

# DEVELOPING APPROPRIATE CONSTRUCTION MANAGEMENT EDUCATION FOR INFRASTRUCTURE DEVELOPMENT AND MANAGEMENT

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**Abstract:** Japanese construction industry has long been utilizing advanced construction technology for rehabilitation and development of modern infrastructures. However the sustainability in the construction investment could not be seen after she turned to one of the developed countries. Further, Japanese contractors have not been able to expand their overseas business significantly beyond the volume in the early 1980. The author investigated that lack of appropriate construction management education in Japan in the past has made the domestic construction industry vulnerable and inhibited Japanese construction industry in expanding overseas business significantly. The practical construction management education for infrastructure development and management is discussed.

*Key words :* construction management, civil engineer, project management, engineering education

## 1. INTRODUCTION

The Japanese construction industry was engaged in building massive as well as unique infrastructures in the period of time starting the post war rehabilitation until the burst of bubble economy that was happened in early 1990s.

The industry has already shown its ability by building world renowned and highly advanced structures such as long span bridges, tunnels under sea and in soft ground areas etc. Technological research and innovation in the universities and industries made possible to realize such unique structures. Similarly, the civil engineering in universities and institute of technologies were engaged in the elemental technology developments and consequently the human resources were trained in the specialized engineering fields, but did not incorporate the appropriate management education in the field of engineering.

As a result, the industry could not realize and incorporate the feasibility of structures and possible changes in social structure and needs while developing infrastructures in the past. Many local governments are now facing financial difficulties to maintain the previously built infrastructures. Such environments have further exacerbated the decline in the public trust with the construction industry.

In addition, Japanese construction industry has not been able to expand its overseas business significantly beyond the 1980s' value. Japanese consultants are also not being able to draw significant overseas business from other than Japan's official development assistance (ODA).

The industry lacks appropriate human resources in construction management area. The author based on his more than 30 years of involvement in Japanese and overseas construction industry has been engaged in developing human resources in construction management.

This paper provides a concept for practical construction management education and recommends an appropriate curriculum which can be applied to various development stages of a country.

## 2. JAPANESE CONSTRUCTION INDUSTRY

### 2.1. Construction Investment

Some of the Japanese construction companies have more than 120 year's histories. Along with the Meiji restoration period in 1860 the construction industry grew steadily until the 2nd World Wars when it came to a standstill. Since then Japanese construction industry grew rapidly after the World War II.

The post war reconstruction and rehabilitation were supported with heavy investment by the government and private enterprise. The construction investments in Japan since 1960 are shown in Figure 1. The investment in the construction industry was sharply increased from the beginning of 1960 at an average annual rate of 15 percent and reached nearly 59 trillion yen in 1973. Thereafter, there was no significant growth in investment in the industry till 1979, the year of second oil crisis.

The largest investment in the construction was observed about 84 trillion yen (US\$1≐Yen 150) in 1992. The industry did not require exploring markets as the government and private enterprise continued to request

more and more infrastructures and construction products. The industry was engaged in technological innovations to fulfill the clients' demand as early as possible without considering the economic feasibility of the projects and technologies and need and demand arising from the changes in social structures.

However, after year 1992 the amount of the investment was continuously decreasing. The investment in 2004 in real terms was lower than the early 1980s value. The

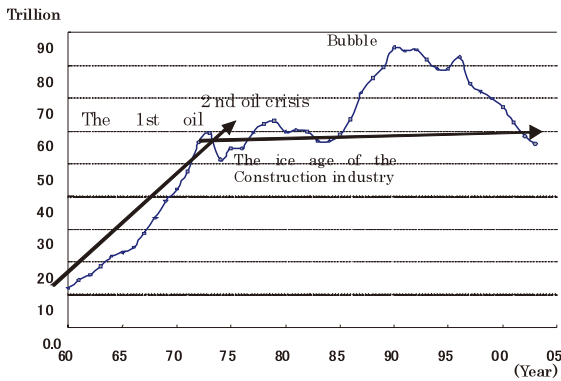


Fig.-1. The Investment amount of the construction

investment in the construction industry has gone back to 20 years in the past. The increasing the investment in the bubble economy must be recognized as “a transient fever”. If it is so, the amount of the investment has not been increases since early 1980. The stage of early 1980s therefore can be taken as major turning point for Japan where she turned to a developed country from a developing country.

## 2.2.Civil Engineers' Roles and the Range of Activities

The construction industry in Japan is now in quite complicated situation. The public confidence in the industry has become very low now. It is not only in the industry but also on civil engineers. It must be because of the industry and the civil engineers have not been fulfilling ones' obligations- to make necessary infrastructures for the people and the society. Then it is needed to think about whether the civil engineers in this country are making necessary infrastructures for the people and the society and does the construction industry have the industrial structure for fulfilling one's obligations or not.

One may be quite confident to say yes, as far as the activities made by the civil engineers until end of 1970s observed because they just implemented the works in accordance with the demands requested by the people and society by that time.

It can be observed the same situation in developing countries. However, when we see the situation after that is happened it must be difficult to say yes. For getting back the people's confidence, it is really needed to consider the situation from civil engineers' roles and functions in the infrastructure development. It can be

said that basically civil engineers shall be required to do following three different roles. Those are;

### (i) Mission & Policy:

The function of Mission & Policy is “To find out and to clarify necessary infrastructures for people and society.” It should answer “Why and what shall be made for the people and the society without compromising the capacity for future generation and society?”

### (ii) Technical Development & Engineering:

Technical development & Engineering is required “To confirm and to develop the appropriate and effective technologies for making the required infrastructures.” It is responsible for “How to make it/them”.

### (iii) Construction Management:

Construction management is essential “To find out and set up the practical and effective way of implementation of a development project.” It provides the ways and techniques required for “How to combine the Mission & Policy and the Technical Development & Engineering practically and effectively.”

As shown in Figure 2 the functions of the civil engineers are to integrate Mission & Policy, Technology development & Engineering and Construction Management. Further, the function of construction management is to combine the mission & policy and technology development & engineering for efficient project development. However, many of the civil engineers like to concentrate in the area of technology development and engineering, and do not consider the mission & policy.

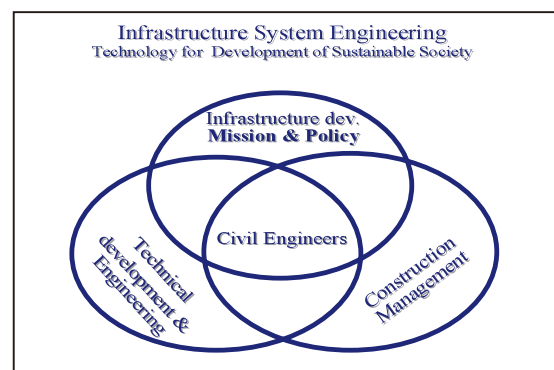


Figure 2: The functions of the civil engineers

As shown in the Figure 3, traditionally universities are executing their activities in academic field and concentrate in elemental technology development. The activities of companies, on the other hand, are mostly to integrate the elemental technology for real project development.

The problem is that the activities of universities and the industry are not smoothly integrated. Since civil engineering is responsible for the development of adequate and appropriate infrastructure for the people without comprising the future needs, the civil engineers' role is wider than that has been assumed traditionally.

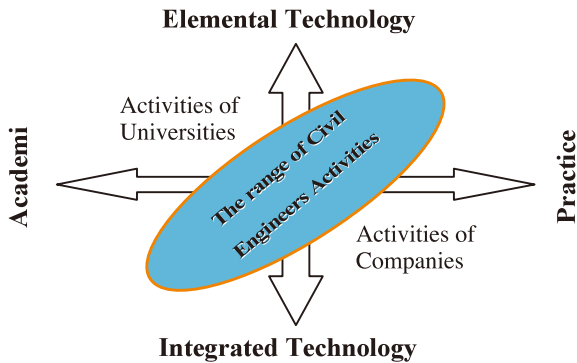


Figure 3: Real Image of Engineering

### 3. BUILDING UP CONSTRUCTION MANAGEMENT EDUCATION PROGRAM

#### 3.1. The Fundamental Issue of Engineers Education

“Combination of practice and theory” may be interpreted to be “merger of logic and the actual works”. It is a question whether such educational theory had been historically existed in Japan or not.

In 1873, the modern engineering education was started in the school proposed by Y. Yamao in Japan. The school was re-organized into Koubu Daigakou (the engineering college) in 1877 under the direction of The Ministry of Public Works.

The education system in the college was preparatory study, special study and added by “the practical study”. During 6 years study period, in the first 2 years, students spent all the time in theoretical studies in the college. In the next 2 years time, they had half-year theoretical studies in the college and half-year practical studies in the field. In the last 2 years time, they were directed entirely to the actual practice in the field works.

It was Henry Dyer, English engineer, who hired by the new government established in Japan actually promoted the establishment of this engineering college. There were two different systems for the engineering education method in Europe at that time. The one system was “theory oriented” education method that was said to be the continental method. The other was “practice oriented” education method that was said to be English method that respects apprentice disciples in the field works.

Dyer thought, in order to raise competent engineering personnel, the 2 methods is to be combined into the wiser way. And he did it for the first time in the world in the engineering college of Japan.

The Nature published in 1877 gave the high evaluation

to the combined model. In England, the practical training had the top priority and systematic education facilities were not established, while adversely in the continental countries like French and German, theory education was given importance, neglecting the actual field education.

The Nature commented for the best effective method of education of the engineers that two systems were to be wisely combined, and was implemented in the engineering college. This is to say the starting point of Japanese engineering education originated in “the combination of theory and practice” thinking not only of Japanese own development, but also of the global development of the industrial techniques. “Theory” pursues never-changing truth and principle, while “practice” does the principles of the real world.

Accordingly, they might change the objects depending on the real life, changeable social circumstances and economic systems and so on. Namely, concerning “to pursue theory”, it is indispensable to master the cultural science, natural science, the social science. The program of real practice course in the engineering college is thought to have had the very important roles in acquiring the management technique.

Why in the college the perfect theory-practice combined education became possible? It is true that without Henry Dyer’s global views and his ideas of engineering education, it could hardly be realized. However the supreme educational ideas must be supported by the appropriate systems and facilities that can turn ideas into reality. The said college belonged to the organization of the Ministry of Public Works which substantially carries out the various national projects for nation’s development. And it is thought the best education surroundings “logic learnt yesterday must be done today” existed at that time. This is the indispensable condition.

#### 3.2. Tow different Types of Research Activities

The author had found a rigid thinking of the specialists and/or faculties who are handling “Main fields of civil engineering” like Structure, Materials, Geotechnical, Water Hydraulics, and Transportation Engineering, etc. while conducting the research and educational activities in Kochi University of technology and he concluded the study of specialists and others in the following two ways.

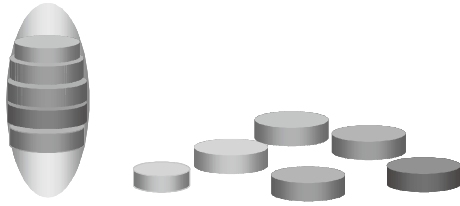
##### (i) Bottle-shape Research Activities

(Research activities are focusing on “depth”)

The research activities categorized in “the major fields of civil engineering” shall be understood as a group of research focusing on depth or height. The author put them the group name “Bottle-shape Research activities”. Figure 4 shows the conceptual image of bottle-shape research.

Most of the researchers/faculties involved in the bottle-shape research consider that “it is necessary that study is to provide for hypothesis, shorten the scope of the objective targets, give the fixed procedures for the

To seek truths existing within own research area and pile them up in the stratified ways for setting out new theory



**Figure 4:** Bottle-shape Research activities

subjects existing in the related fields, piling them up in the stratified ways, and to seek new truth and technology”. For these purposes, they put emphasis on hypothesis and objective, and the logic and scheme required to implement them. To put it adversely, they come to possess an idea that it will not be a research if the process and methods reaching for the targets are not sure.

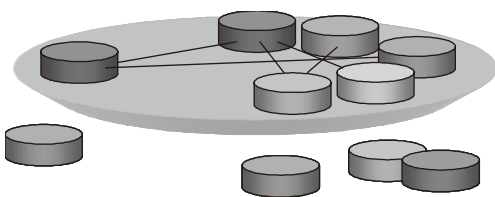
However, if a researcher tries to find out the target from methods and the purpose, he will be inclined to cut off the obscure elements/factors to the possible extent and simplify them. The modern society is complicated, diversified, and is full of uncertain factors/elements. Namely, the study approach faithful to “Scientific ideas” is feared, in the modern society, to have possibility to invite the results isolated from reality. It will be required to have another way of view for identify his research activities. This must be one of the reasons why the people say that Engineering Design education program shall be required.

(ii) Disc-shape Research activities

(Research activities are focusing on “Range”)

These fields like Architectural Design, Environmental Management, and Construction Management are thought to come within the study “Focusing on Range” and to be positioned as such. Figure 5 shows the conceptual image of disc-shape research activities. It shall be understood that the bases of the study for those engaged in this type of study is not “Technical Development and Engineering” but “Mission and

Condensing to seek truths existing in the different fields and integrate them for finding out new theory

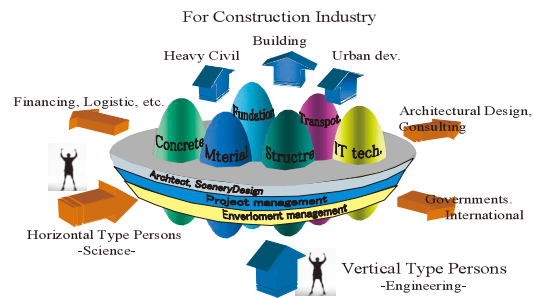


**Figure 5:** Disc-shape research activities

Policy”. Accordingly, the thought of study becomes necessary that they should be free from hypothesis, the scope of the target and mythological argument, and are asked to combine freely truth dotted in the wide range for finding out new theory.

**3.3. Concept of Construction Management Education**

It is considered that thought of the united shape formed by combining the Bottle-shape research activities and the Disc-shape research activities will give the direction for “how the future civil engineering should be, and where it should go to”. Figure 6 shows the basic concept of Department of Infrastructure System Engineering in Kochi University of Technology in Japan that the author belongs to. This concept is coming from idea of combination between Bottle-shape and Disc-shape research activities. It is, however it took almost 1 year and strong argument among the faculties for set up this department policy. At this point, the author considers that this must be “the original concept of civil engineering”. The program of construction management



**Figure 6:** New concept of civil engineering combined Bottle-shape and Disc-shape research

education which forms the objective of this study shall include the enlarged scopes of civil engineering as illustrated in Figure 6.

**3.4. Construction Management Education Program**

Based on the philosophy described up to here and considering the local conditions, such as construction industry, engineering education etc, and also on his over 30 years experience carrying out construction projects both in Japanese and overseas, the author has developed the concept and the structure for the practical education program of construction management suite to.

The program is developed following five broad headings.

- 1) Infrastructure project planning and assessment.  
Technology required for Infrastructure development.
- 2) Project mission management.  
Technology required for project implementation.

**Chart-1. The structure of Construction Management Education Program**

Education Levels: 1=Basic knowledge, 2=Practical Knowledge, 3=Practical technology, 4=Professional Knowledge & technology			3 years Tech.Hig school	5 years Tech.Hig school	College university 1,2 grade	College university 3,4 grade	Master Doctor
<b>1. Planning &amp; assessment of Infrastructure development</b>			Education Levels				
1.1.	Infrastructure development in the world	Infrastructure Development	1	2	2	3	4
		International Construction Industry	1	2	2	3	4
		Globalization, regulations, standards	2	2	2	3	4
1.2.	Infrastructure development in Japan	Infrastructure Development in Japan	2	2	3		
		Situation of Construction industry	2	3	3		
		Mission of Construction Industry	2	2	3		
1.3.	Planning & Assessment of Infrastructure development	Mission & Ppolicy	2	2	3		
		Grand Deign & Master Planning		2		3	4
		District & Regional planning		2		3	4
		F/S; Feasibility Studies		2		3	4
1.4.	Environment management	Environment issue	2	3		3	4
		Environment assessment	2	3		3	4
1.5.	Role of Civil engineers	Engineer's Mission	2	3	3		
		Engineer's Ethics	2	3	3		
<b>2. Project mission management</b>							
2.1.	Law & Regulations related project execution	Construction Law, Audit		2		3	4
		Environmental law & regulations		2		3	4
		Other related Law & Regulations		2		3	3
2.2.	Standard conditions of construction contract	Standard conditions of contract	1	2		3	3
		Int. standard conditions of contract		2		3	3
		CM standard conditions of contract		2		3	4
2.3.	Feasibility Study Project Appraisal	Risk evaluation & management		2		3	4
		Detail Environment assessment		2		3	4
		Feasibility study assessment		2		3	4
2.4.	Project mission planning	Project formation	2	3	3		4
		Basic design & Construction plan	2	3	3		4
		Estimation & Budgeting		2		3	4
		Financial planning		2		3	4
2.5.	Procurement & Contract	Project mission Organization	1	2	3		4
		Contract formation	1	2	3		4
		Tendering, evaluation & contract	1	2	3		4
<b>3. Project execution management</b>							
3.1.	Project administration	Security, External affaires		2	2		4
		Tax & accounting		2	2		4
		Financial control		2	2		4
		Personnel control		2	2		4
3.2.	Project management	Schedule control	2	3	3		4
		Cost control	2	2	2	3	4
		Contract administration		2	2	3	4
		Quality management		2		3	4
<b>4. Project field management</b>							
4.1.	Field work execution plan	Permanent works	2	3		3	
		Temporally facilities	2	3		3	
		Construction equipment	2	3		3	
		Material	2	3		3	
4.2.	Field Control	Safety control	2	3	3		
		Quality control	2	3	3		
		Productivity improvement	1	2		3	4
<b>5. Project Operation &amp; Maintenance</b>							
5.1.	Project Operation	Operation organization		2		3	4
		Financial control		2		3	4
5.2.	Project Maintenance	Monitoring & investigation		2		3	4
		Maintenance, Repair & renewal		2		3	4
5.3.	Project assessment	Social impacts		2		3	4
		Problems Isolation		2		3	4

- 3) Project execution management.  
Management technology required for project execution.
- 4) Project field management.  
Construction technology required for project.
- 5) Project operation and maintenance.  
Technology required for project operation/maintenance.

The details of the curriculum for practical construction management incorporating the techniques required for the execution of international projects as shown in Chart 1.

The part of education activities described on Chart 1 has already been implemented in Department of Infrastructure System Engineering in Kochi University of Technology.

Kochi University of Technology is one of the universities implementing the most advance education program related to the construction management in Japan, but the author still need to develop and maintain the program.

The gray colored areas on Chart 1 show the items that are covered by lectures implementing by the author and his colleagues as of 2006. Since 1967 while performing the actual work in a construction company, the author has been engaged in giving the lectures on construction management in the studies of universities and JICA.

After 2001, he is in charge of education of construction management and its related fields in Kochi University of Technology. It is thought that the following remarks are to be made concerning construction management education, based on his experiences.

#### (i) Commencement of Construction Management Education

The education related to construction management should be commended as early as possible. The present young people are derived of chances to see the construction sites in their growing processes.

After 1970s, the construction sites have been surrounded by the high iron fences, offering less chance for them to witness the actual conditions /situations of the construction sites. For this reason, most of the young people fail to catch, by their real feelings, such fundamental works like excavation, reclamation, concrete works, etc., and there is a high possibility that their knowledge acquired in their special fields through lectures would idly work.

#### (ii) Lecture Method and Remarks

At present, those young people who embrace “what they wish to challenge and what they want to do” are quite less to be found. It is important for the students by themselves to understand the objectives to study civil engineering, to realize the meaning of the works of construction, and the functions of civil engineers

required to shoulder by themselves. For this purpose, the following method for lecturing is necessary:

- (1) Lectures are to be carried out to make students willingly to express their own opinions to the possible extent.
- (2) Education is to be undertaken by a small group consisting of 3 or 4 members, who are directed to concentrate on the case-studies. They are let to tackle with the problems which have no right solutions.
- (3) They will be evaluated by their reports. They are requested to submit reports on the following type question: “To analyze the real images of internationalization, and the future directions. What you will do in the situation changing society?”
- (4) The steps are to be taken that they actively speak on the occasions of the academic lectures so that those receiving lectures can fully realize the fruitful results of education given for them.

## 4. CONCLUSIONS

The author believes that the techniques deployed in international projects are equally applicable to the Japanese domestic construction industry and in other developing countries as well. A practical construction management education incorporating the international construction practices and need of the Japanese construction industry and the society as well has been presented.

The proposed construction management education in civil engineering would enable the civil engineers able to realize the holistic approach in infrastructure development and consequently would improve the infrastructure development environments.

Developing countries can adopt the proposed education system with necessary modification to suite their domestic infrastructure development environments.

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# 社会基盤施設の建設と管理運営のための建設マネジメント教育 プログラムの開発

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**要約:** 日本の建設産業は、長い間、優れた建設技術を戦後の国家再建および近代的インフラの整備に対して活用してきた。しかし、日本が先進諸国の一員となった後は、国内建設投資の継続的な増加を期待することはできなくなった。さらに、日本の建設企業は、1980 年前半に達成した事業量を大きく超えるレベルにまで海外事業を拡大することができない状態にある。これまでの建設マネジメント教育が適切を欠いており、これが国内の建設産業を弱体化させ、同時に、海外事業の拡大を妨げとなったのではないかと、著者は本研究において掘り下げた。本研究はインフラ開発およびマネジメントのための実践的な建設マネジメント教育について述べたものである。