The Business Roundtable

MANAGEMENT EDUCATION AND ACADEMIC RELATIONS

A CONSTRUCTION INDUSTRY COST EFFECTIVENESS PROJECT REPORT

Report A-5
June, 1982
Reprinted November, 1992

MANAGEMENT EDUCATION AND ACADEMIC RELATIONS

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I

SUMMARY

The education of project managers and construction managers[1] can be extremely important in improving cost effectiveness in the construction industry. To be truly effective this education should combine academic and on-the-job training. If proper education led to a reduction of project cost of only 1%, approximately $.1.3 billion a year would be saved in the commercial, industrial and utility sectors. Many believe that much greater savings are achievable through improved education.

The objectives of this study were to research current management education efforts and recommend improvements, and evaluate current industry-academic relations and suggest improvements.

This study relies in great part on replies to questionnaires. One was sent to 446 owners, architect/engineers, contractors and construction management firms, with 112 replies. A separate questionnaire was sent to 170 major academic institutions with 111 responding. Other sources included owner and contractor organizations and numerous professional societies.

The more significant findings of the study are:

- Owners and contractors often differ on their preference of educational background for their project managers and construction managers (owners generally prefer a bachelor of science degree in engineering; contractors, a degree in building construction). However, both agree on the need for a combination of technical skills and construction management courses.

- Undergraduate courses need to be upgraded and standardized. There is a serious question of a four-year engineering program meeting the needs of the construction industry.

- The industry-academic relationship must be strengthened.

Industry needs to increase substantially its financial support of academic institutions including specifically designating funds for construction programs. Needs vary among schools and include scholarships, research grants, summer jobs for students and faculty, guest

[1] The terms project manager and construction manager relate to functions rather than job titles A project manager is the individual responsible for managing a project from its inception until its completion The function includes, among other things, overall responsibility for planning, design, construction, inspection and start-up activities The construction manager is responsible for managing on-site construction activities.

lecturers, and rotational assignments between construction industry personnel and the academic community.

- Continuing education is the best short-term answer to strengthening the construction education process.

- Construction must be promoted as a profession to attract top quality students to the industry.

- Most companies favor formation of a professional construction organization on a regional basis to improve the industry's relations with academia.

- More coordination is needed among the numerous professional and industrial societies already active in construction education.

Ultimately, the entire construction education system must be strengthened. Greater involvement in the educational process by owners and contractors is needed and justified. The work of a few progressive companies and individuals needs to be expanded to include a broad cross-section of the construction industry.

The Construction Industry Cost Effectiveness Task Force believes this report illuminates not only the problems of construction management education, but more importantly, the opportunities that are available to the industry. The report's recommendations provide a master plan for strengthening the construction education process toward the ultimate goal of having well-educated and properly trained managers in responsible charge of construction projects.

II

STUDY OBJECTIVES

This study had three broad goals.

One was to determine and describe ways and means to educate project managers and construction managers so that they can be more cost effective. Another was to assess the present abilities of colleges and universities to carry out this function. The last was to propose mechanisms through which owners (buyers of construction), architect/engineers, professional societies and the construction industry in general can work effectively with universities to increase the supply and quality of both project and construction managers.

III

INTRODUCTION

Lack of an adequate education in management skills for project and construction managers is one of the factors contributing to the decline in cost effectiveness of the industry. There is an urgent need for owners, architect/engineer firms, construction management firms, and contractors to recognize that this shortcoming exists. But they should be heartened by realizing the problem can be reduced by strengthening the capacity and the effectiveness of colleges and universities in their teaching and research efforts.

Until the recent past, university education for project and construction management has been secondary to that in other professional pursuits. As a result, many former craftsmen, foremen, general foremen, etc., have moved up to become managers, much as a lot of able businessmen of years ago evolved from the shrewd horse traders. Management skills have been developed by trial and error, with many trials and lots of errors.

Since construction is the largest industry in the United States, it seems imperative that project and construction management be recognized as a dignified profession by both the business world and the academic community. A beginning has been made toward this end, but much remains to be done.

Broadly speaking, project and construction management requires 1) scientific and technical knowledge of "what to do," 2) management skills for planning and administering, and 3) the technical knowledge of "how to do it." The challenge for the project manager or construction manager is to combine this assorted knowledge and skill into effective performance. The challenge to the academic community is 1) to provide the basic educational background professional people will need to accomplish these tasks in the real world, 2) to research new approaches, and 3) to participate in continuing education to carry fresh findings and insights to practitioners.

IV

FOUR-YEAR UNDERGRADUATE PROGRAMS

Findings

A confusing variety of four-year programs in project and construction management has developed over time at universities, Most programs were started by one or more enterprising faculty members in departments as varied as civil engineering, architecture, industrial arts, business, and agricultural engineering. The common element was that construction was an important part of the discipline. Sometimes construction spokesmen helped with advice, and there has been modest financial support from the industry.

At each school, the curriculum in construction and project management was affected by the organizational, financial, and administrative climate in which it was launched. Some programs enjoyed acceptance and support from other faculty members: others faced strong opposition, primarily because construction was viewed as "trade school stuff," but also because it challenged existing programs and would consume money plus student and faculty interest, time, and credit hours.

Most four-year programs can be classified as belonging to one of two almost equal groups: 1) construction and 2) civil engineering or civil engineering with a construction option. (See Table 1.)

TABLE 1
FOUR-YEAR UNDERGRADUATE PROGRAMS
IN CONSTRUCTION AND PROJECT MANAGEMENT

(1981 Roundtable Survey)

University Subdivision	Number of Schools: 1981 Roundtable Survey	Number of Graduates: 1980	Number of Graduates: 1981
Construction	54	1182	1272
Civil Engineering or Civil Engr. - Constr. Option	40	1140	1207
Other	17	214	243
Totals	111	2536	2722

Table 2 shows how the different types of schools divide their curricula by subject matter. It also shows the curriculum guidelines of the American Council for Construction Education (ACCE). There are considerable differences in content between the two main programs.

Construction programs emphasize the construction business, technology, and management, which reduce the time and attention available for mathematics, science, and engineering design (labeled construction design). Civil engineering programs take the opposite approach.

TABLE 2
SUBJECT MATTER BREAKDOWN IN FOUR-YEAR CONSTRUCTION PROGRAMS

(Expressed as a % of total course units)

General Topic	1981 Roundtable Survey			ACCE Guidelines
	Constr.	Civil Engr.	Other	
1. General education (socio-humanistic)	20.5	17.9	16.1	12.5
2. Mathematics and science	16.5	28.5	19.5	15.0
3. Construction design	12.3	20.4	20.4	17.5
4. Construction business	11.0	3.8	7.0	15.0
5. Construction technology	17.6	9.4	18.8	12.5
6. Management of construction	10.8	4.8	7.4	17.5
7. Other requirements (electives)	11.3	15.2	10.8	10.0
TOTAL	100.0	100.00	100.0	100.0

Because of the four-year time frame, it appears to be impossible to add subject matter to emphasize the less heavily treated areas in either of the principal groups without dropping other topics or extending the school year. Many barriers, including faculty strengths and preferences and university structure, make changes difficult. Another constraint is that the construction group has its organization, the Associated Schools of Construction, while the engineering group has ties with the American Society of Civil Engineers and the American Society of Engineering Education. Furthermore, the desire to acquire or maintain accreditation by the appropriate agency makes sharp shifts in either curriculum very difficult. For the long run, shifting to a five-year program may be the solution, but this requires added staffing and money as well as curriculum adjustments. Often, administrative and other difficulties within the university must be overcome. Clearly, the two approaches to four-year programs for construction education are with us; moreover, changes will be very difficult to achieve in the short run. Those developing plans for future industry-academic relations must recognize this dual nature of four-year academic programs and prepare to work with both.

Owners, architect/engineer firms, contractors, and construction management firms were surveyed to determine their current and future needs for managers. A total of 446 questionnaires were distributed. Of these 112 (25%) were returned. Of 208 owners solicited, 73 (35%) responded. Only seven (11%) responses were received from 62 queries to architect/engineer and construction management firms. Of 176 contractors, 32 (18%) responded. Accordingly, results were treated with some caution. The owner's sample was considered adequate, and the study team believes the results have credibility. The response from contractors, architects/engineers and construction management firms was disappointing, and the study team either verified the information reported by these segments or did not include the information in this report. Copies of the survey analyses are available from The Business Roundtable.

Conclusions

1. A bachelor of science degree has been considered adequate education for project managers or construction managers. Questionnaire responses showed that less than 10% of the respondents now in construction managerial jobs hold advanced degrees.

2. Owners prefer that project and construction management personnel hold a B.S. degree in an engineering discipline. Contractors tend to prefer a degree from a building-construction school. There is a need for both types of program.

3. Where a technical bachelor's degree (that is, one in civil, electrical or mechanical engineering) is desirable, there is not enough time in a typical four-year program to permit a sufficient number of construction management courses.

4. In addition to a good technical background in math and science, the management courses listed below should have the following priorities in undergraduate curricula:
   a. Highest priority: written and oral communication
   b. High priority
      - Principles of management, including decision making
      - Managing construction methods and equipment
      - Business ethics
      - Estimating
      - Productivity measurement and improvement skills
      - Principles, of contract law, including contract documents
      - Principles of operations planning and control

c. Medium priority

- Principles of accounting, including budgeting and cost control
- Work breakdown structure and value engineering
- Principles of labor negotiations
- Engineering economics
- Public speaking
- Project organizational structures

d. Low priority

- Policy formulation and administration
- Principles of the governmental regulatory process
- Statistical analysis
- Computer programming[2]
- Management in the public sector
- Marketing of construction ·
- International business

5. Attempts to forecast supply and demand for construction and project management personnel are inconclusive. Poor response from architect/ engineer and construction management firms, which hire considerable numbers of graduate engineers, adds uncertainty to results. The economic recession and in particular, the slump in construction, makes forecasting more difficult. Even so, the study indicated demand exceeding supply by about 2,500 (25%) per year over the next five years.

[2] Although computer programming was given a low priority, knowledge about how to use computers was considered important (i.e., standard programs such as critical path programs, etc.)

V

GRADUATE EDUCATION AND UNIVERSITY RESEARCH

Findings

Graduate education for project and construction managers is relatively new, having begun in the mid 1950's. A 1979 Associated General Contractors (AGC) survey showed that about 45 schools[3] offer such programs; annual enrollment ran about 500 to 1,000 equivalent full-time students. Most of these programs were full-time for the nine-month school year, although some schools encouraged part-time study, with some classes offered at night.

In almost all cases, graduate programs are outgrowths of undergraduate activities. The AGC survey showed them administered in the following departments: civil engineering, 29; architecture, 4; building construction or management, 4; engineering management, 4; and engineering administration, 4. The degrees awarded (M.S. except for some B.S. degrees in architecture) carried a variety of labels.

A 1981 Roundtable survey drew responses from 39 schools. They reported issuing degrees in the following: construction management, 11; civil engineering-construction option, 10; construction engineering, 6; civil engineering, 5; construction technology, 1; and other, 5. (It should be noted that project or construction management programs have not been reported in engineering departments other than civil. The listing does not include graduate MBA programs, although some of their graduates, as well as those with graduate degrees in law, accounting, economics, and other disciplines find careers in construction.)

Graduate programs in project and construction management vary widely in size and scope, and many of them are struggling for funds to do a better job. For example, the number of graduates from advanced-degree programs range from 40 or more to only a few per year. In the Roundtable survey, the 39 schools answering the questionnaire indicate that 13 have the potential to increase the size of their programs significantly and 13 more can handle modest increases. Full, pad-time, and other department faculty total 187, or an average of 5.5 for the 39 schools reporting. Full-time faculty range from 0 to 17, with an average of 2.7. The AGC survey shows 20 schools offering Ph.D. degrees. Some universities offer full-blown courses of study and carry on research; others that report "con-

[3] The survey did not include all schools with construction programs.

struction programs" merely permit students to piece available courses together from existing undergraduate and graduate offerings in varied departments.

Currently, there is no accrediting procedure to standardize graduate programs as is done, at least in part, for four-year undergraduate programs.

Academic requirements for new faculty for schools with graduate programs weigh the Ph.D. heavily; it is required by 67 percent of the schools, the M.S. is a minimum in 94% of the cases. This contrasts with 32% Ph.D. and 86% MS. degree or better at undergraduate schools. On the other hand, undergraduate schools give far greater attention to professional experience in selecting faculty.

Finding qualified faculty for graduate schools is reported to be extremely difficult. There are also minor to severe faculty-retention problems. The principle difficulty reported is salaries, which average about a third less than the amount needed to attract qualified people.

Research is a far more important activity for graduate schools than for undergraduate ones. Fourteen graduate schools reported research grants averaging $60,000 per year, while the 29 reporting undergraduate schools had an average of $5,000 each. However, the fact that ten graduate schools reported no research grants at all further emphasizes the diversities among universities and their programs. As a generalization, the schools that promote research have lighter teaching loads but press their faculties to undertake sponsored research. This enhances the school’s name, supports graduate students, and brings the university itself income to carry a portion of faculty salary costs plus overhead charges for general university expenses.

It should be stressed that this emphasis on research creates serious internal problems for construction faculties because funds are so difficult to obtain. Consider the cases at two research-oriented universities. At one, the entire construction program may be in jeopardy unless research income increases substantially. At the other school, research funding per construction-faculty member is about one-tenth that for electronics. As a consequence, both salary levels and the prospects of promotion for construction faculty may be impaired. At a few schools, writing or prestigious consulting assignments may be available as substitutes for sponsored research. In any event, these kinds of pressures make academic life in construction less attractive than it may appear from the outside.

Evaluation

Proponents of graduate programs claim that they fill needs not covered by four-year programs including:

- A solid scientific and technical background. This provides not only technical competence, but also develops skills in analytical approaches to problem solving.
- Advanced courses in management and construction technology and methods. This background provides the foundation from which an understanding of on-the-job problems can be developed quickly.
- Individuals qualified for professional licensing and engineering society membership. This provides added status in dealing with owner representatives, contractors, engineers, architects, lawyers, accountants, and public officials. At times, these qualifications are either required or highly desirable for such activities as giving expert-witness testimony in legal proceedings[4]

Conclusions

1. A graduate program is needed to provide the added education in management skills for future project and construction managers who have an engineering bachelor's degree.

2. A graduate program would benefit those in industry whose management skills need updating.

3. There is little incentive today for those with bachelors degrees to attend graduate school.

4. 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.

5. A graduate program is necessary for those who will eventually obtain Ph.D. status and teach construction programs in colleges and universities.

VI

[4] Highly commendable efforts are underway to achieve comparable status and licensing for accredited degrees in construction.

CONTINUING EDUCATION

Findings

Large colleges and universities have only a very limited participation in continuing education for project arid construction managers. Some offer night or weekend courses, an occasional seminar, or short one- to three-week courses covering management subjects.

More courses and programs are offered at smaller two- and four-year colleges where there appears to be greater flexibility about establishing courses. These programs are often incomplete or cover only the most essential points. Programs frequently are taught at night by faculty who also work for engineering or contracting firms. Programs are usually technical, with little emphasis on management subjects.

In continuing education, much remains to be done at major universities. Although The Roundtable's questionnaire showed that owners, contractors and design firms provide some support to employees that attend continuing education courses, there is little financial support for colleges and universities to encourage sponsorship of such efforts.

There appears to be more activity in course and seminar sponsorship by free-lance professors and consultants. Usually the material taught at these sessions is practical and worthwhile. The disadvantage of short, one- and two-day sessions is that, although the material taught is current and useful, it is often not retained by students. Nor is it part of a planned program to update a student's skills. The short, one- and two-day programs do not have the same educational value as a more intensive several-week program presented in an academic atmosphere.

Most owners, engineering firms and contractors have some type of in-house academic training program for construction and project managers. A few are reasonably comprehensive but, on the whole, much improvement can be made. Less than one-half of the companies that responded to The Roundtable questionnaire reported that they have a formal on-the-job training to assure comprehensive education that employees will remember and use.

Conclusions

There is a wide spectrum of efforts in continuing education, It includes evening and summer courses at two- and four-year colleges and universities, in-house training in management subjects, programs by consultants, professional societies, industry associations and Others. Course content varies widely from a single subject to a

comprehensive program. The study team did not attempt to evaluate the content and success of these programs.

The study team concluded that any short-term improvements in management education can best be made in the continuing education area. Improvements in college and university programs are expected to take longer.

The questionnaire results showed, of those responding:

1. Continuing education is provided for office personnel by 79%.

2. Continuing education is provided for field personnel by 62%.

3. Attendance at meetings, seminars, and programs covering management subjects is encouraged by 92%. Interpersonal contact was rated as equal in importance with program content.

4. Classroom training is provided on management subjects by 85%.

5. Less than one-half have a formal (planned) on-the-job training program.

VII

INDUSTRY-ACADEMIC RELATIONS

Findings

After World War II, a number of contractors and their trade associations began activities in support of education for construction. For example, the Associated General Contractors formed an education committee composed of interested members. In the late 1950's, a joint committee with the American Society for Engineering Education was founded. It has been largely superseded by the Associated Schools of Construction and the American Council on Construction Education. Construction professionals in the American Society of Civil Engineers have many joint activities with university personnel. Some construction companies are directly involved with the universities; they recruit on campuses, supply speakers and advisory groups, offer employment to faculty and students, and contribute financially.

Owners who buy construction services, with a few notable exceptions, have had relatively few ties with university education in construction. Recently, with a growing awareness that active involvement in a broader spectrum of the construction process is essential to their well being, owners' activities in this field are beginning to increase.

It should be stressed that, despite these activities, owners and contractors are not deeply involved in construction education. The industry provides only a small amount of financial aid--S1.8 million a year, according to the results of the team survey--to schools for construction education and/ or research. (See Table 3.)

TABLE 3
ANNUAL CONTRIBUTION TO UNIVERSITY CONSTRUCTION PROGRAMS AS REPORTED IN THE ROUNDTABLE SURVEY

Purpose	Annual Amounts (thousands of dollars) Undergraduate Programs	Graduate Programs	Total
Scholarships	$379	$ 73	$ 452
Research	151	822	973*
Program Support	293	126	419
TOTALS	$823	$1,021	$1,844

* Total support in 1980 for all university engineering research was $620 million, of which 80% came from governmental agencies.

The survey shows some 2,800 undergraduate degrees were awarded, which means that about 12,000 students were enrolled. Scholarship support would thus average about $30 per student.

Research support per faculty member (both full- and part-time) is less than $1,000 each. As indicated by the footnote for Table 3, most of this came from governmental agencies. The reported $973 thousand for construction research is minuscule when compared to the $620 million for total research. As a specific example, at one research-oriented university, each construction faculty member, by aggressively pursuing money, raised only one-tenth as much as a counterpart in electronics. If the total financial support for university construction education amounted to $3 million per year, and if the total annual volume for commercial, industrial and utility construction approximates $137 billion per year, as it did in 1979, then university construction program financial support only amounts to 0.002%. Or if profits run 2% of volume, then contributions total 0.1% to 0.2% of profits. Contractors and owners on average appear to be investing very lightly in construction education and research. In addition, it should be recognized that with added or redirected financial aid must go strong personal involvement.

As indicated earlier, a minimal amount of research on construction problems is carried out in universities, and what little is done occurs primarily in graduate schools. Worse, most of it is financed by government agencies and targeted at problems of interest to the sponsoring agency. Moreover, obtaining aid using government research grants demands inordinate amounts of time for proposal writing and progress reporting. Under these circumstances, there is little opportunity for university faculties and advanced students to seek out arid focus their activity on problems that may prove of critical importance to the private sector of the construction industry.

The preponderance of owners, contractors, and designers apparently do not feel that university research can do much to improve productivity in construction. For one reason or another, construction is perceived as "different" from other industries by its purchasers and practitioners. For one thing, university research for construction has little track record since it began only recently. Accordingly there is little pressure from the corporate executives either to sponsor it or use the results. Moreover, mechanisms such as in-service education or widely-studied publications that disseminate the results of research that has been performed have a very small audience. A sad story, but a true one.[5]

The industry questionnaire showed that some form of relations with the academic community is maintained by 70% of the respondees and that 62% provide financial support. If so, it seems quite possible that some companies are contributing to a university's general funds

[5] The subject of construction research is discussed in detail in a separate report, B-2 *"Technological Progress in the Construction Industry".* The Business Roundtable, 1982.

but that little, if any, of those contributions are allocated to construction programs.

Respondees also favored formation of a professional group or society to serve as liaison between the construction industry and academia. They preferred that the group or society function on a regional basis rather than national.

A large number of professional societies and organizations are active in construction education, but their work is largely uncoordinated.

Conclusions

1. Academic institutions report they need substantially more financial support--especially grants--to improve their effectiveness, and, in some cases, merely to maintain the status quo. It is in the industry's long term interest to provide increased financial support.

2. Other needs include money for research; scholarships; employment of faculty as consultants or during summers; summer jobs for students, preferably in positions consistent with their training; opportunities to trade jobs temporarily with industry executives,

3. Ninety-four percent of the colleges responding to the academic questionnaire reported low salaries as a problem in attracting and retaining qualified faculty. Salaries should be increased about 34 percent.

VIII

RECOMMENDATIONS

Owners and contractors have begun to recognize proper management education as a prerequisite in achieving cost effective projects. Certainly the potential exists for significant improvement in the formal education and training of project managers and construction managers. Collectively, the industry and academia can and should develop and implement needed changes in the educational process directed at the construction industry. Actions are recommended in the following four areas of construction education.

Undergraduate Education

1. Owners, architect/engineer and construction management firms, and contractors employing nongraduates in responsible construction and project management positions are urged to provide incentives to encourage their employees to obtain a bachelor's degree.

2. Academia, with the assistance of owners, architect/engineer and construction management firms, and contractors, should upgrade and standardize undergraduate construction programs to better meet the needs of the industry. Assuming existing curricula continue to provide an adequate technical background in math and science then:

   High priority should be accorded to courses in-
   - Written and oral communications
   - Principles of management, including decision making
   - Managing construction methods and equipment
   - Business ethics
   - Estimating
   - Productivity measurements and improvement skills
   - Principles of contract law, including contract documents
   - Principles of operations planning and control
   - Use of computers for management control

   Medium priority should go to courses in-
   - Principles of accounting, including budgeting and cost control
   - Work breakdown structure and value engineering
   - Principles of labor negotiations
   - Engineering economics
   - Public speaking
   - Project organizational structures

Graduate Education

1. Owners, architect/engineer and construction management firms and contractors should urge the establishment of a graduate program in project and construction management at those colleges and universities that presently have only an undergraduate engineering and/or building construction program.

2. Owners, architect/engineer and construction management firms and contractors should provide incentives to encourage employees to obtain a masters degree from construction programs.

3. Owners, architect/engineer and construction management firms and contractors should actively promote project and construction management as a profession in order to help attract and retain top quality personnel to the industry.

4. The academic community should provide increased educational opportunities leading to a Ph.D. degree in order to train qualified faculty and research personnel for university construction programs.

Continuing Education

1. Owners, architect/engineer and construction management firms and contractors should develop comprehensive and formal classroom and on-the-job training programs to improve the skill and competence of the work force in the short term.

2. Employers of project and construction managers should develop career-paths for employees to assure that in future years each has all the required academic and on-the-job training that these two demanding jobs require.

3. Guidelines should be developed for the content of a comprehensive training program. Such guidelines continue to be needed by owners, architect/engineer and construction management firms, contractors, professional societies, industry associations, consultants, and the academic community.

Industry-Academic Relations

1. Owners, architect/engineer and construction management firms and contractors should provide substantially increased financial support, i.e., grants to academic institutions. Money should be specifically designated for construction programs. More financial support should also be provided in the form of: a) research, b) scholarships, c) summer, part-time and

consultant positions for faculty members, and d) summer job opportunities for students.

2. Owners, architect/engineer and construction management firms and contractors should support higher faculty salaries by urging university administrators and, if necessary, state legislators to provide financial incentives to attract top quality faculty members.

3. An organization or professional society should be formed to provide a regional format to industry-academic relations. Responsibility for coordinating the efforts of the many groups now active in construction education should be part of the new organization's mission.

IX

APPENDIX

SOURCES OF DATA ON EDUCATION FOR PROJECT AND CONSTRUCTION MANAGEMENT AND INDUSTRY ACADEMIC RELATIONS

Data on university education for project managers and construction managers are, at best, incomplete, since many educators, owners, contractors, or consultants did not respond to some or all of the questionnaires or inquiries made. The following sources of data were used in preparing this report:

1. A 1979 survey of construction education conducted by the Associated General Contractors (149 responses).

1. A 1981 survey of construction education conducted for The Business Roundtable (111 responses).

2. A 1981 Roundtable survey of owners (buyers of construction), design and construction management firms, contractors, and subcontractors (112 responses to 446 requests).

3. A report covering the Associated Schools of Construction in *Engineering News-Record,* May 28, 1981.

4. Data on engineering and engineering technology education published by the American Society for Engineering Education.

5. Results of a Construction Program Assistance questionnaire circulated to universities by AGC, in March 1981 (30 responses).

6. Detailed data on activities at a few specific schools.

7. The knowledge and conclusions of members of The Business Roundtable Study Team A-5 on Management Education.

CICE REPORTS

The Findings and Recommendations of The Business Roundtable's Construction Industry Cost Effectiveness project are included in the Reports listed below. Copies may be obtained at no cost by writing to The Business Roundtable, ATTN: CICE, 200 Park Avenue, New York, NY 10166.

Project Management -- Study Area A

- A-1 Measuring Productivity in Construction
- A-2 Construction Labor Motivation
- A-3 Improving Construction Safety Performance
- A-4 First and Second Level Supervisory Training
- A-5 Management Education and Academic Relations
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