2006-1748: A SURVEY OF THE AMERICAN ARCHITECTURAL ENGINEERING CURRICULUM

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A Survey of the American Architectural Engineering Curriculum

Abstract

This paper presents the results of a comprehensive survey of all ABET (Accreditation Board for Engineering and Technology) accredited architectural engineering programs. The analysis is based on data collected from a detailed study of the curricula of these programs. Five major groups of courses are discussed: mathematics and science, general education, architecture, other, and engineering coursework. The analysis reveals what is, or is not, being covered in architectural engineering and the implications for future professional practice. The paper discusses the two approaches to teaching architectural engineering (from the architecture schools and from engineering schools), how well curricula satisfy ABET accreditation criteria, and what the current distribution of coursework indicates is the priority of architectural engineering education. Like many other disciplines, it is apparent that the current architectural engineering curriculum is highly specialized when it comes to technical subjects, but rather unfocused regarding liberal arts and other important non-technical skills.

Introduction

The field of architectural engineering is currently experiencing an exciting growth, as illustrated by the growth and development of the Architectural Engineering Institute (AEI), which is part of the American Society of Civil Engineers (ASCE)[1]. Also, the National Council of Examiners for Engineering and Surveying has recently added a professional engineering licensing exam in the area of architectural engineering. This clearly indicates that the demand for programs in architectural engineering is strong and with the booming building construction industry, the demand for architectural engineers is expected to continue to grow.

There are several sources listing different architectural engineering programs. The Gourman Report[6] includes rankings of architectural engineering programs and lists eight programs. The Princeton Review lists twenty-one programs, some of which are architectural engineering technology[7]. The AEI webpage lists sixteen programs, two of them as new degree programs[1]. The 2003[3] and 2004[2] editions of the ASEE Profiles of Engineering and Engineering Technology Colleges lists seventeen programs, one of which did not list architectural engineering on their website. Table 1 lists the enrolment and number of degrees awarded by these seventeen programs. These data clearly indicates an increasing trend in the number of students pursuing architectural engineering.

Table 1: Enrolment and degrees awarded in Architectural Engineering[2].

	1999	2000	2001	2002	2003	2004
Part-time	152	97	110	102	126	116
Full-time	2015	2360	2404	2537	2793	2878
Total Enrolment	2167	2457	2514	2639	2919	2994
Degrees Awarded	497	559	554	513	627	590

ABET lists fifteen programs as being accredited, fourteen of which are accredited at the bachelor's level and one at the master's level. This is the group of programs used in the analysis for this paper. The programs are:

1. California Polytechnic State University - San Luis Obispo, San Luis Obispo, CA (accredited since 1975, and housed in the College of Architecture and Environmental Design, Department of Architectural Engineering);
2. University of Colorado at Boulder, Boulder, CO (accredited since 1936, housed in the College of Engineering, Department of Civil, Environmental, and Architectural Engineering);
3. Drexel University, Philadelphia, PA (accredited since 1991, housed in the College of Engineering, Department of Civil, Architectural, and Environmental Engineering);
4. Illinois Institute of Technology, Chicago, IL (accredited since 2003, housed in the College of Engineering, Department of Civil and Architectural Engineering);
5. Kansas State University, Manhattan, KS (accredited since 1980, housed in the College of Engineering, Department of Architectural Engineering and Construction Science);
6. The University of Kansas, Lawrence, KS (accredited since 1936, housed in the College of Engineering, Department of Civil, Environmental, and Architectural Engineering);
7. The University of Miami, Coral Gables, FL (accredited since 1962, housed in the College of Engineering, Department of Civil, Architectural, and Environmental Engineering);
8. Milwaukee School of Engineering, Milwaukee, WI (accredited since 1988, housed in the College of Engineering, Department of Architectural Engineering and Building Construction);
9. North Carolina Agricultural and Technical State University, Greensboro, NC (accredited since 1969, housed in the College of Engineering, Department of Civil, Architectural, Agricultural, and Environmental Engineering);
10. Oklahoma State University, Stillwater, OK (accredited since 1986, housed in the College of Engineering, Architecture, and Technology, School of Architecture, Architectural Engineering Program);

11. Pennsylvania State University, University Park, PA (accredited since 1936, housed in the College of Engineering, Department of Architectural Engineering);
12. Tennessee State University, Nashville, TN (accredited since 1977, housed in the College of Engineering, Technology, and Computer Science, Department of Architectural and Facilities Engineering);
13. The University of Texas at Austin, Austin, TX (accredited since 1938, housed in the College of Engineering, Department of Civil, Architectural, and Environmental Engineering);
14. The University of Wyoming, Laramie, WY (accredited since 1986, housed in the College of Engineering, Department of Civil, Environmental, and Architectural Engineering); and
15. The University of Nebraska-Omaha, Omaha, NE (**MAE** has been accredited since 2004, housed in the College of Engineering and Technology, Department of Architectural Engineering).

There are two new programs that intend to seek accreditation in the near future and will also be included in this study:

16. The University of Missouri at Rolla (housed in the College of Engineering, Department of Civil, Architectural, and Environmental Engineering) and
17. Texas A&M University – Kingsville (housed in the College of Engineering, Department of Civil and Architectural Engineering).

An in-depth analysis of the student body of the two general types of programs, four- and five-year programs will be conducted in a later publication. Here we provide a general analysis of the two types of programs: five-year programs such as the one at Oklahoma State University and four-year programs such as the one at The University of Texas at Austin. The program at Oklahoma State University is housed in the school of architecture with the faculty teaching architectural engineering numbering five. The enrolment is approximately 50 students, 65% of who are from Oklahoma and the remaining 35% international and from other states[5]. The program is not a traditional engineering program; it is a professional program with admission limited only to those students in their junior year, not the freshman level. This is a very selective program, accepting only 15 students per year. The program produces 10 to 15 graduates each year. The University of Texas at Austin's program is housed in the Department of Civil, Architectural, and Environmental Engineering, and is the number one ranked architectural engineering program in the country based on the Gourman report[4]. The Architectural Engineering program (comprising 40% of the student body in the Department) has averaged 270 admissions applications per year over the last two years. Freshman admission into the program is limited to an average of 78 students or 29% of the applicants according to Dr. Edward Gibson[4], former Associate Chairman for Architectural Engineering. The main reason for limiting enrolment of freshman students according to Dr. Gibson is limited space, including laboratory and studio facilities. This program produces approximately 40 graduates per year.

The programs at Texas and Oklahoma State exemplify the two types of existing programs in Architectural Engineering: those housed in engineering (the majority) and those housed in architecture (two programs). There are other programs that are not ABET accredited, such as the program at the University of Illinois at Urbana-Champaign (housed in architecture), and other programs that are not accredited by ABET because they are certification programs (such as the one at Duke University) or civil engineering programs with emphasis on architectural engineering (such as the one at California State University at Fullerton).

Methodology

These seventeen programs may be divided into two general categories: four- and five-year programs. The academic periods include both semesters and quarters. In general, there are two semesters and three quarters per year. All five-year programs (four of the seventeen) are on semester academic periods. Three of the four-year programs are on quarter academic periods; the remaining ten programs are on semester periods. Generally, semester and quarter based programs account for course hours in different ways. A typical four-year semester based program is between 126 to 136 semester credit hours, four-year quarter based programs are between 193 to 203 quarter hours. Five-year programs are between 158 to 167 semester credit hours. Typically, the quarter-based programs divide course sequences more finely than those programs that are semester based. For instance, a calculus sequence in semester credit hours may be divided into two three-credit hour courses, but in the quarter system this same sequence is divided in to more courses (three or more) of the same number of hours. Table 2 lists the minimum, average, and maximum number of hours required for all AE programs in the USA. The quarter and four-year semester based programs have similar requirements; therefore, the remaining analysis will compare only the semester based four- and five-year programs.

Table 2: Average National Architectural Engineering Curriculum.

Four-Year Programs						Five-Year Programs Semester-based (4 programs)		
Semester-based (10 programs)			Quarter-based (3 programs)					
Min	Average	Max	Min	Average	Max	Min	Average	Max
126	129.3	136	193	197.8	203	158	162.2	167

With regards to required courses, the analysis of the national AE curriculum is divided into five general areas: (1) mathematics and science (including computer science), (2) general education, (3) architecture, (4) engineering, and (5) other (including technical electives). These classifications are based on five general areas identified by ABET for accreditation of architectural engineering programs. The information was collected by analyzing the published curricula of the seventeen different programs. Table 3 lists the minimum, average, and maximum number of hours required in each of the aforementioned general areas for the semester-based programs.

Table 3: Average National Architectural Engineering Curriculum by Category.

	Four-Year Programs Semester-based (10 programs)			Five-Year Programs Semester-based (4 programs)		
Categories	Min	Average	Max	Min	Average	Max
Architecture	6	11.6	16	11	29.2	45
Mathematics and science	26	32	37	32	35	38
General education	12	19.3	27	12	18.5	24
Technical Electives	6	8.8	18	6	10	12
Engineering	52	57.7	65	61	69.5	74

Table 3 clearly illustrates that the additional year is spent primarily on architecture and engineering courses. On average, students on the five-year curricula spend 18 additional hours, or six 3-hour courses, on architecture than those on the four-year curricula; this represents a 150% increase in time spent on architecture topics when comparing the four- and five-year programs. Engineering is another area where the five-year programs spend more time, though not as significant as architecture. The increase is only 12 hours or four 3-hour courses, a 20% increase.

Conclusions

The analysis presented in this paper is expected to give architectural engineering program administrators a comparison of their curriculum to that of the national average. It is interesting to note that there is an increase of one 3-hour course in the technical electives area, but no significant increase in mathematics and science or the general educational requirements as five-year programs compared to four-year programs. Regarding ABET, all programs comply with the semester hour count in the three areas required: general (one semester), mathematics and science (one year), and engineering (one an one-half years). It is the hope of the author that this discussion will start a national dialog regarding the requirements for the architectural engineering programs in the US. It appears that the four year curriculum is serving the architectural community well; however, with the new national movement in engineering to move to the Masters Degree (or equivalent 30+ graduate hours) as the first professional degree, it might reasonable to assume that the five year programs already meet this criterion. Another issue that must be considered is that of states trying to curtail their public universities curricula to fewer hours than currently required. For instance, in the state of Texas, we are considering a 120

hour curriculum for all bachelor's degrees. It will be interesting to see if we can continue to cut hours and still provide the necessary information to our students so that they can fully participate as practicing engineers upon graduation or shortly thereafter. Let the dialog begin!

Bibliography

1. American Society of Civil Engineers (ASCE), Architectural Engineering Institute (AEI), URL: http://www.aeinstitute.org, accessed October 2005.
2. American Society of Engineering Education (ASEE), 2004 Edition of Profiles of Engineering and Engineering Technology Colleges, 2005, ASEE.
3. American Society of Engineering Education (ASEE), 2003 Edition of Profiles of Engineering and Engineering Technology Colleges, 2004, ASEE.
4. Estrada, H. Personal communication with Dr. Edward Gibson, former Associate Chairman for Architectural Engineering at the University of Texas at Austin.
5. Estrada, H. Personal contact on December 14, 2004 with Dr. Randy Seitsinger, Professor and Head of the School of Architecture at Oklahoma State University.
6. Gourman, J. (2004). Gourman Report: Rankings of Colleges by Department, 10th Edition.
7. The Princeton Review, Schools Offering the Major of Architectural Engineering, URL: http://www.princetonreview.com, accessed July 2005.