EC2000 Impact on Mechanical Engineering Curricula

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Abstract

Starting in 2001, all engineering programs will be accredited by the Accreditation Board of Engineering and Technology (ABET) 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 with Ph.D. programs and nine schools without Ph.D. programs is 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 is envisioned. This follow-on study will compare results and identify any significant changes in curricula as the EC2000 assessment process matures.

I. 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. All engineering programs will be accredited by the Accreditation Board of Engineering and Technology (ABET) 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.

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.

II. Background

Nine schools with Ph.D. programs and nine schools without Ph.D. 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 may elect to have their programs evaluated under either the Conventional Criteria or Engineering Criteria 2000. All reviews occurring during 2001-02 and thereafter will be 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.

Institution	Year of Last/Next Review	Criteria under which Review 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

Table 1. ABET Criteria Selection for Schools Studied

III. 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 web site on the internet.[2-19] Degree requirements were broken down into ten 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 authors express their 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 into the defined categories.

As much as possible core technical curriculum requirements were included in the break out of subject areas to minimize course work 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 vibrations, system dynamics, and controls category. Otherwise, they were included as electives.

A few programs listed instrumentation, experimentation, measurement, and laboratories as separate course work. 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 school's web sites 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.

Figures 1 through 6 are graphs of the programs studied. 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 to the total requirements for degree completion.

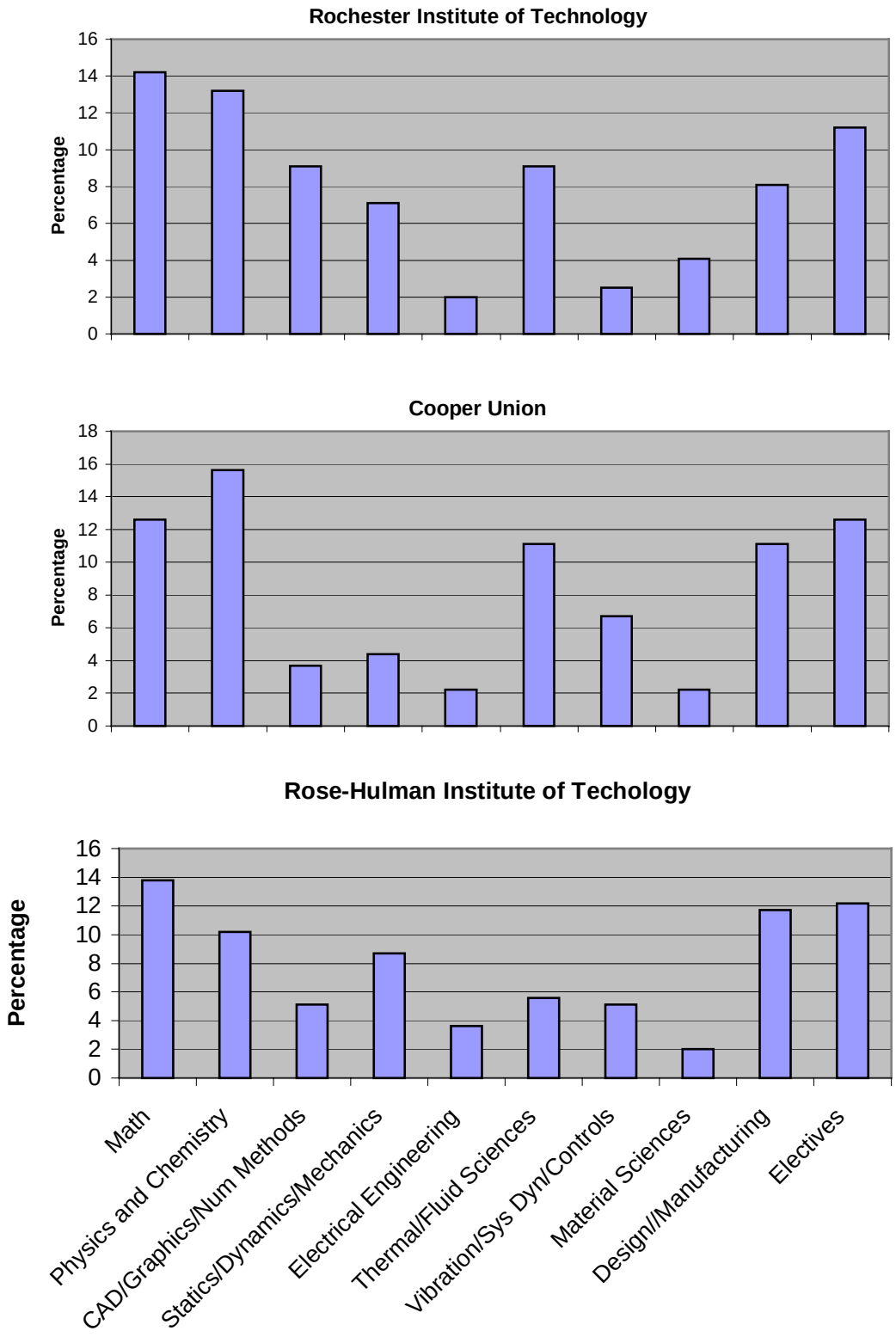

Figure 1. Programs of Study

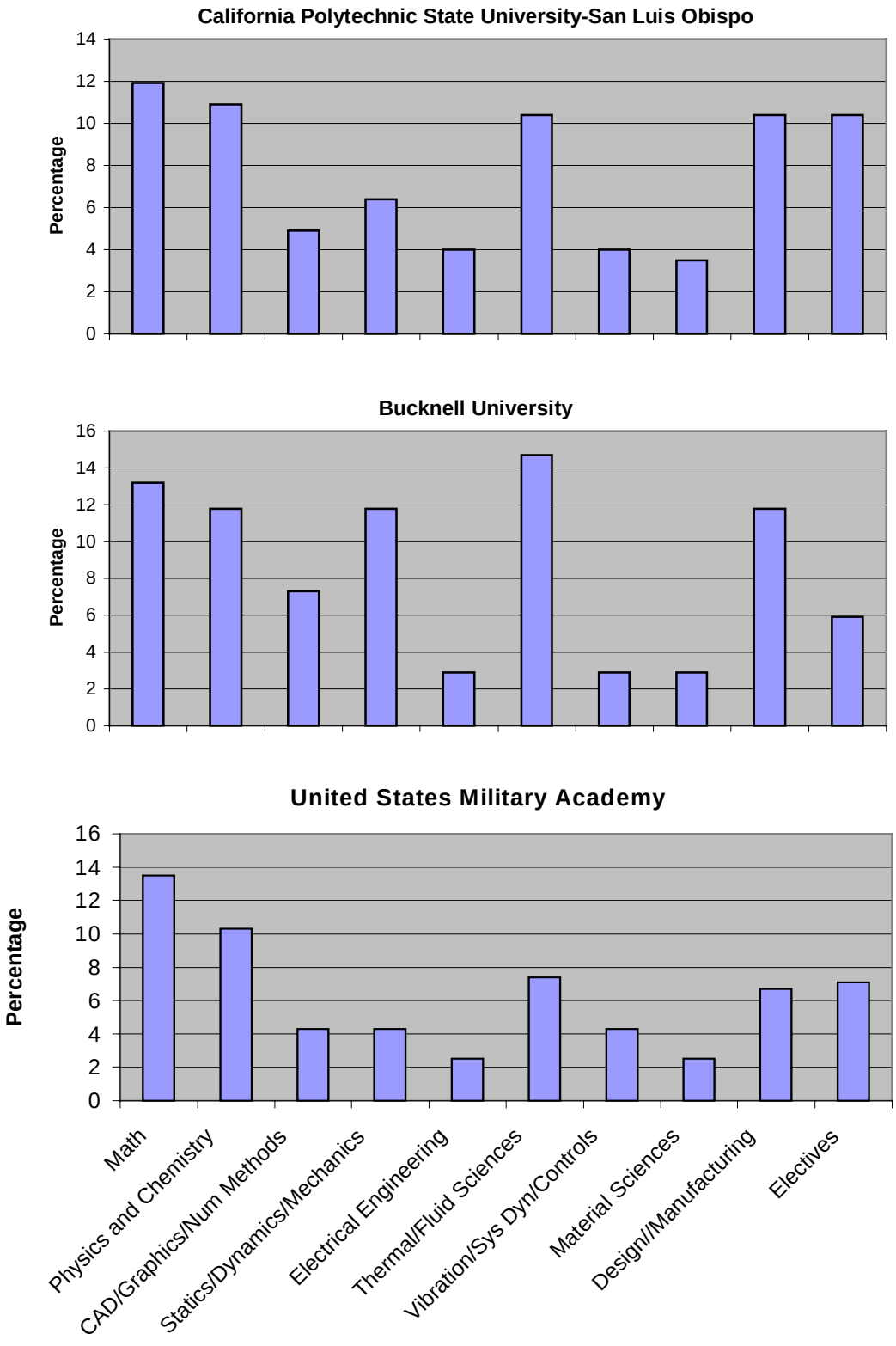

Figure 2. Programs of Study

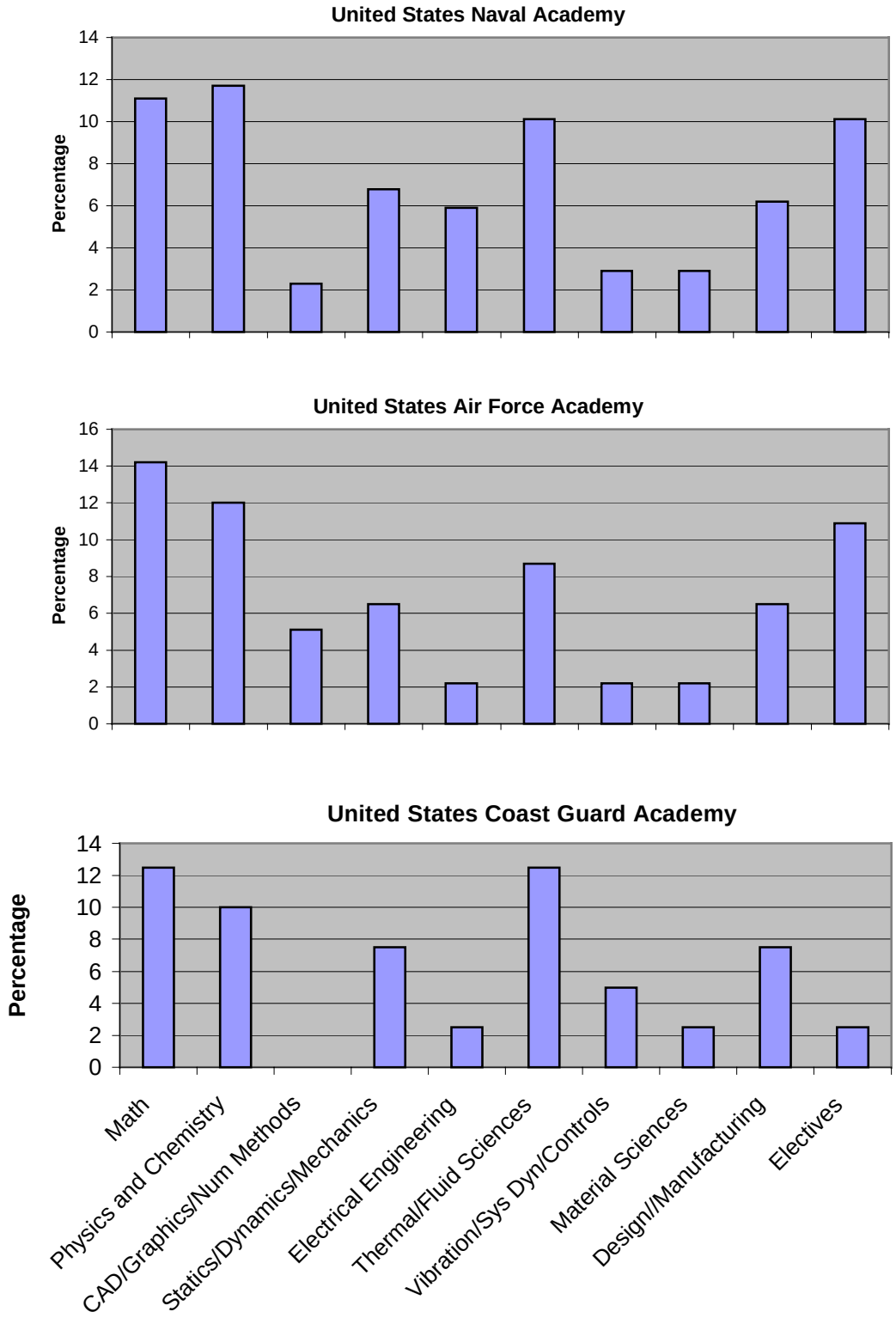

Figure 3. Programs of Study

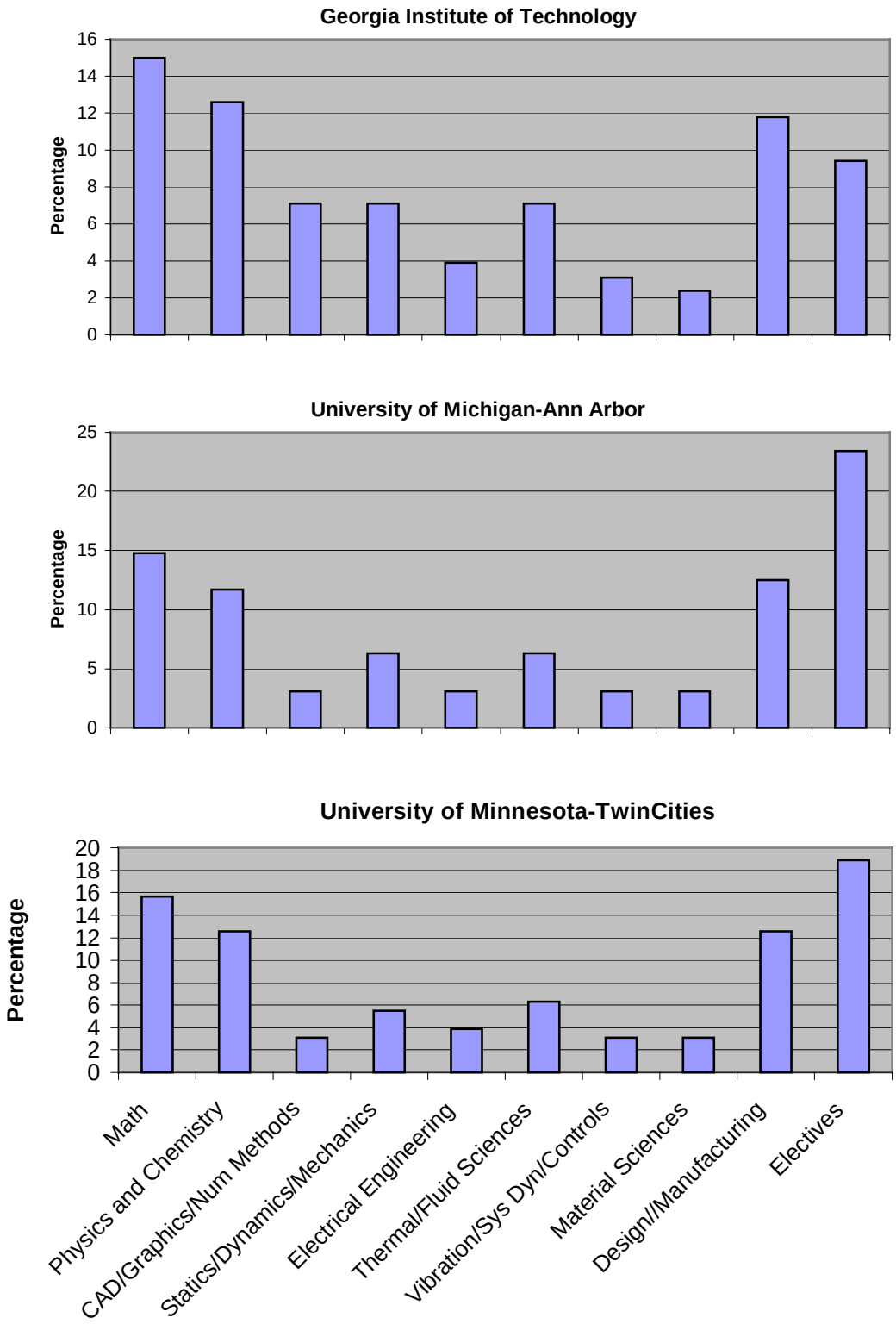

Figure 4. Programs of Study

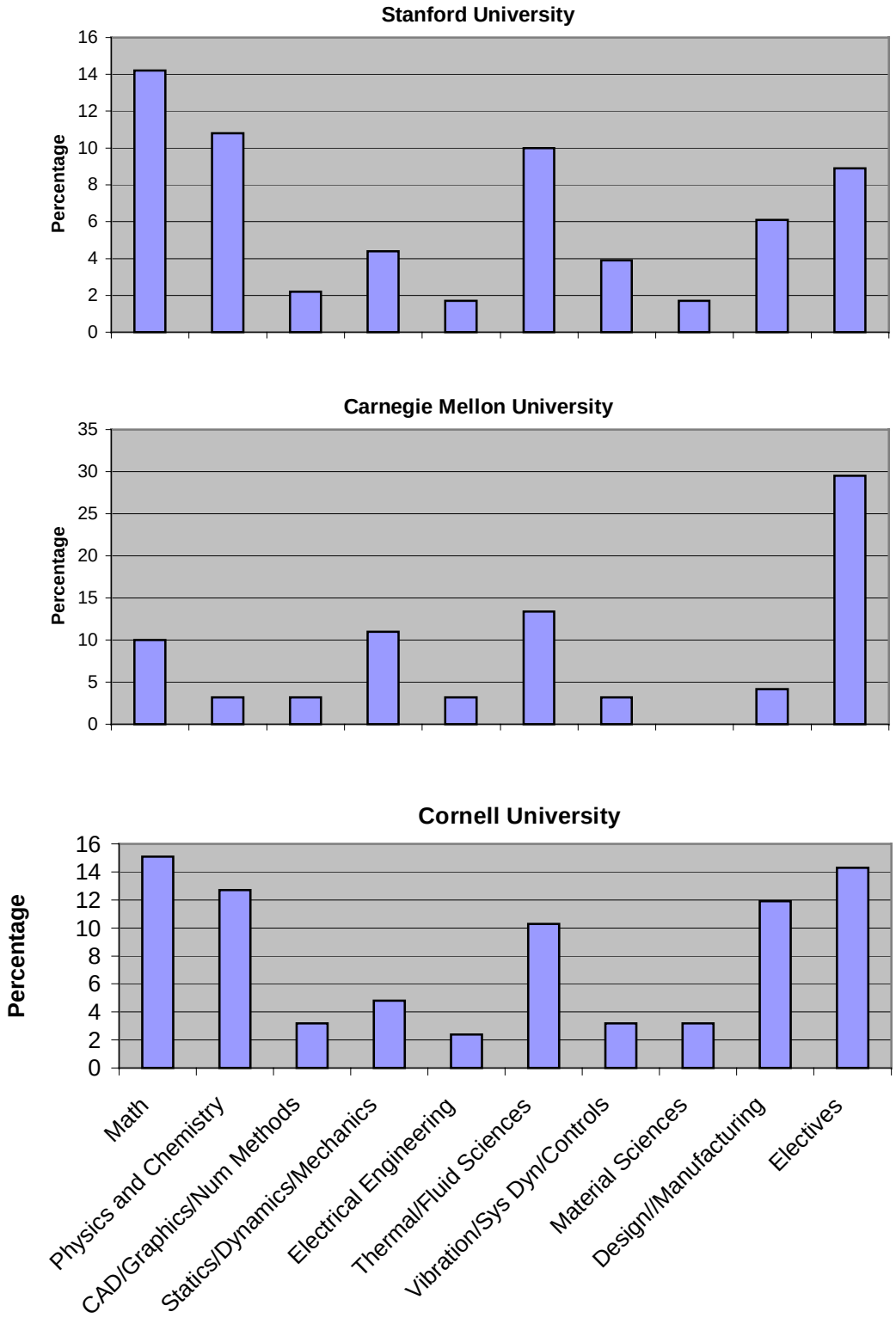

Figure 5. Programs of Study

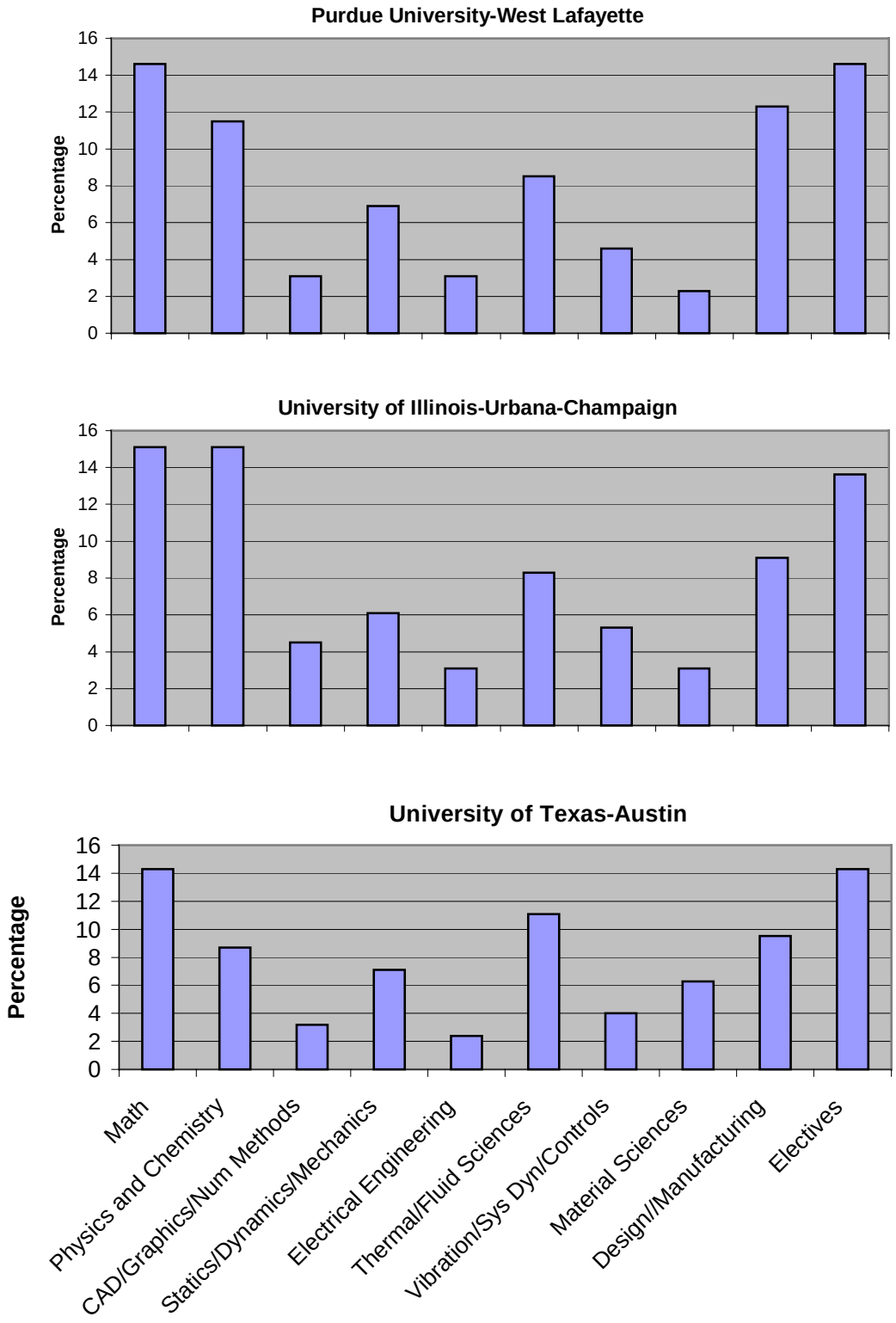

Figure 6. Programs of Study

Figure 7 shows the consolidated liberal arts and social science subjects as a percentage of total degree requirements.

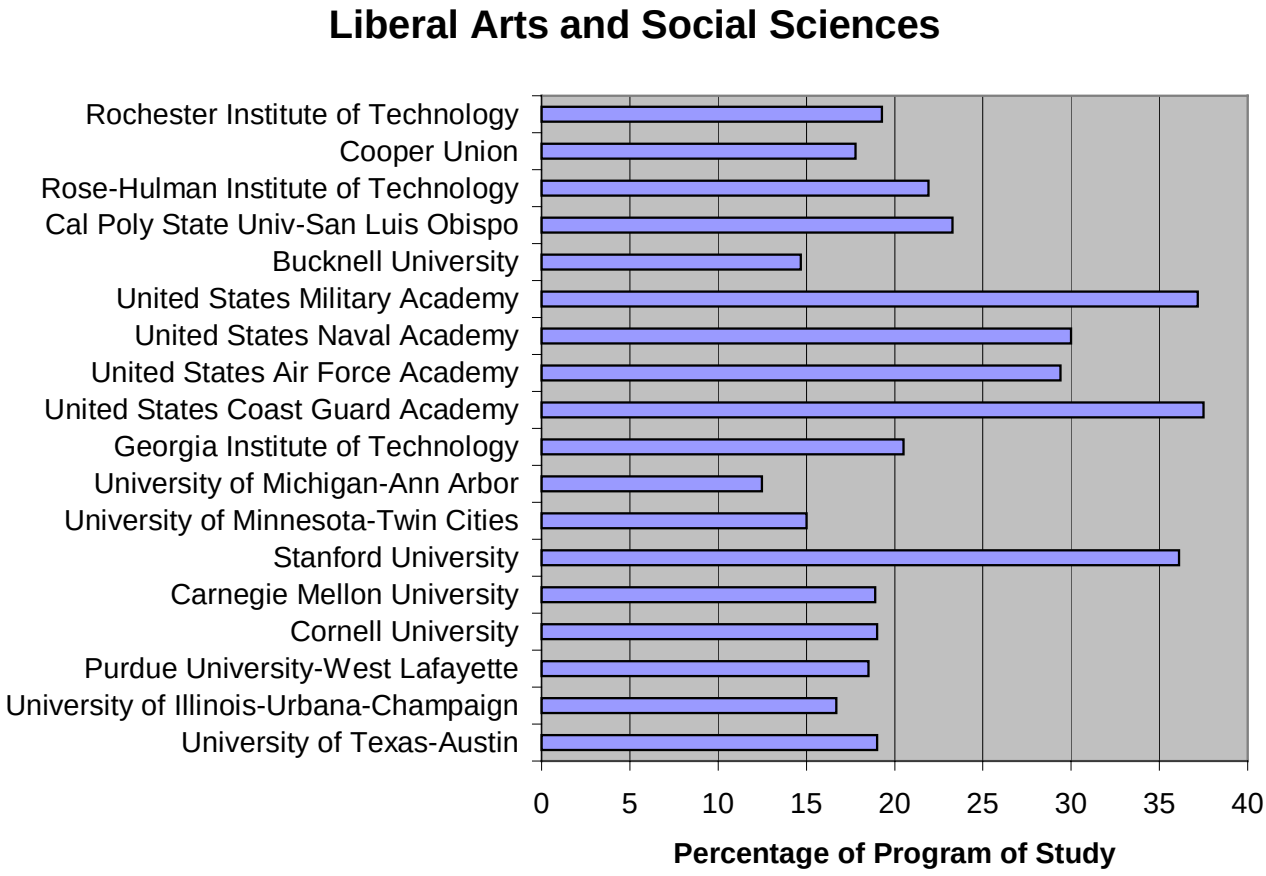

Figure 7. Liberal Arts and Social Science Requirements

IV. Comparison with Previous Studies

A similar study was conducted in 1987.[20] Whereas the current study relies on information from web sites on the internet, the 1987 study 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 Ph.D. programs in mechanical engineering and six of these schools were common to and included in our current study.

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

Percentage of Program Averages	Earlier Survey (1987)[20]	Current Study (2000)
Mathematics	13.6	13.66
Physics/Chemistry	12.1	11.37
Computers/Engr Design Graphics/Num 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

Table 2. Comparison of Previous Survey (1987)[20] and Current Study (2000)

V. Results and Discussion

The results of our current study reveal that, in general, undergraduate mechanical engineering programs are quite similar across the country. There was also no discernable difference between schools that offered Ph.D. 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 thirteen 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 course work may be attributed to the emphasis ABET placed on design starting in the 1980's. The increase in the percentage of liberal arts and social science subjects can be partially attributed to the inclusion of the military academies in our current study versus the 1987 survey which did not include these schools. However, even when the military academies are not included in the current study figures, the calculated percentage of liberal arts and social science coursework is 19.51% instead of the 22.63% reported in Table 2. This is still an increase from the 16.6% reported in the 1987 study.

VI. 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 to a similar survey from 1987 also reveals that mechanical engineering curricula have changed only slightly over the last thirteen 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 any significant changes in curricula as the EC2000 assessment process matures.

VII. Acknowledgements

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