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# Technology Manpower Supply in the Educational System in Korea and International Comparison*

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Korea is facing a severe shortage of technological manpower and the low employment rate of 50.6 percent of university and college graduates. This paper analyzes the technological manpower supply system in Korea and compares it with the systems in Japan and Taiwan.

The Korean education system has failed to match the supply of educated manpower with rapidly changing industrial demand. Several proposals are made to remedy the mismatch.

Also financing sources of the higher educational institutions are compared for some countries and some proposals are made to improve financing for universities and colleges in Korea.

## 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 voca-

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tional 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 enrollement and advancement ratios by the levels of education in section II, and stock and supply of science and technology manpower in section III. And section IV will describe ways to improve Korea's technology manpower development systems and finally section V we will describe the subsidy schemes for the higher educational institutions and the engineering school.

## 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 graduates 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 which can be one cause of the recent serious social 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 declining rapidly whereas non-entrants to the higher schooling among the general high school and university and college

**Table 1**

ENROLLMENT RATIO BY LEVEL OF EDUCATION IN SELECTED COUNTRIES

(unit: %)

| | Year | Elementary Education | Secondary Education | Higher Education |
|---|---|---|---|---|
| Korea | 1986 | 100.2 | 92.1 | 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: %)

| | Prim. School graduates | Middle Sch. graduates | High Sch. 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.

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

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

**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 |

*Notes:* 1. April, 1988.
2. The 41% of the employed High School graduates entered the manufacturing sector.

*Source:* Ministry of Ecucation, Statistical Yearbook, 1988

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

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 scientists and technicians, although they may perform medical research.

## 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.

## 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. Germany (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) | 51,600 | 32,117 | 19,493 |

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

tenth of that of Japan in the all education levels. However, the distribution of manpower in the different 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

## 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 | Uiv. & College, Graduate School |
|---|---|---|---|---|
| Korea | | | | |
| 1980 | 98.9 | 40.2 | 10.0 | 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 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 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 Taiwan, but higher than the Japanese ratios. Especially the ratio of engineering students in Taiwan is higher by nine percentage points than the ratio in Korea (see Tables 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%) |

*Note:* 1. Natural Science excludes Engineering, Medical and Pharmacy, Agriculture and Forestry, and Fishery and Marine.

*Source:* Ministry of Education, Statistical Yearbook, 1988.

## Table 8

TOTAL ENROLLMENT, ENGINEERING AND NATURAL SCIENCE STUDENTS IN TAIWAN (1988-89 SCHOOL YEAR)

(unit: persons, %)

| | Total Enrollment | Engineering Students |
|---|---|---|
| MA. Ph.D. Courses | 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%) |

*Notes:* 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.

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

**Table 9**

TOTAL ENROLLMENT, ENGINEERING AND NATURAL SCIENCE STUDENTS IN JAPAN (1988)[1]

(unit: persons, %)

| | Total Enrollment | Engineering Students |
|---|---|---|
| MA. Ph.D. Courses | 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 |
| | | 67,747 ( 2.8%) |

*Notes:* 1. Special Training Schools and Miscellaneous Schools are excluded.
2. The number here includes only those at the college level in 1989: the last two years students and also those in national schools for training engineering teachers.

*Source:* Statistics Bureau, Japan Statistical Yearbook, 1989.

## IV. Changes Needed in the Educational System to Produce Technicians and Engineers

### *A. 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.

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]

[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.

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 continuously 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

**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.

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).

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 the 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

**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 |

*Note:* 1. Employment rates, as of April 1 each year, of graduates of February of the same year.

*Source:* Ministry of Education, Statistical Yearbook, 1980-1988.

**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 SCHOOLS 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.

keen competition 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 announced 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 independent 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.

### *B. 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 universities 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 colleges 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.

### *C. 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 higher 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).

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

## Table 14

NUMBER OF STUDENTS IN THE HIGHER EDUCATION[1] (1988)

| | Junior College[2] | Univ. and Coll. | 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 |

*Notes:* 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.

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

## 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.

The advance rate of H.S. graduates to the higher institutions in 1987 is 36.7 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 educational 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).

## Table 16

NUMBER OF JUNIOR COLLEGE GRADUATES AND EMPLOYMENT RATES[1]

(unit: persons, %)

| | No. of graduates | Employment rates | Employment rates of engineering graduates |
|---|---|---|---|
| 1981 | 57,580 | 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 |

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

## 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. Germany | 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.

However the proportion of the graduate students (M.A. and Ph.D. courses) in engineering to total gradute students in Korea is 16.6 pecent, 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).

**Table 18**

ADMISSION RATES TO HIGHER EDUCATION INSTITUTIONS[1]

(unit: %)

| | 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 |

*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.

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 high than those of the graduates of undergraduate colleges.

When we count all the students in the higher educational institutions including universities and colleges, graduate schools and junior colleges 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 the 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 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.

## 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.

## Table 20

EMPLOYMENT RATES OF UNIVERSITY AND COLLEGE GRADUATES BY MAJOR FIELDS[1]

(unit: %)

| | 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 |

*Note:* 1. As of April 1 of each year.
*Source:* Ministry of Education, Statistical Yearbook, 1970-1988.

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 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.

## Table 21

COMPOSITION OF GRADUATE STUDENTS
(MA & Ph.D. Courses)

(unit: %)

| | Total | Humanities | Social Science | Natural Science | Engineering | Medical 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) |

*Source:* Ministry of Education, Statistical Yearbook, 1986-1988.

## Table 22

NUMBER OF STUDENTS IN THE 4 YEAR UNIVERSITIES AND COLLEGES BY FOUNDERS IN KOREA (1983)

| | All Univ. & Coll. | 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) |

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

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.

**Table 23**

NUMBER OF STUDENTS BY FOUNDERS IN TAIWAN (1987/88)

| | Univ. & Coll. | Engineering Students |
|---|---|---|
| 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 |
|---|---|---|---|
| Univ. & Coll. (4 yrs) | 100% | 25 | 75 |
| (Engineering) | 100% | 32.9 | 67.1 |
| Technical Colleges (4 yrs) | 100% | 93.5 | 6.5 |

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

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 and engineering schools. The students-faculty ratios 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 than 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 STAFF 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 |

*Notes:* 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).

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

## 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 |

*Note:* Graduate Schools are Included.

*Source:* Min Won Suh, 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

## 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 Suh, Statistical Indicators of Korean Higher Education, 1989. 1., Korean Council for University Education.

should be strengthened. The ratio of R&D expenditure to 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 pecent.

As shown in the statistical indicators on the previous pages on educational 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. Subsidy for the Higher Educational Institutions and the Engineering School

### *A. Current Revenue Sources*

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

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 national and private institutions. However, support for private engineering schools is nominal and the quality of education tends to be worse and is in jeopardy.

The government is now helping private engineering schools by allowin them to borrow some funds from the IBRD and the OECF 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 statistic of other countries.

First the Ministry of Education (MOE) budget accounts for 20.7 percent of the government budget, and the higher education budget accounts for 6.73 percent of the MOE budget. 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 in 1987. It is much lower than the ratios of the advanced countries such as 5.7 percent in Japan (1982), and 5.5 percent in the U.S.A. (1983).

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 schools' foundations. However, in 1987, school foundation supply accounted for only 15.5 percent of the total revenue of private universities. 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 received only one percent of revenue from the government.

All levels of government in Korea should devote more resources to all universities. The share of the government support in the total revenue of private 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 in Korea.

### *B. 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.

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 PEPE.

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

The Education Tax which started in 1982 will expire in 1991. The tax is imposed on liquor and tobacco, and the revenues of finance and insurance companies. The tax period should be extended and the tax coverage needs to be expanded to cover luxuary comsumption activities. Also the tax can be imposed as a surcharge to those whose property 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 prosperous through its autonomous operations and competition among the institutions.

(4) Education Bond

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

## VI. Summary and Conclusion

The Korean economy suffers from a sever 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 months after graduation, and the number of the unemployment 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 policy recommendations are proposed for the smooth 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 percent of that of the all vocational high school graduates. It is desirable to increase the numbe of the industrial and other vocational high schools substantially, by setting up annexed vocational schools to the existing general high schools or independent vocational schools.

(3) Junior colleges 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 applies to the industrial high schools and universities 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 graduate 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 is 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) Research and development function of the universities and colleges should be raised to improve the quality of education, to strengthen the graduate programs and to utilize the R&D manpower in the academia.

(6) 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, and establishment of Education Promotion Fund in each province can be some of ways to increase the education funds.

(7) 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 institutions has been declining in spite of the fact that those who need the vocational training have been increasing. The current vocational training system should be revised so as to increase the number of trainees substantially.

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