Two-Year Construction Curriculums: Industry Revisits Its Recommendations

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

Abstract

The objective of an educational program is to provide the necessary information and skills for its graduates to perform successfully in a chosen profession. However, this goal may prove difficult if the curriculum 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, the content and applications of a successful program become old and needs to be revised.

A method often undertaken by universities is a follow-up study of the alumni. This data measures the success of the program's graduates and consequently, the relevance of the program's curriculum content. Employers can provide considerable information regarding the value of a graduate's educational training and their perception of the ideal construction curriculums, and possible other course selections.

Advancements in the construction field mandate that construction programs be reviewed periodically to determine how effectively they meet the needs of both the student and the industry. Construction programs must seek information from the industry to adapt to rapidly changing occupational requirements. This data will provide another resource for evaluating the individual construction curriculums in order to stay current.

In fall 2000, the Associated General Contractors (AGC), in conjunction with The Pennsylvania State University, conducted a national study of the AGC members in order to evaluate the subject areas offered in two-year university/college construction programs. The report, which was accepted by the national education committee, will update AGC's publication on "Recommended Guidelines for University Four and Two–Year Construction Curriculums." The report will also be disseminated to accreditation agencies that will utilize this data as a resource for their standards.

This paper will review this study and discuss AGC's recommended guidelines for a two-year construction curriculum.

INTRODUCTION

The goal of any educational program is to provide each student with the necessary information and skills that allow him or her to perform in a chosen career. This goal may prove difficult if the curriculum offered by the university is not revised or updated in order to keep abreast of the changes and advancements being made, especially in the industrial world. Throughout any period of time, techniques, methods and content, which are included in a successful program, become outdated and need revisions.
A method often undertaken by universities is a follow-up study of the alumni. This data measures the success of the program's graduates and consequently, the relevance of the program's curriculum content. This method also provides feedback from potential employers

and from the industrial world itself. Employers provide considerable information regarding the value of a graduate's educational training and their perception of the ideal construction curriculums, and possible other course selections. A study of employer input could also indicate critical areas in students' preparation for the work place and recommendations for curriculum enhancements.

THE STUDY AND ITS SIGNIFICANCE

The success of any technical curriculum is, to a large degree, measured by the success in preparing students to enter the job market. Advancements in the construction field mandate that construction programs be reviewed periodically to determine how effectively those programs meet the needs of both the student and the industry.

In 2000, the Associated General Contractors (AGC), in conjunction with Pennsylvania State University/Harrisburg, conducted a national study on two-year college construction curriculums.

This study sought to answer the following questions:

1. What criteria are used during an accreditation analysis or review of a two-year program?
2. What was the background of the respondents and their firms?
3. How do the constructors assess the different construction subject areas in the curriculum?
4. How did the constructor rate the value of the subjects in the construction curriculum?
5. What significant differences exist between the types of constructors relating to a construction curriculum?
6. What modifications do the constructor feel are needed in a construction curriculum?

The results of this study were used to update AGC's educational goals and establish a recommended two-year college construction curriculum for the construction industry. This study also provided another resource for evaluating individual construction curricula.

METHOD AND PROCEDURE

The study employed a questionnaire that was developed to review the 1986 AGC "Two Year College Construction Curricula" and AGC's 1998 "Four Year Construction Curricula" survey. The compiled data for each question from the previously submitted questionnaires was evaluated. In addition to the tabulated results, the review included both comments and write-in responses. Part I of the previous questionnaires rated the importance of various courses and subjects on a scale of one (1) to five (5), with one (1) being least important and five (5) being most important. In order to decide which topics/subjects to keep in the questionnaire, the previous overall rating was considered

The format to Part II of the previous two-year questionnaire remained the same although the subject areas were changed. Previous studies showed the importance of the subjects as a whole to the constructor. This format also allows for an easier comparison while referring to or using accreditation curriculum criteria reports in evaluating college effectiveness.

Part II of the questionnaire asks specific questions regarding the profile of the responding firm. This information can be used in many different manners, including computed in a data

set and sorted and evaluated in several different scenarios in order to find out more about what contractors are expecting from recent two-year construction program graduates.

The survey development also included reviewing the standards and criteria of three accreditation councils or commissions; 1) The American Council for Construction Education (ACCE), standards and criteria for Associate Degree Programs (2000), 2) The Accreditation Board for Engineering and Technology (ABET), criteria for accrediting Engineering Technology Programs (2000), and 3) The Associated General Contractors of America (AGC), Collegiate Construction Education Directory (1992). A breakdown showing the application of each accreditation criteria is shown in the chart below:

Category	ACCE	ABET	AGC
General Education			
Socio-humanistic Topics	X		
Communications	X	X	X
Mathematics and Science			
Math	X	X	X
Physical Science	X	X	X
Natural Science	X	X	
Computer Science	X	X	X
Design Principles and Practice			
Construction Science and Fundamentals	X	X	X
Construction Practice	X	X	X
Business and Management			
Business Principles	X		X

Figure I – Accreditation Boards

All three criteria addressed four categories 1) General Education, 2) Mathematics and Science, 3) Design Principles and Practice, and 4) Business Management.
The General Education category consists of the socio-humanistic and communications subjects. For example, subjects such as English composition, speech, technical writing, history, geography, psychology, and ethics were common among the criteria. The Mathematics and Science category consisted of common subject areas as algebra, trigonometry, analytic geometry, pre-calculus and calculus. The Design Principles and Practice category subjects were very wide spread with common design and technical courses. These courses included construction design principles, construction practices, strength of materials, statics, hydraulics, drafting and plan reading, specifications, estimating, scheduling, bidding and safety. The final category, Business Management, listed subjects including accounting, finance, business economics, business law, and contract law and business ethics.

The questionnaire included the three parts of the previous questionnaires. The first part of the questionnaire covered six areas dealing with subjects in construction curriculums. The first area dealt with the General Education courses. The second area dealt with Mathematics and Science that are generally available for construction majors. The elements of Engineering and

Design Principles were dealt with in the third area. The fourth area dealt with the Fundamental Elements of Construction and aid in construction problem solving. The fifth area dealt with is Business Administration and Management needed for construction business operations. Suggestions for other electives, options, and course requirements were dealt with in the final area.

Area	Subject
Area I	General Education
Area II	Mathematics and Science
Area III	Engineering and Design Elements
Area IV	Fundamental Elements of Construction
Area V	Business Administration and Management
Area VI	Other Electives

Figure II – Subject Areas

The second part of the questionnaire provided respondents an opportunity to indicate in their opinion, the significant value of each of the six subject areas.
The last part of the questionnaire consisted of nine questions that covered the background information and personal data on the constructors. The questions concerned (1) type of firm, (2) type of work performed, (3) approximate volume of work, (4) average number of people on payroll, (5) average volume of work done in house, (6) regional locations of work performed, (7) education earned, (8) name of firm responding and (9) name of the officer completing the survey. Questions 8 and 9 were optional for the person or company completing the survey.

The National AGC reviewed and approved the survey and mailed it to selected local chapters after considering geographic factors. The initial mailing was in the spring of 2000, with a follow up mailing in the fall of 2000. From the two mailings, 280 questionnaires were returned that were used.

PRESENTATION AND ANALYZING OF DATA

Data Analysis 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. The results from the constructors were keyed into a spreadsheet and double-checked for accuracy before submitting the data to the Penn State Data Collection Center. Once the data was entered and analyzed, the report was generated. The report showed all responses and the mean based on total responses per question. The report then separated the responses

by six common types of firms responding including General Contractor, Sub-Contractor, Design Build Contractors, Specialty Contractors, and Developer-Contractors.

Relative Importance of Subjects

The first question of the questionnaire concerned the "General Education" area. The data in Table I based on total responses showed that Leadership was ranked as the most important subject with a mean of 4.49. "Technical Writing," which was the most important subject in the 1986 Report is now ranked second with a mean of 4.48. The other three subjects that had means of 4.0 or above were Ethics (4.37), Speech (4.14), and English Composition (4.10). The least important subject matter within this area was History (American), with a mean of 2.84.

The data in Table II indicated the mean average and ranking based in total responses in the "Mathematics and Science" area. Computer Science (programming – data processing – microcomputer usage) received the highest ranking with a 4.32 average. College Algebra was ranked second with 4.21. The constructors ranked Chemistry the lowest science and subject area in this category with a 2.84 average.

The highest ranked subject in the "Construction Science" area was Plan Reading with a mean of 4.76 as shown in Table III. The other subject that had a mean of 4.0 or higher was Basic Structural Design with a 4.19. The subject areas with a mean between 3.99 and 3.75 are Surveying (3.96), Strength of Materials (3.93), Soil Mechanics (3.84), and Drafting (3.83). The respondents ranked Statistics/Mechanics the lowest, with a mean of 3.66.

The data in Table IV indicated the mean average and ranking in the "Construction" area. The respondents ranked Plan Reading with the highest average of 4.76. The six remaining subject areas that had an average greater than 4.0 were Estimating and Scheduling (4.61), Construction Methods and Materials (4.53), Safety (4.33), Computer Applications (4.28), Specifications (4.15), and Quality Control and Inspection (4.08). The two lowest rankings for the Construction area were Building Codes and Construction Equipment with 3.81 and 3.76, respectively. It is important to note the subject area results, based on averages, were all very close. The highest average was 4.73 with the lowest for this area being 3.76.

In the "Business and Management" area, Principles of Management was the highest ranked subject as indicated in Table V, with 4.22. The next three highest ranked subjects were Business Law/Contracts, Human and Industrial Relations and Accounting (basic), with 4.00, 3.86, and 3.88 respectively. Economics ranked last with a mean of 3.24

Comparative Significance of Subject Area

The data in Table VII showed the category "Construction" with 26.22%, the highest value for relative significance for each subject area. "Construction Science" ranked second with an 18.67% value toward curriculum, with Business Management, Math and Science, and General Education finishing third, fourth, and fifth respectively.

Comparative Results of Subject Area and Last Survey (1986)

Table XIV shows the results of the current survey compared to the results from the 1986 AGC Two-Year College Construction Curricula survey. Subject areas not listed in this survey

but included in the 1986 survey are in bold letters. Plan Reading was the only subject that was rated number one in the Construction Science and Construction subject areas in both the 1986 and 2000 survey. Technical Writing, English Literature, Physics (Mechanics), Safety, Business Law/Contracts, and Economics were the only subjects that maintained their rankings in both the surveys.

In the General Education subject area, Leadership ranked number one, and this subject was not included in the 1986 survey. Ethics jumped from a previous ranking of 6 to a current ranking of 3. English Composition had the most noticeable drop in ranking. In 1986, it ranked number 1, while in 2000, it dropped to 5.

Mathematics/Science subjects showed completely different rankings throughout. Computer Science increased by two from a ranking of 3 in 1986, to number 1 in 2000, replacing College Algebra, which slipped to the fourth ranking. The subject showing the greatest increase is Statics. In 1986, it ranked number 5 and in 2000, it ranked number 2. Physics and Analytic Geometry each dropped four positions from the previous survey to sixth and seventh, respectively.

The Construction Science and Construction subject area's number one ranking is Plan Reading. Plan Reading was also ranked number one for Construction Science in the 1986 survey but it was not an option for the Construction subject area in the 1986 survey. Drafting, Construction Principles and Mechanical–Electrical Systems showed the largest decrease in ranking. Basic Structural Design, Strength of Materials, Statics/Mechanics, Estimating and Scheduling all showed an increase in rating.

Business Management subjects remained the same except for Business Law/Contracts that ranked second. Principles of Management increased to the number 1 position with Human Industrial Relations increasing from fourth to third, and Basic Accounting falling from the number one position to number four. Economics remained the same in both surveys.

Summary of Responding Firms

Major findings of the firms responding to the survey were:

1. Of the contractors who returned the questionnaire or answered the questionnaire, the large majority was general contractors.

2. The large majority of those surveyed indicated they are in Building Construction.

3. Of the contractors surveyed, the annual volume of work performed was between 5 million and 20 million.

4. When the contractors indicated the number of employees on the payroll, the largest number were trade-related people in the field.

5. The respondents indicated a majority of them do over 70 % of their work "in-house".

6. When provided with the opportunity to evaluate the courses in each of the areas, the courses "Leadership" in the General Education area, "Computer Science" in the Mathematics and Science area, "Plan Reading" in the Construction Science and Construction area, and "Principles of Management" in the Business Management area were ranked first by the contractors.

CONCLUSIONS and RECOMMENDATIONS

CONCLUSIONS

The following conclusions were made on the basis of the findings of this study:

1. A slightly more concentrated emphasis in the construction subject area was important to a successful two-year construction curriculum.
2. A two-year construction curriculum should include basic and applied courses in Leadership, Computer Science, and Plan Reading.
3. Construction majors should take the general study courses, English Composition, Speech, Technical Writing, College Algebra, Trigonometry, and Physics in their two-year curriculum.
4. A construction curriculum should incorporate business-related courses, including Principles of Management and Business Contracts/Law.
5. Basic courses in construction areas should be taught including Basic Structural Design, Estimating and Scheduling, Surveying, and Construction Methods and Materials.

RECOMMENDATIONS

1. A two-year college construction curriculum should continue to have a slightly more concentrated emphasis in the construction area.
2. There should be a re-evaluation of two-year construction curricula to insure that the courses that were highly ranked are incorporated into these programs.
3. Subjects such as Leadership and Ethics should be added to the curriculum.
4. Computer Science, Technical Writing, College Algebra, Basic Structural Design, Surveying, Estimating and Scheduling, Construction Methods & Materials should all remain based on their strong showing in the 1986 and 2000 surveys.
5. Business Management subjects that include Principles of Management, Business Law/Contracts and Basic Accounting all remain strong courses for a two-year curriculum.
6. Two-year colleges should work on their public relations so those contractors are better informed about their curricula.
7. Further discussion as to the goals and curriculum courses should take place by the Associated General Contractor.
8. A follow-up survey should be conducted within a five to ten year basis in order to keep pace with the ever-changing construction industry.

TABLES

Total Responses

Table I
General Education

Subject	Mean	Responses	Rank
Leadership	4.49	276	1
Tech Writing	4.48	280	2
Ethics	4.37	274	3
Speech	4.14	280	4
English Composition	4.1	279	5
History (Tech,Arch,Const)	3.5	273	6
Psychology	3.31	277	8
English Literature	2.46	277	8
History (American)	2.84	276	9

Table II
Mathematics and Science

Subject	Mean	Responses	Rank
Computer Science	4.32	279	1
College Algebra	4.21	279	2
Trigonometry	4.06	279	3
Physics (Mechanics)	3.89	279	4
Analytic Geometry	3.85	279	5
Physics (Heat,Light,Elec)	3.54	280	6
Geology	3.28	279	7
Pre-Calculus	3.22	276	8
Statistics	3.19	275	9
Chemistry	2.84	279	10

Table III
Construction Science

Subject	Mean	Responses	Rank
Plan Reading	4.76	279	1
Basic Structural Design	4.19	279	2
Strength of Materials	3.93	277	3
Surveying	3.96	279	4
Soil Mechanics	3.84	280	5
Drafting	3.83	279	6
Mech & Electrical Systems	3.74	278	7
Statistics/Mechanics	3.66	275	8

Table IV
Construction

Subject	Mean	Responses	Rank
Plan Reading	4.73	279	1
Estimating & Scheduling	4.61	280	2
Const Methods & Materials	4.53	280	3
Safety	4.33	279	4
Computer Applications	4.28	280	5
Specifications	4.15	278	6
Quality Control & Inspection	4.08	279	7
Building Codes	3.81	280	8
Const Equipment	3.76	280	9

Table V
Business and Management

Subject	Mean	Responses	Rank
Principles of Management	4.22	279	1
Business Law/Contracts	4	280	3
Human & Industrial Relations	3.86	279	3
Basic Accounting	3.88	280	4
Economics	3.24	280	5

Table VI
Other Requirements and Electives

Subject	Mean
Estimating	5.0
People Skills	5.0
Labor Relations	4.0

Table VII
Subject Area Significance

Subject	Value (%)
I. General Education	15.84
II. Math and Science	17.1
III. Construction Science	18.67
IV. Construction	26.22
V. Business Management	17.52
VI. Other Requirements	4.62

Table VIII
Type of Firms

Subject	Value (%)
General Contractor	55
Subcontractor	26.1
Specialty Contractor	8.6
Design Build Contractor	6.4
Developer-Contractor	1.4
Other	2.5

Table IX
Type of Business

Subject	Value (%)
Buildings	53.6
Municipal / Utility	7.1
Heavy / Highway	15.7
Specialty Tradework	12.9
M&E Tradework	7.5
Other	3.2

Table X
Annual Volume of Work (Dollars)

Annual Range	Value (%)
Under $ 1 Million	2.9
$1 Million to $5 Million	16.4
$5 Million to $20 Million	31.4
$20 Million to $50 Million	21.1
$50 Million to $100 Million	12.9
Over $100 Million	13.2
Other	2.1

Table XI
People on Payroll

Subject	Mean
In the office	39
In the field (Non-trade people)	26
In the field (Trade people)	146

Table XII
Percentage of Work with Own Forces

Percentage	Mean
0% - 10%	10
11% - 25%	20
26% - 50%	16.4
51% - 70%	14.3
Over 70%	35.7
Other	3.6

Table XIII
Primary Geographic Work Location

Subject	Mean
Northeast	32.5
Midwest	45
Southeast	20.7
Mountain	29.6
Pacific	10.4
International	2.5

TABLE XIV
COMPARATIVE RESULTS of SUBJECT AREA & LAST SURVEY (1986)

Order	General Education	86	Order	Mathematics/ Sciences	86	Order	Construction Science	86	Order	Construction	86	Order	Business Management	86
1	Leadership	---	1	Computer Science	3	1	Plan Reading	1	1	Plan Reading	---	1	Principles of Management	3
2	Tech Writing	2	2	College Algebra	5	2	Basic Structural Design	4	2	Estimating & Scheduling	1	2	Business Law/Contracts	2
3	Ethics	6	3	Trigonometry	3	3	Strength of Materials	5	3	Construction Methods & Materials	2/4	3	Human Industrial Relations	4
4	Speech	3	4	Physics (Mechanics)	1	4	Surveying	8	4	Safety	5	4	Basic Accounting	1
5	English Composition	1	5	Analytic Geometry	4	5	Soil Mechanics	3	5	Computer Applications	---	5	Economics	5
6	History(Tech, Arch,Const)	4	6	Physics (Heat,Light,Elec)	2	6	Drafting	2	6	Specifications	6			
7	Psychology	5	7	Geology	3	7	Mech & Elec Systems	---	7	Quality Control and Inspection	---			
8	English Literature	8	8	Pre-Calculus	6	8	Statics/Mechanics	6	8	Building Codes	---			
9	History	7	9	Statistics	4	**9**	**Reinf Concrete**	7	9	Construction Equipment	---			
10	**Philosophy**	10	**10**	**Chemistry**	2				10	Construction Principles	3			
11	**Sociology**	9	**11**	**Biology**	5				**11**	**Mech. & Elec. Systems**	7			
12	**Physical Ed**	11												

* Bold topics were not listed in that subject area in 2000 survey

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Author

Joseph J. Cecere, Ph.D., CPC, is an associate professor and chairman of the Civil Engineering Technology program at Penn State Harrisburg. He serves on numerous construction boards and committees. His national appointments include AGC's Full Education Committee, AGC's Higher Education Subcommittee, Chaired the AGC's Two & Four-year Curricular Task Force, AGC's Education and Research Foundation, and AIC's Certified Professional Constructor Commission.