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To Nancy
who more than any one else brings out the teacher in me
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About the Author
This book is intended primarily for graduate students and postdocs interested in academic careers in science and engineering. It should also be of interest to college juniors or seniors considering graduate school in one of these fields. In addition, I hope professional scientists and engineers in government and industry who are contemplating a return to academia as professors will profit from the material. The book should also be of benefit to beginning faculty, and to all faculty and administrators in a position to encourage and support those interested in becoming professors.

Schools of science and engineering produce a number of “products” of value to society. The first is graduates at the bachelor’s, master’s, and, in certain cases, doctoral level. The second is courses that can be taken in one form or another by industry employees. The third is all forms of scholarship including basic research, the integration and application of knowledge, and the development of new courses and methods of instruction. The key to all three of these products is a fourth product, professors, whom we want to be well prepared, highly motivated, and strongly supported.

There are approximately 1500 four-year institutions of higher education in the United States and Canada. Virtually all new faculty hires at these institutions, particularly at the assistant professorship level, have doctorate degrees. Of these 1500 institutions, approximately 250, or 17%, offer doctorates in one or more fields of science or engineering. These schools also employ approximately 55% of the total number of professors at four-year institutions. Thus, while the “producers” of Ph.D.s are also the “buyers” of Ph.D.s, the remaining 1250 schools also hire a significant number of Ph.D.s as professors. Of these schools, approximately 700 grant both bachelor’s and master’s degrees, while approximately 550 are liberal arts schools primarily offering four-year degrees.

This book represents a new way to help individuals prepare for, find, and succeed at careers as science or engineering professors. It derives from a course I teach at Stanford University. It also builds on my background as an engineer in industry and as a director of a nonprofit scientific and educational society. It
further profits from my experiences as a college professor, career counselor, associate dean, and executive director of two Stanford University research centers with extensive relationships among graduate students, faculty, government, and industry.

I have taught at a variety of schools in the United States and Canada, including community colleges, institutions offering bachelor's and master's degrees, and those schools with a strong emphasis on research and the granting of doctorate degrees. Yet, as I began writing this book, it became obvious to me that I needed further information about both the schools students attended for their doctorates, as well as the other nondoctorate-granting institutions where many wished to go to pursue an academic career.

As a consequence, I identified as sources of more in-depth information seven sample schools in the United States and Canada covering the spectrum of institutions of interest to most future science and engineering professors. These schools are representative of the four major categories of four-year institutions defined by the Carnegie Foundation for the Advancement of Teaching. The schools and their classifications are: Bucknell University in Lewisburg, PA (Private Baccalaureate), Memorial University of Newfoundland in St. John's, Nfld. (Public Doctorate), the University of Michigan in Ann Arbor, MI (Public Research), the Rochester Institute of Technology in Rochester, NY (Private Master's), San Jose State University in San Jose, CA (Public Master's), Stanford University in Stanford, CA (Private Research), and the University of New Orleans in New Orleans, LA (Public Doctorate).

During a three-year period, I also talked at length with over 70 faculty, graduate students, and postdocs at some 20 additional institutions in all fields of science and engineering. Their comments and insights have proved invaluable. Indeed, quotes from most of these individuals appear in the pages that follow. Thirty of them are also the subjects of the vignettes appearing throughout the book.

I would like a special note of appreciation to go to the students in the Stanford Future Professors of Manufacturing program who have contributed so much through their participation in my ongoing Proseminar in Manufacturing Education. They are: Dina Birrell, James Bradley, Kyle Cattani, Eliav Dehan, Wendell Gilland, Andrew Hargadon, Neil Kane, David Kasmer, Christopher Kitts, Jeff Kundra, Constantinos Maglaras, Christopher Marselli, Mark Martin, David Owens, Sanjay Rajagopalan, Keith Rollag, Glen Schmidt, Steven Spear, and Jan Van Mieghem.


A number of individuals took the time to read portions of the manuscript covering their area of specialty or interest, and their comments were particularly helpful: Rafael Betancourt, Ron Bracewell, Claudio Coelho, Russ Hall, Stacy
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I want to particularly acknowledge the contribution of Albert Henning. It was he, more than anyone else, who emphasized my need to go beyond the boundaries of Research I and II universities, to think deeply about the broader role of scholarship at colleges and universities, and to examine carefully the reality behind much of today's higher education rhetoric. His patient and thoughtful analysis of all my drafts has resulted in a far better final product than would have been the case without his contribution.

I want to thank Deanna Reis for her very helpful editing, and Elizabeth Droteff for her editorial help and constructive input on Chapters 10–14.

Harrianne Mills provided very helpful suggestions with respect to graphic approaches. Kiersten Lammerding is mainly responsible for the layout, graphic design, and many of the illustrations in the book.

Vince Mooney was my research assistant who, in the process of gathering and synthesizing information, had the opportunity to talk with over 40 faculty at 20 different schools. As a result, he gained considerable insight into the workings of academia, and I gained valuable information, a broader network of faculty colleagues, and a good friend.

I also wish to acknowledge the financial support for this project from Stanford University's Center for Integrated Systems (Robert Dutton), Electrical Engineering Department (Joseph Goodman), and School of Engineering (Jim Gibbons and Jim Plummer).

Finally, let me point out that I see this book as the beginning of a process, not an end. While much of the material is time-independent, I expect that periodic updates of certain statistics and trends will be desirable. Also, material that could not be included in the book because of space limitations, such as additional vignettes or an elaboration of a process or procedure, should also be of interest to some readers. Furthermore, it is likely we could all profit from sharing information, opinions, ideas, and stories. To promote the above, I have created a World Wide Web Home Page (http://cis.stanford.edu/structure/reis.html) and an electronic mail address (Reis@stanford.edu). Through the Home Page, you can access updated information and comments from readers, while the e-mail address can be used for correspondence. I very much look forward to our exchanges.

Richard M. Reis
Stanford University
Introduction

We begin by setting the stage in Part I for the more specific work to follow. Chapter 1, "The Academic Enterprise," is a look at the unique characteristics of higher education. Graduate students and postdocs, of course, have been part of such enterprises for some time. Yet, most lack an accurate understanding of how colleges or universities function, and the important ways in which they differ from other organizations in society.

The place of science and engineering in academia is examined in Chapter 2, "Science and Engineering in Higher Education." Here, we look at the similarities, and more importantly, the differences among various science and engineering departments and disciplines. We also discuss the prospects for cross-disciplinary collaboration among these various fields.

Part I concludes with Chapter 3, "New Challenges for the Professoriate." It begins by examining the significant forces currently impacting higher education. These include the prospects of decreasing government funding, the changing relationship between industry and academia, the increasing use of communication and computational tools, the rising costs of doing research, and the greater focus on interdisciplinary programs. We then discuss the implications the above factors have for faculty scholarship and the preparation of tomorrow's professors of science and engineering.

Part II, "Preparing for an Academic Career," begins with Chapter 4, "Your Professional Preparation Strategy." Here, we explore the decision to pursue an academic career, particularly in light of the current situation with respect to supply and demand. We then outline a three-pronged preparation strategy to prepare you for an academic career while maintaining your options for careers in government and industry.

Chapter 5, "Research as a Graduate Student and Postdoc," looks at how to apply the above strategy to the many research activities that you need to complete prior to becoming a professor. Some activities, such as choosing a research topic and identifying an advisor, are required of all Ph.D. students and postdocs,
while others, such as writing proposals and supervising other researchers, although not specifically required, will nevertheless put you ahead of most of your competition in looking for academic, government, and industry positions.

Part II concludes with Chapter 6, "Teaching Experiences Prior to Becoming a Professor." The chapter begins with a discussion of the benefits of acquiring such experiences, followed by a look at some innovative ways to go beyond teaching assistantships to developing and presenting lectures, conducting laboratory sessions, and even teaching full courses at your own or another institution. The chapter concludes with a discussion of the teaching portfolio, and how it can be used to capture the successes of your teaching experiences for presentation to potential employers.

How to find, and then get, the best possible academic position is the subject of Part III. As the supply and demand for new assistant professorships in science and engineering shift, anxiety among graduate students and postdocs about obtaining an academic appointment increases. However, as will be seen in Chapter 4, the situation is more complex, and in many instances more positive, than recent headlines would suggest. At the very least, if you follow the strategy discussed in Chapters 4–6, you are apt to be in a much more competitive position than many of your colleagues who have not done so.

It is important to keep in mind that finding "a" job is not the issue; finding the "best" possible academic position, the right one for you and for the hiring department and school, is the real goal. Detailed suggestions on how to do all of the above are the subjects of Chapter 7–9.

Chapter 7, "Identifying the Possibilities," explains that in seeking an academic position, it is essential for you to explore before you search. You need to compare what is available (types of institutions, positions, and locations) with what you need and want (capabilities, interests, and values). Only then will you be in a position to search—apply for specific jobs.

Chapter 8, "Applying for Positions," is a detailed discussion of the job search process. Here, we examine how new faculty positions are established, what departments look for in new faculty, how to find out what is available, and the time frame for academic openings in your field. We then discuss the preparation of your application materials, including cover letters, curriculum vitae, and letters of recommendation. Conferences, campus visits, and the all-important academic job talk are looked at next. The chapter concludes with an examination of jobs outside academia, and how you can accept one of them while keeping your options open for a future academic position.

Chapter 9, "Getting the Results You Want," begins with a look at the negotiation process by examining in some detail the principles you need to use in responding to academic job offers. We then explore some of the special problems faced by dual-career couples, in particular those in which both members are seeking faculty positions. The chapter concludes by discussing what to do if you did not receive an academic job offer, or received one that is unacceptable to you.
Your shift from a graduate student or postdoc to beginning professor is going to be exciting and dramatic. At such a time, the most valuable thing you could probably do would be to ask a half dozen professors at the institution to which you are going what they feel it takes to succeed as a beginning professor. If you pick the right assistant, associate, and full professors, the advice you receive could be invaluable. In Part IV, "Looking Ahead to Your First Years on the Job—Advice from the Field," we do the next best thing by capturing insights for success in five key areas from science and engineering professors across North America. The five areas are: time management (Chapter 10), teaching and learning (Chapter 11), research (Chapter 12), professional responsibility (Chapter 13), and tenure (Chapter 14).

Each chapter begins with an introduction, followed by four or five vignettes on faculty who provide insights on the theme under discussion. These vignettes are followed by a detailed, "In Addition" section describing other sources you can turn to for further information and understanding. The chapters conclude with a section summarizing the main ideas from both the vignettes and the readings.

While you can earnestly follow the suggestions described in Chapters 1–14, unless academia does its share to support you, your success could be limited. Changes are required to help graduate students and postdocs obtain meaningful teaching experience, participate directly in the research development process, obtain the best possible academic position, and then succeed in their chosen careers as faculty. The book concludes with Chapter 15, "Insights on Academia: Needed Changes." It suggests ways in which administrators and senior faculty can provide an environment that will enable tomorrow's professors to prepare for, find, and succeed at academic careers in science and engineering.
SETTING THE STAGE
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 under-
graduate 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 popula-
tion, 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 num-
ber 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>
<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 fewer than 40% of their baccalaureate degrees in liberal arts fields or are less restrictive in admissions.</td>
</tr>
</tbody>
</table>

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

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<th>INSTITUTIONS</th>
<th>TOTAL</th>
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<td>Doctorate-granting</td>
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<tr>
<td>Research I</td>
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<tr>
<td>Research II</td>
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<tr>
<td>Doctorate I</td>
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<tr>
<td>Doctorate II</td>
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<td>Master's-granting</td>
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<td>MA I</td>
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<td>MA II</td>
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<td>Baccalaureate-granting</td>
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<td>Professional schools and specialized institutions</td>
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<td>Tribal colleges</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>3,600</td>
</tr>
</tbody>
</table>


Figure 1.1 Proportions of institutions by Carnegie Classification, 1994.

Source: The Carnegie Foundation for the Advancement of Teaching