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Engineering Education as the Entrance to Lifelong Engineering Career

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REFORMS IN ENGINEERING EDUCATION

After Meiji Restoration in 1868, Japanese government introduced a set of modernization programs, which were mostly the transplantation of advanced western political, judicial, educational and industrial systems. Establishment of higher education was one of key issues. Engineering education on university level started in 1873 when Henry Dyer of Glasgow founded Engineering College (origin of the Engineering School of the University of Tokyo) by the request of the government. Thanks to his passion and endeavor, Japan succeeded to establish National University system in which Engineering School was installed as an inevitable and key component of higher education. Prof. Dyer materialized his dream of combining technology and science in universities, not in his motherland but here in Japan.

Though our engineering education started in British style, it had been modifying itself to adjust to the local situation. Especially during the rapid expansion period of Japanese industries till the end of 1980s, they requested us to supply as much human "raw material" as possible, which they forged to competitive engineers after employment through long-sighted in-house and on-the-job trainings.

"Engineering" used to be translated into Japanese as "工学". These two characters mean literally "Technology" + "Science", that is, science for technology. According to the western definition (ABET, Eng. Council of UK, etc.), "Engineering" means a profession, but it has been understood as science for technology or engineering science here in Japan. We have been long unaware of this definition gap.

The most important reform in our engineering education consists in the conversion from teaching engineering science to building fundamental capacity of students, who later develop themselves to independent professional engineers, capable of taking responsibility to the safety and reliability of modern industrialized societies.

FOR ESTABLISHING ENGINEERING PROFESSION

Science Council of Japan SCJ 日本学術会議, Japan Federation of Engineering Societies 日本工学会, Japan Society of Engineering Education 日本工学教育協会 and EAJ have been cooperating closely to reform public consciousness on profession, especially to enhance public awareness on the importance of engineering profession. In December 1998, the president of SCJ, Dr. H. Yoshikawa, addressed a public declaration in which the following issues were

pointed out:

- 1) The safety and reliability of modern society depend heavily on artifacts (artificial products; buildings, vehicles, IT devices and systems, etc.).
- 2) Engineers are totally responsible for artifacts, throughout planning, developing, designing, manufacturing and operating phases. Engineers must be qualified to accept such responsibility.
- 3) Society should recognize the role of engineers properly. To obtain the public understanding, there must be a publicly acceptable system that assures the professional qualification of engineers.
- 4) Introduction of Japanese version Professional Engineers is urgent, that should match, of course, with global standard.
- 5) Introduction of accreditation system of engineering education on university level is also urgent. Accreditation not only offers basic education for qualified engineers, but also generates strong driving force for the improvement of university education.
- 6) To maintain the lifelong expertise of engineers, introduction of Continuing Professional Development (CPD) must be also incorporated.

We have been trying to establish a consistent national system that can maintain the activities of engineers at the top gear throughout their lifelong career, for the benefit of the society and the individuals as well. Such system must include quality assurance of engineering education at the graduate level and also certification of professional engineers compatible to the global standards. They are described separately in the following sections.

ACCREDITATION OF ENGINEERING EDUCATION

In order to establish quality assurance system of engineering education at graduate level, a committee named "Global Engineers Education Committee" headed by Dr. Yoshikawa was founded in 1987. After elaborate consultation and dissemination among relevant organizations, that is, educational institutions, major engineering societies, Min of Edu 文部省, MITI通産省, STA科学技術庁 and also employers represented by Keidanren経団連, Japan Accreditation Board for Engineering Education 日本技術者教育認定機構 (JABEE, <http://www.jabee.org>) was finally founded on November 19, 1999 by the enthusiastic support of all relevant organizations.

Membership of JABEE is categorized into two groups, i.e., ordinary and supporting members. An engineering program applied for accreditation is first evaluated by the relevant engineering societies and JABEE decides the accreditation on the basis of their evaluation report. In this context, only participating engineering societies are eligible for ordinary members. Industrial companies that have strong interest in the quality of engineering education are eligible for supporting members. Among 16 Board Members, 14 are presidents of major engineering societies. They are considered as the ex-officio representatives of more than 65 (as of August 2000) ordinary members.

Our accreditation practice follows basically that of Engineering Criteria 2000 set up by ABET. Introduction of engineering ethics and enhancement of communication capability are examples of what is rather new for us. Intensive preparatory works are now going on. Dissemination of the significance of accreditation to educational institutions and industries, and the training of evaluators are urgent tasks. JABEE started trial accreditation of 20 engineering programs this year and plans to enter full operation within 2 years. Immediately after the first announcement of accredited programs, JABEE plans to apply for the membership in Washington Accord, thus establishing the link of global equivalence of our engineering education.

The organizational structure of JABEE is illustrated in the following figure.

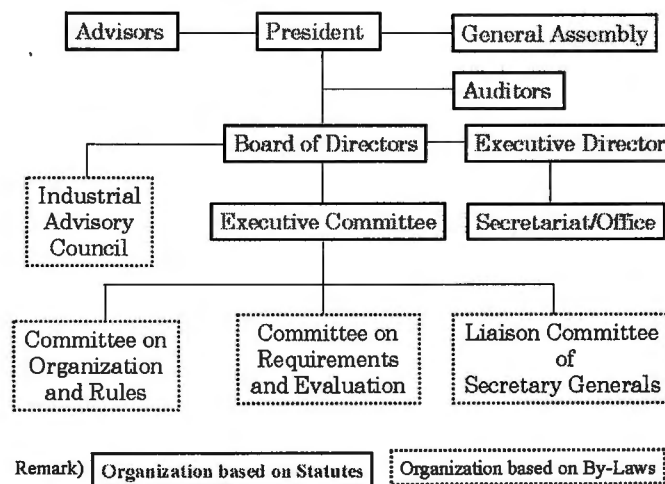


Fig. 1 Organizational Structure of JABEE

INTRODUCTION OF PROFESSIONAL ENGINEERS ACT

Introduction of professional certification of engineers compatible to PE of USA, CEng of UK, CPEng of Australia, for example, is urgently needed when engineering activities are expanding on global scale. The present Japanese professional certification "技術士 Consulting Engineer" lacks global equivalence and is isolated. Last year, Council of Consulting Engineers of STA 技術士審議会 submitted to the government a set of recommendations on necessary revisions of the present system. The revised "Professional Engineers Act" was enacted in this April and will go into effect from April 2001.

The revised Act defines new procedures to obtain and maintain the professional qualification renamed Professional Engineer as illustrated in Fig. 2. The procedures consist of Primary Examination, training and practice (Initial Professional Development), Secondary Examination, certification of PE, and CPD. Graduates of accredited engineering programs are exempt from Primary Examination, since the fundamental competence is assured by the program itself.

The enforcement of the new Act will have great influence on the public perception of engineering profession. We expect that the number of certificated engineers will increase

tenfold from the present number (about 40 thousand) in ten years and that the average age of rookie PEs will reduce to around 30. The responsibility to the public (engineering ethics) is stressed in the new Act and it will hopefully help regain public confidence on engineers and engineering achievements.

Once we complete our national system for engineering profession, it will become far easier to adapt to any regional or international professional certifications such as APEC Engineer and International Engineer now discussed by Engineer Mobility Forum. Engineering societies are expected to play principal roles in the implementation of accreditation and CPD.

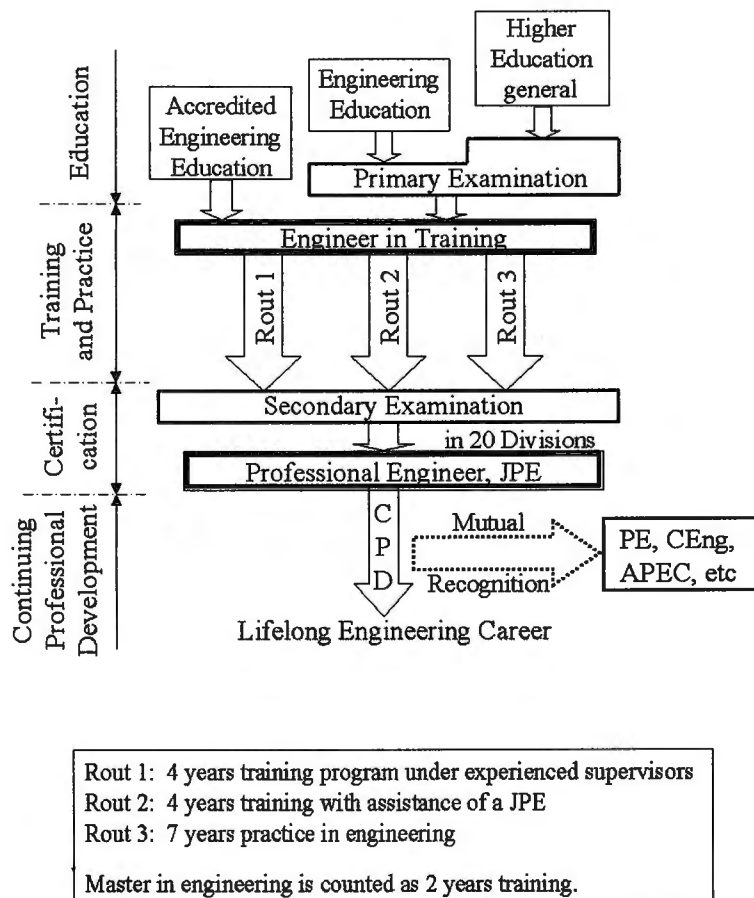


Fig. 2 Procedures of Japanese Professional Engineers

ROLES OF ENGINEERING SOCIETIES

There are 2.4 million engineers in Japan. Among them, approximately 600 thousands belong to one or plural number of engineering societies that have definite range of disciplines to serve.

Each engineering society has two major functions, that is, academic (scientific) and professional. Academic function of JSME (Japan Society of Mechanical Engineers), for example, is to promote the advance of mechanical engineering science on the basis of quality (originality) judgment by peer review. Another function is to help mechanical engineers

maintain and develop their expertise as professionals. In the case of JSME, more than 70 % of her members are engineers working in industries and, therefore, the role as a professional society should be at least as important as the role as an academic one. So-called trunk societies such as of Civil Engineers, Electrical Engineers, Chemical Engineers, Architects, etc., have the character similar to that of JSME.

The members of engineering societies come from all engineering-related sectors: academia, industry, government, local autonomy, etc. Engineering societies are the sole organizations that may represent engineering interests in integrated form. Engineering societies are expected to perform key contribution in every phase of engineering profession, as illustrated in the following figure.

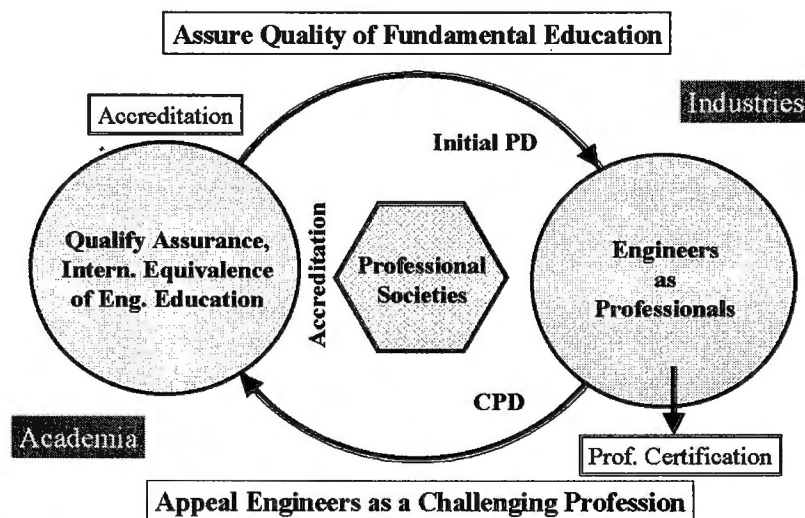


Fig. 3 Engineering Societies as the Key Contributor to Engineering Profession

CONCLUDING REMARKS

Recent criticality accident at JCO's Tokai Facility in Japan left severe damages to the public confidence on technology and subsequently on engineers. Short-term remedies are not sufficient to improve this situation. We are confident that the endeavor described in the above will be a sure step forward to recover the public confidence.

Every nation has own history, culture and feeling of amenity. All reforms we are trying to achieve seem apparently within the frame of so-called westernization or introduction of Anglo-Saxon systems. The same situation happened 130 years ago when Japan went through Meiji Restoration. After mixing and fusing of native and imported species, new systems customized to Japanese climate and situation started to breed, grow and develop. We are now in a similar situation. New Japanese systems for the 21 Century are now under construction.