges are two-year course except the college of Nursing and Marine of three years.

[**Table 15**] Composition of Junior College Students by Major Fields

(unit: %)

	Total	Linguistics, Literature	Social Science	Natural Science	Engineering	Others
1984	100	1.4	16.9	0	39.5	42.2
1986	100	1.9	18.9	0	39.5	39.7
1988	100	2.8	17.1	0	39.6	40.5

Source: Ministry of Education, Statistical Yearbook, 1984-1989.

[**Table 16**] Number of Junior College Graduates and Employment Rates(1)

(unit: persons, %)

	No. of graduates	Employment rates	Employment rates of Engineering graduates
1981	57,578	27.0%	NA
1983	74,476	54.0	NA
1985	72,616	66.8	73.3%
1986	76,814	70.4	78.6
1987	81,083	74.7	84.8
1988	82,409	76.3	86.5
1989	83,855	79.4	87.7

Source: Educational Council for Junior Colleges.
Note (1) As of July 1 of each year.

leges have had much higher employment rates than all the junior colleges.

91 percent of students in the junior colleges are enrolled in private schools[4] which have severe financial problems, poor facilities and experiment equipments and lack teaching personnel. It is desirable that the government establishes more industrial junior colleges and encourages large businesses to donate more funds to the industrial junior colleges.

3. School of Engineering in the Universities and Colleges (Four Year Course) and Graduate Schools

The number of enrolled students in the junior colleges (two or three years) and universities and colleges (four years) has increased dramatically 5.8 times from 239,000 in 1975 to 1,387,000 in 1988. And the number of the high education students per 10,000 inhabitants has increased from 68.8 in 1975 to 325.7 in 1988 which is the highest next to U.S.A. and Canada (see Table 17).

The advance rate of H.S. graduates to the hihger institutions in 1987 is 36.7

[**Table 17**] Higher Education Students per 10,000 Inhabitants

(unit: persons)

	1975	1980	1984	1985	1988
Korea	68.8	160.9	294.1	310.3	325.7
Japan	201.7	206.5	200.6	NA	NA
U.S.A.	517.9	531.3	518.5	NA	NA
W. Germ.	168.4	198.7	249.2	254.6	NA
France	197.1	200.5	231.0	236.2	NA
U.K.	130.8	184.8	157.1	NA	NA
Canada	360.0	368.8	483.7	509.2	NA
U.S.S.R.	191.6	197.2	194.6	194.7	NA

Source: Ministry of Education, Statistical Yearbook
UNESCO, Statistical Yearbook, 1987.

[**Table 18**] Admission Rates to Higher Education Institutions(1)

	1980	1981	1985	1987
Korea	23.7%	35.3%	36.4%	36.7%
U.S.A.	31.6	32.6	33.7	NA
Japan	37.4	36.9	37.6	36.1

Source: Min Won Suh, Statistical Indicators of Korean Higher Education Korean Council for University Education, January, 1989.

Note (1) In Korea: Number of Entrants to H.E. Institutions ÷ High School Graduates. In Japan: Entrants to College and Universities ÷ Middle School Graduates three years ago.

[4]In Korea private universities and colleges are financially weaker than national and public universities and colleges of the same region.

percent which is higher than 36.1 percent of Japan and 33.7 percent of the U.S.A. (1985) (see Table 18).

The admitted students to the higher education institutions amount to 305,109 persons in 1988, 32.9 percent of the 18 years old population. 63.5 percent of the admitted students advanced to the universities and colleges and 36.5 percent went to junior colleges.

In 1988 the students in the engineering schools of universities and colleges accounted for 21.6 percent of the total university students.

This ratio is higher than the 17.3 percent of Taiwanese students but slightly lower than 21.9 percent Japanese students. In Japan technical college students at the four year course are added to the university and college students (see Tables 7, 8, 9).

However the portion of the graduates students (M.A. and Ph.D. courses) in engineering to total graduate students in Korea is 16.6 percent compared to 32.5 percent in Taiwan and 35.4 percent in Japan. And one of the differences in the graduate schools in Korea is that the absolute number of total graduate students in all major fields in Korea is very high relative to that of the other two countries (see Tables 7, 8, 9).

The employment rates of the graduates of the graduate schools and the natural science (including engineering) graduate schools are 78.7 percent and 73.4 percent respectively which are much higher than those of the graduates of undergraduate colleges.

When we count all the students in the higher education institutions including universities and colleges, graduate schools and junior college the ratios of the engineering students to the total students are 24.4 percent, 29.3 percent and 21.9 percent in Korea, Taiwan and Japan respectively in 1988 (see Tables 7, 8, 9). Considering the fact that existing engineer stock in Korea is very low compared with that of advanced countries and the employment rate of the engineering students is much higher than that in the other areas it is desirable to have a higher proportion of engineering students to total university students. Especially engineering schools on the graduate level need to be expanded to a large extent (see Tables

[**Table 19**] Composition of University and College Graduates

(unit:%)

	Total	Humanities	Social Science	Natural Science	Engineering	Others
1970	100	12.1	24.4	9.1	15.9	38.5
1975	100	9.9	17.9	7.3	21.3	43.6
1980	100	11.0	21.2	8.4	26.1	33.4
1985	100	16.0	27.7	9.5	21.4	25.4
1988	100	15.7	28.4	10.5	21.6	23.8

Source: Ministry of Education, Statistical Yearbook, 1970-1988.

19, 20, 21).

One of the equally important issues in engineering is the quality of education. The business circles claim that there is a severe shortage of engineering graduates in the high-tech fields and that the high ranking universities in Seoul should be allowed to increase their quotas for entrants in those fields. The universities and colleges in the provinces suffer from very low employment rates even in the electronics and electricity engineering fields. This shows that academic ability of the graduates of the provincial engineering schools is evaluated to be very low by businesses. It is more conspicuous in the private schools in the provinces. The problem of double structure in the universities and colleges (henceforth called universities) can be alleviated only when a large amount of investment is devoted to engineering schools in the private universities and especially in the provincial private universities.

The numbers of engineering students by public vs. private schools are shown in the Table 22.

The share of the students in the private universities compared to all universities is 72.5 percent, but it is 80.2 percent among engineering majors. It means that engineering schools have more severe financial problems than other schools. And due to the costs of various equipment for experiments the education costs born by the private engineering universities is excessively high. The quality of education in engineering has been getting worse; the number of engineering students

[**Table 20**] Employment Rates of University and College Graduates by Major Fields(1)

	Total	Humanities	Social Science	Natural Science	Engineering	Medi Pharm.	Others
1975	71.8	65.2	68.1	58.7	76.4	76.2	72.5
1980	73.0	70.9	78.7	57.6	83.8	85.6	65.2
1984	63.5	53.3	71.8	41.8	73.3	86.4	53.3
1986	45.7	32.7	52.9	50.3		88.4	34.0
1988	50.6	40.8	55.4	56.5		84.5	36.5

Sorce: Ministry of Education, Statistical Yearbook, 1975-1988.
Note (1) As of April 1 of each year

[**Table 21**] Composition of Graduate Students (MA & PH.D. courses)

(unit: %)

	Total	Humanities	Social Science	Natural Science	Engineering	Medi. Pharm.	Others
1986	69,962	8,392	21,681	5,270	11,023	6,368	14,824
	(100.0)	(12.0)	(31.0)	(7.5)	(15.8)	(9.1)	(21.2)
1988	75,117	8,682	21,228	4,800	12,463	6,876	21,068
	(100.0)	(11.6)	(28.3)	(6.4)	(16.6)	(9.2)	(28.0)

Sorce: Ministry of Education, Statistical Yearbook, 1986-1988.

[Table 22] Number of Students in the 4 year Universities and Colleges by Founders in Korea

	All University & College	Engineering Students
All	573,020 (100%)	130,795 (100%)
National, Public	158,075 (27.6)	25,935 (19.8)
Private	414,945 (72.5)	104,860 (80.2)

Sorce: Korean Council for University Education, Evaluation on the Private Engineering Schools of 1983, April 1983.
Research Report No. 83-4-14, Seoul.

in the national and public universities increased 1.6 times from 1978 to 1983 but that in the private universities 2.5 times in the same period.

In Taiwan and Japan the public vs. private story is the way around as shown in Table 23 and 24. The ratio of national and public ownership is much higher in engineering than in all the universities in both countries. In the Japanese junior colleges (2 yrs) in which the share of female students is 91 percent and the share of the engineering students is only 5.3 percent, the 91 percent of students are enrolled in private junior colleges. The above statistic offers a good guideline for the future of the Korean engineering schools.

In order to enhance the quality of the high cost education and to provide adequate number of high-tech related manpower of a high quality in the engineering field, national and public engineering schools or schools of large business groups should be expanded or increased and private engineering colleges with poor educational and financial conditions should be curtailed.

Now we will examine some criteria of educational quality. We looked at students-faculty ratios, the number of students per lecture classroom, and the number of library seats per students as indicators of educational conditions in universities

[Table 23] Number of Students by Founders in Taiwan (1987/88)

	University & College	Engineering Stdents
All	100.0%	100.0%
National, Public	44.3	59.3
Private	55.6	40.7

Source: Ministry of Education, Educational Statistics of the Republic of China, 1989.

[Table 24] Number of Students in Public vs. Private Schools in Japan (1988)

	All	National, Public	Private
University & College (4 yrs)	100%	25	75
(Engineering)	100%	32.9	67.1
Technical Colleges	100%	93.5	6.5

Source: Ministry of Education, Japan.
Educational Statistics, 1989.

and engineering schools. The students-faculty ratio in Korea in 1986 is 37.5 which is more than double the ratios in advanced countries and three times those in Hong Kong, Argentina and U.S.S.R. (see Table 25). The engineering schools in Korea has much higher ratio that the average ratio of all universities. This is mainly because private engineering schools have very high ratios which have been continuously increasing (see Table 26). This is in sharp contrast with the situation in the other advanced countries. For example, in the U.S. the students-faculty ratio in the engineering schools in 1983 is 12 which is far below the average of all universities in the U.S. The number of students per lecture classroom increased more than three times from 1970 to 1987 and the classrooms of the private schools are more crowded (see Table 27).

And the university libraries had on average 0.2 seats per student from 1965 to 1988. Such a lack of university facilities also applies to the facilities in the engineering schools.

[**Table 25**] Number of Students Enrolled per Academic Stiaff in Higher Education

	1975	1980	1984	1985	1986
Korea	20.9	28.8	37.0	37.7	37.5
Japan	19.8	18.5	17.4	17.1	17.2
U.S.A.	16.7	NA	15.5	15.6	NA
W. Germany	8.1	8.1	9.8	NA	NA
France	20.0	NA	21.7	21.6	NA
U.K.	7.5	7.4	11.1	NA	13.9
Canada	17.8	19.0	21.0	21.3	NA
H.K.	14.6	12.5	13.0	NA	NA
Argentina	13.2	10.6	10.5	12.0	NA
U.S.S.R.	15.3	14.3	14.0	13.6	NA
Taiwan	21.3	20.8	20.6	20.6	20.3

Source: Min Won Sub, Statistical Indicators of Korean Higher Education. 1989. 1. Korean Council for University Education.
Directorate-General of Budget, Acconting and Statistics. Statistical Yearbook of the Republic of China, 1988. Executive Yuan, Republic of China.

Note (1) In Japan: Students of University and College + Academic Staff of University and College.
(2) In U.K.: Students of University (4 yrs) ÷ Academic Staff of University (4 yrs)

[**Table 26**] Students-Faculty Ratio in the Engineering Colleges

	1978	1979	1980	1982	1983
Engineering Schools	40	39	39	42	42
National, Public	40	32	27	31	31
Private	40	43	43	47	47

Source: Min Won Suh, Statistical Indicators of Korean Higher Education, 1989.1., Korean Council for University Education.

Note: Graduate Schools are Included.

[**Table 27**] Number of Students per Lecture Class Room in Higher Education Institutions

		Univ. & Colleges		Vocational Junior Coll.		
	Total	Nat., Pub.	Priv	Total	Nat., Pub.	Priv.
1970	28.6	41.3	26.0	-	-	-
1975	34.7	42.3	33.7	-	-	-
1980	56.6	62.2	54.6	49.5	48.5	49.6
1985	88.0	84.3	89.4	65.7	63.4	65.9
1987	90.0	81.7	93.1	65.6	71.1	65.1

Source: Min Won Sub, Statistical Indicators of Korean Higher Education, 1989.1., Korean Council for University Education.

One of the ways to improve the quality of education in graduate schools is to transform a few leading universities into those with graduate programs as the main programs. In order to expand the graduate schools and to improve the quality of education both in graduate and undergraduate schools, the research and development functions of universities should be strengthened. The ratio of R&D expenditure to the the GNP is 1.93 percent in 1987 which is far below that found in Japan (2.51 percent, 1986); the U.S. (2.77 percent, 1986); and West Germany (2.83 percent 1985). And the technology-related budget of the government was 0.7 billion dollars in 1987. It is 1.3 percent of the U.S.A., 5.6 percent of France and 6.3 percent of Japan.

The share of the use of the universities in the total R&D expenditure is 10.5 percent in 1987 which is less than the U.S. (12 percent, 1986); Japan (15.6 percent, 1985) and France (14.7 percent, 1984).[5] However, the universities have 34.1 percent of the total R&D manpower engaged in science and technology areas; businesses have 48.7 percent and research institutes have 16.2 percent.

As shown in the statistical indicators on the previous pages on education conditions in the universities the quality of education is very poor in the engineering schools (graduate and undergraduate) in Korea. Upgrading the quality of education is believed to be more important than increasing the number of students in the engineering schools.

V. MID-TERM PLAN TO COUNTER THE TECHNOLOGICAL MANPOWER SHORTAGE

Facing the very severe shortage of the technological manpower the Minitry of Education announced the plan to increase the ratio of the number of students in the vocational high schools to that of the general high schools annually from 37 to 63 percent in 1988 to 50 percent in 1996. Then the number of students in the

[5]KAIST, Prospects for the long-term demand upto 21st century for the science and technology manpower, 1983.

vocational high school will exceed one million. It will be done by setting up new vocational schools expanding current vocational scools and transforming part of general classes into vocational classes in the existing general high schools.

The number of enrolled students in the junior engineering colleges will increase by 9,000 persons annually in the period, 1992 to 1995. And the junior nonengineering colleges will also have the annual increase of 6,000 enrolled students in the fields of industrial design, jewel processing and information processing and so on in the same period. As the result the total number of students enrolled in the engineering and its related fields in the junior colleges will increase by 60,000 by 1995.

The government is planning to establish a dual educational system by introducing a technology educational system into the current system as in the European countries. The current single educational system is as follows: primary school (6 years) → middle school (3 years) → high school (3 years) → junior college (2 years) or university (4 years) → graduate school. In addition to the above ststem the technology education ststem will be added: primary school → middle school → technology school (5 years) → university of technology (2 years or 4 years) → technology graduate school. This line of new system will absorb and train the youth who do not proceed to the university as the technological manpower.

It is planned that nine sets of technology schools and universities of technology will be set up in the nine major industrial estates. Each set will be specialized in the different fields such as machinery, electronics, computer science, automobile, semiconductor, new material and so on.

About 6500 technicians and intermediate level engineers are expected to be produced annually from the above institutions. And about 0.2 billion dollars is estimated to be needed to complete the need system within the coming five years. The establishment and operation of the new schools will be left to the business sector.

The four-year universities will also be allowed to increase their enrollment by 4,000 every year from 1992 to 1995 in the natural sciences and engineering; 1,000 in the natural sciences and 3,000 students in the high-tech engineering fields such as electricity, electronics, machinery, chemical engineering and so on. And the private universities will be able to obtain subsidies from the government for the part of the costs involved when they establish the high-tech engineering departments.

The increasing number of large business is setting up the college- and graduate-level education programs within their plants. And the expansion of vocational training programs is also being planned by the national Industrial Manpower Management Corporation.

One of the most important reasons for the shortage of manpower in the mining and manufacturing sector is that the employment in the service industries is growing very fast as in Table 28.

[**Table 28**] Composition of Workers by Sector
(1,000 persons, lst quarter of each year)

Sector	1988	1989	1990	1991
Primary sector(1)	2,620(16.7)	2,480(15.3)	2,530(15.0)	2,300(13.2)
Mining, manufacturing sector	4,720(30.1)	4,940(30.4)	4,810(28.5)	5,050(29.0)
Service sector	8,340(53.2)	8,800(54.3)	9,510(56.5)	10,090(57.8)
Total	15,670(100)	16,220(100)	16,850(100)	17,430(100)

Source: Bureau of statistics, Economic Planning Board.
Note (1) Agriculture, forestry and fishery industry.
(2) Figures in the parentheses are percentages.

In 1990 the government shortened the opening hours from 4AM of the following day to midnight of every day in the liquor drinking indutry such as night clubs, cafes and room salons, and raised tax rates on their businesses. The effects of the above measures on the liquor drinking industry were quite visible and strong. The service industry, however, expands at the rapid speed due to the booming construction activities and relatively high wages in the service industries.

In order to increase labor supply to the mining and manufacturing sector the larger number of workers working in those industries than before are exempted from the military duties. And labor imports from abroad are also being considered seriously. On the side of businesses automation facilities investments are rapidly expanded both in the large and medium- and small- sized businesses, and firms are more willing to hire woman and part-time workers than ever before. In korea the woman labor participation rate is still much lower than that in the advanced countries.

In spite of all the above efforts by the government and businesses the labor shortage problem in the mining and manufacturing sector is expected to be very serious in the 1990s mainly due to the lack of past investments in the education and manpower training.

VI.SUBSIDY FOR THE HIGHER EDUCATIONAL INSTITUTIONS AND THE ENGINEERING SCHOOLS

1. Current Revenue Sources

Education is a public good to some extent. Engineering education is one of the most important factors behind economic development. Thus an important part of the high costs involved in engineering education should be born by the public sector both for public and private institutions. However, support for private engineering schools is nominal and the quality of education tends to be worse is in jeopardy.

The government is now helping private engineering schools by allowing them

to borrow some funds from the IBRD and the OECD for the improvement of the facilities and equipment for experiments.

Next we will examine the scale of the government budget and the public education expenditure, the revenue sources of the higher education institutions in Korea, and compare them with the statistics of other countries.

First the Ministry of Education (MOE) budget account for 20.7 percent of the government budget, and the higher education budget accounts for 6.73 percent of the MOE budget (see Table 29). Public education expenditure is defined as including central and local government, school foundation and parents educational expenditures. The ratio of public educational expenditure to GNP is 3.2 percent in Korea. It is much lower than the ratios of the advanced contries (see Table 30).

In Korea national and public universities mainly rely on tuition and fees, and government support as sources of revenue whereas private universities rely on tuition and support from the school's foundations. However, in 1987, school foundation supply accounted for only 15.5 percent of the total revenue of private universities. Research grants and contracts, and service income from the hospitals are included in the others (see Table 31). Comparing with other countries the share of the government support in Korea is too small and provincial government support is zero. Especially private higher institutions receive only one percent of revenue from the government.

[**Table 29**] Ratios of Government Budget of Higher Education Institutions to GNP, Government Budget and MOE Budget.

(unit: billion won)

	GNP (A)	Government Budget (B)	Min. of Education Budget (C)	Budget for Higher Education Institutions (D)
1966	1,032	142	25	1.62
1970	2,736	446	78	4.87
1975	10,092	1,587	228	14.94
1980	36,672	5,804	1,099	66.15
1985	72,371	12,532	2,492	169.04
1988	111,576	17,464	3,611	243.12

	C/A(%)	D/A(%)	D/B(%)	D/C(%)	C/B(%)
1976	2.4	0.16	1.14	6.48	17.80
1970	2.9	0.18	1.09	6.24	17.58
1975	2.3	0.15	0.94	6.55	14.36
1980	3.0	0.24	1.14	6.02	18.94
1985	3.4	0.23	1.35	6.78	19.89
1988	3.2	0.22	1.39	6.73	20.70

Source: The Condition of Higher Education, Data 86-9-37,
Korean Council for University Education, Seoul

All levels of government should devote more resources to all universities. The share of the government support in the total revenue of higher institutions is 12.9 percent in Japan (1983), 18.4 percent in the U.S.A. (1984) and 8.2 percent in Taiwan (1983). And the proportions of endowment, research contracts, incomes from assets and hospital services should be raised considerably as in Japan and the U.S.A. (see Appendix Table 1, 2, and 3).

[**Table 30**] The ratios of Public Educational Expenditure to GNP and Total Government Expenditure in Selected Countries

(unit: %)

	Year	Ratio to GNP	Ratio to Total Government Expenditure
Korea	1975	2.2	13.9
	1980	3.5	18.7
	1987	3.2	NA
Japan	1975	5.5	22.4
	1980	5.9	19.6
	1982	5.7	19.1
U.K.	1975	6.7	14.3
	1979	5.4	13.9
	1983	5.3	11.5
W.Germany	1979	4.6	10.0
	1983	4.5	8.8
France	1982	5.8	NA
U.S.A.	1981	6.7	NA
	1983	5.5	17.7
Canada	1983	8.0	17.0(1981)

Source: UNESCO, Statistical Yearbook, 1985, 1986.

[**Table 31**] Current-Fund Revenue of University and College in Korea, by Source (1987)

(unit: Million Won)

	Total		Nation & Public		Private	
	Amount	%	Amount	%	Amount	%
Total	1,238,313	100.0	328,131	100.0	910,182	100.0
Tuition & Fees	876,822	70.8	147,149	44.8	729,673	80.2
National Treasury	174,837	14.1	165,590	50.5	9,247	1.1
Foundation Support	141,332	11.4	-	-	141,332	15.5
Endowment	-	-	-	-	-	-
Original Property	1,137	0.1	134	-	1,003	0.1
Others	44,185	3.6	15,258	4.6	28,927	3.2

Source: Jung-Il Yoon & Others, International Comparison of Higher Education Finance, Council for University Education Finance, 1988, Seoul.

2. Increase in the Financial Resources for Higher Educational Institutions

(1) Increase in the Private Education Promotion Fund (PEPF)

The government has contributed 30 billion won (about 44 million dollars) to the PEPF in 1989 and 1990. The PEPF is designed to promote facility investment in the private educational institutions. The fund should be increased to the much larger scale, and the government should encourage businesses to contribute to this fund.

The property tax is very low in Korea compared with that of other countries and could be raised significantly. In addition, a certain percentage of the raised property tax can be earmarked for the PEPF contribution. A part of the PEPF should be used to help the private universities in hiring faculty members. The japanese government provides a matching fund to the private universities when they hire new faculty members. The Taiwanese government hires about 150 new faculty members a year and assigns them to private universities and provides salaries for those faculty members. The Korean government is planning to apopt a brain pool system by which about 200 scholars in the universities and research institutes in the foreign countries and in Korea will be hired as faculty members and assigned to the domestic universities starting from 1992. The majority of the hired scholars will come from the high-tech fields.

Each provincial government needs to have its own education promotion fund since it will have the system of self-government starting in 1990.

Low interest loans can be made to private universities for investment in facility and equipment. And compensation for low interest loans from the banks can be paid by the PEPF.

(2) Extension of the Education Tax Period and Expansion of the Education Tax Coverage

The Education Tax which started in 1982 as a temporary tax is expected to be changed into al permanent one. The tax is imposed on liquor and tobacco, and the revenue of finance and insurance companies. The tax coverage needs to be expanded to cover luxuary consumption activities. Also the tax can be imposed as a surcharge to those whose preoperty tax or land tax is above a certain level.

(3) Deregulation of Private Universities

The universities and especially private universities should have full autonomy in their operation, for example, in setting tuitions and fees and student admission policy. The education industry can be made properous only through its autonomous operations and competition among the institutions.

(4) Education Bond

Issuing the Education Bond to raise funds for education is a propr measure since the next generation is the beneficiary from the improvement of education.

(5) Admission by Contribution

Some number of students should be allowed to be admitted to the universities if they contribute more than a certain amount of money to the universities to raise the quality of education.

VII. SUMMARY AND CONCLUSION

The Korean economy suffers from a severe shortage of technicians and engineers in the high-tech fields. However the graduates of the general high schools and universities face very high and rising unemployment rates: the former about 30 percent and the latter about 50 percent two month after graduation, and the number of the unemployed graduates in April, 1988 among those who graduated from high schools and universities in February, 1988 was 310,000 persons. This is because the education system has not changed to match the rapidly changing industrial demand. Whether the Korean economy can grow at the rapid speed in the 1990s as in the past or not depends upon whether the education system is revamped and produces much more advanced technical manpower than before.

The following points are proposed for the smoothe supply of technology manpower.

(1) The stock of scientists, engineers and technicians is very low comparing with the advanced countries, thus the supply of technical manpower should be increased.

(2) The proportion of the vocational high school students in the total high school students was 36.6 percent in 1988, and has been decreasing since 1980. In Taiwan it was 71 percent. Furthermore, the share of the engineering high school students in the vocational high school students in Korea was 23.5 percent, compared to 47.2 percent in Taiwan. Both proportions are twice as high in Taiwan. This explains one of the important reasons why Taiwanese small-and medium sized firms have high competitive power in the world export market.

The employment rate of the industrial high school graduates was 93.3 percent in 1988 which is higher than 78.5 perent of that of the all vocational high school graudates. It is desirable to increase the number of the industrial and other vocational high schools shubstantially, by setting up annexed vocational schools to the existing general high schools or independent vocational schools.

(3) Junior college and especially industrial junior colleges should be also substantially increased since graduates of those schools are in high demand and have high employment rates. National or public schools rather than private schools need to be expanded and increased to ensure adequate investments in the high cost industrial schools. This point also applied to the industrial high schools and unviersities of the four year course.

(4) Engineering schools in the universities and colleges and, especially in graduate

schools need to be increased and expanded. The proportions of the engineering students in the total students in the higher educational institutions is 24.4 percent in Korea, 33.4 percent in Taiwan and 20.5 percent in Japan. And the shares of the graudate students in engineering in the all graduate students is 16.6 percent (Korea), 32.5 percent (Taiwan) and 35.4 percent (Japan).

Improving the quality of education seems to be more important and urgent than merely increasing the number of students in the engineering schools. The share of students in the private universities in total students is very high and is in increasing trend in all universities and engineering schools, which tends to worsen the financial problems of the engineering schools which needs facilities and continuous replacements of expensive equipments for experiments. The educational conditions in the universities and in engineering schools in Korea are much below those in the countries which have per capital incomes similar to that of Korea. For example, the students-faculty ratio is more than twice that in the many countries in South America and South East Asia.

(5) The government announced various reforms in which the number of students enrolled in the industrial high schools, engineering junior colleges, colleges of Technology, and universities and graduate schools would be increased substantially during the period, 1992 to 1996.

On top of that various policies are being devised to counter the severe labor shortage problem in the mining and manufacturing sector. Despite of these efforts by the government and the businesses 1990s in Korea can not avoid the serious harm to the manufacturing sector due to the rapid changes in the economic structure and the lack of investments for building appropriate technological manpower.

(6) Reserach and development function of the universities and colleges should be raised to improve the quality of education, to strengthen the graduate programs and to utillize the R&D manpower in the academia.

(7) The government should increase drastically its share of the education costs in the higher educational institutions and especially in the private institutions. And the high educational institutions, and especially private schools should have a much broader autonomy in their operations. Every effort should be made to increase the funds for the promotion of higher education both from public and private sources. The expansion of the Education Tax coverage, substantial increase in the Private Education Promotion Fund, issuing the education bond, admission by contribution and establishment of Education Promotion Fund in each province can be some of ways to increase the education funds.

(8) Vocational training programs should be designed to have a complementary function to the school education. In the 1980s the number of people who had vocational training in the public institutions, within-the-plant or authorized intitutions had been declining in spite of the fact that those who needed the

vocational training had been increasing. The current vocational training system should be revised so as to increase the number of trainees substantially.

APPENDIX

[**Table 1**] Revenue Sources of Higher Educational Institutions in Japan (1983)
(unit: %, billion yen)

	National (%)	Publ. (%)	Nat. & Pub. (%)	Priv. (%)	Tot. (%)	Amounts (bill. yen)
Tuition & Fees	6.4	6.9	6.4	48.4	30.4	1,242
National Treasury	65.4	1.8	57.9	12.4	32.0	1,309
Local Gov.	-	56.8	6.8	0.5	3.2	132
Endowment	1.3	0.2	1.1	2.3	1.8	75
Assets Income	3.7	-	3.2	10.4	7.3	298
Service Income	18.3	31.9	19.9	20.1	20.0	819
Borrowing	2.2	-	2.0	4.8	3.6	146
Others	2.7	2.4	2.7	1.2	1.8	75
Amounts(bill.yen)	1,523	212	1,766	2,330	4,096	4,096

Source: Institute for Higher Education, Tokyo, Japan, Bulletin of Institution for Higher Education, No.8, 1988.
Note: Public Schools include Broadcast Universities.

[**Table 2**] Revenue Sources of Higher Educational Institutions in Taiwan (1983)
(unit: %)

	National & Public	Private
Tuition & Fees	30.02	84.60
Government	68.78	8.19
Endowments	-	-
Borrowing	-	0.37
Others	1.86	6.84

Source: Kenneth Che-Sheng Gai, Development of Higher Education and Financing Problems in the Republic of China, *Proceedings of International Seminar on University Finance, Comparative Study on University Finance in Asia,* Korea Council for University7 Education, 1986, Seoul.

[**Table 3**] Current-Fund Revenue Sources of Higher Educational Institutions in the U.S.A. (1984/85)

(unit: Million US dollars)

	Public		Private	
	Amout	%	Amount	%
Total	59,794	100.0	32,679	100.0
Tuition & Fees	8,638	14.5	12,636	38.7
Fed Gov.	6,310	10.6	5,199	15.9
State Gov.	26,965	45.1	618	1.9
Local Gov.	2,179	3.6	208	0.6
Private Gifts, Grants, Contracts, Endowments Endowment Income	2,188	3.7	4,804	14.7
Sales & Services	11,968	20.0	7,734	23.7
Others	1,537	2.6	1,479	4.5

Source: U.S. Department of Education Statistics, Center for Education Statistics, "Financial Statistics of Institutions of Higher Education," Surveys, 1986.

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