History of Technology and the Changing Era

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Abstract:
It is said that those who do not learn the lessons of history are doomed to repeat the mistakes of the past. If we are at a turning point in history, we should ask ourselves if it is useful to study the history before this point. History is always determined by focusing on the necessity of the era. Who builds the era? Yes, human beings. Technology is created by human beings. By tracing the acts of human beings, we can determine what is necessary tomorrow, and the day after tomorrow.

1. Introduction

We are in the transition stage from the 20th century to the 21st century . It is therefore meaningful to respond to the following questions in order for us to step onto a new stage: What is the main significance of the century change? What is changing and how and why is it changing? Let us hasten to discuss this question and find an answer to it. World civilization is going to change, and the keyword to such change is sustainability. In responding to the above questions, the role of technology will have a different focus than it had in the past. Essentially, what is technology? What was its role? What has it achieved so far, and how is it changing? From the standpoint of manufacturers, what to produce has been rather clear, and therefore the only big issue was how to produce and sell the products. However, this is changing it is being asked what products should be manufactured and why.

The followings are statements by two senior Japanese experts:
Takanori Okoshi, who was the first chairman of the History Committee of the Institute of Electrical Engineers of Japan (IEEJ), said, at a special lecture of an IEEJ conference, “In the history of the 20th century, the year of 1989 was very significant. The liberation of the East European countries was initiated in that year, and its essential nature seemed to be a revolution by information. The decades of the nineteen-seventies and the nineteen-eighties were the age of skepticism about science and technology. However, since then, they have been obtaining reinstatement. I think that liberation such as that in East Europe could be recognized as a turning point to the age in which science and technology regained positive evaluation. I also think that study to pursue the history of technology would receive new attention.” [1]

Takamitsu Sawa asserted in his literature [2] as follows:
We Japanese have very much enjoyed the 20th century type industrialized civilization. Such civilization was based on mass production, mass consumption and mass waste, and we could build a so-called rich country by dashing into the orbit of high-degree economic growth. The issues of global environment protection, however, are suggesting that we should create a metabolism type civilization in the 21st century, which will have a mechanism that encourages both of producers and consumers to pursue reasonable consumption, minimum waste, recycling, energy saving, and long life of products. The division between these two kinds of civilization depends on consideration of value norm of sustainability.

2. Expected Role of Electrical Technology

The IEEJ (Institute of Electrical Engineers of Japan) was established in 1888 (Meiji 21st). In the first number of its journal, which was reproduced on the 100th anniversary of the IEEJ, a statement of Takeaki Enomoto, the first president of the IEEJ, was printed from his speech at the first general meeting of the IEEJ. He first stated that establishing the IEEJ and offering opportunities to discuss the various electrical phenomena and effects could be a great benefit to society. He then shot questions to the audience: Why should the IEEJ be newly founded despite the fact that other organizations such as the Institute of Mathematics & Physics and the Science Association were already active in promoting and uplifting the electrical studies? Why should it be founded in spite of the fact that the Engineering Association was already in existence to pursue electrical art and technology? His answer was that the success of studies would be effectively promoted through comprehensive pursuance in a work sharing manner, because electrical engineering and technology showed rapid progress and the ability of independent persons was limited. Meiji was the era in which much attention was paid to introducing the US and European civilization, in which the progress of modern science and technology was achieved by specialization. Thus, to modernize Japan, Enomoto’s view was logical and natural in the circumstances he faced. In fact, the highdegree of technology growth in Japan in the Meiji

era as well as the post Second World War period was effectively accomplished by the efforts of technology cultivation based on subdivided activities. Many of us electrical engineers can testify to the rapid progress achieved by this subdivision.

3. Learning Lessons from History of Technology

Now, the structure of civilization are at a turning point.

In discussion regarding the future of technology, what lessons can we learn by looking back in the past? Okoshi stated in his speech above [1] "When I talk about results of my studies which were personally satisfying, I conclude that the starting points of such studies considered the histories of related technologies. Therefore, I think that an important reason for the originality of the studies would be obtained from careful consideration of history." Okoshi also introduced three (3) interesting points of view: to learn from the extension of history, to learn from the systemization of history, and to learn from the repetition of history. Finally, he predicted that the practical unit to express the characteristics of the laser beam would be changed from the wave length () to the frequency (f) so that the application of the laser beam could be further progressed.

Compared with pure science, engineering technology has a social nature, and engineers are pursuing what is acceptable to society as theory or products. Since social acceptability is an important factor in considering the future of technology, a sample past situation on liquid crystal technology is discussed at first as follows:
The principle of the liquid crystal was first proposed in 1888 by F. Reinitzer, a botanist from Austria, and after that, O. Lehmann, a German crystal researcher, verified the optical anisotropy of the crystal. Lehmann proposed to call it the Liquid Crystal (Flüssige Kristalle). After long term research on its compounding method and physical characteristics, R. Williams of RCA Corporation in the US initiated, it is said, development of an application technology for the liquid crystal in 1968, forming the stripe domain by voltage activation [4]. RCA, however, did not pursue commercialization of the liquid crystal beyond a trial production, since they predicted that the picture tube technology of the television would have a practical advantage. The practical technologies associated with the liquid crystal progressed remarkably through a limited application to watch/clock and electronic calculator by Japanese manufacturers. Since then, the application of such technologies has expanded to the field of personal game machines, video cassette recorders, computers and televisions. In the course of this process, manufacturers and researchers clearly envisioned that the rail of the technology evolution will be extended from a initial stage, in which the focuses were on saving electricity, compactness and long life, to a future step, in which the focuses will be on bigger screen, higher definition, faster response, real color, and wider range of view [5].

Next, as a typical example in which technology has been promoted by factors other than a specific intention of a certain technology, the activities of technology alliance cooperation in Japanese enterprises are of note. Before the Second World War, three Japanese manufacturers in the electric machine field conducted technology tie-up with foreign enterprises; Shibaura Corporation, now Toshiba, with General Electric in the US in 1909 (Meiji 42nd), Mitsubishi Electric with Westinghouse in the US in 1923 (Taisho 12th), and Fuji Electric with Siemens in Germany in 1923 (Taisho 12th). In the case of Shibaura, the technology tie-up contributed directly to improvement of its technology, and, at the same time, contributed to general improvement of Japanese technology in the field of electric apparatus production. This occurred because such tie-up at Shibaura gave a great incentive to all manufacturers competing with Shibaura in Japan and greatly improved their technology developments. As a result of such effects, it is said that the electrical industries in Japan were able to meet the domestic demand even when the import of foreign goods was stopped due to the First World War (1914 - 1919) [6].

There were active efforts to nationalize technologies in this era. An example is in a preface written for the first number of "OHM", which has been one of the leading monthly magazines for electrical engineers and was started in 1914 (Taisho 3rd). There was a sense of crisis because there was a break in the relationship with Germany and Austria when they became enemies of Japan during the First World War. This was especially true in the case of Germany, which was a model country for Japan in the process of its modernization. This preface passionately advocated that only hard studies and researches of technology could accomplish successful independence of technology for imperial Japan [7].

Seeing the rated capacity of the hydraulic power turbine-generators developed in this era in Japan, a 10 MVA machine had already been manufactured in 1925 (Taisho 14th). In 1939 (Showa 14th), a 100 MVA machine (16.5 KV, 150 rpm) was manufactured. This was the largest in the world at that time. It was installed at Shuifeng power

station of Yalujiang Shuidian. This record capacity remained the largest in Japan until the appearance of a 133 MVA machine (15.4 KV, 200 rpm) for Oku-tadami power station of the Electric Power Development Co., (EPDC) in 1959 (Showa 34th) [8]. After the Second World War, various Japanese companies proceeded with technology transfer from leading companies in the US and Europe to catch up with technology on thermal power plant apparatuses and others.

We can learn various lessons from the various processes of progress in various technologies. In most cases, however, it may be difficult to clearly understand the essences of such lessons unless we grasp the background situation in which a certain technology progress was affected by factors other than purely technological matters such as industrial policies, business strategies and social requirements. Distinguishing the history of technology from the history of science, Tsuneo Mitsui, who is the chairman of the History Committee of Electrical Engineering in the IEEJ, classified the significance of learning the history of technology into five (5) categories [9]: (1) Accumulation and succession of technology, (2) Widening the range of vision, (3) Great performance of technology leaders in the past, (4) Excavation of new issues in technology fields, and (5) Relation between technology and culture & human beings. It can be concluded that history suggests some reliable guide lines to our daily actions.

4. Again, What Is Technology

When we discuss technology in the electrical engineering field, we clearly understand the word “electricity”. That is, we have a fixed image of the word electricity in connection with words such as static electricity, electromagnetism, electric generation & distribution, communication, and electronic circuit. The main reason is that the word electricity has only a short history and, in particular, it has no social nature. It also seems that few people feel any discomfort that electricity is a part of technology. For reference, let us consider the history of the word “electricity” in East Asia. It was used for the first time in China in 1851. That is, the word appeared in a publication entitled “Bowutongshu”, a guide book on natural history, which was written in Chinese by an American medical missionary, Daniel Jerome Macgowan. He described the mechanism of telegraph in this publication, where the word “Dianqi (electricity)” appeared. This Chinese publication was transferred to Nagasaki in western Japan in 1854 [10] [11].

On the other hand, the word “technology” in either Chinese or Japanese does not convey a clear image of its meaning. Fewer people understand that all meanings of the word “technology” used in expressions such as science and technology, electrical technology, technology for generating intellectual property and technology for telling a lie, have the same nature. Various investigations regarding technology were already performed by Fumio Arakawa, and presented as the title of “the prospects of research and development for the 21st century” [12] at an IEEJ symposium held in 1997. In the paper he discusses several topics. Typical ones are as follows: Are there any technologies which really have Japanese nature; Pursuing the history of technology in the engineering field; Searching the origin of science and technology; Asking about the past to predict our future.

Let us consider technology from a different viewpoint. How is the word technology used at school? In accordance with the education program which was revised by the Ministry of Education of Japan in 1998, the curriculum for the “technology and homemaking course” in junior high school covers eleven (11) items: wood and its processing, metal working, machines, electricity, cultivation, information base, family life, food, clothing, dwelling, and nursery. The target of this curriculum is to make students clearly understand how technology has a relationship with family life and social life by learning fundamental knowledge for life and acquisition of technology so that students can develop creativity and a practical manner. However, the nationwide technology group in the Association of Japan Education University emphasized the value of education of technology based on the premise that our society would collapse rapidly if there were no technology and labor. They also defined the purposes for education in technology in the general education course as Practical sensibility/creativity and technical skill, ability for fair evaluation of technology, Sound sense for labor and occupation. They summarized that units to be educated through the primary school and the senior high school should consist of six (6) units as (1) Manufacturing, (2) Resources, energy and transportation, (3) Information & communication, (4) Crop production, (5) Production & environment, and (6) Industrial society & humanity [13] [14].

Again, the word technology itself has a long history and also its meaning has been changing. In China, Simaqian used the word technology in his literature as Shiji, a historical memoirs, written around 91 BC stating that the reason why people whose occupations were in medical technology or various other technologies work hard, using their full ability is to get the maximum payment for their works. However, in western countries, Aristotle (BC 384 - BC 322) thought that the Greek “Techne” was one of five (5) measures to be effective when the human mind pursued the

truth. Base on this thinking, he distinguished technology from the scientific intellect. After the Meiji era in Japan, the word technology was used in various contexts such as technology for art or technique and technology in industry. After the Second World War, Yonosuke Goto, who was a writer of an Economic White Paper published by the Economic Planning Agency in July 1956, made the Japanese words "technology innovation" by translating the English word of innovation. Then, the importance of the technology became recognized by general people, since the expression of such words had an image that the technology could remarkably affect the rapid progress of society [15].

5. Summary

In June 1998, the Electric Utility Industry Council, which is an advisory body of the Ministry of International Trade and Industry, provided an interim report of the long term view of electric power supply and demand in Japan. As a result, three (3) "E's" were identified as issues to be resolved. They were, Energy security, Economic growth, and Environmental protection. Sawa talks about the expectation of technology in the 21st century and the responsibility of engineers, proposing that we should create the technology and a social system that will be equivalently powerful in compensating for the amount consumed from non-sustainable resources so that we can transfer them to the next generation [2]. The 149 Committee of the Japanese Science Promotion Society identified three (3) issues with regard to the basis of information and communication. They were, 1) Realization of a global and free system for information distribution to be effective for world wide and balanced progress,2) Commitment to a system for information distribution with moderate nature which does not bring any district difference and the handicapped people on the information technology, 3) Establishment of an information base to respect the rights of individuals, peculiar local cultures and freedom of faith [16].

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2) Commitment to an information distribution system with moderate nature which never generate any regional difference and disadvantageous people on the information, 3) .....

Toward the 21st century, the issues to which we need to devote our attention are becoming clear. While the resolution of such issues is not so easy, the roles to be expected of technologies and researchers/engineers are very important. The signification for existence of technologies and researchers/engineers will be clearly acknowledged if we, researchers and engineers, actively pursue resolution of issues with the recognition that such actions are necessary to realize the continuance of human society on an environmentally friendly earth.

References:

(1) Takanori Okosi, "Prospect of the 21st Century: A view from an Electrical Engineering Historian (Written in Japanese)", Journal of IEEJ, Vol. 114, No. 3, pp. 173-178 (March, 1994)
(2) Takamitsu Sawa, " Protection to the climate change of earth - Turning point of 20th century type economy system (Written in Japanese)", Iwanami Shinsyo No. 529, Iwanami Syoten, pp.59-65 (November, 1997)
(3) The first number of Trans. IEEJ (December, Meiji 21st) (Written in Japanese) republished at the 100th anniversary of IEEJ, pp. 3-8, (May, 1988)
(4) The 142 committee of organic material in the Japanese science promotion center, "Handbook of liquid crystal device (Written in Japanese)", Daily Industrial News Paper Company, (September, 1989)
(5) Fumio Kodama, "Expansion from the small to the large - New business development and trickle up (Written in Japanese)", Technology and Economy No. 378, Science Technology and Economy Association, pp. 25-33, (August ,1998)
(6) Japan Electrical Manufacturer's Association, "History of Electrical Industries in Japan (Written in Japanese)", pp. 197-204, (April, 1981)
(7) The first number of "OHM" (Written in Japanese), Ohm company, (November, 1939)
(8) IEEJ, " The 100 year's History of IEEJ (Written in Japanese)" pp. 322, (1988)
(9) Tsuneo Mitsui, "Invitation to History of Electrical Technologies (Written in Japanese)", Journal of IEEJ, Vol. 118, No.1, pp. 38-41, (January, 1998)
(10) Toshifumi Yaji, "History of Telegraph before the Meiji era and.J. Macgowan (Written in Japanese)", Associate team for History of Electrical Technologies HEE-94-1, pp. 1-13, (February, 1994)

(11) Mitsuo Fuse, “Telegraphic instrument introduced in the natural history book in China (Written in Japanese)”, Associate team for History of Electrical Technologies HEE-97-5, pp. 27-34, (March, 1997)
(12) Fumio Arakawa, “History is always new (Written in Japanese)”, General Study Team in 1997, pp. 73-80, (November, 1997)
(13) Conference for promotion of Technological Education, “Proposal for establishing technological education system through the primary, junior high, and senior high school to promote the continuous progress in the 21st century (Written in Japanese)”, Japan Education University Association, (March, 1995)
(14) The nation-wide technological education division in the technological education research committee, “Fundamental concept of technological education in general education program for primary, junior high and senior high school (Written in Japanese)”, Japan Education University Association, (August, 1997)
(15) Ken-ichi Iida, “ One Word Dictionary - Technology (Written in Japanese)”, Sanseido, (December, 1995)
(16) Symposium of high technology and international environment, The 149 committee in the technology promotion center in Japan, “The infrastructure for information and the international cooperation to be considered in the 21st century (Written in Japanese)”, (June 11, 1998)