INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The Placement of the Study of Computing in Academic Organizations

BY

Patrick C. Olson

A Dissertation submitted to the Faculty of The Claremont Graduate University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate Faculty of Information Science.

Claremont, California
1999

Approved by:

Jack H. Schuster

UMI Number: 9912496

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

We, The undersigned, certify that we have read this dissertation and approve it as adequate in scope and quality for the degree of Doctor of Philosophy.

Dissertation Committee:

Chair

Member

Member

Visiting Examiner

Abstract of the Dissertation

The Placement of the Study of Computing in Academic Organizations

by

Patrick C. Olson
The Claremont Graduate University: 1999

What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments? This is the central question this study pursues. The end products from computing have become fixtures in modern culture. The ramifications of computing and society are important, and one important aspect is the approach to computing by colleges and universities. An examination of the current status of computing as part of academic organizations and curriculum reveals that there are multiple approaches and that faculty that have an interest in a particular approach are not always aware of or collegial toward other faculty involved in computing.

Information about the study of computing has been compiled to establish a means to examine the central question. This information includes the names (e.g., Computer Science, Information Systems) of computing programs, and the institutions that have computing degree programs. The relationship of certain types of institution (e.g., Research, Masters) on how the study of computing is organized has been examined.

To answer the research question required examining important academic officers at colleges and universities, specifically the chief academic officer and computing department chair (or chairs). Two distinct surveys were administered to these administrators. The surveys were constructed to examine the relationship of the placement of the study of computing to attitudes toward the study of computing, the deployment of institutional resources, attitudes toward multiple programs in a subject area, and attributes of computing programs. The survey responses, coupled with the aforementioned collection and refinement of data about colleges and universities and computing degree programs, provide the basis for conclusions. These include a finding that there is a lack of support in principle for various kinds of duplication within the curriculum of institutions. However, the key administrators - - chief academic officers and department chairs - - did not regard multiple computing programs at their institutions to be disadvantageous. In

addition, there are indications that multiple computing programs at an institution, despite certain redundancies, provide important benefits to those programs and society.

Dedicated to the faculty, particularly those who came before, and especially those to come.

Any acknowledgment must begin with the dissertation committee. The members of this committee are among the most gentile people I have ever met. I thank them all, especially my chair Dr. Jack Schuster.

There are many family and friends who have helped me achieve this work. However, one stands out, Dr. Donna M. Schaeffer. Donna has provided inspiration and encouragement. She was also there for help from the development of mailing lists, and solving postage problems to proof reading the final draft. I owe her much.

Table of Contents

Chapter 1

Introduction

Employers in the computing field post advertisements that are so filled with acronyms that the ad resembles alphabet soup! Among the necessary qualifications, readers may find the initials BSCS, BSCE, and BSIS. These acronyms stand for Bachelor's of Science degrees in Computer Science, Computer Engineering, and Information Systems. The acronyms may be broadened. Some employers specify EE, or Electrical Engineering, a field of study that, at some universities, may subsume Computer Engineering. Other employers try to be more specific about the fields of study that are acceptable by adding more initials to the acronym, e.g., MIS signifies Management Information Systems.

The following excerpts from advertisements in the classified section of a recent *Washington Post* (1997) illustrate opportunities for holders of a Bachelor's degree in computing. Some advertisements call for applicants from a broad range of degrees, while others are more specific:

- CSC seeks Senior Systems Analysts--one needs a Bachelor's degree in Computer Science, Computer Engineering, or Information Systems, with experience in hardware and software, digital imagery, Windows NT, and an object-oriented programming language, e.g., C++.

- A worldwide leader in coin operated games seeks a programmer who holds a Bachelor's degree in Computer Science. Candidates should have experience with the C/C++ programming language, graphics, and DOS.

- Raytheon E-Systems seeks Systems Engineers. Candidates should hold a Bachelor's degree in Computer Engineering and be familiar with software and hardware, the C programming language, Unix, and telecommunications.

- The U.S. Bankruptcy Court seeks a Systems Manager who holds a degree in Management Information Systems. Candidates should have experience in hardware and software, local area networks, Windows and Unix.

These advertisements have a few common themes. For example, regardless of the degree one holds, employers assume candidates have familiarity with hardware and software and an operating system, although the specific operating system varies. The C programming language appears in many advertisements. Some of the positions require expertise with graphics or imaging, while others call for expertise in telecommunications. The most striking thing about the advertisements in this particular issue of the *Washington Post* was that many did not indicate that a degree was required. When employers did seek candidates with college degrees, often the discipline was listed as some flavor of computing (e.g., Computer Science or Computer Information Systems) or a related field.

After reading the classified advertisements, one may wonder what prospective employees should do to prepare for these posts. Further, what should colleges and universities do to offer students the opportunity to prepare for careers in computing? This is an important question because the end products of the study of computing have been in the center ring of a publicity circus for several decades.

The Internet

One of the end products that has been in the center ring of the publicity circus in recent years is the Internet. The Internet has been a Time cover story on several occasions in the 1990s (Elmer-Dewitt, 1993a, 1993b, 1994). In recent years, the Internet has set Congress to work on a spectrum of issues ranging from mitigating the potential social divisiveness of technology to the use of the Internet for pornography. The Internet has sparked the imagination of the world, and arguments are raised that such technology could be used to radically change education (Perelman, 1992).

Hyperbole may be the true nature of many of these concerns. This is likely to be particularly true of education in view of the difference between the desired use of technology in education and the likely uses expressed in sustained scholarship (Papert, 1993). However, the social impact of a technology such as the Internet is enough, in and of itself, to raise interest in an inquiry into the organization of the study of computing as part of the academic side of higher education.

Personal Computers

The growing popularity of the Internet is not the solitary example of the impact of end products of the study of computing in our society. A decade earlier, on January 3, 1983, Time Magazine named one of its most provocative Men of the Year--the personal computer. During this era, Time Magazine had several cover stories related to the impact of personal computing. For example, it examined the "computer generation"on May 3, 1982 and had featured Apple Computer and Steve Jobs on its February 15, 1982 cover. It is fashionable and probably correct to make the assumption that the commercialization of the personal computer was largely the result of entrepreneurial efforts that were removed or somewhat distant from colleges and universities. In fact, most discussions of startup companies usually include a nostalgic and overly romanticized discussion of the company starting out in someone's garage in the geographic area that is now known as Silicon Valley. However, the fanfare for the common man that usually accompanies these discussions is stretched beyond the metaphor's reach. Even if one ignores the educational backgrounds of the young entrepreneurs who created the personal computer industry and concede the point that they were not college graduates, it is important to recognize that the essential element in the growth of the personal computer industry is software. For example, the demand for personal computers in American business was fueled in part by the availability of a spreadsheet program. The particular spreadsheet that fueled the demand was Lotus 1-2-3; however, the first spreadsheet was Visicalc which was developed as a project by Dan Bricklin, a student at the Harvard Business School. Microsoft owes its existence to the ability of its founders to build a BASIC language compiler for the Altair 6000 personal computer. The BASIC programming language was originated at Dartmouth College by two mathematics professors.

Computer Chips

The first Time Magazine cover story that concerned computing is very probably the February 20, 1978 cover on "The Computer Society." This cover depicts a calculator, an early personal computer, a digital watch, a printed circuit board, a magnetic tape drive, a mini-computer, a uniform product code (bar code), and a robot from Star Wars. This cover likely portrays the first example of the influence that work in computing had on society. This influence was propagated by the introduction of computer chips in many products. Computer chips transformed some products and made others possible. The new products caused Time Magazine to cover the "Robot Revolution" on December 8, 1980. This feature discussed the impact of chips on manufacturing processes. Another example of the impact of computer chips is the January 18, 1982 cover story on video games. It is interesting to note that the first video game *Computer Space* is an implementation of a mainframe computer game designed at Massachusetts Institute of Technology in the 1960s (Burcham, 1996).

Identity

Questions worthy of study arise singularly from the need to look at the organization of computing as a field, or as indicated by current practice - - fields of study. For example, given that computing has come to have such a broad social impact, has the subject grown beyond the boundaries implied by an academic department? The effort undertaken to examine this question demonstrates two further problems.

The first problem is related to the "identity" of the subject. Historically, identity has been a problem for computer science as demonstrated by Newell's

(1967) editorial arguing that computing is a science. This argument is ongoing today. Denning et al. (1989) spent considerable effort justifying the claim that a new discipline, called Computing, has developed. Glass (1992) asserts that the separation of software engineering from both information systems and computer science is desirable. In information science, the "identity" problem is a subject for research as witnessed by scholarly articles like "Can the Field of MIS be Disciplined?"(Banville & Landry, 1989).

Scholarship

The second problem is that groups of scholars in specific sectors of the "computing discipline" dismiss the relevance of work by those in other sectors. This is the natural result of the "identity" problem. The best illustration of this is provided by Glass (1992). The intent of his article is to illustrate that software engineering is a distinct entity. This declaration is made to justify the treatment of software engineering as a separate department and research area. This notion is difficult to establish without showing that the scholarship that is usually thought to relate to software engineering is not, by definition, software engineering. It is not the contention, herein, that Glass (1992) has deliberately or inadvertently done this. However, a close examination of the article from the point of view of a computer science or information systems person is likely to reveal statements that would not be deemed flattering.

Glass (1992) is an example of a kind of discourse that is necessary in a new and changing field, that is, as new domains of study develop they should be identified under the control of peer reviewed scholarship. In fact, this occurs in many computing publications, but some instances of the use of this rhetoric are more troubling. For example, Glass (1992) is making a scholarly appeal for a more focused study of software engineering, while in other cases the use of this reasoning process has the result of excluding groups from a discipline. Two examples of this are the National Research Council (1992) and Denning et al. (1989).

The National Research Council's (NRC) study concerned the future of computing. This report was produced by a part of the NRC called the Computer Science and Telecommunication Board. This board included no Information Systems faculty. The board advocated that computer science and engineering should broaden its focus. This included expanding the curricula beyond programming to include social issues, and participating in interdisciplinary studies. Yet, in spite of a notion of greater inclusion, the board excluded information systems in this statement:

> The diversity in computer-related degree programs makes it difficult to obtain detailed insight into degree production. In gathering data sources for this report, the committee considered whether or not to include in its definition of CS&E degree recipients those who had received degrees in "information sciences" or "information systems." since many sources group these categories together. Because it was most concerned with what might be considered "core" activities in CS&E, the committee chose to exclude these categories, recognizing that in doing so it might also exclude, for example, those for whom CS&E database work was some part of their educational or research portfolios. (NRC, 1992, pp. 239 - 240)

Denning et al. (1989) is the result of work by a task force on the core of computer science. The task force included seven members, some of whom were also members of the NRC's Computer Science and Telecommunication Board. None of the task force members were from information systems programs. The task force advocated that computing is a discipline. However, it excluded information systems from that discipline in the following statement:

> "We immediately extended our task to encompass both computer science and computer engineering, because we concluded that no fundamental difference exists between the two fields in the core material."

Insight into the exclusion of information systems is provided in this statement:

> "Many computing graduates wind up in business data processing, a domain in which most computing curricula do not seek to develop competence; whether computing departments should develop that competence is an old controversy."

These examples illustrate ways that a reasoning process that can be used to discern among options can be used to exclude without cause. These examples are particularly important because they are paradoxical, that is, in each instance inclusion is the real intent, but the result is exclusion of information systems. It is vital that these examples be used as stated, and speculation about motives for these statements should be avoided. Rather, these statements provide evidence that a "cohesion-accuracy tradeoff" (Weick, 1984) may be involved in this community of scholars.

Management Dilemma

This problem results in an administrative quandary in higher education. An administration may consider the expansion of computing. Using Denning's (Denning et al., 1989) argument that computing should be a discipline might cause an administrator to consider a combined effort to offer computing through using a single independent center, school or college. However, if infighting could cause important areas of inquiry to be disregarded, centralization might be avoided by leaving things as they are. This dilemma, coupled with computing's relatively recent arrival as an academic subject in higher education, contribute to a great potential for an interesting examination of academic organization.

The issue of the academic organization of computing programs is important for two reasons. Computing programs require resources that have unusual characteristics. For example, the production of computing faculty is considered inadequate (NRC, 1992). Thus the market for computer faculty is nearly the opposite of markets in other disciplines. The result is the ironic existence of as many as three computing programs at an academic institution, even though the faculty for these programs are scarce resources. Thus, the issue of academic organization is important because it concerns the optimization of available faculty.

The faculty resources are one part of the resources required for computing programs. Another set of important resources for computing programs is computers. Even though the price and availability of important computing resources has dropped, it is important for computing programs to provide students with access to equipment that is considered at or near the technological state of the art (NRC, 1992). Since some may perceive the acquisition of these resources as a trivial undertaking, the Internet provides an example to the contrary. A computing program that seriously includes the Internet, and seriously conducts research on improving the Internet's infrastructure would require a 155 megabit connection. This is likely to be from 3 to 155 times faster than the connection that most academic institutions currently posses. The management of these resources involves deciding: What is needed? How to procure the resources? How to allocate the resources? Thus, the first reason the issue of academic organization is important is because it concerns the optimization of resources.

The second reason that the issue of academic organization of computing programs is important concerns the credibility of computing programs. The prior section on the identity of computing programs provides insight about credibility. In that section it was noted that every sector of the study of computing has concerns about identity. For example, is computing a discipline? At the heart of these identity problems is concern over what really constitutes a credible computing program. Unfortunately, accreditation does not solve this problem. There are three separate accreditation bodies related to these programs, however, two of these bodies are for the accreditation of engineering and business programs. The third accreditation body is for computer science programs, and has only accredited a few programs. Managers find themselves in the position of working to optimize scarce resources and wondering if the investment will pay.

Research Questions

This research examines the question: What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments?

This central question requires the examination of two sets of related questions that are implied from and exist within this question. The first set of three questions is foundational. The answers to these questions comprise the methodology for this inquiry. The first of these questions is: What are computing programs entitled? As of 1985, there were 190 different titles for computing programs listed in the College Blue Book (Schaeffer and Olson, 1996). The three specific most commonly used titles representing the three major sectors of the study of computing include Computer Science, Information Systems and Computer Engineering.

The second question is: What institutions have computing programs? The reader may be surprised that not all colleges and universities had programs of study in computing as of 1992.

The third question is: Does the type of institution (e.g., Research, Doctorate-granting) influence the placement of computing programs? This inquiry found the percentage of institutions that have computing and the average number of computing programs in each category of institution indicated that the type of institution is an important variable.

The second set of questions include four that have not been addressed for the field of computing in prior studies. These questions include:

- What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing?
- Is there a relationship between the deployment of resources at an institution and the placement of the study of computing in an academic organization?
- What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations?
- What is the relationship of particular attributes of computing programs, such as program size and academic training of program chairs, to the placement of programs within academic units?

Chapter Two includes a review of the literature related to academic organization. This chapter particularly examines the origin of the academic institution and the development of its organization, decision making in modern academic institutions, the relationship between organizational theory and academic institutions, the origin of the modern academic department, and the relationship of the academic department to innovations in academic organization. This chapter provides the needed understanding of how the current organization of academic institutions came into being and how change can take place in the organization of academic institutions.

Chapter Three presents a literature review that is related to computing and academic organization. In particular, this chapter examines the research that has occurred within computing scholarship related to curriculum and the organization of the study of computing in the academic organization.

Chapter Four details the methodology of the study. This inquiry has two major components. The components are a survey of chief academic officers and a survey of chairs of departments of computer science, information systems, and computer engineering.

Chapters Five, Six and Seven present the results of the inquiry. Chapter Five presents the results of the survey of Chief Academic Officers. Chapter Six presents the portion of the results of the survey of Department Chairs from computer science, information systems, and computer engineering that was also asked of Chief Academic Officers. Chapter Six includes comparison of the

Department Chairs' responses and the Chief Academic Officers' responses. Chapter Seven presents the results of the portion of the Department Chairs survey that was not asked of the Chief Academic Officers.

Chapter Eight provides a discussion of the implications of the results. Conclusions are drawn and recommendations made.

Chapter 2

The Academic Organization's View of the Academic Organization of the Study of Computing: A Review of the Literature

Introduction

In order to provide insight into the question "What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments?" one must examine the literature on higher education. From such study, the origins of the academic institution, the organization of the academic institution, decision making in academic institutions, the origin of academic departments, and the nature of academic departments may be examined. Important threads that are found in this literature include the curriculum and the changes to curriculum that result from external influences.

Origin of the Academic Institution

Before one can examine the modern academic organization, one should investigate the origins of higher education. As an institution, higher education dates from before the twelfth century when universities were established at Salerno and Bologna (Haskins, 1957). The University of Bologna has been in continuous operation since it was founded.

Since their founding, universities have been influenced by external entities. For example, the University of Salerno was established to be a medical school, and the reason it no longer exists has a great deal to do with the lack of latitude that medieval culture afforded the study of medicine. Another example is the University of Bologna, which was established as a law school and has been in continuous operation to this day. It is interesting to note that the curriculum at the institution that survived was more in line with the wishes of the Roman Catholic Church as expressed in the Council of Lateran.

The influence of external entities on the curriculum such as the Council of Lateran is almost immediately apparent in the example of the early universities. The Council of Lateran required cathedral schools to maintain three professors to teach grammar, philosophy, and canon law (Walsh, 1920). Thus, academic organization was a reflection of the wishes of important environmental influences that were external to the institution.

Initially, the curriculum at most medieval universities supported the study of theology (Rudolph, 1977). The course work established to this end is sometimes referred to as the seven liberal arts. These courses are separated into two categories--the travidium and the quadrivium. The travidium consists of logic, grammar, and rhetoric. The quadrivium consists of arithmetic, geometry, astronomy, and music. It is important to remember that all university study was conducted in Latin. The language of choice provides another example of external influences, as the use of Latin particularly supported the operation of the Roman Catholic Church.

During the Renaissance, the purpose of the university expanded to include the education of the ruling classes. The changes in university curriculum included the addition of the study of natural science, Greek, Hebrew, and ancient history. These new subjects effectively expanded the definition of liberal learning.

The Protestant Reformation imposed new demands on the university for the training of clergy. This is an important distinction because while the original intent of the university included the study of theology, the completion of a course of study at a medieval university did not make a person a Roman Catholic priest. The Roman Catholic Church provided its own means for "qualifying" its clergy. Because the Protestant Reformation brought with it the idea that the Bible can be read by those able to read, a means of establishing a qualified clergy for the Protestant community was needed. University curriculum in theology provided the means to this end.

The curriculum at the original American colleges and universities reflected the same interest groups mentioned above. The charters of early American colleges reflect several societal responsibilities. Among the most permeating were religious, though the religious goals were often supplemented with service to the community. For example, the charter of the College of William and Mary stated its purpose as the " . . . proper education of ministers of the Gospel, as well as the pious education of youth and the conversion of Indians (Walsh, 1935)." In its charter, Yale University described itself as " . . . a college in which youth might be fitted for public service in church and state (Walsh, 1935)." Cremin (1970) notes the charter of Harvard University called for ". . . training a learned ministry, masters for grammar schools, educated gentlemen for the magistrate, and competent practitioners for the professions."

The colonial colleges and universities were established in a time and place that made them part of a curricula change that was particularly responsive to intellectual changes in Europe. Most notably, the early American colleges and universities paid great attention to mathematics. In particular, the early 18th-century saw the establishment of algebra courses. By the time of the American Revolution, six of the eight colonial colleges had professorships in Math and Natural Philosophy.

Another change that occurred in the 18th-century was the movement away from instruction in Latin and Greek. Now, the language used for instruction was to be English. This movement enabled the subsequent movement towards a study of literature written in English, as opposed to the study of Classics written in Latin and Greek. Ultimately, courses such as Moral Philosophy are enabled by instruction provided in English.

In the 19th-century, changes in American colleges and universities may also be considered in light of external events. The most profound external influence was the Industrial Revolution which provided new demands on colleges and universities. Prior to the Industrial Revolution, colleges and universities provided instruction for theologians and the governing classes. The Industrial Revolution, in a sense, expanded the demands on the ruling classes from the governance of nations to the governance of enterprise. An example that illustrates this progress is the telegraph.

The telegraph, and more particularly the code that made the telegraph useful, was invented by Samuel F.B. Morse. Morse graduated from Yale College in 1810 and studied art in England. In 1825, he began work as a Professor of the Literature of Arts of Design at the University of the City of New York, which later became New York University. As part of his compensation, he was provided quarters in the university's building on Washington Square. During the winter of 1835-1836, he built his first telegraph instruments. He stretched 1700 feet of wire around his room at the university and transmitted signals (Dunlap, 1944).

The importance of such inventions is that society then placed demands on universities for the support of enterprise. The demand was not simply for enlightened individuals, but rather for discoveries and inventions that could be used in some cases to create entirely new industries, as the telegraph did.

Another external influence on the American colleges and universities during this period was the German universities. The German university system had attained intellectual leadership in the 19th-century as a result of the concept that an institution of higher learning should be "above all, the workshop of free scientific research" (Brubacker and Rudy, 1958, p. 171). It is important to note that the German model of higher education emphasized both freedom of teaching and freedom of learning. This dual emphasis lead "ultimately to a stress on the various services which higher learning could render to the state" (Brubacker and Rudy, 1958, p. 171). In Germany these emphases became part and parcel of rise in nationalism beginning in 1871.

The application of the German model of research as a method for teaching and learning in the United States provides a model by which the state and enterprise are served by higher education. In this country this model is particularly applied to graduate education. The first instance of a university modeled after the German research institution is Johns Hopkins University. While Johns Hopkins University is not usually connected to the advancement of enterprise in discussions of its contribution to higher education, its ties to enterprise were evident when "It finally lost its primacy, to be sure, partly because it was financially crippled due to the misfortunes of the Baltimore and Ohio Railroad, in which most of its funds were invested" (Brubacker and Rudy, 1958, p. 178).

A second event of this period is the establishment of the elective system. The elective system evolved in part as a reaction to the Industrial Revolution and in part a reaction to the growth in the amount of knowledge available. Electives provided academic institutions with the means of being more things to more people. Thus, institutions were able to support business enterprises without having to have uniquely qualified sets of faculty for each enterprise that develops. For example, rather than have one institution dedicated to the study of potato farming in Ireland, each institution may offer courses in the study of botany and biology. These subjects support multiple enterprises rather than just one enterprise, such as potato farming.

As a result of these changes, the modern curriculum that has resulted was observed to have had, by 1960, 2,452 different kinds of degrees, 832 of which had been abandoned for a lack of interest (Rudolph, 1977). The College Blue Book has recorded an index of majors which has grown from 1,800 in 1968 to over 6,000 by 1981 (Schaeffer and Olson, 1996). While higher education's efforts to support external demands are necessary and laudable, the expense of a trial and error approach to curriculum is troubling. How can 6,000 majors possibly be organized in a way that is understandable to those, for example, prospective students, who are approaching the aggregated academic institutions from the outside?

Source Concepts Used to Organize Academic Organizations

Academic institutions are commonly organized according to subjects, for example, the three Rs - - reading, 'riting, and 'rithmetic. The first use of "subjects" of study is sometimes attributed to Greek philosophers who lived before the common era. Some disciplines trace their beginnings to particular philosophers. An interesting example is geometry, a subject with a very old heritage. Geometry enjoys the distinction of having one of the oldest textbooks still in use, Elements (of geometry) by Euclid of Alexandria, the father of mathematical rigor (Beckmann, 1971). This twelve-volume work was written 2,250 years ago. Most high school geometry texts are a reflection of the first four volumes of Euclid's work.

Other subjects trace their origins to the nexus between modern academic organization and the Greeks. The nexus is not found in the organization of the Greek academies (which are not considered the beginnings of modern colleges and universities - - the afore-mentioned universities at Salerno and Bologna that were founded fourteen to sixteen centuries later are generally considered the forerunners of modern academic institutions.) The nexus is found in the two ways that the Greek philosophers contribute to academic organization. These are epistemology, or the study of the organization of knowledge, and the tradition of studying certain subjects.

Epistemology has roots that extend to the Greeks. It is also a subject that is alive today, and is usually studied in philosophy. This subject is important to this inquiry about the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities because a scholar's view on the academic organization is related to his or her philosophy about the organization of knowledge. This implied philosophy about the organization of knowledge may not be the scholar's, but the identification of the implication is useful as it may shift discussions of academic organization from political discussions, bounded by parochial issues, to scholarly discussions.

An example is provided by comparing the Greek view of epistemology to the American pragmatic view of epistemology (Lee, 1969). The Greek view of epistemology holds that all knowledge already exists, is finite, and can be discovered. Thus knowledge has borders, and the whole of knowledge can be divided into domains. The American pragmatic view is that knowledge is the formulation of a process of adjustment of a human organism in a continually changing environment. An important aspect of the American pragmatic view is change. When knowledge results there has been change to the environment and the human organism. Thus knowledge is not finite, and does not have borders. This does not invalidate the idea of using domains for what is known, but it does mean that the domains are likely to change over time.

The two views are likely to produce different academic organizations. The Greek view would be consistent with a fixed set of academic departments, and the American pragmatic view would be more consistent with an academic structure that allows change. Put another way, the Greek view is consistent with a fixed curriculum as practiced in the early nineteenth century and the American pragmatic view is more consistent with the elective system that was developed in the late nineteenth century.

The second contribution of the Greek philosophers is a tradition of studying certain subjects. One aspect of this tradition is that there are people who believe that academic organization is necessarily tied to the organization of knowledge. Thus the extent that academic organization is related to the organization of knowledge, or that decision makers perceive it to be, epistemology becomes important to any inquiry about the placement of academic programs. Tradition is important for reasons beyond the mere suppositions of a few people. In a previous section, geometry was given as an example of a subject that can be traced to study before the common era. The subjects or knowledge that were established long ago cannot be dismissed lightly.

This point was established by Dewey (1938) in Experience and Education. Progressive education is an application of the American pragmatic view in education. In application, progressive education emphasized the use of experience to educate. Dewey carefully inquired about the application of his principles, which were heavily criticized. In this book, Dewey criticized the traditional and progressive approaches, and made the point that the progressive approach dismisses what is known and replaces it with nothing. In effect, those who practiced progressive education improperly dismissed the knowledge that was already established. The implication for the academic organization is that the decision to dismiss a subject established by tradition should not be made lightly.

There is an important external influence that can cause difficulties for those making decisions about the subjects to include in curriculum. This force is the information explosion. Discussion of this phenomenon is pervasive, but it is usually the premise for an assertion. For example, it is used as the basis for a claim that life insurance can be sold to customers even when interest rates rise (Scully, 1995). This use of the concept of an information explosion, though legitimate, has the effect of reducing the credibility of the premise due to the potential overuse of the concept. Thus, an assessment of how the information explosion affects curriculum requires identifying scholarly treatments of this concept.

Scholarly treatment can usually be traced through the references cited in scholarly works. An interesting aspect of the information explosion is that scholars often use the concept, yet often fail to cite references for the concept. This even occurs in famous and well respected writings. For example, the sixth paragraph of Vannevar Bush's 1945 article, "As We May Think," discussed a "growing mountain of research", but no citation to the study of the phenomenon is provided. In fact, in the early 1970s, the Annals of the American Academy of Political and Social Science (Lamberton, 1974) was organized around the theme "The Information Revolution." But there is just one citation in any part of that Annal to a reference that studies the phenomenon of an "information explosion" rather than the ramifications of this premise for the conference, and this reference was to a popular rather than scholarly work, that is, Alvin Toffler's Future Shock.

While the seeming lack of scholarly treatment could dampen the enthusiasm for the phenomenon of an information explosion, there is actually important and compelling scholarly evidence for the existence of this concept. For example, by 1830 there were 300 scientific journals. Since it was no longer possible for scientists to keep abreast of everything, the first abstract journal appeared then (Bell, 1973). In 1944, the first warning that the retrieval and storage of knowledge was becoming a problem was made by a librarian who showed that in the middle of the 19th century, the necessary library shelf space doubled every 32 years, and by the middle of the 20th century the necessary library shelf space doubled every 16 years (Rider, 1944).[1] Another important documentation of this phenomenon is the near doubling of the number of periodicals listed in Ulrich's International Periodicals Directory from 1969 to 1988 (Schuster, 1990).

This evidence for an information explosion, in the context of a Greek view of epistemology, provides further justification for the inquiry into placement of academic programs. Under the Greek view of epistemology knowledge exists within finite borders, and can be discovered. The information explosion causes an organization problem for the Greek view, e.g., when does a new subject occur as opposed to an extension of an existing subject? In the case of computing and the curriculum, is computing a new subject or simply a new technology applied to the study of existing subjects?

---

[1] It is estimated that the necessary library shelf space currently doubles every eight years (Streitfeld, 1989)

The relationship of the American pragmatic view of epistemology to the information explosion leads to the need for a closer examination of the information explosion. The American pragmatic view holds that knowledge is the formulation of a process of adjustment of a human organism in a continually changing environment. Thus, an explosion of information could be a by-product of this adjustment and not an increase in knowledge. The ramifications of this potential critique entail two questions: Are information and knowledge interchangeable terms? Is there an increase in knowledge generation rather than an increase in the by-products of the process of producing knowledge?

It has been noted that a generally accepted definition of information is elusive (Williams and Clark, 1992). However, the interchangeableness of the terms information and knowledge has been argued (Machlup, 1980) and used as a precedent (Williams and Clark, 1992). The precedent will be followed in this inquiry; however, it is important to keep in mind that definitions of information and knowledge are so important that the quality of any research related to, or dependent upon, the information explosion relies on these definitions.

The second question concerns the growth of knowledge. There is a tendency to give credence to the idea that there is a growth in the amount of human knowledge based on one's own personal experiences. While this is realistic, the potential existence of by-products as opposed to the actual generation of new knowledge should be considered. For example, the economic consequences of the information explosion have been examined, but the analysis discussed only increases in the amount and means of distribution of information (Beale, 1995). A careful analysis of this phenomenon reveals that there has been an explosive growth in the distribution of information, and while there is growth in the generation of information, it can not be fairly stated that there has been an explosive growth in the generation of information (Williams and Clark, 1992).

Even though there are popular books that have been based around a premise that information generation is proceeding in such a manner as to exhaust the means of information distribution, careful reflection on what technology has achieved (radio, television, the Internet, etc.) shows that more means of distribution have been achieved. While this makes sense on a personal level, it still leaves open the phenomenon of heavy growth in information generation and explosive growth in information distribution.

If the term knowledge is used to represent information generation and information is used to represent information distribution, there is a potential for "a world with much information, but not necessarily more knowledge" (Esposito, 1993, p. 668). While this view is extreme, and misstates the evidence, the statement helps put in context the notion that a discrepancy between information generated and information distributed is likely to mean that the information generated may be distributed more than once. If information is being packaged the problem of retrieving information that achieves a user's ends is likely to be discussed in scholarly research. This problem has been observed by librarians and treated as a balance or bias question (Barford, 1994). Ironically, the librarians advocate letting the users dictate their research needs, while users question the use and validity of the information received (Kress, 1993).

The questions that the American pragmatic view logically raises about the information explosion have been analyzed and show that this view of epistemology must also be concerned with the implications of the information explosion on the curriculum. The aforementioned questions about computing in the curriculum that followed from the Greek view of epistemology also follow from the American pragmatic view of epistemology. These questions are: Is computing a new subject? Is computing simply the application of new technology to existing subjects? However, this analysis shows that an additional implication must be considered.

This is the idea of brand differentiation, a marketing concept traditionally used by makers of soap or toothpaste.

For information, consider that there may be an imbalance between the quantity of information generated and the quantity thereafter distributed. This might occur because a quantum of information originally generated may well be distributed over and over again, especially if the use of different channels for distribution - - say, information that appears the same repeatedly in a number of books and articles - - is taken into account. Thus the variations in the means of distribution of information could become the principal, perhaps the only difference, and such a difference would be based solely on the variety of images, meanings and associations elicited by the "brand" (Satow, 1989) or, in this case, the various vehicles of distribution.

In the field of computing, an example of brand differentiation is shown by the current materials produced about Java. Java is a programming language developed in 1991 by Sun Microsystems Inc. to program consumer electronics in 1991. As the Internet, and particularly the World Wide Web, became a sensation, Sun made available a Web browser called HotJava in 1994. Many aspects of this language were desirable for developing Internet software, and in 1995 Sun responded to market demands and made the language and a software development kit available. By early 1996, there were just two or three books available on Java. By the end of 1996, there were more than two dozen books available about Java. The aspect of this production of books that is most salient to this discussion is that the topics covered by the books and the depth of discussion on these topics have little variance from book to book - - yet the packaging varies dramatically. There are books that tout themselves as ideal for "dummies" and others that claim the users will teach themselves Java in 21 days.

In terms of academic programs, brand differentiation could mean that some types of education becomes training. While training may be generally needed, it may not be within all colleges' and universities' missions. In fact, experiential learning can become training as foreshadowed in Dewey's (1938) criticism of progressive education and further shown in Cusins (1995) where action and experiential learning are advocated for training. Regardless of the extent to which brand differentiation may be possible, it is clear that the information explosion should not be the sole justification for spawning multiple departments studying similar or possibly even the identical subject matter.

The use of an American pragmatic view of epistemology thus leads to the issue of whether the differences among computing departments in various parts of a given college or university is evidence of the existence of truly different subjects or evidence merely of brand differentiation. This is important because brand differentiation as the only difference among computing programs is problematic in the context of duplicated costs. For example, consider this idea in the context of brand differentiation as the concept is often used for Procter and Gamble products, that is the difference between computer science and computer engineering arguably is the same as the difference between Dial and Safeguard. This is a larger problem if brand differentiation or training does not fall within the traditional and/or current mission and societal use of colleges and universities. Cost and mission are matters for deliberation. Thus the true differences among computing programs hinges upon decision making at academic institutions.

Decision Making in the Academic Institution

Several important matters that require academic decision making have been identified in the discussion to this point. These include the prominent concern about the curriculum and decisions about subjects. A small but still significant concern includes how and when to react to external demands for change placed on academic institutions. Another consequential set of academic decisions concerns the institution's mission.

A careful examination of the interaction that occurs in the face of the need to change the mission of an institution, and an administration's decision to change the mission, was made about New York University (NYU). Power and Conflict in the University (Baldridge, 1971) is a case study of NYU. This study was conducted during an era - - the late 1960's - - when student, faculty and administrative concerns were sharply at odds, which provides a particularly interesting view of the interaction among these groups.

The students were interested in the free speech and protest movements that occurred during this period. The most interesting aspect of the activities of the students was their interaction with the other groups. The local demands that students made concerned the ability to have assemblies of students and to make uncensored remarks at these assemblies. Student interest in the curriculum, or the change in the institution's mission were not in evidence. The administration was clearly victimized by this circumstance because of the need to avoid bad publicity. The administration thus tried to deal with student leaders quietly and carefully. The faculty were often sympathetic to the students' interests, but more importantly, they had concerns over the institutions' change in mission, and sought to include students as much as was possible. Thus the faculty instituted student evaluation forms for classes, and student participation on every committee possible.

At the time of the study, the administration was charged with moving NYU from a school of opportunity (i.e., access) to a research university. This change was needed in response to either the development of the accessible City University of New York (CUNY) system or an expansion of that system. NYU, a private university, was being faced with stiffening competition from a low-cost government supported system, CUNY. The government supported system cost students far less money, and eroded the base of support for NYU. The change to a research university moved NYU into a domain with less local competition and more possibilities of attaining Federal research funding. In a sense the administration had no alternative.

In this case, the faculty members' chief interest seemed to be maintaining the status quo. The faculty, particularly in some disciplines and at some locations, were interested in maintaining the mission of NYU as a school of opportunity. One example was the School of Commerce. This school was housed on a separate campus, which was subsequently closed. It had a tradition of "teaching" which means the faculty taught many sections each term with lots of students. It also meant this faculty had done relatively little research over the years. If a change in the mission occurred, the best these faculty could have hoped for was an unpleasant job, and the more likely result would be the loss of their jobs.

There is a lesson to be learned from the faculty's attempt to involve the students in the issue of the institution's mission. Over time, students were not in attendance at committees and not moved to protest the change in mission. There are two interesting reasons that this took place. The first appears to be that the students who were successful organizers and protesters were not able to maintain their student status, that is, to keep paying fees and making academic progress. The second is that the turnover of the student body was fast enough to preclude students from becoming masters of local campus politics.

In the end, the mission of NYU was changed. While it appears that this is a decision the administration can make and maintain, this would be an improper interpretation of this study. This is because the administration did not make this decision capriciously. The administration was navigating the institution and while they steered away from the rocks it would be naive to believe the transformed institution that emerged is solely due to the steering and not in some way related to the existence of the rocks. Put another way, the environment that is external to the institution is an important force shaping institutions.

The problem with the external environment is that it is unlikely to be easy to read, or to continue the steering metaphor, it is more likely that fog will reduce visibility. A current example of this would be the rhetoric about what colleges and universities should be doing that is generously provided by business and political leaders. From the sometimes righteous indignation that comes in these messages it would appear that colleges and universities deliberately forego the benefits of their clear statements. Up the Infinite Corridor (Hapgood, 1993) presents a history of Massachusetts Institute of Technology (MIT). MIT has required a strong science foundation in its curricula, and in the nineteenth century was treated to the rhetorical blasting of these same groups, business and political leaders. The growth of the telegraph and the rise of the telephone proved MIT right. MIT became, for a time, the only place to find graduates qualified to work in these domains. MIT has taken a unique approach to its curricula and has been quite successful. The decision to approach the curriculum in this fashion was made by the founding President in the 1860's and continued as a tradition.

At MIT and NYU decisions were made that were timely and correct. These examples of successful decisions at two institutions also indicate several important elements related to academic decision making. In each case forces external to the institution were present. In the case of NYU change was made necessary by changes in the environment external to NYU. In the case of MIT there was a need to resist external pressures for change and maintain faith in a decision that had been made. In both cases the key to handling external pressures was leadership.

Each of these examples indicate the existence of identifiable groups interested in these institutions. These groups are found inside and outside these institutions. Groups inside these institutions include administration, faculty and students. Groups outside these institutions include employers, alumni, government, and other institutions. The existence of groups with legitimate interest in the activities in these institutions implies a need for clear, complete, and fair communication.

Further, the existence and influence of external groups implies a need for planning. That is, there must be an internal mechanism that scans, analyzes and reacts to the external environment. This is one of the normal functions of management, and should be the responsibility of those inside the institution entrusted with management duties. The group that appears most like management are the administrators.

However, the existence and influence of internal groups imply that an academic organization is unlikely to function effectively with autocratic leadership. These internal groups are identified with traditional roles in these institutions, and as a practical matter autocrats should be able to perform each of the tasks under their control. However, as noted earlier, as of 1830 it was observed that it was no longer possible for a person to read the total collected knowledge of humanity. Thus an autocrat is unlikely to successfully act in the capacity as each and every member of the faculty. Further, as the faculty role contains managerial tasks, a system of governance that includes the internal groups in an institution is implied. Thus governance, planning, communication, and leadership are four principal attributes of successful institutional decisions (Schuster, Smith, Corak and Yamada, 1994).

The problem with these attributes is that they are not always in concert. In fact, the structure of an academic institution is such that planning and governance are involved in similar domains and sometimes appear irreconcilable. There are four pressures on academic decision making that create this effect. These are a push for participatory governance, a mandate for efficient management, the urgency of adapting to a changing environment, and the salience of leadership (Schuster, Smith, Corak and Yamada, 1994). An example is found in the instance where an issue that requires a decision falls into both the domain of governance and planning. Faculty will tend naturally to seek involvement in the institution's decision making, thus reacting to an imperative which seeks more participatory governance. Administrators will react to a call for more efficient management and seek to handle the decision within their domain. Thus no single group is likely to hold an exclusive right to academic decisions.

Further, when leaders of modern academic institutions make decisions, each individual is likely to come up with a different solution for similar problems. Thus, the decision making process is likely unique at each of the thousands of colleges and universities in the United States. In How Colleges Work, Birnbaum (1988) examines change at colleges and universities. He uses cybernetics to explain how change is brought about, and presents four models of institutions. The four models he outlines are collegial, bureaucratic, political and anarchical. These models reveal the institutional tendencies toward decision making; however these models do not reveal what the result of an academic decision making process is likely to be. For example, are bureaucratic institutions more likely to have multiple computing programs than collegial institutions? Thus there is a need to determine if it is possible to use organizational theory to establish the relationship of organizational attributes, particularly with respect to decision making and the results of those decisions, to the number and placement of computing programs within the university.

Organization Theory and Academic Institutions

Birnbaum's four models of institutions in higher education match schools of thought within organizational theory. These models correspond to particular organizational attributes, for example economics, that are the major factors in the events occurring at colleges and universities. For example, the political model is particularly influenced by issues relating to power. In the case of the bureaucratic model, the organization is particularly influenced by issues relating to efficiency. For this study of the number and placement of computing programs at colleges and universities, these two issues - - power and efficiency - - provide contrary implications. In the case of power, if there are multiple and mutually exclusive sources of funds for the study of computing, multiple computing programs is an appropriate response. In the case of efficiency, a single computing program is an appropriate response. This is not intended as a criticism of Birnbaum's work, but this study requires an explanation that includes more variables. To this end, the field of organization theory was searched.

Organizational theory as a distinct area for scholarship begins in the early 20th century. Over the course of the century the field has evolved through several schools of thought (Khandwalla, 1977). Each of these schools represents a contribution to this field and offers a distinct means of analyzing organizations. While there is no consensus on what exactly constitutes a "school", seven such distinguishable schools of thought are briefly described below.

The Bureaucracy school is the oldest school of thought in organizational theory. In fact, this is the beginning of the study of organizations that evolves into organizational theory. Max Weber is the founder of this school of thought with his 1909 description of the characteristics of bureaucracies. The focus of this school is on the nature of organizations and in particular the optimal organizational form for the support of an increasingly complex society. The formalization of aspects of the organization, for example lines of authority, is intended to produce efficiency and equity.

The initial development of the Principles of Management school is attributed to Winslow Taylor and Henri Fayol. Taylor specified four principles that are intended to help organizations perform optimally. Taylor advocated the use of science as a means of achieving optimal performance and is well known for applying scientific management to operations. Fayol was a French engineer whose 1916 book on management included the notion that management consists of planning, organizing, coordination, leadership and control. This school has a focus on optimization and includes the study of the optimal compartmentalization of organizations.

The Human Relations school has a focus on group dynamics, nonformal organization, and style of supervision. The founding of this school is attributed to Elton Mayo's 1927 industrial engineering project on illumination at Western Electric Company. This school investigates the membership of individuals in groups and the activities with groups.

Another school that highlights the individual in organizations is the Bounded Rationality school. This school was founded by Herbert Simon's 1947 book *Administrative Behavior*. The central tenant for this school is that individuals are rational but are constrained by access to information and the ability to process information.

In 1951 Eric Trist and K. W. Bamforth originated the Sociotechnical systems school with their study of the mechanization of coal mining in Britain. This school takes the view that an organization is a system, a collection of parts that together form a whole. This system has social, psychological and techno-economic facets. A premise for this school is that organizations are significantly pressured by markets, technology and culture, and as these pressures vary so must organizational structures and processes, thus the way an organization adapts to these pressures is of particular interest to this school.

Chris Argyris and Douglas McGregor are responsible for the Human Resources school that dates from McGregor's 1957 article in the *Harvard Business Review*. This school is more concerned with individuals in organizations and explores self-actualization and the need to stop the waste of human resources in modern organizations. Theory Y, holding to ideas such as self-direction, as opposed to Theory X, holding to ideas such as authoritarianism, is advocated in this school of thought.

The Contingency Theory school is concerned with the organization structure that results in a given context. This concern with the end result and the ability to predict this result differs from the Sociotechnical school which is interested in process within organizations. This school began in 1958 with a study conducted by Joan Woodward.

The inappropriateness of using the Bureaucracy school for research on the number and placement of computing programs within the university was mentioned earlier. This is because this school focuses on achieving efficiency which may not be the appropriate response for a university. The Human Relations school, the Bounded Rationality school and the Human Resources school are also inappropriate. These schools focus on the individual and are typically not concerned with organizational structure.

The Sociotechnical Systems school and the Contingency Theory school are also inappropriate. The main reason for this is the premise that each shares about organizations as systems reacting to pressure for change. This premise notes that there are pressures and as these pressures vary so must organizational reactions and structures. The problem with this is that the 800 year history of higher education and the expansion of colleges and universities throughout the world defies this premise.

There is a further problem with the use of systems theory for work on organizational structure that concerns the correspondence of the formal organization structure, for example departments, to subsystems of organizations. For systems theory to apply to a study of organizational structures there must be a one to one correspondence between the formal organizational structure and the subsystems implied by a systematic analysis of the organization. More exactly, if student interest in computing is a pressure on an academic organization, the expected result would be one program of study in computing, not several. In effect, the questions under study in this research would have to be resolved before systems theory could be applied to further the research.

The remaining school, the Principles of Management school, does provide helpful information for this research on computing programs. Organizing is one of the parts of management suggested by Fayol. This school suggests various means of grouping individuals in organizations. These are functional, divisional, and hybrid. The functional arrangement suggests establishing departments based on the activities performed, for example, marketing. The divisional structure indicates making departments based on complementary skills, for example assigning doctors, nurses and secretaries to a ward. The hybrid structure uses both organizing principles in a matrix. In this case the individuals have membership in a functional area, for example nursing, and a divisional area, for example the children's ward, which implies two supervisors. The availability of choice among organizing principles raises the issue of which organizing principle applies to academic departments in colleges and universities.

Origin of Academic Departments

Decision makers at colleges and universities can choose among organizing principles for the departmentalization of the academic part of the institution. The organization could be functional, divisional, or hybrid. Departmentalization could be the result of political influence (power) coming from inside or outside the institution. The resulting departmentalization could also be influenced by or singularly be the result of a need for efficiency. The story of the relationship between academic departments and higher education is the best source for clues about the interplay among these possibilities.

The Council of Lateran, discussed in a previous section, is an example of an external influence (power) that caused an improved diffusion of education in general, and higher education throughout Europe. Departmentalization, at least as currently conceived, is not in evidence at this point in the history of higher education. However, it is worth considering the organizing principles and influences present during the origins of higher education. These include the mandated divisional organization, and response to the external political influence (power). The establishment of these schools is the result of a powerful external influence, that is the Council of Lateran, and the Pope. The result of the Council of Lateran is a directive that cathedral schools maintain three professors each assigned to teach, respectively, grammar, philosophy, and canon law (Walsh, 1920). The organization of the professors by subject is divisional.

The influences that occur at the beginning of higher education are not evidence of phenomena that are usual or normal for colleges and universities. For example, the origin of a social institution, like higher education, must be the result of external influence due to the fact the social institution by definition, does not come into being until after the events that contribute to its creation. However, the repetition of these influences, as will be shown in the origin of academic departments, is reasonable grounds for a notion that these are natural or normal phenomena affecting colleges and universities.

An example is the case of the Chair of Rhetoric and Belles Lettres at the University of Edinburgh (Bator, 1989) in the early 18th century. The town fathers caused the University of Edinburgh to establish the Chair to provide an attraction that would keep local students from seeking to enter other universities. Scottish students were often inclined to attend Dutch universities like Leyden. The Dutch universities were perceived to have a high quality faculty that were specialized in a subject. The establishment of "fixed professorships" in Edinburgh was an effort to keep up with the Dutch. These "fixed professorships," first established in 1708, instituted a practice of faculty that specialize in one area rather than all areas taught at an institution. This practice is a beginning of academic departments and demonstrates the presence of external political influences and divisional organization.

Departmentalization in American colleges and universities occurred during the 19th century, at the same time the structure of higher education was being influenced by scholars who had attended German universities. The first instances of an academic department occur in the 1820's, and were the result of actions by Americans who earned college degrees from American colleges and engaged in advanced study at German universities.

The first department was established at Harvard (Quincy, 1977). Among the events that resulted in departmentalization at Harvard was the return of an American from a German university to a Professorship at Harvard. George Ticknor, an 1807 graduate of Dartmouth, and Edward Everett are the first Americans to engage in advanced study at a German university, and both became members of the Harvard faculty. Ticknor returned to the United States to become the Smith Professor of French and Spanish and Belles-Lettres at Harvard (Rudolph, 1962). Both men provided Harvard's introduction to German scholarship, but Ticknor was particularly interested in seeing Harvard transition to the German approach.

In 1823 events would conspire to allow Ticknor to realize his vision with respect to his own department. A major student rebellion occurred, which caused the faculty and the corporation to consider reforms. This enabled Harvard departments to offer elective courses and to group students according to ability. This change did not manifest itself in a revision of the Harvard course of study, which would occur under President Eliot in the late 19th century. However, Ticknor's department did hold to these reforms, and his successor maintained them.

The reaction to the student rebellion shows that there was at least one part of the faculty that had begun to act as a department at Harvard in 1823. This was George Ticknor's department, which began with his professorship. In this case, as with the events at the University of Edinburgh, there are external political influences, and the use of divisional organization as opposed to functional organization. The external influences included the desire to adopt a German university model and the dissatisfaction of students that is so pervasive as to result in rebellion. The divisional organization, by subject, in this case is the department that ascends from Ticknor's professorship in French and Spanish and Belles-Lettres.

The first American university to be completely departmentalized was the University of Vermont in 1826, at the behest of president James Marsh (Rudolph, 1962). Marsh called for the studies at the University to be divided into four departments. He also called for allowing students not pursuing a degree to be allowed to study in a single department. While this approach was visionary, Marsh resigned due to his disaffection with the problems that were part of the job of a college president. Vermont was an example of external political influence, in this case the efforts of a new president applied to the University. The issue of the method of organization is unclear; however, this organization is likely to have been divisional because it influenced the reforms that were later adopted at Brown which were divisional.

In the late 19th century departmentalization became the norm among colleges and universities in America. An example of this is the reorganization of the department of biology at the University of Chicago in 1893. It was divided into the departments of zoology, botany, anatomy, neurology, and physiology (Goodspeed, 1916). This divisional method of organization is needed due to the size of universities, and the growth of knowledge. However, what was lost in this transition should be noted. Rudolph (1962) notes that this is a "symbolic statement" about the "disunity of knowledge" that was never made by the old colleges.

Nature of Academic Departments

Rudolph (1962) notes that departments may be necessary, but problems are also inherent in the approach. He notes that departments enable contributions to knowledge, but they also promote the splintering of subjects to reflect such unsavory characteristics of the faculty as competition for attention, funds, and approval. He specifically states:

> . . . it was also a development that unleashed all of the competitiveness, that currying of favor, that attention to public relations, that scrambling for students, that pettiness and

> jealousy which in some of its manifestations made the university and college indistinguishable from other organizations.
> (Rudolph, 1962, p. 400)

There are two particular points that should be noted about the nature of departments as a means of providing academic organization. The first point is that departments tend to evolve over time (Murray, 1964). The evolution often begins with a great scholar and evolves to a group of scholars who maintain power in the department. A group of newer faculty handle operational matters for the elder faculty. This tends to focus the department's attention on the interests of the elder faculty.

This result is echoed in the second point that departments tend to focus the faculty. From another perspective this could be considered the implementation of the problems that Rudolph suggests. A recent study documented fragmented communication, tight resources, and evaluation and reward problems are related to academic departments (Massey, Wilger and Colbeck, 1994). The study notes that while the department helps provide focus which facilitates the pursuit of knowledge, it also isolates faculty and provides barriers to communication among faculty across departmental boundaries. The study further documents Rudolph's point about competition, particularly for funds when there are constrained resources. Inappropriate evaluation and reward systems are also documented that particularly show a negative effect on teaching. It is also observed that these systems tend to maintain the status quo and frustrate changes in the organizational structure.

In fact, it has been observed that flexible department structures have been a particularly strong attribute of higher education in the United States (Blau, 1973, p. 103). However, new departments must be established and old departments must be winnowed in order to fight vested interests and create environments that nurture progress (Blau, 1973, p. 207). Highly bureaucratic colleges and universities tend to avoid redepartmentalizing, as do those institutions with "local" (more closely related to local campus concerns) rather than "cosmopolitan" (more closely related to their disciplines) faculty (Blau, 1973, p. 201). Efforts to redepartmentalize are most successful at institutions where power over academic matters is decentralized to the faculty, and where there is a thoughtful President who works carefully against the group think that can occur among the faculty. The only identifiable activity that integrates the whole faculty is a common interest in the educational enterprise (teaching), and in particular undergraduate education (Blau, 1973, p. 269). This is a particularly important point - - excessive bureaucracy damages educational performance, and has no particular relationship to research performance (Blau, 1973, p. 280). This provides an explanation for the observations made by Massey et al.

There can be unhappy results when a college, university or group of institutions fails to optimize the benefits of departments, and to minimize the problems brought about by departmentalization. An example is found in Nova Scotia where the chair of the Nova Scotia Council on Higher Education has undertaken an effort to cull departments at Nova Scotia's colleges and universities (Dwyer, 1994). This echoes the longstanding effect on colleges and university from external political influences.

Conclusion

The origins of the academic institution, the organization of the academic institution, decision making in academic institutions, the origin of academic departments and the nature of academic departments have been examined in this chapter. From this examination emerges the notion that an academic department is not a divine commandment. More importantly it is rather a means to an end that must be managed.

Chapter 3

The Academic Units' View of the Academic Organization of the Study of Computing: A Review of the Literature

Introduction

An ordinary approach to examining the issue of the academic organization of a domain of study, like computing, would focus first and foremost on those scholars working in the particular domain. The ordinary approach might limit such an investigation to only those scholars working in the domain. In fact, this chapter examines the scholarship within the domain of computing that relates to the question "What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments?" In addition, the research methodology presented in Chapter 4 and pursued for this study does make a careful examination of scholars working in the domain of computing as well as those administrators responsible for the academic function of colleges and universities.

However, it is important to remember that these reference groups are not the single point of reference for this research. Chapter 2 examined scholarship on academic organization, which is extremely important, and is not contained within the domain examined by scholars on computing. Additionally, Chapter 1 noted that there are important attributes of the domain of computing that necessitate careful reflection on scholarship, and scholars, from the computing domain used to examine this topic. Specifically, as noted on page 7, the scholars who work in the domain of the study of computing are not a unified group that recognizes a common definition of their domain of study. It is important to revisit the prevailing significance of computing as a reminder that the research question is not a minor issue that amounts to a squabble among small factions of academics.

Importance of Computing

Commerce related to computing has become important, and is becoming more important. For example, this industry employs a large labor force, and the size of this labor force will grow. The following is from a Web page at Microsoft that describes the importance of Microsoft training and certification programs. This is clearly a promotion of "training and certification" products; however, what industry, other than computing, could seriously consider such an effort, and make a profit in the process?

> "There is a serious and growing shortage of skilled IT workers throughout the US, which severely impacts the competitiveness of the industry. The Information Technology Association of America reports that 190,000 IT jobs are vacant today in the US because companies can't find people with the requisite skills. The IT industry workplace currently totals 2.5 million and it is forecast that in order to meet industry needs, it should grow by 7-10% annually. The Bureau of Labor Statistics forecasts that employment in the IT service segment of the industry alone will nearly double by the year 2005, from its current figure of 1.1 million" (Microsoft, 1997).

This industry has become the third largest industry in the United States, behind automobiles and electronics, an industry that is also related to this research (Byte, 1997). This view of the demand for computing personnel is shared by the National Research Council in their report, Computing Professionals Changing Needs for the 1990s (NRC, 1993). However, the report notes a reduction in the number of undergraduates completing degrees in computing. If this information is coupled with the fact that the ratio of personal computers to workers grew beyond one to one before the tenth anniversary of the 16-bit personal computer (Time, 1991), the academic world faces a difficult situation. That is, on one hand it is difficult to find a reasonable argument that a college graduate with no computing skills is an "educated" person, and on the other hand the personnel required to provide this education are in such great demand that the academic world must compete with the commercial world for these personnel. In addition, considering the potential life and death impact of poor computing, a heavy social responsibility is involved in the issue of the academic organization of computing programs.

Impacts of the Failure of Computing

Life and death consequences of poor computing are not hyperbole. The Sizewell B nuclear reactor in the United Kingdom is an example that shows the extent that software is relied upon, and the life and death nature of the result if the software fails. This is the first reactor in the United Kingdom that contains both software-based protection systems and conventional systems for emergency shutdowns. This system uses hundreds of microprocessors, and more than 100,000 lines of software code (Littlewood and Strigini, 1992). Given the impact of software problems on the telephone systems, and the potential result of software failure in a nuclear reactor, it seems reasonable to expect that an improvement in software development should be required before lives are bet on the reliability of these systems.

A more familiar example of the impact of computing is the change of zip codes from five numbers to a “5+4" format. This was a situation in which the US Postal Service made a reasonable decision intended to improve mail service, and in the process made an unintended decision to have virtually all programs that used zip codes rewritten. The idea that this is a computing failure is not appropriate from the point of view of the programmers who built the original programs. However, the user of the computer system is likely to have the view that the computer is supposed to know how to handle zip codes, and now it is failing to recognize zip codes. Legend holds that the cost of changing these programs to recognize the new zip code format was on the order of $9 billion dollars. The veracity of this claim is not as important to this work as the impact of the change in zip code format. To get a sense of the magnitude of this impact consider the following datum. The zip code format change is used as an example of a software maintenance problem in computing literature, and it is used to show how an alternative approach to software development would have helped avoid the impact of such a change (Meyer, 1997).

Another computing failure, also referred to by Meyer (1997), is the year 2000 problem. This problem is of sufficient broad concern that it has made the cover of Newsweek (Newsweek, 1997). This problem concerns the matter of simple counting, that is, what number comes after 99? In many computer programs the year has been represented as two digits, and the count is from 00 to 99. The years represented are 1900 to 1999. For these computer systems the day after December 31, 1999 is January 1, 1900. Therefore, if one deposits a paycheck dated December 31, 1999 after the New Year holiday, a computer that contains such a program will view the paycheck as illegally post dated (by a century). The point of view, as mentioned in the case of the zip code format change, determines if this constitutes a computing failure. To a programmer, in this case circa 1977, this is a software maintenance problem. To a bank customer, accused of trying to deposit a post-dated check, this is a computing failure.

The impact of a computing failure can have broad and painful implications on those receiving the consequences of the failure. This is an indication that a debate about the academic organization of computing programs is an issue that is interconnected and important to the larger society. In fact, a specific instance of the interconnection is discussed in the next section.

The Relationship of Higher Education and Commerce

Computing is particularly tied to the commercial sector of the larger society. This phenomenon is not unique to computing programs in higher education, but it is an issue that must be carefully examined to properly examine the research question. For example, the external demands on higher education, especially what competencies employers want to see in prospective employees, could be a guide to establishing the academic organization of computing programs.

It is important to consider the relationship of higher education to the larger society before examining the more specific relationship of external demands to computing programs. As noted in Chapter 2, higher education has historically been responsive to external demands. For example, many European institutions were established at the behest of the church, and higher education as it is now constituted traces its roots to these institutions established in the thirteenth century, although many other stakeholders over the centuries have sought to shape higher education to meet their needs. More precisely, the development of departmentalization in higher education has roots in external influences, particularly the demand for instruction that helped provide credibility for Protestant clergy. Thus external influences that shape higher education are not unique to computing and are in fact the normal operating environment for higher education.

It is clear that there are facets of the relationship between academic computing programs and external influences that prevent the use of historical analogs as a guide for the organization of these programs. One aspect of this is the relative complexity of academic work. An example is the use of the departments providing instruction to people who sought to become Protestant clergy as an historical analogy for computing programs. At the time the external influence to produce clergy was applied to higher education, academic work was mainly undergraduate teaching. If this relatively simple model is applied to computing programs in our current environment, the answer to the research question would almost surely be that there should be only one computing department. This conclusion is the result of applying research and scholarly statements on this point. This research shows that the undergraduate products of computing programs, that is, students who major in some computing field, seem to work in the same kinds of jobs (Denning et al., 1989; Mackowiak, 1991; Richards and Sanford, 1992; Richards, 1992). However, this analogy ignores several aspects of academic work in modern higher education. For example, is the research produced by the faculty in computing programs the result of one external influence or many external influences? If there are many external influences, are multiple computing programs warranted? Further, are the products of graduate computing education proceeding to the same kind of external employment, or are there variations, and are these variations enough to warrant multiple computing programs at an academic institution? Thus great care must be used before imputing academic organization from external influences on higher education.

In fact, external demands do not provide clear or cogent guidelines for higher education's organization of academic computing programs. An example is found in the demand for undergraduate computing. The U.S. Department of

Education has conducted a study that shows that industry is satisfied with the work of higher education in teaching undergraduate computing (Adelman, 1997). However, industry dissatisfaction with the results of undergraduate teaching is a longstanding recurrent theme in computing research (Hartog, 1985; Heiat, Heiat and Spicer, 1993; LaPlante, 1991; Trauth and Farwell, 1993).

This tension between industry and the academy is vividly demonstrated in the National Research Council (NRC) report, Computing Professionals: Changing Needs for the 1990's (NRC, 1993). The persons assembled to prepare this report included academics and leaders from industry. Rather than proceeding directly to the purpose for which the group was assembled, it appears that a considerable amount of time was devoted to resolving a major difference separating academic and industry perspectives on what undergraduate education should produce. The group purports that undergraduate education is foundational and should serve as a preparation for future endeavors, whereas training is the proper domain of industry.

This interchange between academics and industry in an NRC forum can help explain the difference between the research conducted by the Department of Education and the research conducted within the world of employers of persons who are computing specialists. For example, a close reading of the NRC report shows that the industry participants appeared to have a greater interest in higher education as a means of solving business problems than in the capabilities of new graduates. These business problems include examples like off-loading training costs, using higher education as a means of further distributing and entrenching particular computing products, and selling more products. Thus, the difference between the Department of Education research and other research is a matter of control. That is, it is possible that by limiting the effects of desires on the part of industry to solve current business problems, the computing research cited above might have the same results as the Department of Education research. However, the important issue related to the organization of academic computing programs is that the external demands on higher education are not clear.

Some researchers have simply asked the external stakeholders. This research has been examined in a previous section, and the results are conflicting. Thus the question becomes, "What was inherently preventing prior research from reaching consistent conclusions?"

The answer to this question arguably can be found in a document about a completely separate topic. In a recent article about academic freedom and student evaluations the following observation was made:

> Psychological research has recognized the severe cognitive

> problems and limitations of "intuitive," and "experience-informed" everyday judgements for over thirty years, ... , yet the mistakes continue in everyday practice situations (Haskell, 1997, p. 11).

This article cites six studies. These include a study on expert versus novice performance on solving physics problems which has Nobel prize winner Herbert Simon among the authors (Larkin, McDermott, Simon, and Simon, 1980); a study on clinical judgement (processing information "in the head") versus actuarial judgement (Dawes, Faust, and Meehl, 1989); and an article relating experience, training and clinical judgement (Garb, 1989). A review of these citations shows that there is a greater problem with using "experience- informed" information than the problem observed in the NRC group. This problem is that even if the parochial interests are mitigated, and the "experienced" professionals who possess the desired information take the matter seriously, these professionals may be unable to articulate the information because they simply have not discerned the information. In short, they know it but they can't tell us. Thus another means of examining the issue of the organization of academic computing programs must be found.

The Research Question and Computing Research

The foregoing discussion shows that computing is a facet of society that is important, and sufficiently important to warrant a careful examination of the treatment of the subject by higher education. Further, the external pressures on higher education do not provide adequate guidance on how higher education should handle computing. Thus there is need for a study on the organization of academic computing programs.

The Growth of Computing Majors

As mentioned in Chapter 1, there is a common topic among the various sectors of scholarly writing on computing that pertains to defining the boundaries of computing as an academic field. As the topic appears in computer science literature, a single discipline called computing is advocated (Denning, et al., 1989). The computer engineering literature advocates a separate curriculum for software engineering and in the process of making this argument notes that all facets of computing scholarship contain discussions of identity and validity of computing (Glass, 1992). Identity issues also occur in information systems literature. In fact the titles of articles sometimes raise the issue, for example, "Can the Field of MIS be Disciplined?" (Banville and Landry, 1989). Finding the origin of these feelings of insecurity would be interesting, but it might not be possible to isolate a cause. That is, the origins of this lack of security may be found in the scholars themselves and may be the natural result of scholarship beginning as a part of some recognized discipline and evolving over time to be a new discipline with new departments and PhDs.

The problem with this explanation is that there are at least two other factors that could explain this insecurity that are also identifiable in the evolution of computing programs in higher education. Table 3-1 is from a study that counted the names of computing-related majors that occurred in the College Blue Book (Schaeffer and Olson, 1996). The first name for a computing program occurs in the 1965 edition of the College Blue Book; there were no identifiable computing programs prior to this point. The two factors that can be deduced from this table are the large growth of programs, and problems with the vocational demands on computing.

Table 3-1. Growth of the Names of Computing Programs (Source: Schaeffer and Olson 1996)

Year	Total # of Programs, per Blue Book	Total # of Programs related to computers	Name starts with Computer	Name starts with Data	Name starts with Information	Name appears at all degree levels
1965	na	1	0	1	0	1
1968	>1800*	12	7	2	2	3
1969 - 1970	>2000*	16	9	5	2	3
1972	>2000*	33	23	2	8	2
1975	>2000*	38	25	5	8	2
1977	>2500*	68	51	5	12	3
1979	>2500*	73	52	7	14	7
1981	>6000*	74	57	6	11	10
1983	>6000*	130	101	11	18	9
1985	>6000*	190	149	20	21	10

*as reported in the College Blue Book

Academic programs in computing developed during a period in which there is generally a large growth in the number of programs in higher education. This should have been a period in which the establishment of computing programs would be embraced and supported. However, the chart shows that the growth of computing programs lags behind the general growth. Specifically, the rate of growth for names of computing programs appears slower than the rate of growth for all programs, particularly between 1979 and 1981. In addition, computing programs whose names begin with the words "data" or "information" have reductions in the number of programs names in some periods. While this is not definitive proof, it appears that the growth of computing programs does not behave in the same manner as the growth of programs generally. During this period credible computing programs would have required access to mainframe computers, which were expensive devices that could cost millions of dollars. Computing programs would, therefore, be considered expensive and may have been reluctantly established. Thus computing has had the burden - - overcoming financial barriers - - that is unlikely to have been applied to other programs.

The second factor concerns the problems of vocational demands on computing. The table partially reveals this in a comparison of the growth of computing program names that occurs at all levels through the PhD to the growth of all computing program names. This is further revealed by the story of the name of the first computing program. This name was data processing (DP), and it was the only name in existence in 1965. During the initial growth of computing this name had credibility and there were programs through the PhD level. In the late 1970s the name began to lose credibility, and PhD programs in DP began to disappear. By the 1980s the only programs in DP were at the associate level, and the name was beginning to disappear. In fact the term DP has become so closely identified with vocational aspects of computing that the Data Processing Management Association (DPMA) has recently changed its name to the Association for Information Technology Professionals, eliminating DP. From this information it appears that as a name for a computing program becomes associated with vocational aspects of computing it will lose credibility both inside and outside higher education. Computing programs are affected by the need to maintain credibility, which involves creating sufficient vocational skills in undergraduates to maintain credibility with employers, without becoming so vocational that the name of the program loses credibility.

The history of academic computing programs is not long, and in that short history, the academic study of computing has encountered a surprising combination of obstacles. These challenges, which are largely external to the academic work in computing, should result in a unification of those faculty interested in computing (Blau, 1973) and the establishment of specialized computing departments. The small number of names for computing programs that occurs at all degree levels would lend support to this idea, but is this the case?

National Research Council Reports

The study of computing is sufficiently important that the National Research Council (NRC) has established the Computer Science and Telecommunications Board under the Commission on Physical Sciences, Mathematics, and Applications. From 1992 to 1994 three NRC committees examined and reported on various aspects of computing. These reports contained concepts and material that are useful for the study of the academic organization of the study of computing. However, it is important to recall that scholars in each of the various sectors of computing tend to be dismissive of the work of scholars in the other sectors (Chapter 1). While these materials are useful, none of these committees should be viewed as representing the totality of scholars involved in the study of computing.

The report from the Committee on Academic Careers for Experimental Computer Scientists, entitled Academic Careers for Experimental Computer Scientists and Engineers (NRC, 1994), contains concepts whose ramifications include the notion that computing programs should not be placed in the same organizations as science and engineering. A fundamental concept is that computer science and engineering is a "synthetic discipline." This domain of study examines artifacts that are entirely the creation of human activity. The report illuminates the difficulties, or near impossible nature of, academic careers for those who choose experimentation as their research methodology in computing. These difficulties include the prevalence of conference proceedings as publication outlets and the collaborative nature of research in the study of computing. The report discusses these and other difficulties in obtaining tenure, promotion, and a fair evaluation of research, and it provides recommendations to aid the careers of those involved in experimental research in computing.

The report contains interesting arguments that the study of computing is not simply a part of science, engineering, or mathematics. The difference between this domain of study and science and/or mathematics is that the artifacts are completely human creations and not "given" by nature (NRC, 1994, p. 15). To help illustrate this concept consider virtual reality. In this application of computing it is possible for a user to be "inside" another reality containing sight, sound, and touch. What the user sees, hears, and touches is in this virtual reality, and it is possible that no sight, sound or touch enters this virtual domain from the "real world." This is a good example because everything about such a system is produced by humans. While scientists and/or mathematicians may work on the fantastic issues that humans cannot experience without the aid of media devised by humans, for example sub-atomic particles, these phenomena are "given" by nature. While the effort to seek truth is possible in both domains, for science and/or mathematics the truth must be obtained from nature.

It may not be obvious that mathematics should be thought of as being in the company of natural science and distinct from computing. An issue raised by this NRC committee provides a clarification, and this issue concerns the attributes of a contribution to new knowledge in computing versus science and mathematics. The committee notes that a new fact concerning nature is generally accepted as a contribution to new knowledge, while developing something new in synthetic disciplines is not in and of itself a contribution. For example, a new word processor or text editor could be developed, but the existence of so many similar systems is an indication that this is unlikely to be a contribution to new knowledge. In fact, a new word processor or text editor could be a contribution, but to show this contribution the developer would have to prove that there is improved performance. There are other means of showing a contribution with a new artifact which include proof of concept and proof of existence. This additional burden of proof for synthetic disciplines is not generally applied to science and/or mathematics.

Engineering may appear to have more in common with computing, but the report notes that engineering is concerned with physical constraints on artifacts. The committee states:

> Other engineering disciplines are also focused on artifacts, and indeed ECSE [experimental computer science and engineering] share certain characteristics with these other disciplines. However, the artifacts of other engineering disciplines are typically constrained by well-defined phenomena (e.g. gravity, conductance of metals, compressibility of gases). This limits the variety of the artifacts and presents clear-cut criteria for evaluating their merit (NRC, 1994, p. 21).

While the purpose of this report was not to advocate a change in academic organization, two issues are raised that are important. First, academic careers in this area are difficult, and part of that difficulty concerns the evaluation of research. Second, a case can be made for fundamental differences between computing and those disciplines commonly associated with computing (science, mathematics, and engineering).

Computing the Future: A Broader Agenda for Computer Science and Engineering was prepared by the Committee to Assess the Scope and Direction of Computer Science and Technology of the NRC. This report is a careful and critical look at the importance of computing to the nation, the welfare of the producers of computing for the nation (mainly higher education), and the appropriate support for computing by consumers (government, industry, and academic institutions). This report contains recommendations for government, industry, and academic institutions aimed at maintaining and improving the contributions computing makes to the economy and the nation generally. A particularly important recommendation made in this report is that academic institutions "broaden" curriculum and research in computing, in part to respond to changes in society and realize the potential of the study of computing, and partly as the growth one would expect to see in a domain of knowledge.

Of particular interest to this study of the academic organization is the observations made about computing departments in the report (NRC, 1992, p. 231). The committee notes that computing programs are generally housed in colleges of arts and sciences, but these programs can also be found in colleges of engineering and colleges of computing. These departments can stand alone, that is computing is the only domain of study in the department. They can also be mixed with other domains, for example mathematics and computer science combined in one department. The committee gives an example of a well regarded department for each category but does not consider the relative merits of the various organizational structures.

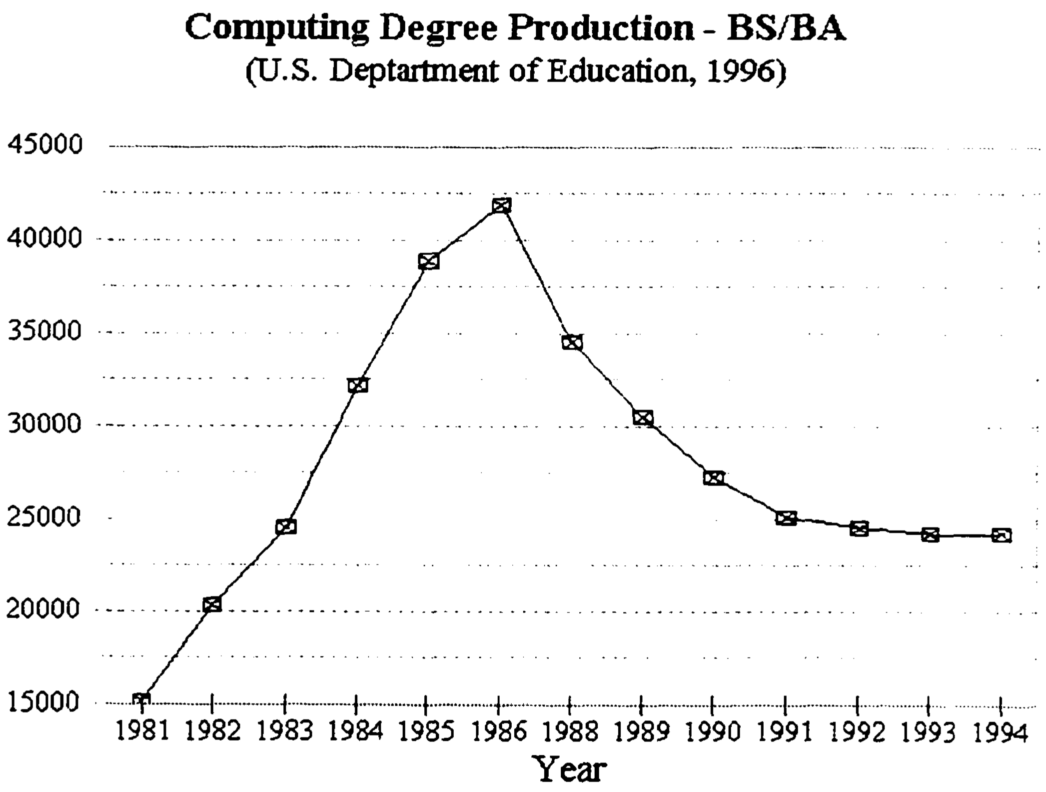
Contained within the report is considerable attention to the relation of computing to other disciplines. This analysis was necessitated by the committee's recommendation that computing broaden its focus, and this analysis provides important points that inform this research on the academic organization of computing departments. For example, this report specifically notes and demonstrates a mistrust of computing housed within other disciplines particularly, observing that other disciplines are reluctant to recognize computing as a discipline (NRC, 1992, p. 63). The report notes further that for many fields it is possible to create a "subfield" by simply adding the word computing to the name of the field (NRC, 1992, p. 60). Computational biology is an example. It is noted, too, that the "subfields" owe their existence in part to the simplification of programming which makes the domain-specific knowledge more difficult to obtain relative to programming skills. However, it is also noted that this is an improper attitude toward programming (NRC, 1992, p. 64) and that the simplification of programming may not be available on more powerful technologies such as parallel computers that may become available and needed for these "subfields" (NRC, 1992, p. 60)

An approach advocated by this committee is for computing professionals to "embrace" all applications and work with other disciplines building applications. A specific example of a mistake that computing has made in this regard is involvement in general business computing (NRC, 1992, p. 62). The committee notes that computer science and engineering have not participated in business computing. One might wonder if this interest in business computing is scrupulous, that is, does this interest spring from an actual acknowledgment that there are computing issues in business computing that are worthy of recognition, or is this interest spurred by the thought that business might be a source of funding that could make up for potential reductions in federal funding resulting from the end of the cold war? Regardless of the reason for interest in business computing, it is important to the study of the organization of academic computing departments for two reasons. First, the study of computing and general business is conducted in colleges of business, which is an academic venture not represented on this committee. Second, for whatever reason, this committee of computer science and engineering scholars has recognized business computing as a legitimate endeavor. In time the implications of this will be realized and it will be interesting to discover if the result is a turf war, a consolidation of computing from colleges of business into computer science and engineering departments or some other result.

There are two points in the 1992 report that are similar to issues raised in the 1994 report. The first point is attention in the 1992 report to an "object of study" (NRC, 1992, p. 164). The "object of study" is an explanation of the difference between computing and other disciplines. This point is like the discussion of "synthetic disciplines" in the 1994 report (NRC, 1994). The second point is a discussion of the necessity for groups of scholars to collaborate on research (NRC, 1992, p. 89) which foreshadows the discussion of collaborative work in 1994 (NRC, 1994).

The status of the study of computing, at least in computer science and engineering departments, is also examined in the 1992 NRC report. There is a

Figure 3-1



great variation in curricula in computing programs, and this variation is greatest at the undergraduate level (NRC, 1992, p. 118). The committee also notes Ph.D. production was 648 in 1989, the lowest in the sciences and engineering, and that there has been a drop in the number of undergraduate degrees awarded in computing since 1986 (Figure 3-1). Computing has the highest percentage of foreign students in sciences and engineering and has the highest degree-to-faculty ratio in the sciences and engineering. The committee specifically notes that it would take 11,000 additional faculty to move computing to the same average degree-to-faculty ratio as the rest of the sciences and engineering (NRC, 1992, p. 258). This would take 16.9 years of Ph.D. production at the 1989 rate. It is noted in the report that in 1977 thirty-five percent of the computing faculty were full professors, and in 1989 thirty percent of the faculty were full professors. This drop is explained by the growth in the number of computing faculty during this period. However, in 1977 twenty-nine percent of the computing faculty had computing Ph.D.s, and in 1989 forty-one percent of the computing faculty had computing Ph.D.s.

These indicators have important implications for the academic organization of computing. An important implication concerns the faculty. The decrease in the percentage of full-time professors and increase in the percentage of computing faculty with Ph.D.s in computing, taken together, imply that even though Ph.D. programs in computing have existed since before 1977, some amount of the computing faculty hired since 1977 were hired without Ph.D.s in computing. This implication is nearly a certainty when the fact that the computing faculty grew by a factor of 3.5 during this period (NRC, 1992, p. 257). Thus, perhaps a third of the new hires during this period did not have computing Ph.D.s. The organizational issue related to this and other indicators from this report concerns the "use" of computing by other disciplines, or rather the question is computing being "used" by other disciplines? Some issues related to this idea are that computing is sometimes housed in "mixed" departments, other disciplines consider computing a "subfield", low degree production, variation in curricula, difficulty in obtaining tenure, and implications that workload is distributed unfairly (as seen in the degree-to-faculty ratio).

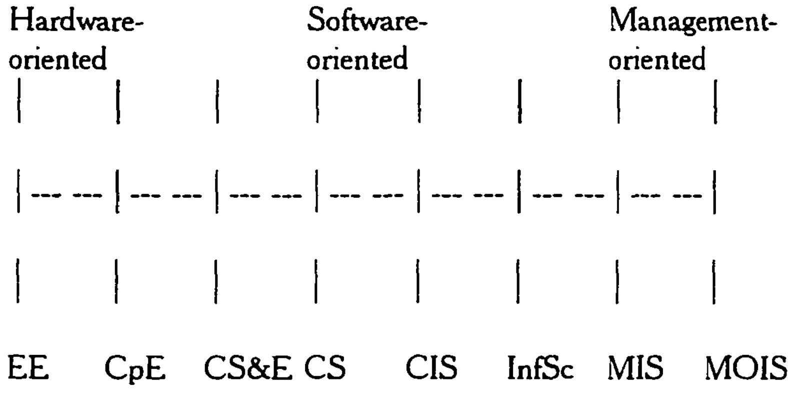
The committee notes the importance to society of computing in higher education in terms of technology transfer to society (NRC, 1992, p. 42) and the need to diffuse computing in society (NRC, 1992, p. 5). The importance of computing has been discussed at various points so far, but at this point the concern about the ability of the academy to fulfill the needs of society, given the current organization of academic programs in computing, has been raised.

The issue of the relationship of computing to other disciplines is raised in Computing Professionals: Changing Needs for the 1990s prepared by the Steering Committee on Human Resources in Computer Science and Technology (NRC, 1993). Though this issue was a concern for the other two committees, this report is addressing this issue as a result of a different cause. This committee encounters the "industry demand" that the graduates of computing programs have at least a minimal understanding of the environment that will be encountered in their working life. Some topics that are mentioned include project management and cost estimation. The committee comments that a new "educational product" that includes a core of computer science and another discipline may be evolved to address this need (NRC, 1993, p.83). The "educational product" is similar to the "subfields" mentioned in the 1992 report. The committee shows that the practice of using graduates from other fields, with subsequent training or study in a subfield, will not address the needs of "industry." The reason is that the fundamental computing knowledge is large, dynamic and a prerequisite for these jobs (NRC, 1993, p. 92).

This report is critical of the current academic organization of computing programs. It notes that the variations in curricula are so great that the result is confusion (NRC, 1993, p. 76). The committee reports that the large variety of programs, and variation of curriculum among programs with the same name, raise questions about quality and the appropriateness of the available education (NRC, 1993, p. 92). The curricular problem is so ponderous that it appears unlikely that students or industry can intelligently select among the available programs.

The curricular problem is compounded by a "labeling" problem. The report cites a lack of consensus on a label for the field (NRC, 1993, p. 80). The variation in labeling coupled with the variation in the types of colleges that house computing (as noted on page 78) make data collection efforts like those undertaken in the Integrated Postsecondary Education Data System (IPEDS) difficult. If the data collection effort obtains data for the college/school level of universities, the data would not show the whole situation for computing. If data were collected at the department level, the variation in labels would render less relevant aggregation of the various department data into data on the whole of computing. Further, the degree titles are not used consistently (NRC, 1993, p. 120). In appendix B (Figure 3-1) a scale is shown that arranges eight program titles in order, moving from hardware-oriented programs to software oriented-programs to management-oriented programs, and it is noted that the term "computer science" is used to refer to programs that are found in six of the eight categories on this scale (NRC, 1993, p. 125). The committee calls for improvement in the definition of degree programs,

Figure 3-1. A Taxonomy of Computing Programs (Source: NRC, 1993, p. 125)



and it is particularly noted that fewer categories would be valuable to employers and prospective students (NRC, 1993, p. 92). Notably, the committee notes that "industry" would prefer a singular curriculum (NRC, 1993, p. 78).

An attribute of computing that was particularly noticed by the committee was the rapid rate of change in computing. Interestingly, the committee does not comment about the means of adapting curriculum to this change. However, the committee notes that careers in computing are a poor basis for curriculum because of the rapid rate of change (NRC, 1993, p. 79). Further, the committee comments that accreditation as applied to curriculum is not likely to be effective because it is unlikely that accreditation requirements will be able to remain coordinated with the rapid changes in computing (NRC, 1993, p. 80). Finally, the committee recommends that students be made aware of and amenable to the fact that the rapid pace of change in computing means that they will be required to undertake "lifelong learning" to maintain their competence in computing (NRC, 1993, p. 86, and 92).

Conclusion

The study of the academic organization of computing programs informs thought about curriculum for computing programs, the marketplace for computing faculty, and careers for graduates of computing programs. It is also important to any examination of teaching, research, service, and governance related to academic careers in computing.

However, it may be that the study of the academic organization of programs is most important for purposes of shaping the responses of colleges and universities to the growing shortfall in available workers for computing jobs, which has grown from an estimated one million new workers needed over the next ten years forecasted by the U.S. Department of Commerce in September 1997 to an estimated 1.3 million new workers needed over the next ten years forecasted by the Department of Commerce just two months later in December 1997 (Frost, 1998). The projected worker shortage is confirmed by the U.S. Department of Labor at 1.3 million workers over the next ten years (Bowman, 1997). Further, there are 346,000 vacant positions in computing, in other words ten percent of the computing workforce is unfilled positions (McGee, 1998). Higher education is providing 24,000 new graduates per year to fill 100,000 new jobs (Davey, 1998).

A lack of response to this shortfall by colleges and universities is likely to propagate the sentiment expressed by the president of the Information Technology Association of America;

> The industry can't step back and say, 'we depend on our universities to solve the problem.' That's not working now, and it's not going to work in the future (McGee, 1998 p. 30).

Chapter 4
Methodology

This inquiry concerns the most effective placement of computing degree programs in American colleges and universities. In this chapter, the methods used for this study are established in order to avoid potential pitfalls. One example of such a pitfall is the temptation to simply ask the "experts". This requires an answer to the question, "Who are the experts?" If the selected experts are department chairs, the potential bias noted in Chapter One is likely to create a result that fails to reveal the most effective placement of computing programs.

Who Are The Experts?

A reasonable attempt to overcome this problem might be to select as an "expert" the next person up the chain of command from the department chair. This person may be a dean or the campus chief academic officer (CAO). This solution provides the further advantage of a point of view that includes, in the case of the CAO, all academic units, including the institution's finances and the institution's academic reputation. However, the advantages of this solution are coupled with serious disadvantages. A CAO is a particularly pivotal position in an academic organization; thus, while he or she can be relied upon to complete surveys because of a sense of duty, issues related to computing or the organization of such specialized academic units may not have been among the important concerns encountered by this person. Or, if they do constitute a salient concern, the CAO may not have a sophisticated understanding of the intricacies and needs of the study of computing. Thus, CAOs might not be "expert" in all the desirable ways.

The limitations of each of these groups of experts, that is the department chairs and the CAOs, can be overcome, at least in part, by using both groups. Thus, a survey was administered to the population in each group. Surveys were designed to include some questions common to both groups, and as well as additional questions that sought information unique to each sector. As a result, responses to the surveys were used to triangulate a close approximation of the perceived most effective placement of computing programs.

Institutions in the Study

The next step required the identification of the specific institutions to be studied. Computing programs are central to the examination of the issues involved in this study. The first tool needed to examine the placement of computing programs at colleges and universities is an answer to the question: what are these programs called?

The earliest mention of programs of study in computing in college guides, such as the College Blue Book, was in 1965 when 98 institutions self-reported programs of study in "data processing" (Schaeffer and Olson, 1996). Over the next two decades, the reports would grow to include 190 different degree titles at more than 1,813 institutions. It is beyond the scope of this research to address the origins of program names, but most programs can be identified as fitting within one of three major areas: Computer and Information Sciences, Computer Engineering , and Information Sciences and Systems.

These areas reflect the three principal terms that refer to computing curricula and are the terms used in the College Entrance Examination Board's Index of Majors and Graduate Degrees, gleaned from the Classification of Instructional Programs (CIP) employed by the National Center for Educational Statistics (College Entrance Examination Board, 1993, p. v).

The term Computer and Information Sciences (CS) generally refers to Computer Science as found in Colleges or Schools of Arts and/or Science. The term Computer Engineering (CE) generally refers to programs found in Colleges or Schools of Engineering. The term Information Sciences and Systems (IS) refers to programs usually found in Colleges or Schools of Business. These categories of computing programs are also used in discussions of computing curriculum (Denning, Comer, Gries, Mulder, Tucker, Turner, Young, 1989) and in discussions of changes in curriculum (Glass, 1992). For the further purposes of this study, these are the categories of computing programs and the terms used to refer to the programs surveyed.

The College Entrance Examination Board, as noted, publishes an annual Index of Majors and Graduate Degrees, and this was used as a means of deciding the list of programs and institutions to be included in this study. The College Entrance Examination Board's data are established by annual interaction with colleges and universities. The 1993 edition contains data provided by 2900 institutions (College Entrance Examination Board, 1993, p. v) and was used to establish a database of computing programs using Paradox®, a database program. The information included in this database is the name of the institution, the state, and the computing degree programs offered at the institution.

The Carnegie classification of colleges and universities provides a recognized means of differentiating among colleges and universities. It does not provide a ranking system but rather provides categories of types of higher education institutions, and this was used to establish the types of institutions in the database. A field was added to the database, and the most recent Carnegie classifications, as they appeared in the April 6, 1994 Chronicle of Higher Education, were placed in the database.

The Carnegie classifications were collapsed into four categories. These are: Associate, Baccalaureate, Masters, and Doctoral institutions. There are 2881 institutions in these categories. There are 1656 campuses with at least one computing program at these institutions. These programs are distributed as shown in Table 4-1.

Table 4-1: Dispersion of Computing Programs

	Associate	Baccalaureate	Masters	Doctoral	Total
Institutions with computing	542	424	468	222	1656
Total Institutions	1480	633	532	236[1]	2881
Percentage with computing	37%	67%	88%	94%	57%

---

[1] The fourteen institutions that did not appear to have computing programs in this category were carefully analyzed. Two of the institutions did, in fact, have computing programs. The remaining institutions have been specialized in such areas as Medicine and Education and are included in this category due to the possession of programs at the institution beyond the area of specialization.

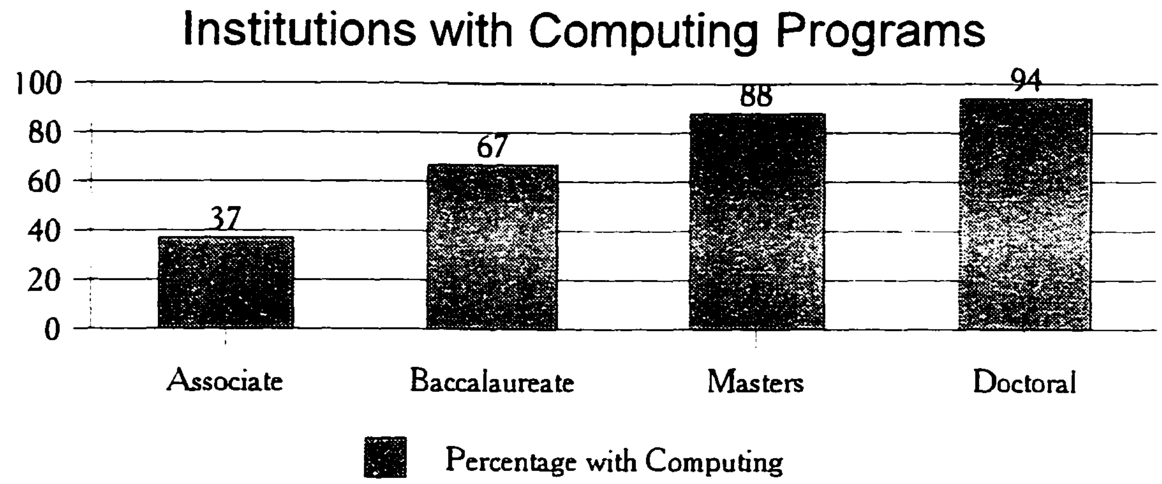
This analysis demonstrates that there are remarkable differences in the extent to which computing is offered from one category of institution to another. This may be due to the characteristics of the educational environments in each of these groups of institutions. In fact, some might argue that this is necessarily the case because of financial constraints. Further, it is likely that research on the placement of computing programs at colleges and universities is affected by organizational complexity. This is in concert with the observation that the percentages of Figure 4-1, show an important characteristic of computing at colleges and universities. It appears that there is a strong correlation[2] between the category of institution, in terms of highest degree awarded by the institution, and the presence of a computing program. This raises the question of whether there is in fact a correlation, and, if so, why this correlation occurs.

A second analysis concerns how the categories of computing are represented in the different categories of institutions. As noted earlier, there are three categories of computing programs. At institutions with computing programs there could be as many as three different computing programs. Table 4-2 shows the number of

---

[2] The strength of this correlation relies on the amount of credibility one wishes to give the source of the data. That is, institutions report this data to the College Board, and while it seems there is an incentive to be accurate (i.e., recruiting students) there is no guarantee.

Figure 4-1

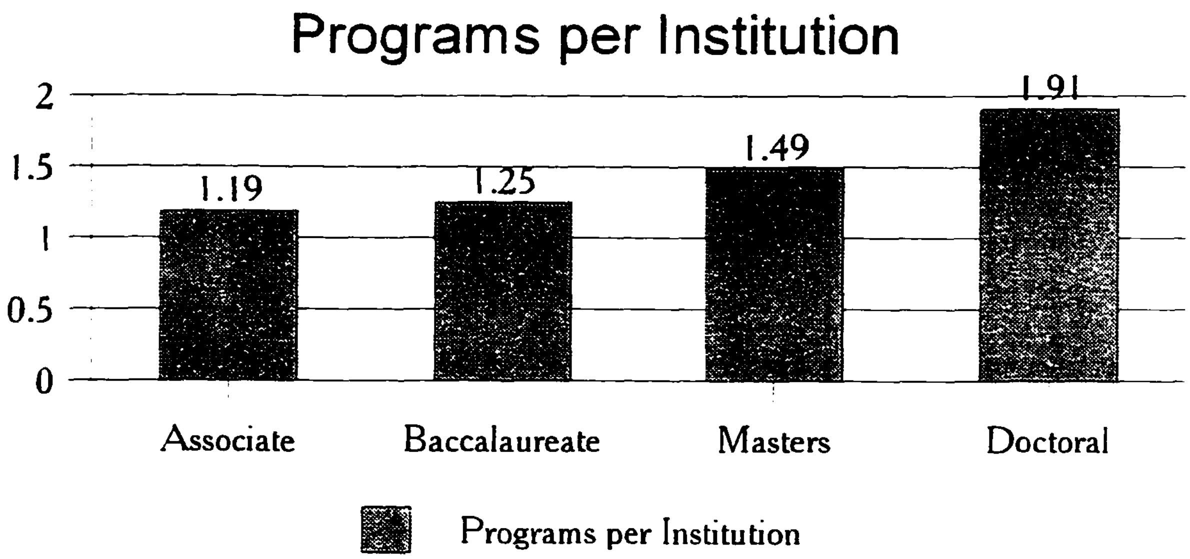


programs in each category of institution, the number of institutions, and the programs per institution. A similar phenomenon is shown in this table. This analysis shows that the likelihood of multiple computing programs increases as the category of institution changes from Associate to Doctoral. This effect is depicted Figure 4-2.

Table 4-2: Programs Per Institution

	Associate	Baccalaureate	Masters	Doctoral	Total
Total programs	646	528	696	424	2294
Total institutions	542	424	468	222	1656
Programs per institution	1.19	1.25	1.49	1.91	1.39

Figure 4-2



This graph illustrates that there is a correlation between the number of computing programs and the highest degree awarded by the institution. This is a second characteristic of computing programs at colleges and universities that varies as the highest degree awarded at the institution varies.

These characteristics of computing at colleges and universities raise several issues that are subject to inquiry. One such question, about the correlation of highest degree awarded by an institution and the presence of a computing program, was noted earlier. One approach to inquiry into this question would identify ways in which colleges and universities differ and to test the relationship of these differences to computing programs in a sample of all colleges and universities.

Another approach would carefully study computing as it is manifested in each category of institution and identify the characteristics of the institutions in the category that affect computing. This study, which focuses on doctoral level institutions, is a launch into the studies suggested by the second approach.

In fact, there are interesting questions that should be examined in each category of institution. At the associate level there is the obvious question related to the presence of computing programs at some institutions and the lack of computing programs at other institutions. There are also questions related to the way various potential missions of associate level institutions (i.e., preparation of students to enter four-year programs, providing programs of interest to members of the community, and vocational programs) relate to the presence of computing programs, the organization of instruction in computing, and the placement of computing in the academic organization of these institutions. Baccalaureate level institutions provide an opportunity to examine the relationship between the traditional "liberal arts" approach to undergraduate education and the treatment of computing. The baccalaureate level institutions may be an ideal set of institutions to study the relationship of institutional financial health to the study of computing. Masters level institutions are a set of institutions that provide a good setting for an examination of the relationship between the level of degrees offered (i.e., baccalaureate, or masters, or both) and the study of computing. The masters institutions may also be a good venue for the study of the differences in the treatment of the study of computing at public and private institutions. Doctoral institutions are the category of institution that produces members of the academic community who hold doctoral level degrees. Thus, the doctoral level institutions are the best category of institution to study the relationship of the responsibility for production of new faculty to the study of computing.

Two possible research approaches were mentioned earlier. These approaches are to identify ways in which colleges and universities differ and test the relationship of these differences to computing programs in a sample of all colleges and universities; the second approach is to carefully study computing as it is manifested in each category of institution and identify the characteristics of the institutions in the category that affect computing. The first approach risks the effect of the fallacy *post hoc ergo propter hoc*. Research using this approach may be unable to describe all the possible characteristics of colleges and universities that may relate to computing, and the interaction of these characteristics. In fact, the second approach may be required before the first approach could be undertaken. Though a list of characteristics might be developed without conducting the research suggested by the second approach, such a study would never be able to insure that the relationships found are anything more than a temporal result (i.e., the characteristic occurs and an effect on computing comes after, therefore the characteristic affected computing).

This study followed the second approach, and the researcher selected one category of institution as its focus. Computing is allocated differently within each of the categories of institutions. This is shown, at least with respect to the existence of computing programs at the institutions in each category (Table 4-1), and the existence of each type of computing program at the institutions that have computing within each category (Table 4-2). Computing faculty are likely to have their final degree from one of the doctoral institutions. Even the faculty at associate level institutions are likely to have masters degrees from doctoral institutions or from institutions with faculty that have doctoral level degrees from doctoral institutions. Most computing faculty are likely to be influenced, in some way, by experiences at doctoral institutions. Because this makes these institutions de facto leaders, and this leadership affects the curricula at many institutions in all categories, this study focused on computing at doctoral institutions.

The study, as noted, was directed toward institutions that have computing programs, and institutions that are in the Doctoral category. Thus, the definition of the population was provided through the use of an operational definition. For the purpose of this study, to be included a computing program must have met the following criteria:

1. The program fits into one of the three categories of computing programs established in The College Board Index of Majors and Graduate Degrees (College Entrance Examination Board, 1993).
2. The program is at an institution that is in the Doctoral category.
3. The computing program provides Baccalaureate, Masters, and Doctoral degrees.

The third criterion provides a safeguard against a research vs. teaching bias on the part of the respondents. Initially, the third criterion was established to provide consistency in the process of establishing the population; however, defining "educational program" as having the requisite of instruction at all levels has been done. In fact, in Europe the use of the concept in third criterion warrants its own language, for example the Norwegian term *studiefag*. This was used in a discussion of emerging programs, and it was noted that this term is difficult to translate for English language journals because this condition (instruction at all levels) as well as teaching and research are implied in the term and there is no equivalent in English (Karseth, 1995, p. 195).

The application of the three criteria yielded 136 institutions and 198 computing programs. The criteria yielded a number of CS and CE programs, but only a small number of programs of study in IS. The small number of IS programs was a result of the usual placement of these programs in schools or colleges of business. These schools or colleges are often graduate business schools and thus do not house undergraduate programs. In order to ensure that IS was adequately represented in the population, the number of IS programs included for purposes of this study was expanded by 32 (adding ten institutions), drawing on the survey by Jarvanpaa, Ives, and Davis (1991).

The Survey Instruments

The survey of computing department Chairs sought information related to the relationship between the concept of computing as a discipline and "careerism" (i.e., programs established with the intent of having graduates enter specific careers) as a justification for multiple departments. This survey includes questions that assess the Chairs' perceptions of their institution's support for the study of computing. The issues related to the institutional support for computing provides a means of calibrating the responses of the Chairs and CAOs. For example, if the responses showed that Chairs believe the resources needed to support computing are scarce and CAOs believed there are plenty of resources for that purpose, other differences in the attitudes of these groups may be explained.

The survey of CAOs investigates the relationship between the concerns of the institutions generally and the willingness of institutions to support multiple computing programs. The survey of CAOs also examines the relationship between the CAOs' perception of institutional concerns and the CAOs' perceptions of the institutions' general support for computing. The CAOs' perceptions of the institutions' general support for computing may be used as a way to assess the differences between the CAOs' responses and the Chairs' responses.

Ultimately, responses to the surveys illuminate the question, "What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments?" To achieve this end several intermediate questions were examined.

The first intermediate question is, "What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing?" The need to establish the expertise of the CAO was noted previously, and this intermediate question responds to that need. However, it is important to note that the similarity of responses to this intermediate question both on the part of department chairs and CAO's may contribute to efforts to answer the research question. For example, if all parties at an institution agree that the study of computing is important, then there is at least merit to the notion that the academic organization at that institution is effective. The alternative case, where the CAO regards the study of computing as unimportant, at least presents doubt about the academic organization for computing at such an institution. Questions 1 through 8 on the CAOs Survey and questions 14 through 20 and 26 on the survey of computing department Chairs concern attitudes about the study of computing.

These survey questions include an examination of the need for the study of computing and availability of resources to support the study of computing. This addresses the second intermediate question, "Is there a relationship between the deployment of resources at an institution and the placement of the study of computing in an academic organization?" In addition, CAOs Survey question 11 and computing department Chairs Survey question 11 concern the normal amount of courses taught by faculty at the institution during an academic year. Questions 9 and 10 on the survey of CAOs are similar to questions 3 and 4 on the survey of computing department Chairs. The only difference in these questions is scope. On the survey of CAOs question 9 is about the number of computers available to students at the institution, and question 10 is about the number of computing faculty at the institution. Question 3 on the survey of computing department Chairs is about the number of computers available to students in the academic unit, and question 4 is about the number of computing faculty in the academic unit. This intermediate question continues the examination of expertise mentioned earlier by making sure that belief and actions are in concert. This also helped the researcher to establish more characteristics of an effective academic organization for the study of computing. For example, if the CAO and department chair agree that the institution's resources are properly deployed, there is further merit to the notion that the institution has an effective organization for the study of computing.

The third intermediate question is, "What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations?" This particularly demonstrates an important aspect of the research question. If there are multiple computing programs, and the CAOs and department chairs believe this is a reasonable approach, then there is further merit to an assertion that this is an effective academic organization. This could also show the contrary, for there might be one computing program, and the CAO and department chair might both believe multiple programs are wasteful, thus showing merit to the assertion that this arrangement, too, is an effective academic organization. Questions 12, 13, 16 through 19 and 21 on the survey of CAOs and questions 21, 22, 27, 28 and 31 to 33 concern attitudes toward aspects of having multiple computing programs and emphasize the relationship to faculty and students. CAOs Survey questions 23 to 25 and computing department Chairs survey questions 35 to 37 are about attitudes toward aspects of having multiple computing programs that emphasize the relationship to the institution and the administration.

There are several questions on the CAOs Survey that further examine this intermediate question. Question 14 on the survey of CAOs is not asked of the computing department chairs. This item inquires about the CAO's attitude toward policies and procedures at their institutions related to similarity of courses. This question is about minimizing similarity (that is, redundancy) among courses. Question 15 is unique to the survey of CAOs. This question assesses the attitude of CAOs toward the existence of pressures outside the institution that seek to reduce course duplication. The effect that a program to eliminate academic units might have on computing academic units is assessed in question 20 of the survey of CAOs. This question is asked only of CAOs.

The expertise of the department chairs was sought for the fourth intermediate question, " What is the relationship of particular attributes of computing programs, such as program size and academic training of program chairs, to the placement of programs within academic units?" The data sought for this question is demographic, and is included to insure the identification of factors shaping placement of computing programs that are not related to an ideal of effective placement. An example would be a dearth of faculty. If no faculty are available to teach a subject, the effective placement in an academic organization is a moot question. There are fifteen questions that appear on the survey of computing department Chairs that are not asked of CAOs. These are questions 1, 2, 5 through 10, 12, 13, 23 to 25, 29, and 30. These questions concern attributes of the department Chair, the academic unit, the curriculum, the faculty, and the students.

Question 5 seeks to establish an attribute of the department Chair. Question 5 establishes the levels of administration between the Chair and the CAO. This variable will also be used to test for its relationship to the attitudes of the Chairs.

Questions 1, 2, 6, and 7 are about attributes of the academic units. Question 1 establishes the degree levels provided by the academic unit. Question 2 is about the students in the academic unit, particularly enrollment and graduation. Question 6 concerns the part (college/school/center) of the institution that contains the academic unit. Question 7 is about the age of the academic unit.

Attributes of the curriculum in the academic unit are examined in questions 23, 25, 9, 10, and 24. Questions 23, and 25 are about model curricula that may be the basis for the academic unit's curriculum. Question 9 concerns the accreditation of the academic unit's curriculum. The topic areas in an academic unit's curriculum and where the topic is taught are examined in question 10. The topic areas were identified from journals in Computer and Information Science (Denning, Comer, Gries, Mulder, Tucker, Turner, Young, 1989, p. 12), Computer Engineering (Glass, 1992, p. 280) and Information Sciences and Systems (Heiat, Heiat, Spicer, 1993, p. 30). The topic areas are listed in alphabetical order rather than by type of computing curriculum. This eliminates the implication that the survey favors one computing curriculum over another. Question 24 concerns the relationship of adherence to a model curriculum and duplication of courses taught in other academic units.

Questions 12, 13, 29 and 30 are about attributes of the faculty. Question 12 is about the teaching workload of faculty in the academic unit. Question 13 is about academic journals preferred in the academic unit. The list was compiled by selecting the three journals that tend to be cited frequently as references in the journals deemed to be most relevant to each of the three computing curricula. The same number of journals was used for each of the three curricula, and the list of journals is alphabetized to avoid an implied endorsement of one journal over another. Question 29 examines the relationship of experience as a student in a program that uses a model curriculum and the desirability of faculty with that background. Question 30 is about the desirability of faculty with PhDs in the same computing curriculum.

Question 8 is about attributes of students. This question seeks to determine if there is a difference in the jobs that graduates of the three computing curricula attain upon graduation. The list of jobs is the result of previous research examining the computing jobs that appeared in the Washington Post (Mackowiak, 1991, p.

12). The jobs are listed in alphabetical order to avoid the implication of favoring one job over another.

Pilot Tests

Prior to the mailing, the surveys were pilot tested. The pilot test was undertaken to insure that the breadth of topics, depth of topics, construction of the questions, and time required to complete the surveys was realistic. A CAO and three department chairs (one each from CS, CE, and IS) completed the surveys. Upon completion of the survey each respondent was interviewed about the survey. Each respondent was from a campus of the California State University system. These institutions are not part of the survey population because they do not have doctoral programs, but the departments had characteristics that were similar to the institutions in the survey population, such as number of students attending the institution. The results of the pilot test and interviews were very encouraging, and in the case of the department chairs amounted to an endorsement of the study.

Procedures

The Paradox® database was queried to extract the mailing information for survey recipients. Each survey packet was comprised of:

- the survey, which for CAOs is four pages (double-sided) in black ink on gray paper (see Appendix F) and for department chairs is seven pages (single-sided) in black ink on yellow paper for CS, buff for CE, and ivory for IS (see Appendix G).

- a letter of conveyance (shown in Appendix H), which is personalized and printed in black ink on ivory University of Redlands Department of Management and Business letterhead.
- a 4 x 9 inch white business-reply envelope with the researcher's name, the University of Redlands Department of Management and Business address and the meter permit number.
- a 9 x 12 inch manila, top opening mailing envelope which held the letter of conveyance, the survey, and the return envelope. The University of Redlands Department of Management and Business return address was stamped in the top left corner and a label with the address of the destination institution was affixed to the center of the envelope. The correct postage was metered on the upper right-hand corner of the envelope.

Two census surveys were administered to the population. One survey was conducted with the institution's CAO, e.g., Vice-President of Academic Affairs or Provost (Appendix A) and the other survey investigated computing department Chairs (Appendix B). The cover letters varied according to the likely availability of information relevant to this study at the two organizational levels. This facilitated comparison among the categories of respondents.

The surveys were sent via first class mail from Redlands, CA. Follow-up reminder telephone calls were made and additional copies of the surveys were sent via facsimile to some recipients.

Respondents were able to complete and submit the survey electronically, if they chose. To this end, interactive forms were designed and placed on the World Wide Web. The letter of conveyance gave the address for the page.

Chapter 5

The Chief Academic Officers' Viewpoint

The Chief Academic Officer (CAO) is an important role in an academic institution, and the opinions held by the person in this role are particularly important to this study about the most effective placement for, and organization of, academic studies in computing within the curriculum of American colleges and universities. The CAO may be called a Provost, a Vice President for Academic Affairs, or any of a number of other titles. In spite of this variation in labels, the key feature of the CAO role, importantly related to the purpose of this inquiry, is the responsibility in some measure for oversight over the entire curriculum, although at many universities intra-unit curricular decisions are devolved to the units themselves.

This chapter describes the results of a survey of 136 CAOs. This survey addressed the research question: What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments? The CAO survey particularly addresses the first three of four intermediate questions described in chapters 1 and 4. The first intermediate question is: What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing? The second intermediate question is: Is there a relationship between the deployment of resources at an institution and the placement of the study of computing in an academic organization? The third intermediate question is: What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations?

The First Intermediate Question

Survey questions one through eight provide information for the first intermediate question about attitudes toward the importance of the study of computing. These questions illuminate three domains related to the importance of the study of computing. These are attitudes about the need for the study of computing, attitudes about the available resources for the study of computing, and attitudes about the distribution and placement of the study of computing.

Questions one and two directly examined attitudes about the need for the study of computing, There were 54 valid responses for each question for a response rate of 39.7 percent. The prevailing attitude among CAOs is that there is need for the study of computing at present and in the future, which corresponds with the information presented in Chapter 3. Responses to these questions are shown in Table 5-1. The results show that five-sixths of the CAOs agreed, at some level, that the need for academic units dedicated to computing studies has grown recently, while three of every four CAOs predict that the need will grow in the near future.

Table 5-1. The Need for the Study of Computing

Question / Response	Question 1. The need for academic units dedicated to the study of computing has grown in the last five years. (N = 54)	Question 2. The need for academic units dedicated to the study of computing will grow in the next five years. (N = 54)
Strongly Agree	21 (38.9%)	14 (25.9%)
Agree	16 (29.6%)	15 (27.8%)
Inclined to Agree	8 (14.8%)	11 (20.4%)
Neutral	2 (3.7%)	7 (13.0%)
Inclined to Disagree	5 (9.3%)	4 (7.4%)
Disagree	2 (3.7%)	3 (5.6%)
Strongly Disagree	0 (0%)	0 (0%)

Attitudes about the available resources for the study of computing are collected in questions 3, 5, 6, and 8. Questions 3 and 8 are about the faculty. There were 54 valid responses to Question 3 and 51 valid responses to Question 8. Question 5 and 8 are about money, and Question 6 is about students. There were 54 valid responses to Question 5 and 53 valid responses to Question 6.

Table 5-2 shows the responses to the survey questions about faculty resources. The CAOs largely agree (more than three of four) that the faculty must bring money into the institution. It is clear that the CAOs mean for faculty to bring money directly to the institution, rather than indirectly through the revenue provided by the tuition earned by an attractive program of instruction. However, it is less clear that funds must be procured beyond those funds needed for the research that would be required for tenure. This orientation on the part of CAOs should be considered in connection with the CAOs' response to Question 3. The CAOs do not hold a consistent view about the availability of qualified faculty for the study of computing; in fact they are evenly split on the point. Taken together these questions indicate that computing faculty must engage in fund raising and research at the same level as any member of the faculty.

Table 5-2. The Faculty Resource

Question Response	Question 3. It is difficult to staff academic units dedicated to the study of computing with well qualified faculty. (N = 54)	Question 8. Fund raising, especially securing research grants, is required of the faculty and is an expectation for tenure. (N = 51)
Strongly Agree	1 (1.9%)	21 (41.2%)
Agree	10 (18.5%)	9 (17.6%)
Inclined to Agree	13 (24.1%)	9 (17.6%)
Neutral	6 (11.1%)	3 (5.9%)
Inclined to Disagree	12 (22.2%)	3 (5.9%)
Disagree	12 (22.2%)	3 (5.9%)
Strongly Disagree	0 (0%)	3 (5.9%)

Question 5 concerns the resources provided by the institutions' budget for the study of computing. Before discussing the CAOs' responses to this question, the assumptions that were made in the development and inclusion of this question in this survey are documented. Primarily, Question 5 is related to the issue of the expense of computing programs as compared to other programs at colleges and universities. This comparison may be interesting in other contexts, but it is not examined or needed for the purpose of this research. In fact, the question specifically asks about the adequacy of current budgetary support rather than potential support of computing programs for future purposes.

It is not an intentional assumption in this research that computing programs are more expensive than other programs. In fact, the resources required for institutions to provide the study of computing has changed significantly over the past twenty years. The equipment necessary to provide a viable program of instruction in computing, which required a computer center and a mainframe, was prohibitive prior to the advent of the personal computer. However, personal computers are dramatically less expensive than mainframes, and the price for performance has continually dropped since the development of personal computers. This could mean that computing programs may be roughly similar in cost to most other programs, and may be less expensive than many other science programs, for example, particle physics, which require specialized labs. Further, since Question 8 (Table 5.2) showed that faculty are generally expected to cover the cost of their research, computing programs may not need the same budgetary support that would be required if the faculty were not involved in sponsored research.

The CAOs' response to Question 5 (Table 5.3) shows that half of responding CAOs agree that their institution's budget adequately supports computing; however, a significant group, over 43 percent, do not agree that their institution's budget adequately supports the study of computing. Question 5 was intended to elicit an indication of the relationship between the perceived level of budgetary support and the extent to which a duplication of computing programs exists by simultaneously having computer science, computer engineering, and information systems programs.

Table 5-3. The Money Resource

Question Response	Question 5. This institution's budget adequately supports the study of computing. (N = 54)
Strongly Agree	2 (3.7%)
Agree	17 (31.5%)
Inclined to Agree	8 (14.8%)
Neutral	4 (7.4%)
Inclined to Disagree	11 (20.4%)
Disagree	11 (20.4%)
Strongly Disagree	1 (1.9%)

The relationship between the number of programs and the CAOs' response to Question 5 was cross tabulated (Table 5-4) and a correlation coefficient was calculated (-.111). If one assumes that computer programs are expensive, it is reasonable to further assume that the relationship between the response to Question 5 and the number of computing programs would be positive. That is, the more computing programs there are at an institution, the more demands on budgets, and therefore the more likely that the CAO will disagree with the statement: "This institution's budget adequately supports the study of computing." This was not the case. There was no positive correlation between the number of computing programs at an institution and the response to Question 5 by CAOs. In fact, the most accurate statement about the result is that there is a weak negative correlation between the CAOs' response to Question 5 and the number of programs at their institution.

Table 5-4. Cross Tabulation of Perceived Budget Adequacy and the Number of Computing Programs

Number of programs Response to Question 5	One	Two	Three
Strongly Agree	1		1
Agree	12	3	2
Inclined to Agree	4	3	1
Neutral	1	3	
Inclined to Disagree	5	4	2
Disagree	9	2	
Strongly Disagree	1		

Another key element of computing programs is students. The evidence previously depicted in Figure 3-1 shows that there has been a severe drop in the number of students taking computing degrees since 1986. Chapter 3 contains documentation of some important demands and expectations made on colleges and universities by the society at large, particularly the need in business for college-prepared computing employees. Before examining the CAOs' response to a survey question concerning students, it is important to recall at this point that the appropriate response to this external demand has not been discussed. Even though Chapter 3 documents some very important concerns, it may be useful to underscore that the intended goal of this research is to examine the appropriate organization of academic programs in computing and not the academy's response to external student-generated demand. Thus far the relationship of this external demand to this research is that it aids the demonstration of the significance of this research. In fact, Question 6 was not designed to test the CAOs' knowledge of computing programs. Question 6 was singularly designed as an indicator of the relationship between student demand for programs and the organization of programs. Thus, if the CAOs' responses indicated that students' needs are not being met, it was expected that there would be other indications by CAOs that a reorganization of computing programs was needed.

However, CAOs consistently disagree with the statement: "Not enough students are strongly interested in the study of computing." Table 5-5 shows the CAOs' response to survey Question 6. There were 53 valid responses, and 4 out of 5 CAOs disagreed with the statement at some level.

Table 5-5. The Student Resource

Question / Response	Question 6. Not enough students are strongly interested in the study of computing. (N = 53)
Strongly Agree	0 (0%)
Agree	0 (0%)
Inclined to Agree	1 (1.9%)
Neutral	9 (16.7%)
Inclined to Disagree	16 (29.6%)
Disagree	19 (35.2%)
Strongly Disagree	8 (14.8%)

Attitudes about the distribution of the study of computing are examined in questions 4 and 7. There were 52 valid responses to Question 4 and 53 valid responses to Question 7 which are shown in Table 5-6. There was no consensus among CAOs in response to either question. The adequate distribution of academic units dedicated to the study of computing among colleges and universities was the subject of Question 4. About half of the responses were in agreement with this statement, whereas about 3 out of 10 CAOs disagreed with this statement.

The notion that fields, particularly professional schools, should provide their own courses for the study of computing was the subject of Question 7. Slightly more than 4 out of 10 CAOs agreed with this statement whereas nearly 5 out 10 disagreed with the statement. While these responses indicate that CAOs are generally satisfied with the distribution of computing programs in higher education and are not supportive of a proliferation of computing courses among fields, it is important to note that there is no polarization of opinions. Further, it is not clear what experiences at an institution may help form these opinions. For example, the CAOs' response to Question 5 about money is similar to their response about the proliferation of courses in Question 7. Thus, the only constraint to proliferating courses may be money. But this does not help explain the responses to Question 4 which show a distribution similar to Question 7 and should be unrelated to budgets.

The reasons for this variation are important to the programs of study in computing, particularly as a means of understanding the overall institution and the placement of individual programs inside the institutions. For the purpose of understanding decisions about the placement of the study of computing in colleges and universities, and the particular intermediate question on the importance of computing programs, the lack of consensus among CAOs on these questions helps qualify their opinions as expressed in questions 1 and 2. That is, directly asking about the importance of computing programs, as in questions 1 and 2, can result in respondents reporting what they feel they should report, rather than their actual opinion. Thus, the other questions discussed help color the response to questions 1 and 2.

Table 5-6. The Distribution of the Study of Computing

Question / Response	Question 4. Academic units dedicated to the study of computing are adequately distributed among American colleges and universities thereby giving almost all students the opportunity to study computing. (N = 52)	Question 7. Most fields, and especially professional schools, should provide their own courses for the study of computing. (N = 53)
Strongly Agree	0 (0%)	1 (1.9%)
Agree	11 (21.2%)	8 (15.1%)
Inclined to Agree	15 (28.8%)	14 (26.4%)
Neutral	10 (19.2%)	5 (9.4%)
Inclined to Disagree	9 (17.3%)	9 (17%)
Disagree	6 (11.5%)	12 (22.6%)
Strongly Disagree	1 (1.9%)	4 (7.5%)

Questions 1 through 8 on the survey of CAOs are related to the intermediate question: What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing? These questions have been examined, and it is fair to state that the CAOs view the study of computing as important. However, it is also fair to note that the survey questions related to resources for these programs failed to indicate that CAOs provide special attention to computing programs.

The Second Intermediate Question

The second intermediate question is: Is there a relationship between the availability of resources at an institution and the placement of the study of computing in an academic organization? There are three questions on the CAO survey that provide information about this intermediate question. These are questions 9, 10, and 11.

Question 9 is about the ratio of computers to students in the common or "publicly" available computer labs in the institution. The question concerns resources that are available to all students, but not those resources dedicated only to a particular major. The availability of grants from various extramural sources used for the purpose of creating and maintaining computer labs means that the ratio that Question 9 seeks to determine is not the same thing as the institution's overall commitment to computing. A variation among answers to this question would be revealing, particularly if the variation correlated to the number of programs at the institution. However, this was not the case. The cross tabulation of the CAOs' responses to Question 9 and the number of computing programs at an institution is presented in the three rightmost columns of Table 5-7. The correlation coefficient for this cross tabulation is -.145, which demonstrates no correlation or, more precisely, a weak negative correlation.

Table 5-7. The Ratio of Publicly Available Personal Computers to Students

Question / Response	Question 9. How many personal computer are "publicly" available (for use by any student) in your institution? (N = 50)	Institutions with 1 computing program	Institutions with 2 computing programs	Institutions with 3 computing programs
More than 1 computer per student	1 (2%)	1		
1 computer per student	1 (2%)			1
1 computer for every two students	1 (2%)	1		
1 computer for every five students	12(24%)	5	6	1
1 computer for every ten or more students	35 (70%)	24	8	3

Table 5-7 shows that 70% of CAOs reported that their institution maintains one personal computer for every 10 or more students. This may demonstrate that this ratio is not only normal, but has become common practice. In effect, the lack of variation indicates that the number of computing programs is unrelated to the number of computers in public labs.

Question 10 asked the CAOs how many computing faculty are at their institution. Most of the responding CAOs tried to answer this question. There were 45 responses out of the 54 that responded to the survey. The responding CAOs identified a mean of 31 full-time tenured faculty in computing, with a standard deviation of 33. The standard deviation and the range of responses demonstrate that the question is more difficult to answer than it might, at first examination, appear.

The difficulty is the result of the problem of separating faculty that are involved in disciplines that are closely related to computing from those faculty that are singularly computing faculty. This is due, at least in part, to the fact that computing programs are often in departments that house computing and another discipline. This occurs in each of the three domains of computing that this research is examining. That is, computer science is sometimes housed with other disciplines, for example, mathematics. Information systems is often housed with other disciplines like accounting, and computer engineering is so often housed with electrical engineering that it is sometimes difficult to discern the separation between computer engineering and electrical engineering. Chapter 6 will examine this problem more closely.

In spite of this difficulty the CAOs produced a response, as a group, to Question 10 that is close to the faculty lists available from the departments' Internet sites. Chapter 6 contains a closer examination of the nature of computing departments, and as part of that examination the faculty lists for each of the departments were collected. From this data the normal (mean) number of faculty in a department is 25 with a standard deviation of 20. Thus, the CAOs' response for an institution is very credible. The CAOs' response is correlated with the number of computer departments at their institution. The correlation coefficient between Question 10 and the number of computing programs is .39, with 48 degrees of freedom. A .99 level of confidence requires a .36 correlation coefficient, thus the assumption that more programs means more faculty would appear to be correct.

Question 11 asks about the normal annual teaching load for the faculty. The CAOs report a mean of 4.3 courses per year with a standard deviation of 1.1. The median is 4.0 and the mode is 4.0. This is close to the response by department chairs who report that the institution's normal teaching load is a mean of 4.4 with a standard deviation of 1.8 and a median and mode of 4.0. The number of computing programs does not correlate to workload; the correlation coefficient for this question and the number of computing programs at an institution is -.10.

At this point the answers to the second intermediate question "Is there a relationship between the availability of resources at an institution and the placement of the study of computing in an academic organization?" suggest that there is no relationship between resources and the placement of computing programs. This is particularly true of financial resources. More evidence on this question will be examined in Chapter 6.

The Third Intermediate Question

The third intermediate question is: What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations? The CAOs were surveyed about five elements related to this intermediate question. The first concerns attitudes toward course overlap among academic units. Survey questions 12 - 16 and 24 examine this issue. The second element, examined by questions 17 and 18, concerns attitudes toward the differentiation of academic units. The third element queries CAOs about attitudes toward course similarities. Questions 19 - 22 are about course similarities. Question 23, the fourth element, is about departmentalization generally. Question 25 is about administrative workload, which is the fifth element.

The CAOs' responses to those questions pertaining to course overlap are summarized in Table 5-8. The CAOs were asked to indicate their agreement on a 7-point scale, ranging from strongly agree (1) to strongly disagree (7). A justifiable characterization of the CAOs' response to the queries on course overlap is that the CAOs are generally neutral on the subject, and their responses did not correlate to the number of computing programs at their institutions.

Table 5-8. Course Overlap Responses

Statistic / Question	Mean survey response	Correlation coefficient to number of computing programs
12. There is too much overlap in course content among computing programs at this institution.	4.8	-.012
13. Academic units that overlap in their offerings (i.e. replicate one or several courses) are a significant disadvantage to the institution.	3.7	-.278
14. This institution has policies and procedures that minimize the similarity of course content among courses taught in different academic units.	3.2	-.142
15. There are strong pressures from outside the campus to reduce course duplication among academic units.	3.5	-.161
16. Proliferation of courses among academic units, despite overlap in course content, increases the effectiveness of the faculty in securing grants.	5.4	.034
24. There is generally too much overlap in course content at this institution.	4.9	-.127

The CAOs' responses to course overlap questions are generally responses that would be expected. In questions 12, 14, and 24 the CAOs' response could be influenced by attitudes about prudent behavior or good practice. That is, if the institution has "too much" course overlap, good practice would likely require that this be characterized as a problem, and that a solution to the problem be undertaken. Policies and procedures to minimize overlap are also likely to be considered prudent behavior. Further, reporting too much overlap in course content at the institution would also appear to imply a lack of good practice. The responses to these questions do not correlate to the number of computing programs at an institution.

Questions 15 and 16 provide some insight about influences on decisions about course overlap. While the response to Question 15 is most fairly described as neutral, the response is on the agreement side of neutral. Thus it is fair to note that at some institutions there are external pressures to reduce and eliminate course overlap. However, the response to this question did not correlate to the number of computing programs at an institution. The CAOs tend to disagree with Question 16, and that response does not correlate with the number of computing programs at an institution. This is an indication that CAOs do not appear to believe there is a relationship between the courses taught by faculty and the ability to win grants for research, and once again this response does not correlate to the number of computing programs at the institution. Thus, there appear to be external pressures to avoid course overlap, and the faculty do not appear to demand course overlap to support research.

The most interesting response concerns Question 13. The CAOs are neutral to the statement that describes overlap of course offerings among academic units as a problem for this institution. However, the CAOs' response has a moderate negative correlation to the number of computing programs at an institution. Thus there is a tendency for the CAOs to be more likely to respond that they disagree with the statement if they have multiple computing programs. It is reasonable to conclude that where there are multiple computing programs at an institution, there appears to be either support for the programs at the institution, or the programs are not perceived as overlapping.

The second set of questions related to the third intermediate question inquire about the CAOs' attitudes toward differentiation among computing programs. Differentiation concerns the perceived differences among programs. There were two questions that addressed this topic on the survey of CAOs. The first, Question 17, was about the ability of students to discern the differences among computing programs. The response provided by the CAOs is presented in Table 5-9. The CAOs generally agree with the statement posed in Question 17. The mean response was 3.22. The response to Question 17 does not correlate to the number of computing programs at an institution. The correlation coefficient between the CAOs' response to Question 17 and the number of programs at an institution is -.035.

Table 5-9. Students and Program Differentiation

Question / Response	Question 17. Students can tell the difference between various types of academic units (e.g., Computer Science, Information Systems, Computer Engineering) to make an adequately informed decision about which program best fits their needs. (N = 54)
Strongly Agree	1 (1.9%)
Agree	23 (42.6%)
Inclined to Agree	14 (25.9%)
Neutral	4 (7.4%)
Inclined to Disagree	4 (7.4%)
Disagree	7 (13%)
Strongly Disagree	1 (1.9%)

Question 18 concerns the treatment of computing programs in the real or hypothetical case of a need to reduce academic units at an institution. More than one-third of the CAOs report that computing programs would not be involved in an effort to reduce program units. More than half of the CAOs report that computing programs would be treated the same as any other programs. Four CAOs report that computing programs would be specially treated due to the potential for duplication among computing programs. (This is an interesting result because three out of these four CAOs are at institutions for which only one computing program was identified.) As a group, the CAOs' response to Question 18 did not correlate to the number of computing programs at the institution. The correlation coefficient between the response to Question 18 and the number of computing programs was -.016.

Table 5-10. The Treatment of Computing when Reducing Units

Question / Response	Question 18. If an effort is made to reduce academic units on your campus (or if such an effort currently exists), what is the likely effect of such a program on academic units that teach/research computing (e.g., Computer Science, Information Systems, Computer Engineering)? (N = 51)
None	19 (37.3%)
Academic units that teach/research computing would not receive special attention (they would be reviewed in the same way any academic unit would be reviewed).	28 (54.9%)
Academic units that teach/research computing would receive special attention due to a perceived concern that there may be a duplication of effort among these academic units.	4 (7.8%)

The responses to questions 17 and 18 provide a small insight into the CAOs attitudes about the differences among computing programs. Given these responses it is reasonable to draw the inference that in general, CAOs do not identify a lack of differentiation among computing programs that would cause a problem for students, or require that computing programs be specially treated in a program to reduce academic units.

Course similarity is the topic of the third set of questions related to the third intermediate question. These questions examine the effect of academic freedom on controlling course similarity, the effect of course similarity on students, faculty morale and the reputation of the institution. Questions 19 through 22 contain these queries, and the results are compiled in Table 5-11.

Table 5-11. Course Similarity Responses

Statistic Question	Mean survey response	Correlation coefficient to number of computing programs
19. Similarity of courses among academic units is difficult to control because of academic freedom.	4.5	.063
20. When courses that contain similar content are offered in different academic units, students get confused.	4.3	-.222
21. Existence of similar courses among academic units, in effect, increases faculty morale.	4.9	.099
22. Existence of similar courses among academic units, in effect, enhances this institution's reputation.	5.1	.092

CAOs tend to disagree with the statement that course similarity is difficult to control due to academic freedom, and the responses to Question 19 did not correlate with the number of computing programs at institutions. The responses to questions 21 and 22 indicate that faculty morale and the institution's reputation are not increased or enhanced by course similarity, and the CAOs' responses to these questions did not correlate to the number of computing programs at these institutions. The CAOs were neutral about the potential for student confusion to result from course similarity, and this response had a weak negative correlation to the number of computing programs at an institution. That is, the more computing programs that an institution has, the more likely the CAO will disagree with the idea that students are confused by course similarity.

The fourth area of inquiry related to the third intermediate question solicits the CAOs' attitudes toward the state of departmentalization, generally, at colleges and universities. Question 23 was the tool used to make this inquiry, and the responses are shown in Table 5-12. The mean response for this question is 2.96, and 71.7% of the CAOs agreed or were inclined to agree with this statement that colleges and universities are generally over-departmentalized.

Table 5-12. Over-departmentalized

Question / Response	Question 23. Colleges and universities are generally over-departmentalized/over-compartmentalized. (N = 53)
Strongly Agree	7 (13.2%)
Agree	17 (32.1%)
Inclined to Agree	14 (26.4%)
Neutral	8 (15.1%)
Inclined to Disagree	1 (1.9%)
Disagree	5 (9.4%)
Strongly Disagree	1 (1.9%)

The CAOs are largely in agreement with the statement that colleges and universities are over-departmentalized presented in Question 23, and this is unrelated to the number of computing programs at an institution. There was no correlation between the responses and the number of computing programs, and the correlation coefficient is .00035. However, this response is curious. That is, in questions 19 through 22 the CAOs tend to agree that similarity among courses is not good, and in questions 13 and 16 the CAOs tend to indicate that course overlap is not good. Questions 12 and 24 indicate that CAOs do not feel that their institution has problems with course overlap, and in questions 14 and 15 the CAOs report that their institutions have practices that mitigate against course overlap. Further, this group of CAOs are from many of the larger institutions in the nation. Thus, the academic leaders at many of the institutions where one would expect to find overlap and similarity among courses are reporting that their institutions are largely free of these problems, but they are also reporting that colleges and universities are generally effected by these problems.

The fifth and final element related to the third intermediate question pertains to administrative workload. This is examined in Question 25, and the mean response for Question 25 is 4.1, and the correlation coefficient is -.199. The CAOs are neutral about the relationship of course proliferation to administrative workload, and this response has a weak negative correlation to the number of computing programs at an institution. That is, CAOs at institutions that have more than one computing program are more likely to disagree with the notion that more course proliferation leads to greater administrative workload.

Once again this is an interesting response. It seems reasonable that the more courses there are at an institution the more work is involved for the CAO.

However, CAOs provide a mean response that is neutral. If the responses inclined to agree, neutral, and inclined to disagree are grouped together, 69.8% of the responses are in this central or neutral group. In a sense, it is fair to draw from their responses a sense that the CAOs are relatively unaffected by the number of courses at an institution and perhaps by the number of programs at an institution, as well.

Table 5-13. Administrative Workload

Question / Response	Question 25. Proliferation of courses among academic units significantly increases administrative workload. (N = 53)
Strongly Agree	1 (1.9%)
Agree	5 (9.4%)
Inclined to Agree	13 (24.5%)
Neutral	14 (26.4%)
Inclined to Disagree	10 (18.9%)
Disagree	8 (15.1%)
Strongly Disagree	2 (3.8%)

The five elements of the third intermediate question provided these insights. CAOs were generally neutral concerning the effects of course overlap; however, they appear to view course overlap as a negative thing generally that they perceived, however, to be under control at their institutions. The CAOs did not view students as having difficulties differentiating among computing programs, and they would not treat computing programs differently from other programs if an effort were made to reduce duplication. The CAOs tended to view course similarities as undesirable but, again, as not affecting their own institutions. The CAOs viewed colleges, and universities as generally over-departmentalized, but were neutral to the notion that a proliferation of courses would increase their workload.

The third intermediate question was, "What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations?" It is reasonable to characterize the CAOs' responses as unsupportive of over-departmentalization, course overlap, and course similarity. However, it is also reasonable to characterize the CAOs' responses as demonstrating an unwillingness to characterize their institutions as affected by such problems. Thus, it is fair to state that the CAOs generally do not seem to regard Computer Science, Computer Engineering, and Information Systems to be either similar or overlapping programs. It is also reasonable to state that the CAOs generally regard the status quo concerning course or program overlap in their own institutions to be relatively problem free.

Summary

The survey of CAOs examined the first three intermediate questions related to the research question. The first of these intermediate questions is: What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing? The CAOs indicate that there is a present and future need for the study of computing; however, their responses do not indicate that computing requires special or separate attention apart from other programs. The second intermediate question is: Is there a relationship between the availability of resources at an institution and the placement of the study of computing in an academic organization? The CAOs' responses to the questions in this area were examined in light of the number of computing programs at institutions. The result indicates no relationship between resources and the placement of the study of computing in an academic organization. The third intermediate question is: What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations? While the CAOs generally see colleges and universities as over-departmentalized, they did not indicate that this was the case at their own institutions. The CAOs do not indicate that they have noticed a lack of differentiation among computing programs, and they appear confident that there are institutional means that insure against the problems of course overlap, and course similarity at their institutions.

Conclusion

These three intermediate questions, which the CAO survey examines, provide the CAOs perspective on the research question: What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments? The CAOs are generally satisfied with the status quo at their institutions, and this attitude does not appear to correlate to the number of computing programs at an institution. As a result the CAOs do not, as a group, provide a clear indication of an appropriate or preferred method for organizing the study of computing in academic institutions.

Chapter 6

The Departments Chairs' Viewpoint With Comparison to the Chief Academic Officers

The Department Chairs' role in the academic organization, and the perspective this role implies, is important to this study about the most effective placement for the study of computing in academic organizations. The Department Chairs represent the curriculum and the faculty of their departments beyond the departmental setting. The Department Chairs are, among other things, responsible for a specific part of the curriculum at an institution. This part of the curriculum is usually large enough to warrant a major for undergraduates, but not so large that the work of other departments would be duplicated. There can be variations in the application of the concept. For example, some academics hold that there be a distinguishable curriculum and research paradigm with more-or-less circumscribed boundaries as a precondition for the existence of a department. But other types of departments exist, too, organized around a topic area that cuts across disciplinary boundaries, and to which scholars interested in a topic from a variety of fields would be welcome. Physics or Economics are often-used examples of the former, and Canadian Studies or East Asian Studies would be typical examples of the latter.

This chapter describes the results of a survey of 198 Department Chairs. (The method for identifying them was discussed in Chapter 4.) This survey addressed the research question: What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments? The Department Chair survey addresses the four intermediate questions described in Chapters 1 and 4. This chapter will proceed through an analysis of each of the intermediate questions, summarize the results, and conclude with the implications of these responses to the research question.

The First Intermediate Question

Survey questions 14 through 20 and 26 provide information for the first intermediate question: What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing? These questions encompass three domains related to the importance of the study of computing. These are attitudes about the need for the study of computing, attitudes about the available resources for the study of computing, and attitudes about the distribution and placement of the study of computing.

Questions 14 and 15 directly examined attitudes about the need for the study of computing. There were 61 (30.8%) responses to the survey of Department Chairs of which 55 were valid responses. The Chairs' attitude is seen in their very strong agreement with the statements in questions 14 and 15 that the study of computing is needed both now and in the future. Responses to these questions are presented in Table 6-1. The results show that 87.2% of the Chairs agreed, at some level, that the need for computing programs has grown in the last five years, and 90.9% of the chairs agreed, at some level, that the need for computing programs will grow in the next five years.

Table 6-1. The Need for the Study of Computing

Question / Response	Question 14. The need for academic units dedicated to the study of computing has grown in the last five years. (N = 55)	Question 15. The need for academic units dedicated to the study of computing will grow in the next five years. (N = 55)
Strongly Agree	28(50.9%)	25(45.5%)
Agree	12(21.8%)	13(23.6%)
Inclined to Agree	8(14.5%)	12(21.8%)
Neutral	5(9.1%)	3(5.5%)
Inclined to Disagree	0(0%)	1(1.8%)
Disagree	1(1.8%)	0(0%)
Strongly Disagree	1(1.8%)	1(1.8%)

Attitudes about the available resources for the study of computing are collected in questions 16, 18, 19 and 26. Questions 16 and 26 are about the faculty. Questions 18 and 26 are about money, and Question 19 is about students. There were 55 valid responses to each of these questions.

Table 6-2 shows the responses to the survey questions about faculty resources. The Chairs generally agree (Question 16) that it is difficult to staff computing departments with qualified faculty, even though the Department Chairs that were surveyed are involved with departments that are likely to be considered desirable by job seekers. These Departments are likely to be desirable to job seekers because they include both undergraduate and graduate education, further, the survey was limited to institutions classified as Research and Doctoral by the Carnegie Foundation for the Advancement of Teaching. Faculty that have obtained a Doctorate in computing often will have come from one of the surveyed programs and presumably are likely to desire jobs in environments that are like those with which they are familiar.

The Department Chairs also agreed (Question 26) that securing research grants is an expectation for tenure. This response does not relate with the response to Question 16 in the way that one might initially assume. That is, if there are difficulties obtaining qualified faculty, why place stumbling blocks in the tenure process? It is likely that the response to Question 26 is a function of the sample of institutions included in this research - - that is, research-oriented institutions - - rather than an attitude that particularly affects the organization of academic institutions. This is an interesting response because the common perception is that these institutions require faculty to "publish or perish," but it appears that they may actually require a prior condition, namely, that faculty "procure (funds) or perish."

Table 6-2. The Faculty Resource

Question / Response	Question 16. It is difficult to staff academic units dedicated to the study of computing with well qualified faculty. (N = 55)	Question 26. Fund raising, especially securing research grants, is required of the faculty and is an expectation for tenure. (N = 55)
Strongly Agree	9 (16.4%)	23 (41.8%)
Agree	12 (21.8%)	16 (29.1%)
Inclined to Agree	14 (25.5%)	5 (9.1%)
Neutral	6 (10.9%)	3 (5.5%)
Inclined to Disagree	4 (7.3%)	4 (7.3%)
Disagree	7 (12.7%)	1 (1.8%)
Strongly Disagree	3 (5.5%)	3 (5.5%)

Question 18 concerns the adequacy of resources provided by the institutions' budget for the study of computing, and the Department Chairs' responses are shown in Table 6.3. The mean response is 5.0 on a 7 point scale. More than half of the Department Chairs (50.9%) disagree or strongly disagree that their institution's budget adequately supports the study of computing. While some

Department Chairs agreed that their institution's budget adequately supports the study of computing, there was no strong agreement, and of the 27.3% of Department Chairs who did agree with the statement, most were only "inclined to agree" (20.0%).

In Chapter 5 the CAOs' response to the question equivalent to Question 18 (Question 5, regarding budget adequacy) was discussed in relation to the CAOs' response to the question equivalent to Question 16 (Question 8, regarding the importance of securing research funds for tenure). In that discussion it was noted that it is likely that faculty at many institutions are expected to cover the cost of their own research. The responses given by the Department Chairs provide more information for that analysis. The information provided by the Department Chairs may be indicating, at least in the case of computing, that faculty are expected to

Table 6-3. The Money Resource

Question / Response	Question 18. This institution's budget adequately supports the study of computing. (N = 55)
Strongly Agree	0 (0%)
Agree	4 (7.3%)
Inclined to Agree	11 (20%)
Neutral	4 (7.3%)
Inclined to Disagree	8 (14.5%)
Disagree	16 (29.1%)
Strongly Disagree	12 (21.8%)

provide some of the money required to operate a computing department. Thus, while it is an interesting notion that faculty might be required to "procure or perish," the potentially adverse effects, that is, the impact on a given faculty member's career, may extend to other consequences. Thus, the faculty members' failure to obtain research funds is likely to adversely impact instructional laboratories and work-study opportunities for students. While the responses to the questions in this survey provide no direct evidence that this is the case, a cursory scan of the NSF grants provided for computing research shows that the previously mentioned results (labs used for instruction and funding for student work-study) are in fact among the activities that benefit from many NSF grants.

As mentioned in Chapter 5, the intended purpose of Question 18 is to elicit an indication of the relationship between the perceived level of budgetary support and the extent to which a duplication of computing programs exists by simultaneously having computer science, computer engineering, and information systems programs. The test of this relationship uses a cross tabulation of the two responses (Table 6-4) and calculation of a correlation coefficient, as in Chapter 5. The correlation coefficient is -.077, which indicates that there is no positive correlation between the number of computing programs at an institution and the attitudes of the Department Chairs toward the budget provided by the institution.

Another important element in academic programs is students. This is also true for computing programs. In Chapter 3 two important aspects of this resource were documented. It was demonstrated that there has been a decline in students earning an undergraduate computing degree since 1986, and there is a large current and future demand for these graduates. Question 19 on the survey of Department Chairs is related to this issue. It states, "Not enough students are strongly interested in the study of computing." The intent of this question is to provide an indicator of the relationship between student demand for programs and the organization of programs.

Table 6-4. Cross Tabulation of Perceived Budget Adequacy and the Number of Computing Programs

Number of programs Response to Question 18	One	Two	Three
Strongly Agree			
Agree		3	1
Inclined to Agree	6	3	2
Neutral	2	2	
Inclined to Disagree	4	3	1
Disagree	4	10	2
Strongly Disagree	5	7	

The idea behind the question is that if there is an indication that there are not enough students interested in computing, there would be corresponding evidence of a need to justify the existence of multiple computing programs, budget problems, and indications of cuts or consolidation of programs. That is, there should be indications of adjustment to student demand. The Department Chairs did not agree with the statement in Question 19, as shown in Table 6-5. The mean response from the Department Chairs' was 4.9 (on a 7 point scale), indicating an inclination to disagree with the statement in Question 19 that there is insufficient interest among students.

Table 6-5. The Student Resource

Question / Response	Question 19. Not enough students are strongly interested in the study of computing. (N = 55)
Strongly Agree	2 (3.6%)
Agree	4 (7.3%)
Inclined to Agree	7 (12.7%)
Neutral	2 (3.6%)
Inclined to Disagree	17 (30.9%)
Disagree	14 (25.5%)
Strongly Disagree	6 (16.4%)

Attitudes about the distribution of the study of computing are examined in questions 17 and 20. There were 54 valid responses to each question. The adequate distribution of academic units dedicated to the study of computing among colleges and universities was the subject of Question 17. Half of the responses were agreement with this statement, however nearly three out of ten Department Chairs disagreed with this statement. The notion that a given field, particularly professional schools, should provide their own courses for the study of computing was the subject of Question 20. More than two out of ten Department Chairs agreed with this statement whereas nearly six out of ten disagreed with the statement. The response to Question 20 shows that the Departments do not favor a proliferation of computing programs, and a reasonable implication from this response is that Department Chairs do not support having multiple computing departments at an institution. These responses indicate that Department Chairs are generally satisfied with the distribution of computing programs in higher education and are not supportive of a proliferation of computing courses among fields.

Table 6-6. The Distribution of the Study of Computing

Question / Response	Question 17. Academic units dedicated to the study of computing are adequately distributed among American colleges and universities thereby giving almost all students the opportunity to study computing. (N = 54)	Question 20. Most fields, and especially professional schools, should provide their own courses for the study of computing. (N = 54)
Strongly Agree	8 (14.8%)	2 (3.7%)
Agree	9 (16.7%)	3 (5.6%)
Inclined to Agree	10 (18.5%)	7 (13%)
Neutral	11 (20.4%)	10 (18.5%)
Inclined to Disagree	10 (18.5%)	9 (16.7%)
Disagree	6 (11.1%)	13 (24.1%)
Strongly Disagree	0 (0%)	10 (18.5%)

The Department Chairs and CAOs were largely in agreement with each other in their responses to these questions. Table 6-7 is a summary of the responses to these questions. It was constructed by aggregating the responses that indicated agreement (inclined to agree, agree, or strongly agree) or, in two instances, those in disagreement (inclined to disagree, disagree, or strongly disagree) into a single

Table 6-7. A Comparison of the Department Chairs' and CAOs' Responses to the First Intermediate Question

Topic	Question	Department Chairs' Response	CAOs' Response
Need for Study of Computing	Question 14. The need for academic units dedicated to the study of computing has grown in the last five years.	88.2% Agree	83.2% Agree (Question 1)
Need for Study of Computing	Question 15. The need for academic units dedicated to the study of computing will grow in the next five years.	90.9% Agree	74.1% Agree (Question 2)
Available Resources	Question 16. It is difficult to staff academic units dedicated to the study of computing with well qualified faculty.	63.7% Agree	44.5% Agree (Question 3)
Available Resources	Question 26. Fund raising, especially securing research grants, is required of the faculty and is an expectation for tenure.	80.0% Agree	76.4% Agree (Question 8)
Available Resources	Question 18. This institution's budget adequately supports the study of computing.	65.4% Agree	42.7% Agree (Question 5)
Available Resources	Question 19. Not enough students are strongly interested in the study of computing.	62.8% Disagree	79.6% Disagree (Question 6)
Distribution and Placement of the Study of Computing	Question 17. Academic units dedicated to the study of computing are adequately distributed among American colleges and universities thereby giving almost all students the opportunity to study computing.	50.0% Agree	50.0% Agree (Question 4)
Distribution and Placement of the Study of computing	Question 20. Most fields, and especially professional schools, should provide their own courses for the study of computing.	59.3% Disagree	47.1% Disagree (Question 7)

percentage. Table 6-7 shows that larger of the two percentages reported by Department Chairs.

The Department Chairs and CAOs are in agreement about Question 17, with exactly one half of each group agreeing with the statement. This agreement is helpful for providing two points of view reporting the same result. Thus, the current distribution of computing programs is likely to be providing students with adequate opportunity, at least as perceived by the administrators with oversight responsibilities.

They are also in agreement about questions 14,15, 20 and 26, but the Department Chairs have larger percentages. The disparity in the percentages may be the result of how information is moving in these organizations. For example, it was noted in the Origin of Academic Departments section of Chapter 2 that colleges and universities are responsive to external pressures on the institution. One example provided in Chapter 2 was the origin of the academic department. Thus, it is reasonable to presume that the members of the college or university community that interface with these pressures are clear about the message provided by those exerting the pressures, and those members of the institution that have less reason to interact with these pressures are less likely to be in agreement about the message.

The external pressures indicated in questions 14, 15, 20, and 26 vary. In questions 14 , 15 and 20 the external pressures are the labor market for graduates, the external needs for research in computing, and the growth of knowledge about computing. In Question 26 the external pressure is the availability of external funds. If there were no funds, presumably there would be no requirement for faculty to obtain funds. Further, the presence of these funds, and the internal pressure to retrieve these funds gives the funding source at least an influence, if not outright power, over research agendas.

Applying the idea presented in the paragraph before last, those who interface with computing programs are most likely to be familiar with computing programs, and those who have no interface with computer programs would be least informed. Thus, the Chair of a computing department may know more than the Dean, who in turn may know more than the CAO, etc. This appears to be the case with questions 14, 15, 20 and 26, that is, the Chairs have a greater consensus on these matters than the CAOs possibly because they are more familiar with them.

The CAOs and the Department Chairs disagreed with the statement in Question 19, but the CAOs were more likely to disagree. Using the argument stated in the prior paragraph, it can be stated that the CAOs, who are more likely to interact with issues relating to planning, particularly the institution's capacity to meet student demands, are presumably more accurate in their report on this point.

The Department Chairs and the CAOs were not in agreement on questions 16 and 18. The Department Chairs expressed agreement with both questions. The CAOs disagreed with Question 16, and the responses to Question 18 were distributed across the scale. These questions concerned the difficulty of staffing computing departments and the adequacy of the institution's budgetary support for computing programs. In both cases nearly two-thirds of the Department Chairs agreed that it is difficult to staff computing departments, and that the institution's budget adequately supports computing programs. The CAOs are not in concert with the Department Chairs on these questions, but it would be inaccurate to represent the CAOs' responses as directly in opposition to the Department Chairs' responses. The CAOs' responses to these questions spread across the range; however, the plurality of CAOs agreed that it is difficult to staff computing programs (Question 16), and disagreed that the institution's budget adequately supports the study of computing (Question 18).

These results are better understood by applying the reasoning process used for question 14, 15, 20 and 26 above. In the case of Question 16, about the difficulty in staffing computing programs, the Department Chairs are closer to the phenomenon and presumably know more about it, thus the greater consensus in Department Chairs' responses. In the case of Question 18, about the adequacy of the institution's budgetary support for the study of computing, the CAOs are closer to the phenomenon (the institution's budget) than the Department Chairs, and presumably know more about it. However, this does not explain the greater consensus in the Department Chairs' responses as compared to the CAOs', or the plurality of CAOs that disagreed with the statement presented in Question 18, which are counterintuitive results. Essentially, one would expect Department Chairs to criticize institutional budgets and CAOs to defend institutional budgets. A reasonable explanation is that the Department Chairs may perceive their budgets as adequate, due in part to the contributions of research grants. The CAOs may perceive the institution-wide support required for all computing programs as inadequate due to the broader scope of their view, that is, all computing programs.

Questions 14 through 20 and Question 26 on the survey of Department Chairs are related to the intermediate question: What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing? It is fair to state - - and hardly unexpected - - that the Department Chairs view the study of computing as important, and that their attitude largely corresponds to the CAOs' views. Further, there is no evidence that the attitude toward the importance of computing, while largely positive, increases the likelihood that there will be more than one computing program at an institution. There is some slight evidence that the positive attitude toward the need for computing programs does not transfer to the practice of providing greater resources for these programs.

A potentially helpful implication concerns the perspectives of the two organizational roles which appear to be shaped by the relative closeness of the organization role to the phenomenon under discussion, at least as evidenced by the degree of consensus of the respondents closest to the phenomenon, that is, the Department Chairs. Thus, there are resource issues that may require those interested in managing the resource to pay close attention to the ways attitudes are shaped in an academic organization. An example is provided by attitudes toward the difficulty of staffing computing programs. The Department Chairs are reporting that it is difficult to staff these programs, which corresponds to the general shortage of computing workers discussed in Chapter 3. The CAOs, who are likely to play an important role in staff planning, are less intense in their response on this point, thus providing the insight that on some occasions computing Department Chairs, and possibly faculty, may need to attentively work on providing decision makers with information about the marketplace for staff in their program.

The Second Intermediate Question

The second intermediate question is: Is there a relationship between the availability of resources at an institution and the placement of the study of computing in an academic organization? There are three questions on the Department Chairs' survey that provide insight about this intermediate question. These are questions 3, 4, and 11.

Question 3 is about the ratio of computers to students studying computing in an academic unit. This question has a different focus from the related question that was asked of CAOs. The CAOs were asked about resources that are available to all students, whereas the Department Chairs were asked about resources available to students in their program. The question was intended to determine if there was a

Table 6-8. The Ratio of Publicly Available Personal Computers to Students

Question Response	Question 3. How many personal computers are "publicly" available (for use by any student) in your academic unit? (N = 55)	Institutions with 1 computing program	Institutions with 2 computing programs	Institutions with 3 computing programs
More than 1 computer per student	3 (5.5%)	2		1
1 computer per student	2 (3.6%)	1	1	
1 computer for every two students	7 (12.7%)	2	4	1
1 computer for every five students	29(52.7%)	11	15	3
1 computer for every ten or more students	14 (25.5%)	4	9	1

variation among the available computing resources based on the number of computing programs at an institution. There was no variation. The cross tabulation of the Department Chairs' responses to Question 3 and the number of computing programs at an institution is presented in the three rightmost columns of Table 6-8. The correlation coefficient for this cross tabulation is .041, which indicates no correlation. Table 6-8 shows that most Department Chairs (52.7%) reported that their program maintains one personal computer for every five students.

Question 4 asked the Department Chairs how many full-time faculty are in their academic unit. There were 56 responses out of the 61 that responded to the survey. The Department Chairs' responses indicated a mean of 15 full-time tenured faculty in their academic unit, with a standard deviation of 11. The Department Chairs identified a mean of 23 full-time (with or without tenure) faculty. Faculty lists for each of the surveyed departments were collected from the World Wide Web as part of the data collection effort related to the fourth intermediate question discussed below. From this data the mean number of full-time faculty in a department appeared to 25 with a standard deviation of 20. Thus, the two sources of data yielded similar results.

The Department Chairs' response is correlated with the number of computing departments at their institution. The correlation coefficient between Question 4 and the number of computing programs is .253. This is a weak positive correlation between the number of programs at an institution and the number of faculty in a department. Thus, the more programs present at an institution, the larger the number of full-time faculty in each department.

Question 11 asks about the normal annual teaching load for faculty at an institution. The Department Chairs report a mean of 4.4 courses per year with a standard deviation of 1.9. The median is 4.0 and the mode is 4.0. The number of computing programs does not correlate to workload; the correlation coefficient for this question and the number of computing programs at an institution is .011.

The CAOs and the Department Chairs were asked the same questions; however, two of the questions differed in scope. The CAOs were asked about the amount of publicly available computers at their institution (Question 9), and the Department Chairs were asked about the amount of computers available to students in their programs (Question 3). The CAOs generally said there are 10 students per computer, and the Department Chairs generally said there are five or fewer students per computer. There are implications from this difference that are interesting, for example, what is the appropriate number of students per computer? These implications will be discussed in Chapter 7; however, there is one point that should be noted here. While this disparity (the number of students per computer) is not direct proof, it provides another indication that the "research" money raised by faculty appears to have the impact of providing for the operation of computing departments as suggested in the discussion of Question 26 which asks about fund raising as an expectation for tenure.

In Question 4 the Department Chairs were asked about the number of faculty in their academic unit, and the CAOs were asked about the number of computing faculty at their institution. There were comparable responses from both surveys, especially considering that the CAOs are likely to be reporting on the number of faculty across multiple departments. The interesting results were that the CAOs responses weakly correlated to the number of computing programs at an institution, thus the more programs, the more total computing faculty at the institution. However, the Department Chairs' responses also weakly correlated to the number of computing programs at an institution, indicating the more programs, the larger the number of faculty in a given program. That is, one would normally expect to find a larger total number of computing faculty in the cases where there are multiple programs, as reported by the CAOs. But, one might not expect to find that there are larger departments (more faculty) when there are multiple programs.

Question 11 on the Department Chairs' survey was also Question 11 on the survey of CAOs. Both sets of respondents report the normal annual teaching load in the institution as four courses per year. This response did not correlate to the number of computing programs at an institution for either the CAOs or the Department Chairs.

The indications for the second intermediate question, "Is there a relationship between the availability of resources at an institution and the placement of the study of computing in an academic organization?" are that there is evidence of a relationship between resources and the placement of computing programs, except by implications. The data show that the more computing programs there are at an institution, the more computing faculty at the institution. The data also show the more computing programs at an institution, the larger the computing department faculties at that institution. The implication from this is that where there are more computing programs, more resources are devoted to these programs.

Since this could be a reflection of the size of the enrollments at these institutions, the number of computing programs at these institutions was correlated to the size of the undergraduate student population. The undergraduate student populations varied from 900 to 44,000 students in 1993. Normally, there were between 10,000 to 12,500 students at an institution, with the exact mean at 12,117 students. The student populations were categorized by size in units of

2500. This was correlated to the number of computing programs at these institutions. The correlation coefficient was .286 with 24 degrees of freedom. A correlation coefficient of .389 is required for a .95 level of confidence and .496 is required for a .99 level of confidence. Thus, the size of student enrollment cannot be considered the explanation for these phenomena.

The Third Intermediate Question

The third intermediate question is: What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations? The Department Chairs were surveyed about five elements related to this intermediate question. The first one concerns attitudes toward course overlap among academic units. Survey questions 21, 22, 27, and 36 examine this issue. The second element, examined by Question 28, concerns attitudes toward the differentiation of academic units. The third element queries Department Chairs about attitudes toward course similarities. Questions 31 to 34 are about course similarities. Question 35, the fourth element, is about departmentalization generally. Question 37 is about administrative workload, which is the fifth element.

The Department Chairs' responses to those questions pertaining to course overlap are summarized in Table 6-9. The Department Chairs were asked to indicate their agreement on a 7-point scale, ranging from strongly agree (1) to strongly disagree (7). A justifiable characterization of the Department Chairs' response to the queries on course overlap is that they are generally unfavorable toward course overlap, and course overlap is not affecting their institutions. The Department Chairs' responses did not correlate to the number of computing programs at their institution.

Table 6-9. Course Overlap Responses

Statistic / Question	Mean survey response	Correlation coefficient to number of computing programs
21. There is too much overlap in course content among computing programs at this institution.	5.3	-.004
22. Academic units that overlap in their offerings (i.e. replicate one or several courses) are a significant disadvantage to the institution.	3.6	.205
27. Proliferation of courses among academic units, despite overlap in course content, increases the effectiveness of the faculty in securing grants.	5.3	-.052
36. There is generally too much overlap in course content at this institution.	4.8	-.024

The Department Chairs' responses that course overlap is undesirable are generally responses that would be expected. However, the response to Question 22 has an interesting implication. The Department Chairs agree with the statement, but this agreement is only slightly higher than neutral. However, there is a weak positive correlation to the number of computing programs at an institution. That is, in the cases where there are multiple computing programs the Department Chairs are more likely to agree with the statement that overlap is a disadvantage to the institution. This is an indication that Department Chairs do not see multiple computing programs as overlapping, or that there are rivalries among programs as was discussed in Chapter 1.

The second element related to the third intermediate question inquires about the Department Chairs' attitudes toward differentiation among computing programs. Differentiation concerns the perceived differences among programs. There was one question that addressed this topic on the survey of Department Chairs. This was Question 28, about the ability of students to discern the differences among computing programs. The response provided by the Department Chairs is presented in Table 6-10. The Department Chairs are divided on the statement posed in Question 28. The mean response was 3.8 (on a 7-point scale with 1 strongly agree, and 7 strongly disagree), with 47.3% agreeing at some level, and 38.1% disagreeing at some level. The response does not correlate to the number of computing programs. The correlation coefficient between the Department Chairs' response to Question 28 and the number of computing programs at an institution is .059. From this response, there is more

Table 6-10. Students and Program Differentiation

Question / Response	Question 28. Students can tell the difference between various types of academic units (e.g., Computer Science, Information Systems, Computer Engineering) to make an adequately informed decision about which program best fits their needs. (N = 55)
Strongly Agree	2 (3.6%)
Agree	10 (18.2%)
Inclined to Agree	14 (25.5%)
Neutral	8 (14.5%)
Inclined to Disagree	13 (23.6%)
Disagree	8 (14.5%)
Strongly Disagree	0 (0%)

evidence, though weak, that Department Chairs do not identify as a problem student inability to differentiate among computing programs.

Course similarity is the topic of the third set of questions related to the third intermediate question. These questions examine the effect of academic freedom on controlling course similarity, the effect of course similarity on students, faculty morale, and the reputation of the institution. Questions 31 through 34 contain these queries, and the results are compiled in Table 6-11.

The Department Chairs had mixed opinions regarding the statement that course similarity is difficult to control due to faculty members' academic freedom; in fact 26% of the Department Chairs were "neutral," 37% agreed, and 37% disagreed. The correlation with the number of programs, while positive, is so low that there is no meaningful correlation between the number of programs at an institution and the Department Chairs' response to Question 31. The responses to questions 33 and 34 indicate that the faculty's morale and the institution's reputation are not affected by the existence of similar courses. Nor did the Department Chairs' responses to these questions correlate significantly with the number of computing programs at these institutions. However, the Department Chairs tend to agree about the potential for student confusion to result from course similarity, with 46% of the Department Chairs responding that they "agree" or are "inclined to agree" with the statement (Question 32). Fewer Chairs were "neutral" (28%) or disagreed (26%). There is also a weak positive correlation between the number of computing programs at an institution and the Department Chairs' response to Question 32. This indicates that the larger the number of computing

Table 6-11. Course Similarity Responses

Statistic / Question	Mean survey response	Correlation coefficient to number of computing programs
31. Similarity of courses among academic units is difficult to control because of academic freedom.	4.2	.102
32. When courses that contain similar content are offered in different academic units, students get confused.	3.7	.288
33. Existence of similar courses among academic units, in effect, increases faculty morale.	4.8	-.070
34. Existence of similar courses among academic units, in effect, enhances this institution's reputation.	5.1	.005

programs at an institution, the more likely that Department Chairs will agree that students get confused when there are courses with similar content (Question 32).

The fourth area of inquiry related to the third intermediate question solicits the Department Chairs' attitudes toward the degree of departmentalization, generally, at colleges and universities. Question 35 was the tool used to make this inquiry, and the responses are shown in Table 6-12. The mean response for this question is 3.7, and 47.2% of the Department Chairs agreed or were inclined to agree with the statement that colleges and universities are generally over-departmentalized.

The Department Chairs' mean response is properly represented as neutral regarding the statement presented in Question 35; however, nearly half of the Department Chairs agree with the statement though their degree of agreement varies. There was a weak negative correlation (correlation coefficient = -.143)

Table 6-12. Over-departmentalized

Question Response	Question 35. Colleges and universities are generally over-departmentalized/over-compartmentalized. (N = 53)
Strongly Agree	3 (5.7%)
Agree	8 (15.1%)
Inclined to Agree	14 (26.4%)
Neutral	13 (24.5%)
Inclined to Disagree	5 (9.4%)
Disagree	10 (18.9%)
Strongly Disagree	0 (0%)

between the responses and the number of computing programs. This is an indication that the more computing programs exist at an institution, the less likely computing Department Chairs are likely to agree with the notion that colleges and universities are generally over-departmentalized.

The fifth and final element related to the third intermediate question pertains to administrative workload. This is examined in Question 37. The mean response for Question 37 is 3.9, and the correlation coefficient with the number of computing programs at an institution is .247. The Department Chairs are properly classified as mixed in their opinions about the relationship of course proliferation to administrative workload; however, 41.2% of the Department Chairs agree with the statement to some degree. In addition there is a positive correlation between the

Table 6-13. Administrative Workload

Question / Response	Question 37. Proliferation of courses among academic units significantly increases administrative workload. (N = 51)
Strongly Agree	2 (3.9%)
Agree	5 (9.8%)
Inclined to Agree	14 (27.5%)
Neutral	15 (29.4%)
Inclined to Disagree	5 (9.8%)
Disagree	8 (15.7%)
Strongly Disagree	2 (3.9%)

number of computing programs at an institution and the Department Chairs' responses to this question. While this correlation is not so large as to demonstrate the viability of this correlation at a .95 confidence level, it is large enough that the relationship should be noted. The indication is, therefore, that the more computing programs exist at an institution, the more likely Department Chairs are to agree that the proliferation of programs increases administrative workload. The Department Chairs' responses are reported in Table 6-13.

The responses from the Department Chairs and the CAOs for the third intermediate question are summarized in Table 6-14. It was constructed by aggregating the responses that indicated agreement (inclined to agree, agree, or strongly agree) or, those in disagreement (inclined to disagree, disagree, or strongly

Table 6-14. A Comparison of the Department Chairs' and CAOs' Responses to the Third Intermediate Question

Topic	Question	Department Chairs' Response	CAOs' Response
Course Overlap	Question 21. There is too much overlap in course content among computing programs at this institution.	**76.3%** Disagree	**58.6%** Disagree (Question 12)
Course Overlap	Question 22. Academic units that overlap in their offerings (i.e. replicate one or several courses) are a significant disadvantage to the institution.	**52.8%** Agree	**52.8%** Agree (Question 13)
Course Overlap	Question 27. Proliferation of courses among academic units, despite overlap in course content, increases the effectiveness of the faculty in securing grants.	**65.5%** Disagree	**69.2%** Disagree (Question 16)

Topic	Question	Department Chairs' Response	CAOs' Response
Course Overlap	Question 36. There is generally too much overlap in course content at this institution.	**62.7%** Disagree	**64.1%** Disagree (Question 24)
Differentiation of Academic Units	Question 28. Students can tell the difference between various types of academic units (e.g., Computer Science, Information Systems, Computer Engineering) to make an adequately informed decision about which program best fits their needs.	**47.3%** Agree	**70.4%** Agree, (Question 17)
Course Similarity	Question 31. Similarity of courses among academic units is difficult to control because of academic freedom.	**37.1%** Agree, **37.1%** Disagree	**31.4%** Agree, **54.9%** Disagree (Question 19)
Course Similarity	Question 32. When courses that contain similar content are offered in different academic units, students get confused.	**46.3%** Agree	**28.3%** Agree, **47.2%** Disagree (Question 20)
Course Similarity	Question 33. Existence of similar courses among academic units, in effect, increases faculty morale.	**57.7%** Disagree	**51%** Disagree (Question 21)
Course Similarity	Question 34. Existence of similar courses among academic units, in effect, enhances this institution's reputation.	**60%** Disagree	**58.7%** Disagree (Question 22)
Over-departmentalization	Question 35. Colleges and universities are generally over-departmentalized/over-compartmentalized.	**47.2%** Agree	**71.7%** Agree (Question 23)
Administrative Workload	Question 37. Proliferation of courses among academic units significantly increases administrative workload.	**41.2%** Agree	**35.8%** Agree, **37.8%** Disagree (Question 25)

disagree) into a single percentage. Table 6-14 shows that larger of the two percentages reported by Department Chairs.

Each of the five elements of the third intermediate question are presented in Table 6-14. The pluralities of Department Chairs and CAOs provide the same responses (agree or disagree) to each of the four questions that comprise the first element. The only major difference between the responses of the two groups occurs on Question 21, about too much overlap of course content among computing programs. Once again, this is likely to be the result of social distance, as discussed in the analysis of the Department Chairs, and CAOs responses to the issues presented for the first intermediate question. In this case, it is likely that computing department chairs are more aware of the course content in their program, as well as other computing programs at the institution, than the CAOs would be. The result is a greater plurality in agreement with the statement (Question 21) by the Department Chairs as compared to CAOs.

The Department Chairs and CAOs indicate, by their responses to Question 22, that they consider course overlap disadvantageous. The two groups also indicate that neither proliferation of courses, nor course overlap, provides aid to the faculty in securing funds (Question 27). An assumption that might naturally be made is that course overlap is not beneficial, and these responses provide support for this attitude.

Both Department Chairs and CAOs report that their institutions' curricula do not contain too much course overlap. These responses should be kept in mind for the following discussion regarding over-departmentalization of colleges and universities generally.

The second area addresses the differentiation among academic units. Question 28, about the ability of students to differentiate among computing programs, is asked of both groups. A plurality of both groups states that students can tell the difference among programs, but there is a large difference in the size of the plurality. Seventy percent of the CAOs concur with the statement but only 47% of the Department Chairs. The Department Chairs have a closer social distance to the students, and in the cases where there are multiple computing programs, the Department Chairs should be inclined to state that students can differentiate. Further, the Chairs have reported that at their institutions' computing programs do not overlap. Thus, there is reason for concern about the ability of students to differentiate among programs, as reported in Chapter 3 on page 85.

The third element is course similarity, and the Department Chairs' and CAOs' responses diverge in this area. The two groups are in concert when asked about perceived benefits arising from course similarity. They report, with similar pluralities, that course similarity does not boost the reputation of an institution (Question 34) or increase faculty morale (Question 33). However, when the relationship of course similarity and academic freedom is raised in the context of controlling course similarity, the two groups are not in accord. The Department Chairs have varied opinions. The CAOs, who are presumably more experienced with academic freedom at the institutional level, tend to agree that academic freedom does not make course similarity difficult to control.

Question 32 has divergent responses from the two groups. The CAOs' responses resulted in a plurality that disagrees with the notion that students would be confused by course similarity in different academic units. The Department Chairs' responses resulted in a plurality that agrees with the notion that students would be confused by course similarity in different academic units. The Chairs are closer to the students and the courses and arguably are the more sensitive respondents.

The two responding groups are in agreement that course similarity does not produce benefits, at least in the cases of the two specific benefits that were asked of them. However, they are not in agreement about the results of course similarity. In fact, the particular result of course similarity (student confusion) that would presumably cause a need to control the phenomenon was recognized as a problem by only one group of respondents (Department Chairs). Applying the concepts that the Chairs are both closer to students, and interact with students more often, it is likely that students are, in fact, confused by course similarity. However, this particular issue is likely to be more complicated that it might appear. It is likely that CAOs assume that the college and school structure at their institutions (College of

Business, College of Engineering, etc.) provide suitable references for students to select their academic career path. In the case of the study of computing, this may not be appropriate because students are seeking a career in computing and except in the few cases where there are Colleges of Computing there is no helpful information.

The fourth area is about over-departmentalization of colleges and universities. The plurality of both CAOs and Department Chairs believe that colleges and universities are generally over-departmentalized. However, there is a disparity in the size of these pluralities. The group that is more familiar with this phenomenon is the CAOs because of their overview of the institution and the likelihood that they contend with program proliferation issues on an institutionwide basis. In Chapter 5 it was noted that this result is interesting because the CAOs report that their institution is controlling course overlap, and course similarity, but for all institutions they are essentially stating that there are organizational problems with departmentalization which would presumably result in course overlap and course similarity. The Department Chairs are providing the same report. Thus, overall there is something of a contradiction. On the one hand, there is a shared belief among both groups that colleges and universities generally have a problem, but there is little or no evidence among the two groups of respondents that their own institutions or departments suffer from that problem.

The fifth area is administrative workload, and Question 37 examines the relationship of proliferation of courses and administrative workload. The two groups of respondents have differing views. The Department Chairs indicate that proliferation of courses increases administrative workload, but the CAOs indicate that proliferation of courses does not increase administrative workload. The issue in the question concerns courses, and Department Chairs are socially closer to courses. Thus, their responses may be more illuminating. They, not the CAOs must contend with course offerings.

The Department Chairs and CAOs have consistently indicated that course overlap, course similarity, and over-departmentalization are not desirable. The two responding groups also consistently report that these undesirable effects are under control at their own institutions. From these indications, multiple computing programs appear not to have these undesirable attributes. A problem with maintaining this conclusion is that both groups indicate that colleges and universities are over-departmentalized. This attitude toward other universities could be dismissed; however, the two responding groups are not consistent in their indications about the results of these effects, particularly course similarity.

A pattern appears in the cases of diverging responses between these two groups. This was first noted in the analysis of the responses related to the first intermediate question, particularly with respect to Question 19, about the availability of students interested in the study of computing. This pattern is repeated in Question 28 which inquires about the ability of students to differentiate among competing computing programs, and in Question 32 which asks if students are confused by course similarity. The CAOs have consistently been more optimistic about student capabilities to make discerning distinctions than the Department Chairs.

The impact of this disparity, which is important to this research, has implications for curriculum and program development. It seems reasonable that these efforts, as with other forms of communication, require an appropriate assessment of the intended audience. An optimistic, or conversely, a pessimistic view of the students (audience) seems likely to produce problems in designing curriculum and programs.

If one further assumes that Department Chairs and CAOs (as faculty) should have similar prior interactions with students, and the only difference is that the Department Chairs currently interact with students more directly and more often, then there should not be a great or consistent disparity in their assessments of student capabilities. However, given that this divergence in perceptions is consistent, this pattern may be indicating an influence on CAOs that could have an impact on curriculum development, and thus on the placement of computing programs. Therefore, the cause of the effect of CAO optimism about student capabilities needs to be identified in further research.

Summary

Thus far three intermediate questions related to the research question have been examined from the survey of Department Chairs. The first intermediate question is: What is the relationship among key academic administrators between attitudes toward the importance of the study of computing and the actual placement of programs for the study of computing? As one would expect, the Department Chairs view the study of computing as important. This response was similar to the CAOs' response. However, there is no evidence that these attitudes increase the likelihood of the existence of multiple computing programs at an institution. The second intermediate question is: Is there a relationship between the availability of resources at an institution and the placement of the study of computing in an academic organization? The data provided by the Department Chairs show a relationship between the existence of multiple computing programs at an institution and the number of faculty in each program. The third intermediate question is:

What is the relationship among key academic administrators between attitudes toward having multiple computing programs and the placement of computing programs in academic organizations? The Department Chairs' responses were generally similar to the CAOs. The Department Chairs indicated that various attributes of course duplication were undesirable; however, they also indicated that these attributes did not constitute problems at their institutions.

Conclusion

Three intermediate questions, which the Department Chairs' survey examines, provide part of the Chairs' perspective on the research question: What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments? Chapter 7 will show the Department Chairs' view of the forth intermediate question.

Chapter 7

The Departments Chairs' Viewpoint About The Fourth Intermediate Question

The fourth intermediate question is: What is the relationship of particular attributes of computing programs, such as program size and academic training of program chairs, to the placement of programs within academic units? The data for this intermediate question come from 15 questions on the survey of Department Chairs and from data collected from the Web sites of all the institutions identified as described in Chapter 4. These data concern five topics. These topics include attributes of the Department Chair, the academic unit (a department in most cases), attributes of the curriculum, attributes of the faculty, and an attribute of students.

The characteristics of the Department Chairs, for both the population and respondents, that were examined include the subject of the Chairs' PhD, the year the PhD was awarded, and the span of control at the institution. Additionally, the Department Chairs provided the number of years they have been at their institution.

Table 7-1 lists the field of the Department Chairs' PhD for the all the Chairs that were surveyed, except for eight that could not be identified. This is recorded in the column marked Population Percentage. The table also includes the percentages for the respondents. Nineteen fields are represented. While it should be reasonable to assume that the Department Chairs of programs that provide PhD-qualified graduates are likely to have a PhD in the same subject, the evidence provided does not demonstrate that this is generally the case. Thus, while it may be that the respondents' diversity of degrees is unusual, no evidence gathered from the population of Department Chairs suggests strong similarities. For the respondents, 78.4% earned their highest degree in Computer Science, Engineering, or Math while the corresponding figure for the general population of Chairs is 73.2%. The issue of concern here is the relation of Department Chairs' degrees to the placement of subject of computing in academic institutions. The data about the subject of

Table 7-1. The Fields of the Department Chairs' PhD

Chairs' PhD Subject	Population Percentage (N=190)	Respondent Percentage (N=61)
Applied Mechanics	.5%	0%
Biophysics	.5%	0%
Business	9.6%	6.7%

Chairs' PhD Subject	Population Percentage (N=190)	Respondent Percentage (N=61)
Chemistry	1.1%	0%
Computer Science	32.1%	36.7%
Economics	2.1%	3.3%
Education	1.6%	0%
Engineering	25.1%	20.0%
Information Science	1.1%	1.7%
Language & Literature	.5%	1.7%
Library Science	.5%	1.7%
Management	.5%	1.7%
Math	16.0%	21.7%
Moral Philosophy	.5%	0%
Operations Research	1.6%	0%
Physics	3.7%	1.7%
Psychology	1.6%	3.3%
Sociology	.5%	0%
Statistics	.5%	0%

Department Chairs' PhD, for the population of Chairs, was correlated to the number of computing programs at each institution. The correlation coefficient was .036 indicating a very weak positive correlation. This correlation coefficient is usually considered an indication that there is no correlation between the PhD field of the Chairs, and the number of computing programs at an institution. Therefore, the placement of the study of computing is unlikely to be related to the PhD held by Department Chairs.

There are two sources of data that provide the year the Department Chairs earned their PhD. One source was used to obtain data for the population and another for respondents to the survey. This was the Web site of the Department Chairs. The data were available on the Web for 187 out of 198 Department Chairs. On average the population of Department Chairs received their PhDs in 1975. For the responding Chairs, using data collected from the World Wide Web, 1975 was the year that PhDs were awarded, on average. The Chairs were asked about the year of their PhD on the Department Chairs' survey, and 44 Department Chairs responded to this question. The mean response indicate that 1975 was the year that the respondents receive their PhDs, on average. The correlation coefficient between the degree year of the population of Department Chairs and the number of computing programs at the institution was calculated. This would indicate if there were a relationship between the seniority of the Department Chairs, and the existence of multiple computing programs. The result was .106 indicating a weak positive correlation. This low value for the correlation coefficient is usually considered an indication that there is no meaningful correlation.

The Department Chairs' survey included a question about how many years the Chairs had been at their particular academic institution. There were 44 responses to this question. The Chairs indicated they had been at the institution a mean of 14.5 years and a median of 14.5 years. The correlation coefficient between the Chairs' years at an institution and the number of computing programs is .137, which is a weak positive correlation. This provides an indication that the seniority of the Department Chairs does have some relationship to the tendency to have multiple computing programs at an institution. In this case a value of .287 would be required to have a .95 confidence level in this correlation.

The collection of data from Web sites included collection of span of control data for each of the departments in the population. The span of control was collected for the institution, the college (or school) and the department. At the institution level the span of control was defined as the number of colleges and schools that comprise the university. This count did not include institutes and centers that did not maintain independent faculty. The span of control at the college or school level, for present purposes, is the number of departments in the particular college. For present purposes, the span of control for a department, which is the Department Chairs' span of control, is taken to be the total full-time faculty in the department.

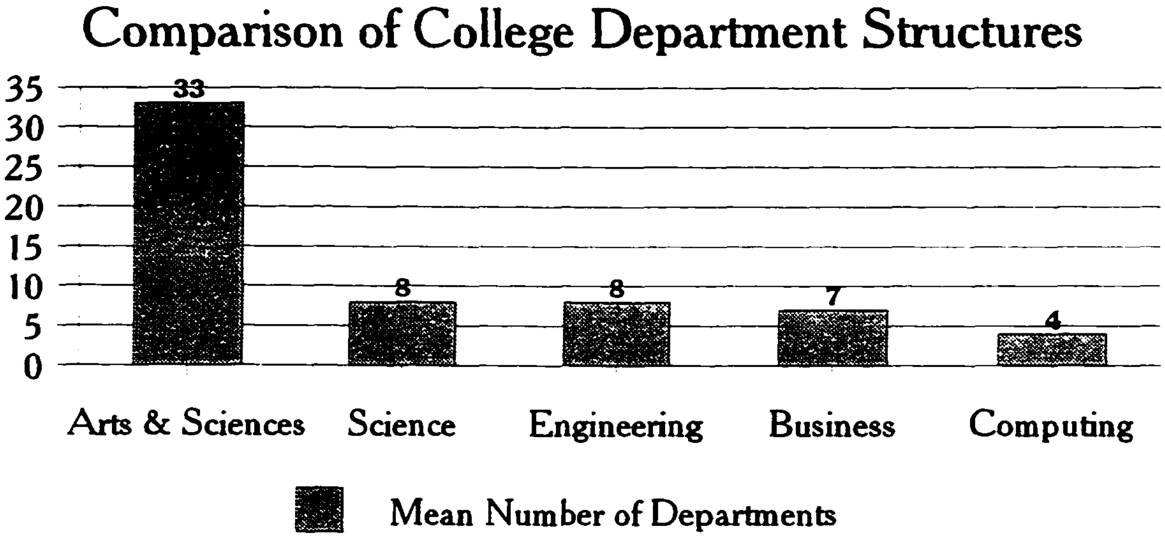
The institutional span of control for the population was a mean of 11 colleges and schools. The range was from 1 to 25 colleges and schools. The data were obtained for 132 of the 136 institutions in the population. There was a standard deviation of 4.7 which is an indication that variation among institutions is more restrained at this level than at the other levels about to be discussed. For the population the cross comparison between the span of control at this level and the number of computing programs at an institution resulted in a .234 correlation coefficient. There are 40 degrees of freedom for this measure, and a correlation coefficient of .304 would be required to achieve a .95 confidence level. There is a positive correlation between the span of control at the institutional level and the number of computing programs that is nearly large enough to warrant rejecting the null hypothesis and accepting the statement that the institutional span of control influences the number of computing programs.

The statement that as institutions have more colleges and schools, they are more likely to have multiple computing programs may seem to be common sense. However, at some institutions there are as many as 25 colleges and schools, but there are three computing programs at all of these. Why aren't there 25 computing departments? In fact, these departments are found in five different types of colleges which are Arts & Science, Science, Engineering, Business, and Computing. The range in the number of computing departments at a given institution is from one to three. This relationship is likely to be more profound than a simple explanation permits.

The college or school level span of control for the population is a mean of 13 departments. The range was from 1 to 108 departments. The data were obtained for 173 colleges and/or schools at 132 institutions within the population. There was a standard deviation of 13.9. For the population the cross comparison between the span of control at this level and the number of computing programs at an institution resulted in a -.033 correlation coefficient. There is a very small negative correlation, which is usually considered no correlation.

There is an interesting aspect of the span of control at the college level to be noted. For colleges of Arts & Sciences, the mean number of departments was 33, with a standard deviation of 21. Colleges of Science have a mean of 8 departments with a standard deviation of 2. Engineering schools or colleges also have a mean of 8 departments with a standard deviation of 3. Business Schools have a mean of 7 departments with a standard deviation of 2. Computing Schools have a mean of 4 departments, with a standard deviation of 3. The newest kind of college (Computing) has the lowest average, and the oldest kind of college (Arts & Sciences) has the highest average. Also note that the span of control for a college of Arts & Sciences is greatly at variance with all other spans of control discussed so

Figure 7-1



far including the institutional span of control. In fact the variance, particularly as pictured in Figure 7-1, is large enough to raise questions about how dissimilar these organization units might be, and how that would affect curriculum.

The departmental span of control, which is the Chairs' span of control, for the population was a mean of 24 full-time faculty. The range was from 2 to 111 full-time faculty. The data were obtained for 190 of the 198 academic units in the population. There was a standard deviation of 17. For the population the cross comparison between the span of control at this level and the number of computing programs at an institution resulted in a .221 correlation coefficient. There are 98 degrees of freedom for this measure, and a correlation coefficient of .192 would be required to achieve a .95 confidence level. There is a positive correlation between the span of control at the department level and the number of computing programs that is large enough to warrant rejecting the null hypothesis and accepting the statement that the departmental span of control and the number of computing programs at an institution are connected.

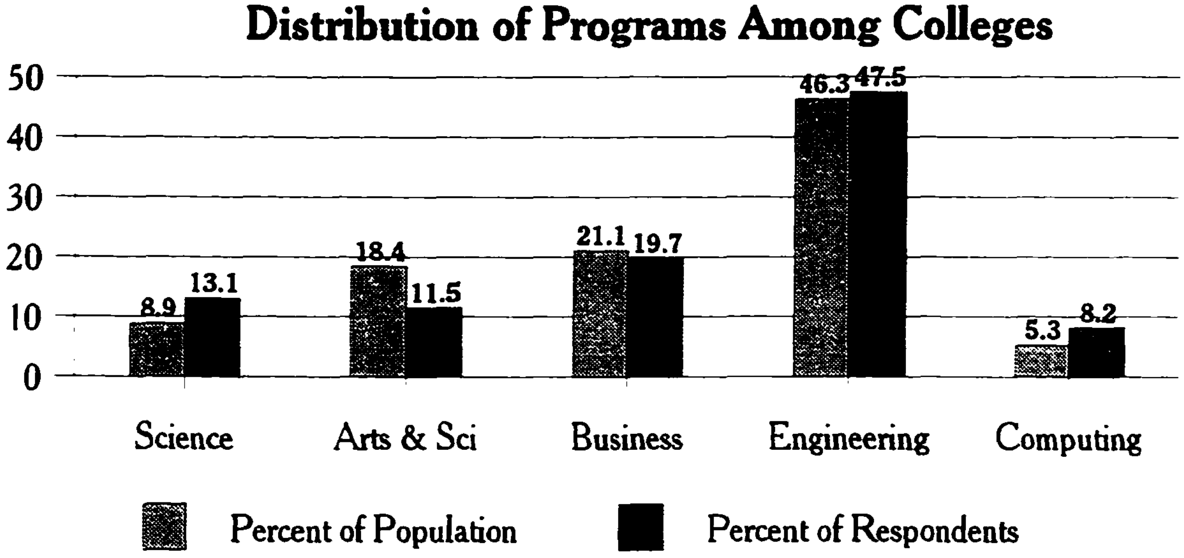
In essence, when there are more computing programs, each program tends to have more full-time faculty. This relationship was observed in the discussion of the second intermediate question. With the addition of these data, for the population, some ramifications should be noted. To the extent that more faculty per department is a sign of the health of a program, computing programs are in a more advantageous position when there are multiple programs. In this case they are likely to command more institutional resources, at least in as much as they are able to employ more faculty.

This might, at first, seem contrary to the obvious idea that these programs should be competing for resources. However, recall that faculty are expected to obtain resources in their quest for tenure, thus as there are more faculty there are more resources. Further, these resources are not provided by the institution and the departments are not competing with each other in their institution. While it is speculation, when institutional resources are involved the Deans are probably competing not Department Chairs. In the cases where computing resources (hardware, software, etc.) are sought, the faculty have the expertise in this area and the Deans are likely to be dependent on that expertise. When there are multiple computing departments, there are more and perhaps better informed Deans competing for institutional resources. When these resources are obtained the Deans must make good on their claims, thus more resources would go to computing departments. While no proof of this process is provided here, it is a possible explanation for the counter intuitive behavior of these resources.

The characteristics of the academic units that were examined include the degrees offered, enrollment and graduation information, the type of college or school that houses the unit, and the last time the unit was reorganized. These data were collected on questions 1, 2, 6, and 7 on the Department Chairs' survey. In addition to the information provided by respondents about the college type, these data were collected for the population from the institutions' Web sites.

Question 1 on the Department Chairs' survey asked the degree programs were provided by the academic unit. The Chairs could identify Associate, Baccalaureate, Masters, or Doctorate. The academic units selected to receive the Department Chairs' survey each had indicated having Baccalaureate, Masters and Doctorate programs in the College Entrance Examination Board's Index of Majors and Graduate Degrees. The only exceptions were Information Systems programs that reside at Graduate Schools and therefore do not offer undergraduate

Figure 7.2



Distribution of Programs Among Colleges

programs. The responses from the Chairs mirrored the originally collected data, with exceptions in Information Systems. These exceptions concerned programs that were expected to respond that they offered only a graduate degree, but instead noted that they also offer the undergraduate degree. This is an indication of a shift in offerings of Business Schools generally.

Enrollment and graduation data were sought in Question 2 of the survey of Department Chairs. Approximately half of the 61 respondents elected to skip this question. Thus there are no useful data resulting from this question.

Question 6 is about the type of college or school that houses the academic unit. The distribution of respondents among colleges or schools is presented in Figure 7-2. Most of the respondents were found in Colleges of Engineering. The only way to ensure that this distribution was not reflecting that one group of respondents, for example, Chairs in Colleges of Engineering, were responding at a disproportionate rate was to collect the college type data for the entire population. Interestingly, the largest group of computing programs were found in Colleges of Engineering which indicates that this group was not responding at a disproportionate rate. This is also presented in Figure 7-2.

There are interesting anecdotal differences among the type of computing programs and the type of college or school that houses them. For example, Computer Engineering is always in an Engineering college or school. Information Systems is usually found in a college or school of Business; however, it is also found in a Computing college or school and even once in an Arts & Sciences college. Computer Science is found everywhere, except in colleges or schools of Business. This raises a question that was partly answered in Chapter 3: Are Computer Science departments always the same, or does the college or school that houses them influence their curriculum? In Chapter 3 a study was cited (NRC, 1993) which discussed this issue at length and concluded that the variation among computer curricula is so large as to be confusing. Thus what remains to be tested in the future is the correlation of that variation to the type of college or school that houses a Computer Science program.

Question 7 inquires about the last time the academic unit was reorganized. Of the 56 Department Chairs that responded to this question more than three quarters reported that the academic units had either never been reorganized or had not been reorganized in five or more years. Table 7-2 shows the responses. Each of the responses was coded with a numeric value from one to five, for example, the response, "this academic unit has never been reorganized" was given the numeric value one. Thus, the coding indicates the response, not the time since reorganization. The Department Chairs' response to Question 7 about the reorganization of the academic unit was correlated with the number of computing departments at the institution, and the correlation coefficient was .041 which indicates a weak positive correlation that would be considered no correlation.

Table 7-2. Time Since Last Reorganization

Question Response	7. Please check the statement that best describes how long it has been since your academic unit was reorganized. (i.e., moved to a new College/School/Center; combined with another academic unit; etc.)
this academic unit has never been reorganized	26.8%
less than 1 year	3.6%
between 1 year and 3 years	7.1%
between 3 years and 5 years	10.7%
more than 5 years	51.8%

The characteristics of the curriculum of the academic units that were examined includes external accreditation, courses in the curriculum, similarity to a model curriculum, and the relationship of adhering to a model curriculum and duplication of courses with other academic units. These data were collected using questions 9, 10, 23, 24, and 25 on the Department Chairs' survey.

Question 9 was about the accreditation, if any, of the academic unit's curriculum by an external body. Only 26 of the 61 respondents indicated that they were accredited by the Accreditation Board for Engineering Technology, the American Assembly of Collegiate Schools of Business, or the Computing Sciences Accreditation Board. Further the responses did not correlate to either the number of computing programs at an institution, or the type (Computer Science, Information Systems, or Computer Engineering) of program.

Question 10 is about the courses offered by the academic unit. This survey question presented a list of courses constructed from published recommendations (Denning, Comer, Gries, Mulder, Tucker, Turner, Young, 1989; Glass, 1992; Heiat, Heiat, Spicer, 1993) in each of the three domains of computing that are discussed herein (Computer Science, Information Systems, and Computer Engineering). The 29 courses were alphabetized, and respondents were asked if each course was required or an elective, and asked if the course was taught in their academic unit or by another academic unit. The assumption was that there would be a separation of responses among the three computing domains. There were 53 responses to this question. Two correlations were calculated. The correlations were to the number of programs at an institution and to type of program. For both correlations, the degrees of freedom was four, requiring a correlation coefficient of .811. None of the courses achieved this coefficient in either correlation. Thus, the responses did not establish that particular courses were more closely associated with a particular type of computing program. This result was confirmed by inspection, that is, in most cases a course would be required by at least one program in each computing area. If the course was not required, it was at least an elective for some program. This implies that the curriculum for the types of computing programs may not vary in practice from one another as much as the existence of multiple programs at an institution would tend to imply.

The next curricular issue was about model curricula. These curricula are proposed and codified by professional associations, for example the Association for Computing Machinary (ACM), and provided as models to be applied as curricula. Three questions related to this topic. Questions 23 and 25 were about the use of a specific model curriculum at the respondents' institution. Question 24 concerned whether conformity to a model curriculum would require duplicating courses in other academic units. The responses to these questions are presented in Table 7-3.

Table 7-3. Model Curriculum

Question / Response	Question 23. This academic unit's curriculum is based directly on the model curriculum advocated by the Association for Computing Machinery. (N = 55)	Question 24. Adherence to a model curriculum requires this unit to teach courses that also are taught by other academic units. (N = 54)	Question 25. This academic unit's curriculum is based directly on the model curriculum advocated by the Data Processing Management Association. (N = 54)
Strongly Agree	5(9.1%)	0(0%)	0(0%)
Agree	11(20%)	0(0%)	0(0%)
Inclined to Agree	12(21.8%)	2(3.7%)	2(3.7%)
Neutral	8(14.5%)	11(20.4%)	3(5.6%)
Inclined to Disagree	3(5.5%)	14(25.9%)	4(7.4%)
Disagree	12(21.8%)	16(29.6%)	19(35.2%)
Strongly Disagree	4(7.3%)	11(20.4%)	26(48.1%)

A plurality of respondents (50.9%) attempt to maintain a curriculum that conforms to the ACM's model. More than three quarters (75.9%) disagreed with the notion that adherence to a model curriculum would require duplication of courses in another academic unit. Only a small group of respondents (3.7%) agreed that their curriculum is based on the Data Processing Management Association's model. The responses to these questions did not correlate with either the number of programs at an institution, or the respondents' program type (Computer Science, Information Systems, and Computer Engineering).

Model curricula are supported by the respondents, that is they are not regarded as having the negative effect of course duplication. This support, however, does not translate into practice. For example, even though half of the respondents agreed that their curriculum was in concert with the ACM model, slightly more than one-third disagreed. In addition, the responses to questions 25 and 9 indicate that the support for a model curriculum does not translate into actually offering a model curriculum.

The characteristics of the faculty of the academic units that were examined include annual teaching load, preferred publication outlets, and academic background. There data were collected using questions 12, 13, 29, and 30 on the Department Chairs' survey.

Question 12 asked what the annual teaching load, in courses, was for the respondents' academic unit. There were 55 responses to this question, and the mean response was 3.8. The mode and median responses were 4.0, and the standard deviation was 1.17. This response is half a course per year less than the response to Question 11, which was about the annual course load for all faculty at the institution. This response did not correlate to either the number of programs at an institution nor to the type of academic unit that houses the respondent.

Question 13 asked the respondents to indicate the relevance of listed publication outlets toward tenure. Nine journals, including three journals from each computing area, are listed. The respondents were asked to report if the journal was very relevant, relevant, neutral, or irrelevant. The responses were correlated with the type of academic unit that houses the respondent. Only one of the journals had a correlation coefficient that is close to the value required for a .95 confidence level. In this case there were six degrees of freedom which would require a correlation coefficient of .707 to achieve a .95 confidence level. The MIS Quarterly received a -.623 correlation coefficient. Nearly all Information Systems respondents felt that this journal was very relevant for tenure; however, nearly half the Computer Science respondents felt the journal was irrelevant. The other half of Computer Science respondents were neutral. Computer Engineering respondents were evenly split among relevant, neutral, and irrelevant. This was the only journal that had a large coefficient, and therefore the importance of particular journals did not correlate to program type.

Questions 29 and 30, shown in Table 7-4, are about the academic background of the faculty in the respondents' academic unit. Question 29 asks if there is a preference for faculty with academic backgrounds that include completion of a model curriculum related to the academic unit. Question 30 asks if there is a preference for faculty whose PhDs were earned in the same particular computing domain as the academic unit. The responses are spread across the scale, and the mean response to each question is neutral. The plurality response to Question 29 is 49.2% disagree, and the plurality response to Question 30 is 60.0% agree. Thus, there is a tendency to hire PhDs in the department's particular computing area, but there also a tendency to disagree with the notion of requiring a background in a particular model curriculum. The responses did not correlate to either the number of programs at an institution or to the type of program that houses the respondent.

Table 7-4. Academic Background of the Faculty

Question / Response	Question 29. The most desirable faculty for this academic unit are those with prior academic experience as students in the model curriculum used by this academic unit. (N = 55)	Question 30. This academic unit only hires faculty with PhD's in our field (e.g. as an Information Systems faculty we only hire Information Systems PhDs and no Computer Science or Computer Engineering PhDs). (N = 55)
Strongly Agree	3(5.5%)	5(9.1%)
Agree	2(3.6%)	18(32.7%)
Inclined to Agree	9(16.4%)	10(18.2%)
Neutral	14(25.5%)	3(5.5%)
Inclined to Disagree	9(16.4%)	6(10.9%)
Disagree	14(25.5%)	9(16.4%)
Strongly Disagree	4(7.3%)	4(7.3%)

The one characteristics of the academic units' students, that was examined is job placement. This data were collected using Question 8 on the Department Chairs' survey. This question uses a list of 16 job titles (Mackowiak, 1991), and asks the respondent to check off the percentage of graduates from their academic unit that become employed in the listed job area. Only 32 respondents chose to complete this question. The responses did not correlate to either the number of programs at an institution or the type of computing program that houses the respondent.

This section has examined the fourth intermediate question: What is the relationship of particular attributes of computing programs, such as program size and academic training of program chairs, to the placement of programs within academic units? The data for this intermediate question come from 15 questions on the survey of Department Chairs and data collected from the Web sites of the institutions surveyed. These data concern five topics. These topics include attributes of the Department Chair, the academic unit (a department in most cases), attributes of the curriculum, attributes of the faculty, and an attribute of students. The characteristics that were found to be related to the occurrence of multiple computing programs concerned span of control and the tendency for there to be larger faculties in computing academic units at institutions with multiple computing programs.

Summary

The survey of Department Chairs examined four intermediate questions related to the research question. The first three intermediate questions were examined in Chapter 6. The fourth intermediate question is: What is the relationship of particular attributes of computing programs, such as program size and academic training of program chairs, to the placement of programs within academic units? Data were collected for this intermediate question on the Department Chairs' survey and at World Wide Web sites. The characteristics that were found to be related to the occurrence of multiple computing programs concerned span of control, the larger the span of control the more likely there were multiple computing programs, and the tendency for there to be larger faculties in computing academic units at institutions with multiple computing programs.

Conclusion

The four intermediate questions, which the Department Chairs' survey examines, provide the Chairs' perspective on the research question: What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments? The data collected from Department Chairs, and about computing departments, show a satisfaction with the current placement of programs. Further, there is some indication that the practice of maintaining multiple computing programs may provide an advantage to these programs at least as demonstrated by the relatively larger size of the faculties in academic computing units in universities with multiple programs.

Chapter 8

Conclusions and Recommendations

At the outset the importance of computing was discussed in Chapter 1. The Internet, the personal computer, and the chip were each discussed as important and recent innovations that have had a great impact on society. In fact, there is speculation that this sector of the U.S. economy can maintain, in and of itself, growth for the entire economy. This is due to the size of this sector and the high rate of growth by this sector, which is likely to be maintained (Gilder, 1997). This means that colleges and universities are likely to experience an increased percentage of graduates who will be employed, in some capacity, in this economic sector.

The ability of colleges and universities to maintain credible programs in computing is affected by the activities of this sector. There are current labor shortages in computing, and the shortages are expected to continue into the future (Bowman, 1997). Additionally, these jobs require college graduates, thus a solution is not likely to come from increased efforts in vocational programs. This economic sector has resorted to importing as much qualified labor as possible from other nations. When the quotas for emigration are filled, companies establish elaborate programs that offload work to facilities in other nations. Under these conditions it may only be a matter of time before adequate numbers of qualified faculty are no longer hard to get, but are simply impossible to find.

In spite of this potential shortage of faculty, there are often multiple computing programs at colleges and universities. Current and anticipated conditions for academic computing, including the inevitability of limited resources, lead to the research question raised in this study: "What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments?"

Conclusions

A compelling reason to accept the idea of an organization with multiple computing programs as the most effective placement of computing programs would be evidence of significant epistemological variation among groups of programs, that is, evidence of variation in courses and content of the degree programs rather than substantial redundancy. It was argued, in Chapter 3, that evidence of epistemological variation was unlikely to be found by this research (NRC, 1993).

Evidence of epistemological variation was neither produced by the surveys of computing Department Chairs nor CAOs. There was evidence that neither Department Chairs nor CAOs considered multiple programs to be redundant; however, this does not provide definitive evidence that these programs are truly different.

Since these programs are not definitively shown to be epistemologically different, the question of how multiple programs came into existence is raised. Multiple computing programs are likely to be an artifact of multiple colleges and schools within universities.

Computing is often noted as being a new endeavor. The college and school structures predate the establishment of computing programs, and the colleges of Arts & Sciences, Science, Engineering, and Business each has reason to establish their own computing programs. The existence of multiple colleges and schools makes the university more responsive to society's needs, and one result is multiple computing programs. However, this responsiveness is likely to come at the expense of efficiency in the university.

The multiple computing program structure is potentially advantageous to computing programs, and from the point of view of computing programs the most effective placement in curriculum and organization for computing in colleges and universities. The surveys and publicly available information provide evidence that when there are multiple computing programs at an institution, there are larger faculties in each program. While this effect could also result from greater student interest in computing at these institutions; by this one indicator, faculty size, computing programs appear to be healthier when there are multiple programs.

Recommendations

The first and most important recommendation is that computing faculty should cease their denigration of other domains in computing. Further, research interests should not cause this denigration. Two publications support this point. The first is the NRC study calling for more breadth in the computing field (NRC, 1992). The second is Consilience (Wilson, 1998), in which several research themes are discussed, and in each case it is noted that the progress of research depends on cooperation among fields. There is nothing to be gained by denigration, and resources are likely to be lost.

In one NRC report (NRC, 1992), there is a call for more breadth in computing research. Another NRC report (NRC, 1993) depicts a taxonomy of computing programs ranging from Electrical Engineering on one extreme to the Management of Information Systems (MoIS) at the other extreme. It is herein recommended that a regular census of programs be conducted, and that this taxonomy be used for that purpose. It is further recommended that the taxonomy be augmented by adding a classification for computing programs that are combined with non-computing programs, a classification for multiple types of computing programs housed in a department, and a classification for computing programs completely housed in a non-computing department. There should also be additional categories to indicate the type of college or school that houses the computing program. If a similar system were applied to the programs that were asked to participate in this research, the result would be similar to the representation in Table 8-1.

Table 8-1 was constructed by applying the aforementioned recommendations to the population of departments used in this research. The NRC taxonomy was not used, since this research has used three classifications for computing programs; however, the results provide an indication that the census recommended above may be useful.

The category that most often applied to the computing departments studied was a computing program housed in a department with a program that is not computing. There were examples of this in each of the three computing classifications used. As examples, Computer Science was sometimes paired with

Math, and Information Systems was sometimes paired with Accounting.

Table 8-1. A Classification System for Computing Programs

Classification	Number	Percentage
Computing in a department with a non-computing field	70	36.8%
Computer Science in a College of Engineering (stand alone)	33	17.4%
Computer Science in a College of Arts & Sciences (stand alone)	26	13.7%
Computer Science in a College of Science (stand alone)	16	8.4%
Multiple computing programs in one department	14	7.4%
Information Systems in a College of Business (stand alone)	11	5.8%
Computing College	9	4.7%
Computing contained within a non-computing department	9	4.7%
Computer Engineering in a College of Engineering (stand alone)	1	.5%
Information Systems in a College of Arts & Sciences (stand alone)	1	.5%

The next classification is Computer Science as a stand alone department (with no non-computing programs) housed in a College of Engineering. The third most often occurring classification is Computer Science as a stand alone department housed in a College of Arts & Sciences. The fourth most often occurring classification is Computer Science as a stand alone department housed in a College of Science. The next classification is multiple computing programs, for example Computer Science and Computer Engineering, housed together. The sixth most often occurring classification is Information Systems as a stand alone program housed in a College of Business. There is a tie for seventh place between Colleges of Computing, and computing programs completely contained within a non-computing department, for example Management. There is also a tie for ninth place between Computer Engineering as a stand alone department in a College of Engineering, and Information Systems as a stand alone department in a College of Arts & Sciences.

The last recommendation is to find a way to optimize scarce resources. This is likely to become more difficult due to a shift in computing. This is due in part to the maturation of computing as a discipline, the Internet, and the development of object-oriented programming, These factors and perhaps others have shifted computing from rationalism to empiricism (Wegner, 1997). This shift was observed during this research effort because of the need to keep abreast of the changes in Department Chairs, and computing departments. One of these changes involved a large research university that is the flagship of their state system. Computer Science was originally housed with Statistics in a College of Arts &

Sciences. This program changed to a stand alone Computer Science department in a College of Engineering. The statements available on the World Wide Web indicate that the Statistics faculty were left in the College of Arts & Sciences, and were not particularly happy with this transition. Another example occurred with an Information Systems program that was housed with Decision Sciences faculty in a College of Business. The Information Systems faculty and the programs moved to a new department housed with the Accounting faculty. There were also indications that this was not a harmonious transition. This shift in computing is likely to invalidate the attempts to include faculty from "related" disciplines, and therefore require a different approach to optimizing the faculty for computing.

Further Research

There are several interesting questions that should be examined related to this research. The first concerns an assumption underlying the organization of colleges and schools within a university. Usually, the organization of colleges contains departments for faculty, and the colleges contain majors for students which are strictly tied to the faculties' department. However, does the organization of the faculty, and the organization of students by majors require a strict coupling? For example, the faculty departments could be organized into a College of the Faculty, and the students can be organized by Schools that contain majors. Thus, regardless of the school the faculty can be responsible for their majors. There were two institutions in this research that maintained the faculty organization separately. These were multi-campus universities, so when computing, for example, is taught on any campus or in any college or school the computing faculty are responsible.

There are areas of research about the middle management (colleges and schools within universities) of colleges and universities than can be undertaken. When middle management in business is discussed by management scholars it is often noted that the number of workers devoted to this area has normally been reduced. While this is interesting, the more interesting questions for colleges and universities involve the logic behind the establishment of these middle structures (colleges and schools within a university) and the practical function of these structures in an academic organization. Thus, one question could be, "Is epistemology important to the organization of colleges and schools within modern colleges and universities?" Another useful and more basic question is, "Why are colleges or schools established, in practice, within a university, and what is the intended function of these organizational structures?"

The "information explosion" is a matter that should be of great interest to colleges and universities. These institutions help produce a significant amount of this information, and colleges and universities are also the institutions in our culture that preserve and, more importantly, prioritize this information for transmission among members of our culture. The inquiry into this area could begin with the question, "How has the growth of data, information and knowledge affected colleges and universities?" Another important question could acknowledge that the "information explosion" is often discussed in commerce and therefore ask, "Why is commerce concerned about this phenomenon, and are colleges and universities relatively unconcerned?" The last suggested question concerns the organization of colleges and universities, "What approach to organizational structure will allow colleges and universities to best respond to the growth of knowledge?"

The last two suggested questions concern the organization of the study of computing and colleges and universities. The first notes that out of the three classifications of the study of computing used for this research, Computer Science was often housed in various type of colleges. Even though there is considerable evidence that the result is inconsistent curricula, what is the whole effect of this variation? Thus the question, "How are computing programs with the same name affected by being housed in different types of colleges or schools (e.g., Science, Engineering)?"

The last suggested area for additional research concerns the relationship of the importance of computing to society, including the likely expected interaction between people and computers, and college and university curricula. Several citations in this research, particularly those concerning the labor shortage in computing, indicate that a large percentage of college graduates will be expected to at least interact with computers. Therefore, "How much study of computing should be required for all students, particularly using the notion of achieving a well informed citizenry as a result of obtaining an undergraduate degree?"

Recommended Academic Organization

The observation that having multiple computing programs provides benefits to the study of computing does not provide an adequate basis or principle for organizing academic units. At best this observation may guide faculty toward a notion of cooperation among programs, but it does not provide an answer to the research question: "What is the most effective placement for academic studies in computing in the curriculum and organization of American colleges and universities as perceived by chief academic officers and chairs of computing departments?"

Unfortunately, there is no simple answer at this time. Reliance on a principle that having multiple computing programs is desirable creates at least two problems. The first problem concerns labor supply. Some observers believe there has always been and continues to be a shortage of qualified computing faculty. Those who wish nevertheless to advocate that there are enough qualified faculty should be asked to respond to two issues. These are the relationship of the overall shortage of workers in computing to the computing faculty market, and the effect of the fundamental change in the computing field from rationalism to empiricism on the availability of qualified computing faculty, particularly those faculty from related disciplines which were once thought to be suitable substitutes for faculty with computing PhDs. The second problem concerns the variation among curricula. Multiple computing programs with observably different curricula would imply that multiple computing fields in fact do and should exist. However, the existence of multiple, reasonably discrete computing fields was not observed in the quest of this research to exist in practice, and as noted in Chapter 3 the continued existence of parallel programs with essentially the same curricula does create a problem of redundancy.

One solution might be to establish colleges or schools of computing, but this, too, is problematic. One observation is that creating a college of computing does not assure that computing programs will exist only in that college of computing. For example, Ohio State University has a college of computing, but it accommodates additional computing programs in at least two other colleges. Further, even if other colleges were prohibited from establishing computing programs, the examination of the operation of each of the institutions in this research indicated that there is generally little interaction among colleges or schools within a university. It is true that most institutions have a general studies requirement that must be met by taking courses from the College of Arts & Sciences, but beyond this there was little evidence of cooperative work. Given these circumstances, it is fair to ask how will the College of Business obtain services from the College of Computing? Further, to the extent that multiple computing programs are allowed to exist, the problems mentioned above are still likely to exist even with the establishment of a college of computing.

There is a third possibility that appears to be practiced at Polytechnic University (formerly Brooklyn Polytechnic) and by the use of a system of Faculties at Rutgers University. Their solution is to establish a College of the Faculty (or words to that effect) that houses all the faculty departments, in effect, disconnecting the identity of the departments from the colleges or schools within the university. For the sake of reference this will be called the College of the Faculty model. While no explanation for this organizational approach was observed during this research, it is interesting that this organizational strategy would provide an academic organization that could operate in the fashion recommended by Peter Blau in The

Organization of Academic Work (1973). That is, Blau recommends that academic departments be considered dynamic rather than static units. Therefore, new departments should be established regularly, and established departments should be culled (which does not mean firing faculty, but it does mean continuous reorganizing).

The problem with establishing new departments under current organizational approaches is the potential adverse effect on students. Since majors, minors, advising, and several other key matters are tied to colleges or schools and departments, radical or even continuous reorganization would likely leave students in a constant state of confusion. In the College of the Faculty model, however, various colleges and schools are established specifically to accommodate students. Thus a student may major, say, in Computer Engineering in a College of Engineering, but the responsible faculty department in the College of the Faculty could be modified without impacting the students.

The implication of the College of the Faculty model for faculty should be positive. While the actual practice of this model for purposes of retention, tenure and promotion decisions was not observed, the implications of Blau's recommendation should be positive. For example, faculty interested in working in new areas should be able to propose and expect the establishment of a new, fluid department comprised of faculty with similar interests.

Further, the dynamic nature of this organizational approach should require that retention, tenure and promotion decisions be handled by a single faculty committee for the College of the Faculty rather than the three faculty committees (department, college, and university) that ordinarily handle these issues under other, hierarchical organizational arrangements. While the effectiveness of relying on a single committee to handle academic personnel decisions may be no better than the traditional use of three committees, it does provide the possibility that local infighting (for example, computer engineers versus information systems) would have less impact on these faculty personnel decisions, thus allowing such debates to take place in scholarly work where they belong. (This approach leaves aside how a single committee can have adequate expertise to assess scholarship in scores of fields.)

The implications of the College of the Faculty model for the study of computing should also be positive. While it is true that the current practice at Polytechnic University and Rutgers University is to have a computing department, if the model is practiced with the assumption of dynamic departments, there is no reason to assume that a single department is the necessary outcome. As noted on page 86, there are several possible types of computing departments. If, for example, a group of faculty comes together to launch an Information Systems curriculum that is different from existing computing curricula, a new "department" should be established. Another example could be based on research. A faculty could collect together for the purpose of researching high speed computer networks, obtain funding, decide a curriculum is not yet appropriate, and still have a research unit or department to support the development of this area of inquiry.

The remaining groups that could be affected by an implementation of the College of the Faculty model are the Administration and Staff. For the most part this organizational approach should have no significant impact on these groups. However, Deans are likely to experience a change in their work. Obviously, the Deans of colleges and schools outside the College of the Faculty are likely to have a different relationship with faculty than in other organizational arrangements. However, the net effect may be positive. These Deans are more likely to be involved in curriculum, and they may find it reasonable to focus more attention on teaching than some Deans had chosen in other organizational arrangements. Thus, instruction or at least the perception of the quality of instruction might be improved.

A final advantage the College of the Faculty model might provide is a flexible means for colleges and universities to respond to the growth of information and knowledge. Dynamic departments in a College of the Faculty can provide a method to respond to both research needs and curriculum needs as demands arise due to growth.

This portrait of the College of the Faculty model depends on some assumptions. While it appears - - rhetorically - - to address many issues related to redundancy that have been raised in this research, it would be helpful to further examine two issues at least before concluding that the College of the Faculty strategy would be effective. These include examination of, first, the need to organize faculty and students using the same organizational structure as dictated by prevailing practice, and, second, the role of colleges and schools within a university. This discussion has assumed that students and faculty need not be organized into academic units with the identical boundaries and, further, the role of colleges and schools within a university is flexible. If these assumptions turn out not to be the case, the College of the Faculty model would not constitute an adequate response to the problems posed by current practice.

Concluding Comment

The placement of the study of computing at colleges and universities is not simply a matter to be resolved by giving undue weight to internal politics at colleges and universities. There are compelling indications, flowing from both the importance of computing to society, and the opportunities in computing for generations of graduates, that colleges and universities should approach the academic organization of computing programs with greater thoughtfulness and attention to sound principles of academic organization. The dynamic nature of the study of computing is likely to further test the capabilities of colleges and universities to adjust astutely to changing realities.

Bibliography

Baldridge, J. Victor. Power and Conflict in the University. John Wiley & Sons, Inc., New York. 1971.

Banville, Claude, and Maurice Landry. "Can the Field of MIS be Disciplined?" Communications of the ACM, Volume 32, Number 1, January 1989, pp. 48-60.

Barford, Jane A. "Balance or Bias? Information Selection for the Researcher." New Library World. Volume 95, Number 1116. 1994. pp. 7 - 11.

Bator, Paul G. "The Formation of the Regius Chair of Rhetoric and Belles Lettres at the University of Edinburgh." The Quarterly Journal of Speech. Volume 75, Number 1. February 1989, pp. 40 - 64.

Beale, Jeremy. "The Information Explosion." OECD Observer. Number 196. Oct/Nov 1995. pp. 6 - 9.

Beckmann, Petr. A History of π (pi). St. Martin's Press, New York. 1971.

Bell, Daniel. The Coming of the Post-Industrial Scoiety. Basic Books, New York. 1973.

Birnbaum, Robert. How Colleges Work. Jossey-Bass Publishers, San Francisco, California. 1988.

Blau, Peter. The Organization of Academic Work. John Wiley & Sons, New York. 1973.

Bowman, Charles. "BLS Projections to 2006 - a Summary." Month Labor Review. November 1997. pp. 3 - 83.

Brubacher, John S. and Willis Rudy. Higher Education in Transition. Harper & Brothers Publishers, New York. 1958.

Burcham, Sara Elizabeth. "The Video Game [R]evolution." Crossroads. Winter 1996, pp. 7 - 8.

Bush, Vannevar. “As We May Think.” Atlantic Monthly. July, 1945.

Chronicle of Higher Education. “Carnegie Foundation’s Classification of 3,600 Institutions of Higher Education.” April 6, 1994, pp. A18 - A25.

College Entrance Examination Board. 150 Popular College Majors. College Entrance Examination Board, New York. 1992.

College Entrance Examination Board. Index of Majors and Graduate Degrees. College Entrance Examination Board, New York. 1993.

Cusins, Peter. “Action Learning Revisted.” Industrial & Commercial Training. Volume 27, Number 4. 1995. pp. 3 - 10.

Davey, Thomas. “IT’s Hiring Challenge.” InformationWeek. January 19, 1998. p. 144.

Dawes, Robyn M., David Faust, and Paul E. Meehl. “Clinical Versus Actuarial Judgement.” Science. Volume 243. March 31, 1989. pp. 1668 - 1674.

Denning, Peter J. et al. "Computing as a Discipline." Communications of the ACM. Volume 32, Number 1. January 1989. pp. 9 - 23.

Dewey, John. Experience & Education. Kappa Delta Pi. 1938.

Dwyer, Victor. “Assault on the Ivory Tower.” MacLean’s. May 23, 1994. pp. 51 - 52.

Elmer-Dewitt, Philip. "Cyberpunk." Time. Volume 141, Number 6. February 8, 1993. pp. 58 - 65.

Elmer-Dewitt, Philip. "The Electronic Superhighway." Time. Volume 141. Number 15. April 12, 1993. pp. 50 - 55.

Elmer-Dewitt, Philip. "The Battle for the Soul of the Internet." Time. Volume 144, Number 4. July 25, 1994. pp. 50 - 56.

Esposito, Joseph J. "Future of Knowledge." Vital Speeches. Volume 59, Number 21. August 15, 1993. pp. 666 - 668.

Frost, Greg. "U.S. To Tackle Shortage of High-tech Workers." Reuters. Berkeley. January 13, 1998.

Garb, Howard N. "Clinical Judgment, Clinical Training and Professional Experience." Psychological Bulletin. Volume 105, Number 3. 1989. pp. 387 - 396.

Gilder, George. American Perspectives, CSPAN. September 27, 1997. 10:00 p.m. ET

Glass, Robert L. "A Comparative Analysis of the Topic Areas of Computer Science, Software Engineering, and Information Systems." The Journal of Systems and Software. Volume 19, Number 3. November 1992. pp. 277 - 289.

Goodspeed, Thomas Wakefield. A History of the Univeristy of Chicago Founded by John D. Rockefeller: The First Quarter Century. Chicago. 1916.

Hapgood, Fred. Up the Infinite Corridor: MIT and the Technical Imagination. Addison-Wesley Publishing Company. 1993.

Hartog, Curt. "Of Commerce and Academe." Datamation. September 1, 1985. pp. 68 - 77.

Haskell, Robert E. "Academic Freedom, Tenure, and Student Evaluation of Faculty: Galloping Polls in the 21st Century." Education Policy Analysis Archives. Volume 5, Number 6. February 12, 1997. pp. 1 - 34.

Haskins, Charles Homer. The Rise of Universities. Cornell University Press. 1957.

Heiat, Abbas, Nafisseh Heiat and Jan Spicer. "An Empirical Study of Practitioners' and Academics' Views of MIS Curricula." Interface. Volume 15, Issue 3. Summer 1993. pp. 27 - 31.

Jarvenpaa, Sirkka L., Blake Ives, and Gordon B. Davis. "Supply/Demand of IS Doctorates in the 1990s." Communications of the ACM. Volume 34, Number 1. January 1991. pp. 86 - 97,

Karseth, Berit. "The Emergence of New Educational Programs in the University." The Review of Higher Education. Volume 18, Number 2. Winter 1995. pp. 195 - 216.

Khandwalla. Organization Design. 1977.

Kress, George. "Turning Information into Knowledge." Industrial Management. Volume 35, Number 2. Mar/Apr 1993. pp. 30 - 32.

Lamberton, ed. Annals of the American Academy of Political and Social Science. 1974.

Larkin, Jill, John McDermit, Dorothea P. Simon, and Herbert A. Simon. "Expert and Novice Performance in Solving Physics Problems." Science. Volume 208. June 20, 1980. pp. 1335 - 1342.

Lee, Harold N. "Two Views of the Nature of Knowledge." Tulane Studies in Philosophy, Volume XVIII. 1969. pp. 85 - 91.

Littlewood, Bev and Lorenzo Strigini. "The Risks of Software." Scientific American: The Computer in the 21st Century. 1995. pp. 180 - 194.

Karseth, Berit. "The Emergence of New Educational Programs in the University." The Review of Higher Education, Volume 18, Number 2, Winter 1995, pp. 195-216.

Machlup, F. Knowledge: Its Creation, Distribution and Economic Significance, Vol I. Princeton, New Jersey: Princeton University Press. 1980.

Mackowiak, Kate. "Skills Required and Jobs Available for CIS Majors." Interface. Volume 13, Issue 4. Fall 1991. pp. 9 - 14.

McGee, Marianne Kolbasuk. "IT Skills Drought Worsens." InformationWeek. January 19, 1998. p. 30.

Massy, William F., Andrea K. Wilger and Carol Colbeck. "Overcoming "Hollowed" Collegiality." Change. Volume 26, Number 4. July/August 1994. pp.11 - 20.

Microsoft. 1997. http://www.microsoft.com/

Murray, Robert K. "On Department Development: A Theory." The Journal of General Education. Volume 16. 1964, pp. 227 - 236.

National Research Council. Computing the Future: A Broader Agenda for Computer Science and Engineering. National Academy Press, Washington, D.C. 1992.

National Research Council. Computing Professionals Changing Needs for the 1990s. National Academy Press, Washington, D.C. 1993.

National Research Council. Academic Careers for Experimental Computer Scientists and Engineers. National Academy Press, Washington, D.C. 1994.

Newell, Allen, Alan J. Perlis and Herbert Simon. "Computer Science [a letter to the editor]." Science. Volume 157, Number 3795. September 22, 1967. pp. 1373 - 1374.

Papert, Seymour. The Children's Machine. Basic Books. 1993.

Perelman, Lewis J. School's Out. Avon Books, New York. 1992.

Quincy, Josiah. The History of Harvard University. Arno Press, New York. 1977.

Richards, Roy Martin and Clive C. Sanford. "An Evolutionary Change in the Information Systems Curriculum at the University of North Texas." Computers and Education. Volume 19, Number 3. 1992. pp. 219 - 228.

Richards, R. M. "Professional Career Paths in Management Information Systems." Interface. Volume 14, Issue 3.

Rider, Fremont. The Scholar and the Future of the Research Library. New York. 1944.

Rudolph, Frederick. The American College and University: A History. Vintage Books, New York. 1962.

Rudolph, Frederick. Curriculum. Jossey-Bass, San Francisco. 1977

Satow, Kay. "The Changing State of Research in the United States." Journal of Market Research Society. Volume 31, Number 4. October 1989. pp. 521 - 525.

Schaeffer, Donna and Patrick Olson. "The Evolution of Computing in the Curriculum in Higher Education in the United States: 1965 - 1985." Proceedings of the Thirteenth International Conference on Technology and Education. Volume 2. March 17 - 20, 1996. pp. 676 - 678.

Schuster, Jack H. "The Context of Scholarly Communication." The Serials Partnership: Teamwork, Technology, and Trends Proceedings of the North American Serials Interest Group, Inc. June 3-6, 1989. pp. 15 - 23.

Schuster, Jack H., Daryl G. Smith, Kathleen A. Corak, and Myrtle M. Yamada. Strategic Governance. Oryx Press,. 1994.

Scully, John C. "Information Overload?" Managers Magazine. Volume 70, Number 5. May 1995. p. 2.

Streitfield, David. "Style Plus; Focus - Infomania." Washington Post. February 3, 1989. p. b5.

Toffler, Alvin. Future Shock.

Trauth, Eileen M., Douglas W. Farwell and Denis Lee. "The IS Expectation Gap: Industry Expectations Versus Academic Preparation." MIS Quarterly. September 1993. pp. 293 - 303.

Walsh, James J. The Thirteenth Greatest of Centuries. Catholic Summer School Press, New York. 1920.

Washington Post, February 23, 1997.

Wegner, Peter. "Why Interaction is More Powerful Than Algorithms." Communications of the ACM. Volume 40, Number 5. May 1997. pp. 80 - 91.

Williams, Joseph and Jon D. Clark. "The Information Explosion: Fact or Myth?" IEEE Transactions of Engineering Management. Volume 39, Number 1. February 1992. pp. 79 - 84.

Wilson, Edward O. Consilience: The Unity of Knowledge. Alfred A. Knopf, New York. 1998.

Appendix A

A Survey of Chief Academic Officers. About Computing Programs in Higher Education

The University Of Redlands

Please indicate your opinions about the following statements using a seven-point scale. Please fill in the circle, or place an X over the number that corresponds to your opinion.

Strongly Disagree
Disagree
Inclined to Disagree
Neutral
Inclined to Agree
Agree
Strongly Agree

1 The need for academic units dedicated to the study of computing has grown in the last five years ①②③④⑤⑥⑦

2 The need for academic units dedicated to the study of computing will grow in the next five years ①②③④⑤⑥⑦

3 It is difficult to staff academic units dedicated to the study of computing with qualified faculty ①②③④⑤⑥⑦

4 Academic units dedicated to the study of computing are adequately distributed among American colleges and universities thereby giving almost all students the opportunity to study computing. ①②③④⑤⑥⑦

5 This institution's budget adequately supports the study of computing ①②③④⑤⑥⑦

6 Not enough students are strongly interested in the study of computing. ①②③④⑤⑥⑦

7 Most fields, and especially professional schools, should provide their own courses for the study of computing. ①②③④⑤⑥⑦

8 Fund raising, especially securing research grants, is required of the faculty and is an expectation for tenure. ①②③④⑤⑥⑦

9 How many personal computers are "publicly" available (for use by any student) in your institution? (Please check the statement that is most applicable to your current environment.)

- ☐ More than 1 computer per student
- ☐ 1 computer per student
- ☐ 1 computer for every 2 students
- ☐ 1 computer for every 5 students
- ☐ 1 computer for every ten or more students

10 How many full-time-equivalent faculty at your institution are currently part of academic units that teach/research computing (e.g. Computer Science, Information Systems, Computer Engineering)? (Please include faculty on sabbatical or similar leave, and exclude faculty in administrative positions [Deans, Vice Presidents, etc.] with return rights.)

full-time tenured ______
full-time probationary ______
full-time other ______
part time ______

11 What is the normal expected teaching workload for members of the faculty at your institution? (Please check the statement that applies to your institution. Assume class refers to the number of groups of students lectured to rather than the number of subjects lectured about.)

☐ 1 class per year
☐ 2 classes per year
☐ 3 classes per year
☐ 4 classes per year
☐ 5 classes per year
☐ 6 classes per year
☐ 7 classes per year
☐ 8 classes per year
☐ 9 classes per year
☐ 10 classes per year
☐ Other ___________

Strongly Disagree
Disagree
Inclined to Disagree
Neutral
Inclined to Agree
Agree
Strongly Agree

12 There is too much overlap in course content among computing programs at this institution. ①②③④⑤⑥⑦

13 Academic units that overlap in their offerings (i.e. replicate one or several courses) are a significant disadvantage to the institution. ①②③④⑤⑥⑦

14 This institution has policies and procedures that minimize the similarity of course content among courses taught in different academic units. ①②③④⑤⑥⑦

15 There are strong pressures from outside the campus to reduce course duplication among academic units. ①②③④⑤⑥⑦

16 Proliferation of courses among academic units, despite overlap in course content, increases the effectiveness of the faculty in securing grants. ①②③④⑤⑥⑦

17 Students can tell the difference between various types of academic units (e.g., Computer Science, Information Systems, Computer Engineering) to make an adequately informed decision about which program best fits their needs. ①②③④⑤⑥⑦

18 If an effort is made to reduce academic units on your campus (or if such an effort currently exists), what is the likely effect of such a program on academic units that teach/research computing (e.g., Computer Science, Information Systems, Computer Engineering)? (Please check the statement that best applies.)

- ☐ None
- ☐ Academic units that teach/research computing would not receive special attention (they would be reviewed in the same way any academic unit would be reviewed)
- ☐ Academic units that teach/research computing would receive special attention due to a perceived concern that there may be a duplication of effort among these academic units

Strongly Disagree
Disagree
Inclined to Disagree
Neutral
Inclined to Agree
Agree
Strongly Agree

19 Similarity of courses among academic units is difficult to control because of academic freedom. ① ② ③ ④ ⑤ ⑥ ⑦

20 When courses that contain similar content are offered in different academic units, students get confused. ① ② ③ ④ ⑤ ⑥ ⑦

21 Existence of similar courses among academic units, in effect, increases faculty morale. ① ② ③ ④ ⑤ ⑥ ⑦

22 Existence of similar courses among academic units, in effect, enhances this institution's reputation. ① ② ③ ④ ⑤ ⑥ ⑦

23 Colleges and universities are generally over-departmentalized/over-compartmentalized. ① ② ③ ④ ⑤ ⑥ ⑦

24 There is generally too much overlap in course content at this institution ① ② ③ ④ ⑤ ⑥ ⑦

25 Proliferation of courses among academic units significantly increases administrative workload. ① ② ③ ④ ⑤ ⑥ ⑦

Please enter the following information. The following information is necessary for further discussion of this topic (e.g., distribution of executive summaries, etc.)

Name of the person responding ______________________________

Title ______________________________

Institution ______________________________

Address ______________________________

____

Telephone Number __________ Fax Number __________ E-mail address __________

Years at this Institution __________ Year Your Terminal Degree was Awarded __________

Name of Your Terminal Degree (e.g., PhD in Computing) ____________________

Institution that Awarded Your Terminal Degree ____________________

Are there factors in your own professional experience that particularly inform your outlook about the organization of computing programs in higher education? Please explain

____

____

____

____

____

I would like my response to this survey held in confidence.
☐ YES
☐ NO

Please use this space for additional comments. If more space is required, please use the back of this page

For more information, please call Patrick Olson at 909 626 0546

Return survey in the enclosed envelope or mail to
Patrick C Olson
% The University of Redlands, Alfred North Whitehead College
1200 East Colton Avenue
P O. Box 3080
Redlands, CA 92373-0999

[Or FAX to 909.335.5125]
Thank you!

Appendix B

A Survey of Computing Department Chairs. About Computing Programs in Higher Education

The
University
Of
Redlands

1 What degree levels does your academic unit offer? (Please check those that apply.)

☐ Associate
☐ Baccalaureate
☐ Masters
☐ Doctorate

2 For each degree level offered by your academic unit, please list the number of students that enrolled, and the number of students that graduated, in the academic years 1990-1991 and 1995-1996. Please estimate the number of students you anticipate will enroll and will graduate in the academic year 2000-2001

	Baccalaureate		Masters		Doctorate	
	Enrolled	Graduated	Enrolled	Graduated	Enrolled	Graduated
1990 - 1991	______	______	______	______	______	______
1995 - 1996	______	______	______	______	______	______
2000 - 2010	______	______	______	______	______	______

3 How many personal computers are dedicated to students (solely for their use) studying computing (at all levels) in your academic unit? (Please check the statement that is most similar to your current environment. For this question student refers to head count.)

☐ More than 1 computer per student
☐ 1 computer per student
☐ 1 computer for every 2 students
☐ 1 computer for every 5 students
☐ 1 computer for ten or more students

4 How many full-time-equivalent faculty are currently in your academic unit (please include faculty on sabbatical or similar leave, and exclude faculty in administrative positions [Deans, Vice Presidents, etc.] with return rights)?

full time tenured ______
full time probationary ______
full time other ______
part time ______

5 How many levels of administration are between your academic unit and your institution's chief academic officer? (e.g., If there is a Dean responsible for a group of academic units that includes your academic unit, and that Dean reports to the Provost/Vice President of Academic Affairs, there would be 1 level of administration between your academic unit and the chief academic officer.)

☐ 0
☐ 1
☐ 2
☐ More than 3
☐ Other ______

6 Please check the statement that best describes the part of your institution that contains your academic unit

☐ College/School/Center of Arts
☐ College/School/Center of Science
☐ College/School/Center of Arts and Sciences
☐ College/School/Center of Business
☐ College/School/Center of Engineering
☐ College/School/Center of Information Studies
☐ College/School/Center of Computing
☐ Other ______________________

7 Please check the statement that best describes how long it has been since your academic unit was reorganized (i.e. moved to a new College/School/Center; combined with another academic unit, etc.)

☐ this academic unit has never been reorganized
☐ less than 1 year
☐ between 1 year and 3 years
☐ between 3 years and 5 years
☐ more than 5 years

8 Please check the statement that best describes the percentage of students who have entered into the following job categories upon graduation from your academic unit over the last 3 years

	None	1-25%	26-50%	51-75%	75%
Application Programmer or Analyst (in Business)	☐	☐	☐	☐	☐
Application Programmer or Analyst (not Business)	☐	☐	☐	☐	☐
Configuration Management Specialist	☐	☐	☐	☐	☐
Database Administrator or Database Designer	☐	☐	☐	☐	☐
Knowledge-Based Information Systems Specialist ☐	☐	☐	☐	☐	
LAN Specialist or LAN Development Specialist	☐	☐	☐	☐	☐
LAN Systems Administrator	☐	☐	☐	☐	☐
Network Manager or Administrator	☐	☐	☐	☐	☐
Personal Computer Support Specialist	☐	☐	☐	☐	☐
Software Analyst or Specialist	☐	☐	☐	☐	☐
Software Engineer or Developer	☐	☐	☐	☐	☐
Systems Administrator or Manager	☐	☐	☐	☐	☐
Systems Analyst	☐	☐	☐	☐	☐
Systems Designer	☐	☐	☐	☐	☐
Systems Engineer or Specialist	☐	☐	☐	☐	☐
Telecommunications Specialist	☐	☐	☐	☐	☐
Other ______________________	☐	☐	☐	☐	☐
Other ______________________	☐	☐	☐	☐	☐
Other ______________________	☐	☐	☐	☐	☐

9 Is your academic unit's curriculum accredited by any of the following? (Please check those that apply.)

☐ Accreditation Board for Engineering Technology
☐ American Assembly of Collegiate Schools of Business
☐ Computing Sciences Accreditation Board
☐ Other ____________________

10 The following list was aggregated from several topic lists. For those topics that apply to your academic unit please check those that are required or electives. If a topic is part of your curriculum, please check whether the topic is taught in your academic unit or by another academic unit.

		Required	Elective		Taught by this unit	Taught by anoth unit
Algorithms/data structures		☐	☐		☐	☐
Architecture		☐	☐		☐	☐
Artificial intelligence/robotics	☐	☐		☐	☐	
Behavioral theories		☐	☐		☐	☐
Computer hardware		☐	☐		☐	☐
Data communications/networking		☐	☐		☐	☐
Database management systems		☐	☐		☐	☐
Databases and information retrieval		☐	☐		☐	☐
Decision support systems		☐	☐		☐	☐
Expert systems		☐	☐		☐	☐
Graphics and image processing		☐	☐		☐	☐
Human-computer interaction		☐	☐		☐	☐
Information systems organized by functional areas		☐	☐		☐	☐
Management information systems		☐	☐		☐	☐
Management theory		☐	☐		☐	☐
Numerical/symbolic computation		☐	☐		☐	☐
Operating systems		☐	☐		☐	☐
Principles/applications of software design		☐	☐		☐	☐
Programming languages		☐	☐		☐	☐
Project management		☐	☐		☐	☐
Quantitative analysis		☐	☐		☐	☐
Simulation		☐	☐		☐	☐
Software generation/maintenance		☐	☐		☐	☐
Software methodology/engineering		☐	☐		☐	☐
Software project management		☐	☐		☐	☐
Software systems engineering		☐	☐		☐	☐
Software verification and validation		☐	☐		☐	☐
Specifications of software systems		☐	☐		☐	☐
Systems theory		☐	☐		☐	☐
Other required topic ______________		☐	◆		☐	☐
Other required topic ______________		☐	◆		☐	☐
Other required topic ______________		☐	◆		☐	☐

11 What is the normal expected teaching workload for full-time members of the faculty **at your institution**? (Please check the statement that applies to your institution. Assume class refers to the number of groups of students lectured to rather than the number of subjects lectured about.)

☐ 1 class per year
☐ 2 classes per year
☐ 3 classes per year
☐ 4 classes per year
☐ 5 classes per year
☐ 6 classes per year
☐ 7 classes per year
☐ 8 classes per year
☐ 9 classes per year
☐ 10 classes per year
☐ Other ________

12 What is the normal expected teaching workload for full-time members of the faculty **in your academic unit**? (Please check the statement that applies to your academic unit. Assume class refers to the number of groups of students lectured to rather than the number of subjects lectured about.)

☐ 1 class per year
☐ 2 classes per year
☐ 3 classes per year
☐ 4 classes per year
☐ 5 classes per year
☐ 6 classes per year
☐ 7 classes per year
☐ 8 classes per year
☐ 9 classes per year
☐ 10 classes per year
☐ Other ________

13 Please check the statement that best reflects the extent to which publication in each of these outlets will help a candidate's prospects for tenure and/or promotion in your academic unit.

	Very Relevant	Relevant	Neutral	Irrelevant
Communications of the ACM	☐	☐	☐	☐
IEEE Computer	☐	☐	☐	☐
IEEE Software	☐	☐	☐	☐
Information & Management	☐	☐	☐	☐
Journal of Management Information Systems	☐	☐	☐	☐
Journal of Object Oriented Programming	☐	☐	☐	☐
Journal of Systems and Software	☐	☐	☐	☐
MIS Quarterly	☐	☐	☐	☐
Publications from ACM Special Interest Groups (SIGs)	☐	☐	☐	☐
Other ____________	☐	☐	☐	☐
Other ____________	☐	☐	☐	☐
Other ____________	☐	☐	☐	☐

Please indicate your opinions about the following statements using a seven-point scale. Please fill in the circle, or place an X over the number that corresponds to your opinion.

STRONGLY AGREE
AGREE
TEND TO AGREE
NEUTRAL
TEND TO DISAGREE
DISAGREE
STRONGLY DISAGREE

14. The need for academic units dedicated to the study of computing has grown in the last five years. ①②③④⑤⑥⑦

15. The need for academic units dedicated to the study of computing will grow in the next five years. ①②③④⑤⑥⑦

16. It is difficult to staff academic units dedicated to the study of computing with qualified faculty. ①②③④⑤⑥⑦

17. Academic units dedicated to the study of computing are adequately distributed among American colleges and universities, thereby giving almost all students the opportunity to study computing. ①②③④⑤⑥⑦

18. This institution's budget adequately supports the study of computing. ①②③④⑤⑥⑦

19. Not enough students are strongly interested in the study of computing. ①②③④⑤⑥⑦

20. Most fields, and especially professional schools, should provide their own courses for the study of computing. ①②③④⑤⑥⑦

21. There is too much overlap in course content among computing programs at this institution. ①②③④⑤⑥⑦

22. Academic units that overlap in their offerings (i.e., replicate one or several courses) are a significant disadvantage to the institution. ①②③④⑤⑥⑦

23. This academic unit's curriculum is based directly on the model curriculum advocated by the Association for Computing Machinery. ①②③④⑤⑥⑦

24. Adherence to a model curriculum requires this academic unit to teach courses that also are taught by other academic units. ①②③④⑤⑥⑦

25. This academic unit's curriculum is based directly on the model curriculum advocated by the Data Processing Management Association. ①②③④⑤⑥⑦

26. Fundraising, especially securing research grants, is required of the faculty and is an expectation for tenure. ①②③④⑤⑥⑦

Please indicate your opinions about the following statements using a seven-point scale. Please fill in the circle, or place an X over the number that corresponds to your opinion.

		STRONGLY AGREE	AGREE	TEND TO AGREE	NEUTRAL	TEND TO DISAGREE	DISAGREE	STRONGLY DISAGREE
27	Proliferation of courses among academic units, despite overlap in course content, increases the effectiveness of the faculty in securing grants	1	2	3	4	5	6	7
28	Students can tell the difference between various types of academic units (e.g., Computer Science, Information Systems, Computer Engineering) to make an adequately informed decision about which program best fits their needs.	1	2	3	4	5	6	7
29	The most desirable faculty for this academic unit are those with prior academic experience as students in the model curriculum used by our academic unit	1	2	3	4	5	6	7
30	This academic unit only hires faculty with PhD's in our field (e.g., as an Information Systems faculty we only hire Information Systems PhDs and no Computer Science or Computer Engineering PhDs)	1	2	3	4	5	6	7
31	Similarity of courses among academic units is difficult to control because of academic freedom.	1	2	3	4	5	6	7
32	When courses that contain similar content are offered in different academic units, students get confused.	1	2	3	4	5	6	7
33	Existence of similar courses among academic units, in effect, increases faculty morale.	1	2	3	4	5	6	7
34	Existence of similar courses, in effect, enhances this institution's reputation.	1	2	3	4	5	6	7
35	Colleges and universities are generally over-departmentalized/ over-compartmentalized.	1	2	3	4	5	6	7
36	There is generally too much overlap in course content at this institution.	1	2	3	4	5	6	7
37	Proliferation of courses among academic units significantly increases administrative workload.	1	2	3	4	5	6	7

Please enter the following information. The following information is necessary for further discussion of this topic (e.g. distribution of executive summaries, etc.)

Name of the person responding ______________________

Title ______________________

Department ______________________

Institution ______________________

Address ______________________

____

Telephone Number __________ Fax Number __________ E-mail address __________

Years at this Institution __________ Year Your Terminal Degree was Awarded __________

Name of Your Terminal Degree (e.g. PhD in Computing) ______________________

Institution that Awarded Your Terminal Degree ______________________

Are there factors in your own professional experience that particularly color your outlook about computing programs in higher education?

____

____

____

____

____

I would like my response to this survey held in confidence
☐ YES
☐ NO

Please use this space for additional comments. If more space is required, please use the back of this page.

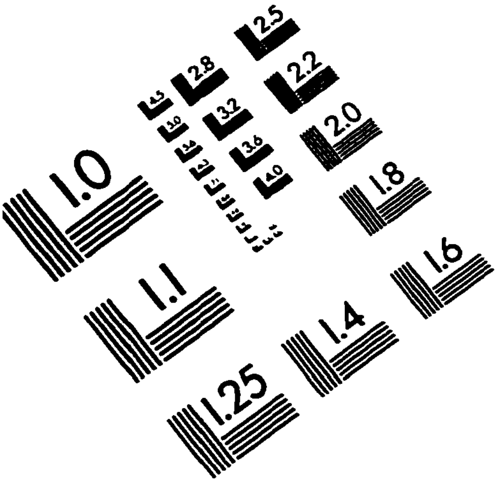
For more information, please call Patrick Olson at 909 626 0546

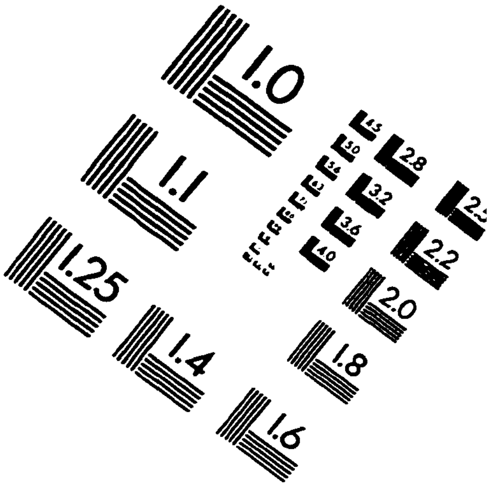
Return survey in the enclosed envelope or mail to
Patrick C. Olson
℅ The University of Redlands, Alfred North Whitehead College
1200 East Colton Avenue
P.O. Box 3080
Redlands, CA 92373-0999

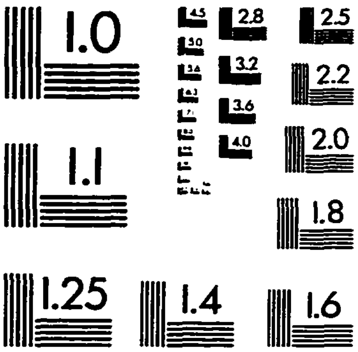
[Or FAX to 909 335 5125]
Thank you!

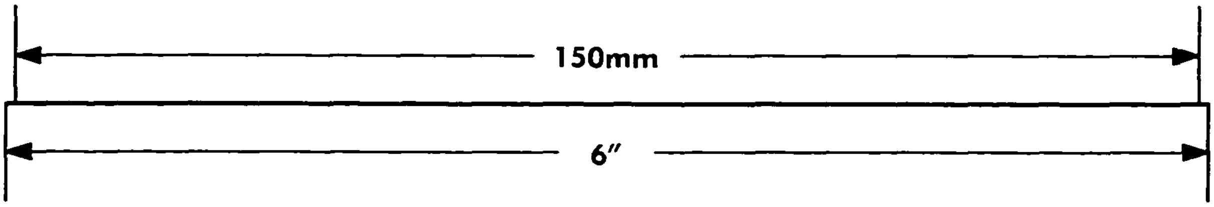
The Cheltenham font was used in this document. It was originally commissioned by Ingalls Kimball for his Cheltenham Press in New York, and was produced by both Linotype and ATF. It became one of the best known of all American typefaces - though credit for its enormous popularity in advertising belongs less to its designer, Bertram Grosvenor Goodhue (in 1902), than to its brilliant exploitation by Morris Benton of ATF into an unprecedented family of weights and widths. (SOURCE: <u>The Electronic Type Catalog</u>)

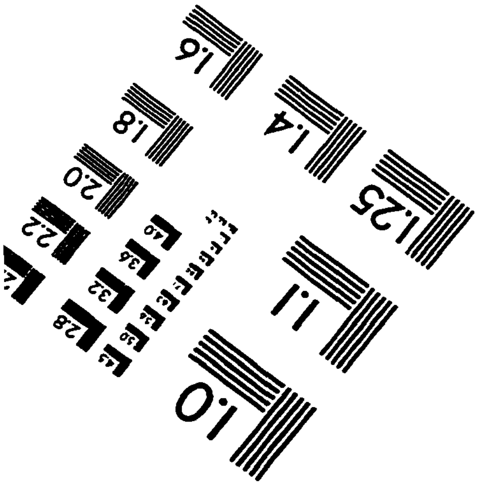
IMAGE EVALUATION
TEST TARGET (QA-3)

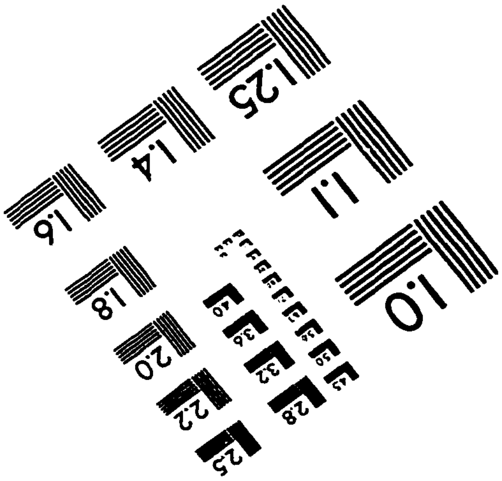












APPLIED IMAGE . Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989