

Construction History in Education - Why and How It Should Be Learned

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BACKGROUND AND PURPOSE

The context of the construction industry in Japan has been changing for more than a decade. The amount of domestic construction, which peaked at the beginning of the 1990s, is still decreasing. Contract systems for public construction work, including tendering and procedures for procurement have also changed. Although it is undoubted that construction will continue to play an important role in sustaining the infrastructures required for human existence, social needs regarding construction are changing inevitably.

In this paper issues related to education in construction are studied and discussed from the perspective of construction history. First, the development of the Japanese construction industry is discussed and the awareness of a cultural and historical profile for civil engineering clarified. Then, case studies of the teaching of construction history in civil engineering colleges are examined. Among these, the teaching practice of civil engineering history, with which author is personally involved, is carefully analyzed on the basis of data by questionnaire to the students. Finally the role of construction history in education is explored.

CHANGES IN THE CONSTRUCTION INDUSTRY IN JAPAN

The Specific Features of the Japanese Construction History

Modern construction history in Japan is conditioned by two discontinuities, one occurring during the latter half of nineteenth century, another in the middle of twentieth century. Japanese construction technology developed rapidly together with the other engineering fields after the introduction of Western technologies in the 1860s, when Japan opened its doors to foreigners following more than two hundred years of national isolation during Edo era (1600-1867).

The latter half of nineteenth century marked the first point in history that technology was widely transferred on a global scale. The flow of railway construction technology from western countries, especially the UK, to Asia was spurred on by exports of iron girders and by the overseas dispatch of construction engineers, which had a large impact on construction practice in the region. There were a number of factors behind this, including a desire to stimulate demand for railway related equipments, an increasing exports pressure brought about by heavy investments in related industrial facilities with a corresponding rise in production capacity in western countries and imperialist policies.

Railway construction projects began in India during the 1850s, starting with a line connecting Calcutta and Delhi by the East India Company, as the first railway in East Asia. In 1856 W.G. Armstrong & Co. sent 4 000 tons of 28 spans of 150-foot lattice girders for the East India Railway and British railway construction companies set up works in India to assemble and fabricate girders with iron from the home country. This boom in railway construction brought many British engineers to India, and a number of these later found employment in Japan as well. Among the British engineers who worked for the construction of the first railway in Japan, from Shimbashi to Yokohama, opened in 1872, were: Edmund Morel (1841-1871) and John England(1823-1877), both of whom had been involved in railway construction projects in South Australia; Richard V. Boyle(1822-1908) and Thomas R. Shervington 1827-1903), both of whom had worked in India. Others followed. In this way Japan was influenced by the influx of Western construction technology, which caused a discontinuity in Japanese engineering history, but the development of construction technology was carried out in efficient way by strong leadership from the Japanese government.

The second major disruption in the Japanese construction history was brought about by World War II, when most of the country's infra-structure, such as railways, roads, harbors etc., were destroyed. The construction industry was diversified under the new political and economic system after the war. The Ministry of Construction (present MLIT; Ministry of Land Infrastructure and Transport) was founded as specialized government organization for construction and public works in 1948 and Construction Business Act was enacted in 1950. A Five-year Road Improvement programme started in 1954 and continued until 1997. This new system, which had achieved the reconstruction from the damages of the war by the 1950s, started to develop the new infrastructures: motorways, railways, dams, land reclamation, water training, sewage and many other fields to realize the remarkable high economic growth of Japan during the 1960s to 1970s.

Recent Changes in the Construction Market

The environment of Japanese domestic construction market started to change at the end of 1980s as part of a global trend following the changes that occurred in Europe during the 1970s. After the achievements of the post-WWII reconstruction programme, the Japanese construction market was expanding in a relatively isolated environment for thirty years, from the end of 1960s to the beginning of the 1990s. During this period foreign contractors did not operate in the Japanese construction market and the system of procurement for public works saw no international influence. On the other hand, Japanese contractors had opportunities to become involved in construction work overseas through the international contract system. However, this was regarded as a separate business and the overseas experiences did not influence the domestic construction market and its systems. The matter of concern for the construction industry in this period was the practicalities of how the expanding amount of construction work could be managed. These thirty years produced the singular aspect of the Japanese public work procurement system, which reflected the closed Japanese construction market with barriers to foreign contractors.

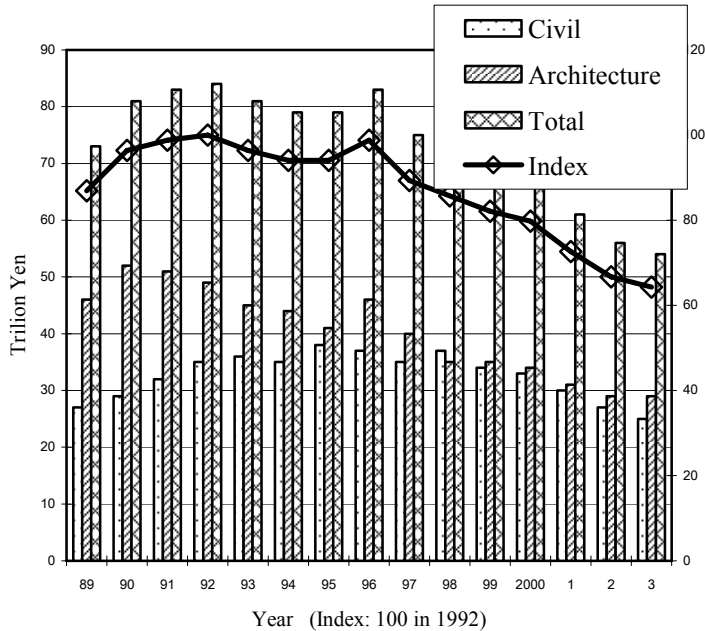


Figure 1. Recent change of construction investment in Japan
(Source; Ministry of Land Infrastructure and Transport)

From the beginning of the 1990s the construction market in Japan began to change, following Western trends, largely as a result of pressure from foreign countries criticizing the closed Japanese construction market. This led to huge construction projects such as the Honshu-Shikoku bridge project, the Kansai airport project, the Tokyo transit bay link project, etc. A turning point was the Japan-US construction talks that started in 1986 on the demand to open the Japanese construction market to foreign construction companies, and continued to 1992. During these talks, the Japanese public procurement system was studied from the viewpoint of comparison with systems in western countries. This stimulated the changes of tendering systems and the procedure for the public works was subsequently revised.

Important too is the downturn in the construction investment since the beginning of the 1990s (Fig. 1). Investment in construction had been increasing throughout the period of rapid economic growth, from the 1960s to 1970s, reaching a peak in 1992. From then on it has been decreasing steadily until the present with the total amount of 2003 at only 64% compared with 1992. For example, steel bridge construction works, which comprised only 100 thousands ton at the beginning of 1960s in steel consumption base, increased to 900 thousands ton in the middle of 1990s. (During the 1990s, the total amount of steel bridge construction in the US and Europe was about 500 thousands ton.) Due to the control policy of the current government, the amount of the investment to public works is still decreasing.

To summarize: The modernization of the industrial structure that had already been accomplished in the other business fields finally started for construction at the end of the 20th century. The principal impact of the modernization of construction industry is that, as in the West construction is becoming a business field governed by the market economy, which is followed by changes in the sense of values and social demands.

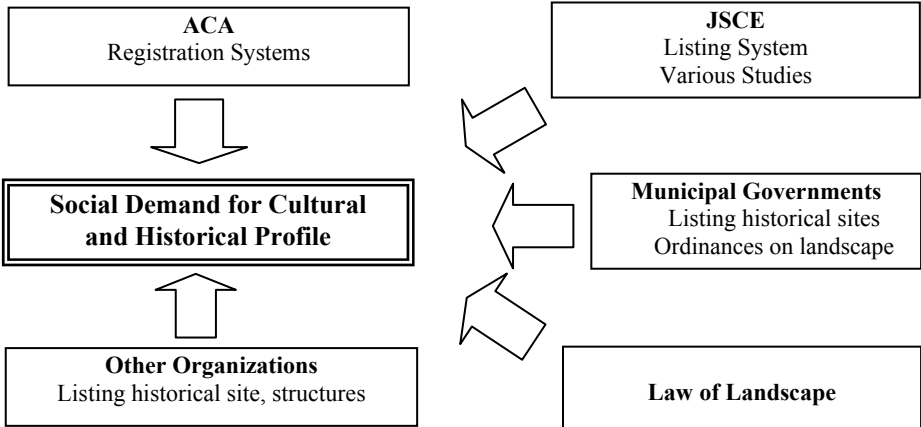


Figure 2. The social demand for a higher cultural/historical profile for engineering construction in Japan.

AWARENESS OF THE NEED FOR A CULTURAL AND HISTORICAL PROFILE IN CIVIL ENGINEERING

The accumulation of the infrastructure brought with it social demands regarding the historical and cultural profile of civil engineering works. These demands are reflected in the numerous new ordinances on the landscape in municipal government, Japanese government polices and the recent introduction of a “Law of Landscape”, including civil engineering works which impact on the landscape in a particular area. The Agency of Cultural Affaires (ACA), a government organization, has established a registration system for historical structures. Various issues regarding the conservation of the engineering heritage and its application have been studied by the Japanese Society of Civil Engineers (JSCE) and other organizations. The JSCE also introduced a listing system for civil engineering structures with cultural value and many municipal governments are likewise listing historical sites, including civil engineering structures that enhance and revitalize the local areas as tourist destinations (Fig.2), (Table1).

In 1996 the Law for the Protection of Cultural Properties was revised to relax the heritage registration process and Civil engineering heritages became targets for registration in addition to architecture. In 2003 government launched the Visit Japan programme. Under this policy the conservation of historical and cultural public structures are encouraged as environmental assets. The

“Fundamental Principles on the enhancement of the Environment and Landscape”, issued in 2004, adopted the same concept for historical engineering heritages and this policy is expected to diversify the construction administration. The enforcement of the Law of Landscape means that value of a “profile” for beauty, character, fine view, natural, history and culture of civil engineering works are now officially recognized and regulated.

Table 1. Facts regarding the conservation of Japanese civil engineering heritage

Date	Events
1950s	1958: JNR set conservation rules for structures with historical and cultural value. The Rokugo-gawa Bridge imported from England in 1872 was registered.
1960s	From the 1960s to the 1980s an inventory for modern historical architectures organised by The Architectural Institute of Japan: “Modern Japanese historical architectures – architectures of Meiji, Taisho, Showa etc.”.
1970s	Introduction of the concept “Industrial Archaeology” Industrial heritage as well as other cultural assets were in a critical situation due to land developments and construction boom resulting from high economic growth.
1980s	Substantial research started on the Japanese civil engineering heritage. -Historic places in harbors by the Japan Port and Harbor Association. -Railway, sewage, park water, harbor inventory by Yokohama Archives of History. -Steel and iron bridges by Hokkaido Government -Conservation of the Otaru Canal for historic place by Otaru City Government
1990s	1990: Comprehensive survey on modern heritage including civil engineering heritage by Agency for Cultural Affairs 1994: Committee for the research on conservation and applications of modern heritages by Agency for Cultural Affairs 1993-95: Survey on modern civil engineering heritage in the whole country by JSCE. 1994: Survey on historical and cultural civil engineering by Ministry of Construction. 1996: Law for the Protection of Cultural Properties revised and introduction of registration system. 1996-98: 2000 important modern civil engineering heritage sites were selected by JSCE. (Evaluation and listing system)
2000s	2000: Registration system of selected civil engineering heritages by JSCE 2003: The Visit Japan programme 2004: Fundamental Principles on Charming Environment and Landscape. 2005: Enforcement of Law of Landscape

Since the beginning of 1990s the Committee on Civil Engineering History, appointed by The Japan Society of Civil Engineers studied and quantified the historical value of civil engineering heritage

sites. During 1993 to 1995, modern civil engineering heritage sites were surveyed for the whole country. For 3 years, from 1996 to 98, the results were evaluated and selected on about 2000 of the most important modern civil engineering heritage sites for listing. A registration system of selected civil engineering heritages started from 2000 and about 10 civil engineering heritage sites are selected every year.

In 1999 the JSCE issued “Sendai Declaration on Social Overhead Capital and Civil Engineering Technology” stating the following:

Due to modern and contemporary civil engineering works, quite a few engineering heritages, culture, climate and tradition peculiar to the areas have not been paid attention to and lost. However, it is civil engineering structures that play a role in forming the culture. The security of their existence for future generations depends on conserving such valuable assets for humans as engineering structures in order to convey heritage to the future as well as creating new culture. Civil engineers should take to their works with a sense of pride that construction capital’s fusion with social traditions produce new culture and civilization.

(From item 4 Concept Philosophy-3 Historical heritages, Respect of the tradition in
Journal of JSCE, Vol.85, pp.12, September 2000)

THE EDUCATION OF CONSTRUCTION HISTORY AT UNIVERSITY

In a session organized by Committee on Civil Engineering History at the 59th annual conference of JSCE, September 2004, case studies of the teaching of construction history in several universities were presented. The following are some of them:

Department of Civil Engineering and Architecture, Faculty of Engineering, Niigata University

In 1993 the subject of the history of civil engineering and architecture started to be taught to first-year students before they separated into civil and architecture courses. *Modern Civil Engineering History in Japan* by Y. Takahashi was adopted as the textbook. Visual material such as videos and slides were mainly used for lectures as well as sheets of handouts on the theme to encourage students to do preparation. A homework paper was imposed for every lecture. The aim of the syllabus is to pursue the way civil engineers understand construction history as clarification of the relation between human society and nature. The goal is the understanding that construction engineers engage in the social projects related to human life, to acquire engineering ethics, to understand that civil engineering technology has the power to change the way of nature and also to learn the concept of a symbiosis of the nature and human existence and the methods for achieving this.

Main themes of lectures are as follows:

- The history of *Okouzu Barrage* (1922). (Its construction and opposition to it in the area)
- Traditional technology of stone arch bridges and issues on their conservation
- The Conservation of modern civil engineering structures as heritage
- Changes in bridge technology and the responsibility of engineers in technical failure.
- The lifetime of a megalopolis and its maintenance, the history of city planning
- The Impact of mega-technology on the global environment and its restoration.
- Technology transfer from western countries through foreign engineers and Japanese students studying abroad.
- Thousand-year lifetime structures (temples) and engineers with artisan spirit.
- Reconsideration of civil engineering technology in the 20th century

Department of Environmental and Civil Engineering, Faculty of Environmental Science and Technology, Okayama University

Five subject groups are set: Structure/Material; Geo-technical/Ground; Hydrology; Environment / Sanitation and Planning / Landscape. Students of the Environmental Design Course have to select three groups out of five. In the group, Planning / Landscape,” during the Spring Term of third-year, students are set a compulsory project, “The History of the formation of civilization and the environment”; for the Autumn Term they have an optional project, “Landscape and Exercise”. Both are part of a series and their main contents are:

- The interaction between civilization and global scale environment. (Merits and demerits of technology)
- The impact of technology on city, transportation, landscape and gardens.(Technology and society)
- Engineering history according to the development of science, materials, social revolutions from the nineteenth to the twentieth century.
- Techniques such as design, sketching, perspective drawings.
- Conservation and its application in civil engineering heritage.

The interest of students does not continue if the contents are limited to the history of civil engineering projects and historical civil engineers. The changes in technology is prospected according to the change of society and related social, scientific and human factors are covered as well. The objective is to train an eye for landscape, to have a high regard for the life of great engineers in history and to have respect and affection for the engineering heritage. Students are requested to submit a paper at every lecture. For the purpose of visual presentation, about 2 000 slides are presented for one year. Students are encouraged to study excellent landscapes in their

hometowns. The teacher produced own edited textbook. Since construction history has a wide range, various teaching approaches should be adopted.

Architecture and Civil Engineering, Faculty of Engineering, Shinshu University

A course in construction history started in 1996 for third-year students, entitled, “The History of the formation of country environment”. The aims are as follows:

- To understand the role of civil engineering projects for the development of civilization.
- To review the well-known events in Japan and the world from the civil engineering perspective.
- To understand the significance of civil engineering heritage and conservation, maintenance and application.

Students are required to submit a report on and site survey of engineering heritage in their hometown. The nature of the subject of construction history has been discussed in the course and it is not recognized that the construction history is a major compulsory subject. It is also argued that construction history should become a subject for first-year students. However, site survey of engineering heritage may not be possible in this case. It is important for students to appreciate excellent civil engineering heritage and high quality collections of photograph and drawings are necessary for teaching materials.

Department of Transportation Engineering & Socio-Technology, College of Science and Engineering, Nihon University

The subject “History of Transportation Engineering” is set for students of all years. The majority of the attendants are from Second Year. The aim of this course is as follows:

- To understand the intention in the projects of road planning, city planning, national land planning.
- To understand the civil engineering heritage and train writing report paper and making presentation by slides and videos and also by site surveys.

The course is composed of 14 lectures and the main themes are: “World heritage sites and modern engineering heritage”; “Observation and survey techniques for the civil engineering heritage”, “Trends in conservation of engineering heritage”, “Maintenance and repair of engineering heritage” and “Civil engineers and ethics”. A short report paper is submitted at every lecture and longer report paper is submitted 3 times a term. Evaluation is by examination and coursework.

Consideration of the above Four Cases

There are 100 courses in civil engineering and related fields in Japan. Very few have courses on construction history. The four examples mentioned above are unusual for their understanding of the necessity of teaching construction history. Since the teachers in all these cases belong to the Committee of Civil Engineering History, at the JSCE, they understand the importance of construction history in education. The contents of the lectures in the subject are well designed and sophisticated. There are several common aspects to the four cases. The students in construction history are not first-year students, but tend to be second-year students who have already started to learn civil engineering. This means that the main aim of the construction history is not related to the introduction of civil engineering. Training in observation/recording of the engineering heritage, the understanding of the relationship between technology and society, training in the ethics of civil engineering and also the adoption of site survey techniques for engineering heritage sites are common to all four cases.

On the other hand, the subject of construction history is not necessarily well understood by other teachers on the course. In some cases construction history is regarded as an introductory subject before students start to learn specialist subjects. The enlightenment of all the teachers about the importance of the construction history should continue. Regarding the ethics of civil engineering, attention should be paid to the fact that the Japan Accreditation Board of Engineering Education (JABEE) is currently encouraging colleges to adopt construction history as part of the curriculum.

Department of Civil Engineering, College of Industrial Technology, Nihon University

In this case the author was in charge, during Spring Term, 2005, of a lecture course entitled, “The History of Civil Engineering Technology”, for first-year students as a selective. Students were advised on selection and almost all the students actually opted for this topic. The syllabus is shown in **(table 2)** and the aim of this lecture course was to understand the evolution of the construction technology for such civil engineering structures as bridges, roads, dams etc, historical civil engineers and construction projects. The special focus was the establishment of modern engineering and the process of modernization in civil engineering.

Since the attendants were first-year students (the students are separated into courses at the beginning of first year) and also because it was a Spring Term subject, the aim of this subject was to introduce general civil engineering information. The specific objectives of this subject were as follows:

- To understand fundamental and general knowledge on civil engineering (30%).
- To understand the processes of technology and projects of civil engineering and also the relation of civil engineering to society and nature (50%).

- To understand the role of civil engineering and civil engineers in society (20%).

The lectures were intended to make students comprehend these factors in relation to past events. For this reason contemporary civil engineering situations and issues were introduced first followed by engineering history in the modern period. After this, lectures followed chronology from ancient times to the present. The modern period was emphasized so as to make the factors producing the present civil engineering comprehensible.

Modern Civil Engineering History in Japan by Y Takahashi was adopted as the textbook. Handouts were used as well and power point and other visual teaching materials were also adopted. Copies of related articles and a list of recommendation literature were distributed before the end of the term.

Table 2. Syllabus of Civil Engineering History Course, Nihon University

No.	Contents
1	<ul style="list-style-type: none"> -Guidance for subject regarding syllabus, handouts, report paper, evaluation methods etc., - General Knowledge on civil engineering – what is civil engineering? - Well-known civil engineering structures, such as dams, motorways, bridges, tunnels in Japan and the rest of the world. - Disaster and civil engineering (the roles of civil engineers in recent disasters, earthquake in Niigata, Indonesia.) - A Career in civil engineering. The professional system of civil engineering - Issues regarding the contemporary construction industry - Source of information, Institution, JSCE, industry associations,
2	- Significance and characteristics of civil engineering history
3	- Reconstruction after the War and civil engineering From construction technology to systems in construction industry
4	- Civil engineering from reconstruction to high economic growth Change of technology, materials, structural systems of industry such as establishment of Agencies
5	- Mega-projects such as Honshu-Shikoku Bridges, Kansai Airport, etc., -Change of tendering systems
6	- From ancient times to Middle Ages. Civil engineering before Edo era. Ancient road systems, <i>Shingen</i> barrage.
7	- Civil engineering and projects in Edo era(seventeenth to nineteenth century) - Contract systems and mathematics and other traditional knowledge
8	- Origins of civil engineering in western countries. Military engineering and civil engineering in France and the UK
9	- Intermediate examination

No.	Contents
10	- Introduction of modern civil engineering technology from Western countries
11	- Railway construction and hired foreign engineers
12	- Civil engineers in modern Japan
13	- Engineering education in modern Japan
14	- End-of-Term examination

Table 3. Evaluation of Achievements

No.	Achievement goal	Intermediate examination	End-of-Term examination	Research Papers
1	To understand fundamental and general knowledge on civil engineering (30%).	33.3% (10)	33.3% (10)	33.3% (10)
2	To understand the process of technology and projects of civil engineering and also the relation of civil engineering to society and nature (50%).	40% (20)	40% (20)	20% (10)
3	To understand the role of civil engineering and civil engineers in society (20%).	0 (0)	0 (0)	100% (20)
	Total	(60)		(40)

The method of evaluation of students' achievements is through intermediate and End-of Term examination (60%) and research papers (three times) (40%). The students who got more than 60% are accepted to get 2 units (graduate condition of units is more than 134). Each achievement goal is measured in the weights shown in **(table 3)** respectively.

Research papers are evaluated for the research ability as well as the contents in **(table 4)**.

Table 4. Evaluation Standard of Research Paper

No.	Viewpoint	Mark
1	Conformity to specifications (Paper size, pages, words)=2	Accepted =2 Not accepted=0
2	Spelling and grammar = 2	Mistakes: None=2 ;Few=1; Many=0 1
3	Structure of sentence = 3 (Logical expression)	Yes=3;a little2,;half=1;No=0
4	Accurate answer = 3	Yes=3;a little=2; half=1; No= 0

Table 5. Questionnaire to students

	A: First (Before the term)	B: Second (After the term)	Results Change from A (%) to B (%)
1	Why did you choose the subject?	Why would you recommend the subject to next fresher?	Introduction to civil engineering: (36%---50%) Interest in Construction history: (10---36%)
2	What did you expect from the contents?	How do you value the contents?	Contribution to society: (32%---39%) Liberal arts: (16%---16%)
3	What do you expect the outcome to be?	How do you recognize the outcome?	Help to understand new technology: (30%---36%)
4	What is your view on the subject?	What is your view on the subject?	Contribution to society: (46%---37%) Impact on environment: (28---41%)
5	Which period is the most important?	Which period is the most important?	Contemporary: (58%---43%) Modern: (28%---50%)

Analysis and Consideration

The students' evaluation to the lectures was surveyed by questionnaire. The first survey was before the term and the second was at the end of the term. There are five questions shown in (table 5). The five alternatives were prepared to select for the answer to each question. The results are analyzed by the changes between the first and the second survey. The following results were obtained by the analysis.

Regarding Question 1, 36% of the students (22 out of 50) selected "Introduction to civil engineering" and the same reason was given by 50% of students (22 out of 44) at the end of the term. This means that students expected the subject to be an introduction to civil engineering.

Regarding Question 2, asking about the contents of the subject, there are not such significant differences between the first and second survey. 32% of the students (16 out of 50) selected "contribution of civil engineering to the society" at the first survey and 39% (17 out of 44) selected the same answers at the second survey.

Another answer, "Civil engineering history is accepted as a liberal art" got 16% (8 students) at the first survey, 16% (5) at the second survey. The answer to the question, "contribution civil engineering to the society" seems to be quite normal and easy to select for the students who had just entered the University of their Choice.

Regarding Question 3, asking the effect or outcome of this subject, 30% of the students (15 out of 50) selected, "help to understand the new civil engineering technology" at the first survey. This

changed to 36% in total of 20%(9 students) of the same answer and 16% (7 students) of similar answer “to help to understand whole of civil engineering”. This result shows that students expect the subject as introduction to civil engineering.

Regarding Question 4, asking about their view of the subject, 46% (23 students out of 50) selected the answer “construction history shows how civil engineering contribute the society” and 28 % (14 students) selected “construction history is important for thinking about environment issues” at the first survey. These answers changed to 37% (12 students) and 41% (18students) respectively. These two answers do not differ so much, even though the latter answer is more concrete and easy to answer. A total number of 74% and 78% are almost the same and there are no changes in this question between the first and the second survey.

Regarding Question 5, asking the importance of the period in the history, 58% (29 students out of 50) selected contemporary and 28% (14 students) selected modern at the first survey. This changed to 43% (19 students) and 50% (22 students) respectively at the second survey.

This seems to be justly a result that modern period was most emphasized in the subject to understand the factors to produce the present. Attention should be paid that more than 80 to 90% of students think the modern and contemporary periods are most important for engineering history.

In addition to the above questionnaire on the contents of the subject, lecture questionnaire was also carried out. This is a common questionnaire for the whole college. The results are shown in **(table 6)**.

Table 6. Results of Common College Questionnaire. (No.registered:50;Effective answer:41.

No.	Questions	Average	Yes Point:4	Some what Yes Point:3	Some what No Point:2	No Point:1
1	Appropriate Syllabus	3.8	77.5%	22.5%	0.0%	0.0%
2	Teaching in lectures.	3.7	75.0	22.5	2.5	0.0
3	Understandably Spoken	3.5	60.0	35.0	2.5	2.5
4	Understandable writing materials	3.7	72.5	22.5	5.0	0.0
5	Appropriate quantities of home work	3.6	67.5	25.0	7.5	0.0
6	Encouraging students to join lectures	3.4	47.5	42.5	10.0	0.0
7	Understandable contents of lectures	3.4	47.5	45.0	7.5	0.0
8	Intellectual stimulation	3.5	45.0	55.0	0.0	0.0
9	Your attendance of lectures	3.7	80.0	10.0	10.0	0.0
10	Preparation and review	1.8	5.0	20.0	25.0	50.0

Major descriptive answers	<ul style="list-style-type: none"> -Interesting and enjoyable lectures (multiples) -Understandable by using OHP, PPT and handouts -List of recommended books was useful -Stimulated interest in Civil Engineering -Wide and shallow knowledge of Civil Engineering -Most interesting lectures in this course. -Well understood on Construction history -More readable board-writing and clear voice
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There are 9 questions in the questionnaire and through question 1 to 9 except question 8 of “Intellectual stimulation” Point 4 (Yes) is the majority. The lecturing method was generally acceptable to students. However, more readable blackboard writing and a clearer voice in the lectures are requested in descriptive answers. For students, question 10 of “preparation and review” was not satisfactory at all. Homework or any other self study should have been imposed in addition to the list of recommended books.

CONCLUSIONS

Why Construction History Should Be Learned

The role of construction engineers in the 1960s to 1970s was quite simple and clear. Construction of dams against flood control and hydroelectric power, construction of highway systems and bridges for efficient transportation are accepted by people as socially beneficial deeds without doubt. In the early 1970s, when the author started his engineering career as a bridge designer most of engineers were tackling their roles with certainty. However, that sense of the value and need of construction in society has changed and diversified due to the increase and complication of impact of construction activity on the environment.

As stated before, the society is requiring engineers to be involved in the aspects of history and culture collateral of engineering structures as well as issues of safety and durability. For engineers, a bridge should be a structure with cultural and historical functions as well as the basic function to connect physically point A and B. A wide a range of viewpoints such as the observation of natural phenomena and the environment, culture, history and the psychological impact of construction are essential. This means that the role of engineers has changed. They have to cope with this by utilizing the knowledge base common to engineers, which is cultivated by learning construction history as well as subjects of specialist fields. This is the background to determining the role of construction history in education and the answer on how construction history should be learned.

How Construction History Should Be Learned

In construction industry, awareness of the history of construction appear in various corporate activities such as published books or films on the history of companies and the change of

technologies, managing private museums or exhibitions of construction technologies. There are many company home pages with contents of construction history. JCECA, the Japan Civil Engineering Contractors' Association Inc., composed of major Japanese construction companies, has been holding exhibitions of civil engineering heritage sites and introduced modern engineering heritage sites in the home page for engineering education. However, it cannot be denied that engineers employed in construction companies generally hesitate to join the committee activities on history in JSCE, or, any other institutions compared with the committees on practical technology directly connected with everyday life. This reflects an aspect of the real attitudes of companies toward the construction history. The enlightenment of engineers especially involved in practical engineering is important.

It is expected that the increasing stock of infrastructures will produce a demand of repair and strengthening of deteriorated structures with historic and cultural values in the near future. These practical activities on the conservation of civil engineering structures may cause practical engineers to become involved with and understand construction history. In addition to construction industries, enlightenment on the construction history is required in educational institutions too. There are not many civil engineering courses in universities that have courses in construction history. It is common that even if they do teach the subject of construction, the aim is to show the past engineering events as an introductory subject leading to specialist subjects. Construction history is not accepted as an independent subject in its own right. As the result of our questionnaire shows, first-year students expect an introductory subject, an introductory subject is required in the curriculum of civil engineering course. As far as the author is concerned, the subject may have to be designed to satisfy both the need for an introduction to specialist subjects and the history of construction, due to the regulation of the curriculum in the universities. However "pure construction history" is also required for the students more senior than second-year or for a masters course. In this case, lectures should include the contents on practical engineering issues such as conservation, strengthening and repair of civil engineering structures with historical values.

There is a lot of information available for teaching materials for construction history in companies, institutions and the JSCE. The important thing is to gather that for books, brochures, films, photo or drawing collections in paper or digital form. JSCE should take an active part in this project as a part of the role of the enlightenment on construction and civil engineering to the society.

In the syllabus of civil engineering courses, relations or interactions between society and technology in construction projects in the history should be focused on rather than the changes in construction technologies. The impact of construction works on the environment, consensus on engineering projects, the processes of the projects, including financial aspects and evaluation by society are part of them.

This kind of training will develop students' abilities to grasp the changing needs of society regarding construction engineers, and to show what they themselves should learn with respect to the

changing needs. The lecturers for construction history should preferably be teachers with the experience of practical construction in the industries or administrations in government organizations as well as teachers who have been involved in education. A proposed content design for a lecture course on the subject of construction history, based on the above discussion, is given above (**Table 7**) This course is for first-year students and includes an introduction to specialist subjects.

Table 7. Proposed contents of a construction history course for first-year students

Title	Contents	Lecturer
Guidance Introduction	<ul style="list-style-type: none"> -General knowledge on civil engineering – what is civil engineering? -Well-known civil engineering structures, such as dams, motorways, bridges, tunnels in Japan and the rest of the world. -Disasters and the role of civil engineers in recent disaster, earthquake in Niigata, Indonesia) -Career of civil engineering./ Professional system of civil engineering - Issues related to contemporary construction industry -Sources of information, institutions, JSCE, industry associations etc. 	Full-time teacher
Lecture 1	-Reconstruction after the War and the role of civil engineering Technology and systems in construction industry.	Full-time teacher
Lecture 2	-Civil engineering in reconstruction and high economic growth (1960s, 1970s) Change of technology, materials, systems of construction industry.	Full-time teacher
Lecture 3	- Mega-projects such as Honshu-Shikoku Bridges, Kansai Airport, etc. (1980, 1990) Change of tendering systems and construction contracts.	Full-time teacher
Lecture 4	- From ancient times to the Middle Ages. Civil engineering before Edo era and ancient road systems.	Full-time teacher
Lecture 5	- Civil engineering and projects during the Edo era (seventeenth to nineteenth century) Traditional engineering knowledge	Full-time teacher
Lecture 6	- Origin of civil engineering in Western countries. Military engineering and civil engineering in Western countries.	Invited speaker
Case study 1	Before Modern (Edo era); Irrigation projects.	Invited speaker
Case study 2	Modern era; Railway projects.	Invited speaker
Case study 3	Modern era; Bridge reconstruction from Great Earthquake.	Invited speaker

Title	Contents	Lecturer
Case study 4	After WWII; Environmental impact of the Metropolitan Expressway	Invited speaker
Case study 5	Contemporary; Consensus on Narita Airport construction	Invited speaker
Lecture 7	Conservation of civil engineering heritage	Full-time teacher
Site	Survey report	Full-time teacher

It is reported that the ratio of young people who resign their jobs within three years after the graduation to the total number of the generation are 70% for junior high school, 50% for high school and 30% for university in all the industries in Japan. A mismatch of young people's expectations and those of companies is indicated as the reason of these unusual phenomena. Why does this mismatch occur? The basic problem is the lack of ability of young people to comprehend the changing value systems in a complicated and diversified society, and to learn the knowledge and wisdom to cope with these changes. Part of the solution for this issue lies in the subject of history. Through learning about construction history, engineering students have a chance to consider what the relationship between society and the construction industry is, what they as engineers could do, what kind of engineer they should be.

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