

Characteristics of ASC Legacy Schools

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In 1965, fourteen representatives from nine universities met to consider the formation of an organization which would meet the needs of collegiate schools with curriculums in construction. This organization would soon be called the Associated Schools of Construction (ASC), an organization whose goal remains to promote construction education as a legitimate and unique professional area of study, and, to promote cooperation and understanding between construction education and industry. From 2016-2017, site visits were conducted at seven of these 'legacy' programs (Arizona State University, Auburn University, Clemson University, Colorado State University, University of Florida, University of Nebraska, and Virginia Polytechnic Institute) as well as Texas A&M University, Purdue University and the University of Washington. The purpose of these site visits was to collect data to identify common characteristics that define programs among the longest tenured and most successful in ASC, an organization that now consists of more than 140 institutional members around the world. Specifically, this research is intended to assist ASC members identify strengths and weaknesses within their programs, and, provide advocacy for the institutional and industry support necessary to further develop construction education on their campuses.

Key words: construction education, program assessment.

Introduction

As a product of industry demand, construction education has experienced significant growth since the 1970s. In fact, nearly half (45%) of roughly 130 4-year construction management (CM), construction engineering (ConE) and construction engineering technology (CET) programs have been accredited since 2000 (Figure 1). As an 'emerging' profession, however, construction education continues to struggle for acceptance among more traditional academic disciplines such as architecture and civil engineering. As a result, many construction programs remain largely underdeveloped or stagnant as a result of inadequate institutional support for faculty, staffing, equipment and facilities. A relative few, however, have managed to achieve sustainable growth and development during 60-80 years of existence and 30-40 years of accreditation at public land grant universities where undergraduate and graduate enrollments, scholarly achievement and industry support meet or exceed the institutional standards formerly set by architecture and engineering programs.

From 2016-2017, site visits and interviews were conducted at ten of these programs including Arizona State University, Auburn University, Clemson University, Colorado State University, University of Florida, Purdue University, Texas A&M University, University of Nebraska, University of Washington and Virginia Polytechnic Institute. The purpose of these visits was to identify metrics that could be used by other ASC programs to provide advocacy for the institutional support necessary to develop construction education beyond minimum ACCE and ABET accreditation criteria. Of several metrics identified, facilities, student recruitment and staffing were considered by those surveyed as being critical factors influencing the growth and development of these construction education programs. Industry and alumni relations, however, was considered *most* critical in terms of funding and advocacy for faculty and staff positions, facilities and equipment, curriculum development, scholarships and internships, student organizations and job placement.

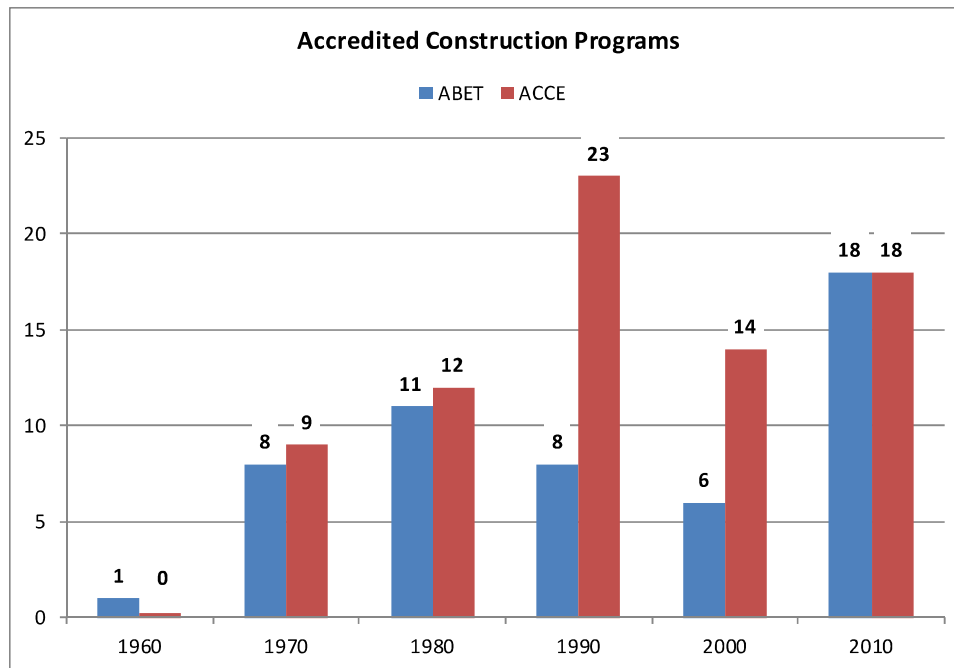


Figure 1. Number of 4-year accredited construction programs by date of initial accreditation, 1960-2018.

Background

As construction projects became more complex and interdisciplinary, industry became increasingly dissatisfied with the preparation provided by civil engineering and architecture programs. As a result, construction education evolved in response to needs that these traditional disciplines either ignored or were unwilling to meet. Among these needs were a greater focus on management competencies and less emphasis on science and engineering (Burt et al., 2008). In doing so, however, construction education faced a new problem - acceptance and recognition from the academy. This struggle has closely paralleled the industry's pursuit of recognition as a profession, seeking equal status with engineers and architects (Robson and Bashford, 1995).

By its very nature, construction education is a unique, experiential profession where theory is applied through professional practice, industry service and contextualized (e.g. 'hands-on') teaching and learning (Bilbo and Yeager, 1990). At major universities, however, the expectations for practitioner and academician are not well aligned and there is little chance of programs garnering institutional support where faculty do not obtain research funding and publish. As a result, many ASC programs have been relegated to teaching-centric institutions or exist as 'second-class citizens' at major research universities.

A relative few, however, have managed to achieve sustainable growth and development during 30-plus years of accreditation at public land-grant universities where programs have maintained strong industry relationships and commitment to undergraduate education while developing complimentary applied research and graduate programs. Limited information, however, exists on the organization and structure of construction programs in general (Rogers and Weidman, 1990; Jacobs and Tang-Hung, 2013) and particularly those with a track record of success since separating from architecture and engineering more than 70 years ago.

Methods

Beginning in spring of 2016, site visits were conducted at ten construction management programs including Arizona State University, Auburn University, Clemson University, Colorado State University, University of Florida, Purdue University, Texas A&M University, University of Nebraska, University of Washington and Virginia Polytechnic Institute. The purpose of these site visits was to collect data to identify common institutional characteristics that define programs among the longest tenured and most successful in ASC to help other ASC members identify organizational strengths and weaknesses within their programs, and, to further develop construction education on their campuses. Assessments of student learning outcomes (SLOs) or similar student-specific performance standards were not part of this study.

Prior to site visits, staff at participating programs were provided a 2-page, 35-question electronic questionnaire requesting general administrative information as well as information on undergraduate programs, graduate programs and research, faculty and staffing, facilities and equipment, and, industry and alumni relations (Tables 1-5). All surveys were completed prior to or during on-campus interviews. Because the accuracy of the site surveys was dependent on the knowledge and experience of the individuals participating in the surveys and interviews, respondents were limited to department heads, undergraduate and graduate program coordinators, and, senior administrative staff at each institution. Following site visits, data was analyzed using simple frequency distributions and descriptive statistics. Given the limited sample size and non-random selection of participants, the results are not considered (nor intended) to be statistically significant.

Results

Of 10 construction programs visited in 2017, five had programs originating in the 1940s or earlier, including the first program of construction education in the U.S. at the University of Florida in 1935. Seven programs (Arizona State University, Auburn University, Clemson University, Colorado State University, University of Florida, University of Nebraska, and Virginia Polytechnic Institute) were involved in the formation of ASC in 1965. All except the University of Nebraska became charter members. Nebraska and Texas A&M University formally joined ASC the following year along with the University of Washington in 1972. Nine have maintained ACCE undergraduate accreditation for 30 years or more. Five of these institutions have ABET accredited construction engineering (ConE) programs although only 3 (ASU, Nebraska and Virginia Tech) have both CM and ConE programs co-located in the same school. Six programs are located in colleges of architecture and 2 in colleges of engineering. All programs are stand-alone departments or units with undergraduate and graduate enrollments of between 250-1,100 students, the largest of these being Colorado State and Texas A&M. Students at roughly half of the programs surveyed, however, are not counted toward undergraduate enrollment until professional admission during the second or third year, accounting for some variation in enrollment data between programs.

Table 1. General program metrics.

Accreditation	ACCE (10) - CM	ABET (3) - ConE
College	Architecture (6)	Engineering (2) / Other (2)
Unit	School (5)	Department (5)
Enrollment	550 (average)	250-1,100 (range)
System	Semester (8)	Quarter (2)

As public institutions, all programs surveyed are funded by a combination of state appropriations, tuition and fees, endowments and various other sources of income such as overhead on research grants, continuing education, extension, etc., with at least eight programs having significant endowment funds ranging from approximately \$5M to more than \$30M. Five of these programs are designated as (or part of) endowed or named 'schools' (ASU, Auburn, Florida, Nebraska and Virginia Tech). Six (6) programs have differential tuition which allows programs to raise tuition and (or) student fees commensurate with the higher costs of instruction. These discretionary sources of operating income are essential to offset a trend in declining state appropriations which currently account for \$1.5-\$3.5M or roughly one-quarter of the annual operating budgets for these programs. These discretionary funds are also essential for faculty development, staff support and performance incentives, facilities and equipment upgrades, travel, and, student activities and recruitment (e.g. student organizations, scholarships, etc.).

Undergraduate Programs

Undergraduate enrollments in surveyed programs average roughly 465 students, accounting for more than 11,000 student credit/contact hours (SCH) of instruction per year. Of construction management programs surveyed, undergraduate curricula for seven (7) programs consists of 120 credit hours. Of these, between 60 and 70 credit hours are required construction management coursework. Half (5) of these programs have enrollment caps based on academic standing, diversity goals and other selective admissions criteria. Average ACT scores vary from 24-30 among programs and are factored into the admissions primarily for first-year students, of which 50% or more are typically among the top 10% of their graduating class. Several programs, however, waive ACT requirements for transfers. More than half (~60%) of all students in these programs are transfers from other programs, most often from other units within their college (e.g. architecture or engineering) or from community college ‘feeder’ programs. As a result, many students enter CM programs ‘out of sequence’ and must complete additional prerequisite coursework. This, in addition to prior non-credit qualifying coursework in previous majors, results in credits well above 120 credit hours upon graduation for most students.

In addition to university requirements, all programs maintain minimum GPA standards for overall and in-major coursework. In most cases, students must additionally pass required courses with a ‘C’ or better and are limited in the number of times they may retake required courses. Roughly half of programs surveyed offer combined degree programs between CM and ConE programs, undergraduate and graduate programs, and (or) minors (e.g. business, civil engineering, etc.). In addition to university requirements, half of all programs surveyed have a personal computer requirement for students entering to the program.

Table 2. Undergraduate program metrics.

Enrollment	465 (average)	200-1,050 (range)
Credit hours	120-134 (CM)	120-128 (ConE)
ACT	26 (average)	24-30 (range)
Transfer students	60% (average)	20%-80% (range)
Minimum GPA	2.5 (average)	2.0-2.5 (range)
Primary/specialty tracks	Commercial (10)	Yes (5) – civil, MEP, residential
Internship credit/required	Yes (10)	Yes (7)
Student orgs/competition teams	Yes (7ea)	Yes (8ea)
AIC exam/pass rate	Yes (6)	70%
Graduates/year	90 (average)	40-170 (average)
Job placement/salary	>95%	\$58,000 (average)

The undergraduate curriculum for all programs surveyed is aligned primarily to commercial construction, although several programs have specialty tracks in heavy civil and highway construction, residential and specialty contracting (e.g. electrical, mechanical, healthcare, demolition, etc.). All programs offer structured internships for course credit. For seven (7) of these programs, internships of 3-4 and (or) 6-8 months (400 and/or 800 hours) are required prior to the semester of graduation. For programs that require internships, programs often provide assistance and assume some measure of responsibility for internship placement. All programs have student service organizations including industry organizations such as the Associated General Contractors of America (AGC), the Association of Builders and Contractors (ABC) and the National Homebuilder Association (NAHB) as well as academic honor societies such as Sigma Lambda Chi (SLX).

Surveys suggest that programs with a large number of student organizations (≥ 6) often have several organizations that are inactive. In addition, all programs field student competition teams, either voluntary or as partial fulfillment of course credit (e.g. technical elective, Capstone, etc.) The most common of these are commercial, heavy-civil/highway, design-build and specialty teams at the Associated Schools of Construction (ASC) regional competitions and national/open-class competitions. For programs that are large enough to have ‘shadow’ teams of underclassmen, offer course preparation credit and involve industry mentors, the outcome of the competition is usually favorable. In addition, six (6) programs have special studies programs such as international exchange and (or) study abroad programs and five (5) have certificate, distance education, executive and (or) continuing education programs.

All programs have outcome assessments as a condition of accreditation. Roughly half of the programs surveyed (6) utilize the American Institute of Constructors (AIC) level 1 Associate Constructor (AC) certification exam. This third-party exam allows programs to compare student outcomes against national averages in several core competencies including methods and materials, estimating and cost control, scheduling, project management and safety. Programs also utilize some combination of internal exams and (or) senior exit interviews. At least four (4) programs tie exit exams (either AIC or internal) to course credits, usually in senior Capstone. All programs report a senior job placement rate approaching 100% for graduates seeking employment with starting salaries ranging from \$52,000-\$65,000. Salaries appear to be driven by cost of living factors with higher starting salaries on east and west coasts and lower salaries in the south and Midwest.

Graduate Programs and Research

All programs surveyed have graduate programs, although only four (4) have doctoral programs within the school or department with the largest and most established of these at the University of Florida. All masters level curriculum consist of at least 30 credit hours with some variations between thesis and non-thesis degree options. Seven (7) of these programs have requirements for undergraduate course articulation for non-construction majors, core construction coursework requirements (12-18 hours), or both. Each of these programs offer required construction courses distance, during summer semesters, or both. All programs offer graduate teaching and (or) research assistantships with roughly half of all graduate students receiving assistantships funded primarily through the unit or college, discretionary funds (e.g. endowments), research grants or continuing education or extension services. These assistantships typically provide a 0.50 FTE (20 hour/week) stipend, tuition waiver (9-12 credit hours/semester) and in some cases health insurance and other fringe benefits.

Table 3. Graduate programs and research metrics.

MS program/enrollment	Yes (10)	55 (average)/20-115 (range)
PhD program/enrollment	Yes (4)	15 (average)
Credit hours/core CM hours	30-33 (total)	12-18 (core CM)
Assistantships	Yes (7)	20hr/week stipend/tuition
Research expenditures	\$0.75M/year (average)	\$0.2M-2.0M/year (range)
Publications	45 (average)	15-130 (range)

Of all programs surveyed, six (6) have at least one center or institute supported by grants, endowments, or continuing education programs. In a few cases, centers at these programs were also funded by state appropriations or other public funds such as proceeds from contractor licensing fees. External funding supporting research and outreach activities at these programs ranges from approximately \$150K to more than \$2.0M per year, or approximately \$50,000-\$75,000 per tenured and tenure-track faculty. On average, approximately \$5.5M in research proposals are submitted each year by each program to produce \$0.75M in research awards for a success rate of roughly 15%. This amounts to approximately 20 proposals per unit per year or roughly 2 proposals per tenured and tenure-track faculty. As a benefit to the programs as a whole, a portion of the institutional overhead from these grants are usually returned to the participating faculty and unit as discretionary funds for student activities, equipment upgrades, etc. In addition to extramural funding, the production of peer-reviewed publications were found to be another key attribute of scholarly activity at these programs and a key factor for faculty promotion and tenure. On average, programs surveyed produce approximately 40-45 peer-reviewed publications per year, or roughly 20 journal and 20-25 conference proceedings papers. This equates to approximately 4 peer-reviewed publications per tenured and tenure-track faculty per year.

Faculty and Staffing

Among programs surveyed, eight have unit heads with 1-3 years of experience leading their programs. On average, programs surveyed have between 15-20 full-time faculty consisting of tenured and tenure-track faculty, and, non-tenure track instructors, lecturers, clinical faculty or professors of practice. In addition, all programs utilize part-time or temporary adjunct faculty. These most often include practitioners from industry and post-doctoral fellows. Teaching apportionments for tenured and tenure-track faculty average approximately 60% of a full-time equivalent

(e.g. 0.60FTE). This apportionment is equivalent to teaching two 3-credit hour courses per semester, or, four courses per academic year. A 'course' was generally defined as a section of a required or elective course meeting minimum enrollment criteria and not special topics, independent study, thesis or dissertation credits which are often credited as student advising under service apportionment. Teaching loads for tenured and tenure-track faculty vary between programs as do teaching loads for research faculty and new tenure-track faculty which are often reduced by half (e.g. 0.30FTE or 1+1) for the first 2-3 years of the average tenure-accruing period (6 years).

Table 4. Faculty and staffing metrics.

Tenure/tenure track	13 (average)	9 tenured/4 non-tenured
Apportionment/teaching load	60% (T) / 30% (R) / 10% (S)	2 + 2 (12 credit hours - average)
Non-tenure track	5 full-time instructor	4 part-time/adjunct
Apportionment/teaching load	90% (T) / 0% (R) / 10% (S)	3 + 3 (18 credit hours - average)
Faculty/student ratio	1:30 (average)	1:20-1:40 (range)
Student contact hours	570 (average)	450-775 (range)
Research expenditures	\$75,000 per T/TT (average)	\$200,000 per 1.0 (research) FTE
Publications	4-5 per year	2 journal / 2-3 conference
Faculty development funds	Salary supplements (all)	Start-up/travel (all)
Support staff/specialized	4 (admin)	2 (advising/recruiting/industry)

Among non-tenure track faculty, teaching apportionments on average, are significantly higher compared to tenured and tenure-track faculty. Specifically, teaching loads for instructors, lecturers and professors of practice range from 0.80-0.90FTE, or, 3-4 courses per semester. Course credit for teaching multiple sections of the same course vary between programs. Overall, programs credit 12.5%-15.0% FTE per course section. Faculty-to-student ratios at programs surveyed range from 20 at research and graduate intensive institutions, to more than 40 at undergraduate focused programs. Student credit or contact hours average roughly 570 SCH across all programs surveyed.

Salaries for tenure track and non-tenure track faculty were found to be higher among programs surveyed when compared to overall ASC average salaries. Starting salaries for Assistant Professors average \$70,000-\$85,000 depending on prior teaching and (or) industry experience, compared to the average ASC starting salary of \$59,500. Average starting salaries for Professors of Practice average \$65,000 compared to the ASC starting salary of \$53,000, although salaries for lecturers and instructors with extensive industry experience may exceed \$90,000. Salaries for tenured faculty typically start at \$90,000 for Associate Professors and can well exceed \$150,000 for Full Professors, especially those serving in unit leadership positions. For all faculty except unit heads, salaries are typically 9-month, with additional salary available for summer teaching, research or administrative assignments. All programs surveyed provide performance-based salary supplement incentives, travel funds and other sources of faculty development support such as 'start-up' funding for new faculty. Travel funds provided by programs surveyed range from \$750-\$5,000 per faculty per year (\$3,500 average).

Among programs surveyed, each have on average 4-6 dedicated administrative staff of which two are specialized staff providing support for information technology, academic advising, student recruiting, industry and alumni relations, job placement and related functions. Often, these staff are former industry professionals.

Facilities and Equipment

Six programs surveyed have dedicated, stand-alone facilities with at least 2 other programs in the planning and fundraising stages for new facilities. These facilities average 43,500 GSF or roughly 70-90 GSF per student, and include specialized instructional spaces including several BIM and virtual design and construction (VDC) spaces as well more traditional soils, structures, MEP and safety labs. In addition, all programs have trade partner, craft awareness and (or) field simulation facilities including high bay spaces with overhead cranes, field labs and offsite laydown yards. Within each of these spaces exists the full complement of specialized testing and personal protective equipment (PPE) as well as demonstration units and mock-ups for field lab exercises (e.g. formwork, wiring, plumbing, rigging, etc.). In addition, seven programs have at least one dedicated vehicle for student travel to field trips, student competitions, etc.



Figure 2. Program facilities, Auburn University (left) and Arizona State University (right).

Industry and Alumni Relations

Industry and alumni involvement was found to be integral for programs having significant endowments and those designated as named schools. For all programs, industry and alumni relations are most often engaged through their respective industry advisory organizations and university foundations. Among programs surveyed, industry advisory organizations have on average between 50 and 200 individual and corporate members, some organized as an independent, non-profit entities (e.g. 503.c.). For larger organizations, members are generally organized into tiers, with the top tier (e.g. 'executive' council or committee) often reserved for the largest employers and (or) benefactors. In addition to program guidance, curriculum development and faculty mentorship, industry advisory organizations were naturally found to be extensively involved in student recruitment and employment activities.

Among programs surveyed, most have internship and job placement events (e.g. career fairs) that attract between 75 and 175 construction employers twice per year, each paying between \$500 and \$2,500 to participate in each event. Similarly, several programs have nationwide alumni networks or associations in partnership or independent of the university foundation. Along with industry, alumni were found to be key contributors to outreach and fundraising efforts that provide support for student scholarships and activities, staffing and performance incentives (e.g. endowed chairs and professorships), new facilities and equipment, teaching assistantships, and in some cases, applied research. In addition to job placement and salary, scholarships were found to be an important recruitment tool for prospective students. Among programs surveyed, 50-100 undergraduate students receive scholarships from industry and alumni each year.

Table 5. Industry and alumni relations.

Industry advisory board	50-200 members	Membership levels, fee
Career fair	75-175 employers	\$500-\$2,500 ea.
Scholarships	50-100/year	\$1,000-\$5,000

In addition, nearly all programs conduct surveys every 1-5 years to re-engage alumni and to assess program strengths and weakness as graduates progress in their construction careers. Among all programs visited, recognition of industry sponsorship and alumni was readily visible in promotional materials and displays. Specifically, at least five programs have an alumni 'hall of fame' or similar to recognize graduates for their contributions to industry and to their respective programs.

Summary and Conclusions

According to the department heads, program coordinators and senior administrative staff surveyed, industry and alumni involvement was considered most critical in terms of providing support for faculty and staff, facilities and equipment, curriculum development, scholarships and internships, student organizations and job placement. Specifically, industry and alumni financial support was found to be essential to offset a trend in declining state appropriations at public land-grant institutions, which currently account for roughly one-quarter or less of the annual operating budgets for these programs. Although construction programs were found to be highly valued in colleges of Architecture, these and other liberal arts colleges tend to be devalued and under-funded at major public research universities. Conversely, colleges of Engineering tend to be highly valued and funded at major public research universities, but construction programs within colleges of Engineering do not tend to be valued or funded at levels comparable to other engineering disciplines.

Among programs surveyed, discretionary funding provided by industry and alumni support enabled programs to hire experienced faculty and staff from industry, provide scholarships to increase student admissions standards and enrollment, build state-of-the-art facilities, and, provide resources for industry outreach and applied research. Together, these and other industry-driven outcomes have enabled these programs to provide the level of preparation required by the construction marketplace while moving the profession of construction education closer to acceptance and recognition by both the academy and university administration.

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