

ENGINEERING EDUCATION IN JAPAN - PAST AND PRESENT -

Hideo Ohashi

Kogakuin University, Tokyo, Japan
ohashi@cc.kogakuin.ac.jp

The history of engineering education in Japan since Meiji Restoration is reviewed and the great foresight and leadership of Mr. Yamao, the founder of the first engineering college, are introduced. The difficulties we faced in Japan after booming 1980's are analyzed, and the efforts to reform our society and individuals are summarized as the transformation "from organization-based to individual-based society". We live in a society surrounded by human-made hard- and software to which engineers are principally responsible. To enhance safety and reliability of the society, a national infrastructure to support life-long career development of engineers is being constructed presently in Japan.

1. Introduction

Japan's transformation toward a modern and industrial nation was triggered in 1868 by the well-known Meiji Restoration. Fifteen generations of the Tokugawa Shogunate reigned a remarkably stable and war-free feudal era for 260 years (the Edo period) till being overturned by the Restoration. One of the most distinct features of that era was the strict enforcement of closed-door or seclusion policy that prohibited any human interaction with overseas countries. Contacts and trades with specific foreign countries were admitted at special places like Port of Nagasaki where Madame Butterfly fell in love with Pinkerton, a US Navy Officer. Strong demands from western countries for widening the doors caused severe diplomatic friction with the Tokugawa government especially after the dawn of the 19th Century. Repeated foreign inter-

vention provoked nation-wide disputes over the seclusion policy and further the legitimacy of the Tokugawa government. The magma of frustration grew steadily and exploded in 1868.

The governmental sovereignty was then returned to Emperor Meiji. However, the nation itself was left almost unchanged as it was 260 years ago. In order to join modernized nations, every national system such as government, law, police, army, education, post, transportation etc. ought to be built from nothing.

In 1863, five years prior to the Restoration, five young smugglers arrived in London and became students of the University of London. They carried a secret mission from their local Lord (presently Yamaguchi-prefecture) to learn advanced social and industrial systems of western nations. They were expected to return home as a "living machine" or a seed of a new plant. The five ambitious boys shown in Figure 1 became later the first Prime Minister (H. Ito), Minister of Foreign Affairs (K. Inoue), Minister of Industry (Y. Yamao), the father of railway systems (M. Inoue) and the founder of mint bureau (K. Endo).



Fig. 1 Five students in London, 1863

Yozo Yamao studied engineering for three years at the University and went to Napier Shipyard in Glasgow to learn the practice of shipbuilding as an apprentice. Two years later he decided to return home after he received the news of Meiji Restoration. He was then 30 years old.

Yamao joined the new government and took initiative to lay the foundation for an industrial nation. Three years after the Restoration, Ministry of Industry was newly founded and he became the Vice Minister. Immediately after this assignment, he took action to establish a college of engineering that should produce core forces for nation's industrial development. Opposing to the ordinary opinion that "the graduates would be useless since there were no industries to work for", he persuaded the leaders of the new government by the following words;

"Even if there is no industry at present in Japan, if we train a man,
he will cultivate an industry."

His deep insight to the future resulted in the opening of Imperial College of Engineering in 1873. Henry Dyer, 25 years old graduate of Anderson's College of Glasgow, was invited as the principal of the new College. He implanted here in Japan an education integrating engineering theory with practice, which he believed was ideal. His concept was rather new at that time and was not implemented even in his motherland. The education he established here became the very roots of Japanese engineering education.

The Emperor Akihito cited the above words in his speech at the Centennial Anniversary of the Japan Federation of Engineering Societies (JFES; <http://www.jfes.or.jp/>) that Yamao founded in 1879 and served 36 years as the president. The spirit conveyed by these words carries great value not only in those days before industrial take-off but also today. Every time when we face a new difficulty, we have to return to these words. If we replace the word "industry" by the issue we confront, we will find a great suggestion and stimulation.

2. New restoration of engineering education

The decade that started in 1991 and closed together with the last Century is called in Japan "Lost Decade". It took some time before we became aware that unprecedented changes started to emerge in politics, economies and technologies in global scale. The changes were triggered by and attributed to the end of Cold War symbolized by the dissolution of USSR in 1991.

In addition to this drastic change in the international politics, Japan experienced in the same 1991 such domestic changes as the collapse of decade-long booming economy, start of commercial utilization of internet and rapid proliferation of information and communication technologies, deregulation of governmental control on the curriculum of universities, and so on. We could not foresee the consequences of these changes at the beginning but became gradually aware of the difficulties we were facing, when we followed the decline of the international competitiveness measured, for example, by the IMD ranking as shown in Fig. 2 (cf. World Competitiveness Yearbook). Japanese position dropped from the top to 17th during the Lost Decade.

Because of the economic success and expansion in 1980's when Japan boasted her industrial competitiveness in the global market, we became too much confident in our system and

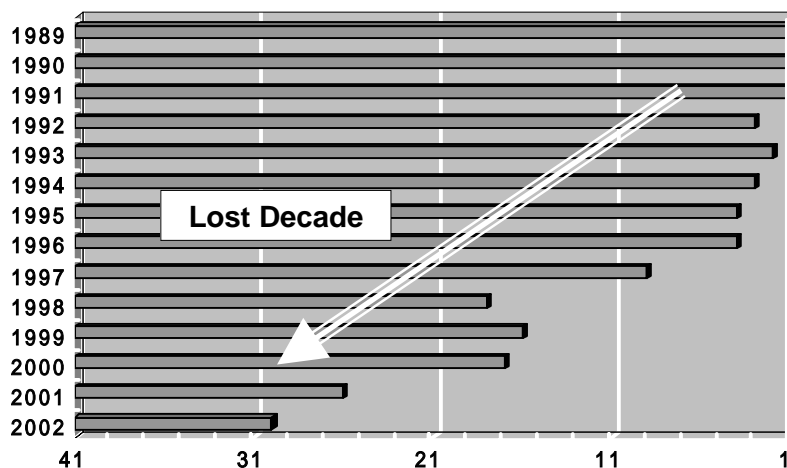


Fig. 2 Trend of overall ranking of Japan by IMD

believed that the situation would last forever. That was however an illusion. At the middle of the Lost Decade it became clear that we needed another restoration to reform our society and individuals so that we might better adjust to the new social and economic environment of the rapidly changing world. The core of the reform was the transformation "from organization-based to individual-based society".

Japanese style management that had been so effi-

cient and competitive till the end of 1980's, could be implemented most easily in an "organization-based society" like ours. In this society, individuals have a strong sense of membership to organizations, especially companies, to which they belong. As the reward to the royalty, individuals are protected lifetime by the organization.

The globalization forced Japanese companies to shift to more globally competitive management style. Re-engineering, restructuring and reduction of manpower became common not only in deficit-ailing companies but also in profit-enjoying booming companies. Our society had to adjust to this new situation with great pains and frustrations of people who were unexpectedly dismissed from their shelters. We had no choice but shifting to "individual-based society", as it is common in the western countries.

3. Roles of professionals

In an individual-based society, professionals play an essential role in maintaining the quality of the society that can be measured by its safety, reliability, stability and sustainability. The image of this society is illustrated in Fig. 3. The whole society is covered and supported by the networks of professionals who bear the responsibility in respective fields with their expertise and morality. Needed there are networks of medical doctors, of lawyers, of accountants, etc., and not to the last, of engineers who are responsible for developing, designing, manufacturing and operating human-made hardware and software, the core of modern technological society.

Even in the individual-based society, the role and importance of organizations will never change. Activities of organizations cross easily the borders of nations. Multinational enterprises are becoming common. The networks of professionals, i.e., professional societies are also becoming borderless. In such borderless age, each professional must prove his or her own competence by some kind of globally acknowledged credentials, preferably by professional qualifications.

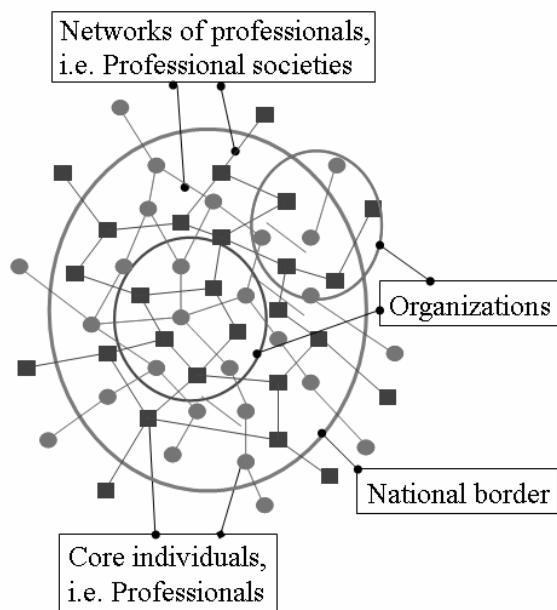


Fig. 3 Individual-based society

To materialize the transformation from organization-based to individual-based society, the hardest barrier existed in our culture and consciousness. We have long cultural tradition of respecting "learning" as the road to sublime truth, but of looking down "profession" as a mere means of getting bread. As the result of this subconscious prejudice, being a professional, especially being an intellectual professional, has attracted little interest and respect in our society. We need a revolution of our consciousness, that is, from ignoring to respecting professionals.

This revolution must be introduced first for the faculties who are responsible for our engineering education in universities and colleges. They, including this author, 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.

Our engineering education was once thought as the driving force of the epoch

making industrial development. Numerous groups from abroad visited us and asked "what is the secret?" There was no secret indeed. We could only mention several features of our engineering education, for instance, emphasis on fundamentals and principles, cultivation of cooperative mind by experiment and practice in a team, and participation in scientific research through graduation thesis. These features happened to match with the demand of Japanese industries, which did not expect job-readiness from fresh graduates and did lay value only on the possibility of future development. They considered new graduates as raw material, which should be forged to powerful components of each organization through long-sighted in-house training programs.

Lifetime employment was, however, the presumption of the above practice. The past features of Japanese engineering education could be effective only in association with Japanese style management. It could not be a universal model for the rest of the world. As Japanese style management had to undergo rigorous reforms to adjust itself to the new environment, our engineering education was also forced to change accordingly.

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 president of Japan Accreditation Board for Engineering Education (JABEE; <http://www.jabee.org/>) 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, communication and information 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 comparable, 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 (CPD) must be recognized.

Responding to the above-mentioned statement, we started to re-engineer our engineering profession accordingly.

4. Infrastructure to support life-long career development of engineers

In order to enhance engineering profession in Japan, it is needed to build an integrated national system that 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. Such system must cover every stage of the Professional Development of Engineers (PDE), that is, fundamental training in universities, training and practice, professional qualification and finally CPD, as illustrated in Fig. 4.

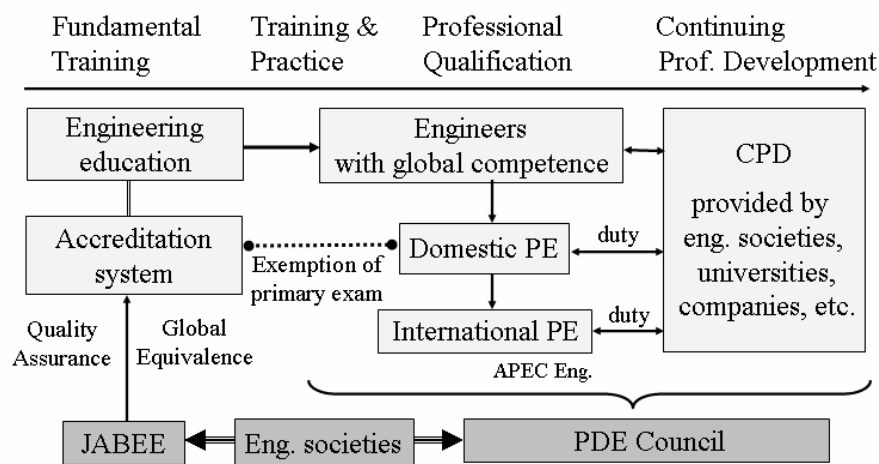


Fig. 4 Integrated support system for the professional development of engineers

Engineering education in universities provides fundamental training needed for entry level engineers. To improve the quality of education and to assure the global equivalence, JABEE was established in November 1999. Accreditation processes of engineering programs are

conducted by JABEE with close cooperation of relevant engineering societies. Those who have finished fundamental education start to accumulate training and practice and gradually build up professional competence as globally deployable engineers. At an appropriate stage of the development, one may apply for a professional qualification such as domestic Professional Engineer as the token of an independent professional. Since the requirements for domestic PE and international PE, e.g. APEC Engineer or EMF International 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 regardless they hold an authorized qualification or not. Engineers without professional qualifications need CPD to maintain and enhance their employability. For PEs, domestic as well as international, CPD is requested as their professional responsibility. CPD is driven, of course, by the initiatives of individuals as the means of endless updating of their expertise.

Professional societies, educational institutions like universities, and in-house training centers of private companies; they are all providers of CPD service for engineers and must share their roles so that the clients may choose the most adequate one from a variety of offered courses that are so different in topics, level, duration and method. The documents (contents) needed for CPD must be also prepared and provided by them.

There are so many participating organizations in CPD, the most downstream of PDE. There must be a coordinating body that harmonizes the interests of CPD stakeholders and integrates whole components into an effective system. PDE Council (<http://www.pdecj.org/>) is expected to perform this function and is now under preparation with close cooperation of major engineering societies, similar to the case of JABEE that performs coordinating function in the most upstream of PDE.

5. Conclusion

Every time when we heard 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 was hurt and deteriorated. Short-term remedies are not sufficient to improve this situation. We are confident that the endeavor for the re-engineering of engineering profession described in the above will be a sure step forward to recovering the public confidence.

Every nation has own history, culture and feeling of amenity. The reforms we are trying to achieve seem all within the framework of so-called westernization or introduction of Anglo-Saxon systems. The same situation happened 130 years ago when we went through Meiji Restoration. After mixing and fusing native and imported wisdom and system, the leaders of Meiji succeeded to produce new systems optimized to the Japanese climate and situation.

We hope the ongoing reforms in engineering will be successful, and our renewed system will be acknowledged as a universal model to enhance our service and contribution to the society.

Curriculum Vitae

Hideo Ohashi: Chairman, Board of Directors, Kogakuin University; Prof. Emeritus, University of Tokyo and Kogakuin University. Vice President, JSEE (since 1998). Vice President, JABEE (since 1999). Past President, JFES (1999-2003). Chair, Preparatory Committee for PDE (Prof. Develop. of Eng.) Council of Japan. Member, Engineering Academy of Japan. Received BE (1954) in Mechanical Engineering, Dr.-Ing. (1958) from TH Braunschweig, Germany and Dr.-Eng. (1963) from University of Tokyo. Five years practice in industry and 45 years education and research in academia.