

## **FOUR YEAR CONSTRUCTION CURRICULUMS: REVISING THE REQUIREMENTS**

**Joseph J. Cecere ,Ph.D., CPC  
Pennsylvania State University  
Harrisburg**

### I. Introduction

The goal of any educational program is to provide each student with the necessary information and skills which allow him or her to perform successfully in a chosen career. Yet this goal may prove difficult if the curriculum offered by the university is not revised and updated to keep abreast of the changes and advancements being made, especially in the industrial world. Over a period of time, techniques and content which are included in a successful program become old and need revisions.

A method often undertaken by universities is a follow-up study of their alumni. This data is used to measure the success of the program's graduates as well as the program's curriculum content. But it is also important to receive other input from potential employers of the program's graduates and the industrial world itself. Considerable information can be obtained from the employers regarding the value they placed upon the graduate's educational training, their perception of the ideal construction curriculum, and possible other course selections. A study of these people could provide a program with what areas are more significant in the students' preparation and what possible changes they might suggest to improve the program.

### The Study

In 1997, the Associated General Contractors (AGC), in conjunction with Pennsylvania State University/Harrisburg, conducted a national survey of AGC's members about their values relating to a four-year university/college construction curriculum. The purpose of the study was to update the Associated General Contractors of America (AGC) 1984 "Educational Goals and Recommended Construction Curricula for the Construction Industry" on four-year university/college construction programs. The study also provided another resource for construction curriculums to use when evaluating their individual programs.

### Significance of the Study

The success of any technical curriculum is, to a degree, measured by the success with which the students are properly prepared to enter the job market. A successful educational program is one, which changes its structure and content to adapt to rapidly changing occupational requirements.

Due to the many advancements which have been made in the construction field since its existence, it was important that construction programs be reviewed periodically to determine how effectively they meet the needs of the students and industry. This is especially true with the rapid changes in computer communications since the last updated study.

The study sought to answer the following questions:

1. How did the constructor rate the value of the subjects in the construction curriculum?
2. How do the constructors assess the different construction subject areas in the curriculum?
3. What was the background of the respondents and their firms?

## II. Method and Procedure

For the purpose of this study, a questionnaire (see appendix) was developed by the Associated General Contractors of America Education Committee. The questionnaire sought information related to a four-year construction curriculum and those courses that would help the student become better prepared for their careers, rank the significance of the construction course areas, and obtain background information on the respondents.

The first part of the questionnaire was concerned with the attitudes of the constructor toward subjects in the construction curriculums. Seven areas were covered. The first area dealt with the general education courses. The second area dealt with mathematics and sciences that are generally available to construction majors. The elements of engineering and architectural design principles were dealt with in the third area. The fourth area dealt with the fundamental elements of effective business administration and management needed for the construction business operations. The attitude of the constructor toward the elements that address the how-to in the construction process such as surveying, computer applications, construction methods, equipment, etc., was dealt with in the fifth area. The sixth area dealt with attitudes towards special techniques for construction administration and management. Suggestions for other electives, options, and course requirements were dealt with in the final area. The contractor placed a value of 1 to 5 to each subject areas with 5 being the highest value.

The second parts of the questionnaire provided the constructors with the opportunity for indicating the significant value of each of the seven areas in a four-year construction curriculum.

The last part of the questionnaire was concerned with the background information and personal data of the constructors, and included eleven questions. The questions included information concerning (1) type of firm, (2) type of work, (3) approximate volume of work, (4) average volume of work done in-house, (5) type of contracts, (6) type of labor arrangements, (7) experience of respondent, (8) age of respondent, (9) education earned, (10) professional affiliations, and (11) accreditation agencies the respondent is familiar with.

National AGC and the Penn State Harrisburg Construction program's industrial advisory board reviewed the tentative questionnaire. Final revisions of the questionnaire were made from this process.

## Method of Collecting Data

The questionnaires were mailed out from the National AGC to selected local chapters. The National AGC made the selection of the local chapters after considering geographic factors. The initial mailing was done in the spring of 1997 and a follow-up mailing was done in the fall of 1997. From the 2500 questionnaires mailed, six hundred twenty-two (622) were returned. This was a 24.88% return. Only five hundred and ninety-eight (598) returned questionnaires could be used for this study.

## Procedure for Analyzing Data

The questionnaires were visually checked and irregular ones were omitted. Each questionnaire was given a number and the information was entered into a software database. The questionnaire's information was entered again, by a separate individual, into a different database. The two databases were compared for individual questionnaire disparities and these were corrected. A frequency distribution and percentage were then computed for these questions.

## III. Presentation and Analysis of Data

This section was divided into three parts corresponding to the three parts of the questionnaire: (1) relative importance of various subjects, (2) the comparative significance of the seven general/topic subject areas, and (3) background information of the respondents and firms.

### Relative Importance of Subjects

The first question of the questionnaire was concerned with the "General Education" area. The data in Table I showed that Technical Writing was ranked as the most important subject with a mean 4.548. The other four subjects which had a mean of 4.0 or above were Leadership (4.379), Ethics (4.378), English Composition (4.156), and Speech (4.152). It was noted that the second most important subject area, leadership, was not one of the listed courses in this area. Three hundred and eighteen respondents added leadership under "other" category and indicated this the most important subject area. The least important subject matter within this area was Art, with mean of 2.231.

The data in Table II indicated the mean average and ranking in the "Mathematics and Science" area. Computer Science (programming - data processing - microcomputer usage) received the highest ranking with 4.516 average. Pre-Calculus (algebra - trigonometry) was ranked second with 4.327. The constructors ranked Chemistry the lowest science and subject area in this category with a 3.133 average.

The highest ranked subject in the "Construction Design" area was Construction Materials with a mean of 4.631 as shown in Table III. The other subject areas which had a mean of 4.0 or higher

average were Structural Design - Reinforced Concrete (4.147), Strength of Materials (4.068), Structural Design - Steel (4.066), Foundation Engineering (4.061), and Soil Mechanics (4.035). The respondents ranked Fluid Flow /Hydraulics the lowest with a mean of 3.258.

In the "Business and Management" area Ethics (business/professional) was the highest ranked subject as indicated in Table IV, with 4.435. The next two highest ranked were Cost Accounting and Accounting (basic) with 4.263 and 4.194 respectively. Three close subjects after accounting were Management Principles (4.149), Human Resources (3.987), and Business Law (3.941). Real Estate (2.739) and Real Estate Law (2.659) were the two lowest ranked subjects.

In the "Business and Management" area Ethics (business/professional) was the highest ranked subject as indicated in Table IV, with 4.435. The next two highest ranked were Cost Accounting and Accounting (basic) with 4.263 and 4.194 respectively. Three close subjects after accounting were Management Principles (4.149), Human Resources (3.987), and Business Law (3.941). Real Estate (2.739) and Real Estate Law (2.659) were the two lowest ranked subjects.

Data reported in Table V ranked "Construction Technology" area. The respondents ranked the subject Contract Plans and Specifications the highest with 4.643. Safety was the second highest subject with 4.417 and Computer Applications ranked third with 4.360. The subjects Electrical, HVAC, Plumbing were the lowest with 3.187, 3.172, and 3.165 respectively.

The highest ranked subject for the "Management of Construction" area shown in Table VI was Estimating and Bidding with a mean of 4.671. This mean average was the highest score in the entire questionnaire. Both subjects, Project Planning and Project Scheduling/Time Control, were high with mean averages of 4.539 and 4.545. The lowest ranked subject was Equipment Economics which had a mean of 3.578.

The respondents had the opportunity to list other requirements and electives that should be included in a construction curriculum. Table VII showed the course/subjects that had more than two respondents.

The data in Table VIII showed that "Management of Construction" had the highest percentage value of any of the subject areas with 18.380%. "Construction Technology" and "Business and Management" were the next highest subject areas with 16.092% and 15.858%. The lowest subject area was "General Education" with 12.818%.

## Background Information

The first question of the respondents' profile was concerned with the type of firm for they work. Table XI showed that 454 respondents or 75.9%, worked as general contractors. Subcontracting firms were next largest type of firm with 87 contractors, or 14.5% responding.

The type of business the contractors were concerned with was the second question. The majority of the contractors were in the commercial building business with 47.554%. There were 20.107%

of the respondents in the highway business. (TableXII)

The next question dealt with the approximate annual volume of work they perform. The average annual volume for the respondents was \$20,648,000.

The volume of work done with the respondent's own (in-house) forces was then asked. All but the building group indicated over 50% of their own work was done with in-house forces. The building group reported 41.412%

The last question asked the respondents' primary geographic work location. Table XIII showed the midwest and southeast received the largest value with 39.5%

Table I  
General Education

Subject	Mean	Rank
Technical Report Writing	4.548	1
Leadership	4.379	2
Ethics (Personal)	4.378	3
English Composition	4.156	4
Speech	4.152	5
History (Technology, science, Building)	3.490	6
Psychology	3.062	7
History (American)	3.279	8
Philosophy	2.796	9
Physical Education	2.782	10
Sociology	2.764	11
English Literature	2.710	12
Foreign Language	2.446	13
Government/Political Science	2.446	13
Art	2.231	15
Anthology	1.958	16
Other	4.545	

Table II.  
Mathematics and Science

Subject Area	Mean	Rank
Computer Science	4.516	1
Pre-Calculus (algebra-trigonometry)	4.327	2
Analytic Geometry and Calculus	3.977	3
Material Science	3.943	4
Physics ( mechanics)	3.884	5
Engineering Geology	3.640	6

Physics (heat, light, electricity)	3.616	7
Statistics	3.411	8
Chemistry	3.133	9
Calculus (differential equations)	3.035	10
Others	4.429	

Table III.  
Construction Science

Subject Area	Mean	Rank	
Construction Material (concrete, steel, masonry, etc.)	4.631	1	
Structural Design - Reinforced Concrete	4.147	2	
Strength of Materials	4.068	3	
Structural Design - Steel/ Aluminum	4.066	4	
Foundation Engineering	4.061	5	
Soil Mechanics	4.035	6	
Formwork Design	3.953	7	
Structural Design - Masonry	3.924	8	
Structural Design - Wood	3.919	9	
Statics	3.634	10	
Structural Analysis	3.578	11	
Dynamics	3.531	12	
Environmental Design	3.436		13
Highway Design	3.358	14	
Fluid Flow/Hydraulics	3.258		15
Thermodynamics	3.043	16	
Other	4.250		

Table IV  
Business and Management

Subject Area	Mean	Rank
Ethics (Business/Professional)	4.435	1
Cost Accounting and Analysis	4.263	2
Accounting (basic)	4.194	3
Management Principles	4.149	4
Personnel Management	3.987	5
Business Law	3.941	6
Finance	3.823	7
Organizational Behavior	3.805	8
Insurance and Bonding	3.740	9
Marketing and Sales	3.697	10
Economics	3.450	11
Total Quality Mgt	3.286	12

Real Estate	2.739	13
Real Estate Law	2.659	14
Other	4.500	

Table V.  
Construction Technology

Subject Area	Mean	Rank
Contract Plans and Specifications	4.643	1
Construction Safety	4.417	2
Computer Science (problem solution/applications)	4.360	3
Construction Methods Improvements	4.273	4
Surveying (building layout)	4.155	5
Material and Methods	4.137	6
Shop Drawing	3.943	7
Surveying (land and earthwork)	3.933	8
Quality Control and Inspection	3.897	9
Building Codes	3.821	10
Construction Equipment	3.750	11
Graphics/Drafting/Drawing	3.605	12
Thermal and Moisture Protection	3.219	13
Electrical	3.187	14
HVAC	3.172	15
Plumbing	3.165	16

Table VI  
Management of Construction

Subject Area	Mean	Rank
Estimating and Bidding	4.671	1
Project Management	4.570	2
Project Scheduling and Time Control	4.545	3
Project Planning and Control	4.539	4
Construction Economics/Cost Control	4.481	5
Project Organization and Supervision	4.394	6
Legal Aspects of Construction	4.224	7
Value Engineering	3.938	8
Construction Labor Relations	3.687	9
Construction Firm Organization	3.684	10
Equipment Economics	3.578	11
Other	4.560	

Table VII  
Other Requirements and Electives

Subject Areas	Mean	Rank
Co-op/ Internship	4.185	
Human Relations	4.300	

Table VIII  
Subject Area Significance

General Subject Area	Value (%)
I. General Education	12.818
II. Mathematics and Science	15.003
III. Construction Science	13.304
IV. Business & Management	15.858
V. Construction Technology	16.092
VI. Management of Construction	18.380
VII. Others	5.482

Table X  
Type of Firms

Respondents	Value (%)
General Contractor	75.9
Subcontractor	12.9
Other	11.2

Table XI

Type of Business	Value (%)
Respondents	
Building	51.474
Heavy - Industrial	11.299
Highway	21.707
Municipal - Utilities	9.881
Other	5.639

Table XII  
Primary Geographic Work Location

Respondents	Value (%)
Northeast	14.9
Midwest	39.5
Southeast	39.5
Mountain	26.9
Pacific	15.2







Table IX  
Subject Area Order

ORDER	GENERAL EDUCATION	MATHEMATICS/ SCIENCES	CONSTRUCTION MANAGEMENT	BUSINESS MANAGEMENT	CONSTRUCTION TECHNOLOGY	MANAGEMENT of CONSTRUCTION
1	Technical Report Writing	Computer Science	Const. Material Conc.stl,masonry	Ethics (Business/ Professional)	Contract Plans & Specifications	Estimating & Bidding
2	Leadership	Pre-Calculus (algebra- trig.)	Struct. Design – Reinforced Conc.	Cost Accounting & Analysis	Construction Safety	Project Management
3	Ethics (Personal)	Analytic Geometry Calc.	Strength of Matls.	Accounting (basic)	Computer Science problem solve/appl.	Project Scheduling/ Time Control
4	English Composition	Material Science	Struct. Design – Steel/Aluminum	Management Principles	Const.Methods Improvements	Project Planning & Control
5	Speech	Physics (mechanics)	Fdtn. Engineering	Personnel Management	Surveying Bldg. Layout	Const. Economics/ Cost Control
6	History (Tech,Sci, Bldg)	Engineering Geology	Soil Mechanics	Business Law	Material & Methods	Proj.Organization & Supervision
7	History (American)	Physics (heat,light,elect)	Formwork Design	Finance	Shop Drawing	Legal Aspects of Construction
8	Psychology	Statistics	Struct. Design – Masonry	Organizational Behavior	Surveying land/earthwork	Value Engineering
9	Philosophy	Chemistry	Struct. Design – Wood	Insurance & Bonding	Quality Control & Inspections	Construction Labor Relations
10	Physical Education	Calculus Differential Equ.	Statics	Marketing & Sales	Building Codes	Construction Firm
ORDER	GENERAL	MATHEMATICS/	CONSTRUCTION	BUSINESS	CONSTRUCTION	MANAGEMENT

	EDUCATION	SCIENCES	MANAGEMENT	MANAGEMENT	TECHNOLOGY	of CONSTRUCTION
11	Sociology		Struct. Analysis (advanced desgn)	Economics	Construction Equipment	Equipment Economics
12	English Literature		Dynamics	Total Quality Management	Graphics/Drafting	
13	Foreign Language		Environmental Design	Real Estate	Thermal & Moisture Protection	
14	Government/ Political Science		Highway Design	Real Estate Law	Electrical	
15	Art		Fluid Flow/ Hydraulics		HVAC	
16	Anthropology		Thermodynamics		Plumbing	

## References

AGC Education Construction Committee, National Conference, San Antonio, Tx 1996.

Chang,, Tuh- Maan and Brisbane Brown, “ Results of University Construction Curricula Survey,” report to AGC Construction Education Committee Task Force on Construction Curriculums, Washington, D.C., June 1984

Cecere, J.J., “An evaluation of Construction Industry Requirements for a University Construction Curriculum in Pennsylvania,” report to AGC Task Force on Construction Curriculum, Washington, D.C., and to Pennsylvania Chapter of AGC and Associated Builders and Contractors, September 1984.

“Educational Goals and Recommended Construction Curricula for the Construction Industry,” AGC guidelines on four-year university/college construction programs. Washington, D.C., 1985

## Biographical sketch:

Joseph J. Cecere, Ph.D., CPC, is an Associate Professor and Chairman of Civil Engineering Technology program at The Pennsylvania State University / Harrisburg. He was the investigator of AGC’s research project and is the Chairman of the AGC National Task Force on four-year construction curriculums. Dr. Cecere serves on a National Commission that oversees the Certified Professional Constructor process.