

## ESTABLISHING ENGINEERING PROFESSION IN JAPAN

– ACCREDITATION, PROFESSIONAL QUALIFICATION AND CPD –

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Various activities for enhancing engineering profession in Japan started around 1995, triggered by the initiatives of WTO and APEC Summit Meetings to accelerate the global mobility of professionals like accountants and engineers. Since then nation-wide efforts have been made under close collaboration of academia, industry and government to establish an integrated system that supports life-long professional development of engineers. This system should at least include such subsystems as accreditation of university education, training of entry-level engineers, professional qualification, and continuing professional development. In designing such subsystems, compatibility and equivalence to globally acknowledged standards were considered to be the key issue. The past achievements and ongoing reforms are reported.

### 1. Impact of Globalization

| Impact of Globalization |  |                      |                          |
|-------------------------|--|----------------------|--------------------------|
| 1991:                   | <b>Collapse of Cold War Regime</b><br>Globalization started to accelerate!   |                      |                          |
| 1995:                   | /1 WTO founded > Accelerate free trade of services<br>/11 APEC Summit Meeting > Mobility of engineers                                  |                      |                          |
| 1996:                   | /3 Coordination of APEC Engr by HRD-WG started<br>/5 Preparation for revision of PE Law<br>/7 Study of accreditation of eng. education |                      |                          |
| 1997:                   | /11 Final agreement on requirements for APEC Engr  |                      |                          |
| 1998:                   | /7 Preparation for founding accrediting organization   |                      |                          |
| 1999:                   | /11 Foundation of JABEE  |                      |                          |
| 2000:                   | /4 Amendment of Professional Engineers Law   |                      |                          |
| 2001:                   | /3 First registration of APEC Engr   |                      |                          |
| 2002:                   | /4 First JABEE accredited programs announced   |                      |                          |
|                         | <table border="0"><tr><td>International events</td><td>Japanese domestic events</td></tr></table>                                      | International events | Japanese domestic events |
| International events    | Japanese domestic events   |                      |                          |

As the above chronology indicates, the starting point was the end of the Cold-War Regime in the beginning of nineties. Since then, expanding economic activities and rapid diffusion of information technologies have been diminishing walls between nations. In such a borderless age, each nation can survive not in seclusion, but only in the economical and cultural interdependence in the global scale.

The year 1995 was a special one for engineering profession in Asia. World Trade Organization was born in January this year and took initiative to remove the barriers that restricted free trade of not only commodities but also services. Services are provided by humans, especially by specialists like accountants and engineers. In accordance with this movement, APEC leaders gathered at Osaka Summit Meeting in November adopted a resolution to accelerate the mobility of registered engineers within the region

Next year in 1996, Human Resources Development WG of APEC started energetic coordination among member countries to establish a common regional engineering qualification, called APEC Engineer. The final agreement on the requirements for APEC Engineer was settled in

Sydney Meeting of the WG in November 1997, and monitoring committees were founded in member countries for the registration of the new regional qualification.

In the initial stage of the coordination, the educational requirement for APEC Engineer was to complete an accredited engineering program at universities. Since the accreditation was not common in the majority of Asian countries, the requirement was later modified to include also engineering programs provided by government-recognized universities.

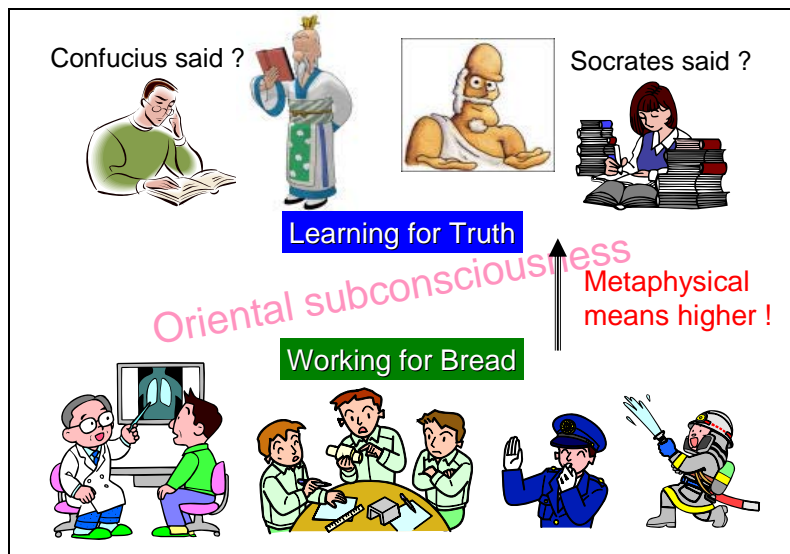
As the framework of APEC Engineer became gradually concrete, Japanese government started in 1996 to revise national systems to make them compatible with APEC or global systems. There were two major issues to cope with, that is, 1) introduction of accreditation system of engineering education at universities, and 2) revision of old-fashioned domestic Professional Engineers Law. The former was materialized by the establishment of Japan Accreditation Board for Engineering Education (JABEE) in 1999, and the latter by the amendment of the Law in 2000.

In March 2001, Japanese Monitoring Committee announced the names of 1500 APEC Engineers who were registered as the first entry. In April 2002, JABEE announced three accredited programs that obtained the honor of the first runners among over 1000 engineering programs currently offered in Japan.

You will recognize from the chronology how big changes took place in a relatively short time, all triggered by the strong impact of globalization.

## 2. Recognition of Engineering as a Profession

In the process of converting our domestic systems to globally compatible ones, we experienced a lot of difficulties, especially in recognizing the meaning and importance of such western concept as "profession". In Chinese-character cultural zone of East Asia, there is no indigenous terminology corresponding to profession. Of course, we can find the word "profession" in every English dictionary but its superficial translation cannot convey the substance and weight that the word bears in western societies.



In Japan, similar to other East Asian countries, we have had a long cultural tradition of respecting "learning" as the road to sublime truth, but at the same time, of looking down "working" as a mere means of getting bread. As the result of this subconscious prejudice that physical working is subordinate to metaphysical learning, our society has been insensitive to the dignity of those people who work in earnest and accomplish a variety of tasks that are needed to run a stable and reliable society. In this social context, being a professional, especially being an intellectual professional has attracted little interest and respect in our society. Only one exception is professionals in sports, because they earn admirable incomes. The above slide could convey to you the image that is still prevailing in our society.

This context was also common among university faculties. The mission of universities was

thought to cultivate knowledge through research, to transfer knowledge through education and to select and breed potential successors for knowledge regeneration. University faculties and even students thought that the university is the place where knowledge is taught, but not the place where professionals are trained. The globalization requested us to change our traditional perception on profession and further on the mission of universities.

Engineering is, of course, one of the most important and responsible professions in the modern society that depends deeply on human-made hardware and software. Engineering faculties took the initiative to reform our traditional perception on university education. In the past, we thought that we should teach engineering related sciences as advanced as possible, and had little awareness that our education was the entrance to the engineering profession. Now, majorities of engineering faculties recognize that engineering education is the process in which entry-level engineers are trained. They shall have, of course, a sufficient ability to understand and apply engineering science.

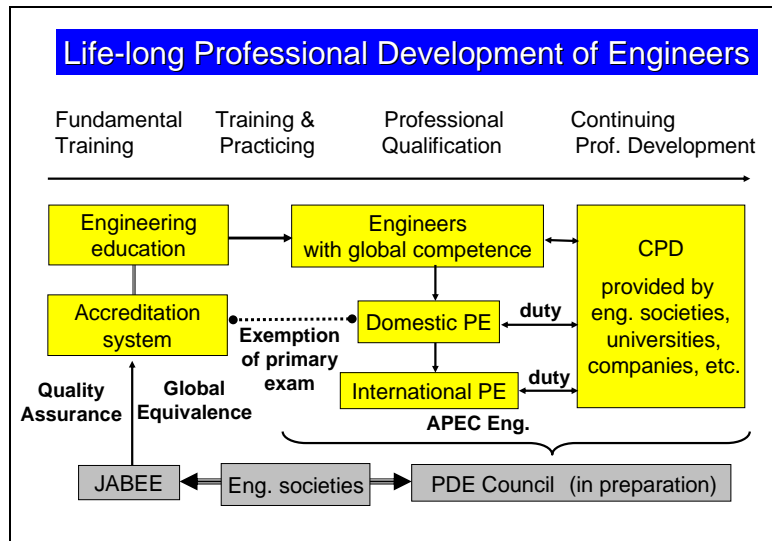
For establishing engineering as a profession in Japan, we needed to share the common understanding with the society. Prof. H. Yoshikawa, previous president of JSEE and the president of JABEE made the following statement public in 1998:

- 1) The safety and reliability of modern society depend heavily on human-made products such as materials, buildings, vehicles, information and communication devices and systems, etc.
- 2) Engineers are thoroughly responsible for such products, 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 of Professional Engineer is urgent, that should be compatible, of course, with global standards.
- 5) Introduction of an accreditation system of engineering education at university level is also urgent. Accreditation not only assures the quality of fundamental education for engineers, but also generates strong driving force for the improvement of university education.
- 6) To maintain life-long expertise of engineers, the importance of Continuing Professional Development must be recognized.

Responding to the above statement, we have been trying to enhance our engineering profession and also to disseminate the role of engineers in the society.

### **3. Life-long Professional Development of Engineers**

In order to enhance engineering profession, it is needed to build an integrated national system. Such system can maintain the performance of engineers in the top gear throughout their life-long career, for the benefit of the society and the individuals as well. It must cover every stage of Professional Development of Engineers (PDE), that is, fundamental training in universities, training and practicing or Initial Professional Development, professional qualification and finally CPD, as illustrated in the scheme below.



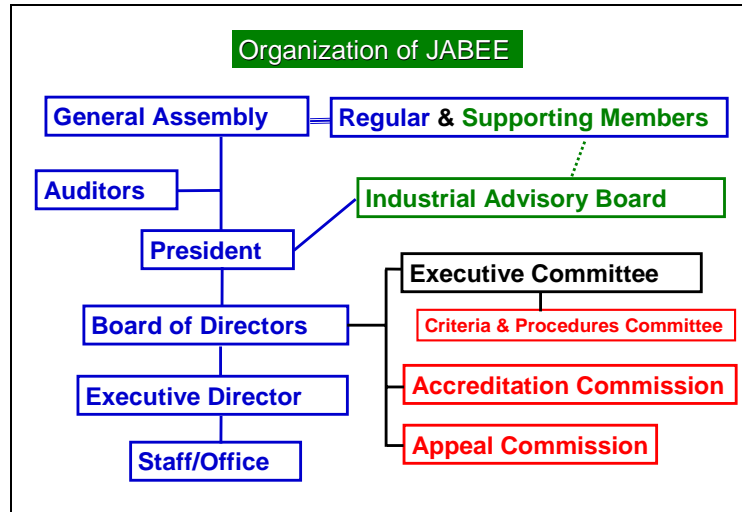
Engineering education in universities provides fundamental training needed for entry-level engineers. To improve the quality of education and to assure the global equivalence, an accreditation system must be introduced. JABEE was established in November 1999 as a non-governmental organization for this 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.

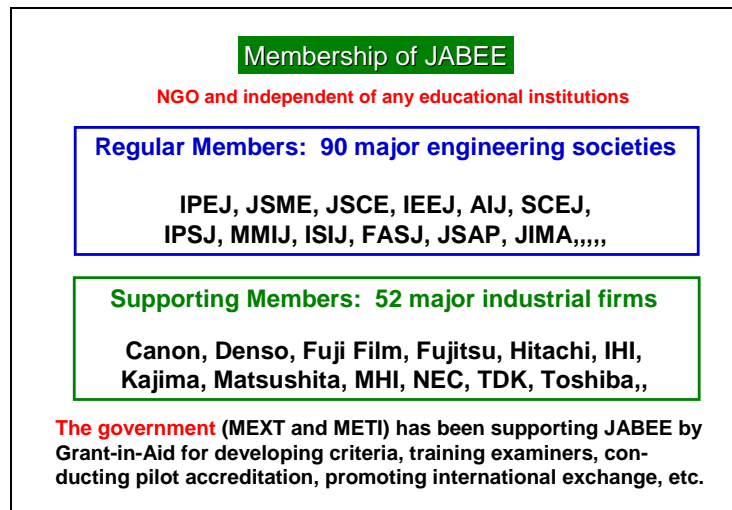
CPD is essential for engineers of every stage. Engineers without professional qualifications need CPD to maintain and enhance their value or employability. For PEs, domestic as well as international, CPD is requested as their professional responsibility. CPD shall be driven by the autonomous initiatives 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.

#### 4. Progress of JABEE Activities

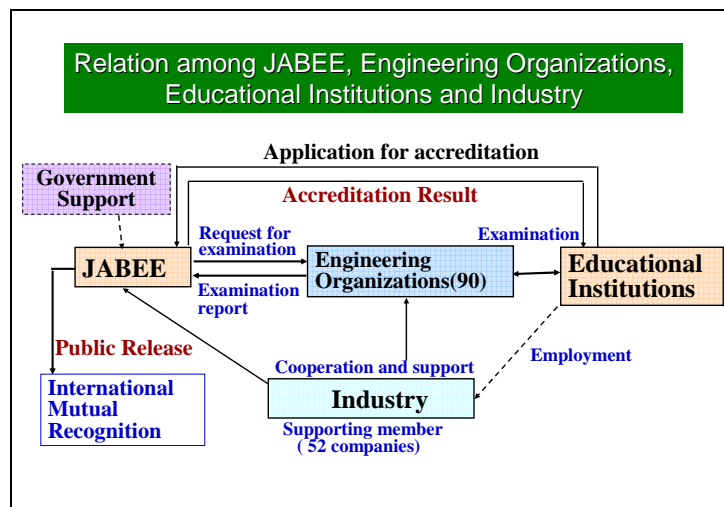
In order to establish a quality assurance system of engineering education in universities, "Global Engineers Education Committee" headed by Dr. Yoshikawa was founded in 1997. After elaborate consultation and dissemination among relevant organizations, that is, educational institutions, major engineering societies, Ministry of Education, Ministry of International Trade and Industry, Science and Technology Agency (STA) and also employers represented by Keidanren (Japan Fed. of Economic Organizations), JABEE (<http://www.jabee.org>) was finally founded in November, 1999 as a NGO by the enthusiastic support of all relevant parties.



The organizational structure of JABEE is shown in the above diagram. The cooperation and communication with industries are materialized by the function of Industrial Advisory Board that is directly connected to the President.



Membership of JABEE is categorized into two groups, namely regular and supporting members.



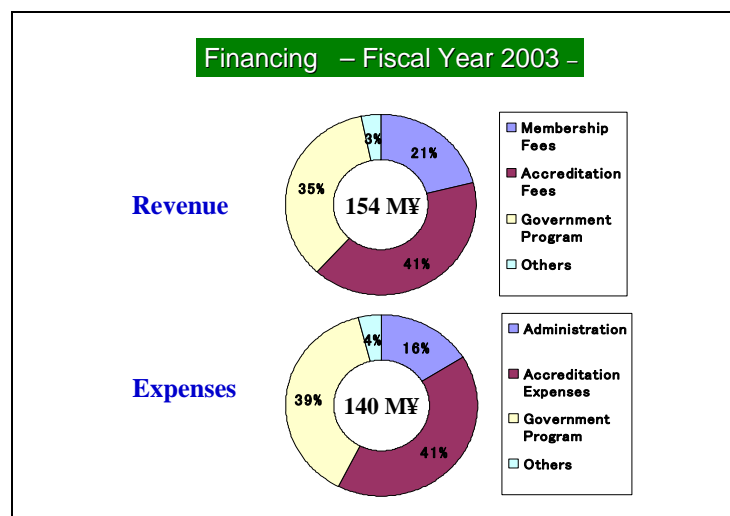
An engineering program applied for accreditation is first evaluated by the relevant engineering societies and then the decision is made by JABEE on the basis of their evaluation report. In this context, only participating engineering societies are eligible as the regular members. Industrial companies that have strong interest in the quality of engineering education are eligible as the supporting members. Among 18 founding Board Members, 16 were presidents of major engineering societies. They are considered as the representatives of more than 90 regular member societies.

Our accreditation practice follows basically that of Engineering Criteria 2000 adopted by ABET of USA. Introduction of outcome-based evaluation, engineering ethics and communication skill are examples of what were rather new for us.

| Progress of JABEE Activities                        |       |            |              |              |                |
|---|-------|------------|--------------|--------------|----------------|
| Fiscal Year   | 2000  | 2001       | 2002         | 2003         | 2010 / Target  |
| No. of Pilot Acc.                                   | 20    | 51         | 35           | 4            | 0              |
| No. of Acc. Programs<br>Sum Total                   |       | 3<br>3     | 32<br>35     | 67<br>102    | 100 +<br>500 + |
| No. of Acc. Graduates<br>Annual Sum Total           |       | 200<br>200 | 2300<br>2500 | 4700<br>7200 | 30,000 +       |
| No. of Certified Reviewers                          | 102   | 335        | 529          | 744          | 1200 +         |
| Version of Documents;<br>Criteria, Procedures, etc. | Ver.1 | Ver. 2     | Ver. 3       | Ver. 4       |                |

The above table summarizes the progress of JABEE activities since its foundation. In order to evaluate, inspect and then improve the accreditation processes, pilot accreditation was conducted prior to the formal one in every discipline. Dissemination of the significance of accreditation to educational institutions and the training of reviewers were also urgent tasks. At present, total engineering field is divided into 16 disciplines and the criteria are composed of the common and discipline-specific descriptions.

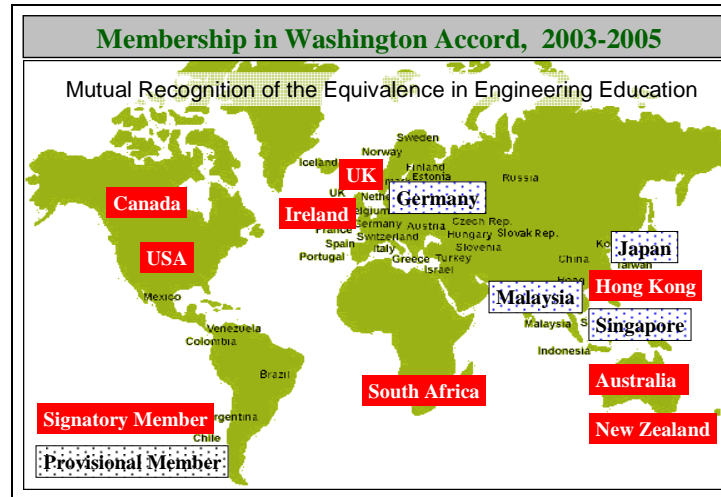
There are over thousand engineering programs currently running in Japan. By the year 2010, JABEE expects to accredit about half of them and to approach to a stable operation.



Financial independence is an important factor to operate an accrediting organization. Fortunately JABEE could get promise from the government and industries that they would support us for the first five years by governmental aides and membership fees of supporting members. As the above figure indicates, the financial situation of JABEE is presently quite

sound, however, we have to be independent in fiscal year 2005. We are almost sure to achieve the target.

It is also encouraging for JABEE that the government decided in March this year to connect the accreditation of engineering education with Japanese PE formally. Every graduate from a JABEE accredited program is exempt from the Primary Examination of PE and can start training and practicing as an Engineer in Training immediately after graduation.



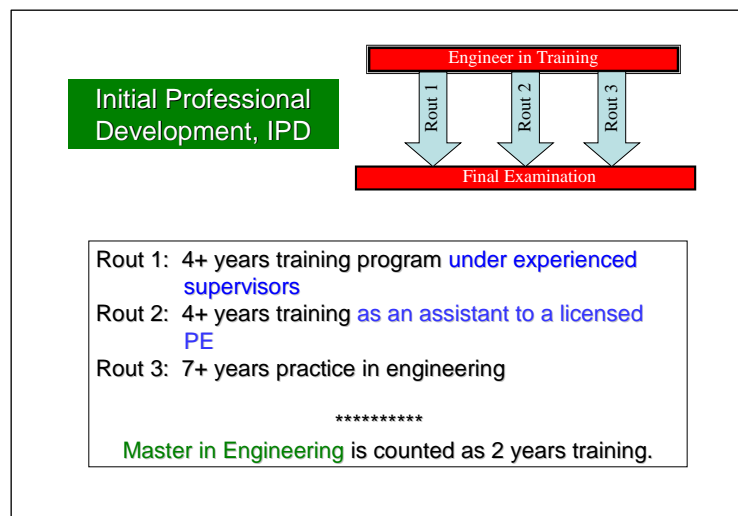
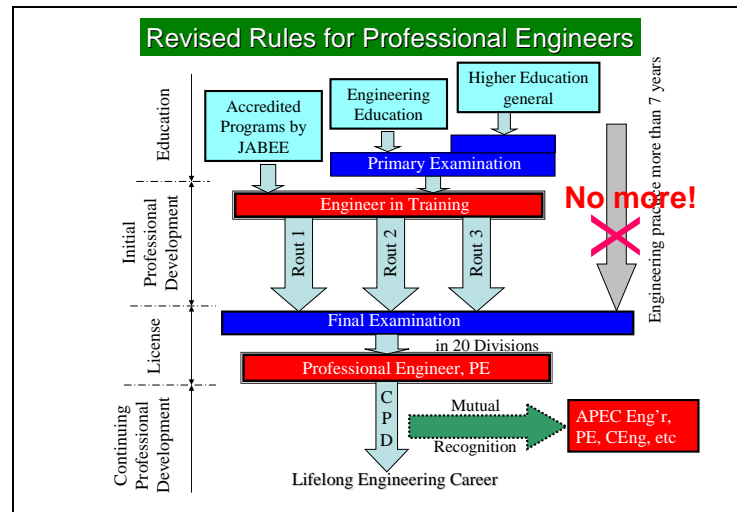
Besides quality assurance, JABEE’s another objective is to prove that the quality of our engineering education is equivalent to global standards. This can be achieved by joining Washington Accord (WA) as a signatory member. JABEE was first admitted as the provisional member at 2001 WA Meeting in South Africa. Two years later, JABEE submitted progress report at 2003 WA Meeting in New Zealand and requested signatories to dispatch formal review team to scrutinize our system and procedures. Three reviewers visited us twice and witnessed our review practice and decision making process in accreditation commission. We sincerely hope that JABEE would be admitted as the 9th signatory member at the coming WA Meeting held in Hong Kong next year.

| International Relations                |                    |  |   |  |
|--|--------------------|--|---|--|
| Year                                   | 2000               | 2001                                     | 2002  | 2003   |
| Washington Accord Meeting              |                    | 5 <sup>th</sup> WA/BM Provisional status |   | 6 <sup>th</sup> WA/BM Application for Signatory status |
| Memorandum of Understanding            | ABET               |  | IEAust  |  |
| Observers sent to                      | ABET 12<br>IPENZ 1 | ABET 7<br>CEAB 5                         | ABET 8<br>CEAB 5<br>IEAust 2                  | HKIE 4<br>ABET 5<br>CEAB 2                             |
| Instructors and reviewers invited from |                    | CCPE 2                                   | EC, IEAust, HKIE, IEI, IPENZ, EC SA (total 8) | CEAB, ABET, IPENZ as reviewers (twice)                 |

The above table summarizes how JABEE has been keeping the international relations with foreign accrediting organizations and engineering institutions. For the training of our reviewers and in the preparation to join WA, their assistance was literally indispensable. JABEE is deeply indebted to the goodwill of global engineering community and would like to reciprocate in the future.

## 5. Amendment of Professional Engineers Law

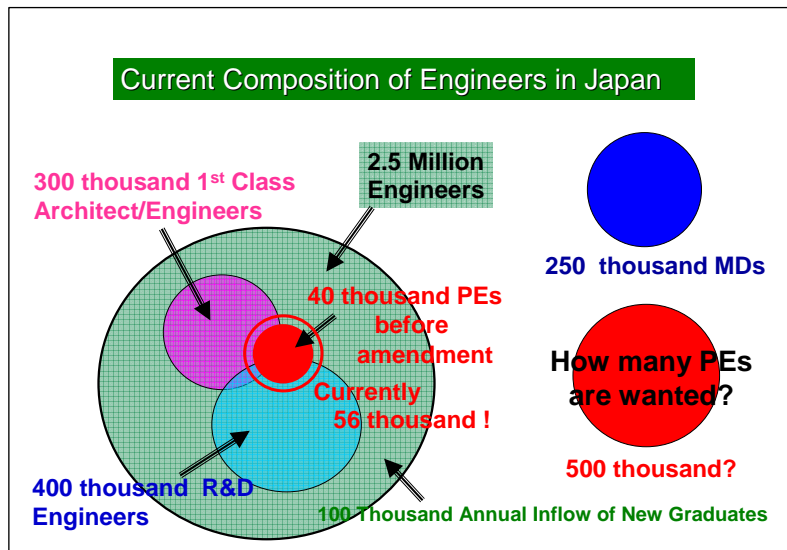
Introduction of domestic professional qualification compatible with that for PE of USA, CEng of UK, CPEng of Australia, etc. is urgently needed in the era when engineering activities are expanding in the global scale. The past Japanese engineering qualification was based on "Consulting Engineers Law" and was utilized predominantly by consultant engineers in domestic construction business. The qualification lacked several basic conditions that are necessary to claim global compatibility and equivalence. In 1999, Consulting Engineers Council of STA submitted to the government a set of recommendations as the necessary revisions of the previous Law. The amended "Professional Engineers Law" was enacted April 2000 and went into effect from April 2001.



The amended Law defines new procedures to obtain and maintain the professional qualification called Professional Engineer (of Japan) as illustrated in the above figure. The procedures consist of Primary Examination, at least four years of training and practice (IPD), Final Examination, registration of PE, and requirement for CPD. Graduates of accredited engineering programs are exempt from Primary Examination, since the fundamental capability as an entry-level engineer is assured by the program itself.

The requirements and procedures for our registered PEs are globally compatible. It will be thus easier for Japanese PEs to apply for any regional or international engineering qualifications such as APEC Engineer or IMF International Engineer now discussed by Engineers Mobility Forum. There will be also little obstacles to the mutual recognition of professional qualifications among the interested nations. In 2003, Australia and Japan signed a bilateral agreement that the APEC Engineers of both nations are entitled to the same legal rights as a registered engineer in the counterpart nation.

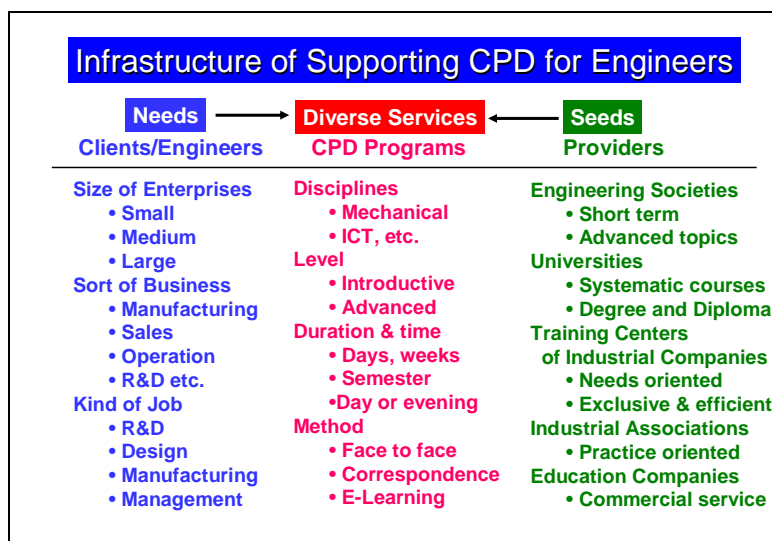
The enforcement of the new Law will have great influence on the public perception of engineering profession. We expect that the number of PEs will increase and the average age of rookie PEs will reduce to around 30. The responsibility to the public (i.e. engineering ethics) is stressed in the new Law, hopefully helping regain public confidence on engineers and engineering achievements.



The above figure illustrates the current composition of engineers in Japan. There are 2.5 million engineers with Bachelor degree in engineering or engineering-related disciplines. There were only 40 thousand registered PEs before the amendment of the Law. The number has increased to 56 thousand, a remarkable 40 % increase in five years. The amendment has been giving engineers a strong renewed incentive to professional registration and seems quite successful.

We have still no consensus over the desirable number of PEs in Japan. There are 250 thousand Medical Doctors working in Japan who are responsible to support the health of 127 million people. Then, how many PEs are necessary who are legally responsible to support the health of our society, that is, the safety and reliability of modern society that is filled with human-made structures and systems? My personal answer is that we need PEs at least twice the number of MDs, that is, 500 thousand. I hope the target will be materialized in ten years.

## 6. Infrastructure of Supporting CPD for Engineers



There are about 2.5 million engineers in Japan. Majority of these engineers work not as an

individual but as a member of organizations, quite different in size (small, medium and large) and objective (manufacturing, sales, operation, R&D, etc.). The needs of engineers for CPD are accordingly diverse in disciplines, level (entry to advance), duration (one day to a semester) and method (face to face to distance learning) as the above figure illustrates.

The features of CPD providers with their own seeds are also diverse. Engineering societies have advantage in offering short-term programs with advanced topics, while universities offer long-term systematic courses that preferably lead to an academic degree or diploma. In-house training centers of industrial companies have long experience to enhance practical business capability in urgent needs. Opportunities for e-learning are also expanding, such as the free site Weblearningplaza (<http://weblearningplaza.jst.go.jp/>) offered by Japan Science and Technology Agency

At present, CPD providers are offering services independently and it becomes increasingly difficult for engineers to choose a most adequate program from the torrent of offerings. There must be an integrated data base of CPD programs for the convenience of the clients.

Japan Federation of Engineering Societies, an assembly of more than 100 engineering societies, set up in 2000 a committee that should prepare the establishment of a council with the objectives summarized below:

- disseminate the importance of CPD among engineers and employers
- promote communication and cooperation of CPD providers
- accredit or endorse CPD providers and assure the quality of programs
- offer a common platform for the selection of programs based on the data base of available CPD services
- introduce common format for the annotation and labeling of CPD programs
- introduce common calculation method for CPD hours with properly defined weight factors
- introduce CPD record format of individuals that is interchangeable across disciplines

The preparation has been progressing with the strong support of the Ministry of Economy, Trade and Industry. New coordinating council, tentatively named PDE Council, will be established within a year and will expand its activities one step by another.

## **7. Conclusions**

Every time when we hear such news as concealment of troubles in nuclear power stations, deliberate delays of recall notice of automobiles and so on, the public confidence on technology and subsequently on engineers is hurt and deteriorated. Short-term remedies are not sufficient to improve this situation. We are confident that the endeavors for establishing engineering profession will be a sure step forward to recovering the public confidence.

Globalization has requested us to reform our system to be compatible with global standards. In many cases we found that the difficulties consist in the gap of western and traditional perception. In Chinese-character cultural zone, we may share a lot of common difficulties and, therefore, regional cooperation is strongly recommended. In the appendix below, a list is attached in which indigenous terminologies relevant to engineering are compared in Chinese characters among China, Taiwan, Korea and Japan. It implies that Chinese characters cannot be a common tool to share the same perception. Mutual communication and understanding are needed for the future cooperation, both from the global and regional viewpoint.

## **APPENDIX**

Comparison of Terminologies used in China, Taiwan, Korea and Japan

| English                             | China        | Taiwan       | Korea        | Japan        |
|-------------------------------------|--------------|--------------|--------------|--------------|
| Science                             | 科学           | 科學           | 科学           | 科学           |
| Scientist                           | 科学家          | 科學家          | 科学者          | 科学者          |
| Technology                          | 技术           | 科學技術(科技)     | 技術           | 技術           |
| Technologist                        | 技术专家         | 科技專家*        | —            | —            |
| Engineering                         | 工程           | 工程           | 工学           | 工学 or 技術業    |
| Engineering Science                 | 工程科学         | 工程科學         | 工学           | 工学           |
| Engineer                            | 工程师          | 工程師          | 技術者 or 技師    | 技術者          |
| Registered Engineer                 | 注册工程师        | 技師           | 技術士          | 技術士          |
| Technique                           | 技术 or 工艺     | (專門)技術       | 技能 or 工法     | 技能           |
| Technician                          | 技师           | 技術員          | 技能人 or 技士    | 技能者          |
| Accreditation                       | 认证           | 認證           | 認證           | 認定           |
| Certification                       | 认证           | 認證           | 認證           | 認證           |
| Doctor in Engineering               | 工学博士         | 工學博士<br>工程博士 | 工学博士         | 博士 (工学)      |
| Master in Engineering               | 工学硕士<br>工程硕士 | 工學碩士<br>工程碩士 | 工学碩士         | 修士 (工学)      |
| Bachelor in Engineering             | 工学学士         | 工學士<br>工程學士  | 工学士          | 学士 (工学)      |
| General, non-disciplinary education | 通识教育         | 通識教育         | 教養教育<br>基礎教育 | 一般教育<br>教養教育 |

\* Not used frequently

Compiled by Hideo Ohashi based on the information given by Prof. Shouwen Yu of Tsinghua Univ. (China), Prof. Wenshion Chang of Lughwa Univ. of Science and Technology (Taiwan), Prof. Jaemin Hyun of KAIST (Korea) and ABEEK.