CHAPTER 1

The Academic Enterprise

George P. Shultz, former U.S. secretary of state, of labor, and of treasury, was also a senior officer in the Bechtel Corporation, and former dean of the Business School at the University of Chicago. He is currently on the faculty at the Stanford University Graduate School of Business. Shultz was asked recently to compare the three types of organizations in which he had spent so much time; industry, government and academia. He replied, "When I worked in industry I had to be careful if I asked someone to do something because there was a very good chance they would do it. When I worked in government I didn't have that problem. But at the university I very quickly came to understand that it was... inappropriate to ask"[1].

Tongue-in-cheek as his comment may be, Shultz is hinting at something important about how colleges and universities differ from industry, government, labor unions, churches, hospitals, and virtually every other institution in society.

Clark Kerr, president emeritus of the University of California, supports Shultz's point in a more formal way by noting that [2]:

[American colleges and universities] have mostly been comparatively privileged entities of tolerant societies exercising great self-restraint toward them. And their principal participants—the faculties—have had more leeway to conduct their lives according to their individual wishes than most other members of the modern labor force—they have not viewed themselves, or been viewed by others, as "employees." It has been a world of comparative institutional autonomy and comparative individual academic freedom.

As a possible future professor, it is important for you to understand the unique features of an institution in which you may spend the rest of your professional life. We begin the development of such an understanding in this chapter, first with a brief look at the evolution of higher education in North America. This historical discussion is followed by an examination of the key characteristics of
academia, including governance and decision making. Some of the critical issues currently facing all colleges and universities are examined next. A new concept of scholarship originally proposed by Ernest Boyer, former president of the Carnegie Foundation for the Advancement of Teaching, is then introduced. This scholarship concept forms the basis for important discussions in the chapters to follow. We then introduce seven sample schools representing the types of four-year institutions to which most science and engineering Ph.D.s and postdocs will go as new professors. The chapter concludes with a vignette describing Ernest Boyer's views on the role of scholarship in undergraduate education.

UNLIKE ANY OTHER INSTITUTION

With all the downsizing and restructuring taking place in higher education, you might think colleges and universities are looking more, not less, like other institutions. Hahnemann University in Philadelphia, PA is a case in point. The Hahnemann administration recently threatened to fire any faculty member, tenured or not, who is not able to attract research grants providing between 50 and 100% of his or her salary. As Leonard L. Roos, dean of the Hahnemann School of Medicine, put it, "If IBM expects that of its employees, why can't we expect it of the academic community? It's a big business" [3].

Another industry-like characteristic, increasing demands for accountability and productivity, has resulted in mandated minimum college and university teaching loads in some states. Hawaii and Florida, for example, now require 12 hours of classroom instruction per week or the equivalent for faculty in four-year institutions [4].

On the other hand, industry has reduced its number of management levels, put more decision making in the hands of those who actually do the "value-added" work, sought consensus across functions, and so on. Could it be that private enterprise is taking on some of the characteristics long associated with colleges and universities? Perhaps, but fundamental differences remain in the culture, governance, mission, methods of generating income, employment security, and accountability between academia and other organizations with which we are familiar.

Historical Perspective

Before looking more closely at these differences, let us consider a little history. Higher education in the United States and Canada began during the 17th century as an outgrowth of both the medieval European universities and the British universities of Oxford and Cambridge. In these so-called colonial colleges, teaching was central. It was viewed, "... as a vocation—a sacred calling—an act of dedication honored as fully as the ministry" [5, Ch.1, p.4]. It was during this time that the self-governing nature of universities developed, as well as the idea
that universities were “communities of scholars” [6, p.3]. It was also during this period that the notion of “Town and Gown” developed as a way of “separating” scholars from the local lay population [6, pp.22–23].

The number of institutions and students remained small until the passage in the United States in 1862 of the Morrill Act establishing land grant colleges and universities. Through this act, every state was granted 30,000 acres of land for each senator and representative it had in Congress. The land was then to be sold and the proceeds invested to create and maintain institutions that were to emphasize agriculture and mining (A&M) as a way to produce better educated farmers and engineers. The universities of Arizona, California, Illinois, Texas, and Washington are just a few such institutions formed during this period. The late 19th century was a time when colleges were to provide “useful studies,” and when “going to college” was viewed as a way of “getting ahead.” As one undergraduate put it in 1871, “A degree from Harvard is worth money in Chicago” [6, p.29]. By the end of the century, 59 separate land grant colleges had been established in 44 states under the Morrill Act [7]. Many of you have attended, are now attending, or will eventually teach at such institutions.

A second significant advance occurred in the 1890s with the establishment of research-oriented private universities such as Johns Hopkins, Chicago, Cornell, and Stanford [8]. A further growth period occurred after World War I with the passage of additional legislation and the involvement of state universities in large-scale applied research.

However, the Golden Age of higher education was clearly the one during the three decades following World War II. The 1950s and 1960s was a period of unprecedented expansion, both in the size of existing institutions and the number of new institutions. In the United States, it was a result of federally funded research, an outgrowth of experiences at the Massachusetts Institute of Technology’s Lincoln Laboratory (radar) and the University of Chicago (atomic bomb) during the war. Expansion was also due to the GI Bill and subsequent equal opportunity funding initiatives, and the requirements of a labor force trained in emerging engineering fields, particularly electronics and computers [2, p.22].

Historian John Thelin put it this way [9]:

By 1965 one could speak of an “academic revolution” in which American society had come to rely on and accept the expertise of colleges and universities, indicative of an “information society” whose foundation was a “knowledge industry.” Student enrollments had grown, both in actual numbers and as a proportion of total population, such that higher education had been transformed from an elite to mass access.

During the period right after World War II to the early 1970s, the number of college and university professors and students approximately tripled. The number of institutions also grew, as did the number of graduate programs [10, p.229]. The most rapid growth in faculty occurred in the 1960s.
Most of these faculty will soon retire, a fact clearly relevant to those of you considering academic careers. You should be aware, however, that anticipated increase in demand expected from such retirements will be at least partly offset by advances in teaching productivity through instructional television and computers, the increasing use of part-time faculty, particularly at the community college level, and the downsizing or even elimination of some departments. We will discuss the supply and demand topic in greater detail in Chapter 4, "Your Professional Preparation Strategy."

**KEY CHARACTERISTICS**

There are currently about 3600 (1600 public, 2000 private) accredited institutions of higher education in the United States, up from approximately 3400 in 1987, the last time a survey of such institutions was conducted by the Carnegie Foundation for the Advancement of Teaching [11, p.A17]. These institutions enroll approximately 14.5 million students and award slightly over two million degrees, a quarter of which are in science and engineering [12, pp.2/6–2/10]. While there is considerable variation among fields, Ernest L. Boyer, the Foundation’s late president, points out that overall: “There is now more higher education than ever in history... and predictions of decline are simply not supported by the facts” [14].

A similar growth pattern exists in Canada. Current full and part-time enrollment in higher education exceeds 870,000, up from 630,000 in 1980–1981 [13, p.29]. Canada currently has 80 institutions offering bachelor’s, master’s, and doctorate degrees [13, pp.64–67].

**The Carnegie Classification**

The Carnegie Foundation for the Advancement of Teaching groups accredited U.S. institutions into 11 categories based largely on their mission. The categories are: Research universities I&II (Res. I&II), Doctoral universities I&II (Doc. I&II), Master’s (comprehensive) universities and colleges I&II (MA I&II), Baccalaureate (liberal arts) colleges I&II (BA I&II), Associate of Arts colleges (AA), Professional schools (Prof.), and specialized institutions (Spec.). (Note: A new term, Metropolitan University, not formally part of the Carnegie classification, has recently come into use among a number of Master’s institutions located in urban areas.) Table 1-1 describes the basis for these categories. Institutions are classified according to the highest level of degree they award, the number of degrees conferred by discipline, and, in some cases, the amount of federal research support they receive, and the selectivity of their admissions. Table 1.2 lists the number of schools by Carnegie classification. Figure 1-1 shows the proportion of institutions by category. Figure 1-2 summarizes the above informa-
<table>
<thead>
<tr>
<th>CLASS I</th>
<th>CLASS II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Universities</strong></td>
<td>These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctorate degrees each year. In addition, they receive annually $40 million or more in federal support.</td>
</tr>
<tr>
<td><strong>Doctoral Universities</strong></td>
<td>These institutions offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award at least 40 doctorate degrees annually in five or more disciplines.</td>
</tr>
<tr>
<td><strong>Master's (Comprehensive) Colleges and Universities</strong></td>
<td>These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 40 or more master's degrees annually in three or more disciplines.</td>
</tr>
<tr>
<td><strong>Baccalaureate (Liberal Arts) Colleges</strong></td>
<td>These institutions are primarily undergraduate colleges with major emphasis on baccalaureate degree programs. They award 40% or more of their baccalaureate degrees in liberal arts fields and are restrictive in admissions.</td>
</tr>
</tbody>
</table>

### Table 1.2 Number of Colleges and Universities by Carnegie Classification, 1994

<table>
<thead>
<tr>
<th>INSTITUTIONS</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td>Doctorate-granting</td>
<td></td>
</tr>
<tr>
<td>Research I</td>
<td>236</td>
</tr>
<tr>
<td>Research II</td>
<td>88</td>
</tr>
<tr>
<td>Doctorate I</td>
<td>37</td>
</tr>
<tr>
<td>Doctorate II</td>
<td>52</td>
</tr>
<tr>
<td>Master’s-granting</td>
<td></td>
</tr>
<tr>
<td>MA I</td>
<td>532</td>
</tr>
<tr>
<td>MA II</td>
<td>439</td>
</tr>
<tr>
<td>Master’s-granting</td>
<td></td>
</tr>
<tr>
<td>MA I</td>
<td>93</td>
</tr>
<tr>
<td>Baccalaureate-granting</td>
<td></td>
</tr>
<tr>
<td>BA I</td>
<td>633</td>
</tr>
<tr>
<td>BA II</td>
<td>163</td>
</tr>
<tr>
<td>Associate of Arts colleges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>470</td>
</tr>
<tr>
<td>Professional schools and specialized institutions</td>
<td>1,480</td>
</tr>
<tr>
<td>Tribal colleges</td>
<td>690</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,600</td>
</tr>
</tbody>
</table>


### Figure 1-1 Proportions of institutions by Carnegie Classification, 1994.

- 19.2% Special institutions
- 0.8% Tribal colleges
- 2.4% Research universities I
- 1.0% Research universities II
- 1.4% Doctoral universities I
- 1.6% Doctoral universities II
- 12.2% Master’s (comprehensive) universities and colleges I
- 2.6% Master’s (comprehensive) universities and colleges II
- 4.5% Baccalaureate (liberal arts) colleges I
- 13.1% Baccalaureate (liberal arts) colleges II
- 41.1% Associate of arts college

Note: Figures do not add to 100 percent because of rounding

Total: 3,600 Institutions

Source: The Carnegie Foundation for the Advancement of Teaching
tion, and also includes data on the enrollment of students and degrees granted. (Note: The small differences in institutional totals between Table 1.2 and Figure 1-2 are due to differences in reference dates.)

Canada does not use the Carnegie classification, although it is not that difficult to “assign” Canadian schools to the Carnegie categories. We will refer to the Carnegie classification often throughout this book. It provides a convenient way to examine the characteristics of colleges and universities of interest to you as a future science or engineering professor. While science and engineering teaching takes place at almost all types of colleges and universities in the classification, we will concentrate on those 1500 U.S. and Canadian schools offering four or more years of higher education, i.e., Res. I&II, Doc. I&II, MA I&II, and BA I&II. Virtually all of these schools require a doctorate degree of their newly hired faculty.

**Where New Faculty Come From—Where New Faculty Go**

The Appendix lists all 236 U.S. doctorate-granting institutions. These schools award approximately 41,000 doctorates per year, with the top 35 schools awarding 16,874, or 41.5% of the total. It is from these schools that essentially all U.S.-educated science and engineering faculty will come, but it is certainly not where all of them will go. Of all the faculty at four-year institutions, approximately 55% are at Research and Doctoral schools and 45% are at Master's and Baccalaureate schools [14].

An interesting example of where faculty come from and where they go can be found in my own academic neighborhood. Stanford University and the University of California, Berkeley (UCB) are both Research I institutions. San Jose State University is a Master's I institution. All are within 50 miles of each other. Stanford has 221 full-time engineering faculty of which 109, or 49%, received their Ph.D.s from either Stanford or UCB. Yet, at San Jose State University with a total of 97 engineering faculty, 36, or 37%, are also from Stanford or UCB.

Of course, some of you now attending Research universities as graduate students and postdocs attended other types of schools as undergraduates. You have been exposed to Master's and Baccalaureate schools, but probably at a time when you were not yet considering an academic career. The key point in all of the above is this:

**Graduate students and postdocs preparing for academic careers must consider not only the 250 or so schools from which new faculty come, and to which, of course, a number return, but the other 1250 or so schools to which almost half will go as new professors.**

**Teaching and Research Emphasis**

The relative importance of teaching and research varies by type of institution. As will be discussed later, there is increasing talk about putting more emphasis on all forms of scholarship, including teaching at research universities. However,
most of this talk comes from university presidents and deans, not from faculty. As Boyer points out, “Almost all colleges pay lip service to the trilogy of teaching, research, and service but when it comes to making judgments about professional performance, the three are rarely assigned equal merit” [5, Ch.2,
Whether or not the institutional incentives and faculty reward systems can be restructured to bring about this change is a matter of much debate. We will look more closely at such efforts at various points throughout this book.

While some Research universities, in at least some departments, do an excellent job of teaching undergraduates, generally speaking, more emphasis on teaching occurs in Master’s and Baccalaureate schools. Evidence for this difference can be seen in how faculty from each type of school responded to questions about the importance of teaching and research in the awarding of tenure at their institution.

Table 1.3 shows the percentage of faculty who replied “very important” in responding to a series of questions on this subject. These results indicate that research publications and grants are perceived as much more important in tenure decisions at Research and Doctorate-granting institutions, with the reverse being true with respect to teaching at Master’s and Baccalaureate (liberal arts) schools.

There is a tendency among some academics to view the Carnegie Classification as a hierarchy topped by selective liberal arts colleges and major research universities. Boyer discounts this view, pointing out that the classification is not an attempt to build a pyramid in terms of quality. “It doesn’t talk about

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>RES. I&amp;II</th>
<th>DOC. I&amp;II</th>
<th>MASTER’S I&amp;II</th>
<th>L.A. I&amp;II</th>
</tr>
</thead>
<tbody>
<tr>
<td>How important is the number of publications for granting tenure in your department?</td>
<td>56</td>
<td>55</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>How important are research grants received by the scholar for granting tenure in your department?</td>
<td>40</td>
<td>35</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>How important are student evaluations of courses taught in granting tenure in your department?</td>
<td>10</td>
<td>9</td>
<td>37</td>
<td>45</td>
</tr>
<tr>
<td>How important are observations of teaching by colleagues and/or administrators for granting tenure in your department?</td>
<td>4</td>
<td>6</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>How important are recommendations from current or former students for granting tenure in your department?</td>
<td>3</td>
<td>6</td>
<td>13</td>
<td>30</td>
</tr>
</tbody>
</table>

quality, or hierarchy in terms of good or bad," he states. "It is not a measure of creativity or innovation. It talks about the level of complexity of program. It doesn't do more, and it shouldn't do more. It's a beginning point, not an end point" [11, p.A17].

Boyer's comments notwithstanding, faculty at a number of schools are feeling the pressure to help their institution "move up" in the Carnegie categories. From 1987 to 1994, there was a total of 433 category changes. Sixteen Research II institutions shifted, all to the Research I category. Eighteen Doctoral institutions shifted, one to Research I, 16 to Research II, and one "down" to Doctoral II. The shifts among MA I&II and BA I&II are not as easy to interpret since what is "up" and "down" is less clear in these categories [11, p.A20].

During the last seven years, the University of Alabama at Birmingham moved "up" three steps from the Doctoral II category to the Research I category. Commented Kenneth J. Rooren, executive vice president at Birmingham, "We've been striving to get to the top... We didn't develop a strategy to become a Research I institution, but we did develop a strategy to gain excellence and breadth" [11, p.A17].

Recently, the University of California, Irvine, announced plans to "vault" into the ranks of the top 30 research universities by expanding its presence in biomedicine, the neurosciences, and related fields [15].

A more disparaging view of this situation was expressed by a faculty member at a public institution in New York, who noted that her university had gone from "state supported, to state assisted," and this had put tremendous pressures on what was basically a teaching university to raise indirect cost support through research grants.

The teaching–research balance can also vary quite a bit among institutions of the same type, and even within a specific institution. A professor of biology at a large Master’s I institution commented that her department has always had a strong teaching emphasis because the senior professors who were hired in the 1960s, when teaching was the dominant activity, continued to hire like-minded faculty in the 1970s and 1980s. She noted, however, that the Chemistry Department chairman was a "V.C. wannabe," V.C. being the University of California, and that his department had a much stronger research emphasis in its retention, tenure, and promotion process.

The above examples raise a number of important questions. What is actually meant by excellence and breadth? If more schools move "up" than "down," does this mean that total research funding has increased? What does this imply about future success if research support from the government decreases? Is there a measurable trend toward better teaching, and if so, how does this relate to tenure and promotion? We will look more closely at these questions in later chapters. The point to be made here is that, as a future professor, it is important for you to find out about the future goals, as well as the funding history, of an institution or department before accepting a position for which there might be quite different expectations and responsibilities two–five years down the road.
GOVERNANCE AND DECISION MAKING

Organizational Structure

Although there is some variation from one institution to the other, most colleges and universities have similar governance structures. As an example, consider the University of Arizona (Figure 1-3). The president, who reports to the Arizona Board of Regents, is the chief executive officer, chief spokesman, and chief fundraiser for the university. The senior vice president for academic affairs and provost is the chief academic officer. The senior vice president for business affairs is the chief fiscal and operations officer for the university. Both report to the president. The president and the senior vice president for academic affairs and provost are both tenured faculty members. Four vice presidents with responsibilities appropriate to their titles report to the senior vice president for academic affairs and provost. They are the vice president for academic services and undergraduate education, the vice president for institutional planning, the vice president for research and graduate studies, and the vice president for student affairs. None of these four must be tenured faculty members. The deans of the 11 colleges, all of whom are tenured professors, report to the senior vice president for academic affairs and provost. The department chairs report to the various deans, and the faculty report to the department chairs [16].

Figure 1-3 looks like the typical top-down organization chart you would expect to find in most private sector companies. Such is not the case. In most Research and Doctoral institutions, there is very little top-down governance and control. The real power lies with the faculty, and decision making is from the bottom up.

Gerhard Casper, president of Stanford University, explains the politics of academia this way:

Many people think the universities are hierarchical because they have a president with a fancy title, and three or four levels of professors, but they are not hierarchical. Power comes from the bottom up. The most important decisions are those concerning admissions, curriculum and faculty appointments, and these are areas where the university president has almost no power. In most circumstances, I’m the man with the pail and broom [17].

There is more top-down control at some master’s and baccalaureate institutions, yet even here, faculty usually have considerable decision-making authority. Generally speaking, department chairs, deans, provosts, and presidents have the power to block some decisions made by the faculty, for example, those concerning retention, tenure, and promotion. In certain cases, they can also reallocate resources such as space and faculty billets. They can also force cuts in administrative and support services. However, for the most part, decisions about curriculum, grading, and research policies are made by faculty committees.
Figure 1-3 The organization of the University of Arizona.

Arizona Board of Regents

President
Senior Vice President, Business Affairs

Senior Vice President of Academic Affairs and Provost

V. P. of Academic Services & Undergraduate Education
V. P. Inst. & Planning
V. P. Res. & G. S.
V. P. Student Affairs

Deans of Eleven Colleges

- Agriculture
- Architecture
- Arts & Science
- Education
- Eng. & Mines
- Law
- Medicine
- Nursing
- Pharmacy
- Graduate School

Dean of the College of Engineering and Mines

Chairs of the Departments in College of Engineering and Mines

- Aerospace & Mechanical Eng.
- Chemical Engineering
- Electrical & Computer Eng.
- Hydrology & Water Research
- Materials Science & Eng.
- Mining & Geological Eng.
- Nuclear & Energy Eng.
- Systems & Industrial Engineering
Some of these committees operate at the department, or even subdepartment level. Others operate at the school or college level, and still others, such as the faculty senates, at the institution level. Some are technically advisory to the chairs, deans, and provost, and can thus be overruled by these people, but most are true decision-making bodies.

The Multiuniversity

One of the biggest changes in higher education governance over the last 30 years has been the move from single-campus governance to large, complex, and heterogeneous multicampus systems [18]. Such systems involve two or more campuses with a single state-wide governing board. Three-fourths of all students in public higher education in the United States attend a multicampus university [19, pp.358].

There are pluses and minuses to such organizations. On the one hand, state-wide governing boards can often provide a broader, longer term perspective on what is important to students across the state. They may be in a better position to decide what to eliminate or preserve among the programs of the various campuses. They should also be able to play a role in fostering intercampus programs. On the other hand, they can pose a threat to campus autonomy, and can make faculty-shared governance more difficult. How these conflicting interests will play out over the next few years is unclear. As Ami Zusman, coordinator for academic affairs, Office of the President, University of California System, notes [19, pp.358–359]:

During the 1990s, systemwide leadership (boards, administrators, and faculties) will be particularly important in responding to an environment of continuing budget constraints, demands for greater institutional accountability, questions of student access, and other changing conditions...Whether systemwide leadership will be able to exercise initiative is uncertain, however in light of both campus concerns for autonomy and state demands for more direct control.

The Institution of Tenure

Nothing distinguishes academia from other organizations in society more clearly than the institution of tenure. The 1940 Statement of Principles on Academic Freedom and Tenure, drafted by the Association of American Colleges, sets out the reasons for academic tenure this way [20]:

Tenure is a means to certain ends; specifically: (1) freedom of teaching and research and of extramural activities and (2) a sufficient degree of economic security to make the profession attractive to men and women of ability. Freedom and economic security, hence, tenure, are indispensable to the success of an institution in fulfilling its obligations to its students and to society.
This statement was drafted against the background of the Great Depression. Today, you can hear arguments that tenure is no longer needed, and protection against unwarranted firings is now accomplished through legislation applying to employees of all institutions. Still others have argued that, in the parlance of modern business and social language, tenure has enabled dysfunctional behavior by allowing some tenure faculty to be shielded from accountability for their decisions and actions. Nevertheless, tenure is an institution “that professors around the world take to be the prime guarantor of their freedom to seek and deliver truth” [21]. Do not look for it to disappear soon. As Philip Altbach, professor of higher education at Boston College, puts it, “The Professoriate sees tenure as one of its most important perquisites and has defended it vigorously. Administrators and policy makers have recognized the centrality of tenure to the self-concept of the profession” [10, Ch.10, p.237].

This being the case, tenure is something you will need to pay a great deal of attention to in your first years as a new professor. We will look at tenure, and how to improve your chances of getting it, in Part IV, “Looking Ahead to Your First Years on the Job—Advice from the Field.”

**Power and Money**

In a given college or university, power lies less with the consumers of resources than with the providers of resources. This reality explains why the largest departments are not always the most powerful, i.e., have the greatest prestige, are the most listened to by other departments, and have the most faculty on university-wide committees.

Income enters academia from many sources: tuition, funding from state legislators in the case of public institutions, the federal government for both public and private institutions, interest on endowment, and donations from alumni and friends. How resources flow into a college or university affects where the institution puts its emphasis. As Gerald Salancik of Carnegie-Mellon University points out, “Prestigious private universities are more likely than prestigious public universities to have outstanding law and business schools, and prestigious public universities are more likely to have outstanding engineering and agricultural schools” [22, p.66]. As we noted earlier in this chapter, these differences reflect the historical basis of these institutions. According to Salancik [2, p.68]:

Private schools, lacking the subsidies of a state appropriation process, operate very differently than public universities. They survive by accumulating endowment, which depends on their graduates’ wealth and willingness to part with it as they age. Not surprisingly, private schools pay a lot more attention to their undergraduates’ experiences. They want their students to leave with warm feelings and fond memories.
It has been found that high-level administrators, such as directors of development, were more highly compensated in private colleges and universities, where presumably their results were more valued, than in public colleges and universities. The reverse was true for athletic directors [23].

Nevertheless, tuition and endowment are almost never enough to balance the books. For example, at Stanford University, tuition, which now runs close to $25,000 per year, still covers only half the University’s annual operating budget. As a consequence, doctorate granting institutions and, increasingly, other four-year institutions are relying on research grants to help support the enterprise.

Grants from government and industry are, of course, designed to pay for faculty and graduate student salaries, equipment, and travel associated with doing research. However, this use is not the only reason such grants are sought. Universities have an agreement with the U.S. federal government by which the latter will fund both the direct and indirect costs of the research it chooses to support. These costs include the obvious, such as portions of faculty salaries, student research assistantships, laboratory fees, and travel to conferences to present papers on the research. They also involve an overhead amount for indirect costs, those costs that cannot be identified directly with a research activity, but which nevertheless contribute to its operation. These include the costs of libraries to buy and house scientific journals, heating and lighting buildings that researchers use, and even a portion of the costs of roads and other university maintenance. Each university negotiates its indirect cost rate with the government. For private universities, this can run as high as 50–60% of the direct costs of a research grant.

The value of overhead funds is that they are discretionary, and can be used by campus administrators to fund a variety of projects not directly related to a specific research grant. As Jeffrey Pfeffer, professor of organizational behavior at the Stanford Graduate School of Business, puts it [24]:

The most precious resource in any organization is an incremental resource, not already spoken for, that can then be used to solve the organization’s current problems —problems that are more difficult to address using the current resources because of the conflict involved in reallocation.

Not surprisingly, Salancik and others have found that a department’s power is proportional to its contribution to the overhead pool. Indeed, they determined that the major predictors of the differences between the power of departments was the grant monies they each provided [22, p.68].

There is now some indication that the U.S. government may no longer fund the full cost of doing sponsored research. With full-cost recovery, the university did not really care what research faculty “chose” to do since the university always had its costs covered. If full cost recovery is no longer the case, what impact will it have on the research a university “chooses” to support? The
Canadian government has also changed the way it funds provincial education, and this change is having a significant impact on its colleges and universities. We will discuss these and other factors in greater detail in Chapter 3, "New Challenges for the Professoriate." We will also look much more closely at the importance of such grants to beginning professors in Chapter 5, "Research as a Graduate Student and Postdoc."

**INSTITUTIONAL ISSUES**

It is unlikely that you are hearing the term Golden Age on today's college and university campuses. Higher education is currently facing unprecedented pressures and challenges. Here is just a brief list of some of the recent institutional issues making headlines around the country [25]:

- Demands for multiculturalism in the curriculum
- Scrutiny of racially based undergraduate admissions quotas
- Attempts to control violence and hate crimes on campus
- Graduate student teaching assistants going on strike
- Increased prominence of university–industry partnerships and technology transfer activities
- Occasional allegations of scientific misconduct/fraud
- The alleged mismanagement of indirect cost funds
- Dramatic consequences from massive budget cuts brought about by a national economic downturn, and often accompanied by explicit "downsizing" mandates from state legislatures

You can add to the above list anxiety about federal funding, increased global competition, and the current difficulties of graduate students and postdocs in finding industry and academic positions. We see these consequences in downsizing, outsourcing, and greater demands for accountability at all levels of higher education. Everywhere there is a move to consolidate and focus. As one university president noted, "My university can do anything, but it can't do everything."

A computer science professor at a large Master's institution put it more personally when he said:
I've been asked to do four things: improve the quality of my teaching, teach more students, and do it all in less time, and for less cost. I know how to do any three, if I don't have to worry about the fourth. But I can't figure out how to do all four at the same time.

In addition to the retrenchment and reallocation issues noted above, colleges and universities are facing a number of other challenges. Student body compositions and expectations are changing. In general, students are more conservative than they were 20 years ago, and they, and their parents, are demanding more relevance in the curriculum and greater attention to the quality of undergraduate teaching. These demands are particularly pertinent when college costs rise at the same time students have difficulty in enrolling in required courses.

As the demands for improvement in undergraduate education increase, there is increasing tension over the balance between teaching and research. As mentioned above, tenure and promotion, even at four-year colleges, still give greater weight to research and publications than to teaching, particularly undergraduate teaching. There are some trends in the other direction, based in part on a call for an expanded definition of scholarship discussed below. However, given the financial rewards and institutional prestige that come with a greater research emphasis, it is likely that tensions around the appropriate incentive and reward systems in higher education will only increase.

Of particular interest to you as a future professor of science and engineering are the significant changes taking place in the nature of science and engineering research at colleges and universities. These include growing university–industry collaborations, the commercialization of some science and engineering research, greater shifts toward directed and applied research, and the general move toward "big science" and "big engineering" projects involving millions and even billions of dollars [19, p.352]. These programs can provide a number of benefits, but also create a number of potential problems. We will discuss this important topic in more detail in Chapter 2, "Science and Engineering in Higher Education," and Chapter 3, "New Challenges for the Professoriate."

Ironically, even at a time of turmoil, higher education in North America remains the envy of the world. Nowhere else do as many people have as much access to as high a quality of education as they do in the United States and Canada. Furthermore, students from all over the world, particularly at the graduate level, continue to apply to U.S. and Canadian institutions in significant numbers [12, p.2/17], [13, p.6].

The number of students applying to graduate schools in the United States and Canada raises the issue of supply and demand for Ph.D.s in science and engineering and how universities should respond to it. As we will see in Chapter 4, "Your Personal Preparation Strategy," there is currently an oversupply of Ph.D.s in a number of science and engineering fields relative to full-time openings for such Ph.D.s in industry and academia. Should academia just let market
forces take care of the problem? Should they continue their admissions policies, but warn students of the possible nonavailability of some jobs? Should they instead admit fewer students, eliminate or reduce foreign students, or downsize their research programs? The answers are not clear. More importantly, as a prospective science or engineering professor, what does all this mean to you? Realism and market forces, combined with your passion for a particular option, are likely to determine what you do. In Chapter 4, we will outline a strategy to help you prepare for whatever choice you make.

A NEW LOOK AT SCHOLARSHIP

Undoubtedly, you have already heard much about the teaching and research balance debate at your current institution. One of the most important tasks as you move toward your first academic position is to determine what kind of ratio best suits your interests and capabilities. In doing so, you may want to identify institutions, particularly in the Master's and Baccalaureate categories, where other forms of scholarship are valued in addition to traditional research. In at least some institutions, there is a move to place more value on a larger range of activities in the retention, tenure, and promotion process. Ernest Boyer has done the most to articulate the need for such a move. As he noted in the Carnegie Foundation for the Advancement of Teaching 1990 special report, Scholarship Reconsidered: Priorities of the Professoriate [5, Ch.2, p.16]:

We believe the time has come to move beyond the tired old “teaching versus research” debate and give the familiar and honorable term “scholarship” a broader, more capacious meaning, one that brings legitimacy to the full scope of academic work…Specifically, we conclude that the work of the professoriate might be thought of as having four separate, yet overlapping, functions. These are: the scholarship of discovery; the scholarship of integration; the scholarship of application; and the scholarship of teaching.

The scholarship of discovery is what most of us think of as traditional research. The scholarship of integration is work that makes connections across disciplines, but is interdisciplinary, not just multidisciplinary. It is an attempt to put specialties in a large context, and is in part a response to the demands of industry which is increasingly dealing with problems not bounded by specific disciplines. The application of knowledge involves service tied directly to a faculty member’s special field of knowledge, and includes such things as medical service, serving clients in psychotherapy, working with industry on the design of a new microprocessor, and testing a new software application in the local school system. The scholarship of teaching, in the words of Boyer, “both educates and entices future scholars...It means not only transmitting knowledge, but transforming and extending it as well” [5, Ch.2, p.16].
The relationship among the various forms of scholarship is circular, not linear, as shown in Figure 1-4. Each form benefits from, and contributes to, the other.

Boyer notes that the scholarship of teaching was emphasized in the colonial college, the scholarship of application in the land grant institutions of the last century, and that the scholarship of discovery, and to some extent integration, has emerged in the post-World War II university. He believes that with the diversity found in today's institutions of higher education, it should be possible to more fully promote and reward all forms of scholarship.

This perspective is all very well, of course, but the real test is how this plays out in the retention, promotion, and tenure process. In 1990, Boyer made the following observation [5, Ch.2, p.28]:

Today at most four-year institutions, the requirements of tenure and promotion continue to focus heavily on research and on articles published in journals, especially those that are referred. Good teaching is expected, but it is often inadequately assessed. And the category of "service," while given token recognition by most colleges, is consistently underrated too.
Today, however, particularly with better tools available for the assessment of the various forms of scholarship, there is evidence of a movement, albeit a modest one, toward the acceptance of this broader view of scholarship [26],[27]. A number of presidents of metropolitan universities (primarily Master’s I and II universities located in urban environments) have signed a declaration stating, among other things, that the “creation, interpretation, dissemination, and application of knowledge are the fundamental functions of our universities,” and that faculty research must [28]:

seek and exploit opportunities for linking basic investigations with practical application, and for creating synergistic interdisciplinary and multidisciplinary scholarly partnerships for attacking complex metropolitan problems, while meeting the highest scholarly standards of the academic community.

Not surprisingly, at Baccalaureate and Master’s schools, the scholarship of teaching and application is given greater weight in tenure decisions than at Research and Doctoral schools. In a recent survey, 45% of the faculty at liberal arts colleges and 37% of the faculty at Master’s colleges rated student evaluations of courses taught as “very important” for granting tenure in their department. This result compared with 10 and 19%, respectively, for faculty at Research and Doctorate-granting institutions [5, Ch.2, p.30].

While certainly not common, one can point to examples where the scholarship of integration, application, or teaching made a difference with respect to retention, promotion, and tenure for faculty at Research and Doctorate-granting institutions. Nino Masnari in the Electrical Engineering Department at North Carolina State University (scholarship of integration), David Kelly in the Mechanical Engineering Department at Stanford University (scholarship of application), and Susan Montgomery in the Chemical Engineering Department at the University of Michigan (scholarship of teaching) are three specific examples. Whether or not these examples will remain the exception, or whether they foretell of at least a modest trend in the broader scholarship direction, is something we will discuss at greater length in the chapters to come.

SEVEN SAMPLE SCHOOLS

As noted in the introduction, over 70 faculty, graduate students, and postdocs from a range of schools across North America have provided material for this book. In addition to acquiring this broad input, I have examined, as sources of more in-depth information, seven institutions representative of the four-year colleges and universities in the Carnegie classification. The seven schools, which are located across North America, are Bucknell University (BA I), Memorial
University of Newfoundland (Doc. I), the University of Michigan (Res. I), Rochester Institute of Technology (MA I), San Jose State University (MA I), Stanford University (Res. I), and the University of New Orleans (Doc. II). Table 1.4 looks at the institutions by date of founding, type (public or private), location, and enrollment. There is at least one school from each of the four major Carnegie classifications. One school has approximately 4000 students, four have from 10,000 to 18,000 students, and two from 30,000 to 37,000 students. All offer at least bachelor's degrees in engineering and in one or more of the natural sciences. Below is a brief description of each school.

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<th>Table 1.4 Seven sample schools</th>
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<td><strong>Bucknell University</strong></td>
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<td><strong>Memorial University of Newfoundland</strong></td>
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<td><strong>Rochester Institute of Technology (R.I.T.)</strong></td>
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<td><strong>San Jose State University (S.J.S.U.)</strong></td>
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**Bucknell University (BA I)**

Bucknell University is a private, 100-year-old baccalaureate institution of about 3600 students. It is located in Lewisburg, PA, 60 miles from Harrisburg. According to the university catalog, Bucknell is [29]:

...a highly selective, primarily undergraduate institution offering a broad curriculum of studies in the humanities, social sciences, and natural sciences, as well as professional studies in engineering, education, and management. Bucknell benefits from its focus on the liberal arts and the professions, its modest size, its location, and the
large number of qualified applicants attracted by the competitive environment of the private colleges along the East Coast. The University's primary responsibility is to provide wide educational opportunities within a collegiate setting to a controlled number of talented men and women.

According to Martin Ramirez, Assistant Professor of Biology at Bucknell:

I like working in a small liberal arts college with strong science and engineering programs. But one problem faced by many faculty who have professional spouses is that of finding career opportunities for both of them in such a small, isolated location. I know some faculty who live quite a distance from Lewisburg so that their spouses can work in Harrisburg, or even Rochester.

Memorial University of Newfoundland (Doc. I)

Memorial University of Newfoundland (MUN), in St. John's, NFLD, is a public institution founded in 1925 as a memorial to those Newfoundlanders who died in World War I. Newfoundland was a British colony until 1949, and MUN continues to be influenced by British traditions. It is, however, a modern Canadian university, the largest in the Maritime provinces, with extensive undergraduate and graduate programs in the natural sciences and in engineering and applied sciences.

A particularly impressive MUN feature is found in the Ocean Engineering Research Center (OERC) which serves as the focus of ocean engineering research and teaching in Canada. MUN is the only university in Canada to offer the bachelor's degree in naval architecture and the master's and Ph.D. in ocean engineering. The Center's facilities include a 60-meter wave/tow tank and the international class facilities of the Institute for Marine Dynamics of the National Research Council of Canada [30].

Naval Architecture Professor, Mahmood Haddara, describes MUN this way:

MUN has one of the best naval architecture departments in the world, and so it seemed natural for me to want to come here. I particularly wanted to study ship motion, and with all the work going on off-shore these days (platforms), this is the perfect place for me to teach and do research.

The University of Michigan, Ann Arbor (Res. I)

The University of Michigan, Ann Arbor, is a public institution of some 36,000 students founded in 1817. It offers undergraduate programs in the arts and sciences, architecture, business administration, education, engineering, fine arts, natural resources, nursing, professional studies, and military training. It has 12 undergraduate and 18 graduate schools. The College of Engineering, founded in 1853, is one of the oldest in the United States. It established the nation's first programs in electrical engineering (1895), chemical engineering (1898), aeronautical engineering (1914), nuclear engineering (1953), and computer engineering (1965) [31].
Diann Brei, Assistant Professor of Mechanical Engineering, talks about her time at the University of Michigan this way:

To me, it’s like building a house. The first year, I made plans and acquired the materials. The second year, I built the foundation. The third year, I put up the frame, and people began to see that it was going to be a very good house. Between the third year and tenure, I plan to put up the walls, finish the house, and decorate. Hopefully, people will then say that for this town (my research area), this is one of the best houses!

**Rochester Institute of Technology (MA I)**

The Rochester Institute of Technology (R.I.T.) is a private institution of about 13,000 students founded in 1829. It is located in Rochester, NY. According to the school’s bulletin [32]:

R.I.T. offers programs in science, computer science, allied health, engineering, business, hotel management, graphic arts and photography, as well as the liberal arts and includes the National Technical Institute for the Deaf. Most programs include a cooperative education component which provides full-time work experience to complement classroom studies.

Explains Mark Hopkins, R.I.T. professor of electrical engineering:

A particularly interesting feature of R.I.T. is its close relationship with surrounding industry. This relationship allowed me to spend eight years as a professor at R.I.T. while also working as a senior scientist at the nearby Xerox research facility. There is no question in my mind that this benefited both me and my students a great deal.

**San Jose State University (MA I)**

San Jose State University is the oldest (1857) school of what is now a 20-campus California State University system, the largest senior higher education system in the United States. (It is not to be confused with the nine-campus University of California system, associated with the University of California, Berkeley.) San Jose State University enrolls about 26,000 regular students and another 30,000 in its extended education program, the latter reaching out to the community (Silicon Valley) with a variety of professional certificate programs and other educational experiences. The University offers baccalaureate and master’s degrees and professional credentials in more than 150 disciplines, including the professions, business, social work, engineering, science, technology, education, social science, the arts, and the humanities. It is located in San Jose, CA, about 40 miles south of San Francisco [33].
According to Sally Veregee, professor of biology:

My department tends to hire older people. By that, I mean assistant professors in their middle, to even late 30s. We look for good postdoc or industrial experience first. We've found it makes a real difference.

**Stanford University (Res. I)**

Stanford University is a private institution established in 1891 by Leland and Jane Stanford in memory of their son, Leland, Jr., who died of typhoid fever in Florence, Italy, in 1884. It enrolls approximately 6500 undergraduates, and a similar number of graduate students, of which approximately 2300 are from other countries. It offers a full range of bachelor’s, master’s, doctorate, and professional degrees in over 70 fields across seven schools of business, earth sciences, education, engineering, humanities and sciences, law, and medicine. It is adjacent to Palo Alto, CA, about 25 miles north of San Jose [34].

George Springer, chairman of the Aeronautics and Astronautics Department, offers this comment:

From my faculty, I expect one–two conference presentations per year, three–four journal papers every two years and at least one seminal paper prior to tenure.

**University of New Orleans (Doc. II)**

The University of New Orleans was established in 1956 by the Louisiana Legislature to bring public-supported higher education to the state’s largest urban community. According to the university catalog [35]:

The University offers extensive learning experiences and academic training at both the undergraduate and graduate levels to nearly 16,000 students in more than one hundred degree programs. Over thirty-five thousand degrees have been offered since the first graduating class of 115 in 1962, nearly one-quarter of which are at the masters or doctoral level. Programs of study are offered through six academic colleges: Business Administration, Education, Engineering, Liberal Arts, Sciences and Urban and Public Affairs.

Norm Whitley, professor of mechanical engineering at U.N.O., referred to his work this way:

I have been particularly interested not only in the teaching of ethics, but in the ethics of teaching. I’ve been working with my colleagues on developing a code of ethics that I think will have a real impact on how U.N.O. contributes to this important issue.
Our first vignette takes a closer look at some of the views of Ernest Boyer whose work on a new scholarship paradigm is having an important impact on higher education. The vignette is based on his writings and on a speech produced by the National Technological University and given in March 1995 to the National Science Foundation sponsored Engineering Faculty Forum at the University of Maryland in College Park, MD.

Ernest L. Boyer, late President of the Carnegie Foundation for the Advancement of Teaching

The most urgent obligation higher learning now confronts is to reaffirm the undergraduate experience in its full breadth and rediscover the essentialness of teaching. This means making it possible for all students to become scholars through the discovery, the integration and application of knowledge—and through the transmission of knowledge, which will keep the flame of scholarship alive [36].

So says Ernest L. Boyer, former chancellor of the State University of New York, late president of the Carnegie Foundation for the Advancement of teaching, and author of the landmark publication, Scholarship Reconsidered: Priorities for the Professoriate. Boyer passed away in December 1995.

In a March 14, 1995 speech, Boyer suggested that his four-part notion of scholarship may be a way to define the purpose of an undergraduate education [36].

Suppose that we tell every undergraduate that he or she is entering the world of scholarship, and that in so doing we bring the language of the professoriate and the language of the freshman together right from the start by letting the student know what it means to be a scholar. We tell them that it means someone who does discovery, someone who learns to integrate, someone who learns how to apply their knowledge and someone who knows how to share what they’ve learned.

Through such an approach, undergraduates could, for example, begin doing research projects with senior professors. In Boyer’s words, “The student could learn what discovery is all about by starting a conversation with faculty when they are a freshman, not when they are working on their Ph.D.”

Boyer believed that the integration of knowledge can be placed in the context of liberal learning or general education, and not just treated as “something you get out of the way.” The scholarship of application can be a part of every undergraduate’s experience through some type of field work or service. It is important that such service come from a specific area or specialty, for as Boyer said, “Don’t confuse doing good with doing scholarship, important as both may be.” In other words, “To be considered scholarship, service activities must be tied directly to one’s special field of knowledge and relate to, and flow directly out of, this professional activity”[5, p.22].
Sharing, or the scholarship of teaching, would mean that students would have to regularly present their ideas in some form of open discourse. After all, commented Boyer [36]:

One hundred years ago to get a degree you didn’t turn in green stamps to the registrar. You stood up and had a declamation and that’s when you earned your degree. You didn’t get your degree by stacking up units, but by showing that you were educated enough to write a paper, stand up and present it, and defend it in an open discourse of sharing knowledge. That was the test of an educated person.

Boyer understood that you may not be able to do that today, but he suggested that students might be required to take a senior seminar in groups of 20 or so in which they develop a paper and present it orally while others critique it. It would be the final culmination of their sharing of knowledge, or teaching. As he put it [36]:

It would be a fascinating way to rethink what the undergraduate experience is about. You can have everything in it that we have today, but by doing it this way you would give it a greater purpose. You’d have a shared culture so that a senior professor and an incoming freshman would have a common language about discovering knowledge, integrating it, applying it, and sharing it.

Boyer, whose ideas on the broader notion of scholarship will be referred to throughout this book, had a long and distinguished career in education. He came to the Carnegie Foundation in 1979 after serving as U.S. Commissioner of Education (under President Carter). In his seven years as chancellor of the State University of New York, he oversaw the operations of 64 campuses and 350,000 students. In 1990, he was named Educator of the Year by U.S. News and World Report, and in 1994, he received the Charles Frankel Prize in the Humanities, a Presidential citation. Boyer had been named by three U.S. presidents—Nixon, Ford, and Carter—to national commissions, and former Secretary of State George Shultz appointed him to chair the State Department’s National Overseas Schools Advisory Council. Boyer received his Ph.D. from the University of Southern California, and was a postdoctoral fellow in medical audiology at the University of Iowa Hospital. Called by many “an evangelist of education” for his dedication to spreading ideas about teaching and learning, Ernest Boyer will be long remembered and sorely missed [26].

SUMMARY

We began this chapter by pointing out that colleges and universities differ in important ways from other institutions in society. We first looked briefly at the history of higher education in North America, and then examined in greater detail
some key characteristics of today's colleges and universities. We introduced the Carnegie classification of higher education that divides most four-year institutions into four categories: Research I&II, Doctorate Granting I&II, Master's I&II, and Liberal Arts I&II. This classification formed the basis for a comparison of schools along a number of dimensions having to do with mission, type of students, and research and teaching emphasis.

An important difference between higher education and the rest of society is in its governance and decision making. We looked at the "bottom-up" approach to decision making and the powerful role faculty play in academia. We examined some of the sources of power in higher education, in particular the role of discretionary funding that results from research contracts and grants. Concerns about the balance between teaching and research has led some schools to consider new forms of scholarship such as those of integration, application, and teaching, in addition to the more research-oriented scholarship of discovery.

We then examined some of the critical challenges facing higher education in general. These challenges include significant restructuring brought about by massive budget cuts, calls for greater relevance in the curriculum, demands for increasing productivity, and the implications of greater university–industry collaborations.

Finally, we introduced seven sample institutions representative of the various four-year colleges and universities in the Carnegie classification. Focused discussions with faculty at these institutions will provide a way of comparing and contrasting the range of schools of interest to future science and engineering professors. We concluded this chapter with our first vignette highlighting Ernest Boyer's views on the role of scholarship in undergraduate education.

In Chapter 2, we will look more closely at the place of science and engineering in academia, and the similarities and differences within, and among, science and engineering departments. Although you will most likely accept a position in a single department, you will certainly have to, and hopefully want to, work with colleagues in other science and/or engineering disciplines, as well as some in completely different fields. You will be both competing and cooperating with these colleagues, and understanding how they think and operate will be essential to your future success.
## Appendix

### Doctorate-Granting Institutions (Continued)

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<td>Wayne State University</td>
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<tr>
<td>West Virginia University</td>
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<tr>
<td>Yale University</td>
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<td>Yeshiva University</td>
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</tbody>
</table>

## Research Universities II

<table>
<thead>
<tr>
<th>University Name</th>
<th>Main Campus Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auburn University</td>
<td></td>
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<tr>
<td>Brandeis University</td>
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</tr>
<tr>
<td>Brigham Young University</td>
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<tr>
<td>Clemson University</td>
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<tr>
<td>George Washington University</td>
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<tr>
<td>Kansas State University</td>
<td></td>
</tr>
<tr>
<td>Kent State University main campus</td>
<td></td>
</tr>
<tr>
<td>Lehigh University</td>
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<tr>
<td>Mississippi State University</td>
<td></td>
</tr>
<tr>
<td>Northeastern University</td>
<td></td>
</tr>
<tr>
<td>Ohio University main campus</td>
<td></td>
</tr>
<tr>
<td>Oklahoma State University</td>
<td></td>
</tr>
</tbody>
</table>
Chapter I The Academic Enterprise

Rensselaer Polytechnic Institute
Rice University
Saint Louis University
Southern Illinois University at Carbondale
State University of New York at Albany
Syracuse University
Tulane University
University of Arkansas
University of California at Riverside
University of California at Santa Cruz
University of Delaware
University of Houston
University of Idaho
University of Mississippi
University of Notre Dame
University of Oklahoma at Norman
University of Oregon
University of Rhode Island
University of South Carolina at Columbia
University of South Florida
University of Vermont
University of Wisconsin at Milwaukee
University of Wyoming
Washington State University

Catholic University of America
City University of New York Graduate School and University Center
Claremont Graduate School
Clark Atlanta University
College of William and Mary
Drexel University
East Texas State University
Florida Institute of Technology
Fordham University
Georgia State University
Hofstra University
Illinois Institute of Technology
Illinois State University
Indiana University of Pennsylvania
Loyola University of Chicago
Marquette University
Miami University
New School for Social Research
Northern Arizona University
Northern Illinois University
Nova University
Old Dominion University
Polytechnic University
Saint John’s University (N.Y.)
Southern Methodist University
State University of New York at Binghamton
Teachers College of Columbia University
Texas Woman’s University
Union Institute
United States International University
University of Akron
University of Alabama
University of Denver
University of Louisville
University of Maryland
at Baltimore
University of Memphis
University of Missouri at Kansas City
University of Missouri at Rolla
University of North Carolina at Greensboro
University of North Texas
University of Northern Colorado
University of Southern Mississippi
University of Texas at Arlington
University of Texas at Dallas
University of Toledo
Western Michigan University

Doctoral Universities II
Baylor University
Biola University
Clark University
Clarkson University
Cleveland State University
Colorado School of Mines
Dartmouth College
De Paul University
Duquesne University
Florida Atlantic University
Florida International University
George Mason University
Hahnemann University
Idaho State University
Indiana State University
Indiana University-Purdue University at Indianapolis
Loma Linda University
Louisiana Tech University
Michigan Technological University
Middle Tennessee State University
Montana State University

Adelphi University
American University
Andrews University
Ball State University
Boston College
Bowling Green State University

Doctoral Universities I

American University
Andrews University
Ball State University
Boston College
Bowling Green State University
Appendix  Doctorate-Granting Institutions (Continued)

| New Jersey Institute of Technology | University of Alabama in Huntsville | University of the Pacific |
| North Dakota State University     | University of Alaska at Fairbanks   | University of Puerto Rico |
| main campus                       | University of Central Florida       | Rio Piedras campus       |
| Pace University                   | University of Colorado at Denver    | University of San Diego   |
| New York campus                   | University of Detroit Mercy          | University of San Francisco|
| Pepperdine University             | University of La Verne              | University of South Dakota|
| Portland State University         | University of Maine                 | University of Southwestern Louisiana|
| Rutgers University at Newark      | University of Maryland               | University of Tulsa       |
| San Diego State University        | Baltimore County                    | Wake Forest University    |
| Seattle University                | University of Massachusetts         | Wichita State University  |
| Seton Hall University             | at Lowell                           | Worcester Polytechnic Institute |
| State University of New York      | University of Missouri at Saint Louis| Wright State University   |
| College of Environmental Science  | University of Montana               | main campus               |
| and Forestry                      | University of Nevada at Reno        |                            |
| Stevens Institute of Technology   | University of New Hampshire         |                            |
| Tennessee State University        | University of New Orleans           |                            |
| Texas Christian University        | University of North Dakota          |                            |
| Texas Southern University         | main campus                          |                            |

* Indicates that an institution meets the criteria for more than one Carnegie Category.


REFERENCES


[36] Speech given to the National Science Foundation, Engineering Faculty Forum, National Technological University, University of Maryland, College Park, Mar. 14, 1995.