AC 2008-68: MECHANICAL ENGINEERING CURRICULA: A FOLLOW-UP STUDY FOR THE FUTURE EFFECTS OF ABET EC2000

Wayne Whiteman, Georgia Institute of Technology

Wayne E. Whiteman is a Senior Academic Professional and Director of the Office of Student Services in the Woodruff School of Mechanical Engineering at the Georgia Institute of Technology. He received his BS degree from the United States Military Academy in 1979, a master's degree from MIT in 1987, and a Ph.D. in Mechanical Engineering from Georgia Tech in 1996. Whiteman is a retired Colonel in the U.S. Army and completed 24 years of active military service. He served on the West Point faculty from 1987 to 1990, and 1998 to 2003. He has been at Georgia Tech since 2003.

Mechanical Engineering Curricula: A Follow-up Study for the Future Effects of ABET EC2000

Abstract

The Accreditation Board for Engineering and Technology (ABET) is recognized by the U.S. Department of Education as the sole agency responsible for accreditation of educational programs leading to degrees in engineering, engineering technology, and related engineering areas. In the late 1990s, engineering programs began transitioning to a new Engineering Criteria 2000 (EC2000). By 2001, all engineering programs were required to be accredited under the new criteria. 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 current paper is a follow-up study to a preliminary study conducted by the author in 2000 that looked at the initial effects of ABET EC2000. The earlier study examined selected mechanical engineering programs to discern the impact of EC2000 on curriculum development during the initial implementation phase of the new criteria. Data on the layout and composition of mechanical engineering curricula for nine schools in the United States with Ph.D. programs and nine schools without Ph.D. programs was presented and is updated in this current work. Current results are also compared to a study by Robert E. Mates from the State University of New York at Buffalo entitled a *Survey of Undergraduate ME Programs*, conducted in 1987. The conclusions identify changes that have occurred in mechanical engineering curricula as the EC2000 assessment process has matured.

Introduction

This paper is a follow-up study to a preliminary study conducted in 2000 of selected mechanical engineering programs to discern the impact of the Accreditation Board of Engineering and Technology's new Engineering Criteria 2000 (EC2000)[1] on curriculum development.[2] The Accreditation Board for Engineering and Technology (ABET) is recognized by the U.S. Department of Education as the sole agency responsible for accreditation of educational programs leading to degrees in engineering, engineering technology, and related engineering areas. All engineering programs were required to 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 earlier research established a baseline for selected mechanical engineering programs at the beginning of EC2000 implementation. This follow-on study compares results with the data from the paper in 2000 and identifies any changes in curricula as the EC2000 assessment process has matured. The current results are also compared to a study by Robert E. Mates from the State University of New York at Buffalo entitled a *Survey of Undergraduate ME Programs*, conducted in 1987.[3]

Background

Consistent with the preliminary study completed in 2000, the same nine schools with Ph.D. programs and nine schools without Ph.D. programs in mechanical engineering were selected for inclusion in this current research. The criterion for choosing the schools in this study was to provide a wide geographic representation of universities across the United States. Since the data was gathered from the internet, the schools chosen also clearly articulated their mechanical engineering curriculum on their school web site.

The set of criteria for accrediting engineering programs changed from what ABET previously referred to as a set of *Conventional Criteria* to one identified as *Engineering Criteria 2000*. For accreditation visists 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 were conducted under Engineering 2000. Table 1 lists the schools chosen for this study.

	Institution	Date of Next ABET Review
Schools without Ph.D. programs in Mechanical Engineering	Rochester Institute of Technology	2010-2011
	Cooper Union	2006-2007
	Rose-Hulman Institute of Technology	2006-2007
	Cal Poly State University-San Luis Obispo	2008-2009
	Bucknell University	2008-2009
	United States Military Academy	2008-2009
	United States Naval Academy	2005-2006
	United States Air Force Academy	2008-2009
	United States Coast Guard Academy	2007-2008
Schools with Ph.D. programs in Mechanical Engineeering	Georgia Institute of Technology	2008-2009
	University of Michigan-Ann Arbor	2005-2006
	University of Minnesota-Twin Cities	2007-2008
	Stanford University	2006-2007
	Carnegie Mellon University	2006-2007
	Cornell University	2010-2011
	Purdue University-West Lafayette	2007-2008
	University of Illinois-Urbana-Champaign	2007-2008
	University of Texas-Austin	2010-2011

Table 1. List of Schools included in the Study

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.[4-21] 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 somewhat difficult to discern in many 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 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 mechanical engineering programs are introducing 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 ten 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.

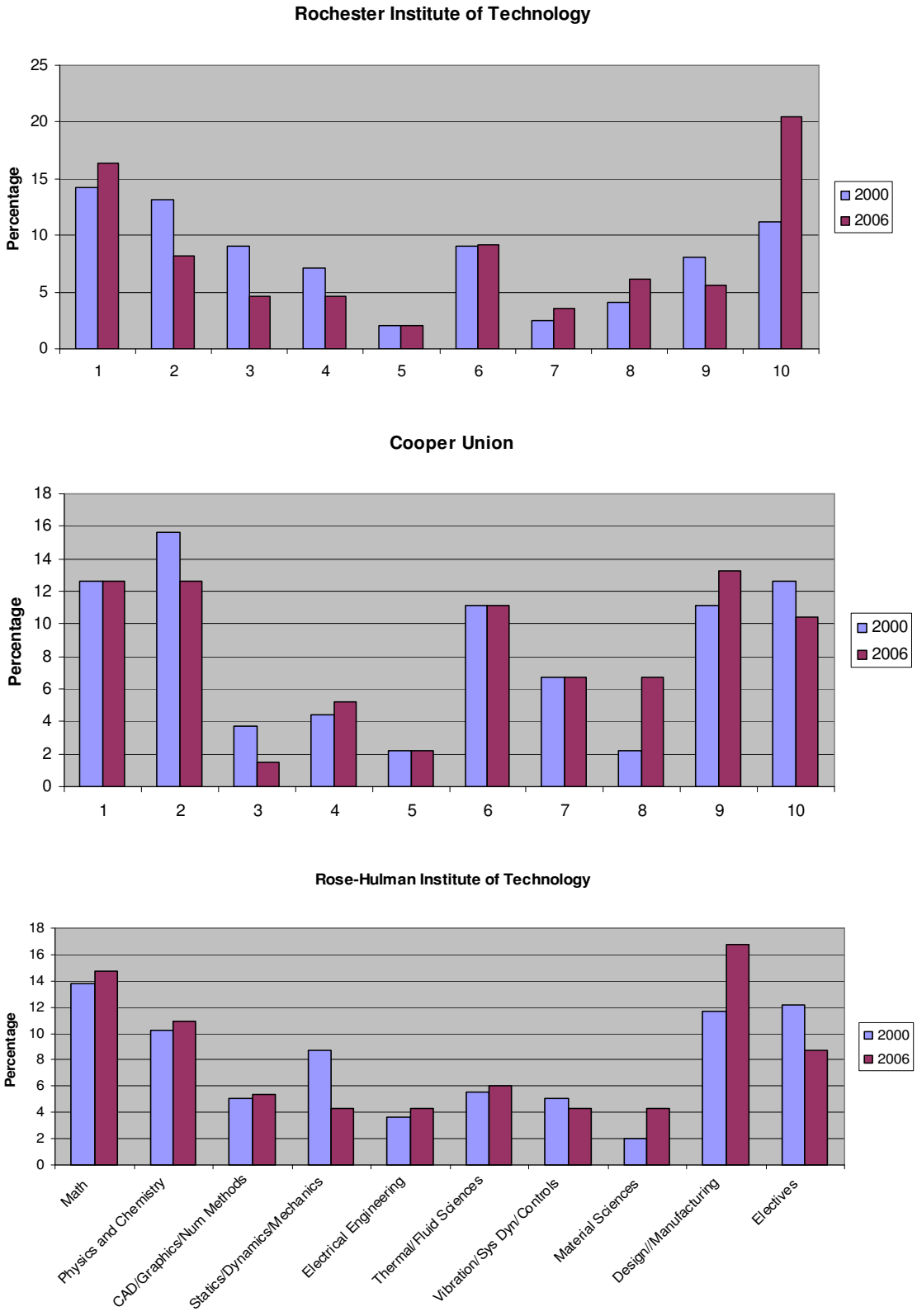

Figure 1. Programs of Study

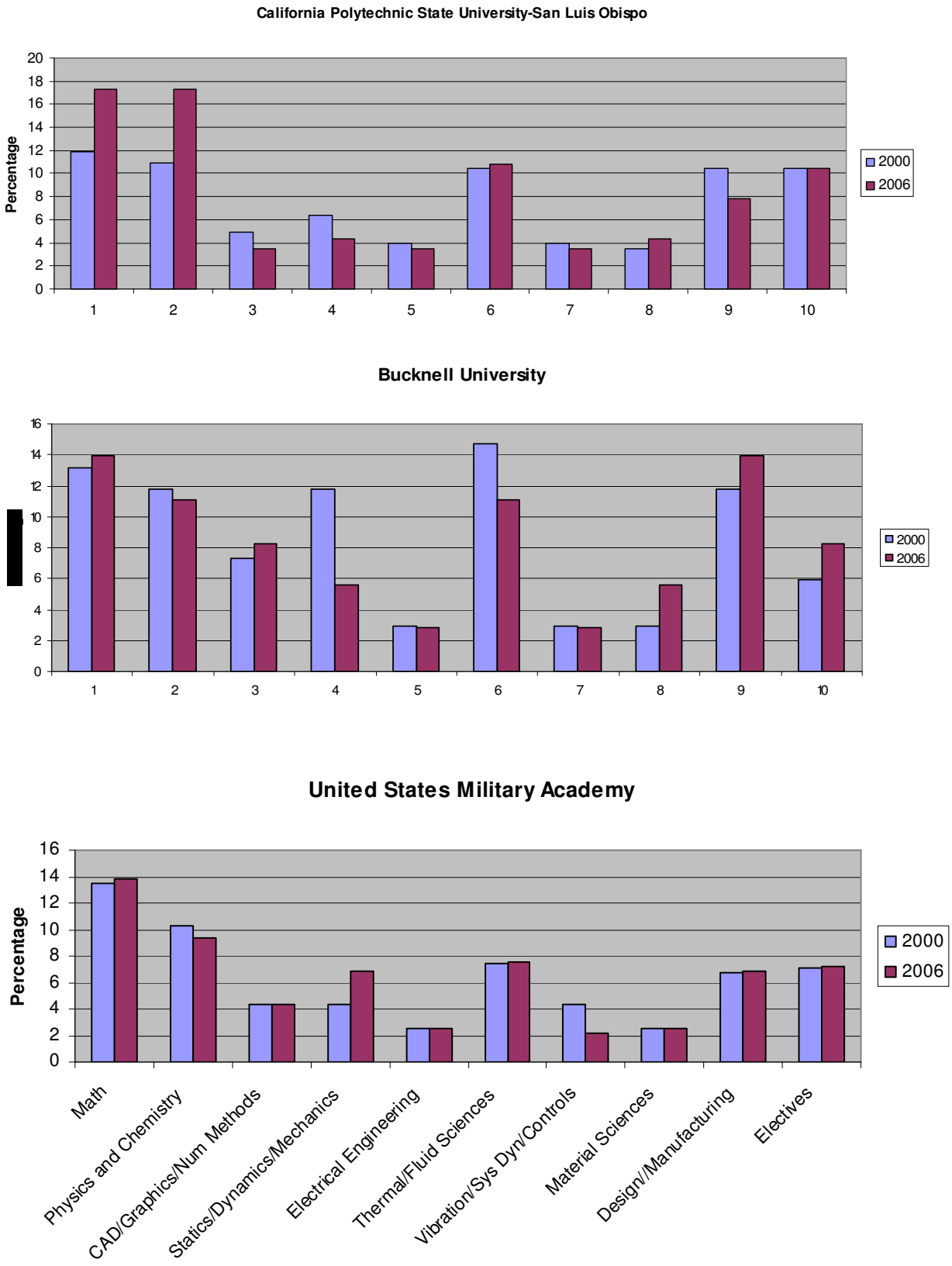

Figure 2. Programs of Study

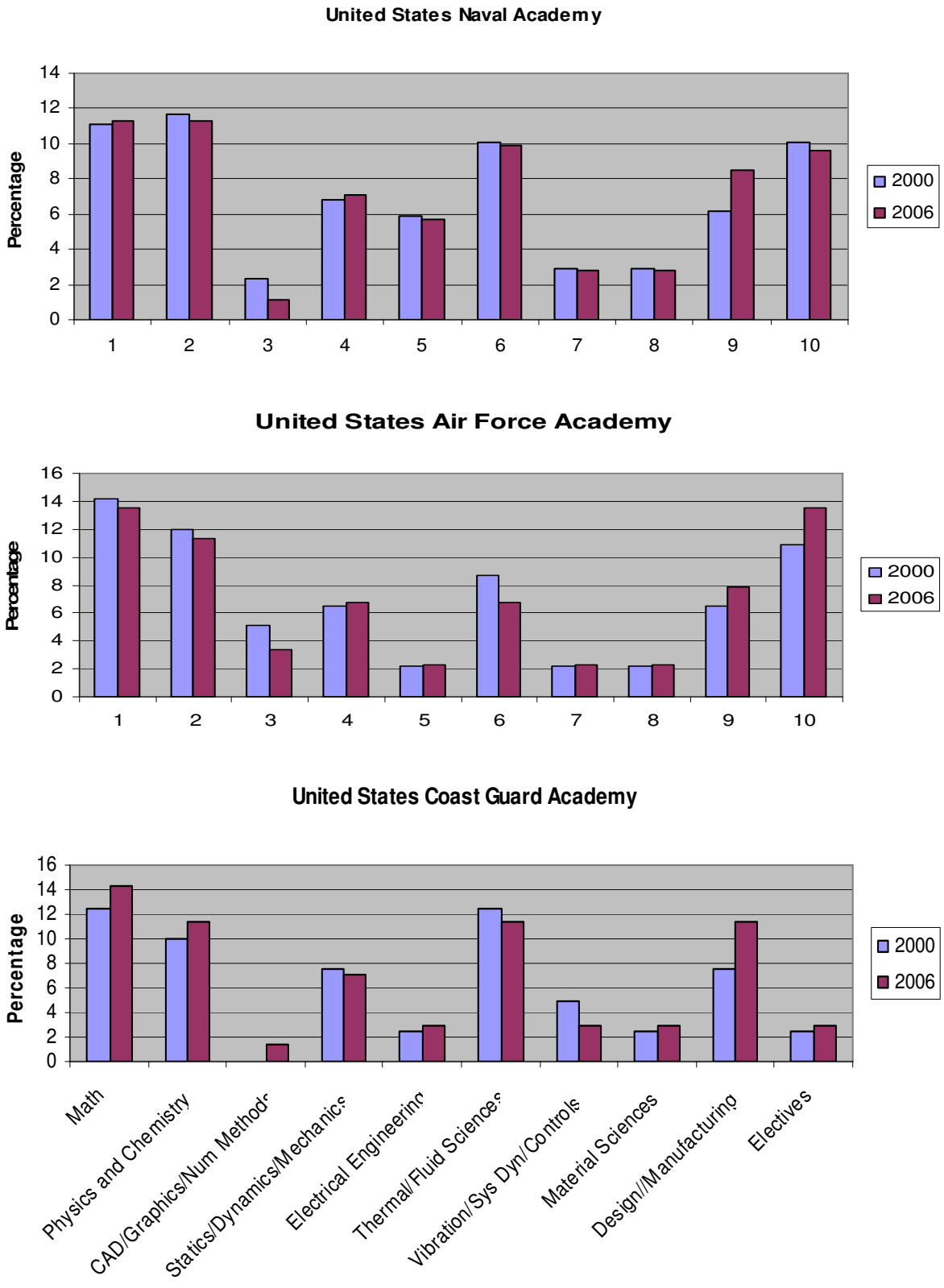

Figure 3. Programs of Study

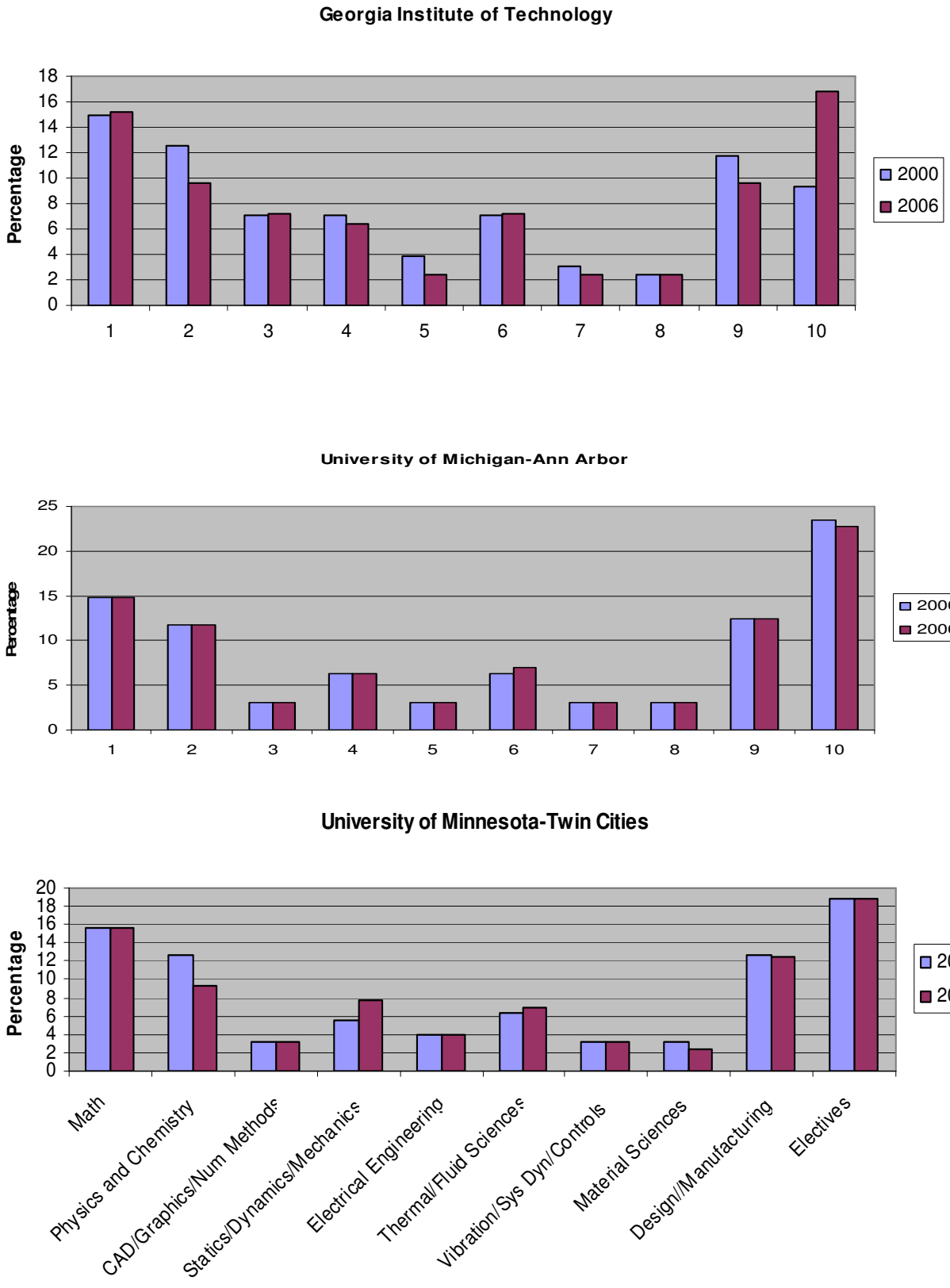

Figure 4. Programs of Study

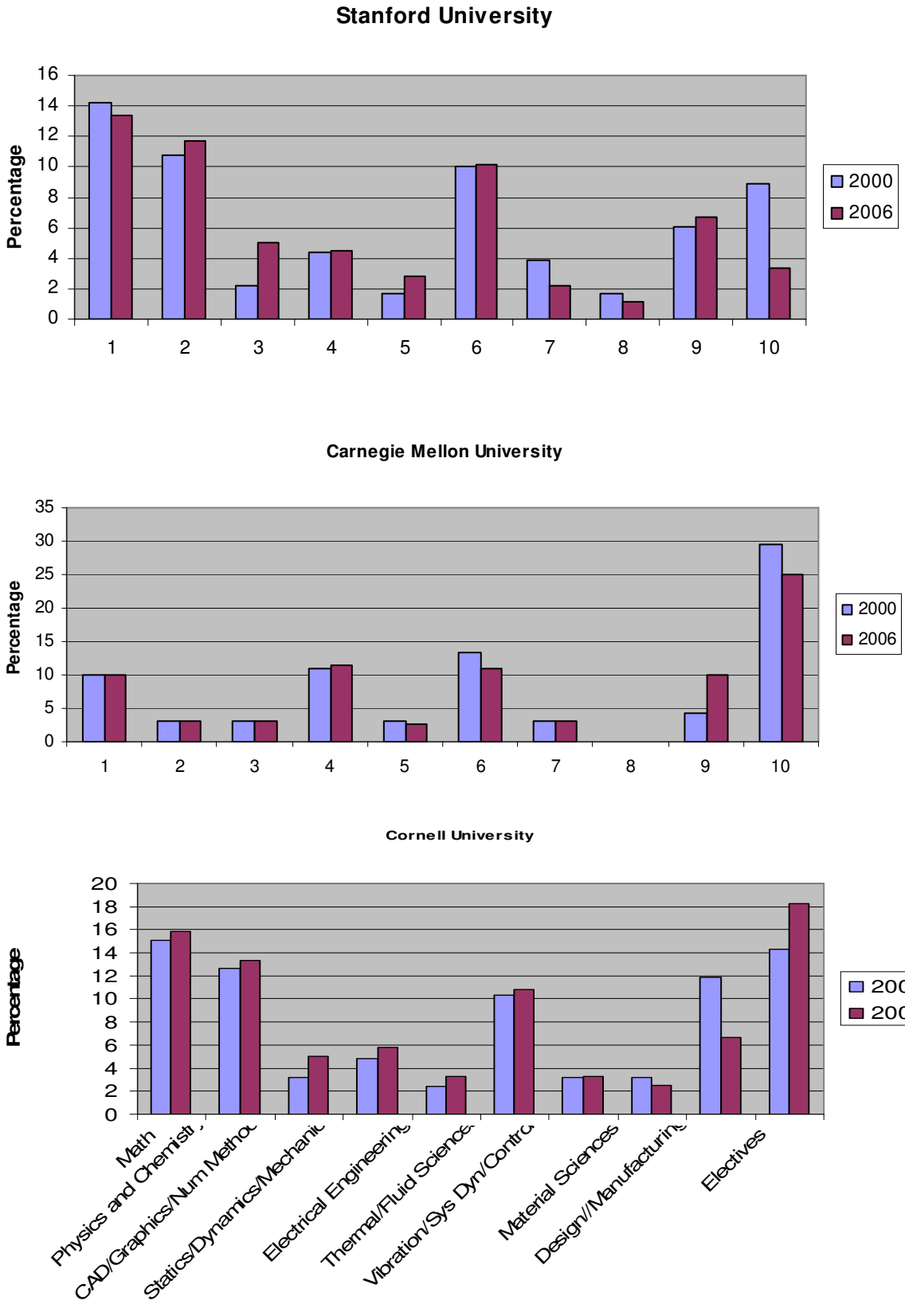

Figure 5. Programs of Study

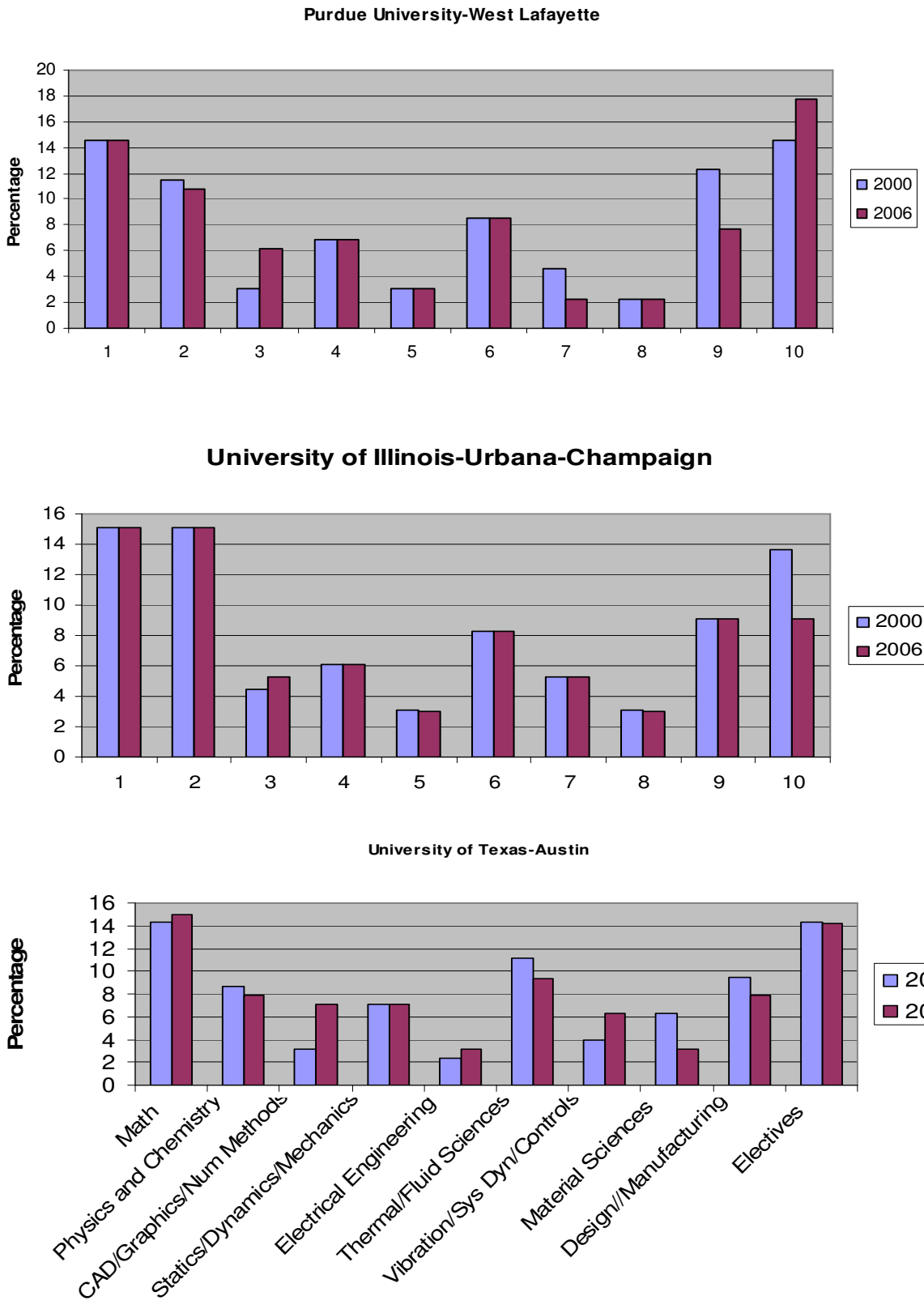

Figure 6. Programs of Study

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

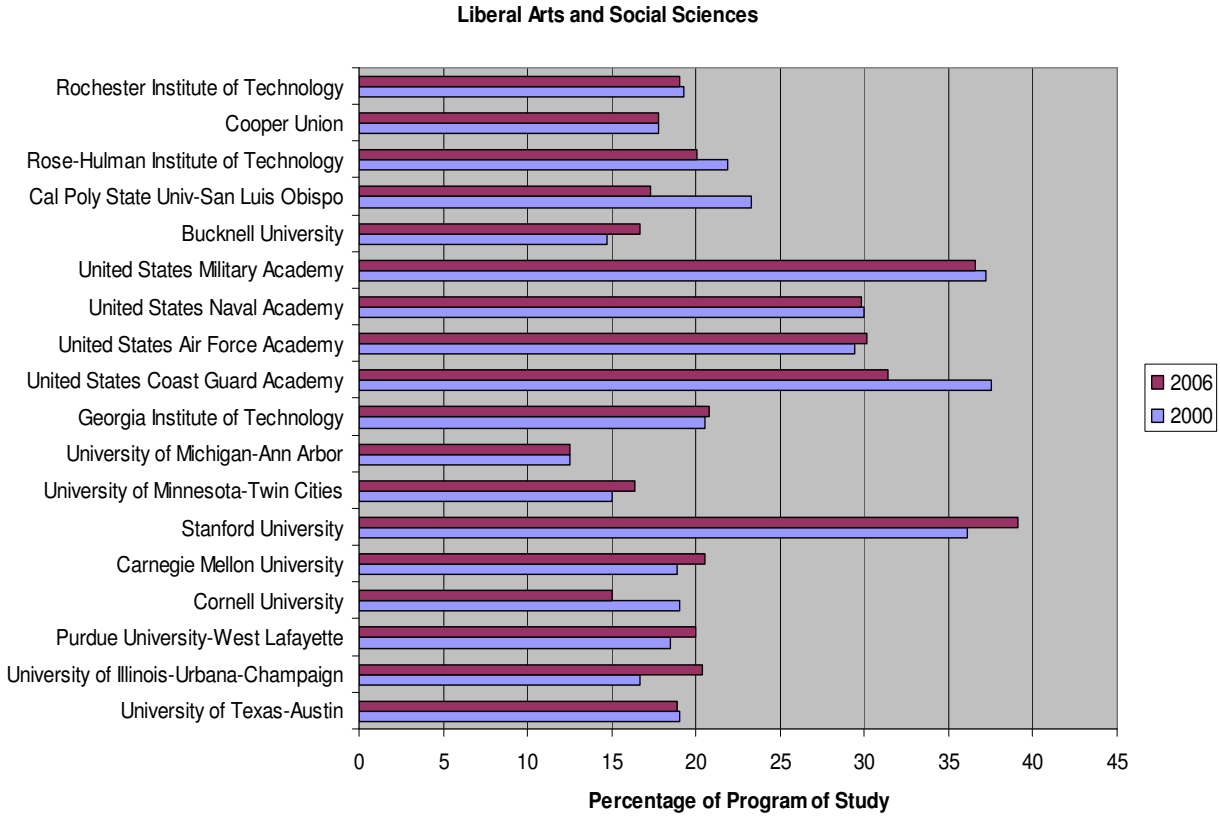

Figure 7. Liberal Arts and Social Science Requirements

Comparison with Previous Studies

Similar studies were conducted in 1987 and 2000.[2,3] The current study and the study conducted in 2000 rely 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 the current study and the study in 2000.

The subject breakdown for the 1987 survey was similar to the current study and the study conducted in 2000. Appropriate assumptions were made to group the 1987 subject areas for comparison with the two more recent studies. The results of this comparison are shown in Table 2. This table shows the percentage of the overall programs that were devoted to the corresponding disciplinary area.

Percentage of Program Averages	1987 Survey	2000 Study	2006 Study
Mathematics	13.6	13.7	14.4
Physics/Chemistry	12.1	11.4	10.8
Computers/Engr Design Graphics/Num Methods/CAD	4.4	4.1	4.5
Statics and Dynamics/Solid Mechanics	7.2	6.8	6.3
Electrical Engineering	3.3	3.0	3.1
Thermal Fluid Sciences/Heat Transfer	9.3	9.5	9.2
Vibrations/System Dynamics/Controls/Mechatronics	3.5	3.8	3.5
Material Sciences	3.6	2.8	3.4
Mechanical Design/Machine Design/Manufacturing	7.7	9.4	9.6
Electives/Seminar	18.7	12.8	13.5
Liberal Arts and Social Sciences	16.6	22.6	21.7

Table 2. Comparison of 1987 Survey and studies from 2000 and 2006

Results and Discussion

The comparison of the current study with the survey in 1987 and the 2000 study reveals that undergraduate mechanical engineering programs are quite similar across the country when looked at in the aggregate. There was also no discernable difference between schools that offered Ph.D. programs and those that did not. It should be noted, however, that there may have been more significant changes in the programs at the course level in terms of adjustment of topics. This study was not designed to detect this level of changes at the course level.

The percentage breakdown of technical subject areas was relatively consistent across all programs for both the 2000 and 2006 studies. The four military academies, along with Stanford

University, had significantly higher percentages 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.

When the individual school graphs are examined, it is evident that the various programs are making continuous changes in their curriculum. However, the most interesting result of the overall comparison is how remarkably similar these three studies are over a period of nearly 20 years. Perhaps the only two small noticeable changes or trends with the most recent study was a slight increase in the percentage of math subjects over the time period of the three studies, and a slight increase in the percentage of elective choices in current mechanical engineering programs when compared to the 2000 study.

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 survey from 1987 and a similar study in 2000 also reveals that mechanical engineering curricula have changed only slightly over the last twenty years. This research indicates that changes have been made in individual mechanical engineering curricula at various schools since EC2000 implementation, but the overall breakout of subject matter percentages remains remarkably similar.

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