
JSEE(일본공학교육협회)와 일본의 공학교육

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JSEE and the Engineering Education in Japan

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국문 요약

20 세기말 10년 동안의 경제 침체는 고용과 교육 시스템을 포함한 사회 구조에 여러 가지 극심한 격렬한 변화를 초래하였다. 일본의 대학은 연구 활동에 노력을 기울였지만, 교수들은 공학 교육에 필요한 교수법의 개발에는 별로 노력하지 않았다. 그러나 18세 인구가 감소하면서 대학의 태도 변화가 요구되었다. 대학 교육은 더 이상 엘리트만을 위한 것이 아니라 젊은이들 사이에 아주 대중화되고 있다. 또한 WTO와 APEC과 같은 조직의 설립에 따른 산업사회의 '세계화(globalization)'의 영향을 받았다. 일본공학교육인증원(JABEE)은 1999년에 국내외 문제에 대처하기 위해 설립되었으며, 2005년에 워싱턴협약(Washington Accord)의 정회원이 되었다. 일본 기술사법(Professional Engineer Law)도 JABEE와 연계되어 개정되었으며, 사회 구조의 변화와 함께 공학 윤리의 중요성이 인식되었다. 일본공학교육협회(JSEE)는 JABEE를 지원하는 활동을 통해서 일본 공학 교육의 개혁에 공헌하고 있다. 이 논문은 현재 일본 공학교육이 직면하고 있는 문제점들과 일본의 공학 교육을 재편하기 위한 JSEE의 역할을 기술한다

Abstract

The economic depression during the last decade of the 20th century caused various drastic changes in the social structure, including employment and educational systems. Japanese universities have devoted much effort to research activity and the development of teaching methodology for engineering education was not a major effort for professors. Decrease of 18 years old population, however, forced universities to change this attitude. University education is no more for only elite but is becoming very popular among young people. Another impact came from the 'globalization' of industrial societies such as establishment of WTO and APEC. Japan Accreditation Board for Engineering Education (JABEE) was established to cope with both domestic and international problems in 1999, and JABEE was admitted as a full signatory member of the Washington Accord in 2005. The Professional Engineer Law was amended linked with JABEE. The importance of engineering ethics has been recognized with these social

structure changes. Japanese Society for Engineering Education (JSEE) is contributing for reformation of Japanese engineering education through its activities including supporting JABEE. This paper describes the problems now Japanese engineering education is facing and the role of JSEE in order to reorganize the engineering education in Japan.

주제어 : 대학 개혁, 인증, 세계화, 기술사, 윤리

Keywords: university reform, accreditation, globalization, professional engineer, ethics

I . INTRODUCTION

During the last decade of the 20th century, Japan had gone through various drastic changes in the social structure. Economic depression started around 1990 forced severe change in employment custom. Lifetime employment is no longer promised. Major Japanese industries used to provide in house CPD programs for the employees but this system may not be so effective in near future. On the other hand, educational institutions such as universities are not ready to take it over.

Japanese universities have their own problems. They devoted much effort to research activity and the development of teaching methodology for engineering education was not a major effort for professors. Promotion has been counted only on the research activities. Engineering education in Japanese university was more from the view point of “study” rather than from the view point of “technology”. In other words, education for engineers were heavily dependent on the in-house CPD after employment and engineering education in Japanese universities was said to be behind the international level, although the level of Japanese industries and their products are considered to be one of the highest in the world.

Decrease of 18 years old population is, however, forcing universities to change these attitudes. University education is no more for only elite but is becoming very popular among young people. JABEE was established with these backgrounds. Programs for engineering education must be tailored to meet the requirement of the demand to educate “engineers”, not “engineering scholars”.

The certificate of Professional Engineer (PE) used to be given for very experienced engineers who may be engaged with consultation for industries. However, PE is now recognized as an important certificate with the increase of international activities, or globalization started remotely with the ‘collapse of the Cold War’ and directly with the establishment of WTO and APEC [1]. The PE Law was drastically amended in 2000 linked with the establishment of JABEE. The graduates of JABEE approved programs are now exempt from the primary examination, instead of ‘experienced engineer’ before. Education of engineering ethics used to be done mostly in industries, but with rapid employment situation change, it became an important part in JABEE programs.

Japanese Society for Engineering Education, JSEE, was established in 1952, in order to provide common place for educational institutions, government organizations and industries in engineering education. JSEE is trying to contribute to the reformation of engineering education in Japan by supporting JABEE and through various activities including international relations with societies for engineering education in the world.

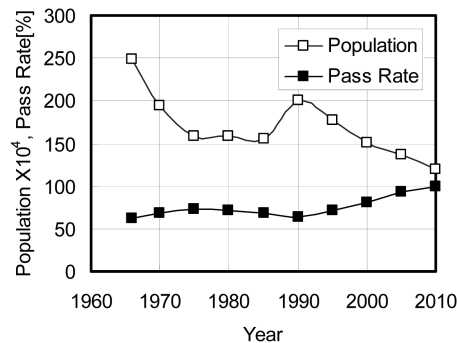
II . Changes in Japanese education

1. Primary and high school education

Primary and high school education in Japan used to be very dense and high level in knowledge base but was considered to be ineffective to develop creativity. At the end of the 20th century, Ministry of Education introduced so called “More Enjoyable Education” to these levels of education in order to promote the development of creativity in the early stage of life. Learning hours were cut down approximately 30% to give more free time to students, but instead of developing creativity, reverse effect seems to dominate. New education programs seem to have resulted in “premature scientific education” for high school graduates. In April 2006, the first class of the new high school graduates entered the universities. We have to assess the quality of new students and if necessary, we have to change our educational programs for the new situation.

2. Population trend and university reform

The most urgent problem for universities to cope with is the decrease of the population of 18 years old as shown in Figure 1. After peaking as 2 million in 1990, it is continuously decreasing and it will be 1.2 million in 2010, which is the same as the capacity as the freshman of the entire universities in Japan. This means that the pass rate of the entrance examination to universities would be 100% in 2010, or even before if the capacity is increased. It was foreseen in the last decade and universities have been making every effort to keep enough students. This attitude of universities also created problems by themselves by introducing various kinds of entrance examinations, some of which don't require enough mathematical or scientific knowledge to enter to engineering schools.



[Figure 1] Population of 18 years and the pass rate.

Another pressure to reorganize university education came from the government. National University Corporation (NUC) law was implemented in April 2004. The governmental financial support for national university will be gradually decreased and private enterprise style administration is expected to dominate in near future.

<Table 1> Number of universities and engineering Schools as of 2000.

	Total	Engineering School	Research Institute
National	99	54	57
Public	74	14	11
Private	497	90	80

Table 1 shows the number of universities, engineering schools and research institutes as of 2000. Engineering schools usually include both undergraduate and graduate schools. Faculty members in the research institute are supposed to be heavily engaged with research activities and usually teach only graduate courses. However, this situation does not apply to some private universities. The ratio of (Engineering school)/(Total) is 0.545 for national university and is 0.181 for private university, because of the high cost of engineering school operation. With the implementation of NUC law, some of them have been merged and the number of national university was decreased to 87 from 99. On the other hand, number of private university increased to 544 against the trend of 18 years old population decrease.

3. Number of engineering students

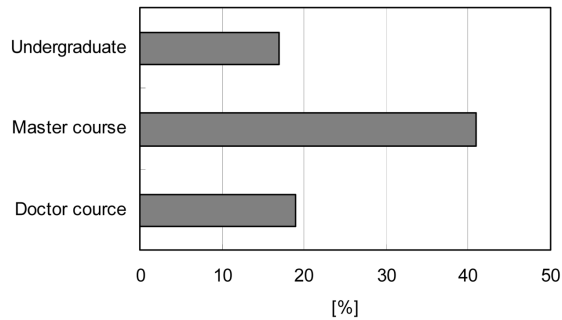
Table 2 shows the trend of number of students from 1990 to 2005. While private universities have majority of the undergraduate students, national universities have more graduate students, particularly in doctor course. This is partly due to the fact that the tuition of national universities is less than a half of private universities and the scholarships for graduate study are not enough to support the students in private universities. Table 2 shows the increase of the student from 1990 to 2000. While the increase of the undergraduate is 20%, the number is doubled for master's student and nearly tripled for doctoral student. National universities are recruiting more graduate students in the past decade and the increase of the graduate student is therefore mostly absorbed by the national universities. From 2000 to 2005, undergraduate student decreased about 7.2% in total, 4.8% for national university and 9.9% for private university. Number of Master's student is still increasing because job market is still shifting towards the graduate degree.

<Table 2> Number of engineering students

	Total			National		Public		Private	
Year	1990	2000	2005	2000	2005	2000	2005	2000	2005
Undergraduate	390,464	467,117	433,377	146,994	141,450	13,816	15,921	306,307	276,006
Master	28,399	59,082	63,908	38,374	40,650	2,272	2,826	18,436	20,432
Doctor	4,315	11,818	10,454	9,858	8,261	465	447	1,495	1,746

The total number of entire undergraduate student in 2005 is 2,501 thousand and the percentage of engineering student is 17%. In Master course this figure is 41% and in Doctoral course, 19%. Approximately 30% of the university graduates enter to the master course as shown in Fig. 2. These figures also indicate that Master's degree is important for engineering student. Number of engineering graduate is approximately 105 thousand each year and this figure is rather high compared to other

countries such as USA. However, quality assurance of these graduates was found to be not enough without proper accreditation system for engineering education programs. This is one of the reasons JABEE was established.



[Figure 2] Percentage of engineering students to the total number.

III . Development of JSEE

1. Brief history of JSEE

Japanese Society for Engineering Education (JSEE) was founded in 1952, when Japan regained independence after the World War II. It was utmost important to recover the industrial activities from the

<Table 3> Brief History of JSEE

1952	Established with 7 Regional Societies
1973	AESEEA1 established, JSEE joined as a Voting Member
1982	One regional society split into 2. Resulted in total 8 Regional Societies
1985	Organized 7th AESEEA Conference held in Tokyo
1993	Signed Agreement between JSEE and ASEE2
1996	Organized AESEAP Midterm Conference in Tokyo
1997	Registered as a member of Science Council of Japan
1999	JSEE supported the establishment of JABEE
2001	IACEE3granted the 9th WCCEE4 to JSEE to be held in Tokyo in May 2004
2003	Signed Agreement between JSEE and SEFI5
2003	Signed Agreement between JSEE and KSEE6
2004	JSEE organized 9th WCCEE in May in Tokyo
2006	JSEE organized the first International Session in the Annual Meeting

¹ Association for Engineering Education in South East Asia. Later it became AESEAP, Association for Engineering Education in South East Asia, East Asia and the Pacific.

² American Society for Engineering Education

³ International Association for Continuing Engineering Education

⁴ World Conference for Continuing Engineering Education

⁵ European Society for Engineering Education

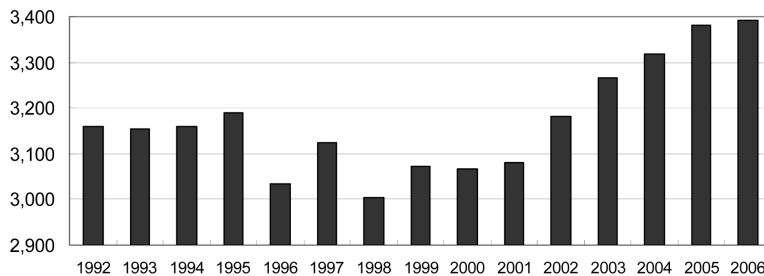
⁶ Korean Society for Engineering Education

destruction during the war. The aim of establishing JSEE was to promote the education of engineers by providing the common place for educational institutions and industries. JSEE started with seven Regional Societies of Engineering Education and one regional society split into 2 in 1982, resulted in eight regional societies. This co-existence of JSEE and the Regional Societies left some administrative problems even today but we are aiming at consolidating all the regional societies to the single JSEE. The brief history of JSEE is shown in Table 3.

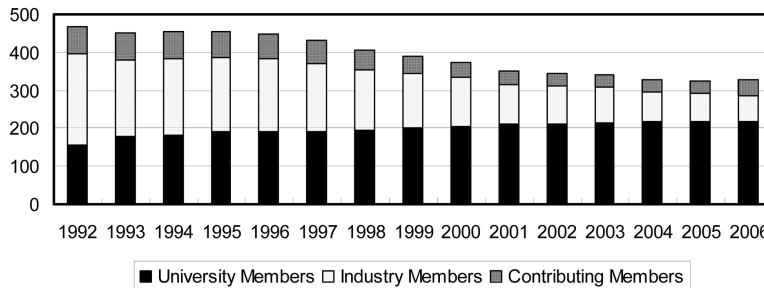
Since 1997 when JSEE became a member of Science Council of Japan, international activities increased. JSEE proposed to invite WCCEE to Tokyo and IACEE granted the 9th WCCEE to be held in Tokyo in 2004. In the meantime, JSEE expanded international relations with other societies of engineering education. In 2003, JSEE signed agreement with SEFI and KSEE. At least one Representative of JSEE has been attending the annual meetings of ASEE, AEEAEAP, SEFI, KSEE and WCCEE, and keeping close relations to these societies. At the 2006 Annual meeting of JSEE, we organized the international session for the first time. Details will be described in section 3.3.

2. Trend of membership and papers in annual meetings

Figure 3 shows the recent membership trends of JSEE [2]. Annual due is 4,000JPY (3,000JPY for Web members) for individual members, 70,000JPY/unit for university members, 20,000JPY/unit for industrial members and more than 100,000JPY is required for contributing members. At least one unit of contribution is required to the university and industrial members. In 2004, the contribution averaged to be about 320,000JPY per organization. While the numbers of individual and university members are increasing,



[Figure 3] (a) Recent trend of JSEE individual membership.



[Figure 3] (b) Recent trend of JSEE organizational membership.

the numbers of contributing and industrial members are continuously decreasing. This trend seems to be improving in recent couple of years, however, JSEE must create services that will justify the fee of industrial organizations.

Table 4 shows the number of papers presented at the JSEE Annual Meetings, together with the number of papers related to engineering ethics. The number of total papers sharply increased in 2002, when JSEE celebrated its 50th anniversary and it is still increasing up to 2006. The increase of number of papers for engineering ethics is related to the establishment of JABEE. When the lifetime employment was dominant, education of engineering ethics used to be done mostly in industries, but with rapid employment situation change, it became an important part in JABEE programs. Educational institutions, engineering societies and industries are all searching proper way to teach engineering ethics to students and engineers at the all stages of professional development.

<Table 4> Number of papers presented at JSEE Annual Meeting from 1997 to 2006

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total	103	142	84	98	104	184	211	361	364	399
Ethics	2	1	1	1	3	4	12	18	19	23

3. International Session in 2006 JSEE Annual Meeting

As described in section 3.1, international activities of JSEE have been increasing. Representative of JSEE have been attending the Annual Meetings of ASEE, SEFI and KSEE but these are mostly "one way" attendance and mutual exchange of information was not achieved as much as we expected. The success of a special lecture in English give by Ray Almgren of National Instruments Corporation in the 2005 JSEE Annual Meeting motivated the planning of an International Session to be held with 2006 JSEE Annual Meeting that will be organized by Kyushu Regional Society for Engineering Education. Prof. Harada of Kyushu Institute of Technology and the present author served as co-organizer of the session. In addition to 6 invited papers, there were 12 contributed papers for a whole day, July 29. Table 5 shows the list of invited papers.

It was very fruitful that presidents or equivalent personnel of the prominent societies for engineering education in the world got together and discussed common problems and exchanged information. We will organize the International session again in 2007 JSEE Annual Meeting, to be held on 3 – 5 August, 2007, at the College on Science and Technology, Nihon University, Tokyo.

4. Professional Engineering Educator

In 2005, JSEE introduced the Certificate of The Professional Engineering Educator (PEE) for the purpose to enhance the teaching ability and reinforce the motivation for teaching of engineering educators. Four ranks of PEE are introduced, Special rank, Senior rank, First rank and Second rank. These ranks correspond approximately but not necessarily with dean, professor, associate professor and lecturer respectively in educational institutions.

<Table 5> List of Invited Papers at the International Session, 2006 JSEE Annual Meeting

Paper Title	Author(s)	Affiliation
Current Status of Engineering Education in America	Ronald E. Bar	Immediate Past President, ASEE Univ. of Texas, Austin
Research and Innovation of Engineering Education in Europe	Erik de Graaff	Vice President, SEFI Delft Univ. of Technology
	Claudio Borri,	President, SEFI, Univ. of Florence
The Present Situations and Issues of Engineering Education and Accreditation System for Engineering Education in Korea	Sung-Goon Kang	President, KSEE, Hanyang Univ.
	Tae-Cheon Rho	Chungnam National Univ.
	Seung-Yeon Hahm	Korea Institute of Curriculum & Evaluation
	Cheong-Sig Kim	Hanyang Univ.
Exploration of Ways to Improve the Quality of Chinese CE Providers	Feng, Changgen	Executive Secretary, CAST* Beijing Institute of Technology
Sustainability issues of the AEESEAP activities	Nasrudin Abdul Rahim	President, AEESEAP Univ. of Malaya
	Suhana Mohd Said	Univ. of Malaya
Current Status of Engineering Education in Japan and the role of JSEE	Hajime Fujita	Director for International Affairs, JSEE Nihon University

* China Association for Science and Technology

PEE is defined in JSEE as follows [2].

PEE is one who possesses a sound work ethic, has superior communication skills, has an understanding of educational psychology, and who possesses any or all of the following skills:

Has an intricate knowledge of their field of expertise, and has enthusiasm for human resource development and education in general.

Has an understanding of education methods, and puts these into practice, bringing out the student's maximum potential.

Has a constant desire to acquire a broad range of general knowledge and advanced expertise in their particular field.

Has educational management skills, and can design and put education reforms into practice.

In order to develop exceptional educational methodology, educators are required to deal with current trends, educational tools, and rapid changes in participants, and changes to the education environment flexibly. The program is being introduced as a way of evidencing the use of various educational opportunities in which the member can search out new information and develop their skills. In 2005, 208 Special, 53 Senior, 17 First and 4 Second rank educators were accredited. For further development, operation of continuing education point system will be introduced in 2006.

5. JSEE in future

Activity Planning Committee is the central organization to plan the mid-term activity of JSEE. It

usually has three subcommittees, such as "The Way to Proceed for JSEE", "Cooperation with K-12 Education" and "Evaluation of Teaching Ability" for the year 2004-2005. Results of the committee are reported at the JSEE Annual Meeting every year and necessary action to realize the recommendation of the committee is taken.

JSEE is seeking goals in the beginning of new millennium as follows [2].

- JSEE individual memberships: 5,000 (Approx. 3,400 at present)
- Eight regional societies for engineering education will be united to JSEE
- Continue to promote engineering education and the ongoing education and training of 2.4 million engineering professionals.
- Support of JABEE
- Create services that justify membership fees for professional members

IV . Development of JABEE

University education in Japan used to be a "sanctuary" and professors had great independence what to teach. Even colleagues in the same department did not interfere each other for their teaching contents. During the drastic social structure change in the last decade of the 20th century, however, university education suffered a lot by this outdated teaching system. The establishment of JABEE in 1999 was very timely to make necessary changes in the teaching system in universities. We used to use a Japanese word meaning "Engineering Scholar Education" for engineering education but JABEE explicitly uses the word meaning "Education of Engineers". As the university education became so popular in Japan, the graduates from engineering schools are expected to be "practical engineers" rather than "researchers". High level standard of the old day's undergraduate education has now shifted to the graduate schools. And even in the graduate school level for Master's degree, researcher type graduates are not so much in demand from the industries.

JABEE requires that each education program must teach the basic knowledge required for engineers including ethics as an engineer. Faculty members with industrial experience are particularly important in the program. The graduates from JABEE program will be exempt from the primary examination for Professional Engineer. Number of program accreditation is shown in Table 6.

During the trial period of 2000 – 2002, various improvements were made for the accreditation procedure and the requirements. Importance of supplementary standards for each particular field of engineering, in addition to the common standards, was clearly demonstrated. 'Plan-Do-Check-Action' (PDCA) order sequence of action for evaluation was noted. 'Amount of Study/Education' condition was added to give minimum of 1,800 hours of total guaranteed study time for each course.

The main activities of JABEE beside accreditation are as follows.

- Training of evaluation personnel.
- Participation in practical trials by ABET.
- Sponsoring symposiums nationwide to publicize the Engineering Education Accreditation System.
- The creation and the development of accreditation standards and evaluation methods, self-assessment documentation /methods, etc.

<Table 6> Number of JABEE Program accreditations

	2000	2001	2002	2003	2004	2005
Trial Accreditation	20	51	37	—	—	—
Accreditation	—	3	32	67	84	95
Washington Accord Membership		Provisional Membership				Full Signatory Membership

National College of Technology (NCT), a 5 year program of the combination of senior high school and junior college, is showing particular interest in JABEE. NCT cannot offer Bachelor's degree because its engineering education program is equivalent to 2 years junior college program. However, additional 2 years advanced program in NCT may be able to offer Bachelor's degree if the program is accredited by JABEE. It has passed 40 years since the establishment of NCT and now it is the turning point. NCT is searching for new role in engineering education among universities, particularly tied with JABEE.

JABEE has indicated its intention to join the Washington Accord (WA) at the beginning. Through the assistance of related member countries, including official letters of support, JABEE was able to gain provisional membership status in the General Assembly of the WA held in June 2001. JABEE was admitted to full signatory status of WA by the unanimous vote of existing full signatories in June, 2005.

Now the foundation stage or running stage is over and JABEE has to step forward with more sureness and confidence. JABEE is trying to accomplish the following tasks for making the foundation of JABEE's activities more solid and reliable.

(1) Continuing Improvement of Accreditation System

(2) Enhancing Collaboration with Industries

Understanding and recognition of JABEE among industries are still low, especially among small and medium-sized enterprises.

(3) Preparation for Accreditation of Master's Programs

On average, 30% of engineering graduates go on to study Master's programs. This figure exceeds 70% in leading research universities. Quality assurance for Master's programs is urgently needed.

(4) Promotion of International Collaboration

(5) Conducting Self-Inspection and External Evaluation of JABEE for Further Improvement

V . Professional Engineers

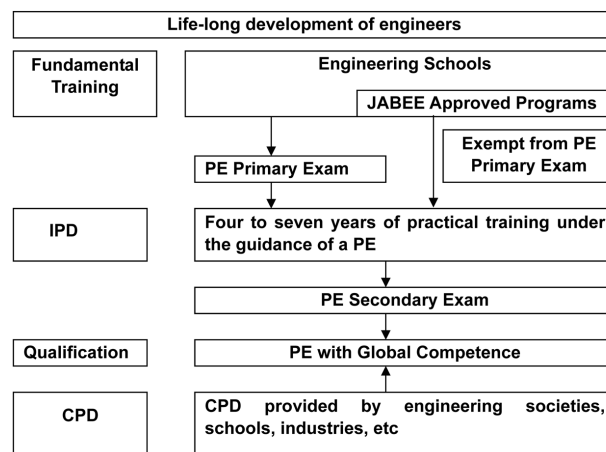
The certificate of Professional Engineer (PE) used to be given for very experienced engineers who may be engaged with consultation for industries. However, PE is now recognized as an important certificate with the increase of international activities, or globalization started remotely with the 'collapse of the Cold War' and directly with the establishment of WTO and APEC [1]. The PE Law was substantially amended in 2000 linked with the establishment of JABEE. The Institute of Professional Engineers (IPEJ) is the representing engineering association of Japan organized under the PE law. The graduates of JABEE

approved programs are now exempt from the preliminary examination, instead of ‘experienced engineer’ before. The new scheme for life-long development of engineers is documented as quoted below [1] and illustrated in Figure 4.

Engineering education in universities provides fundamental training needed for entry-level engineers. To improve the quality of education and to assure the global equivalence, an accreditation system must be introduced. JABEE was established in November 1999 as a non-governmental organization for this purpose. Accreditation processes of engineering programs are conducted by JABEE with the close cooperation of relevant engineering societies.

Those who have finished fundamental education start to accumulate training and practice and gradually build up professional competences as globally deployable engineers. At an appropriate stage of the development, one may apply for a professional qualification such as domestic PE as the token of an independent professional. Since the requirements for domestic PE and international PE, for instance, APEC Engineer, are fundamentally compatible, domestic PEs may apply for an international professional qualification, once their length of engineering practice exceeds the respective requirement.

CPD is essential for engineers of every stage. Engineers without professional qualifications need CPD to maintain and enhance their value or employability. For PEs, domestic as well as international, CPD is requested as their professional responsibility. CPD shall be driven by the autonomous initiatives of individuals as the means of endless updating of their expertise. Professional societies, educational institutions like universities, in-house training centers of private companies, and industrial associations of individual sectors; they are all providers of CPD service and must share their roles so that the clients, that is, all engineers have a variety of programs to choose from. In order to harmonize and integrate the activities of CPD providers into an effective and clients-friendly system, a coordinating body, tentatively named PDE Council, is currently in preparation with close cooperation of engineering societies.



[Figure 4] Life long development of engineers

VI. Concluding remarks

The economic depression during the last decade of the 20th century caused various drastic changes in the social structure, including employment and educational systems. In addition, decrease of 18 years old population triggered universities to reform the engineering education. Another impact came from the globalization of industrial societies. JABEE was established to cope with both domestic and international problems in 1999, and JABEE was admitted as a full signatory member of the Washington Accord in 2005. The Professional Engineer Law was amended linked with JABEE. The importance of engineering ethics has been recognized with these social structure changes. JSEE has more than 50 years of history and trying to support JABEE and other engineering societies in order to solve problems now Japanese engineering education is facing and to reorganize the engineering education in Japan.

[R E F E R E N C E S]

- [1] Hideo Ohashi, Establishing engineering profession in Japan, - Accreditation, professional qualification and CPD -, Presented at the 3rd ASEE International Colloquium on Engineering Education, September 7-10, 2004, Beijing
- [2] Osamu Tsubakihara, Recent Status of Engineering Education in Japan, Presented at the ASEE 2005 Annual Meeting, June 12, 2005.

[B i o g r a p h y]

Hajime Fujita has received his BS and MSE degrees from the Department of Mechanical Engineering, Nihon University, Tokyo, in 1965 and 1967 respectively, and has received Ph. D degree from The Johns Hopkins University, Baltimore, Md. U.S.A. in 1972. After working as a Research Associate at JHU and a Visiting Assistant Professor at the Illinois Institute of Technology, Chicago, IL. U.S.A., he returned to Japan in 1975 and worked at the Mechanical Engineering Research Laboratory, Hitachi, Ltd. where he was mainly engaged with noise control engineering, as well as the in-house CPD Programs for Hitachi group engineers, serving as Senior Scientist and Chief Scientist. He was appointed as the East Japan Railway Professor at the Tokyo Institute of Technology from 1992 to 1995 and he has been a Professor of Mechanical Engineering, Nihon University since 1995. He has been a Council Member of IACEE since 2001 and the Director for International Affairs, JSEE since 2002. He was the Chairman of the 9th WCCEE held in Tokyo in 2004.