Today’s BSCE: A Survey of Credit Hour Requirements

Abstract

The purpose of this paper is to present the results of a survey and analysis of today’s civil engineering and closely related curricula in terms of credit hours required for degree. There has been considerable discussion nationally about a trend to reduce credit hour requirements. While this paper does not address any historical trends, it does provide a comprehensive description of today’s degree requirements. This includes both total credit hour requirement for degree as well as a breakdown of the credit hours required in various major topic areas/categories, such as mathematics and basic sciences, general engineering topics, and general education. The data presented herein also provides individual programs with a sound base from which comparisons of their own program(s) may be made.

Introduction

It seems as though there is a near constant discussion about credit hour requirements, particularly with reference to a so-called “credit hour squeeze.” As the cost of education continues to rise, state legislators, boards of trustees/regents, and other external constituencies push for further efficiencies, reduced costs, improved graduation rates, etc. Many times, the only mechanism for “controlling” cost and time in an academic program is setting limits on the credit hours required for a degree. In some cases, it may be limiting the total hours required for a degree. In other cases, it may be limiting the number of hours allowed per academic term. Regardless, such actions are becoming commonplace in higher education and may limit a program’s ability to include the content the faculty or employers expects or, in the case of accreditation, requires.

Adding to potential credit hour constraints such as those imposed by an institution, there is recognition of the continued increase in what is expected from today’s graduates. What used to be taught only at the graduate level is, in many cases, expected to be made available to undergraduates (through electives) if not required for an undergraduate degree. New engineering analysis and design tools and techniques are being continuously developed. This “exploding body of knowledge” is, without question, impacting what and how the next generation will be and is being educated [4]. While certain topics may have or will become obsolete (e.g., graphical methods in structural analysis) and while certain efficiencies in instruction have been and will continue to be realized through technology (e.g., asynchronous virtual laboratories), there is little doubt that more is expected out of today’s baccalaureate curricula than ever before.

The purpose of this paper is to present the results of a survey of the credit hour requirements of today’s bachelor’s degree in civil engineering and closely related fields. While this paper does not address any historical trends, it does provide a comprehensive description of today’s degree requirements. This include both total credit hour requirement for degree as well as a breakdown of the credit hours required in the traditional ABET categories of mathematics and basic sciences, general engineering topics, and general education [2].
Description of Survey and Respondents

A short and focused survey was developed which requested the following information:

1. Total credit hours required in “engineering topics”;
2. Total credit hours required in “mathematics and basic sciences”;
3. Total credit hours required for “general education”;
4. Total credit hours required in “other” areas;
5. Total credit hours required for degree; and
6. Whether the program was on the semester or quarter system.

The requested credit hour information is consistent with ABET self-study reporting requirements, specifically “Table 5-1 Curriculum” of the ABET self-study report [2] (or prior to 2008, “Table I-1 Basic-Level Curriculum”). As an alternative to completing the survey, respondents were also allowed to provide the curriculum table from their most recent ABET self study if they preferred.

The survey was administered through the ASCE Department Heads Council (DHC) list serve. The DHC includes the heads/chairs of civil engineering, architectural engineering, construction engineering, and environmental engineering departments from throughout the United States and beyond [3]. Therefore, in addition to gathering the above information on civil engineering programs, data was also collected on other closely related degree programs.

A total of 90 programs responded to the survey as summarized in Table 1. Two of the responding programs were five-year programs. All other programs were traditional four-year programs. The majority of the respondents were civil engineering programs (82.2%), with environmental engineering comprising the second largest number (11.1%). Architectural (4.4%), construction (1.1%) and structural (1.1%) programs also are included in the response data.

Table 2 provides the response rates, which are based on the current number of ABET-accredited bachelors-level programs [1]. For civil engineering programs, approximately one-third of the programs responded and are included in this study. Considering civil engineering plus the other closely related programs, slightly more than one-fourth of all programs responded and are included in the study.

Results of Survey

To provide a consistent base for comparison, the two five-year programs were excluded from the data analyses. Additionally, the credit hour requirements for all quarter-based programs were converted to semester credit hours for uniformity in the data. Finally, some programs allow, based on course selection, a range of credit hours within the various credit hour categories. For example, a program may require 36 to 39 hours of math and science and 63 to 66 hours of engineering topics, with 3 credit hours required in either math and science or engineering topics. For data comparisons, the minimum hours allowed are used in each category (e.g., 36 hours in math and science, and 63 hours in engineering topics). This may result in, for a particular program, the summation of credit hours to be less than the total hours required. This difference
was typically small (1 to 4 hours) and is referred to in this study as “restricted electives” because they typically would be taken in one of two categories (e.g., in the above example, 3 credit hours would be designated as “restricted electives”).

It was determined that no statistical difference existed between the civil engineering program data set (74 programs) and the data set combining all the programs’ response data (88 programs). Therefore, the response data from all 88 four-year programs is included in all data analyses presented in this paper.

Table 3 provides summary statistics of the response data from the 88 four-year degree programs. The mean total credit hours required for degree is 130 hours with a coefficient of variation (COV) of 3.4%, the least variable (most consistent) of the credit hour values polled. The mean engineering credit hour requirements is the next most consistent value with a mean of 65.1 hours and COV of 11.4%. An average of 34.3 credit hours is required for math and basic sciences with a COV of 18.7%. General education requirements average 24.9 credit hours with a COV of 20.6%. The most variable credit hour component is the other hours with a mean of 4.5 and COV of 131.4%. It is worth noting that 33 of the 88 (37.5%) reported zero other hours required.

Furthermore, since general education and other hours often are considered to limit the number of hours a program may use in engineering, math and science, the general education hours were combined into a single credit-hour value for each program. The mean hours required for general education and other is 29.4 with a COV of 22.4%. Accordingly, based on the data summarized in Table 3, today’s “average” bachelor of science degree requirements includes slightly more than half the total hours in engineering topics, one-fourth of the total hours in math and science, one-fifth of the total hours for general education requirements, and the remainder of the hours used in other courses.

(Note: The two five-year responding programs require a total of 173 and 175 credit hours. The two programs include, respectively, 85 and 100 credit hours of engineering topics, 52 and 37 credit hours of math and science, 27 and 29 credit hours of general education, and 9 hours each of other credit hours.)

Basic statistics such as those provided in Table 3, while providing characteristic information for initial comparative purposes, be misleading since they provide little insight into the variation and distributions of the credit hours. To provide a more descriptive presentation of the credit hour requirements in today’s curricula, simple plots are provided for each data set. Figure 1 provides a summary of the total credit hours required for degree. Figure 1(a) provides the percentage of programs requiring various total credit hours and Figure 1(b) illustrates the cumulative percentage of programs requiring the same various total credit hours. The most common requirement is 128 total credit hours with the next most common being 132 total hours. Figures 2-6 provide similar presentations of the credit hour requirements for engineering topics (Figure 2), mathematics and basic science (Figure 3), general education (Figure 4), other (Figure 5), and general education combined with other hours (Figure 6).

The credit hour categories, however, cannot be looked at in isolation or individually. Credit hours in certain categories may be mandated, such as with general education requirements dictated by an institution or minimum content in math and science as required by accreditation. Credit hours in other categories may be influenced by the desires of faculty, employers, or other
external constituencies, such as requiring additional depth or breadth in certain engineering
topics. Regardless, often times choices must be made between certain topics areas in recognition
of the total hours required for degree. One way to explore these relationships and trade-offs is a
simple correlation analysis as presented in Table 4.

Considering the correlations between engineering topics and the other categories, it is noted that
with the exception of a small positive correlation with total credit hours all other credit hour
categories are negatively correlated with engineering topics. That is, as additional credit hours
are assigned to math and science or general education (plus other), engineering credit hours tend
to be reduced. This observation may simply serve to confirm what many already believe;
however, the correlation between engineering topics and general education is only -0.17.
Interesting, though, is the lack of any significant correlation between the non-engineering topic
areas. Consider, for example, the 0.06 correlation between general education and math and
science. Thus, the primary trade-off may be between engineering topics and math and science,
which have a correlation of -0.38. This observation is significant noting that, on average,
nominally three-quarters of a today’s degree programs are comprised of these two topic areas. In
fact, looking at the correlations of the total hours required with the various credit hour categories,
the strongest correlations are with the non-technical credit hours (i.e., the general education and
other categories). Thus, as total credit hours increase, the additional hours tend not to go into
engineering topics or math and science.

To provide a visual illustration of how programs divide up the credit hours, two plots were
developed which include all the respondent data. Figure 7 provides a plot of the credit hours
required for each program. The data is rank ordered in ascending order from the lowest total
hours required (120 hours) to the greatest (146.5 hours). This plot includes only the 88 four-year
programs. For each program, the engineering topic hours, math and science hours, general
education hours, other hours, and what is referred to as “restricted elective” hours are included.
As noted previously, for data comparisons, the minimum hours required by a program are used
in each category and the remaining hours were designated as “restricted electives”. This allowed
the minimum allowed hours to be represented in the data while still having the total hours
required for degree to be accurately represented.

Figure 8 is similar to Figure 7, except that the data is rank ordered in ascending order from the
lowest engineering topic hours required (40 hours) to the greatest (81 hours), noting again that
this plot includes only the data from the 88 four-year programs. In this plot the negative
correlation between engineering topics and math and science is noted (i.e., the math and science
hours tend to be greater towards the left, where the engineering hours are lower, and less towards
the right, where the engineering hours are higher). Also noted in this plot is the tendency for the
other hours to be associated with the programs with lower engineering topic credit hours (i.e., the
other hours tend to be larger and more concentrated to the left). There is no readily visible trend
in the general education hours except for a slight reduction for the programs with the higher
engineering content (i.e., the programs furthest to the right).
Summary

The purpose of this paper was to present the results of a survey of the credit hour requirements and provide a comprehensive description of today’s degree requirements. The survey included input from 90 separate civil (74), architectural (4), construction (1), environmental (10) and structural (1) engineering programs. Two of the 90 respondent programs were five-year curricula and 88 of the programs were four-year curricula. For comparative purposes, only the four-year programs were included in the data presentations. The study provided data regarding both the total credit hour requirements for degree, as well as a breakdown of the credit hours required in the traditional ABET categories of mathematics and basic sciences, general engineering topics, and general education. Based on the respondent data, today’s “average” bachelor of science degree is 130 hours and includes slightly more than half the total hours in engineering topics (65 hours), one-fourth of the total hours in math and science (34 hours), one-fifth of the total hours for general education requirements (25 hours), and the remainder of the hours used in other courses. In addition to simple credit hour totals, the correlations between the various credit hour categories were examined. It was observed that as additional credit hours are assigned to math and science or general education (plus other), engineering credit hours tend to be reduced. The data showed no significant correlation between the non-engineering topic areas; therefore, the primary trade-off may be between engineering topics and math and science, noting that nominally three-quarters of a today’s average degree program is comprised of these two topic areas. The strongest correlations of the total hours required are with the non-technical content of the degree (i.e., the general education and other categories). Thus, as total credit hours increase, the additional hours tend not to go into engineering topics or math and science.

References


Table 1. Summary of Program Respondents.

<table>
<thead>
<tr>
<th>Program Respondent</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Responses</td>
<td>90</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Civil Engineering</td>
<td>74</td>
<td>82.2%</td>
</tr>
<tr>
<td>Total Architectural Engineering</td>
<td>4</td>
<td>4.4%</td>
</tr>
<tr>
<td>Total Construction Engineering</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>Total Environmental Engineering</td>
<td>10</td>
<td>11.1%</td>
</tr>
<tr>
<td>Total Structural Engineering</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>Total Four-Year Programs</td>
<td>88</td>
<td>97.8%</td>
</tr>
<tr>
<td>Total Five-Year Programs</td>
<td>2</td>
<td>2.2%</td>
</tr>
<tr>
<td>Semester-Based Programs</td>
<td>74</td>
<td>84.1%</td>
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<tr>
<td>Quarter-Based Programs</td>
<td>14</td>
<td>15.9%</td>
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</table>

Table 2. Response Rates.

<table>
<thead>
<tr>
<th>Program</th>
<th>Number of ABET Programs</th>
<th>Number of Respondents</th>
<th>Percent Responding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Engineering</td>
<td>229</td>
<td>74</td>
<td>32.3%</td>
</tr>
<tr>
<td>Architectural Engineering</td>
<td>17</td>
<td>4</td>
<td>23.5%</td>
</tr>
<tr>
<td>Construction Engineering</td>
<td>11</td>
<td>1</td>
<td>9.1%</td>
</tr>
<tr>
<td>Environmental Engineering</td>
<td>64</td>
<td>10</td>
<td>15.6%</td>
</tr>
<tr>
<td>Structural Engineering</td>
<td>1</td>
<td>1</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>322</td>
<td>90</td>
<td>28.0%</td>
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</tbody>
</table>
Table 3. Summary Statistics of Response Data (Four-Year Programs Only).

<table>
<thead>
<tr>
<th>Summary Statistic</th>
<th>Engineering Topics</th>
<th>Math and Science</th>
<th>General Education</th>
<th>Other</th>
<th>General Ed + Other</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>65.1</td>
<td>34.3</td>
<td>24.9</td>
<td>4.5</td>
<td>29.4</td>
<td>130.0</td>
</tr>
<tr>
<td>Minimum</td>
<td>40.0</td>
<td>1.0</td>
<td>14.0</td>
<td>0.0</td>
<td>18.0</td>
<td>120.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>81.0</td>
<td>56.7</td>
<td>53.0</td>
<td>32.0</td>
<td>63.0</td>
<td>150.5</td>
</tr>
<tr>
<td>Median</td>
<td>65.2</td>
<td>34.0</td>
<td>24.6</td>
<td>3.0</td>
<td>28.5</td>
<td>130.0</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>7.4</td>
<td>6.4</td>
<td>5.1</td>
<td>6.0</td>
<td>6.6</td>
<td>4.4</td>
</tr>
<tr>
<td>COV</td>
<td>11.4%</td>
<td>18.7%</td>
<td>20.6%</td>
<td>131.4%</td>
<td>22.4%</td>
<td>3.4%</td>
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</table>

Table 4. Correlations Between Credit Hour Requirements.

<table>
<thead>
<tr>
<th></th>
<th>Engineering Topics</th>
<th>Math and Science</th>
<th>General Education</th>
<th>Other</th>
<th>General Ed + Other</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Topics</td>
<td>1.00</td>
<td>-0.41</td>
<td>-0.17</td>
<td>-0.49</td>
<td>-0.58</td>
<td>0.12</td>
</tr>
<tr>
<td>Math and Science</td>
<td></td>
<td>1.00</td>
<td>0.06</td>
<td>-0.05</td>
<td>0.00</td>
<td>0.13</td>
</tr>
<tr>
<td>General Education</td>
<td></td>
<td></td>
<td>1.00</td>
<td>-0.30</td>
<td>0.51</td>
<td>0.44</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td>0.67</td>
<td>0.13</td>
</tr>
<tr>
<td>General Ed + Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td>0.45</td>
</tr>
<tr>
<td>Total Hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>
Figure 1. Summary of Total Credit Hours Required (Four-Year Programs Only).
Figure 2. Summary of Engineering Topic Hours Required (Four-Year Programs Only).
Figure 3. Summary of Math and Science Hours Required (Four-Year Programs Only).
Figure 4. Summary of General Education Hours Required (Four-Year Programs Only).
Figure 5. Summary of Other Hours Required (Four-Year Programs Only).

(a) Percent of Programs Requiring Various Other Credit Hours

(b) Cumulative Percent of Programs Requiring Various Other Credit Hours
Figure 6. Summary of Combined General Ed + Other Hours Required (Four-Year Programs Only).
Figure 7. Credit Hours Required in Assending Rank Order of Total Hours Required for Degree (Four-Year Programs Only).

Figure 8. Credit Hours Required in Assending Rank Order of Engineering Hours Required for Degree (Four-Year Programs Only).