Engineering Education in Korea and the □-Structured Educational System

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Abstract

This paper consists of two parts which discuss two different aspects of engineering education in Korea. The first part introduces the recent status of engineering education in Korea, discussing how it has developed during the past decade. The second part introduces the newly proposed educational structure called the □-Structure which is intended to replace the existing simple-layered structure to achieve an efficient engineering education and career interface.

□. Introduction

Engineering education in Korea has comparatively short history of about 50 years. It was begun at the time the Republic of Korea was established in 1948. Though late in start, it has been developed in fast growth rate, thus reaching the number of students of 620,000 for the undergraduate level and 27,000 for the graduate level as of 1996. This steep growth of engineering education has contributed significantly for the economic development of Korea during the past three decades.

As the new millennium of information age is approaching, we now face strong challenges in engineering education in Korea, as is the case in all other countries. Especially, Korea, having limited natural resources, has to rely more on the human resources in the future, and therefore efficient engineering education is much more important. In response to the challenges of the information age, engineering education is forced to be more fundamental and theoretical on one side, and to be more methodological and practical on the other. Therefore it is very demanding to critically review the engineering educational system of today and restructure it such that the engineering science aspect be well balanced with the engineering technology aspect. In the restructured system, the general attainment of engineers has to be taken into account, as well as the smooth and short-term transition toward the industry career.

In this paper we are going to introduce how the engineering education has evolved in Korea during the past decade first, and then introduce a new engineering educational structure called

the □-Structure that has been recently proposed as a means to restructure the existing simple-layered structure. While coupled in terms of engineering education in Korea, those two subjects are rather orthogonal. So we will separate out their discussions in two different sections in the following, combining them in the subsequent conclusion section.

□. Recent Status of Engineering Education in Korea[1]

The overall education system in Korea is based on the 6-3-3-4 education ladder system, consisting of elementary school, middle school, high school, and higher education. The higher education part in the education ladder includes the educations of regular colleges/universities, junior colleges, teachers colleges, air & correspondence colleges, and industrial colleges. The number of higher educational institutes has steadily increased during the past decade. From 1986 to 1996, it has increased by 25.7% overall, and 34.0% and 26.7% respectively for regular colleges/universities and junior colleges. The rate of increase in these two categories is noteworthy as they form the main stream of higher education. This increase is accompanied by the diversification of departments, which has increased in number from 4,639 to 8,221 during the decade, amounting to an increase of 75.9%. Even more striking changes appear in the number of students in higher education, which has increased from 1,262,493 to 2,412,025 during the decade, which corresponds to an increase of 91.1%. This increase is mainly driven by the categories of junior colleges and air & correspondence colleges, and the increase of students in the regular universities/colleges was comparatively low. There was significant growth in the number of faculty members also, with the 68.9% increase in the faculty members of regular colleges/universities and the 78.1% increase of the faculty members in junior colleges

If we consider the status of engineering education, a subset of higher education in general, we see a much higher growth rate for engineering education than for the overall higher education in terms of the number of departments, the number of students, and the number of faculty members. If we single out the number of students for comparison, it has increased by 105% for the engineering education during the decade, which was 91.0% for the overall higher education. This increase is contributed mainly by engineering colleges in the regular colleges/universities category : Their increase rate doubles that of the overall colleges (see Table 1).

In the case of the engineering graduate schools the numbers of engineering students in master's and doctoral studies are only 17.9% and 23.4%, respectively, of the total numbers of students at the same level of advanced education in general. However, the increase rate during the past decade is phenomenal : The increase rates are 165% and 118% respectively

1) Various statistics cited in this section are taken from References [1] to [5].

Table 1. A Summary of Statistics for Engineering Education
(including regular colleges/universities and junior colleges)

Year	Number of colleges		Number of Departments		Number of Students		Number of Faculty Members	
	Overall	Engineer-ing	Overall	Engineer-ing	Overall	Engineer-ing	Overall	Engineer-ing
1986	265	-	4,639	802	1,262,493	301,549	35,162	
1987	268	-	4,724	848	1,291,585	314,132	36,521	
1988	269	-	5,142	949	1,312,053	322,203	38,252	6,506
1989	267	114	5,482	1,037	1,353,088	346,750	39,950	6,711
1990	267	111	5,741	1,099	1,403,898	373,631	41,920	
1991	264	112	5,982	1,188	1,449,657	401,150	44,231	7,728
1992	267	127	6,459	1,258	1,885,393	417,927	46,864	
1993	300	-	6,748	1,352	1,995,047	457,214	49,621	9,660
1994	310	155	7,070	1,480	2,086,912	498,233	52,098	
1995	323	-	7,606	1,655	2,230,058	552,680	56,705	11,685
1996	333	166	8,221	1,848	2,412,025	619,242	63,809	
Increase in Decade	25.7%		77.2%	130.4%	91.1%	105.4%	81.5%	

* "Overall" stands for overall higher education

for the master's and doctoral course students in engineering. (see Table 2)

Table 2. Number of Students in Advanced Engineering Education

Year	Master		Doctor (Ph.D.)	
	Overall	Engineering	Overall	Engineering
1986	59,184	8,124	10,778	1,899
1987	59,490	9,305	10,874	1,894
1988	63,254	10,334	11,863	2,129
1989	67,840	11,063	13,331	2,545
1990	72,417	11,861	14,494	2,898
1991	76,338	13,085	14,966	3,156
1992	80,417	13,334	16,160	3,532
1993	86,329	15,419	17,645	4,198
1994	90,890	17,090	19,093	4,576
1995	93,993	18,322	18,735	4,599
1996	119,910	21,486	23,464	5,480
Increase in Decade	102.6%	164.3%	117.7%	188.6%

So far we have observed that higher education in the past decade in Korea has been driven by engineering education, and, further, engineering education itself has been predominated by the graduate school level advanced education. We have seen a sharp increase in the number of colleges, departments, students, and faculty members in graduate level engineering education. Among them the increase in the member of departments was remarkable, which may be viewed as an indication of the diversification of the major fields.

III. □-Structured System for Engineering Education[2]

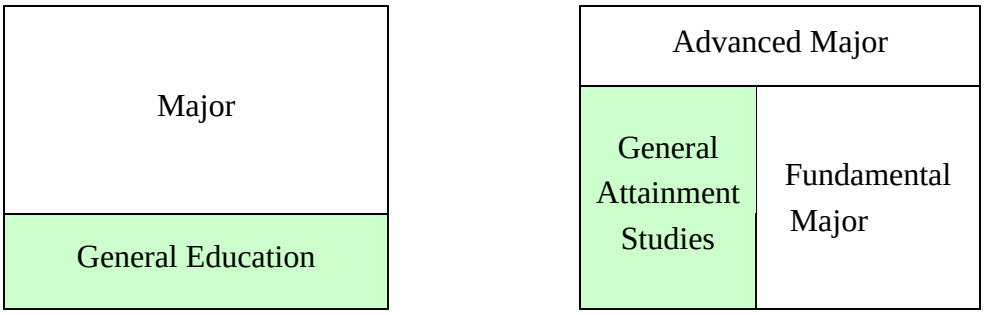
The educational structure for engineering education in Korea has been a simple-layered one in which the General Education program and the Major program are divided school-year based, with the former dedicated to the freshman year and the latter to the sophomore to senior years. In the simple-layered structure, the General Education program is mainly composed of the humanities and social sciences and the basic sciences courses. An engineering student is required to take 30-40 units of General Education courses, including 10-20 units of humanities and social science courses and 20-30 units of basic science courses.

Once the General Education courses are mostly completed in the first year, then the following three years are mainly filled with the Major courses. An engineering student is supposed to take more than 50-60 units of Major courses. The Major courses are composed of engineering sciences and engineering design/methodology courses, but are biased toward the engineering sciences aspect. Most courses emphasize sophisticated theories in electrical engineering, mechanical engineering, chemical engineering, civil engineering or other major fields, paying less attention to the technology aspect such as experiments, designs, and on-site practices.

Considering the limitations in the simple-layered educational structure, we have recently introduced a new educational structure called the □-Structure, which is composed of three components of studies -- the General Attainment Studies, Fundamental Major, and Advanced Major. These three components are stacked in □ shape in which the General Attainment Studies and the Fundamental Major programs are put in parallel as pillars in the bottom and the Advanced Major program is stacked on their top as the capstone (see Figure 1).

For an overall sketch of the □-Structure, we consider the classification of education programs for engineering education (see Figure 2). Considering the subjects of programs we may classify the engineering education programs into humanities and social sciences, mathematics and basic natural sciences, engineering sciences, and engineering design/methodology. This is the classification that has been widely used in engineering education for a long time. If we view the engineering programs from another perspective, we can rearrange it into introductory engineering, fundamental-level major, and advanced-level of major programs. Based on this rearrangement we reclassify the engineering education programs into General Attainment Studies, Fundamental Major, and Advanced Major programs, as depicted in Figure 2.

2) For details of the □-structured educational system, refer to References [6]-[7].



(a) Simple-Layered Structure (b) □-Structure

Figure 1. Educational Structures

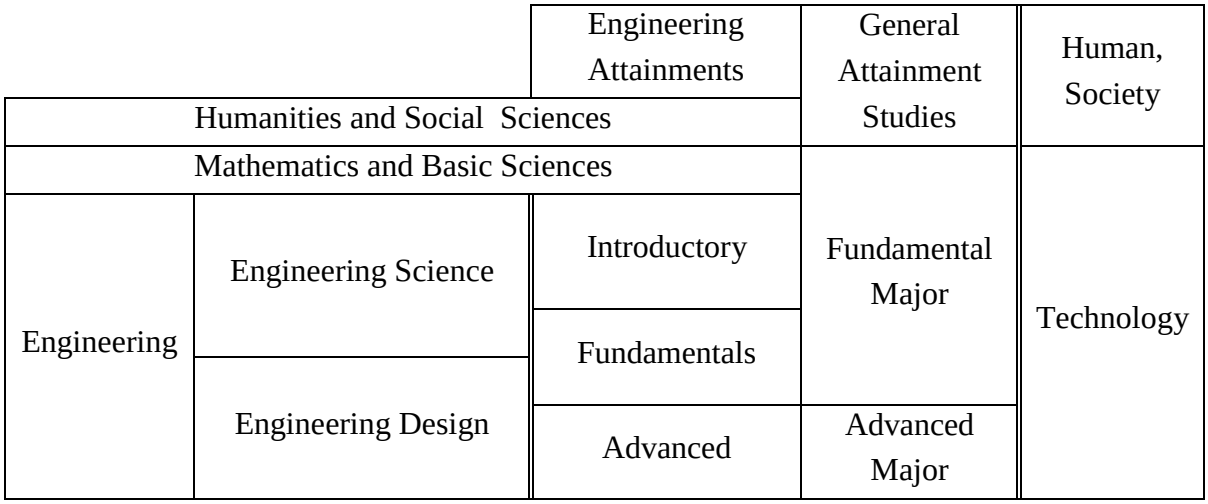


Figure 2. Classification of engineering education programs

The General Attainment Studies program includes the humanities and social sciences as the bases and supplements various other subjects that help developing engineer-specific attainments. It emphasizes the technology-related social science courses such as economics, management, laws, and environments. Especially the economical approach to engineering problems is perceived as an important attainment for engineers, so is stressed in the General Attainment Studies program. In addition, the computer-based information processing and networking capabilities, and the communication skills including oral and written presentation are incorporated in the program. Besides, inter-personal skills, team work ability, and leadership are also accounted as the requisite engineer's attainments and are thus included in the program.

The Fundamental Major program consists of three components -- mathematics and basic natural sciences, introductory engineering, and fundamental-level majors. Those are the basic building blocks of engineering major, on which advanced-level of major may be stacked.

Mathematics and basic sciences are what we have long used as the major menu for the freshman-level engineering education. Introductory engineering is a comparatively new component that is designed to complement the math & science biased freshman education by adding engineering flavor. It may include courses on general understanding of engineering and technology, history of engineering and technology, engineering ethics, novice engineering design, and others. Fundamental-level major courses include the core of a particular major field of engineering that can equip an engineering student with the fundamental principles and practices of the major field. Fundamental-level major courses may consist of engineering sciences and the relevant design and experiments, as well as the related interdisciplinary studies.

The Advanced Major program contains the advanced level of major studies, with the term "major" differently defined depending on the educational goal of each college/university and the career goal of each student. It could be a continuation of the Fundamental Major program in case master/doctoral degree courses are to be pursued. It could be design and implementation oriented in case the career track is directed toward the industry. In some special cases where techno-economics and policy oriented career track is desired, the Advanced Major program could be filled with the pertinent social science courses. Even in this unusual case, the student is supposed to determine himself as an engineer owing to the engineering core education in the Fundamental Major programs.

Table 3 lists a summary of the above discussions on the three constituent components of the □-structured educational system.

Table 3. A summary of the three constituent components of the □-structured educational system

General Attainment Studies	1. Humanities and social sciences 2. Understanding of technology related social studies 3. Economical approach of engineering problems 4. Information processing and networking capabilities, communication skills 5. Inter-personal skills, teamwork ability, leadership
Fundamental Major	1. Mathematics and basic sciences 2. Introductory engineering 3. Fundamental-level major 4. Engineering designs and practices 5. Interdisciplinary studies
Advanced Major	To be determined depending on the educational goal of the college/university and the desired career track of the student.

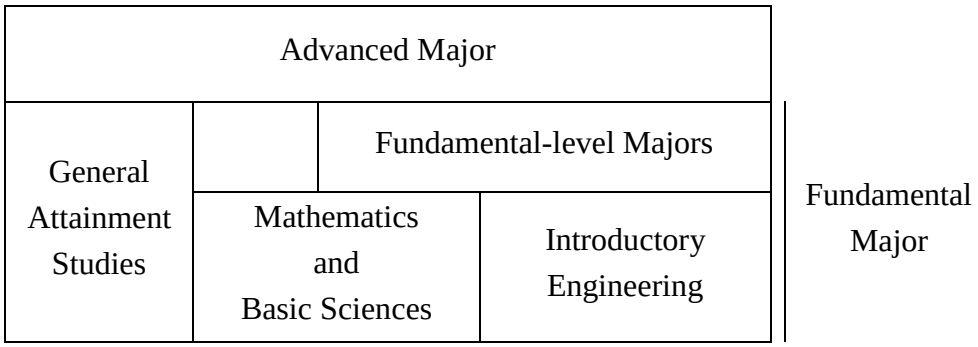


Figure 3. Layout of the □-Structure

Overall, the General Attainment Studies program is intended to nurture the general attainments related to the human being and the society, in contrast to the Fundamental and Advanced Major programs that are intended to strengthen the technology-related capabilities.(see Figure 2)

In laying out the three building components, we stack them in the □ shape in which the General Attainment Studies program and the Fundamental Major program are juxtaposed in the button and the Advanced Major program is put on their top as depicted in Figure 3. It is noteworthy that within the Fundamental Major category the math & science program goes in parallel with the introductory engineering program from the freshman year.

□. Conclusion

As we have seen in the front part of the paper, engineering education has led the growth of general higher education in Korea during the past decade, and the graduate level education has predominated the growth of engineering education. During this decade, the number of students has doubled for the undergraduate level and has almost tripled for the graduate level. This steep growth in engineering education is believed to be strongly correlated with the evolution of industrial structure of Korea. The diversification of engineering education, indicated by the remarkable increase in the number of departments during the decade, may help to drive the progress of tomorrow's engineering education, paving the way toward the knowledge-based society in the upcoming information age.

The simple layered engineering educational structure, which might have contributed to industrial development of Korea so far, needs restructuring for an enhanced efficiency. The newly proposed □-Structure contains more diverse and balanced education programs and the □-shaped organization also better contributes to enhancing the educational efficiency. In

addition it helps to render smooth interfaces to both the lower and the upper boundaries : It provides a stimulated freshmen education on one side and a short-term transition toward the career world. The proposed □-Structure should be applicable not only to the engineering education in Korea but also to the engineering education of most colleges/universities all over the world.

References

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