Mechanical engineering curricula: a baseline study for the future effects of ABET EC2000

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Abstract The Accreditation Board for Engineering and Technology (ABET) is recognized by the US Department of Education as the sole agency responsible for accreditation of educational programs leading to degrees in engineering, engineering technology, and related engineering areas. Starting in 2001, engineering programs are being accredited under the new Engineering Criteria 2000 (EC2000). The philosophy of Engineering Criteria 2000 is to allow institutions and programs to define their mission and objectives to meet the needs of their constituents and enable program differentiation. Emphasis is placed on continuous improvement of programs based on the input of constituents and a process that links outcomes and assessment to program objectives. This paper is a preliminary study of selected mechanical engineering programs to discern the impact of EC2000 on curriculum development. Data on the layout and composition of mechanical engineering curricula for nine schools in the United States with PhD programs and nine schools without PhD programs are presented. This research establishes a baseline for these mechanical engineering programs at the beginning of EC2000 implementation. A follow-on study in two to three years in envisioned. This follow-on study will compare results and identify any significant changes in curricula as the EC2000 assessment process matures.

Keywords mechanical engineering program; mechanical engineering curricula; curriculum development; ABET; EC2000

Introduction

This paper is a preliminary study of selected mechanical engineering programs to discern the impact of the Accreditation Board of Engineering and Technology's new Engineering criteria 2000 (EC2000) on curriculum development. The Accreditation Board for Engineering and Technology (ABET) is recognized by the US Department of Education as the sole agency responsible for accreditation of educational programs leading to degrees in engineering, engineering technology, and related engineering areas. Engineering programs will be accredited under the new EC2000 starting in the fall of 2001. The philosophy of EC2000 is to allow institutions and programs to uniquely define their mission and objectives to meet the needs of their constituents and enable program differentiation. Emphasis is placed on continuous improvement of programs based on the input of constituents and a process that links outcomes and assessment to program objectives.

The views expressed herein are those of the author and do not purport to reflect the position of the US Military Academy, the Department of the Army, or the Department of Defense.

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This research establishes a baseline for selected mechanical engineering programs at the beginning of EC2000 implementation. A follow-on study is envisioned in two or three years to compare results and identify any significant changes in curricula as the EC2000 assessment process matures.

Background

Nine schools with PhD programs and nine schools without PhD programs in mechanical engineering were selected for inclusion in this study. The schools chosen offer a wide geographic representation of the United States.

The set of criteria for accrediting engineering programs is changing from what ABET previously referred to as a set of 'Conventional Criteria' to one identified as 'Engineering Criteria 2000.' For reviews occurring during the three years of 1998–99 through 2000–01, institutions were allowed to elect to have their programs evaluated under either the Conventional Criteria or Engineering Criteria 2000. All reviews occurring during 2001–02 and thereafter are being conducted under Engineering 2000 [1]. Table 1 lists the schools chosen for this study and criteria under which they conducted or plan to conduct their review during this transition period.

Conduct of the study

The mechanical engineering curriculum for the selected schools was attained from the most recent information available at the respective school's website [2–19].

TABLE 1 *ABET criteria selection for schools studied*

Institution	Year of last/next review	Criteria under which review was conducted
Rochester Institute of Technology	1998	Conventional Criteria
Cooper Union	2000	Engineering Criteria 2000
Rose–Hulman Institute of Technology	2000	Engineering Criteria 2000
Cal Poly State University–San Luis Obispo	2002	Engineering Criteria 2000
Bucknell University	2002	Engineering Criteria 2000
United States Military Academy	2002	Engineering Criteria 2000
United States Naval Academy	1999	Conventional Criteria
United States Air Force Academy	2002	Engineering Criteria 2000
United States Coast Guard Academy	2001	Engineering Criteria 2000
Georgia Institute of Technology	2002	Engineering Criteria 2000
University of Michigan–Ann Arbor	1999	Engineering Criteria 2000
University of Minnesota–Twin Cities	2001	Engineering Criteria 2000
Stanford University	2000	Engineering Criteria 2000
Carnegie Mellon University	2000	Engineering Criteria 2000
Cornell University	1998	Conventional Criteria
Purdue University–West Lafayette	2001	Engineering Criteria 2000
University of Illinois–Urbana–Champaign	2001	Engineering Criteria 2000
University of Texas–Austin	1998	Conventional Criteria

Degree requirements were broken down into 10 sub-areas for technical subjects and a lumped category of liberal arts and social science subjects. The technical subject breakdown included topics in: (1) mathematics; (2) physics, chemistry, and basic sciences; (3) computer-aided design, engineering design graphics, and numerical methods; (4) statics, dynamics, solid mechanics, and mechanics of materials; (5) electrical engineering and electronics; (6) thermal fluid sciences and heat transfer; (7) vibration, system dynamics, and controls; (8) material sciences; (9) mechanical design, machine design, and manufacturing; and (10) technical and free electives.

Admittedly, the grouping of technical subjects was difficult in most of the programs studied and several assumptions were made to divide topic coverage appropriately. As such, the author expresses his apologies in advance if any of the selected institutions feel that their programs might be misrepresented. Substantial judgment and interpretation had to be applied in determining how to best allocate course work to the defined categories.

As far as possible, core technical curriculum requirements were included in the breakdown of subject areas to minimize coursework placed in the electives category. Some of the mechanical engineering programs studied are beginning to introduce mechatronics into their curriculum. When these mechatronics courses were part of the mechanical engineering core degree requirements, they were placed in the vibration, system dynamics, and controls category. Otherwise, they were included as electives.

A few programs listed instrumentation, experimentation, measurement, and laboratories as separate coursework. When these courses could be clearly tied to one of the defined technical subject areas, they were included in those respective categories. Otherwise, these courses were again included as electives.

Many of the schools' websites included a 'typical course sequence' to satisfy the mechanical engineering degree requirements. When this was the case, these layouts were used in representing the general curriculum requirements for that institution.

Graphs of the programs studied are presented in Figs 1–6. These graphs include only technical subject areas in the mechanical engineering programs. Along the abscissa are the defined technical subject areas. Along the ordinate axis is the percentage of each school's program requirements for particular subject areas as compared with the total requirements for degree completion.

Comparison with previous studies

A similar study was conducted in 1987 [20]. Whereas the current study relies on information from websites, the 1987 study [20] surveyed undergraduate mechanical engineering programs to ascertain the number of semester hours in various subject areas. Twenty-two universities were included in the 1987 survey data. All of these schools offered PhD programs in mechanical engineering and six of these schools were included in the present study.

The subject breakdown for the 1987 survey was similar to the current study. Assumptions were made to group some of the 1987 subject areas for comparison with the present study. The results of this comparison are shown in Table 2.

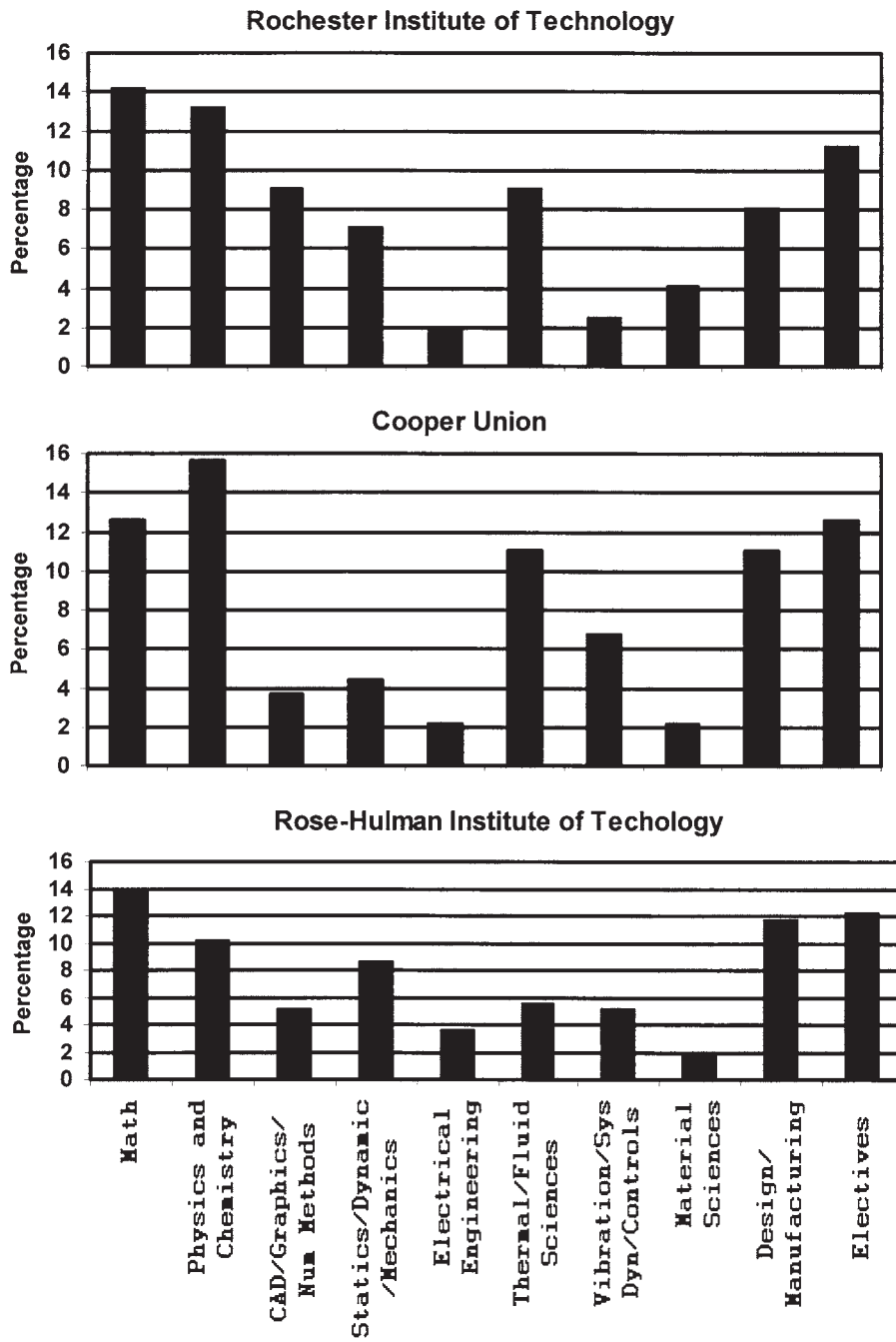

Fig. 1 *Programs of study.*

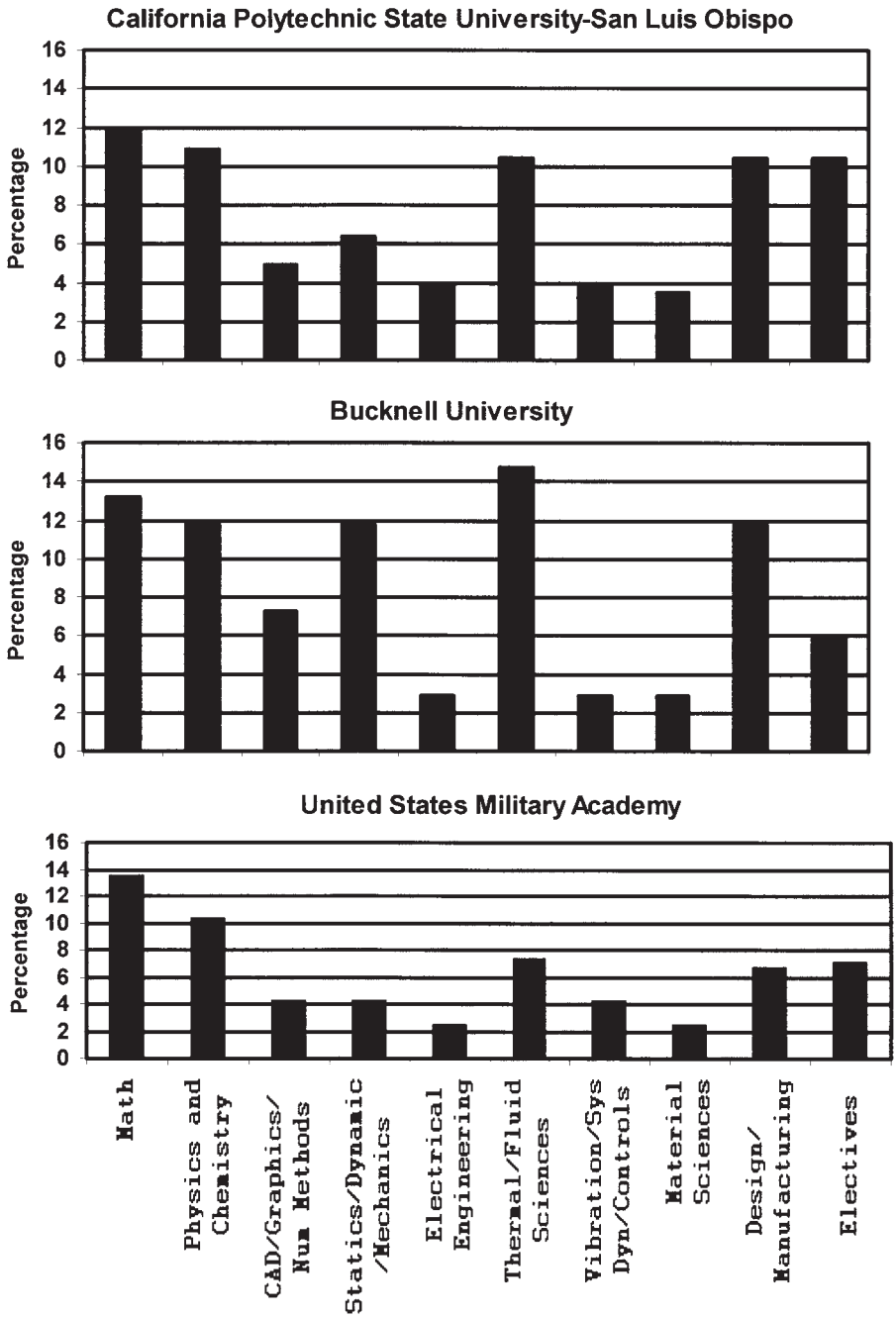

Fig. 2 *Programs of study.*

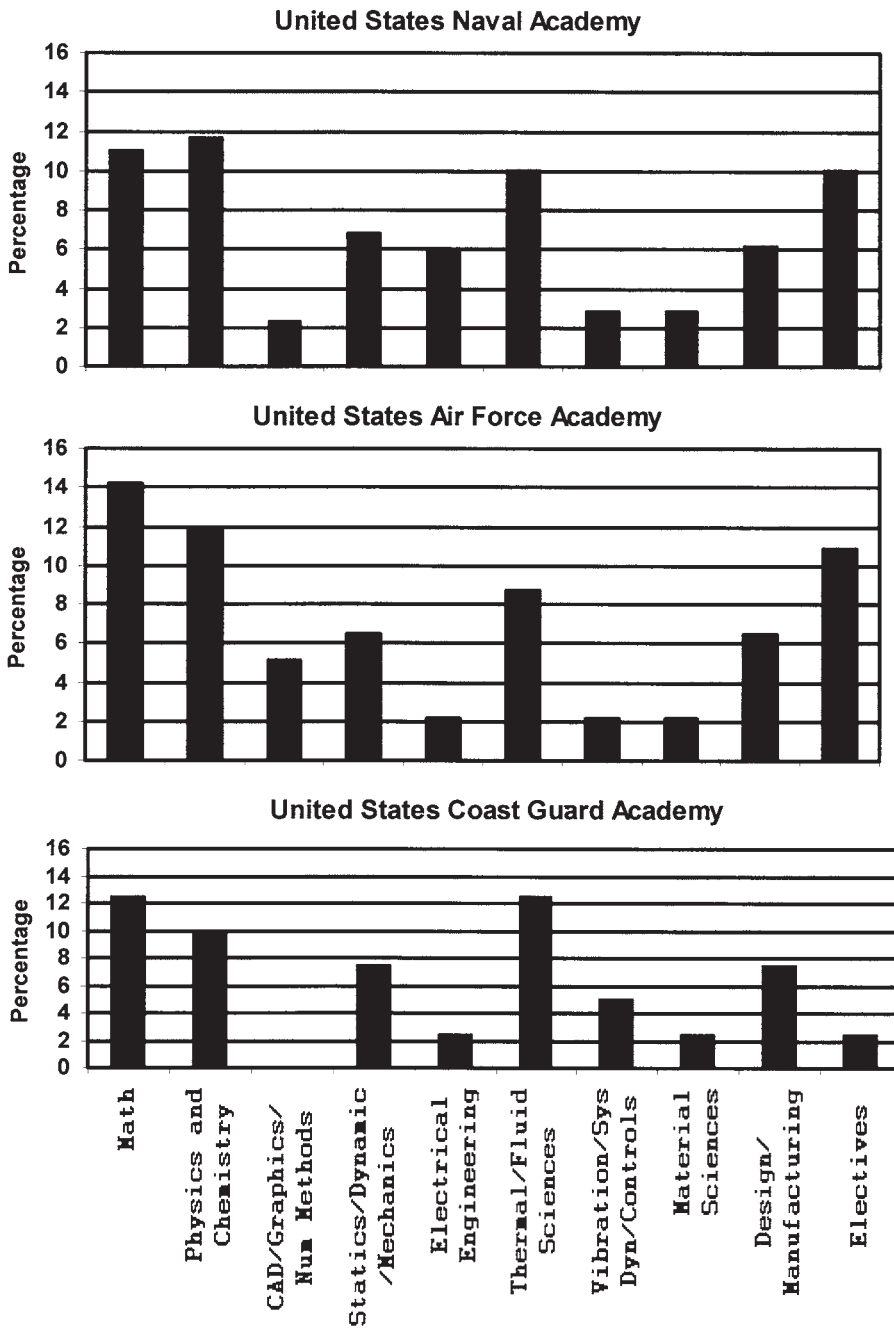

Fig. 3 *Programs of study.*

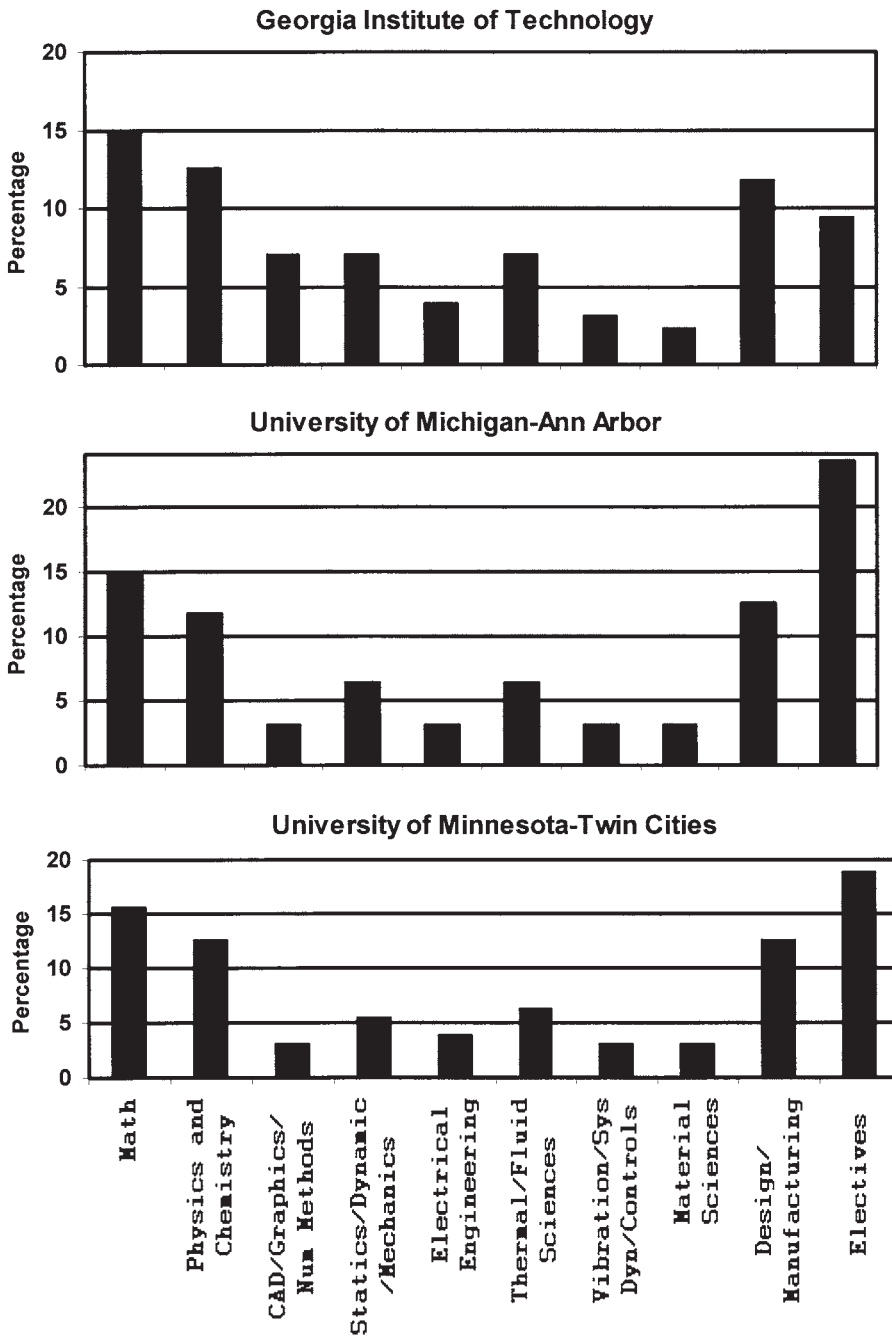

Fig. 4 *Programs of study.*

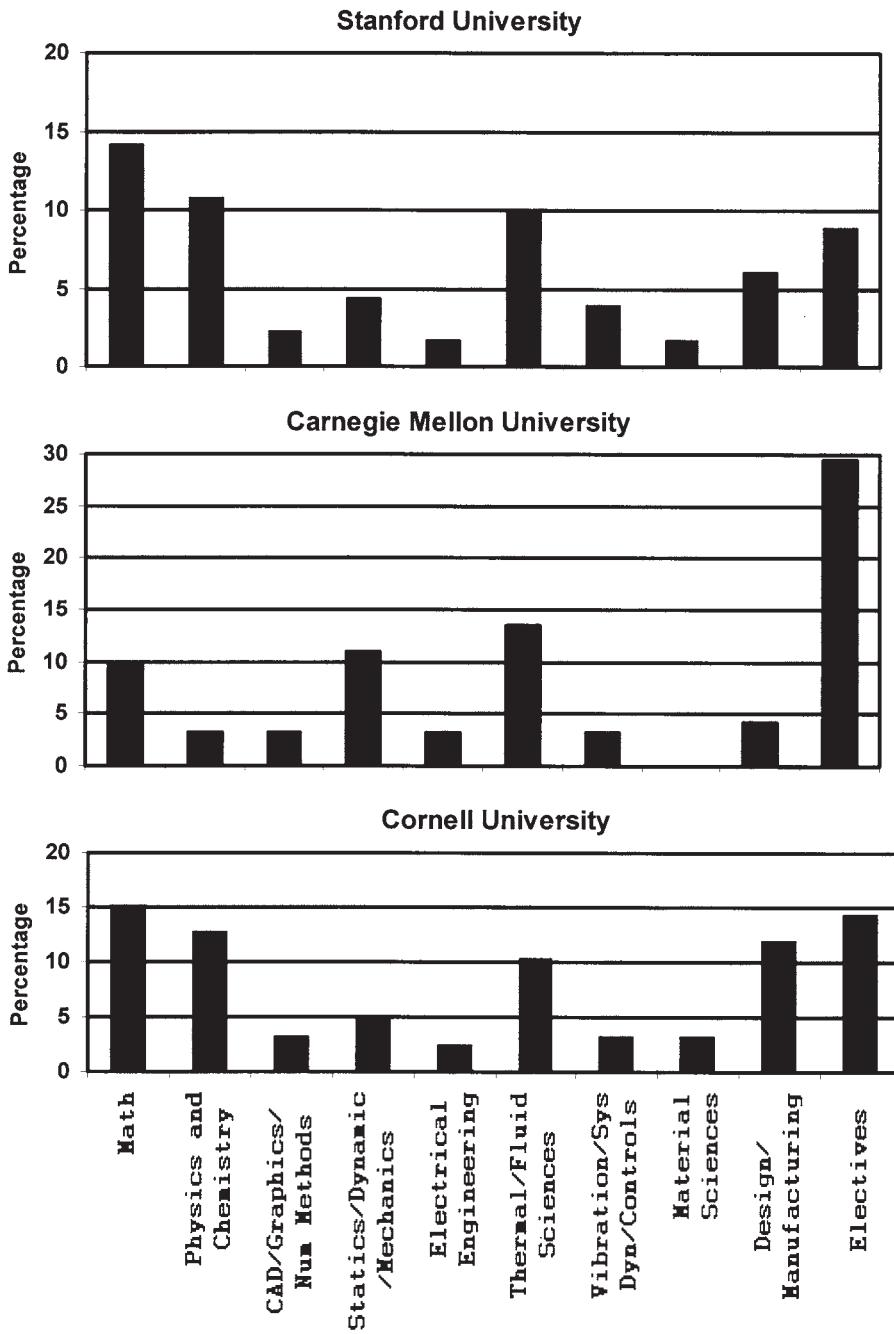

Fig. 5 *Programs of study.*

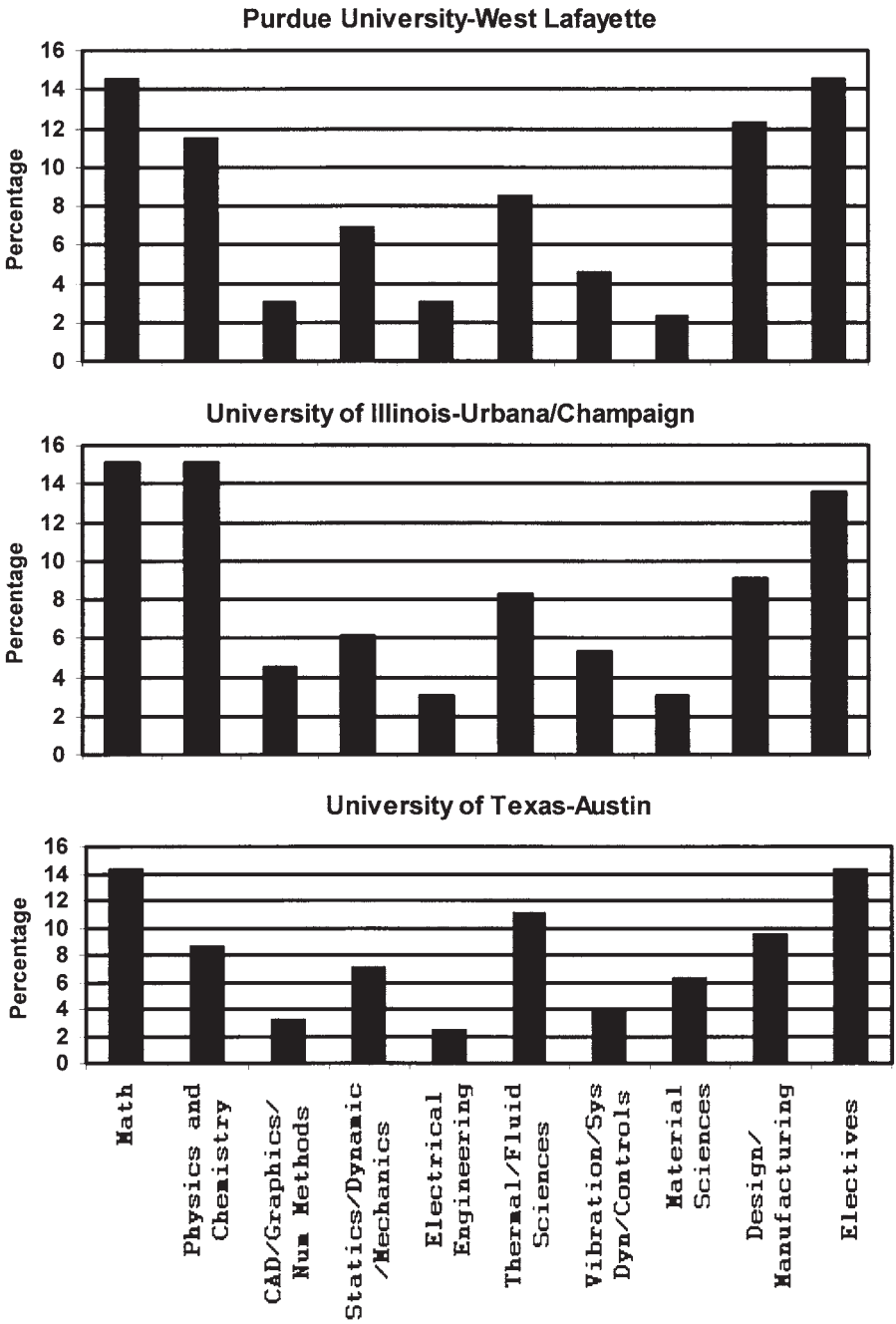

Fig. 6 *Programs of study.*

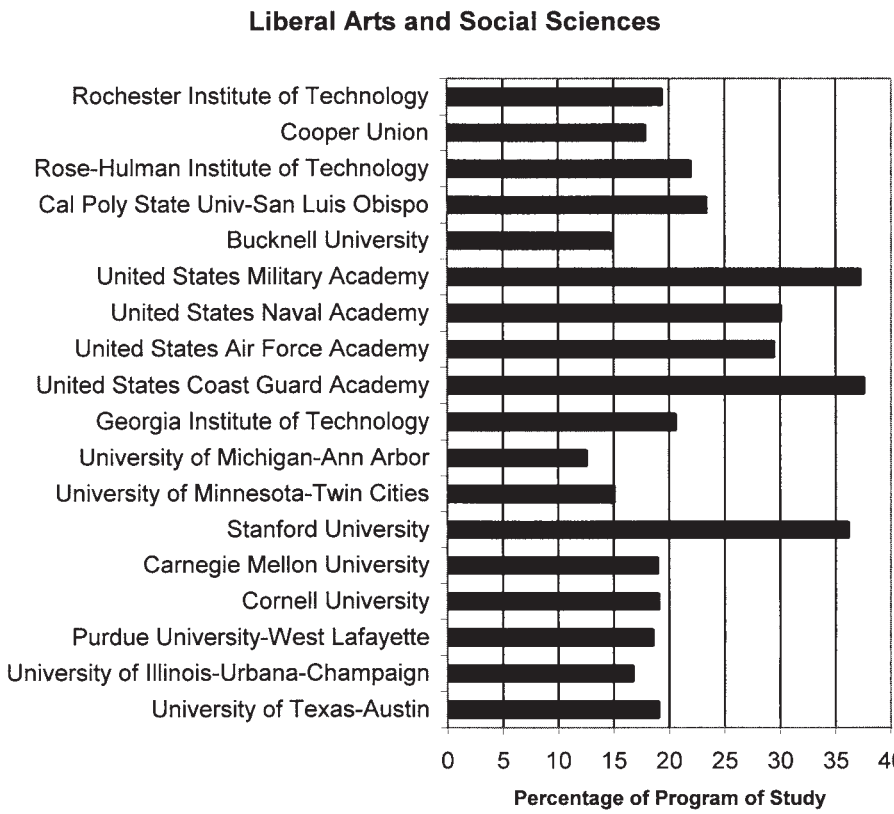

Fig. 7 *Liberal arts and social science requirements.*

TABLE 2 *Comparison of previous survey (1987) and present study (2000)*

	Program averages (%)	
Subject areas	Earlier survey (1987)[20]	Present study (2000)
Mathematics	13.6	13.66
Physics/chemistry	12.1	11.37
Computers/engineering design graphics/numerical methods/CAD	4.4	4.13
Statics and dynamics/solid mechanics	7.2	6.82
Electrical engineering	3.3	3.03
Thermal fluid sciences/heat transfer	9.3	9.49
Vibrations/system dynamics/controls/mechatronics	3.5	3.84
Material sciences	3.6	2.78
Mechanical design/machine design/manufacturing	7.7	9.44
Electives/seminar	18.7	12.77
Liberal arts and social sciences	16.6	22.63

Results and Discussion

The results of the present study reveal that, in general, undergraduate mechanical engineering programs are quite similar across the United States. There was also no discernable difference between schools that offered PhD programs and those that did not.

While some schools offered more elective choices, the percentage breakdown of technical subject areas was relatively consistent across all programs. The four military academies included in this study, along with Stanford University, had a significantly higher percentage of liberal arts and social science subjects included in their curriculum; however, the percentage breakdown of technical subject areas for these schools was again consistent with other mechanical engineering programs.

Most interesting was the comparison of our current research with the survey from 1987 [20]. The results of these two studies were remarkably similar. Perhaps the only two small noticeable changes or trends over this 13-year period was a slight increase in the percentage of design and manufacturing subjects in current curricula, along with an increase in the percentage of liberal arts and social science subjects in current mechanical engineering programs. The increase in design coursework may be attributed to the emphasis ABET placed on design starting in the 1980s. The increase in the percentage of liberal arts and social science subjects may be attributed to the inclusion of the military academies in present study, while the 1987 survey did not include these schools.

Conclusions

In conclusion, the study of undergraduate mechanical engineering programs in this paper reveals similar curricula across a wide variety of higher-learning institutions. A comparison with a similar survey from 1987 also reveals that mechanical engineering curricula have changed only slightly over the 13 years. This research establishes a baseline for these mechanical engineering programs at the beginning of EC2000 implementation. A follow-on study is envisioned in two or three years that will compare results and identify and significant changes in curricula as the EC2000 assessment process matures.

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