GRADUATE CONSTRUCTION PROGRAMS IN THE UNITED STATES

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ABSTRACT: During the past two decades a number of graduate construction programs have been developed at universities. This paper presents the results of a nationwide survey of university graduate construction programs and construction firms. The results provide an evaluation of what universities are currently offering, along with what the construction industry would like to see in graduate construction education.

INTRODUCTION

During the past decade the primary emphasis of construction education at the university level has been on undergraduate programs (5). While most of the attention has been directed at undergraduate programs, a number of universities have developed graduate programs in construction. In 1982 the Business Roundtable issued Report A-5, "Management Education and Academic Relations," as part of its Construction Industry Cost Effectiveness project (1). The conclusions of the report state: "Graduate degrees will enhance the prestige of construction, enabling the industry over time to attract and retain the high quality of project and construction management personnel it needs." The report also noted that there is no procedure to standardize graduate programs as there is for undergraduate programs.

In 1984 the Merit Shop Foundation, Ltd., sponsored a research project to study graduate construction programs in the United States. The study was conducted by the School of Civil Engineering at Oklahoma State University. The purpose of the study was to evaluate coursework and research areas of universities that offer graduate construction programs, survey construction firms in industry to determine their desired contents in a graduate construction program, and compare the results of the survey of universities to the survey of construction firms. Prior to this project there had not been a study of the variety of graduate construction programs that are currently offered in the United States. Neither had there been a survey of construction firms to determine what companies would like to see in a graduate construction program. The purpose of this paper is to present the data that were obtained from the research project for use and further analysis by individuals in industry and universities who are interested in graduate construction programs (1).

DESCRIPTION OF PROJECT STUDY

The administration of the research project was in four phases as shown in the timeline of activities (Fig. 1). Data related to curriculum and re-

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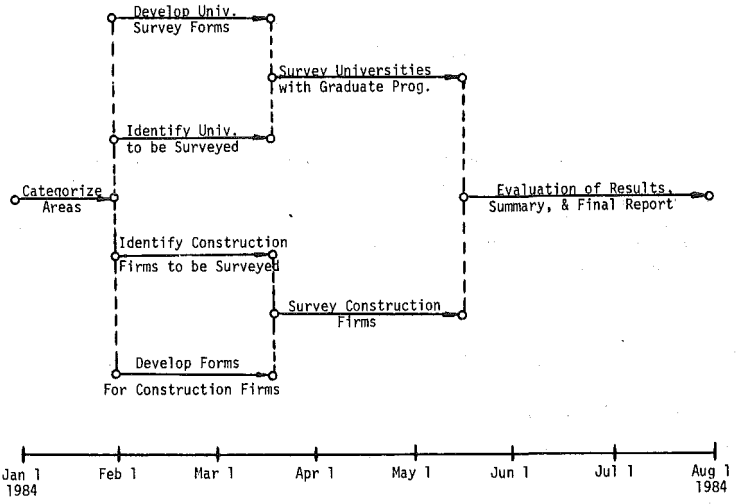

FIG. 1.—Timeline of Activities

search were obtained from the responses of 109 construction firms and 25 universities.

The initial task of this research project involved the definition of categories of construction curriculum and areas of research. Five broad categories were defined. Each of these five categories was divided into subcategories, and the subcategories were further divided into smaller defined areas of construction. Appendix 1 shows a complete listing of the categories and sub-categories used in the study. The information in this appendix was reviewed and agreed upon by selected contractors and university faculty at the February 1984 meeting of the Associated Builders and Contractors in Miami, Florida.

Two survey forms were developed: one for contractors and one for universities. The forms were designed to determine the relative importance of each area of construction as perceived by construction industry and academia. Essentially, the forms request the contractors to indicate the level of effort, if any, that graduate construction curricula should devote to the previously identified areas of construction and what levels of effort should be devoted to research in the areas listed. The universities were asked to indicate the levels of effort of instruction and research that they currently devote to the specific areas.

Responses from Industry and Universities

The contractors form was mailed to 222 companies throughout the United States. The mail list represented both small- and large-sized firms involved in both general and specialty construction. University survey forms were mailed to 34 universities that offer graduate construction programs. Forty-nine percent of the contractors and 74% of the universities responded. The results of the responses from both the contractors and universities are shown in Tables 1–5. The data presented is a per-

TABLE 1.—Project Activities

Category (1)	Type of respondent (2)	Curriculum (%)			Research (%)	
		Full course (3)	Part of course (4)	No course (5)	Yes (6)	No (7)
(*a*) Planning and Scheduling						
Bar Charts	C	9.5	87.6	2.9	53.8	42.6
	U	4.2	95.8	0.0	27.4	78.6
CPM	C	33.6	64.5	1.9	70.4	29.6
	U	28.0	72.0	0.0	70.6	29.4
PERT	C	5.8	74.4	19.8	51.6	48.4
	U	8.3	91.7	0.0	23.1	76.9
Other	C	10.0	65.0	25.5	41.7	58.3
	U	15.0	85.0	0.0	61.5	38.5
(*b*) Estimating						
Conceptual	C	29.3	68.7	2.0	65.3	34.7
	U	20.8	79.2	0.0	70.6	29.4
Quantity take-off	C	49.5	45.8	2.8	64.5	35.5
	U	25.0	75.0	0.0	28.6	71.4
Bidding	C	55.8	43.3	1.9	76.6	23.4
	U	20.0	80.0	0.0	47.1	52.9
Other	C	38.5	53.8	7.7	80.0	20.0
	U	15.4	84.6	0.0	50.0	50.0
(*c*) Project Controls						
Product measurement	C	33.3	64.0	3.0	88.0	12.0
	U	16.0	80.0	0.8	76.5	23.5
Product improvement	C	31.7	67.3	1.0	93.9	6.1
	U	20.8	75.0	4.2	71.4	28.6
Cost control	C	57.1	42.9	0.0	89.9	10.1
	U	8.3	91.7	0.0	83.3	16.7
Quality control	C	33.3	65.7	0.1	88.2	11.8
	U	8.3	83.3	8.3	35.7	64.3
Operations research	C	9.2	64.3	26.5	61.4	38.6
	U	16.0	68.0	16.0	62.5	37.5
Track work	C	8.3	85.4	6.3	64.8	35.2
	U	8.3	79.2	12.5	42.9	57.1
Inspection	C	12.9	81.2	5.9	59.7	40.3
	U	4.2	79.2	16.6	8.3	91.7
Safety	C	32.4	65.7	1.9	79.5	20.5
	U	8.3	70.8	20.8	25.0	75.0
Administration	C	51.5	45.6	2.9	82.9	17.1
	U	11.1	77.8	11.1	15.4	84.6
Other	C	12.5	75.0	12.5	66.7	33.3
	U	0.0	100.0	0.0	20.0	80.0

Note: C = Contractors; U = Universities.

centage of the total responses for each category of construction curricula and research.

Evaluation of Results

The methods used in the statistical analysis of the data collected are discussed in Ref. 4. Generally, the perspectives of the contractors and the universities were similar in regards to the curricula that should be

TABLE 2.—Supervision

Category (1)	Type of respondent (2)	Curriculum (%)			Research (%)	
		Full course (3)	Part of course (4)	No course (5)	Yes (6)	No (7)
		(*a*) Management				
Project	C	68.5	31.5	0.0	85.7	14.3
	U	33.3	66.7	0.0	75.0	25.0
Personnel	C	30.6	67.5	1.9	82.7	17.3
	U	20.8	62.5	16.7	25.0	75.0
Organizational	C	24.5	73.5	2.0	77.0	23.0
	U	29.2	66.7	4.2	62.5	37.5
Labor	C	43.9	53.2	2.8	78.1	21.9
	U	25.9	63.0	11.1	35.7	64.3
Time	C	19.4	73.1	7.4	68.8	31.2
	U	4.3	78.3	17.4	27.3	72.7
Safety	C	25.0	74.0	1.0	79.5	20.5
	U	8.3	79.2	12.5	18.2	81.8
Training	C	34.6	64.4	1.0	85.1	14.9
	U	4.5	59.1	36.4	20.0	80.0
Other	C	22.2	66.7	11.1	100.0	0.0
	U	14.5	71.4	14.5	33.3	66.7
		(*b*) Communications				
Verbal	C	25.4	70.8	3.8	64.8	35.2
	U	12.5	66.7	20.8	0.0	100.0
Written	C	43.9	56.1	0.0	75.0	25.0
	U	16.7	66.6	16.7	10.0	90.0
Reports	C	25.5	74.5	0.0	69.4	30.6
	U	16.7	70.8	12.5	0.0	100.0
Other	C	8.3	83.3	8.3	33.3	66.7
	U	10.0	75.0	15.0	20.0	80.0

Note: C = Contractors; U = Universities

offered in the construction engineering and management graduate programs across the country. As could be expected, there were a few areas where divergent opinions were evidenced. There were substantial differences regarding the areas where emphasis in research was needed vis-a-vis where it is currently concentrated.

In terms of *project activities* (Table 1), there was general agreement in the need for the topics listed in the curriculum. There was a variation in the extent to which some of the topics should be covered, however. The universities indicated greater effort was expended on analytical topics, such as PERT and operations research, than the contractors felt necessary. The contractors wanted more emphasis placed on applied topics such as estimating, cost and quality control, and safety. Surprisingly, the universities are placing little emphasis on safety, neither from the curriculum nor research aspects. The contractors expressed a strong interest in safety, which is inspired perhaps by the substantially increased court awards in workman's compensation cases in many states and the resultant increases in insurance premiums.

Substantial differences of opinion in the curriculum data occurred in terms of *supervision* (Table 2). Most of the responding contractors felt that more emphasis should be placed in the areas of time, safety, and

TABLE 3.—Business and Legal

Category (1)	Type of respondent (2)	Curriculum (%) Full course (3)	Part of course (4)	No course (5)	Research (%) Yes (6)	No (7)
		(*a*) Contract Documents				
General condition	C	29.0	71.0	0.0	69.2	30.8
	U	26.1	73.9	0.0	25.0	75.0
Specifications	C	37.4	62.2	0.0	69.2	30.8
	U	26.1	73.9	0.0	20.0	80.0
Drawings	C	35.2	64.8	0.0	96.2	3.8
	U	19.0	76.2	4.8	0.0	100.0
Other	C	16.7	75.0	8.3	33.3	66.7
	U	30.0	60.0	10.0	0.0	100.0
		(*b*) Business				
Accounting	C	67.3	27.1	5.6	67.1	32.9
	U	57.7	26.9	15.4	7.7	92.3
Economics	C	35.2	58.3	6.5	67.9	32.1
	U	59.3	31.3	9.4	0.0	100.0
Financing	C	49.1	46.2	4.7	77.2	22.8
	U	66.7	27.3	6.0	16.7	83.3
Marketing	C	55.2	40.0	4.8	81.8	18.2
	U	61.8	23.5	14.7	21.4	78.6
Other	C	25.0	50.0	25.0	40.0	60.0
	U	0.0	80.0	20.0	100.0	0.0
		(*c*) Legal				
Contracts	C	58.1	41.0	0.9	76.0	24.0
	U	44.0	56.0	0.0	43.8	56.2
Bonds	C	15.0	81.3	3.7	66.7	33.3
	U	24.0	76.0	0.0	15.4	84.6
Insurance	C	17.0	79.2	3.8	65.3	34.7
	U	24.0	72.0	4.0	8.3	91.7
Liability	C	21.0	79.0	0.0	70.1	29.9
	U	27.3	68.2	4.5	15.4	84.6
Safety	C	22.3	73.8	3.9	73.0	27.0
	U	18.2	72.7	9.1	28.6	71.4
Other	C	12.5	62.5	25.5	50.0	50.0
	U	25.0	75.0	0.0	20.0	80.0
		(*d*) Contract Administration				
Type of contract	C	27.4	69.8	2.8	74.3	25.7
	U	16.7	83.3	0.0	30.8	69.2
Labor relations	C	36.8	59.4	3.8	78.7	21.3
	U	30.4	65.2	4.4	20.0	80.0
Other	C	15.4	69.2	15.4	50.0	50.0
	U	25.0	75.0	0.0	0.0	100.0

Note: C = Contractors; U = Universities.

training management, while the universities expend only moderate effort in these areas. It is obvious from the study that contractors are not satisfied with the communications skills of the current graduates entering the industry as almost half of them felt that a full course in written communications should be included in the curricula. Correspondingly, only 17% of the responding universities offer a full course in technical

TABLE 4.—Methods, Materials, and Technical

Category (1)	Type of respondent (2)	Curriculum (%)			Research (%)	
		Full course (3)	Part of course (4)	No course (5)	Yes (6)	No (7)
		(*a*) Construction Methods				
Formwork design	C	29.1	60.2	10.7	68.6	31.4
	U	16.0	72.0	12.0	25.0	75.0
Equipment management	C	20.4	70.9	8.7	67.1	32.9
	U	36.0	64.0	0.0	35.7	64.3
Design of temporary structures	C	10.7	67.0	22.3	46.4	53.6
	U	14.3	47.6	38.1	33.3	66.7
Steel erection	C	26.0	64.4	9.6	36.4	36.6
	U	4.2	54.2	41.6	0.0	100.0
Other	C	20.0	50.0	30.0	100.0	0.0
	U	25.0	37.5	37.5	0.0	100.0
		(*b*) Materials				
Asphalt	C	8.9	74.3	16.8	55.2	44.8
	U	38.1	42.9	19.0	46.1	53.9
Concrete	C	34.3	57.8	7.9	69.1	30.9
	U	40.9	50.0	9.1	61.5	38.5
Timber	C	21.6	66.7	11.7	59.7	40.3
	U	22.7	59.1	18.2	41.7	58.3
Steel	C	24.0	69.0	7.0	66.7	33.3
	U	38.1	42.9	19.0	33.3	66.7
Other	C	25.0	43.8	31.2	100.0	0.0
	U	16.7	66.6	16.7	25.0	75.0
		(*c*) Engineering				
Computers	C	74.1	24.1	1.8	91.1	0.9
	U	36.0	64.0	0.0	81.3	18.7
Mechanical	C	43.3	52.9	3.8	84.3	15.7
	U	10.5	42.1	47.4	10.0	90.0
Electrical	C	41.9	54.3	3.8	84.5	15.5
	U	15.8	36.8	47.4	30.0	70.0
Other	C	33.3	50.0	16.7	75.0	25.0
	U	0.0	66.7	33.3	0.0	100.0

Note: C = Contractors; U = Universities.

writing, but most universities require the student to demonstrate writing skills as part of the masters report or thesis requirements. The need for more emphasis in both written and verbal communications skills at the universities is evidenced by the contractors' position that is reflected in the data.

There was a reasonable degree of correlation in the data reported for Table 3 under *business and legal*. All responding parties agreed on the inclusion of the listed topics in the curricula and there was general agreement on where the emphasis should be placed. Likewise, the topics and the emphasis on these topics by the universities were reasonably coincidental for the subjects listed in Table 4 under *methods, materials, and technical*.

The greatest deviation in the needs perceived by industry and the curricula currently offered by the universities occurs in Table 5, under *speciality areas*. Very few of the responding universities offer full courses in

TABLE 5.—Speciality

Category (1)	Type of respondent (2)	Curriculum (%)			Research (%)	
		Full course (3)	Part of course (4)	No course (5)	Yes (6)	No (7)
Sales	C	39.2	46.1	14.7	78.6	21.4
	U	0.0	42.9	57.1	0.0	100.0
Mechanical	C	44.5	52.5	3.0	81.2	18.8
	U	0.0	81.8	18.2	0.0	100.0
Plumbing	C	38.4	56.6	5.0	80.6	19.4
	U	0.0	28.6	71.4	0.0	100.0
Electrical	C	48.0	49.0	3.0	79.5	20.5
	U	0.0	38.1	61.9	11.1	88.9
Roofing	C	21.6	66.0	12.4	76.9	23.1
	U	4.5	36.4	59.1	22.2	77.8
Earthwork	C	22.2	68.7	9.1	72.7	27.3
	U	12.5	79.2	8.3	42.9	57.1
Utilities	C	19.2	73.7	7.1	70.1	29.9
	U	5.0	25.0	70.0	0.0	100.0
Paving	C	16.0	68.0	16.0	67.2	32.8
	U	13.6	59.1	27.3	27.3	72.7
Bridges	C	28.0	51.6	20.4	67.7	32.3
	U	4.8	57.1	38.1	0.0	100.0
Industrial	C	34.0	57.7	8.3	75.4	24.6
	U	18.2	36.4	45.5	20.0	80.0
Process	C	28.2	59.8	12.0	71.0	29.0
	U	5.0	35.0	60.0	11.1	88.9
Other	C	50.0	30.0	20.0	50.0	50.0
	U	0.0	37.5	62.5	0.0	100.0

Note: C = Contractors; U = Universities.

any of the subject areas included in the speciality areas such as mechanical, electrical, sales, and industrial processes. Most of the universities do not include these topics as material in other courses. Yet, the responses from the contractors indicate the vast majority of those in the construction industry perceive instruction in these subjects at the university level to be desirable.

In the comparison of the need for research effort with the areas where research is currently conducted as part of the construction management programs, it is easily determined that research in the speciality areas is viewed by the construction industry as quite important. However, few universities are actively involved in research related to the speciality areas as part of their graduate construction program. The contractors indicate a need for greater emphasis on research in the business and legal aspects of the construction industry than is currently being accomplished at the universities. Most of the active university research appears to be concentrated in the project activities and management categories which are also identified by the contractors as areas needing additional research effort.

Conclusions

It is commonly recognized that universities in general and graduate programs in particular are autonomous. It would be both difficult and

undesirable to standardize graduate construction programs. However, there should be some reasonable agreement between what construction firms need in their new graduate engineers and what the various universities are providing in the construction engineering and management programs. The recently concluded nationwide survey reflects discrepancies in two major areas of the curriculum: (1) The lack of instruction in good communications skills; and (2) the lack of instruction in the speciality areas. The former problem area is easily rectified by adding a formal technical-report writing course to the curriculum. At some universities this has been accomplished by requiring the course to be taken as a senior level undergraduate course. The course becomes a required noncredit prerequisite for the graduate degree. At least one graduate program has attempted to solve the communications skill problem by requiring extensive written and oral reports from students on the dozen or so guest speakers who make presentations at the construction management seminar.

Responding to the latter expression of need by the construction industry, the solution will not be so easily accomplished. At most universities, the backgrounds of the faculty members in the construction engineering and management graduate programs are more closely identified with general management functions of the industry vis-a-vis specialty areas of construction. To develop courses in the specialty areas will require additional faculty members, tenured or adjunct. The majority of our universities do not have the financial resources to add additional faculty members even if qualified and willing individuals could be located. Efforts to have the electrical and mechanical engineering departments develop such courses have found little support at most universities because of their own internal problems created by expanding student populations and a decline in the availability (or affordability) of qualified faculty members. The solution to this problem can be solved in the short term only by strong support from the construction industry.

The results of the research portion of the survey reveal a different problem. As opposed to a problem of allocation of effort evidenced in the curriculum data, the research data reflect a problem in the quantity of active research. The research efforts that are underway are being directed at areas identified by the construction industry as needing research. However, the contractors have identified a substantial number of research areas where there is currently no research at all. This substantiates a number of recent studies identifying the lack of research funding in the construction areas as being a significant problem. The recent establishment of the Construction Industry Institute has made significant progress in the identification of specific research areas and sources of funding (6). There have been recent major efforts to identify needed areas of basic research for the construction industry and proposed methods of accomplishing the needed research (2,3). Recent emphasis on engineering by the National Science Foundation should also provide additional support for construction research.

The study that was the subject of this paper did not attempt to distinguish between the perceptions of the various facets of the construction industry, such as heavy construction and building contractors. A

comparison of the perceptions of the various construction interests concerning the curricula and research efforts of the various universities would be a beneficial follow-up to this recently completed study.

Appendix I.—Categories of Construction

I. *Project Activities:*
- A. Planning and Scheduling
  1. Bar charting
  2. CPM
  3. PERT
  4. Other
- B. Estimating
  1. Conceptual
  2. Quantity takeoff
  3. Bidding
  4. Other
- C. Project Controls
  1. Productivity measurement
  2. Productivity improvement
  3. Cost control
  4. Quality control
  5. Operations research
  6. Tracking work
  7. Inspection
  8. Safety
  9. Administrative
  10. Other

II. *Supervision:*
- A. Management
  1. Project
  2. Personnel
  3. Organizational
  4. Labor
  5. Time
  6. Safety
  7. Training
  8. Other
- B. Communications
  1. Verbal
  2. Written
  3. Reports
  4. Other

III. *Business and Legal:*
- A. Contract Documents
  1. General conditions
  2. Specifications
  3. Drawings
  4. Other
- B. Business
  1. Accounting
  2. Economics
  3. Financing
  4. Marketing
  5. Other
- C. Legal
  1. Contracts
  2. Bonds
  3. Insurance
  4. Liability
  5. Safety
  6. Other
- D. Contract Administration
  1. Types of contracts
  2. Labor relations
  3. Other

IV. *Methods, Materials, and Technical:*
- A. Construction Methods
  1. Formwork design
  2. Equipment management
  3. Design of temporary structures
  4. Steel erection
- B. Materials
  1. Asphalt
  2. Concrete
  3. Timber
  4. Steel
  5. Other
- C. Engineering
  1. Computer
  2. Mechanical
  3. Electrical
  4. Other

V. *Specialty:*
- A. Sales
- B. Mechanical
- C. Plumbing
- D. Electrical
- E. Roofing
- F. Earthwork
- G. Utilities
- H. Paving
- I. Bridges
- J. Industrial
- K. Process
- L. Other

Appendix II.—References

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