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Determining United States Construction Management Aspects to be Introduced to Construction Management Education in China

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ABSTRACT

The following study describes the current status of China's Construction Industry, highlights its educational system, and identifies the main constraints that restrain the construction industry from assuming a more effective and efficient role in China's impressive economic development.

This study outlines the problems existing in China's construction educational system. Through analyzing United States construction management education, and comparing it with China's construction education, the advantages of the United States construction management education are determined, and recommendations are made to improve China's construction education.

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CHAPTER I. INTRODUCTION

This study analyzes current construction educational systems in the United States and China. Through comparing United States construction management education with China's, the positives aspects of United Sates construction management education will be identified and introduced to improve China's construction education.

This chapter includes a description of construction management, followed by the construction situation in China, application and development of construction management in China, the statement of the problem, significance of the problem, research objectives, and a statement of assumptions.

Description of Construction Management

To meet the needs of time, the construction industry has developed with a new contract for owners, contractors, and designers: it is called Construction Management (CM), which is not a totally new concept, yet it is "not just more of the same old thing" (Kavanagh, 1978). According to Kavanagh (1978), a "something borrowed" approaches a number of new techniques that have evolved, including network analysis, system analysis, fast-tracking, value engineering and/or analysis, life cycle cost studies, the design-build approach, and turn-key organization.

There is no question that construction management is more than just a reformation of old procedures and methods. In some cases, it is having its impact as a vehicle to introduce new concepts and new management techniques to an industry that is not only tradition-bound but also resistant to change.

Construction management has established itself as a viable approach to meet the needs of the construction industry, and in return, the needs of users of the industry. Construction management may well be the first step for the construction industry to meet the challenge of the twenty-first century, which will see not only a changing market but also a changing economy. The construction industry in the world "representing more than 10% of the GNP" (Kavanagh, 1978), not only will be influenced by these changes but also should have an influence on them.

Construction management is an evolutionary process. It will encourage the industry itself to evolve to produce the best result for the owner from the combined efforts of architects, engineers, contractors, and projector managers. It is this correlation of professional participants to the owner, which will produce success for the construction management approach.

Construction management offers a fresh approach to filling the gaps between construction, engineering, and management as the concepts of the institutions, traditions, and, in essence, the basic fabric of the construction industry evolves with changing needs. The inexorable growth of the construction industry has been brought about "by technical demands for change; by the growth of population and the generated demand for new housing; by new economic development calling for new office buildings, roads, airports, and harbors; by new industry development associated with new capital investment; by the demand for rebuilding urban centers; by the need for energy self-sufficiency; by the desire for improved mass transportation; and by the needs of existing facilities for maintenance, repair, and renewal" (Ross, 1994). Future projects will be characterized by a shift to large-scale undertakings, large organizations, and more advanced

communications between all participants, aided by social, behavioral, and environmental scientists, to meet the needs of society.

Construction Situation in China

China's Construction Industry (CI) is huge and widespread. Today, China could be described as one large construction site. Currently the annual output of the construction industry is about US $ 120 Billion and employs nearly 28 million people (more than 5% of the total labor force). The industry accounts for more than 6% of the Gross Domestic Product (GDP), and has been growing at an average annual rate of 10% since 1979 (Fischl, 1997). The high growth rate of the industry is attributed to an extreme shortage of infrastructure and building space. This growth rate is likely to remain high in the foreseeable future. Statistics show that the percentage contribution of the CI to China's GDP has been increasing since 1978. In 1998 it stood at about 6.5%, compared to 4.7% and 3.8% in1991 and 1978 respectively (Yan, 1999). However, the share of China's CI is still low compared to the developed countries, which implies a strong potential for further growth of the CI in China.

The construction industry started to change in the early 1980s with the introduction of economic reforms and opening up process. At the central level, the government started to introduce regulations to set basic ground rules, and at the enterprise level, the entities were gradually given flexibility to operate as "commercial entities"(Huang, 1999). The World Bank also made a modest contribution in this process by introducing for the first time competitive bidding and international contractors in China (Yan, 1997). One of the Bank's early projects, Lubuge Hydro Power, demonstrated

the advantages of competitive bidding, efficient management, advanced technology, cost effectiveness, quality control and early project completion. Since then, China's CI has come a long way in adopting a commercial behavior.

The contracting system is always a key entity in any construction activity. China has three distinct construction categories, namely, state-owned enterprises (SOE), urban and rural collectives, and rural construction teams. Joint ventures and sub-contracting within these groups are common. There are no private contractors in China yet. SOEs did most of the construction in the past, but their relative share is now decreasing. SOEs, which are comprised of both local unites authorized by municipal governments and central ministry-affiliated enterprises, have done most of construction work of China's infrastructure projects. For some years, notable progress has been achieved in reforming these enterprises in terms of commercial behavior, operational autonomy and competitive bidding. However, SOEs still face many unsolved problems, such as, poor management, old technology, and excessive labor force. The urban collectives and rural teams, on the other hand, have been developing fast; they now account for over 60% of the construction labor force and output value. They are different from the SOEs in that: (a) they are market-oriented and need not rely on assignment of projects, but can more easily look for work in the marketplace; (b) their management has more flexibility with respect to size and workers benefits of the unit; and (c) they are largely motivated by self-interest because the team's profit is firmly linked to the staff members' income and benefit (Fischl, 1997). Their output quality, however, is relative poor, and the professional and managerial levels are lower than those of SOEs. They need modern construction technology, better equipment, proper credit, and more-educated personnel to improve

their quality of construction. The rural construction teams, which previously were the main source of labor force, are increasingly taking on more construction work.

1. Quality Problem

Construction quality is recognized as a critical problem in China. According to the China Building Industry Yearbook, about 80% of the construction undertaken in 1994 was rated as acceptable quality. Quality of construction undertaken by line ministries is generally better than that of provincial enterprises, and the quality of construction by SOEs is considered to be much better than that of the urban and rural collectives. The quality of work done by rural construction teams is the weakest; it is associated with high waste of construction materials. The reasons for low quality construction are poor design, poor materials, weak management, ambitious completion targets, lack of technical skills, etc. Improving quality of construction is one of the major challenges facing China's CI today.

2. Human resource development

Whereas the contractual system has developed rapidly, the corresponding development of managerial skills has not taken place. The lack of construction management is still considered to be a serious weakness in China (Chen, 1997).

On the other hand, profit motivation is so strong that most enterprises work with short-term goals. The past system of management still largely affects current construction practices. Serious consideration has not been given to training by the construction enterprises and design institutes. In China, the Ministry of Construction (MC) has been

trying for a number of years to put in place a national program for different aspects of the construction industry, but the task is daunting (Huang, 1999). This should be a high priority for China to train project owners, engineers, managers, technicians and workers alike to perform more effectively in a changing construction environment.

Application and Development of CM in China

From 1984, the conception and theory of construction management was introduced to China from Germany and Japan. From then on, along with the international culture exchange and development of construction projects invested by international banks and foreign capital, more advanced theories and practical experience of construction management spread into China. Combining the revolution of the construction management system in enterprises utilizing public bidding systems, not only the construction management practices developed in most of the construction enterprises, but also research and education relating to construction management also gradually developed in the relevant colleges or universities of China.

Since bidding and contracting systems were developed in 1984, the construction management systems of enterprises have been a distinct improvement:

1. Before 1984, the construction works were assigned to enterprises by the government, based on their intrinsic systems, classification of business, and organization structures. After the economic revolution in 1984, enterprises contract projects through the marketing competition. In order to meet the requirement of the construction projects, the construction firms began to adjust organization structures and improve management-styles.

2. The relationship of responsibilities between enterprises has changed.

Previously, the enterprises emphasized the relationships with higher-level authorities to obtain the construction business. After the introduction of construction management, these enterprises gradually shifted their focuses on the needs of customers.

3. The management environments of enterprises have changed obviously. In the past, the construction business was limited in local areas and within enterprises. Now, their business extends across area limitations and they have enough abilities to contract trans-regional construction projects.

These changes demonstrate that China has evolved it's own construction market and is preparing a strong foundation for the development of construction management.

Construction Education in China

The main purpose of universities and colleges is to train advanced specialists. Institutions of higher education in China can be classified as comprehensive universities, universities of science and technology, teacher training institutes, and colleges of engineering, agronomy, medicine, commerce, economy, laws, arts, etc. Construction specialties, as well as civil engineering, are set up in comprehensive universities, universities of science and technology, and colleges of engineering, with the aim of producing/graduating civil engineers, designers, contractors, and management personnel.

When entering the 1980s, the state shifted to socialist modernization. The status and role of education has been steadily raised and gradually strengthened. Construction education, among all the fields, has gained a considerable growth recently (Fischl, 1997). In China, the role of construction education is not only to cultivate a large number of excellent engineers, but also to spread the modern construction management knowledge

to students of many other specialties. Several kinds of construction courses are offered every semester, which include some aspects about construction and management technology. Students may elect these courses according to their own requirement.

The Statement of Problem

Since the Chinese Government began to carry out the opening policy in 1978, China has introduced into the country many modern construction technologies and has made great achievements in the field of construction. The changes are really fantastic and exciting, and these modern technologies have greatly assisted China in its social and economic development.

However, there is still a gap between China and many advanced countries in the field of building construction due to its " backwardness" in management levels. The progress of construction management and technology need a new type of employee whose knowledge structure is different from the traditional one. A gap between the demand of the construction industry and the skills and knowledge currently offered at educational institutions exists.

China has embarked on a series of reforms designed to improve the efficiency of productive enterprises through the introduction of elements of a competitive market economy. Construction management education and training need to be expanded and improved to meet the requirements of the changing economy.

Significance of the Problem

The goal of this research project is to analyze and compare the construction management education of China and that of the United States, and then identify the differences that would enhance China's construction education. This research project will offer a few commonplace remarks by way of introduction so that CM professionals may come up with valuable opinions to improve China's construction management level.

Research Objectives

The objectives of this research project are:

1. To investigate CM educational standards in the United States and China;
2. To find differences of CM educational curriculum between the United States and China; and
3. To determine the U.S. construction management aspects suitable to improve civil engineering education in China;

Statement of Assumptions

The assumptions for this study are as follow:

1. The construction environment in these two countries are the similar;
2. Aspects of construction management education, which will be introduced to China construction industry, have been in use in the United States for some time; and
3. Current construction problems in China's construction industry have resulted from the backwardness and uncertainty of the construction management education.

CHAPTER II. LITERATURE REVIEW

The Conception of Construction Management

Construction management is a composite of many modern project management methodologies, having as their objective, the control of time, cost, and quality in the design and construction of a new facility.

Construction management offers a fresh approach to meeting the forthcoming demands of society for new housing, for energy self-sufficiency, for rebuilding cities, and for improving mass transportation. It also includes continuous maintenance, repair, and renewal of existing structures (Barrie, 1984).

Professional Construction Management

Professional construction management is one effective method of satisfying an owner's construction needs. It treats the project planning, design, and construction phases as integrated tasks. Tasks are assigned to a project management team consisting of the owner, the professional construction manager, the design organization, and constructors. A prime construction contractor and/or funding agency may also be part of the team. The team works together from the beginning of design to project completion, with the common objective of best serving the owner's interests. Contractual relationships among members of the team are intended to minimize adversary relationships and contribute to greater responsiveness within the management group (Barrie, 1984). Interactions relating to construction cost, environmental impact, quality, and completion schedule are

carefully examined by the team so that a project of maximum value to the owner is realized in the most economical framework.

Construction in the Present

The present construction industry is different from the manufacturing or service industries. It is a broad mixture of skills, resources, and control groups working together around a specific project (Ross, 1993). The construction industry has characteristics that are shared with other industries, but four characteristics unique to the construction industry are:

1. The physical nature of the service;
2. The structure of the industry together with the organization of the construction process;
3. Pressures of demand; and
4. Pricing processes.

It is important to note, that this situation is slowly changing and will continue to change, and a more conventional industrial structure is emerging (Ross, 1993).

Management in the Construction Industry

Today's construction industry can be generally described as a closely controlled, family-oriented business, which is very competitive. Innovative methods and financial data are kept as top secrets and most contractors apply management principles as an antithetical process, which makes it difficult to provide a sound statistical base for

analysis and projection. It is only possible to make generalized statements and inferences about the current status of the construction industry (Ross, 1993).

The construction industry is adapting management principles currently used by conventional manufacturing industries, such as Just-in-Time (JIT) and Total Quality Management (TQM). "TQM is an all-encompassing term that stands for the quality programs that have spread through most of the U.S. businesses" (Barrie, 1984). Large manufacturing companies that faced aggressive challenges from Japanese competitors initially adopted the TQM concept. Diverse organizations outside of manufacturing such as education and construction are adopting its principles and are improving the quality of their services and structures (Barrie, 1984). There are four essential ingredients in a TQM program:

1. An intense focus on customer satisfaction;
2. Accurate measurement, using a fistful of readily available statistical techniques of every critical variable in the company's operation;
3. Continuous improvement of the products and services;
4. Most importantly, new work relations based on trust and teamwork.

Construction Management Education

The construction industry and the academic environment have changed since the 1970s, both in terms of what is expected of construction education and what is the expected of construction educators. Construction firms now demand that graduates have knowledge, skills, and abilities beyond the traditional technology areas of materials, methods, estimating, scheduling, the architectural areas of design, computer aided

drafting, and the engineering areas of mechanical, electrical, geology, and structures (Missair, 1994). Today's graduates are expected to have at least an introductory level of knowledge in the legal aspects of construction contracting, alternative contractual delivery methods, financial and economic management, systems communication and integration, and human resource management. Today's students that graduate from universities are viewed as potential construction managers who enter the industry at mid-level management positions, i.e., project managers. More emphasis is placed on administrating the design/construct/manage and construction technologies interface than performing them. Indications are that students are gaining acceptance in the industry as professional managers rather than skilled technologists (Williamson & Bilbo, 1999).

Construction programs have addressed three major facets of concern for construction education, whether the student holds an undergraduate or graduate degree in construction:

1. Vertical advancement within the industry;

2. The needs of students desiring to move from industry to academia;

3. Programs are able to provide graduate instruction through innovative and non-traditional methodologies; and

4. The emphasis of these innovative programs should be the enhancement of existing content knowledge to meet the changes of a dynamic industry (Williamson & Bilbo, 1999). Advanced knowledge should be provided in construction management concepts and problems solving through investigative research practices.

Educational institutes must continue to change, grow, and develop. The improvement of the total environment depends on how successful educational institutes are in recruiting creative persons into the construction program. Attracting the most innovative minds to study, learn, practice, and participate at all level in the construction industry is crucial. It is equally important to realize the potential services to develop effective collaborations.

Required Knowledge for Construction Management

According to Haltenhoff (1998), twelve areas of knowledge have been established for the construction management:

1. Budget management

The budget management area of knowledge encompasses all project-related cost aspects of construction management practice. The construction management has the responsibility to conform, generate, track, report, and substantiate all budget costs from the first estimate to the final accounting.

2. Contract management

The contract management area of knowledge encompasses the involvement of the construction management in the operational and administrative provisions of the contracts used on the project. This area is singly important because the construction management system is a unique contracting system, the success of which depends on a workable realignment of traditional contracting roles and participant responsibilities. It is the responsibility of construction management to establish a contracting format for the

project and see that each contractor's operational and administrative requirements are definitively included.

3. Information management

The decision management area of knowledge encompasses the collection, documentation, dissemination, safekeeping, and disposal of verbal and graphic project-related information. The volume of information, generated for the project accountability purposes and by team member participation in decision-making checks and balances, required a multilevel, need-to-know reporting structure and an efficient information storage and retrieval system.

4. Material/equipment management

This area of knowledge encompasses all activities relating to the acquisition of material and equipment from specification to installation and warranty. The construction management format facilitates direct owner purchase of material and equipment of the project. The planning, specifying, bidding, acquisition, expediting, receiving, handling and storing of direct purchases, must conform to the purchasing policies and accurately reflect the requirements of the project schedule.

5. Project management

This part encompasses all of the operations aspects of project delivery, including determining, formulating, developing, installing, coordinating, and administrating the necessary elements from the beginning of the design to the termination of warranty and guarantee periods.

6. Quality management

The quality management area of knowledge encompasses all elements of construction management project delivery that contribute to the quality of the end product.

7. Resource management

The resource management area of knowledge encompasses the selection, organization, direction, and use of all project resources, both human and physical.

8. Risk management

This area of knowledge includes the dynamic and static risks that are part of every capital expansion program. Both types of risks must be identified, evaluated and disposed in a manner that will minimize economic loss to the owner in the event a risk with attached liability occurs.

9. Safety management

The safety management area of knowledge encompasses safe practices at a construction site in accordance with the prevailing regulations in the area of the project.

10. Schedule management

The schedule management area of knowledge encompasses all aspects of scheduling throughout the project. It is a management tool that best represents the controlled operations philosophy of the contracting system. It combines the element of time with the project's resources from the start of design to owner occupancy.

11. Value management

The value management area of knowledge encompasses a project's cost versus value issues. It has three value components: designability, constructability, and contractability.

12. Decision management

The decision management area of knowledge encompasses the development and handling of the interrelationship of the project and construction teams and the relationship of their respective members. This area of knowledge is the least technical, but one of the most important when providing construction management services.

American Council for Construction Education Curriculum Accreditation

The American Council for Construction Education (ACCE) is a private non-profit corporation. The mission of ACCE is to be a leading national and international advocate of quality postsecondary construction education. The primary goal is promotion and continued improvement of postsecondary construction education; specifically, ACCE accredits construction education programs in colleges and universities that request its evaluation and meet its standards and criteria.

Organized in 1974, ACCE is recognized by the Council for Higher Education Accreditation (CHEA) as the accrediting agency for 4-year baccalaureate degree programs in construction, construction science, construction management, and construction technology, and as the accrediting agency for two-year associate-degree programs of a like nature.

General Requirements of ACCE Curriculum

It is recognized that no construction education degree program can offer every course or experience that, justifiably, could be suggested for the education of a constructor. Further, it may be desirable in some instances to develop curricula in one or more areas of construction specialization. Such specialties may be developed as the only program or as part of a multi-option program. It is assumed that each unit will develop its own program goals and objectives and particular emphasis, and will prescribe the number of courses for graduation, sequencing of study, course numbers, and titles.

The curriculum should be designed to accommodate continually expending requirements of the profession, advancements in knowledge, and the contributions of related disciplines. Programs seeking accreditation should strive to provide offerings that exceed the ACCE Standards and Criteria for Accreditation. Curriculum planning flexibility in the subject areas recognizes and encourages differing emphases by the various construction education units. The total curriculum should support the goals and objectives of the construction education units and provide balanced content within the field.

Educational Policies for China's Construction Industry Development

The government of China has formulated strategic guideline based on China's actual conditions, whereby economic development, urban and rural construction and environmental protection are being planned for and developed contemporaneously, so as to maximize economic and social benefits.

China's Agenda 21 (State Planning Commission, 1998) is focusing on the improvement of a management system for construction development. It points out that the realization of construction industry development requires an extremely effective management system, in which capacity building for decision-making and for management are crucial. The development of construction management requires the comprehensive use of planning, administrative techniques, and legal and economic measures. It requires well-trained decision-makers and managerial personnel. It requires the use of advance management techniques and the establishment and improvement of organizational institutions, so as to form a cohesive management system.

The National Program for Education Reform and Development (State Science and Technology Commission, 1998) forwarded its objectives for improvement of the educational system; continue to strengthen professional education; vigorously develop vocational education; actively promote adult education and higher education, so as to build a group of far-sighted leaders and decision-makers, a contingent of highly skilled scientific and technological workers in various fields, and a large labor force with specific skills and scientific and managerial knowledge.

The China State Education Commission promulgated the document of cultivated object and basic requirement for construction management major students in March 1992. It pointed out:

> The cultivated object is comprehensive to include moral integrity, intelligence and physical fitness to meet the need of social development and state construction. Students must master the fundamental principles, knowledge and techniques of civil engineering as well as relative management. They can gain the

degree of Bachelor of Science and apply for a job to do research, teaching, development or management in institutes, universities, secondary schools, factories and administrative departments. They can also apply for graduate study toward an Master of Science or Ph.D., as well (Hayhoe, 1995).

CHAPTER III. METHODOLOGY

Introduction

This chapter presents the procedures and techniques used in this study. The arrangement of this chapter includes summary of the study, followed by a restatement of the problem, research objectives, data gathering methodology, and research procedures.

Summary of the Study

The goal of this research project is to find areas of construction management education improvement through the analysis of the current civil engineering curriculum in China. By comparing the Chinese and American construction management educational systems, the aspects that would improve the construction management level in China will be defined.

Restatement of the Problem

As previously stated, the current problem facing the construction enterprises, as well as construction industry, is the gap between China and many advanced countries in the field of building construction due to its " backwardness" in management applications. The progress of construction management and technology needs a new type of employee whose knowledge structure is different from the traditional one. However, a gap between the demand of the construction industry and the skills and knowledge currently offered at educational institutions currently exists in China. This is a problem that many people are concerned about.

Research Objectives

The research objectives for this study are:

1. To investigate construction management educational standards in the United States and China;

2. To find differences of construction management educational curriculum between the United States and China; and

3. To determine the U.S. construction management aspects that are applicable to improve civil engineering education in China.

Research Procedures

1. Investigate documents of the American Council for Construction Education (ACCE), to identify the standard curriculum for baccalaureate construction educational programs in the United States;

2. Investigate China's higher education law and relevant documents of China's Ministry of Education (MOE), outlining the development direction of China's construction education;

3. Identify the common curriculum for China's baccalaureate civil engineering educational program;

4. Identify the differences between construction curricula in these two countries;

5. Analyze the positive and negative aspects of China's civil engineering curriculum; and

6. Identify the aspects of United States construction management education that will improve the China's construction management education.

Data Gathering Methodology

1. Literature research

In the literature research, the researcher examined journals and newspapers in the field of construction science. Besides, the researcher found very useful reference books such as the latest yearbooks and statistic books as well as those recently published policies and documents of the China's government on improving China's building construction education.

In the literature research, the researcher can contact many important and useful documents about United States construction management education, including the Standard of American Council for Construction Education, which provides the researcher with much useful information for identifying the CM curriculum.

2. Investigation on the Internet

The researcher found valuable materials on the Internet, such as the goals and missions of China's civil engineering education, the common curriculum of China's civil engineering education, and many documents and laws relating the China's higher education.

3. Interview

This methodology provided the researcher with very detailed and practical materials, in which the researcher is very interested, and helped the researcher find enough information to do analysis work. All interviewees have been engaged in the field of construction or construction management in China for many years; they are familiar

with the whole construction environment and grasp the critical factors influencing the construction works.

The researcher interviewed the following persons by telephone:

(1). Mr. Luru Chan, General manager of China Jingye Construction & Contract Co.;

(2). Zhiming Li, General engineer of Central Research Institute of Building and Construction;

(3). Hongxiang Ma, Engineer of China International Construction Group;

(4). Prof. Yuehua Fu, director of department of Science and Technology, Ministry of High Education;

(5). Prof. Dequan Yang, College of Civil Engineering, Zhejiang University;

(6). Mr. Fugang Lu, Director of department of Human Resources, Tongzhou Design/Construction Company; and

(7). Mr. Xuancai Lin, Director of the Design Department, Ministry of Construction.

Study Population

The study population covers China's whole construction industry. In this research, the researcher provides statistical information in Tables 1 through 8 that include: (1) Number of construction enterprises; (2) Number of persons engaged in the industry;(3) Gross output value of the industry; (4) Main Indicators on Construction Enterprises; (5) Students enrollment; (6) Number of graduates; (7) Student enrollment at institutions of higher education by field of study; and (8) Graduates of institutions of higher education

by field of study. Related information of this research were gathered from various forms of writing, web resources, government reports and national year statistics within China's construction industry.

Table-1. Number of Construction Enterprises (1980 – 1997)

Year	Total	State-owned	Urban Collective Owned	Rural Construction Teams
1980	57,404	1,996	4,608	50,800
1985	93,750	3,385	7,765	82,600
1986	88,771	3,608	8,977	76,186
1987	87,474	3,788	9,837	73,849
1988	87,224	3,798	10,336	73,090
1989	80,106	3,927	9,179	67,000
1990	74,145	4,275	9,052	60,818
1991	73,094	4,638	9,187	59,269
1992	77,857	4,985	9,551	63,321
1993	94,582	6,363	14,130	70,486
1994	94,942	7,251	15,196	69,842
1995	96,935	7,531	15,348	71,017
1996	108,555	9,109	29,044	67,191
1997	95,956	9,650	29,872	51,939

Source: China Statistical Yearbook, 1998

Table-2. Number of Persons Engaged in Construction Enterprises (10,000 persons)

Year	Total	State-owned	Urban Collective Owned	Rural Construction Teams
1985	1,701.4	576.7	334.8	789.9
1986	1,800.6	617.3	376.4	806.9
1987	1,852.5	618.2	405.9	828.8
1988	1,899.4	623.5	421.3	854.6
1989	1,773.4	614.7	390.1	768.6
1990	1,716.7	621.0	389.7	706.0
1991	1,783.3	638.9	419.4	725.0
1992	1,961.2	681.2	476.3	803.6
1993	2,156.7	657.1	455.7	926.8
1994	2,448.8	818.2	601.9	969.3
1995	2,511.9	824.3	631.9	980.4
1996	2,992.3	855.9	1,171.4	870.4
1997	2,804.6	828.6	1,148.2	703.1

Source: China Statistical Yearbook, 1998

Table-3. Gross Output Value of China's Construction Industry (100 million Yuan)

Year	Total	State-owned	Urban Collective Owned	Rural Construction Teams
1985	985.10	474.51	200.59	310.00
1986	1,330.80	566.83	241.24	522.73
1987	1,603.61	660.11	292.54	650.96
1988	1,959.42	776.96	354.69	827.77
1989	2,169.48	878.57	404.41	886.50
1990	1,947.58	935.19	409.82	602.56
1991	2,284.78	1,062.48	501.85	720.45
1992	3,298.70	1,432.13	742.31	1,124.26
1993	5,498.35	2,054.83	1,163.85	2,060.28
1994	7,684.36	3,033.66	1,519.45	2,952.34
1995	9,505.00	3,670.25	1,899.47	3,632.60
1996	11,579.2	4,160.21	3,695.67	3,296.90
1997	12,462.6	4,526.52	3,925.81	3,336.09

Source: China Statistical Yearbook, 1998

Table-4. Main Indicators on China's Construction Enterprises

Item	Total
Fixed Assets Owned (Original Value) (100 million Yuan)	3,083.81
Fixed Assets Owned (Net Value) (100 million Yuan)	2,205.31
Number of Machinery and Equipment Owned (10,000 Set)	560.46
Net Value of Machinery and Equipment Owned (100 million Yuan)	993.87
Total Power of Machinery and Equipment Owned (10,000 kw)	8,668.50
Gross Output Value of Construction (100 million Yuan)	12,462.57
Value Added of Construction (100 million Yuan)	2,540.54
Depreciation of Fixed Assets (100 million Yuan)	165.12
Wages Payable (100 million Yuan)	1,163.32
Welfare Expenses Payable (100 million Yuan)	120.63
Taxes and Extra Charges on Project Settle Account (100 million Yuan)	253.51
Taxes in Management Expenses (100 million Yuan)	18.16
Profits of Project Settle Account (100 million Yuan)	741.25
Floor Space of Buildings Under Construction (10,000 sq.m)	128,680.30
Floor Space of Buildings Completed (10,000 sq.m)	62,244.00
Total Profits (100 million Yuan)	109.92
Total Pre-tax Profit (100 million Yuan)	381.58
Overall Labor Productivity	
In Terms of Gross Output Value (Yuan/Person)	43,428
In Terms of Value Added (Yuan/Person)	12.089
Value of Machines per Laborer (Yuan/Person)	4,729
Power of Machines per Laborer (kw/person)	4.10
Rate of Floor Space of Building Completed (%)	48.40
Rate of High Quality Projects (%)	29.70
Ratio of Profit to Gross Output Value (%)	1.20
Ratio of Pre-tax Profit to Gross Output Value (%)	4.20

Source: China Statistical Yearbook, 1998

Table-5. Students Enrollment Between 1978 and 1997 (10,000 persons)

Year	Institutions of Higher Education	Secondary School
1978	85.6	6,637.2
1979	102.0	6,024.9
1980	114.4	5,677.8
1981	127.9	5,014.6
1982	115.4	4,702.8
1983	120.7	4,634.7
1984	139.6	4,860.9
1985	170.3	5,092.6
1986	188.0	5,321.6
1987	195.9	5,403.1
1988	206.6	5,246.1
1989	208.2	5,054.0
1990	206.3	5,105.4
1991	204.4	5,226.8
1992	218.4	5,510.5
1993	253.6	5,383.7
1994	279.9	5,507.1
1995	290.6	6,380.6
1996	302.1	6,824.9
1997	317.4	7,188.3

Source: China Statistical Yearbook, 1998

Table-6. Graduates between 1978 and 1997 (10,000 persons)

Year	Institution of Higher Education	Secondary School
1978	16.5	2,398.5
1979	8.5	2.402.5
1980	14.7	1,629.9
1981	14.0	1,710.2
1982	45.7	1,400.4
1983	33.5	1,254.5
1984	28.7	1,205.6
1985	31.6	1,279.1
1986	39.3	1,388.5
1987	53.2	1,496.9
1988	55.3	1,548.4
1989	57.6	1,502.9
1990	61.4	1,497.5
1991	61.4	1,477.0
1992	60.4	1,545.3
1993	57.1	1,541.9
1994	63.7	1,542.4
1995	80.5	1,705.4
1996	83.9	1,793.8
1997	82.9	1,999.8

Source: China Statistical Yearbook, 1998

Table-7. Student Enrollment at Institutions of Higher Education by Field of Study (Person)

Item	1996	1996	1996	1997	1997	1997
	Total	Regular College Course	Specialized Subject (Three Years)	Total	Regular College Course	Specialized Subject (Three Years)
Total	3,021,079	1,794,630	1,226,449	3,174,362	1,986,125	1,188,237
Philosophy	5,111	3,343	1,768	4,916	3,612	1,304
Economics	461,027	248,947	212,080	483,446	286,001	197,445
Law	104,683	61,797	42,886	118,418	73,026	45,392
Education	121,770	61,103	60,667	128,848	66,786	62,062
Literature	383,960	168,824	215,136	412,019	194,673	217,346
History	47,524	25,034	22,490	48,779	27,454	21,325
Science	315,357	175,166	140,191	332,178	192,847	139,331
Engineering	1,212,554	802,817	409,737	1,262,734	871,281	391,453
Agriculture	106,428	71,544	34,884	111,887	78,225	33,662
Medicine	262,665	176,055	86,610	271,137	192,220	78,917

Source: China Statistical Yearbook, 1998

Table-8. Graduates of Institutions of Higher Education by Field of Study (Person)

Item	1996	1996	1996	1997	1997	1997
	Total	Regular College Course	Specialized Subject (Three Years)	Total	Regular College Course	Specialized Subject (Three Years)
Total	838,638	347,194	491,444	829,070	381,647	447,423
Philosophy	1,960	1,164	796	1,183	682	501
Economics	127,081	35,726	91,292	132,988	50,134	82,854
Law	25,852	10,501	15,351	28,270	12,471	15,799
Education	40,620	14,482	26,138	39,595	13,751	25,844
Literature	120,051	32,296	87,755	116,115	36,216	79,899
History	16,423	6,241	10,182	14,559	5,735	8,824
Science	97,260	39,319	57,941	90,513	39,113	51,400
Engineering	315,005	160,435	154,570	314,418	175,439	138,979
Agriculture	33,032	17,443	15,589	30,190	16,559	13,631
Medicine	61,417	29,587	31,830	61,239	31,547	29,692

Source: China Statistical Yearbook, 1998

Conclusion

This chapter described the methodology and techniques used within this research project. It included a summary of the study and a restatement of the problem followed by the research procedure. This research project used a literature review, internet review, and personal interviews as the basis to find the current problems of China's construction educational system, and by comparing construction management educational systems in the United States and China, the drawbacks and inadequate aspects of construction management currently exist in China's educational system are identified. To counter these problems, the relevant aspects of more advanced construction management of the United States will be recommended for education implementation in China.

CHAPTER IV. FINDINGS

This chapter provides curricula of United States and China's construction education determined by the research study.

ACCE Curriculum Requirement of CM Education Accreditation in the United States

Curriculum	Topic
General Education (18 semester hours)	1.Communications-English composition, speech, technical writing
	2. Human relations-psychology, sociology, social science, ethics
	3. Other general requirements-literature, history, philosophy, art, language
Mathematics & Science (18 semester hours)	1. Mathematics-analytic geometry, calculus, linear algebra, statistics
	2. Physical science-physics, chemistry, geology, environmental science
	3. Other science-computer science, and other science electives
Construction Science (24 semester hours)	1. Materials-construction materials, components, and materials testing
	2. Fundamentals of construction science-statics, strength of materials, dynamics, thermodynamics, soil mechanics, hydraulics
	3. Analysis and design of construction systems-structural, HVAC, plumbing, mechanical, electrical, roadways, drainage, utilities
	4. Construction design-temporary facilities, rigging, formwork, scaffolding, foundations, construction surveying, and construction graphics
	5. Others-project development, feasibility studies, value analysis, site planning, building codes, inspection, basic elements of building and site design, and architectural or engineering electives
Business & Management (21 semester hours)	1.Economics-macro, micro, and labor economics
	2. Accounting & finance-financial accounting, managerial accounting, cost accounting, finance, economic evaluation techniques and application
	3. Industrial relations-personnel management, labor relations, supervision, productivity
	4. Management-business management, industrial management, organizational behavior, investment
	5. Other business-real estate, business law, marketing, business electives

Construction (27 semester hours)	1. Construction fundamentals-orientation, drawings and specifications, contract documents, computer application in construction
	2. Estimating and bidding-quality surveying, pricing, manpower estimating, bid compilation, bidding strategy
	3. Project execution-construction methods, equipment selection, work analysis, safety, field records, quality control and assurance, job supervision, productivity
	4. Project control-scheduling, project budgeting, purchasing, expediting, cost control, cash flow
	5. Specialty construction topics-mechanical, electrical, process plant construction, roadways
	6. History of construction-history of the construction process
	7. Other construction-work experience, construction electives
Other Requirements (12 semester hours)	Topics may be selected from any of the above general subject areas or from related subject areas in the academic field determined by the faulty as meeting the objectives of the program

Source: American Council for Construction Education (ACCE) (2001)

Curriculum Requirement of Construction Education in China

Curriculum	Topic
General Education (24 semester hours)	1.Communications-Foreign language,
	2. History-Chinese history
	3. Social requirements-physical training, Chinese revolution, ethics, Marxist philosophy
Mathematics and Science (31 semester hours)	1. Mathematics-calculus, linear program, statistics, geometry
	2. Physical science-physics, chemistry, physical testing
	3. Other science-the C programming language, the Fortran programming language

Construction and Design (61 semester hours)	1.Materials-decorative materials for architecture, building materials
	2.Fundamentals of construction science-theoretical mechanics, structural mechanics, engineering mechanics, architectural mechanics, seismic engineering, soil mechanics, elastic mechanics, material mechanics, hydraulic mechanics
	3. Analysis and design of construction systems-steel structures, reinforced concrete structures, engineering structures, underground structures, composite structures, structure test, structure reliability, matrix analysis of structure, electrotechnics, structural systems
	4. Construction design-construction technology and planning, surveying, engineering geology
	5. Others-introduction to real estate, value theory and practice,
Construction (21 semester hours)	1. Construction fundamentals-introduction to CAD drawing, building economics, construction laws, construction theories
	2.Construction control-cost estimating, construction accounting, procurement of works, introduction to project management, object-oriented programming, construction planning, quality analysis
Others (6 semester hours)	Railway engineering, traffic engineering, highway engineering, bridge engineering, tall buildings, law of oversea construction operations

Source: Ministry of Education (MOE) and Ministry of Construction (MOC) (P.R.China) (1998)

CHAPTER V. ANALYSIS AND CONCLUSION

This chapter will provide the difference between two construction education curricula within the United States and China and outline the positive and negative aspects of China's curriculum. Based on the comments of the interviewees, recommendations will be presented to improve the current curriculum of construction education in China.

Differences Between Construction Education Curricula in the United States and China

From the above curricula, the researcher found their obvious differences, which include the following:

1. The United States curriculum provides more balanced content than China's curriculum;
2. The China's curriculum pays more attention to the principles of mechanics and design than to fundamentals of construction, while, the United States curriculum covers design and construction aspects almost equally;
3. China's curriculum is short of courses relating to business and management;
4. The United States curriculum covers more construction managerial aspects than China's;
5. China's curriculum is short on education of computer application in construction; and
6. China's curriculum has no education on technical communication.

Advantages of the United States CM curriculum

The United States CM curriculum provides an education that will lead to a leadership role in construction and prepares the student to become a responsible member of society. The curriculum is responsive to social, economic, and technical developments and reflects the application of evolving knowledge in construction and in the behavioral and quantitative science.

Positive Aspects of China's Curriculum

1. A solid foundation of science and technology, especially to comprehend the main aspects and future application of technology;
2. Fundamental principles of engineering mechanics, hydromechanics, and soil mechanics; familiarity with basic knowledge of engineering program, engineering materials, design, and foundation treatment skills;
3. Abilities to draw, survey, test, and calculate; and
4. Abilities to be engage in the field of engineering design, test, analysis, and research.

Negative Aspects of China's Curriculum

1. Lack of knowledge of business and management, which is very important for the construction business to success;
2. Lack of technical writing skills necessary to promote adequate Communications on construction business;
3. Construction education has not covered necessary aspects of construction projects. The students have an inadequate knowledge of project management; and

4. Students cannot apply computer skills to the construction management works.

Recommendations for Improvement of China's Construction Education Curriculum

By comparing United States CM curriculum with China's curriculum, the researcher found that United States construction education paid more attention to the business and management, and construction aspects; while China's curriculum neglected business and management education, and paid less attention to the construction aspect and technical communication in construction management. The following section in this chapter will analyze the importance of these aspects that are neglected in the China's curriculum, and based on the curriculum of ACCE, provide the following recommendations to enhance the curriculum:

1. Business and management

Construction is a risky business to enter; good business management skills are essential for success as a construction manager. These skills are just as important as technical skills of other aspects of construction industry. Companies that get into financial difficulties often lack comprehensive business plans and have weak financial procedures. According to the business failure statistics annually published by China's business report, 5,465 construction firms went out of business in 1996, and 7,128 went out of business in 1998, an increase of almost 30%. The construction firm failure rate in 1998 was 133 per 10,000 firms, significantly higher than the national average for all industries of 96 failures per 10,000 firms (Yan, 1999). These statistics provide a measure of the risk faced by construction firms and highlight the need for good business management skills.

When China opened its door in 1978, it transferred to a market economy. Market development and business planning are two critical elements for all construction firms. China's construction industry is a labor-intensive industry, the skills of organizational behavior, labor relations, and personnel management are required by all construction firms.

Based on American Council for Construction Education (ACCE) standards, the curriculum of construction management must have the students know how to manage the principal resources of the industry, i.e., people and money. The student should have a broad understanding of the fundamentals of following knowledge:

(1). Economics: Labor economics;

(2). Accounting and finance: Financial accounting, managerial accounting, finance, economic evaluation techniques and applications;

(3). Industrial relations: Personnel management, labor relations, supervision, and productivity; and

(4). Management: Business management, industrial management, organizational behavior, and investment.

2. Construction

China's unbalanced educational system has resulted in the fact that the graduates have enough knowledge and abilities to do design work but are short of knowledge of construction management. In China, most problems faced by the current construction industry are not found during the design phase, but are found during the construction period. From Table-4 on page 28, we can see the ratio of high quality projects is just 29.7%. As a characteristic of Chinese standards, the

important aspects of project evaluation are always related to the construction quality and cost, which are not from the design work, but are the result of the construction practice.

According to Mr. Luru Chan, General manager of China Jingye Construction and Contract Co., new employees in a company are very weak in management knowledge and skills at all levels at construction sites, and especially so for higher-level executives. Most graduates are familiar with design work, but they don't understand the necessary knowledge about equipment and material procurement, construction planning, on-site quality control, and management of human resources, which are critical to the whole project. Mr. Xuancai Lin, Director of the Design Department of Ministry of Construction of China, also points out that many high-quality designed works couldn't be transferred to high-quality construction works. Many designers are astonished and feel frustrated when they know that the projects, which were designed from their hands, are evaluated as low-quality projects. Poor construction work not only makes contractors loose reputation and credit, but this also affects the designers' designing zeal.

In China's civil engineering curriculum, students are short much knowledge they need to know. According to ACCE standard, the construction curriculum category is of vital importance in a quality construction curriculum. Courses should include both office and field activities and include the effective management of personnel, materials, equipment, costs, and time. Fundamental topics to provide an appropriate combination of breadth and depth in current construction industry practice are to be considered in this

category. These topics should develop skills, which will facilitate advancement of the individual in the construction profession. The modified curriculum should provide the following courses:

(1). Construction fundamentals: Orientation, drawings and specifications, contract documents, and computer applications in construction;

(2). Estimating and bidding: quality surveying, pricing, manpower estimates, bid compilation, and bidding strategy;

(3). Project execution: Work analysis, safety, field records, quality control and assurance, job supervision, and productivity;

(4). Project control: Scheduling, project budgeting, purchasing, expediting, cost control, and cash flow; and

(5). Specialty construction topics: mechanical, electrical, process plant construction, and roadways.

3. Communication skills

Construction company leaders have indicated that most college graduates that they hired are deficient in the writing skills necessary to promote adequate communications on the construction projects. Many new employees, fresh from college, cannot write business letters to communicate in a professional manner with individuals on the project team.

The lack of communication skill reflects poorly on their company, which in turn can be detrimental to business. Good writing skills are necessary in order to communicate with clients, as well as with partners and co-workers. How successfully a company communicates potential problems and issues will largely

depend on the writing and communication skills of the company employees.

Communication is imperative in a global society. China's construction industry is preparing itself to enter the world market, therefore, learning how to effectively communicate in writing is critical to successful business operations in the world.

Conclusion

This study started with a review of the construction industry in China, described the current structure of the industry, highlighted its achievements, and outlined its shortages and drawbacks that impede the development. Through research, it was found that the main problem existing in the industry is that static and unilateral construction education cannot satisfy the need for development of construction industry. Through the analysis of China's current civil engineering curriculum, the researcher found that knowledge of business management, industrial relations, and communication skills relating to the construction industry are almost neglected. Graduates lacking this knowledge will limit their professional abilities in the future. By comparing China's CM curriculum with the United States, it is clear that providing graduates with additional construction management knowledge is not only the hope of construction enterprises, but also the main task of China's construction education institutions.

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