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ABSTRACT

The responsiveness of young people and postsecondary institutions to changes in the demand for workers in different occupations was examined. The skills that 16- to 24-year-old youth generated in the 1980-1981 year were estimated, along with the postsecondary awards and degrees that this age group would earn between 1984 and 1995. Skill projections were derived from the amounts of education completed and the fields of study. The quality of skills of high school graduates was also analyzed, based on comparisons of the 1972 and 1980 graduating classes. Four types of data were assessed to determine whether youth show the flexibility required to respond to skill shortages and oversupplies: intended fields of study, the levels and fields of completed degrees, and rates of occupational and geographic mobility. Five characteristics of the postsecondary system that seem to facilitate its adaptiveness were identified: the number of different institutions and sectors, substitution between them, heterogeneity among them, student geographic mobility, and the internal organization of the institutions in major sectors of the system. Problems that affect the educational system's ability to respond to changes in training requirements were identified, along with policy issues. Statistical findings are included. (SW)

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Research Report

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THE ADJUSTMENTS OF YOUTH AND EDUCATIONAL INSTITUTIONS TO TECHNOLOGICALLY-GENERATED CHANGES IN SKILL REQUIREMENTS

by

Dr. Sue E. Berryman

With the assistance of
Deborah Peetz and Barbara Eubank

May 1985 RR-85-08

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Report submitted to the National Commission for Employment Policy in fulfillment of Contract No. J-9-M-4-0112. Dr. Berryman is a resident consultant with The Rand Corporation, 2100 M Street, N.W., Washington, D.C. 20037.

All views and opinions expressed herein are those of the author and do not represent those of the National Commission for Employment Policy or The Rand Corporation.

PREFACE

The preparation of young people for the jobs of the future is a critical element in the National Commission for Employment Policy's investigation of the impact of computers on employment. This report examines two aspects of this preparation: the responsiveness of young people to changes in the demand for workers in different occupations, and the flexibility of the institutions that educate and train them.

The report concludes that young people generally are responsive to changing market signals; they alter their fields of study, increase or decrease the amount of time they spend on formal education, and are very mobile both geographically and occupationally. The major concern for policymakers relates more to the quality of the education young people receive rather than to the type or amount.

A second conclusion is that education and training institutions, with some exceptions, have historically accommodated major shifts in the demand for their services, especially at the post-secondary level. However, conditions are changing at this level, presenting a challenge to the system's historical capacity to adjust. The recognition of these changes, discussed in this report, and the challenge, are significant first steps toward maintaining the system's ability to revise educational offerings to meet changing needs.

This report is one of several dealing with the effects of computer-based equipment on the job market. It complements another Commission Research Report by Dr. Burt S. Barnow of ICF, Inc., that examines the education, training and work experience of the adult workforce. Other reports from this project examine how computers affect the number and types of jobs that will exist over the next decade, their training requirements, and the role of computers in public elementary and secondary schools.

This series of reports was designed by Carol Jusenius Romero, Sara B. Toye, and Stephen E. Baldwin of the Commission staff, who are also supervising all aspects of the project. This team worked closely with Dr. Berryman in organizing and presenting the information contained in this report. It should be emphasized, however, that the factual information discussed, as well as the issues it raises, were developed solely by Dr. Berryman and do not necessarily reflect the views of either the Commission or the Commission staff.

The Commission expresses its appreciation to Dr. Berryman for her thoughtful examination of the issues and her clear and careful presentation.

EXECUTIVE SUMMARY

This report estimated the skills that 16-24 year old youth generated in one year and projected the post-secondary awards and degrees that this age group would earn between 1984 to 1995. It also assessed the responsiveness of youth and secondary and post-secondary schools to technologically-generated changes in the skills required in the labor market.

Skill Inventories

We assume that youth's educational and work experiences determine the inventory of their skills. Since we lacked analyses to estimate the number, type, level, and quality[1] of the current and *previous* educational and work experiences of today's 16-24 year olds, we used data to define the number, type, and level of skill "bundles" that this age group generated *in a year*.

These estimates show certain striking results. In the selected year, 1980-81, almost 6 million individuals completed secondary and post-secondary programs of study, a number that represented 5.7 percent of the total employed civilian and resident military U.S. labor force in 1982--or, if we exclude high school graduates, almost 3 percent of the total labor force. The number and skill mix of each year's completions will vary from year to year, depending on the size of the 16-24 year old age group, the amounts of education they have chosen to obtain, and their fields of study. However, the sheer number of these completions per year represents a remarkable opportunity to rapidly re-configure the skill profile of the American labor force.

Non-resident aliens receive a substantial percent of the post-secondary degrees awarded in the United States in computer-related fields. For example, in computer science in 1980-81, 5 percent of the B.A. degrees, 22 percent of the M.A. degrees, and 21 percent of the Ph.D. degrees awarded went to non-resident aliens. If most non-resident aliens return to their countries of origin, the total number of computer-relevant degrees awarded in the United States over-estimates the number of trained individuals available to the U.S. economy.

Projections of skills accumulated by the 16-24 year old age group between 1984 and 1995 show that variations in post-secondary field shares can make an enormous difference in the number of degrees awarded

[1] *Type* refers to the nature of the skill. In schools type translates into fields of study, such as electrical engineering. *Level* refers to the sophistication of the knowledge being learned, taught, or exercised. For example, a B.A. program in electrical engineering is at a different level than an M.A. program in the same field. *Quality* is defined as the competence with which knowledge of the same type and level is taught, learned, or exercised.

in particular fields. For example, the projected numbers of B.A. degrees awarded in each of three fields--computer science, engineering, and mathematics--vary by about 185,000 degrees, depending on whether we use the field shares that pertained for 1970 or for 1981 B.A. graduates. The projected number of B.A. degrees in each of two fields, business and education, varied by about *one million* degrees, depending on field share assumptions. Clearly, if individuals obtain post-secondary education, the fields of study that they select can expedite or hamper our adjustment to technologically-generated changes in high skill requirements.

A serious attempt to assess the quality of the current and future skills of secondary and post-secondary students requires definitional, measurement, and data collection work. We discussed the question of the current and future quality of the skills of high school graduates only. Comparisons of two high school senior classes, 1972 and 1980, confirm data marshalled by several reports on the state of secondary education, such as *A Nation at Risk*. These comparisons indicate a deterioration across the eight years in academic course completions, test performance, and homework effort, but an increase in average grades.

We concluded that the question for the next decade is whether this performance decline will be arrested and reversed. Partly in response to the major reports on the status of secondary education in the United States, state after state has legislated or is contemplating legislation to improve its quality. The initiatives range from increasing high school graduation requirements to competency tests for teachers.

Although probably the quality of elementary and secondary education will improve, at least in the sense that students will take more of what *A Nation at Risk* called the five basics (English, mathematics, science, social studies, and computer science), this blizzard of reforms may ultimately affect quality only marginally--or, worse, exacerbate the problems that we already confront. The structural problems that produced the decline in educational quality are profound, and their amelioration requires fairly major reform. Although the states together have taken a number of actions, the package of reforms passed by any one state may be partial, one-shot, or internally inconsistent. Public elementary and secondary education also remains locally controlled, and state governments have limited power to effect reforms.

Youth Responses to Technologically-Generated Changes In Skill Requirements

Two characteristics of technological innovations--uncertain implications for skill requirements and the existence of adjustment time--imply that the important policy question is not what skills the economy will need, but how rapidly students, workers, and training institutions respond to learning what skills are needed.

The data indicate that youth rapidly respond to changes in skill requirements. These changes occur within a given 16-24 year old age group as they age and between successive groups of youth. We examined four types of data to determine whether youth show the flexibility required to respond to skill shortages and oversupplies: intended fields of study, the levels and fields of completed degrees, occupational mobility rates, and geographic mobility rates.

We found dramatic differences between 16-24 year old age groups in their *intended* fields of post-secondary study. These preference shifts seemed to parallel changes in skill requirements in the economy. For example, the more frequent choice of computer science, business, and engineering majors by recent youth groups fits increased demand for technical skills and the increased attractiveness of the private sector relative to the public and nonprofit sectors. Their less frequent choices of education and arts and science majors parallel the 1970's decline in elementary, secondary, and post-secondary teaching opportunities.

We also see members of a given 16-24 year old age group change their field intentions as they move through the educational pipeline. For example, data on the under-graduate majors and intended doctoral fields of 1980-81 GRE test-takers show that between 17 and 49 percent planned to obtain a Ph.D. in a field different from their undergraduate major.

The data show major changes between successive groups of 16-24 year olds in both the level and the field of *completed* post-secondary degrees. The extraordinary growth between 1970 and 1981 in the number of post-secondary degrees essentially mirrored growth in the school age population. However, there was a significant change in degree shares by level: a redistribution from B.A. degrees to awards in occupational programs of less than four years and from M.A. and Ph.D. degrees to professional degrees.

Degree shares by field also showed large changes. For example, at the B.A. level business and management degrees increased from 14 to 22 percent of the total degrees awarded; the health sciences, from 3 to 6 percent. Degrees in education declined from 21 to 11 percent of the total; letters, from 8 to 4 percent; and the social sciences, from 19 to 11 percent.

Overall, the data on the levels and fields of completed degrees suggest that youth respond to oversupplies by earning fewer degrees in oversupplied fields. If they enter an oversupplied field, they increase the amount of education they obtain--presumably to increase their competitiveness in a loose labor market. They respond to shortages or more liberal employment opportunities by increasing their educational investments in these fields at the lower degree levels and reducing them at the higher degree levels--presumably because they are in a seller's market.

Youth showed considerable occupational mobility. We suggested that their mobility had more implication for demand changes in lower skill than in higher skill occupations simply because youth tend to be in the market for lower skill jobs. The implications for technologically-generated demand changes in higher skill jobs depend on substitution possibilities. In terms of access to different high skill occupations, we know appallingly little about what fields of training can substitute for each other and what kinds of work experience can substitute for formal training. However, available data suggest considerably more interchangeability, even for high skill jobs, than we commonly assume, especially for the newer occupations that technological innovations typically spawn.

Finally, we found that youth change geographic residence at much higher rates than older individuals, a propensity that lets them reduce geographically-specific supply/demand imbalances in training and job opportunities.

We discussed two adjustment problems that can arise from the fact that there is a lag between the decision to study a field and the completion of the course of study. One is that shortages that trigger a decision to enter a field may not be alleviated for several years. However, high skill occupations require different amounts of specialized education. For example, about three-fifths of those working in engineering jobs and two-thirds of those working in computer science jobs have only a B.A. degree. Youth also change fields during the educational process. Thus, shortages in a field that requires a longer training period can be remedied faster than the required training period would suggest--by attracting individuals from related areas into the under-supplied field at intermediate points in the training process.

Responses of Educational Institutions to Changes in Skill Requirements

The data showed that in the last 20 years the post-secondary educational system accommodated profound changes in the demand for their services--changes in the total number of students, among fields, between levels, and in the social composition of their student bodies. We discussed five characteristics of the post-secondary system that seemed to facilitate its adaptiveness: the number of different institutions and educational sectors; substitution possibilities between institutions within a sector and between sectors; variations among institutions and sectors; the geographic mobility of post-secondary students; and the internal organization of the institutions in major sectors of the system.

However, we also concluded that the educational system has three important problems and a potential fourth problem that affect its ability to respond to changes in training requirements. First, secondary vocational education in comprehensive high schools is relatively unresponsive to changes in skill requirements. It has been argued that the job market for high school graduates is essentially a market for training opportunities, not fully developed skills. Although employers act as though this is the case, we can as easily argue that employers have no option but to hire the most trainable, as opposed to the most trained, high school graduates. It appears that the institutional context for most vocational education in this country--

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the comprehensive high school, as opposed to the vocational high school--is the problem, not the concept of vocational education itself. For example, in the comprehensive system vocational students are dispersed across high schools, precluding the economies of scale required to justify the costs of the sophisticated, modern equipment that vocational high schools can realize.

Second, the post-secondary system is facing a period of unprecedented enrollment decline that promises to slow its response to change. Since student-generated revenues constitute a significant part of the total revenues of both public and private institutions, institutions increasingly have to cut the resources going to some units in order to free up money to respond to fields with enrollment growth. This process usually generates considerable resistance, particularly in institutions organized in the way that most post-secondary institutions are organized--with dispersed, rather than centralized, authority. The percent of schools that have unionized and the proportions of faculties that are tenured have also increased over the last decade, making institutions more rigid.

Third, we identified quality as a potential problem in the educational system. Institutions face a much older post-secondary faculty by the year 2000, a development that will raise the average cost of faculty salaries and make it difficult to introduce the new fields and courses that may be needed to meet technologically-generated changes in skill requirements. At the same time, the quality of the future non-tenured faculty that traditionally staffs the newest fields may be lower than in previous decades. The best students are the most able to choose fields with good employment and salary opportunities, and the bleak job market and low salaries for college teachers are not apt to attract the most able individuals.

How institutions adjust to enrollment declines may also endanger the quality of post-secondary entrants, their degrees, and institutional leadership. Institutions already show signs of trying to limit enrollment declines in ways that affect quality, such as lowering admission requirements, seeking nontraditional and academically less preferred students, and responding rapidly to changes in students' field-specific demand, whatever its merit.

Fourth, technologically-generated changes in skill requirements are apt to increase demand among all kinds of employers for individuals who possess the new skills. Since the military-like compensation structures of post-secondary schools limit their ability to compete for the scarce labor required to teach these new skills, there has been concern that the post-secondary schools will become training bottlenecks for the skills most needed to integrate technological advances into the economy.

Our analyses indicate that there is at least a brisk market for, if not shortages of, computer science faculty. We did not see evidence of electrical engineering faculty shortages, although there may be spot shortages in narrow specialties or in particular types of institutions. Perhaps more important, we do not know what effect a faculty shortage has on student training. Substitution can operate as much in the world of learning opportunities as it does in the employment world.

In sum, the public policy problems seem to be the tough ones of the *quality* of skills delivered by our educational system, not their type or level. The quality issue pervades secondary education, not just vocational education in the comprehensive high schools. It promises increasingly to affect the post-secondary system.

Substitution Possibilities

This project dramatized our need to know--and our lack of knowledge--about what can substitute for what among learning opportunities, formal training, and work experience. Being able to answer this question is key to understanding how rapidly management and labor can accommodate technologically-generated skill change.

All of the recent reports on public high schools have sounded alarms about students' verbal, mathematical, and scientific skills. These concerns were predicated partly on the assumption that a solid skill base equips individuals to adjust to job and occupational changes by giving them the foundation for learning new skills. This view seems consistent with private sector training behaviors. Employers conduct training that is critical for helping labor adjust to technological change, but they typically train "at the margin," i.e., build on a base.

This concept of flexibility does not seem to carry over into how we usually think about skill shortages or over-supplies, especially for somewhat higher skill occupations. We implicitly assume that these occupations require occupationally-specific education. If occupations require distinct bundles of skills, they operate like countries with immigration barriers. Workers cannot move freely among these countries. However, data presented in this report indicate that this is a mechanistic and fundamentally inaccurate theory of human cognitive capacities, the educational system, the effects of schooling, and the nature of jobs. Students and even highly skilled workers do move--between post-secondary fields and between high skill occupations. The movement is not unconstrained, but there is movement. We also see evidence that learning opportunities--for example, about computer-based equipment--seem more widely dispersed among post-secondary courses and departments than might be thought. This raises questions about the meaning of field-specific faculty shortages.

The problem for public and private sector policy is that we do not have a good knowledge base about what substitutes for what and under what conditions. Answers to this fundamental question could drastically alter how the public and private sectors conceive of training policies. Certainly they would position employers and policymakers to anticipate better when technologically-generated changes in skill requirements will and will not cause adjustment problems.

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TABLES

I. INTRODUCTION

POLICY BACKGROUND

As recently as ten--and in some cases, five--years ago, technologies such as genetic engineering, computers, and computer-based equipment were exotic curiosities in the United States. Today they are the subject of the popular media--newspaper and magazine articles, futurist movies, television shows, and books; research studies, often commissioned by federal and state agencies; and political activities, including political campaign speeches, labor contract negotiations, and lobbying by certain industries for protectionist legislation. This attention, in all its forms, signals that we are trying to understand what these new technologies mean for us as individuals and for our economic, political, and social institutions. It also signifies early defenses against their consequences, both experienced and feared.

Many questions focus on the employment impact of these technologies. Which skills will become obsolete? Do obsolete skills have to translate into obsolete workers? Will employers encounter severe skill shortages that jeopardize the American competitive position internationally, or the economic position of one region or city relative to others? How should we encourage young people to prepare for the labor market? What kind of retraining are dislocated workers best advised to obtain? How much time is there for adjustment--how fast will these technologies alter skill requirements?

This report addresses the question of skill shortages, especially of skills that can be acquired in post-secondary vocational or academic programs. It assesses how rapidly and in what ways 16-24 year old youth and secondary and post-secondary educational institutions adjust to technologically-generated changes in skill requirements. Youth and education and training institutions are both key to how rapidly and well the labor force adjusts to changes in those required job skills most efficiently learned in structured education programs of longer, rather than shorter, duration. Youth are usually the best-positioned age group to invest in these kinds of programs, but their ability to do so depends on how schools themselves respond to changes in training requirements.

CONCEPTS AND ASSUMPTIONS

Five central assumptions underlie this project on technologically-generated changes in skill requirements. First, a new technology can change the amount, type, level, or quality of the skills required to produce goods and services. It is critical to identify what kind of technologically-generated change is being assumed because the policy implications of such changes will vary, sometimes markedly, depending on which dimensions of change are at issue.

Skill is defined as the capacity to perform a task, whether narrowly or broadly construed. For example, typing a letter and performing the job of secretary are both tasks, but the second is much broader than--and usually includes--the first. When we use the terms *inventory* or *stock* of *skills*, as in the inventory of skills possessed by youth, the best analogy is to the inventory or stock of *goods*, as in a store.

Amount refers to the number of person hours--ultimately the number of workers--required to produce a given output. A new technology can reduce or increase the demand for labor either by altering the number of workers required for the same output or by changing the total output. *Type* is defined as the nature of a skill. In schools type translates into fields of study, such as ceramic engineering; in the labor force it translates into occupations, such as college physics teacher. A new technology can eliminate the need for types of skills now in use and create the need for new ones.

Level refers to the sophistication of the knowledge being learned, taught, or exercised. In schools level refers to points in the educational process--elementary and secondary grades and post-secondary degrees, such as the associate, B.A., M.A., or Ph.D. Thus, the type of skill can be the same--ceramic engineering, for instance, but the level of knowledge different, such as a bachelor's versus a master's degree in the field. In the labor force level translates into different occupations, such as electronic engineer versus electronic technician, or into different grades within an occupation, such as a routine versus statistical computer programmer.

Quality is defined as the competence with which a skill of the same type and level is learned, taught, or exercised. Quality variations emerge from variations among students, teachers, and workers in native talents, educational achievements, and length of work experience. A new technology can increase or decrease the quality required to do the same task.

The second assumption is that how a new technology affects the *type* of skills required depends on the task in question. Computer-based equipment entails design of the equipment itself, design of the manufacturing process to produce it, production activities, marketing, distribution, use, and repair. Designing the equipment, or a process for manufacturing it, for example, can involve radically new skills. However, operating the production process, or using the technology, or repairing it may require fairly standard skills or ones only trivially different from those already in existence. For example, relative to the engineering that underlies the typewriter, text processors are a complex and innovative technology. However, an associated innovation, "user friendly" software, allows typists to convert to text processors without skill changes that in any way approximate the engineering differences between the two technologies.

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In fact, the diffusion rates of a new technology are related to the labor force turbulence that it produces. It is expensive for employers to alter their labor forces dramatically, whether they fire workers that the new technology renders obsolete, hire new workers with the requisite skills, or finance extensive employee retraining. Employers certainly take these actions if the technology's long-term cost savings clearly warrant the cost of introducing it.[1] However, in general those trying to market a new technology have incentives to minimize the labor force turbulence that it produces. The lightning diffusion of text processors seems associated, not just with miniaturization and plummeting prices, but also with the creation of software that lets individuals use them with fairly minor retraining. In sum, new technologies normally generate changes in skill requirements, but the inventory of existing skills limits these changes--either by containing the technology's diffusion or by encouraging changes in the technology to minimize changes in skill requirements.

Third, we can *retroactively* see what technical innovations implied for human skills. However, we do not have the knowledge to predict in any precise way the skill implications of a radically new technology, such as computers and computer-based equipment. In part, this is because a technology can be integrated into the work place in various ways with variable skill effects. This flexibility probably accounts in part for the "mixed" effects on skills that technologies frequently produce (e.g., Spenner, 1984). Although some technologies are quite rigid and have more predictable skill effects, others, such as computer-based equipment, are very flexible and have less determinant skill effects.

Thus, the characteristics of technologies affect, but do not determine, skill requirements. Our ability to predict changes in technologically-generated skill requirements deteriorates as we move from occupations that design, manufacture, market, operate, manage, or maintain the technology to those only indirectly affected by its introduction. In consequence, questions about the skill implications of technical innovations seem most fruitfully treated as questions, not about what skills we will need, but about how rapidly labor and educational institutions respond to *learning* what we need.

Fourth, substitution possibilities[2] pervade the educational system and the work place. Researchers and policymakers tend to assume that a particular occupation requires a unique bundle of skills, obtained from limited sources. *Empirical evidence indicates that this is a mechanistic and fundamentally inaccurate view of human cognitive capacities, the educational system, the effects of schooling, and the*

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[1]The newspaper industry is a good example of where the cost savings of computer-based printing warranted the cost of eliminating the jobs of typesetters.

[2]As used here, the concept of substitution simply means interchangeability.

nature of jobs. The same basic knowledge can often be obtained in alternative ways--in different courses at the same school, in different schools, in jobs as well as in schools, or in military as well as in civilian jobs. The ability to substitute one source of knowledge for another depends on the knowledge in question. Two sources may be completely or only partially interchangeable with each other.

In the economy the need for particular skills can often be met by individuals with different educational and occupational backgrounds. Again the possible substitutes vary in degree and number, depending on the job in question. However, as we show later, case studies of labor sources for the jobs of computer operator, programmer, and systems analyst show that, depending on the task, work experience can substitute for formal training; formal training in one field can substitute for formal training in another; and work experience in one occupation can substitute for work experience in another. Thus, a projected demand for a skill that exceeds the projected supply of new graduates trained in the specific skill by no means necessarily implies a labor shortage.

The fifth assumption is that no technological revolution is instantaneous, no matter how radical the technical concept, rapid the diffusion of the technology, or momentous the ultimate changes in industrial and occupational structures. There is adjustment time. Any major new technical concept triggers a dynamic invention, research, and development process that takes time. Integrating a new technology into the society also takes time, and this process requires a fairly coordinated set of actions by a range of actors and institutions, not just by labor and our educational systems.

For example, a study of the employment effects of four major innovations--the power loom, sewing machine, telegraph, and electric power--concludes that:

> Inventions take on importance only as they are used: the period of adoption, or diffusion, of an invention is just as important as the period of invention. Historically, even for many revoluntionary innovations, this period of diffusion has been relatively long. This delay was caused by several factors:
>
> - Inventions often required modifications before they became commerically successful, a process which took time; many potential customers waited until the early lack of standardization and attendant technological uncertainties were resolved.
>
> - The existing technology did not disappear immediately. It continued to improve and in some cases successfully competed for customers with the new innovation.
>
> - A period of working with a new technology, or "learning by using," was often necessary before its true potentialities were recognized (James, 1984, p. i).

We have witnessed a revolution in agricultural technologies in this country, and these technical changes radically altered the skill mix in the labor force. In 1820 72 percent of the wage earners worked in agriculture; in 1980, 3 percent. The shift is enormous. However, *this change occurred over a period of 160 years,* the percent employed in agriculture declining on average by less than 0.5 percent per year. The percent employed in agriculture declined to 70.5 percent in 1830, to 68.6 percent in 1840, and to 63.7 percent in 1850. At the turn of the century almost 40 percent were still employed in agriculture. These were major *long-term* shifts, but small yearly ones.

Major technological innovations diffuse faster today than in the nineteenth century. Changes in communications, transportation, and marketing strategies alone speed up their "travel." Nonetheless, current evidence indicates that skill requirements will change in *evolutionary,* not revolutionary, ways.

In sum, five basic assumptions underlie this report.

- A new technology can change the amount, type, level, or quality of the skill required to produce goods and services. It is critical to identify what kind of change is presumed because the policy implications of technologically-generated skill changes vary, sometimes markedly, depending on the kind of change at issue.

- How a new technology affects the *type* of skills required depends on the task in question. For example, it may generate the need for new skills to design manufacturing processes for the technology, but require only existing skills to market it.

- The skill implications of a new technology, especially flexible technologies such as computer-based equipment, are somewhat uncertain. Thus, questions about these implications seem most fruitfully treated as questions, not about what skills we will need, but about how rapidly students, labor, and educational institutions respond to learning what we need.

- Substitution possibilities pervade the educational system and work place. Often the same knowledge can be learned in alternative ways--in different courses at the same school, at different schools, and in jobs, as opposed to formal courses. The need for particular skills can also often be met by individuals with different occupational and educational backgrounds.

- Although a new technology can rapidly change skill requirements, no technological revolution is instantaneous. There is adjustment time.

ORGANIZATION OF THE REPORT

Chapter II of the report estimates the inventory of skills that 16-24 year olds acquire in a year. It also projects the total pre-baccalaureate, B.A., M.A. Ph.D., and professional degrees that will be completed by field between 1984 and 1995.

Chapters III and IV assess how youth and secondary and post-secondary educational institutions, respectively, respond to technologically-generated changes in skill requirements. Chapter V summarizes the findings of the report and presents policy conclusions.

II. THE INVENTORY OF CURRENT AND PROJECTED SKILLS FOR 16-24 YEAR OLDS

This chapter describes the current inventory of skills for 16-24 year olds. It also estimates what skills this age group will acquire over the 1984-1995 period, illustrating how these estimates vary according to different assumptions about this age group's educational attainments and choices of field of study.

CURRENT INVENTORY OF SKILLS OF 16-24 YEAR OLDS

We assume that formal training programs and work experience create the inventory of skills possessed by the 16-24 year old age group. To estimate the number, type, level, and quality of the skill "bundles" possessed by today's 16-24 year olds, we need data on their current *and previous* training and work experience. Such data exist in longitudinal data bases, but since the time frame for the project precluded new analyses, we had to use available cross-sectional data for our estimates.[1]

We assumed that the number of graduates from formal training programs by field for one year and the number of 16-24 year olds employed by occupation in one year define the number, type, and level of skill "bundles" that this age cohort generates *in a year*. The skills developed in one year by the age group are not the same as those that it possesses. An individual who gets an M.S. in computer science in the year that we measure may have obtained a B.S. in electrical engineering in a previous year.

We also interpret the age range loosely for formal degrees. The age distribution for those who obtain post-secondary degrees exceeds the 24 year old cut-off. We assume that the interest in 16-24 year olds is an interest in the skills of those best positioned to invest in extensive training. Such individuals are certainly members of younger age groups, but they may exceed the age of 24.[2]

Aside from the difficulty of obtaining a consensus about what dimensions of quality are most germane to the labor force, we do not have the data to estimate quality for graduates of post-secondary programs.[3] However, we present some data that tell us something about

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[1]A longitudinal data base is like a movie: it *follows* a collection of individuals through time. A cross-sectional data base is like a snapshot: it takes only one picture of individuals at one point in time.

[2]For example, 50 percent of those who complete the doctorate are over 33 years of age for all Ph.D. degrees and over 31 years of age for those who earn doctorates in science and engineering.

[3]Assessing the quality of experience in an occupation requires, at minimum, being able to measure the length of experience in the given occupation. Although data on occupational experience exist in longitudinal data bases, again we lack the requisite analyses.

quality at the secondary level. We also discuss educational quality *issues* in this chapter and in Chapter IV.

Skills Generated in the Formal Education System

We define the formal educational system to include: high schools; non-collegiate, collegiate, graduate, or professional post-secondary institutions; apprenticeship programs; and the military. We exclude Job Training Partnership Act programs because no data are now available on field of training. We also exclude private sector training programs--unless the program uses post-secondary institutions. In this case the training will be picked up in the data on post-secondary degrees. We do not have data on other kinds of private sector training by age of the trainee, type of training, or duration of the training program.

Although estimates of how much the private sector invests in training vary wildly, we know that the amount is large. Some private sector training is orientation training--acquainting new and longer-term employees with company policies and practices. However, firms also sponsor occupational training, including significant amounts of informal and on-the-job training that employers often do not even designate as training. These informal means include, for example, observing and questioning more experienced co-workers as they work and are particularly important for learning blue collar manufacturing jobs and the skilled crafts outside of the construction industry.[4]

Employers typically do not assume training responsibility for skills that require substantial investments of time and money. They certainly finance post-secondary vocational, college, and graduate courses for their employees. However, when these investments occur in the context of the job, as opposed to that of fringe benefit packages, employers invest only limited resources per employee. They typically train "at the margin," modifying, but not creating the core of the employee's skill base. Thus, although employer-sponsored training is critical if the labor force is to adjust to technologically-driven changes in skill requirements, the important policy question is less the amount and type of private sector training than whether younger workers enter the labor force with the skill base on which employers can build.

Although we would like to have had data for the same year, the years differ slightly. Apprenticeship data are for 1979;[5] the data on

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[4]Decades of research on how employees acquire skills document the role of informal on-the-job learning. See, for example, *Training of Workers in American Industry*, 1962; *Formal Occupational Training of Adult Workers*, 1964; Perlman, 1969; Horowitz and Herrnstadt, 1969; Doeringer and Piore, 1971; Somers et al., 1972; Lusterman, 1977; Goldstein, 1980.

[5]There are apprenticeship data more recent than 1979. However, 1979 apprenticeship data distinguish the trades in which the apprenticeships were completed whereas those after 1979 do not.

post-secondary degrees, for 1980-81. The military data refer to training received by members of the fiscal year 1982 enlistment cohort who stayed in the military for at least 13 months. Although the data come from three different years, we have no reason to think that the number of completions by field, race, ethnicity, or gender changed particularly across this short time period.

The full set of tables on the number of program completions by level, field, and, in most cases, gender, race, and ethnicity appear in the Appendix.[6] In the appendix and text tables and in the text discussion we use the term "B.A." as the generic term for the bachelor of arts or science and the "M.A." as the generic term for the master of arts or science.

The first text table shows the total education that 16-24 year olds tend to acquire by the age of 30-34 years. We selected the age of 30-34 years because by this age individuals have virtually completed their education.[7] As the table shows, 6 percent of the total cohort has no more than 8 years of education and 16 percent less than 12 years. Thirty-seven percent has a high school education, 47 percent at least some post-secondary education, and 12 percent at least some graduate education. Attainment varies widely by gender, race, and ethnicity. For example, 52 percent of the men, but only 41 percent of the women, have at least some post-secondary education. Forty-four percent of the Asian Americans, but only 10 percent of the Hispanics, have a college degree. Twenty-four percent of the Asian Americans, but only 13 percent of the whites, have graduate education. And a third of the Hispanics, but only 7 percent of the whites, have less than a tenth grade education.

In Table 2 we see the number and gender, racial, and ethnic shares of secondary and post-secondary program completions in one year.[8] This table contains striking information. *In one year almost 6 million*

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[6]Table A.1 describes the number of 1980 high school seniors by curriculum; Table A.2, the number of 1980-81 post-secondary, non-collegiate vocational completions by field; Table A.3, the number of 1979 apprenticeship completions by trade; Table A.4, the number of FY1982 military enlistees who completed 13+ months of service by occupation in which trained; Table A.5, the number of 1-2 years and 2-4 years pre-baccalaureate awards by field; and Tables A.6-A.9, the number of 1980-81 B.A., M.A., Ph.D., and professional degrees, respectively, by field.

[7]Although age groups younger than those 30-34 years old in 1980 will ultimately probably attain slightly more education than those 30-34 years old in 1980, over short periods of time aging has more effect on educational attainment than generation. For example, 84.5 percent of the cohort that was 25-29 years old in 1980 had completed high school, versus 83.8 percent for the 30-34 year old cohort. However, only 22.1 percent of the 25-29 year old cohort had completed college versus 24.6 percent of the 30-34 year old cohort.

[8]Even if "youth" are generously defined, youth will not account for all of these completions. However, virtually all of the high school graduates and first-term enlistee trainees will be youth. Youth will account for most of the baccalaureate and graduate degrees and for

Table 1

YEARS OF SCHOOL COMPLETED BY THOSE 30-34 YEARS OLD IN 1980
BY GENDER, RACE, AND ETHNICITY

Years of School Completed	Total N	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American
Total N		17,709,880	8,755,937	8,953,943	14,797,785	1,915,772	1,155,371	120,455	405,111
		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0	91,339	.52	.55	.48	.40	.61	2.23	.82	1.45
1-4	139,039	.79	.86	.72	.54	.78	6.24	1.13	1.17
5-6	243,248	1.37	1.45	1.30	.97	1.63	10.35	1.76	2.41
7-8	594,578	3.36	3.49	3.23	2.94	4.78	9.52	6.43	2.36
9	517,803	2.92	2.73	3.11	2.57	4.80	5.91	5.24	1.99
10	641,236	3.62	3.21	4.03	3.15	6.82	5.21	6.63	2.33
11	635,812	3.59	3.30	3.88	3.03	7.61	5.19	6.27	2.16
12	6,578,527	37.15	32.10	42.08	37.59	39.55	29.26	38.13	21.06
13	1,469,774	8.3	7.79	8.80	8.38	8.80	6.53	9.70	5.59
14	1,648,011	9.31	10.30	8.33	9.49	8.80	6.64	9.41	9.19
15	787,153	4.44	5.02	3.88	4.53	3.86	3.17	4.27	6.04
16	2,260,246	12.76	14.25	11.31	13.74	6.46	4.63	5.24	20.12
17-18	1,374,506	7.76	8.76	6.79	8.33	3.81	3.17	3.38	12.99
>18	728,608	4.11	6.21	2.07	4.34	1.70	1.95	1.59	11.14
% H.S. Graduate		83.8	84.4	83.3	86.4	73.0	55.4	71.7	86.1
% with >= 4 Yrs. of College		24.6	29.2	20.2	26.4	12.0	9.7	10.2	44.2

SOURCE: Table 262, pp. 40-52, U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population, U.S. Summary, U.S. Government Printing Office, Washington, D.C., 1984.

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Table 2

NUMBER AND SHARE OF PROGRAM COMPLETIONS
BY LEVEL, GENDER, RACE, AND ETHNICITY

	Total	Gender		Race and Ethnicity						
		Male	Female	White	Black	Hispanic	American Indian	Asian American	Other	Nonresident Alien
High school graduates (1980)										
Total N	2,813,094	1,334,813	1,478,281	2,177,780	307,851	260,082	23,324	41,568	2,622	---
Share (percent)	100.0	47.5	52.6	77.4	10.9	9.3	.8	1.5	.09	---
Pre-B.A. completions										
Apprenticeships (1979)										
Total N	43,347	42,211	1,243	35,918	3,190	2,258	704	765	512	---
Share (percent)	100.0	97.4	2.9	82.9	7.4	5.2	1.6	1.8	1.2	---
Military training (excluding combat occupations) (FY1982 enlistment cohorts)										
Total N	189,077	164,611	24,466	140,557	35,939	6,492	800	2,340	2,149	
Share (percent)	100.0	87.1	12.9	74.3	19.0	3.4	.4	1.2	1.1	
Non-collegiate Post-secondary Vocational (1980-81)										
Total N	889,969	NA(a)	NA	NA	NA	NA	NA	NA	NA	NA
Share (percent)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collegiate programs >1 and <2 years (1980-81)										
Total N	87,404	38,030	49,374	NA	NA	NA	NA	NA	NA	NA
Share (percent)	100.0	43.5	56.5	NA	NA	NA	NA	NA	NA	NA
Collegiate programs >2 and <4 years (1980-81)										
Total N	287,416	133,141	154,275	NA	NA	NA	NA	NA	NA	NA
Share (percent)	100.0	46.3	53.7	NA	NA	NA	NA	NA	NA	NA
B.A. degrees (1980-81)										
Total N	934,800	469,625	465,175	807,319	60,673	21,832	3,593	18,794	---	22,589
Share (percent)	100.0	50 24	49.46	86.36	6.49	2.34	.38	2.01	---	2.42
M.A. degrees (1980-81)										
Total N	294,183	145,666	148,517	241,216	17,216	6,461	1,034	6,232	---	22,057
Share (percent)	100.0	49.52	50.48	82.0	5.82	2.20	.35	2.14		7.5

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Table 2 (continued)

	Total	Gender		Race and Ethnicity						
		Male	Female	White	Black	Hispanic	American Indian	Asian American	Other	Nonresident Alien
Ph.D. degrees (1980-81)										
Total N	32,839	22,595	10,244	25,908	1,265	456	130	877	---	4,203
Share (percent)	100.0	68.81	31.19	78.89	3.85	1.39	.40	2.67		12.8
Professional degrees (1980-81)										
Total N	71,340	52,194	19,146	64,551	2,931	1,541	192	1,456	---	669
Share (percent)	100.0	73.16	26.84	90.48	4.11	2.16	.27	2.04	---	.94

Total program completions:	5,786,227
Shares by level (percent):	
Secondary	51.1
Pre-baccalaureate post-secondary	25.9
Baccalaureate	16.2
Graduate	6.9

SOURCE: High school graduates: National Center for Education Statistics, unpublished weighted figures from <u>High School and Beyond</u>. The Hispanic proportion of the total 1980 graduates seeems high. Other completions: Tables A.1-A.7.

(a) NA = Not available.

individuals completed secondary and post-secondary programs of study. About half of this number consisted of high school graduates. Another quarter were pre-baccalaureate, post-secondary completions; the final quarter, baccalaureate and graduate completions. This number for one year represents 5.7 percent of the total employed civilian and resident military U.S. labor force in 1982--or, if we exclude high school graduates, almost 3 percent of the total labor force. Obviously, the number and skill mix of each year's program completions will vary from year to year, depending on the size of the 16-24 year old age group, the amount of education they have chosen to obtain, and their fields of study. Nonetheless, *the potential for changing the skill content of the labor force in one year, let alone over even a five year period, is significant.*

Table 3 excerpts from the Appendix tables the number of post-secondary program completions that are in fields unambiguously relevant to computer-based equipment. The purpose is to illustrate what youth's general educational activities imply for specific skills. The technical skills acquired in military training programs--displayed in the column labeled DoD--may be narrower than those acquired in civilian programs. (For example, those trained in electronic repair tend to learn to repair specific components of a particular weapons system.) Although this training originally occurs in the military, most of it ultimately becomes available to the civilian economy. By the end of four years of service, 70 percent of an enlistment cohort has left the military. By the end of eight years of service, this percent has increased to 86 percent.

We have probably underestimated the total number of persons trained at the post-secondary level in computer and keypunch operations. A training category exists called "data processing technologies, general" which probably trains some of these skills. For 1-2 year programs the number of persons in this category is 1,476; for 2-4 year programs, 11,551.

It is important to keep in mind that non-resident aliens receive a certain percent of the post-secondary degrees awarded in the United States. In 1980-81, they received 2 percent of the B.A. degrees, 7.5 percent of the M.A. degrees, and 12.8 percent of the Ph.D. degrees. (See Tables A.6-A.8.) However, they receive much higher proportions of the degrees awarded in computer-relevant fields. For example, in 1980-81 at the B.A. level 5 percent of the computer science degrees, 9 percent of the engineering degrees, and 4 percent of the mathematics degrees were awarded to non-resident aliens. At the M.A. level aliens received 22 percent of the computer science degrees, 28 percent of the engineering degrees, and 18 percent of the mathematics degrees. And at the Ph.D. level this group received 21 percent of the computer science degrees, 38 percent of the engineering degrees, and 24 percent of the mathematics degrees. To the extent that most non-resident aliens return to their countries of origin, the total number of computer-relevant degrees awarded in the United States substantially overestimates the number of trained individuals available to the U.S. economy.

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smaller proportions, but still the vast majority, of apprenticeships and pre-baccalaureate awards and degrees.

Table 3

1980-81 COMPLETIONS OF POST-SECONDARY COMPUTER-RELEVANT EDUCATIONAL AND TRAINING PROGRAMS BY LEVEL

	Degree						
Degree Field	Non-Collegiate Vocational	DoD	1-2 Year Post-Secondary Program	2-4 Year Post Secondary Program	B.A.	M.A.	Ph.D.
Computer Operator	3,276	1,252	726	488			
Keypunch Operator	7,899		855	85			
Computer Programmer	22,329	352	1,504	8,522			
Electronic Technician	18,189	25,684	5,295	18,886			
Electromechanical Technician	1,090	49,873	335	2,930			
Computer/Information Sciences					15,121	4,218	252
Engineering: all fields					74,954	16,709	2,561
Electrical Engineering					14,938	3,901	535

SOURCE: Tables A.2, A.4-A.8.

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The next table, Table 4, provides some context for interpreting the data in Table 3. It shows the number of people trained in one year in an occupation as a percent of the total number employed in that occupation. It also shows the separation rate for each occupation. Annual vacancies for an occupation reflect both the growth in the total number of people employed in that occupation (positive or negative) and the number of exits (separations) from that occupation. In the average occupation, separations account for 90 percent of the vacancies. This percent is smaller for fast-growth occupations, which are often new occupations created by technological innovations. It is larger for occupations in decline.

Table 4

NUMBER EMPLOYED, NUMBER WHO LEFT THE OCCUPATION, AND NUMBER TRAINED IN POST-SECONDARY PROGRAMS IN THE OCCUPATION FOR EACH OF SEVERAL COMPUTER-RELEVANT OCCUPATIONS (1980-81)

Occupational Category	Total Employed in 1980	Percent Who Left the Occupation in 1980-81(a)	Total Trained in 1980-81	No. Trained as % of No. Employed
Computer Operator	395,547	16.6	5,742	1.5
Keypunch Operator	394,815	24.9	8,839	2.2
Computer Programmer	317,673	8.2	38,707	10.3
Electronic Technician	266,184	11.4	69,054	25.9
Computer Systems: Analysts, Scientists, + Academic Faculty	211,529	5.3	19,591	9.3
Engineering: all fields + academic faculty	1,434,710	7.4	94,224	6.6
Engineering: electrical only + academic faculty	331,028	4.1	19,374	5.9

(a)SOURCES: Total trained: see Table 3. Total employed: Table 277, pp. 1-176 to 1-179, U.S. Bureau of the Census, *Detailed Population Characteristics: United States Summary*, PC80-1-D1-A, Washington, D.C.: U.S. Government Printing Office, 1984; and Table B-4, p. 7, National Science Foundation, *Academic Science/Engineering: Scientists and Engineers, January, 1983*, NSF84-309, Washington, D.C.: U.S. Government Printing Office, 1984. Separation rates: Table 1, pp. 5-6, Alan Eck, "New Occupational Separation Data Improve Estimates of Job Replacement Needs," *Monthly Labor Review*, Vol. 107, No. 3, March, 1984.

The occupational separation rate for an occupation is defined as the percent of individuals previously employed in an occupation who are not employed in that same occupation a year later. Those who leave an occupation may or may not have left the labor force. The occupational separation rates cited here do not include those for college faculty.

Except for computer and keypunch operators, the number trained as a percent of those employed in each occupation is about the same or larger than the separation rate for that occupation. The computer and keypunch operator occupations are low skill, and secondary, as well as post-second..ry, vocational education programs train these skills. The small shortfall for all fields of engineering can only be elucidated by examining the data for engineering sub-specialties.

Skills Created in Jobs

Tables 5 and 6 show the extent to which youth work in high technology occupations and industries by age.[9] In estimating the skill inventory of 16-24 year olds, we included work experience in high technology industries because even if the person is not working in a high technology occupation in a high technology industry, he or she is more apt to be exposed to these occupations and to gain some understanding of what workers in these occupations do.

In 1980 16-24 year olds constituted 21 percent of all employed workers and 16 percent of the high technology labor force. Of all employed 16-24 year olds, 12 percent worked in high technology occupations, most of them as technicians, mechanics and repairers, and precision production operators. Since several high technology occupations require post-secondary education, an increasing proportion of employed youth work in these occupations as the cohort ages. For example, 16 percent of employed 20-24 year olds, versus 4 percent of employed 16-17 year olds, work in these occupations.

In 1980 17 percent of all employed 16-24 year olds worked in high technology industries, the percent increasing with age from 7 percent for the 16-17 year olds to 20 percent for the 20-24 year olds. About half worked in two industries: business and repair services and public administration.

1984-1995 SKILL PROJECTIONS FOR 16-24 YEAR OLDS

We limit skill projections to skills acquired in formal educational programs. The projections discussed here are simply illustrative of how the future stock of skills acquired by 16-24 year olds can vary, depending on assumptions about the amounts of education that they obtain and their fields of study.

[9]Tables A.10a and A.10b show how youth's work experience in high technology occupations varies by race, ethnicity, and gender.

Table 5

PERCENT OF EMPLOYED 16-24 YEAR OLDS WORKING IN HIGH TECHNOLOGY OCCUPATIONS(a) BY OCCUPATIONS AND AGE

Occupation	Age			
	16-24	16-17	18-19	20-24
All Occupations	100.0	100.0	100.0	100.0
High Technology Occupations	12.43	3.53	8.03	15.49
Architects	.42	.11	.02	.05
Engineers	.57	.18	.09	.83
Mathematics and Computer Scientists	.14	.007	.02	.21
Natural Scientists	.16	.02	.05	.21
Survey and Mapping	.29	.007	.02	.04
Technology and Related Support	3.05	.47	1.53	4.01
Computer Operators	.62	.15	.51	.75
Health Diagnosis	.51	.01	.02	.07
Health Analysis	1.13	.09	.20	1.62
Mechanics and Repairers	3.62	1.61	3.10	4.15
Precision Production	3.02	1.12	2.46	3.55

SOURCE: Table 280, pp. 232-233, U.S. Department of Commerce, Bureau of Census, 1980 Census of Population, U.S. Summary, U.S. Government Printing Office, Washington, D.C., 1984.

(a)High technology occupations to include the professional, technical, repair, and operator occupations that involve complex machinery.

Table 6

PERCENT OF EMPLOYED 16-24 YEAR OLDS WORKING IN HIGH TECHNOLOGY INDUSTRIES(a) BY INDUSTRY AND AGE

	Age			
Industry	16-24	16-17	18-19	20-24
All Industries	100.0	100.0	100.0	100.0
High Technology Industries	17.23	7.35	14.15	20.06
Chemical and Allied Products	.90	.21	.63	1.12
Machinery (except Electrical)	2.54	.74	2.15	3.01
Electrical Machinery, Equipment, and Supplies	2.0	.48	1.65	2.32
Aircraft, Spare Vehicle, and Parts	.52	.05	.30	.67
Communications	1.02	.23	.63	1.29
Utilities	.89	.20	.54	1.13
Insurance	1.84	.53	1.61	2.15
Business and Repair Service	4.40	3.22	4.24	4.68
Public Administration	3.17	1.70	2.40	3.69

SOURCE: Table 289, pp. 392-393, U.S. Department of Commerce, Bureau of Census, 1980 Census of Population, U.S. Summary, U.S. Government Printing Office, Washington, D.C., 1984.

(a)The literature defines high technology industries in several ways. Most definitions use one or more of three criteria: use of scientific and technical workers, industry expenditures for research and development, and the nature of the industry's product. Riche, Hecker, and Burgan (1983) developed three alternative definitions of high technology industries, and we use their most inclusive definition: all industries that use technology-oriented workers at a rate of at least 1.5 the average for all industries. They define these as engineers, life and physical scientists, mathematical specialists, engineering and science technicians, and computer specialists.

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Projections of these kinds should be useful to educational institutions for planning purposes. However, we suggest that they are less critical for anticipating skill shortages simply because, as data presented in Chapters III and IV imply, significant skill shortages are infrequent and usually short-term.

To project skills acquired in formal educational programs, we need projections of the educational program completions of those in the 16-24 year old age group between 1984 and 1995 by educational level and field. The National Center for Education Statistics (NCES) projects the number of B.A., M.A., Ph.D., and professional degrees for this time period, and, lacking better alternatives, we use these projections to estimate the number of degrees by level.[10] Since NCES does not project pre-baccalaureate degrees, we estimate the number of associate degrees and other pre-baccalaureate awards for curricula of 1-2 and 2-4 years for 1984-1995 by using the number of completions in 1981-82.

No projections for fields of study exist. However, to show how the number of degrees can vary as student field choices vary, we calculate the number of degrees that will be completed in each field at a given level by using the field shares that prevailed for 1970-71 graduates and those that prevailed for 1981-82 graduates.

Table 7 shows how assuming different field shares affects the number of degrees obtained by field in the eleven years between 1984 and 1995.[11] Even if the total number of degrees awarded at each level does not vary, varying the field shares can make an enormous difference in the number of degrees awarded in particular fields in 11 years. For example, at the B.A. level the number of degrees awarded in each of two fields, business/management and education, vary by about *one million*, depending on field share assumptions. For each of three fields--computer science, engineering, and mathematics--the variation in 11 years is about 185,000 degrees. Clearly, the fields in which post-secondary students decide to invest can facilitate or impede the adjustment of the labor force to technologically-generated changes in high skill requirements.

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[10]It should be noted that the NCES projections are based on past trends and do not take account of factors that should affect youth's future educational behaviors.

[11]Appendix Tables A.11-A.13 present the total degrees produced by level and by field, given 1970-71 and 1981-82 field distributions. Table A.11 presents the data for 1-2 year and 3-4 year pre-baccalaureate awards; Table A.12, for B.A., M.A., and Ph.D. degrees; and Table A.13, for professional degrees.

Table 7

PROJECTED NUMBER OF DEGREES AWARDED IN SELECTED FIELDS, 1984-1995, UNDER DIFFERENT FIELD SHARE ASSUMPTIONS

Field	1-2 Year Degree 1970-71 Field Shares	1-2 Year Degree 1981-82 Field Shares	B.A. 1970-71 Field Shares	B.A. 1981-82 Field Shares	M.A. 1970-71 Field Shares	M.A. 1981-82 Field Shares	Ph.D. 1970-71 Field Shares	Ph.D. 1981-82 Field Shares
Natural Sciences	32,587	58,867						
Public Services	88,300	55,713						
Business/Management			1,368,494	2,257,206	365,037	658,910	9,174	9,540
Computer Science			28,342	215,599	21,921	53,056	1,462	2,814
Education			2,128,657	1,073,944	1,226,004	1,007,744	72,881	85,819
Engineering			541,527	711,577	224,932	188,396	41,411	29,277
Mathematics			298,599	123,488	71,483	29,228	13,633	7,602
Physical Sciences			258,111	255,074	87,685	59,410	49,964	36,733

SOURCE: Tables A.11 and A.12

QUALITY OF CURRENT AND PROJECTED SKILLS

As defined in Chapter I, we use quality to mean the competence with which a skill of the same type and level is taught, learned, or exercised. In this chapter we briefly discuss problems with the concept of quality, present data on indicators of trends in the quality of high school seniors, and discuss implications of the current educational reform movement for changes in the quality of high school graduates. Chapter IV discusses quality considerations at the post-secondary level.

Concepts and Measurement of Quality

"Quality" is constantly invoked in policy discussions about everything from public schools to military manpower. However, users rarely define what they mean, and different users implicitly use different criteria to assess quality. For example, when we talk about a "quality" education, do we mean one that creates solid basic skills or is occupationally relevant? What do we mean by a "quality" worker--someone who is reliable? Innovative? Well-educated?

Even if we agree on meaning, measuring quality poses very tough substantive and methodological problems. For example, is the "quality" of a worker best assessed by supervisory ratings, paper and pencil tests, or ratings of his or her performance at specific tasks? How do we rate performance on tasks that require considerable judgment and discretion? Measuring *changes* in quality is even more problematic than assessing quality at a point in time. For example, sometimes the tests that measure performance themselves change over time. Or apparent improvements in performance ratings turn out to reflect "teaching to the test." Or, as in the case of the Scholastic Aptitude Test, the composition of those being rated changes over time, severely complicating the interpretation of the time series.

In sum, a serious attempt to assess the quality of the current and future skills of secondary and post-secondary students requires substantial definitional, measurement, and data collection work.

Quality of Current and Projected Skills of High School Graduates

Comparisons of two high school senior classes, 1972 and 1980,[12] confirm data marshalled by several reports on the state of secondary education, such as *A Nation at Risk* issued by the National Commission on Excellence in Education. These comparisons indicate a deterioration across the eight years in academic course completions, test performance, and homework effort, but an *increase* in average grades (Fetters et al., 1984).

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[12]Data for these comparisons come from two longitudinal studies of high school seniors, the *National Longitudinal Study of the High School Class of 1972* and *High School and Beyond* (1980 high school class).

- In eight years the less demanding general curriculum gained at the expense of the academic program, the percent of public and private school seniors in the academic curriculum declining from 46 to 38 percent and the general curriculum increasing from 32 to 37 percent. *White,* not minority, students accounted primarily for these curricular shifts.

- The number of English and science courses taken by an average student in high school remained fairly stable, the number of foreign language and social science courses declined, and the number of mathematics courses increased by 10 percent. However, since an increased percent of the English and mathematics courses taken were remedial, the apparent stability in English and gain in mathematics are somewhat illusory. In mathematics, the percent taking remedial courses increased from 4 to 30 percent; in English, from 6 to 31 percent.[13]

- Scores on the same vocabulary, reading, and mathematics tests declined in the eight year period for the total population and for all subgroups of high school seniors--male and female; white and minority; students from families of low, middle, and high socio-economic status; and those in academic and non-academic curricula.

- Between the two time points the average amount of time per week spent on homework declined from 4.26 to 3.85 hours, or by 25 minutes per week. In 1972 35 percent of the high school seniors spent at least five hours per week on homework; in 1980, 25 percent.

- Although test scores and homework effort declined in the eight years, student grade point averages increased from a 2.78 to a 2.85 average for the total student population, on a scale of A = 4, B = 3, C = 2, and D = 1. The average increased for all student subgroups.

The question for the next decade is whether this performance decline will be arrested and reversed. *A Nation at Risk* and other recent reports on the same topic have created an excellence movement in the country. State after state has legislated or is contemplating legislation on high school graduation requirements, state college entry requirements, minimum competency tests for students, credentialling standards for teachers, competency tests for teachers, teacher pay and working conditions, length of the school day and year, class size, and school governance and finance.

[13]In 1972 estimates of remedial courses were based on the survey administrators' examination of student course transcripts; in 1980, on students' self report. Thus, some of the difference between the two points in time may be artifactual. However, subsequent examination of 1980 course transcripts does confirm that a large number of 1980 seniors had taken remedial courses, i.e., the difference is not primarily artifactual.

For example, 43 states have raised high school graduation requirements in the last two years and five more are considering more stringent requirements this year. Fifteen states now require an exit test for high school graduation, and four states are considering this initiative. Thirty-seven states have instituted statewide assessments of elementary and secondary students' achievement in English, writing, mathematics, science, history, and other areas. Twenty-nine states have upgraded teacher education requirements to include a mandatory teacher-competency test, and another ten states are considering this idea ("Changing Course," *Education Week,* 1985).

This flurry of legislative activity would seem to promise an inevitable improvement in the quality of elementary and secondary education over the next decade. And probably the quality of elementary and secondary education will improve, at least in the sense that students will take more of what *A Nation at Risk* called the five basics (English, mathematics, science, social studies, and computer science).

However, good intentions not withstanding, *this blizzard of reforms may ultimately affect quality only marginally*--or, worse, exacerbate the problems that we already confront. The structural problems that produced the decline in educational quality are profound. For example, as women's and minorities' educational and occupational opportunities have increased, our schools have lost their captive labor supply of high quality female and minority entrants into teaching. However, the education community has yet to make the reforms in teacher education, credentialling, career ladders, compensation, and working conditions that are required to compete successfully for good candidates.

Although the states *together* have taken a number of actions, the package of reforms passed by any one state may be partial, one-shot, or internally inconsistent. For example, a state may increase graduation requirements in science and mathematics and fail to take action on teachers' salaries and working conditions that let schools attract the additional teachers needed to handle increased science and mathematics enrollments. Or the reforms may be trivial. For example, a state may institute a merit pay plan to retain good teachers. However, the amount of money that the plan awards an individual teacher may be so small as to have almost no effect on his or her decision to stay in teaching.

SUMMARY

We assumed that youth's educational and work experiences define the inventory of their skills. Since we lacked analyses to estimate the number, type, level, and quality of the current and *previous* education and work experience of today's 16-24 year olds, we used data for one year to define the number, type, and level of skill "bundles" that this age cohort generates *in a year.*

The data showed that in a given year (1980-81) almost six million individuals completed secondary and post-secondary programs of study, a number that represented 5.7 percent of the total employed civilian and resident military U.S. labor force in 1982--or, if we exclude high school graduates, almost 3 percent of the total labor force. Although the number and skill mix of each year's completions will vary from year to year, depending on the size of the 16-24 year old age group, the amount of education they have chosen to obtain, and their fields of study, the potential for changing the skill content of the labor force in one year, let alone over even a five year period, is significant.

Non-resident aliens receive a substantial percent of the U.S. post-secondary degrees awarded in computer-relevant fields. For example, in computer science in 1980-81, 5 percent of the B.A. degrees, 22 percent of the M.A. degrees, and 21 percent of the Ph.D. degrees awarded went to non-resident aliens. To the extent that most non-resident aliens return to their countries of origin, the total number of computer-relevant degrees awarded in the United States overestimates the number of trained individuals available to the U.S. economy.

Projections of skills accumulated between 1984 and 1995 show that variations in field shares can make an enormous difference in the number of degrees awarded in particular fields. For example, at the B.A. level the number of degrees awarded in each of three fields, computer science, engineering, and mathematics, vary in 11 years by about 185,000 degrees, depending on field share assumptions. The variation for business and education is about one *million* degrees.

A serious attempt to assess the quality of the current and future skills of secondary and post-secondary students requires definitional, measurement, and data collection work. Here we discussed the question of the current and future quality of the skills of high school graduates only. Comparisons of two high school senior classes, 1972 and 1980, confirm data marshalled by several reports on the state of secondary education, such as *A Nation at Risk*. These comparisons indicate a deterioration across the eight years in academic course completions, test performance, and homework effort, but an increase in average grades.

The question for the next decade is whether this performance decline will be arrested and reversed. Partly in response to the major reports on the status of secondary education in the United States, state after state has legislated or is contemplating legislation to improve its quality. The initiatives range from increasing high school graduation requirements to competency tests for teachers.

Although the quality of elementary and secondary education will probably improve, at least in the sense that students will take more of what *A Nation at Risk* called the five basics (English, mathematics, science, social studies, and computer science), this blizzard of reforms may ultimately affect quality only marginally--or, worse, exacerbate the problems that we already confront. The structural problems that produced the decline in educational quality are profound, and their amelioration requires fairly major reform. Although the states *together* have taken a number of actions, the package of reforms passed by any one state may be partial, internally inconsistent, short-term, or little more than hortatory.

III. HOW YOUTH ADJUST TO CHANGES IN SKILL REQUIREMENTS

As noted earlier, two characteristics of technological innovations--uncertain implications for future skill requirements and adjustment time--imply that the important policy question is *not* what skills the economy will need, but how rapidly students, workers, and training institutions respond to *learning* what we need. In other words, we need to know how rapidly:

- youth adjust their educational investments to market signals about changes in skill requirements; and
- the educational system responds to changes in student and employer training needs.

This chapter addresses the first question; the next chapter, the second question.

Young people's shifts on four dimensions reveal their ability to respond to skill shortages and oversupplies. These are shifts in their intended fields of study, changes in the amount of education that they obtain in different fields, their occupational mobility rates, and their geographic mobility rates.

Although rates of change tell us something about general flexibility, changes can occur in response to factors other than changes in employers' skill requirements. For example, young people's choices of college majors reflect objectives other than just economic ones--enrichment, social, or political interests, for example, as when students choose an English literature or an ethnic studies major. Nonetheless, these data show us how fluid or fixed youth cohorts are within institutional constraints and relative to older workers, previous 16-24 year old age groups, and earlier choices that members of the age group itself make.

CHANGES IN INTENDED FIELDS OF STUDY

Changes in youth's intended fields of study are important for two reasons. First, field preferences are related--although not perfectly--to occupational preferences.[1] Youth's educational experiences and

[1]Time series data on occupational preferences have problems more severe than those posed by the imperfect relationship between preferred fields of study and occupational choices. The occupational categories are either too gross to be illuminating, as in the *National Longitudinal Study of the High School Class of 1972* and *High School and Beyond*, or the survey data are reported in peculiar ways. For example, the annual data series, *The American Freshman National Norms,* has a reasonable set of occupational categories in its student survey, but only recently have the results been reported for most of these options. In the first half of the 1970's, the choices of at least a fifth of the respondents were lumped into an occupational category called "other."

occupational choices are interactive: their educational experiences affect their occupational preferences, and these preferences in turn affect their educational choices. For example, high school students are more likely to take advanced mathematics electives if they see these as germane to their educational and occupational plans (e.g., Armstrong, 1979; Lantz and Smith, 1981). Thus, changes in field preferences are harbingers of changes in occupational objectives. Second, data on the fields of completed degrees reflect both student field preferences and the supply of educational services. Data on intended fields of study, on the other hand, are less confounded with variations in the supply of educational services.

We conclude that successive groups of youth can choose dramatically different fields of post-secondary study and that these shifts parallel changes in skill requirements in the economy. To assess intended fields of study, we use survey data from those who took the Scholastic Aptitude Test (SAT). Although the SAT population consists primarily of only those who plan to go on to college, we are most concerned about this group's responsiveness to changes in skill requirements. Technologically-generated skill mismatches are more apt to occur in higher skill occupations that require at least some college. Number shortages may arise for lower skill jobs, but skill mismatch problems will be relatively minor.

Table 8 shows marked differences between 1973 and 1984 test-takers in expected college majors *that parallel changes in job opportunities in the economy*. We see declines for education (10 to 4.6 percent) and for a range of academic fields: biological sciences (4.8 in 1976 to 3.1 percent in 1984), English/literature (4 to 1.3 percent), foreign languages (2 to 0.8 percent), mathematics (3 to 1.1 percent), physical sciences (4 to 1.7 percent), and history, social sciences, and psychology (15 to 11.1 percent). We see significant *increases* for business and commerce (10 to 19.1 percent), computer science and systems analysis (1 to 9.7 percent), and engineering (6 to 12 percent).

In general, these changes parallel changes in job opportunities in the economy. Reduced interest in education and the academic disciplines parallels the 1970's decline in opportunities in elementary, secondary, and post-secondary teaching occupations that account for over one-third of the professional labor force.[2] The greater popularity of the computer science, business and commerce, and engineering fields fits increased demand for technical skills and the increased attractiveness of the private sector relative to the public and non-profit sectors.

We not only see changes in preferred fields of study from one youth cohort to another. We also see members of a cohort change their preferences as they proceed through the educational pipeline. Survey data from those who took the Graduate Record Examination (GRE) on college major and intended field of graduate study let us observe the

[2]Table 276, U.S. Bureau of the Census, *Detailed Population Characteristics*, United States Summary, Section A, 1980 Census, U.S. Government Printing Office, Washington, D.C., 1984.

Table 8

INTENDED COLLEGE MAJOR: FIRST CHOICES OF SAT TEST TAKERS
1973 AND 1984
(Percent)

SAT	1973(a)	Post-1973(b)	1984	Difference
Agriculture	2		1.0	-1.0
Arch./Envir. Design	2		1.6	-0.4
Art	4		3.4	-0.6
Biological Sciences		4.8 (1976)	3.1	-1.7
Business/Commerce	10		19.1	9.1
Communications(c)	2		3.7	1.7
Computer Science/ System Analyses		1 (1974)	9.7	8.7
Education	10		4.6	-5.4
Engineering	6		12.0	6.0
English/Literature	4		1.3	-2.7
Ethnic Studies	0		0	0
Foreign Languages	2		0.8	-1.2
Forestry/Conservation		1.2 (1975)	0.4	-0.8
Geography		0 (1975)	0	0
Health/Medical		17.9 (1976)	15.1	-2.8
History/Cultures		2 (1974)	0.5	-1.5
Home Economics	2		0.5	-1.5
Library Science		0.1 (1976)	0	-0.1
Mathematics	3		1.1	-1.9
Military Science		0.9 (1976)	0.7	-0.2
Music	3		1.4	-1.6
Philosophy/Religion	1		0.3	-0.7
Physical Sciences	4		1.7	-2.3
Psychology		3 (1974)	3.5	0.5
Social Sciences	15		7.3	-7.7
Theater Arts		1.1 (1976)	1.0	-0.1
Trade/Vocational	3		0.8	-2.2
Other		2.3	0.9	-1.4
Undecided	7		4.4	-2.6

SOURCE: 1973-83: The College Board, _College-Board Seniors_, Eleven Years of National Data from the College Board's Admissions Testing Program. 1984: The College Board, _National College-Bound Seniors, 1984_.

(a)Data were rounded to the nearest whole percentage point in 1973 and 1974.

(b)Where the definition of a field changed between 1973 and 1984, we give the data for the first year after 1973 in which the definition for the field was the same as that used in 1984.

(c)This field was called journalism in 1973 and 1974.

extent to which members of this subgroup select graduate fields different from their undergraduate majors. Table 9 shows that between 17 and 49 percent of 1980-81 GRE test-takers planned to obtain a Ph.D. in a field different from their undergraduate major. For example, we see shifts from a variety of academic and applied fields into education and from the arts, humanities, education, health, and mathematics into the behavioral sciences.

Nonetheless, this intra-cohort change seems less profound than that between different cohorts of SAT test-takers. We see substantial continuity between undergraduate major and intended graduate field of study, and, when individuals plan to change field, we also see that they tend to select fields related to the undergraduate major. For example, although only 60 percent of those who had majored in biology in college planned to continue in this field at the graduate level, 30 percent planned to enter health or applied biology fields. Of the 17 percent of engineering undergraduates who did not plan graduate study in engineering, half planned to enter mathematics and the physical sciences.

CHANGES IN EDUCATIONAL ATTAINMENTS

When we look at the educational investments of sequential groups of youth--the amount of education completed and the field of the post-secondary degree, we again see very large behavioral shifts from group to group that reflect changes in skill requirements in the economy.

Table 10 shows extraordinary growth between 1970-71 and 1981-82 in the *number* of post-secondary degrees at all but the Ph.D. level. However, numeric growth in degrees essentially mirrors growth in the school age population, not structural changes in the post-secondary behaviors of youth. For example, between the two time periods the 20-24 year old age group grew by 33 percent; the number of degrees earned by this age group (pre-baccalaureate and baccalaureate degrees), by 36 percent.

Table 10 does show structural changes in the *levels* of attainment. Below the graduate level we see a significant proportionate redistribution from B.A. degrees to awards in occupational programs of less than four years. At the graduate level we see a proportionate redistribution from M.A. and Ph.D. degrees to professional degrees. The shift from M.A. and Ph.D. degrees to professional degrees seems consistent with reduced opportunities in the post-secondary teacher market. The shift from the B.A. degree to pre-baccalaureate awards may partly reflect limited opportunities in elementary and secondary teaching and the increasing number of good technical jobs for which training can be obtained in pre-baccalaureate occupational programs.[3]

[3]It has been suggested that the end of the Vietnam War explains this shift, i.e., young men who were trying to avoid the draft and who ordinarily would have obtained only a pre-baccalaureate degree stretched out their deferments by obtaining a B.A. degree. However, the data show exactly the same shift for female as for male post-secondary students,

Table 9

EXPECTED FIELD OF DOCTORAL STUDY OF 1980-81
GRE TEST-TAKERS BY UNDERGRADUATE MAJOR(a)

		Expected Field of Doctoral Study										
Undergraduate Major	Total	Edu-cation	Arts	Other Human.	Other Soc. Sci.	Beh. Sci.	Biol. Sci.	Health	App. Biol.	Engin.	Math. Sci.	Phys. Sci.
Education	100.0	78.1	.3	3.2	3.1	10.4	1.2	2.3	← 1.4 →			
Arts	100.0	11.7	64.9	8.8	3.5	8.6	← 2.5 →					
Other Humanities	100.0	11.6	1.2	66.6	5.4	12.5	← 2.8 →					
Other Social Sciences	100.0	13.7	.6	6.8	51.0	21.3	← 3.7 →				2.6	.3
Behavioral Sciences	100.0	9.3	.2	3.6	7.0	78.2	.6	1.8	← 1.1 →			
Biological Sciences	100.0	2.6	← 1.5 →			3.0	59.6	16.6	13.6	← 3.1 →		
Health	100.0	8.4	← 2.4 →			6.8	5.7	73.6	2.1	← .9 →		
Applied Biology	100.0	5.3	← 2.6 →			3.4	8.0	4.1	75.1	← 1.4 →		
Engineering	100.0	← 1.7 →			2.4	2.8	← 2.1 →			82.7	5.1	3.3
Mathematical Sciences	100.0	5.4	.3	2.5	2.5	6.0	← 2.4 →			4.6	74.1	2.2
Physical Sciences	100.0	1.3	← 1.6 →			1.5	7.6	5.2	1.4	5.6	2.3	73.6

SOURCE: Table 36, pp. 50-51, Marlene B. Goodison, A Summary of Data Collected from Graduate Record Examinations Test-Takers During 1980-81, Educational Testing Service, New Jersey, 1982.
(a) This table excludes respondents who did not answer the question, were undecided about their graduate major, or fell into an "other" category.

Table 10

1970 AND 1981 POST-SECONDARY DEGREES BY LEVEL, NUMBER, PERCENT CHANGE, AND SHARE

Degree Level	Number by Level		Percent Change	Share by Level (percent)	
	1970-71	1981-82		1970-71	1981-82
Total	1,293,530	1,749,749	35	100.0	100.0
Awards for Occupational Curricula of at least 2 and less than 4 years	124,093	304,154	145	9.6	17.4
Awards for Occupational Curricula of at least 1 and less than 2 years	29,456	95,563	224	2.3	5.5
B.A. Degrees	839,730	952,998	14	64.9	54.5
M.A. Degrees	230,509	295,546	28	17.8	16.9
Ph.D. Degrees	32,107	32,707	2	2.5	1.9
Professional Degrees	37,635	68,781	83	2.9	3.9

SOURCE: Tables 11-15.

Tables 11-15 show major structural changes in the cohorts' educational attainments by field at each degree level, Table 11 presenting the data for pre-baccalaureate awards; Table 12, for B.A. degrees; Table 13, for M.A. degrees; Table 14, for Ph.D. degrees; and Table 15, for professional degrees. Each table displays the number of degrees by field for 1970-71 and 1981-82, the percent change between the two time points in the number of degrees by field, and the share of total degrees by field for each of the two time points.

First, the tables often show large percent changes for the 11 year period in the number of degrees awarded in particular fields--even for fields that have a sizable initial base.[4] For example, as Table 12

suggesting that the war did not temporarily inflate the share of B.A. degrees in 1970-71.

[4]The base for some fields is so small that any numeric increase across time produces a very large, but not very meaningful, *percent* change. For example, doctorates in protective services increased by

Table 11

FORMAL AWARDS BELOW THE BACCALAUREATE GRANTED IN AN OCCUPATIONAL CURRICULUM OF AT LEAST ONE YEAR (1970-71 AND 1981-82)

Occupational Field	Number of Degrees 1970-71(a)	Number of Degrees 1981-82(b)	Percent Change	Field Share of Total 1970-71 Degrees (percent)	Field Share of Total 1981-82 Degrees (percent)
Curricula of At Least 2 and Less Than 4 Years					
	124,093	304,154	145.1	100.0	100.0
Business and Commerce Technologies	43,571	104,637	140.15	35.1	34.4
Data Processing Technologies	7,564	22,155	192.9	6.1	7.3
Health Services and Paramedical Technologies	24,370	65,716	169.66	19.6	21.6
Mechanical, Engineering, and Electronic Technologies	30,172	88,513	193.36	24.3	29.1
Natural Science Technologies	6,107	14,617	139.35	4.9	4.8
Public Service Technologies	12,309	28,402	130.74	9.9	9.3
Curricula of At Least One and Less Than 2 Years					
	29,456	95,563	224.43	100.0	100.0
Business and Commerce Technologies	7,466	25,244	238.12	25.3	26.4
Data Processing Technologies	1,181	4,930	317.44	4.0	5.2
Health Services and Paramedical Technologies	10,148	24,716	143.56	34.5	25.9
Mechanical, Engineering, and Electronic Technologies	7,265	35,421	387.56	24.7	31.5
Natural Science Technologies	921	5,399	486.21	3.1	5.6
Public Service Technologies	2,475	5,056	104.28	8.4	5.3

(a)SOURCE: Table 20, Digest of Education Statistics, 1973 Edition, National Center for Educational Statistics, U.S. Department of Health, Education, and Welfare, 1973, p. 103.
(b)SOURCE: Table C-5, Occupational Projections and Training Data, 1984 Edition, Bureau of Labor Statistics, U.S. Department of Labor, 1984, p. 105.

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Table 12

B.A. DEGREES CONFERRED BY INSTITUTIONS OF HIGHER EDUCATION BY FIELD
1970-71 AND 1981-82

Occupational Field	Number of Degrees 1970-71	Number of Degrees 1981-82	Percent Change	Field Share of Total 1970-71 Degrees (percent)	Field Share of Total 1981-82 Degrees (percent)
Total	839,730	952,998	13.5	100.0	100.0
Agribusiness and agricultural production	3,207	5,037	57.1	.38	.53
Agricultural sciences	7,061	12,395	75.5	.84	1.30
Renewable natural resources	2,404	3,597	49.6	.29	.38
Architecture and environmental design	5,570	9,728	74.6	.66	1.02
Area and ethnic studies	2,582	2,862	10.8	.31	.30
Business and management	113,542	212,474	87.1	13.52	22.30
Business and office	1,323	1,527	15.4	.16	.16
Communications	10,324	32,428	214.1	1.23	3.40
Communications technologies	478	1,794	275.3	.06	.19
Computer and information sciences	2,388	20,267	748.7	.28	2.13
Education	176,614	101,113	-42.7	21.03	10.61
Elementary education, general	90,432	37,261	-58.8	10.77	3.91
Special education, general and all specialities	8,360	14,180	69.6	1.00	1.49
Engineering	44,898	67,021	49.3	5.35	7.03
Engineering and engineering-related technologies	5,148	12,984	152.2	.61	1.36
Foreign languages	19,945	9,841	-50.7	2.38	1.03
Allied health	2,556	6,056	136.9	.30	.64
Health sciences	22,634	57,329	153.3	2.70	6.02
Home economics	10,825	17,265	59.5	1.29	1.81
Vocational home economics	342	607	77.5	.04	.06
Law	545	846	55.2	.06	.09
Letters	64,933	34,334	-47.1	7.73	3.60
Liberal/general studies	5,461	18,145	232.3	.65	1.90
Library and archival sciences	1,013	307	-69.7	.12	.03
Life sciences	35,743	41,639	16.5	4.26	4.37
Mathematics	24,801	11,599	-53.2	2.95	1.22
Military sciences	357	283	-20.7	.04	.03
Multi/interdisciplinary studies	8,306	17,651	112.5	.99	1.85
Parks and recreation	1,621	5,335	229.1	.19	.56
Philosophy and religion	8,146	6,309	-22.6	.97	.66
Theology	3,744	5,998	60.2	.45	.63
Physical sciences	21,412	24,052	12.3	2.55	2.52
Psychology	37,880	41,031	8.3	4.51	4.31
Protective services	2,045	12,438	508.2	.24	1.31
Public affairs	6,252	18,739	199.7	.75	1.97
Social sciences	155,236	99,545	-35.9	18.49	10.45
Visual and performing arts	30,394	40,422	33.0	3.62	4.24

SOURCE: Table 2.12, Department of Education, National Center for Educational Statistics, Condition of Education, 1984, Washington, D.C.: U.S. Government Printing Office, p. 90.

Table 13

M.A. DEGREES CONFERRED BY INSTITUTIONS OF HIGHER EDUCATION BY FIELD
1970-71 AND 1981-82

Occupational Field	Number of Degrees 1970-71	Number of Degrees 1981-82	Percent Change	Field Share of Total 1970-71 Degrees (percent)	Field Share of Total 1981-82 Degrees (percent)
Total	230,509	295,546	28.2	100.0	100.0
Agribusiness and agricultural production	573	947	65.3	.25	.32
Agricultural sciences	1,501	2,510	67.2	.65	.85
Renewable natural resources	383	706	84.3	.17	.24
Architecture and environmental design	1,705	3,327	95.1	.74	1.13
Area and ethnic studies	1,032	809	-21.6	.45	.27
Business and management	26,481	61,295	131.5	11.49	20.74
Business and office	0	4	--	0	.001
Communications	1,770	3,104	75.4	.77	1.05
Communications technologies	86	223	159.3	.04	.08
Computer and information sciences	1,588	4,935	210.8	.69	1.67
Education	88,952	93,757	5.4	38.59	31.72
Elementary education, general	17,070	12,788	-25.1	7.41	4.33
Special education, general and all specialities	6,068	14,258	135.0	2.63	4.82
Engineering	16,309	17,526	7.5	7.08	5.93
Engineering and engineering-related technologies	134	413	208.2	.06	.14
Foreign languages	4,755	2,008	-57.8	2.06	.68
Allied health	185	654	253.5	.08	.22
Health sciences	5,260	15,288	190.6	2.28	5.17
Home economics	1,420	2,325	63.7	.62	.79
Vocational home economics	32	30	-6.3	.01	.01
Law	955	1,893	98.2	.41	.64
Letters	11,148	6,421	-42.4	4.84	2.17
Liberal/general studies	549	1,094	99.3	.24	.37
Library and archival sciences	7,001	4,506	-35.6	3.04	1.53
Life sciences	5,728	5,874	2.5	2.49	1.99
Mathematics	5,191	2,727	-47.5	2.25	.92
Military sciences	2	49	2350.0	.0009	.02
Multi/interdisciplinary studies	1,157	3,884	235.7	.50	1.31
Parks and recreation	218	526	141.3	.10	.18
Philosophy and religion	1,326	1,152	-13.1	.58	.39
Theology	2,710	4,064	50.0	1.18	1.38
Physical sciences	6,367	5,514	-13.4	2.76	1.87
Psychology	4,431	7,791	75.8	1.92	2.64
Protective services	194	1,336	588.7	.08	.45
Public affairs	8,215	18,216	121.7	3.56	6.16
Social sciences	16,476	11,892	27.8	7.15	4.02
Visual and performing arts	6,675	8,746	31.0	2.90	2.96

SOURCE: Table 2.12, Department of Education, National Center for Educational Statistics, Condition of Education, 1984, Washington, D.C.: Government Printing Office, p. 90.

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Table 14

Ph.D DEGREES CONFERRED BY INSTITUTIONS OF HIGHER EDUCATION BY FIELD 1970-71 AND 1981-82

Occupational Field	Number of Degrees 1970-71	Number of Degrees 1981-82	Percent Change	Field Share of Total 1970-71 Degrees (percent)	Field Share of Total 1981-82 Degrees (percent)
Total	32,107	32,707	1.9	100.0	100.0
Agribusiness and agricultural production	255	237	-7.1	.79	.73
Agricultural sciences	715	713	-.3	2.23	2.18
Renewable natural resources	116	129	11.2	.36	.39
Architecture and environmental design	36	80	122.2	.11	.25
Area and ethnic studies	144	102	-29.2	.45	.31
Business and management	807	855	5.9	2.51	2.61
Business and office	0	0	--	0	0
Communications	145	182	25.5	.45	.56
Communications technologies	0	18	--	0	.06
Computer and information sciences	128	251	96.1	.40	.77
Education	6,403	7,680	19.9	19.94	23.48
Elementary education, general	219	201	-8.2	.68	.62
Special education, general and all specialities	207	331	59.9	.65	1.01
Engineering	3,637	2,621	-27.9	11.33	8.01
Engineering and engineering-related technologies	1	15	1,400.0	.003	.05
Foreign languages	781	536	-31.4	2.43	1.64
Allied health	10	4	-60.0	.03	.01
Health sciences	449	906	101.8	1.40	2.77
Home economics	121	247	104.1	.38	.76
Vocational nome economics	2	0	-100.0	.006	0
Law	20	22	10.0	.06	.07
Letters	1,857	1,313	-29.3	5.78	.40
Liberal/general studies	11	35	218.2	.03	.11
Library and archival sciences	39	84	115.4	.12	.26
Life sciences	3,645	3,743	2.7	11.35	11.44
Mathematics	1,199	681	-43.2	3.73	2.08
Military sciences	0	0	--	0	0
Multi/interdisciplinary studies	80	358	347.5	.25	1.10
Parks and recreation	2	33	1550.0	.006	.10
Philosophy and religion	554	364	-34.3	1.73	1.11
Theology	312	1,288	312.8	.97	3.94
Physical sciences	4,390	3,286	-25.1	13.67	10.05
Psychology	1,782	2,780	56.0	5.55	8.50
Protective services	1	24	2300.0	.003	.07
Public affairs	185	389	110.3	.58	1.19
Social sciences	3,659	3,061	-16.3	11.40	9.36
Visual and performing arts	621	670	7.9	1.93	1.90

SOURCE: Table 2.12, Department of Education, National Center for Educational Statistics, Condition of cation, 1984, Washington, D.C.: Government Printing Office, p. 90.

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Table 15

PROFESSIONAL DEGREES CONFERRED BY INSTITUTIONS OF HIGHER EDUCATION BY FIELD
1970-71 AND 1981-82

Occupational Field	Number of Degrees 1970-71	Number of Degrees 1981-82	Percent Change	Field Share of Total 1970-71 Degrees (percent)	Field Share of Total 1981-82 Degrees (percent)
Total	37,635	68,781	82.6	100.0	100.0
Dentistry	3,745	5,282	41.0	10.0	7.7
Medicine	8,919	15,814	77.3	23.7	23.0
Optometry	531	1,110	109.0	1.4	1.6
Osteopathic medicine	472	1,047	121.8	1.3	1.5
Podiatry	240	598	149.2	0.6	0.9
Veterinary medicine	1,252	2,038	62.8	3.3	3.0
Law	17,421	35,991	106.6	46.3	52.3
Theology	5,055	6,901	36.5	13.4	10.0

SOURCE: Table 2.17, Department of Education, National Center for Educational Statistics, Condition of Education, 1984, Washington, D.C.: Government Printing Office, p. 100.

shows, although the total number of B.A. degrees awarded grew by 13.5 percent in this time period, the number of B.A. degrees in the computer sciences increased by 750 percent; in engineering technologies, by 152 percent; in health sciences, by 153 percent, and in liberal and general studies, by 232 percent. The number of B.A. degrees in the social sciences declined by 36 percent; in education, by 43 percent; and in foreign languages, by 51 percent.

Second, they show changes in field shares between the two time periods. At the B.A. level the big changes in shares are for business and management (from 14 to 22 percent in 11 years), education (from 21 to 11 percent), health sciences (from 3 to 6 percent), letters (from 8 to 4 percent), and social sciences (from 19 to 11 percent).

Major changes at the M.A. level mirror those at the B.A. level. The Ph.D. field distributions are relatively similar in 1970-71 and 1981-82. The changes that do occur do not necessarily mirror those at lower degree levels. For example, engineering's share *decreased* and education's and psychology's shares *increased* between the two time points.

Overall, the data suggest that youth respond to oversupplies by earning *fewer* degrees in oversupplied fields. If they enter an oversupplied field, such as education, they *increase* the amount of education they obtain--presumably to increase their competitiveness in a loose labor market. They respond to shortages or more liberal employment opportunities, as in engineering, by *increasing* their educational investments in these fields at the lower degree levels and *reducing* them at the higher degree levels--presumably because for these fields they are in a seller's, not a buyer's, market.

When we examine the distribution of degrees across time by field, degree level, gender, and race and ethnicity, we do not find major differences in how different subgroups respond to *changes* in the market. Although whites, blacks, Hispanics, American Indians, and Asian Americans invest at different rates in the same field at the B.A. level, across time they tend to *change* their investments in the same direction. Table 16 demonstrates this point. It shows the ratio of the percent who obtained a B.A. degree in each field in 1976-77 to the percent who obtained a B.A. degree in that same field in 1980-81 for each racial and ethnic group.[5] A ratio of 1.0 indicates no change. A ratio of more than 1.0 indicates a decline in the percent of total degree holders who invested in that field; a ratio of less than 1.0, an increase in the percent who invested in the field. The ratios for all groups in the fields of business and management, computer and information sciences, and engineering, for example, are below 1.0; those for the biological sciences and education, above 1.0.

2300 percent, but the number awarded only increased from 1 to 24, or from 0.003 to 0.07 percent of the total doctorates awarded.

[5]Tables A.14-A.16 presents the ratios for M.A., Ph.D., and professional degrees, respectively.

Table 16

FIELD SHARES OF TOTAL B.A. DEGREES: RATIO OF 1976-77 SHARES TO 1980-81 SHARES BY RACE AND ETHNICITY

Field	Total	White	Black	Hispanic	American Indian	American Asian
Agriculture and natural resources	1.00	1.00	.84	.77	1.27	1.76
Architecture and environmental	1.02	1.01	1.06	.87	1.61	1.00
Area studies	1.14	1.14	1.45	.93	3.0	1.24
Biological sciences	1.26	1.28	1.10	1.00	1.24	1.21
Business and management	.77	.76	.77	.74	.74	.90
Communications	.75	.67	.66	.75	.68	.90
Computer and information sciences	.43	.44	.48	.36	.78	.33
Education	1.35	1.34	1.41	1.25	1.35	1.69
Engineering	.67	.68	.58	.72	.74	.53
Fine and applied arts	1.05	1.05	.97	1.07	1.06	1.19
Foreign languages	1.37	1.37	1.52	1.50	1.43	1.39
Health professions	.91	.91	.90	.88	.80	1.06
Home economics	.96	.96	.97	.81	.85	1.30
Law	.75	.67	.11	.20	12.0	1.0
Letters	1.19	1.19	1.16	1.28	1.27	1.31
Library science	2.25	2.25	.24	0	6.0	1.0
Mathematics	1.32	1.32	1.26	1.39	1.56	1.10
Military sciences	.67	.50	1.0	1.0	0	.50
Physical sciences	.94	.95	.77	.97	1.12	.84
Psychology	1.18	1.20	1.01	1.08	.92	1.31
Public affairs and services	1.02	1.06	.76	.97	.98	1.16
Social sciences	1.18	1.17	1.32	1.23	1.08	1.37
Theology	1.03	1.05	.85	.80	1.71	.65
Interdisciplinary studies	.99	1.0	.91	.91	.79	1.03

SOURCE: Table 111, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1980, U.S. Government Printing Office, Washington, D.C.; and Table 101, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1983-84, U.S. Government Printing Office, Washington, D.C.

OCCUPATIONAL MOBILITY

Members of the labor force adjust to changes in skill demands not only by changing their educational and training investments, but also by changing occupations. Youth show considerable occupational mobility and greater mobility than experienced workers. If we define "occupation" as a category at the 3-digit level of the Census Bureau's occupational code, about 9 percent of employed workers change occupations each year. Rates of change are negatively related to age. For example, in a single year (1980-81) 22 percent of the 16-19 year olds who were working in January, 1980, had changed occupations by January, 1981. For 20-24 year olds, the percent was 17; for 55-64 year olds, the percent was only 2 (Eck, 1984).

Two important factors underlie the inverse relationship between age and occupational mobility. First, youth are still completing their education. They adjust their labor market participation to school schedules, moving in and out of the labor force much more frequently than older workers who have completed their education. Second, the bond between a young employee and the employer is relatively weak because both have less invested in each other. Even when they are not constrained by union seniority rules, employers lay off new employees more readily than experienced workers. Young employees are also more likely to leave a current job for an attractive alternative.

The question is what youth's greater occupational mobility implies for meeting technologically-generated changes in skill requirements. We suggest that it has more implications for demand changes in lower skill jobs than in higher skill jobs simply because youth are more likely to be in the market for lower skill jobs. Out-of-school youth tend to have less education than in-school youth and are therefore more limited to lower skill jobs. The labor force participation patterns of in-school youth--part-time and temporary jobs and movement in and out of the labor force--imply jobs that are easily entered, i.e., jobs whose skill requirements present minimum barriers to entry.

We can also ask if youth's higher occupational mobility rates have any implications for technologically-generated demand changes in higher skill jobs. This is a question about substitution possibilities. What kinds of training and work experience let individuals move among different higher skill occupations? *Answering this question is key to understanding how rapidly our labor force--let alone youth--can adjust to changes in technologically-generated demand in higher skill jobs.*

In the United States we implicitly assume that higher skill occupations require occupationally-specific formal education. This assumption feeds, if it does not produce, anxieties about technologically-generated skill shortages. If occupations require distinct bundles of skills, they operate like countries with immigration barriers. Workers cannot move freely among nations--or, in our case among occupations--to adjust to changes in demand.

In fact, we know appallingly little about substitution possibilities between kinds of training and between types of training and work experience for different kinds of jobs--even though government and corporate training policies are based on assumptions about these issues. For example, although the data exist to look at this question, we do not even know how individuals with different kinds of training and work experience actually move among different occupations.

Fragmentary data suggest considerably more interchangeability, even for higher skill jobs, than we commonly presume, especially for the newer occupations that technological innovations tend to spawn. Data on the supply response to demands for computer skills 20 years ago illustrate this point.

In 1960 the decennial census did not even enumerate the small number of individuals in electronic data processing (EDP) occupations--computer operators, programmers, and systems analysts. The Bureau of Labor Statistics did not include these occupations in its area wage surveys until 1969. However, by the 1970 decennial census there were 121,981 computer operators, 167,556 programmers, and 83,447 systems analysts. Where did these workers come from?

Haber and Goldfarb (1976) examined the 1965 employment status of those employed in EDP occupations in 1970. A third of the 1970 EDP labor force had been employed in EDP occupations in 1965; a third had entered the labor force since 1965; and a third had worked in non-EDP occupations in 1965.

The majority of the lateral transfers did not come from disciplines and occupations related to EDP occupations: only 30.2 percent of these transfers had been engineers, mathematicians, life and physical scientists, engineering and science technicians, accountants, bookkeepers, and office machine operators. Thus, in the EDP case, workers in *unrelated* fields constituted an important part of the labor response to rapidly growing demand.

The 3 EDP occupations vary in their complexity, systems analyst being more complex than programmer, and programmer more complex than computer operator. The data on supply sources showed that entry into more complex fields required more occupationally-germane formal or on-the-job training. Although relatively few advanced through the EDP hierarchy from 1965-1970, 12.8 percent of the 1970 systems analysts, versus only 3.5 percent of the 1970 programmers, came from other EDP occupations. The systems analyst occupation also had a larger share of lateral transfers from related fields than the other EDP occupations--40 percent, versus 30 percent for all EDP occupations. Transfers from related fields came primarily from the science and engineering fields.

Finally, cross-tabulations of supply sources for those who were programmers in 1970 with the education and training backgrounds of these individuals showed that formal education (e.g., a college degree) can substitute for work experience, that formal education can substitute for vocational training, and that less experienced workers need more formal education if they lack vocational training.

Thus, in the EDP case, workers from non-EDP occupations constituted an important part of the labor response to rapidly growing demand. For the years under discussion EDP occupations had no rigid educational requirements for entry, and workers from unrelated fields were able to trade off some combination of general experience or formal education for occupationally-relevant formal or on-the-job training. However, the more complex the EDP occupation, the more they needed occupationally-germane formal or on-the-job training for entry.

The EDP case suggests that, under certain conditions, higher skill workers can help alleviate shortages in higher skill occupations for which they lack specific training. The fact that younger workers who are higher skilled are less attached to a particular job or firm means that they may be a potentially important labor supply source for lateral transfers into other higher skill occupations.

Since the EDP occupations were not established occupations in the 1960's, it might be argued that the supply response to them is a special case, i.e., not germane to the basic question about labor force adjustments to computer-based equipment. Higher skill occupations that are new are not well integrated into educational and employment systems. They lack generally understood entry paths (training sequences, school-work transitions, career ladders) and developed training programs. Their job content tends to be unstable, making it difficult to design relevant educational programs. Thus, de facto, they are higher skill occupations with low entry barriers--"bright," i.e., "trainable," individuals can enter them relatively freely.

However, far from being irrelevant, we suggest that the EDP case may be key for understanding how the economy adjusts rapidly to technologically-generated skill changes. Although new technologies affect demand in established occupations, *new occupations are typical of new technologies*. Not only do we tend to lack trained workers for new occupations, but these occupations tend to be dynamic and therefore potentially better served by workers with a broader range of skills.

We also have illuminating data on employed B.A. and M.A. graduates with degrees in science and engineering. Table 17 shows the probabilities that individuals from different educational backgrounds work in occupations directly related to their field of training. It also shows the extent to which those working in a particular occupation were trained in that field.

As Table 17 shows, relative to B.A. graduates, M.A. graduates were more apt to be employed in a science and engineering field and in a field related to their specific field of training. This result is consistent with data that show that more education makes occupations "sticky," i.e., reduces the probability of changing them (e.g., Eck, 1984). This finding probably reflects both demand and supply forces. Having obtained specialized training, individuals tend to stay in the

Table 17

1982 FIELD OF EMPLOYMENT OF 1980 B.A. AND M.A. SCIENCE AND ENGINEERING(a) GRADUATES (b) BY FIELD OF TRAINING (b)

Degree Field	Percent Employed in Science and Engineering Jobs		Of Those in Science and Enginering Jobs: Percent Employed in Field of Training		Percent of Those Employed in a Science or Engineering Field Who Have a Degree in That Field	
	B.A.	M.A.	B.A.	M.A.	B.A.	M.A.
Total	60.1	74.6				
Chemistry	72.6	60.0	53.3	66.7	52.2	66.7
Physics	77.8	66.7	28.6	50.0	80.0	66.7
Mathematics/ Statistics	76.3	81.8	21.6	50.0	39.0	69.2
Computer Science	91.1	90.6	91.3	90.0	41.8	59.1
Engineering	88.1	87.8	81.1	87.7	81.1	87.2
Environmental Sciences	81.0	100.0	76.5	80.0	81.3	80.0
Life Sciences	60.1	75.0	71.6	79.5	86.8	91.2
Psychology	25.9	46.7	34.9	78.6	88.5	100.0
Economics	39.2	57.1	37.7	75.0	86.7	85.7
Sociology/ Anthropology	28.2	25.0	60.4	50.0	61.7	66.7

SOURCE: National Science Foundation, U.S. Scientists and Engineers: 1982, Report No. NSF84-321; Tables B8 & B17, pp. 23-24 & 42-43; U.S. Government Printing Office, Washington, D.C., 1984.

(a)Science and engineering fields are defined to include mathematics, computer science, the physical sciences, the life sciences, engineering, psychology, and the social sciences.

(b)The population excludes 1980 B.A. and M.A. graduates who were in graduate school full-time in 1982.

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occupation for which they prepared in order to get returns on their educational investments. Employers also have more limited options for filling jobs that require the more specialized training associated with the M.A. degree.

The table also shows that, regardless of the degree level, the probabilities of working in a science and engineering job and in the specific field of training vary by field. B.A. and M.A. graduates in engineering and computer science are very likely to work both in science and engineering jobs and in ones that use their field of training. B.A. graduates in psychology and the social sciences are both less apt to work in science and engineering jobs and in ones that use their specific fields of training. These variations tell us something about field variations in labor supply and demand.

The final two columns of Table 17 tell us whether *only* those with certain training can work in certain occupations. Half of those who work in chemistry jobs come from chemistry backgrounds and half from life science fields. Although most computer science graduates work in computer science jobs, 60 percent of the science and engineering graduates who work in computer science jobs do not have degrees in computer science. Of those working in these jobs, 2.5 percent have degrees in the physical sciences; 22 percent, in mathematics; 11 percent, in engineering; 4 percent, in the life sciences; and 18 percent, in psychology and the social sciences. These data tell us that certain educational backgrounds are interchangeable with each other for certain jobs *under certain supply and demand conditions*. They may indicate either a general interchangeability among educational backgrounds or a shortage of those with the preferred training, employers "making do" with workers trained in related, but less preferred, fields.

GEOGRAPHIC MOBILITY

Demand for a skill obviously varies by geographic location, and localized labor oversupplies and shortages can be resolved by labor migration. Youth change residence at much higher rates than older individuals, increasing their ability to respond to geographically-specific changes in skill requirements that computer-based equipment may produce. Table 18 presents mobility data for age groups whose moves are more apt to reflect their own, as opposed to their parents', mobility. Mobility increases from 15-19 years of age, peaks at 20-24 years of age, and declines steadily with age.

ADJUSTMENT PROBLEMS

Youth clearly vary the level and field of their education, partly in apparent response to changes in market opportunities. However, there is a lag between the decision to study a field and the completion of the course of study. This lag can cause two kinds of problems.

Table 18

PERCENT WHO CHANGED RESIDENCES BETWEEN MARCH 1981 AND MARCH 1982 BY AGE AND TYPE OF MOVE

Type of Mobility	Age (years) 15-19	20-24	25-29	30-34	35-44	45-54	55-64
Non-movers	84.5	63.6	69.0	79.2	86.8	91.2	93.1
Movers in U.S.	15.0	35.5	30.0	20.1	12.7	8.5	6.7
Within same SMSA	6.7	16.8	15.2	10.3	6.1	4.2	3.2
Between SMSA's	1.9	5.0	4.6	3.3	1.8	1.2	1.0
From outside SMSA's to SMSA's	1.0	2.5	1.8	1.2	0.7	0.5	0.3
From SMSA's to outside SMSA's	0.9	2.3	1.9	1.2	0.8	0.5	0.6
Outisde SMSA's at both dates	4.6	9.0	6.5	4.2	3.3	2.1	1.6
Movers from abroad	0.6	0.9	0.9	0.7	0.4	0.3	0.1

SOURCE: Table 4, U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 384, Geographical Mobility: March 1981 to March 1982, U.S. Government Printing Office, Washington, D.C., 1983, p. 14.

One is that the labor shortages that trigger youth's decisions to enter a field of training may not be alleviated for several years. The period required to eliminate a shortage in an occupation depends partly on the amount of specialized education that it requires. Table 19 shows the educational distribution of employed scientists and engineers by the field of their employment,[6] giving us some idea of variations in the amount of education apparently required to work in different scientific and engineering occupations. For example, less than a fifth of those working in physics jobs have only a B.A. degree and almost a half have a Ph.D. degree. In contrast, about three-fifths of those working in engineering jobs and two-thirds of those working in computer science jobs have only a B.A. degree.

It appears, then, that on average we can produce some kinds of specialists faster than others, implying that it will take longer to alleviate shortages in some fields than in others. At the same time, it should be remembered that youth can re-choose their field of study at various points in the educational process. We know from Table 9 that individuals who plan graduate work in a given field come from more or less heterogeneous college majors. For example, there are cross-overs into physics from mathematics and engineering. Thus, shortages in a field that requires a longer training period can be remedied by attracting individuals from related fields into that field at intermediate points in the training process.

The second, lag-related adjustment problem is that responding to market signals can create or exacerbate a supply/demand imbalance. In fact, in some occupations, such as education or engineering, shortages seem to alternate with over-supplies.

These boom-and-bust patterns seem to occur partly because the market conditions that trigger students' choices of their field of study have changed by the time of graduation. *Cobweb dynamics*, or "corn and hog cycles," long associated with markets for agricultural commodities, underlie the market for college graduates. There is elapsed time in agricultural production and in the production of a new B.A. graduate, and supply, whether of corn or degree holders, is determined by previous market conditions. Supply is thus a lagged function of the state of the market (Freeman, 1971, 1975a, and 1975b).

Students are like farmers in another way: they constitute a large number of independent decision-makers without knowledge of each other's choices. Thus, they tend to respond to market signals without adjusting their decisions according to choices that others are making in response to these same signals. Their independent decisions can result in shortages or oversupplies.

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[6] In interpreting these data, it should be recalled that the population's years of schooling have been increasing. Thus, field differences in educational distributions partly reflect differences in the age structures of those employed in the different fields.

Table 19

HIGHEST DEGREE OF EMPLOYED SCIENTISTS AND ENGINEERS(a) BY FIELD, 1982

Field	Percent Employed in Science and Engineering Jobs	Total	Educational Distribution of Employed Scientists and Engineers			
			Ph.D	M.A.	B.A.	Other(b)
All	88.1	100.0	10.8	26.3	52.4	10.5
Chemists	92.2	100.0	27.7	23.8	47.9	.5
Physicists	94.3	100.0	46.0	35.9	17.9	.4
Mathematicians	84.5	100.0	22.9	49.3	26.1	1.6
Statisticians	91.7	100.0	10.7	66.9	21.3	1.9
Computer Scientists	72.3	100.0	3.0	27.8	68.4	.8
Engineers	93.1	100.0	3.2	21.0	58.1	17.7
Environmental Scientists	94.8	100.0	18.9	32.1	48.3	.7
Life Scientists	88.4	100.0	25.1	29.8	43.2	1.9
Psychologists	76.3	100.0	32.8	45.2	21.5	.5
Economists	72.7	100.0	13.7	43.8	41.1	1.5
Sociologists/ Anthropologists	66.3	100.0	18.8	33.0	47.5	.7

SOURCE: National Science Foundation, U.S. Scientists and Engineers: 1982, Report No. NSF84-321; Tables B9 & B12, pp. 47-50 and 62-74; U.S. Government Printing Office, Washington, D.C., 1984.

(a)Science and engineering fields are defined to include mathematics, computer science, the physical sciences, the life sciences, engineering, psychology, and the social sciences.

(b)"Other" includes no degree, an associate degree, or other type of degree.

We can also note that non-market factors can affect--and potentially distort--market signals. There can be a lag between when market signals are sent and when they are received. For example, employment in computer-based occupations grew across the 1970's. Although choice of this field by SAT test-takers increased, it increased slowly from 1 percent in 1974 to 9.7 percent in 1984. Between 1981 and 1983 it almost doubled. We can offer several explanations of this shift. For example, the increasing costs of graduate training may prompt individuals to get B.A. degrees in fields where a B.A. is adequate training for a job in the field of the degree. However, another explanation is that non-market events amplify market signals to the point where they are "heard" by more people. In computers these include popular experience with computer-based technology--from computer game arcades to personal computers in the home--and the national preoccupation with "high technology."

SUMMARY

We examined data on changes in young people's preferred fields of study, changes in the amount of education they obtain, their occupational mobility rates, and their geographic mobility rates to assess whether they show the flexibility required to respond to skill shortages and oversupplies. We found that sequential groups of youth can choose dramatically different fields of post-secondary study and that these changes parallel changes in skill requirements in the economy. For example, the more frequent choices of computer science, business, and engineering majors by recent youth groups is consistent with increased demand for technical skills and the increased attractiveness of the private sector relative to the public and non-profit sectors. Their less frequent choices of education and arts and science majors parallel the 1970's decline in elementary, secondary, and post-secondary teaching opportunities.

We also saw that members of a 16-24 year old age group change their preferences as they proceed through the educational pipeline. For example, data on the undergraduate majors and intended doctoral fields of 1980-81 GRE test-takers show that between 17 and 49 percent planned to obtain a Ph.D. in a field different from their undergraduate major.

Overall, the data on the levels and fields of completed degrees suggested that youth respond to oversupplies by earning fewer degrees in oversupplied fields. If they entered an oversupplied field, they increased the amount of education they obtained--presumably to increase their competitiveness in a loose labor market. They responded to shortages or more liberal employment opportunities by increasing their educational investments in these fields at the lower degree levels and reducing them at the higher degree levels--presumably because they were in a seller's market.

Youth showed considerable occupational mobility. This mobility is more likely to affect responses to changes in demand for lower skill than for higher skill occupations because youth tend to be in the market for lower skill jobs. The implications for technologically-generated demand changes in higher skill jobs depend on substitution possibilities. We know appallingly little about substitution possibilities between kinds of training and between types of training and work experience for different kinds of jobs. However, fragmentary data suggest considerably more interchangeability, even for higher skill jobs, than we commonly assume, especially for the newer occupations that technological innovations typically spawn.

Finally, we found that youth change residences at much higher rates than older individuals, a propensity that lets them even out geographic imbalances in the supply of training opportunities and in the demand for skills.

Adjustment problems can arise from the fact that there is a lag between the decision to study a field and the completion of the course of study. One is that shortages that trigger a decision to enter a field may not be alleviated for several years. However, high skill occupations require different amounts of specialized education. For example, about three-fifths of those working in engineering jobs and two-thirds of those working in computer science jobs have only a B.A. degree. Youth can also re-choose their field of study at various points in the educational process, crossing over into fields at the graduate level that differ from those of their B.A. degrees. Thus, shortages in a field that requires a longer training period can be remedied by attracting individuals from related fields at intermediate points in the training process.

IV. HOW THE EDUCATIONAL AND TRAINING SYSTEM ADJUSTS TO CHANGES IN SKILL REQUIREMENTS

How the educational system responds to changes in training requirements affects how youth adjust to the skill changes that flow from computer-based equipment. This chapter briefly describes the educational system--the nature and size of its different sectors, assesses its general responsiveness to change, and discusses special adjustment problems.

CHARACTERISTICS OF THE EDUCATIONAL AND TRAINING SYSTEM

We define the educational and training system to include: high schools; post-secondary, non-collegiate vocational schools; two-year colleges; four-year colleges; universities; professional schools; military training programs for the enlisted force and officer corps;[1] government training programs such as the Job Training Partnership Act; apprenticeship programs; and employers' formal training *delivered by the firms' supervisors and training staffs,* not purchased from other actors in the educational system. We use the term *sector* to refer to a class of institutions. For example, the military and post-secondary, non-collegiate vocational schools constitute two distinct sectors. This chapter maps certain features of the secondary and post-secondary system that affect its overall adjustment to changes in training requirements.

Table 20 shows that each sector of the educational system has a large number of distinct institutions.[2] At the secondary level these are overwhelmingly publicly governed and financed; at the post-secondary level, both publicly and privately governed and financed.

Two-year colleges confer degrees, certificates, and awards below the baccalaureate, and study programs can be longer than two years in duration. Similarly, four-year colleges can offer programs longer than four years, such as five year programs in engineering, and may offer M.A. or Ph.D. degrees in some fields. For example, in 1978-79 there were 1,823 four-year colleges and only 156 universities, but 523 institutions whose highest degree was a M.A. degree and 452 whose highest degree was a Ph.D. Nonetheless, the major educational activity of four-year colleges is the four-year baccalaureate.

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[1]Military training programs train some enlistees in strictly military occupations--for example, infantry, gun crew, and seamanship. However, they train more individuals in occupations used in the civilian sector--for example, electronic equipment repair, air traffic control, communications, medical and dental specialties, photography, data processing, clerical specialties, public affairs, and electrical and mechanical equipment repair.

[2]The table excludes military programs, formal private sector training, and government training programs such as JTPA because we lack reliable estimates of separate schools and programs for these sectors.

Table 20

NUMBER AND CONTROL OF SECONDARY AND POST-SECONDARY SCHOOLS THAT OFFER OCCUPATIONALLY-GERMANE TRAINING

Type of School	Number			Percent Privately Controlled
	Total	Public Control	Private Control	
Secondary schools(a)	17,686	17,100	586	3
Comprehensive high schools	15,071	15,071		0
Vocational centers	1,394	1,394		0
Vocational high schools	1,221	635	586	48
Post-secondary schools(b)	10,830	2,309	8,521	79
Non-collegiate	7,577	811	6,766	89
Two-year colleges	1,274	940	334	26
Four-year colleges	1,823	464	1,359	75
Universities	156	94	62	40
Apprenticeship programs(c) (registered)	50,000		50,000	100

SOURCE: Tables 93 and 138, p. 104 and 160, U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics 1983-84*, U.S. Government Printing Office, Washington, D.C., 1983.

(a)These data are for 1978-79. The published source combined public comprehensive and vocational high schools. We used a NCES estimate of the number of public vocational and technical high schools in 1976-77 to estimate the numbers of the two types of public high school.

(b)The data for non-collegiate post-secondary schools are for 1978-79; for colleges and universities, for the fall of 1981.

(c)These data are for apprenticeship programs registered in 1979. The Bureau of Apprenticeship and Training of the U.S. Department of Labor estimates that only about half of the nation's apprenticeship programs are registered.

Table 21 shows the extent to which the post-secondary program *completions* in 1980-81 were concentrated in particular sectors and in privately, rather than publicly, governed and financed institutions.[3] Of the large number of total post-secondary graduates each year, over 50

[3]The table excludes government training programs and formal employer sector training.

Table 21

NUMBER AND DISTRIBUTION OF PROGRAM COMPLETIONS
AT THE POST-SECONDARY LEVEL (1980-81)

Program Type	Number of Completions	Distribution of Completions (percent)	Percent Trained in Private Schools
Total	2,875,490	100.0	
Non-collegiate vocational programs	889,969	31.0	N.A.
Community college occupational programs	374,820	13.0	N.A.
At least 2 year, less than 4 year	287,416	10.0	
At least 1 year, less than 2 year	87,404	3.0	
B.A. Degree	935,140	32.5	33.2
M.A. Degree	295,739	10.3	38.3
Ph.D. Degree	32,958	1.2	36.1
First Professional Degree	71,956	2.5	58.9
Military(a)	231,454	8.1	0.0
Apprenticeships(b)	43,454	1.5	100.0

SOURCES: Tables C-2 and C-3, pp. 99-102, U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Projections and Training Data, 1984 Edition*, Bulletin 2206, U.S. Government Printing Office, Washington, D.C., May 1984; Tables 117, 99, and 105, pp. 112, 127, and 135, U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics 1983-84*, U.S. Government Printing Office, Washington, D.C., 1983; Defense Manpower Data Center.

(a)The numbers for the military are for FY1982 enlistees who have served at least 13 months in the service. The training for this group is occupational, not basic training. This number excludes members of the cohort still in training. Of those who completed training, 17.8 percent trained in combat arms occupations that are less transferable to the civilian sector.

(b)The data for apprenticeships are for calendar year 1979 and are based on registered apprenticeship programs. Although more recent data exist, they have not been collected by trade since 1979. The Bureau of Apprenticeship and Training of the U.S. Department of Labor estimates that only about half of the nation's apprenticeship programs are registered.

percent of the awards, degrees, or certificates are at the pre-baccalaureate level, the non-collegiate vocational sector and community college sector alone accounting for almost half of all yearly program completions. The B.A.-producing system accounts for another third.

ADJUSTMENTS TO CHANGES IN TRAINING REQUIREMENTS

Adjustment in the educational system is defined to mean that schools in the system change their supply of educational services to accord with changes in demand for the number, field, level, or quality of skills. Students (or their parents), the labor market, government, or movements such as the current high school excellence movement can change demand.

Size, Substitution, Heterogeneity, Mobility, and Organization

In general, the evidence indicates that the educational system accommodates change, although, as we discuss in the next chapter, there are persistent, specific adjustment problems and harbingers of future ones. Five features of the educational and training system facilitate its adjustment to changes in training demand: number of institutions and sectors, substitution among them, heterogeneity among them, student geographic mobility, and the internal organization of the institutions in major sectors of the system.

- First, although some sectors in the system have many more institutions than others, each sector in the system has a large number. Institutions within the same sector deliver roughly equivalent types and levels (although not quality) of training. Thus, major changes in demand can be dispersed across multiple, substitutable units within a sector, reducing the impact of change for individual institutions.

- Second, although institutions within a sector presumably differ less from each other than from institutions in other sectors in types and levels of training, institutions within each sector nonetheless vary in ways that affect response. For example, some are privately and others publicly financed; some are wealthy and others economically more precarious. They vary in the nature of their traditional clients, percent of the faculty that is tenured, and the strength of specific departments and programs. This variation among institutions within a sector reduces the chances that factors impeding adjustment in one institution will generalize to all institutions in the sector.

- Third, *sectors* overlap in clientele, fields, and levels of training delivered. Thus, there are substitutions, not only among institutions *within* the same sector, but also *across* sectors. This interchangeability between sectors increases the chances that the total system can handle large demand growth that might swamp the capacity of a single sector. For example, several sectors offer roughly equivalent training for blue collar and low level white collar jobs: rigorous vocational high schools and area vocational high schools, employers, non-collegiate vocational schools, the military, and the shorter occupational programs in two-year colleges. Both two- and four-year colleges award pre-baccalaureate degrees and certificates, the four-year colleges accounting for 15 percent of the completions of programs of at least one year and less than four years. Both four-year colleges and universities award B.A., M.A., Ph.D., and professional degrees, even though the emphasis at the former is on the B.A. degree.

- Fourth, like differences among institutions within a sector, differences among sectors also reduce the chances that factors impeding adaptiveness in one sector will generalize to other sectors. Thus, although no sectors are perfect substitutes for each other, the variability that reduces their interchangeability also reduces the chances that all partial substitutes will be unable to adapt to demand changes.

- Fifth, even though most educational institutions and secondary students are geographically fixed, post-secondary students are not. Just as workers relocate for jobs, students move to training opportunities. In the fall of 1983 50 percent of those enrolled in two-year and four-year colleges and universities attended schools at least 51 miles from their homes. Thirty-four percent attended schools more than 100 miles from their homes.[4] In 1981 13 percent of college freshmen enrolled in out-of-state colleges.[5] This mobility increases the chances of a match between training supply and demand.

- Finally, institutions within post-secondary sectors, especially four-year colleges and universities, are what organization theorists call "loosely coupled systems" (e.g., Weick, 1976).[6] The term means that organizational subunits, such as different academic departments, are like acquaintances, not close friends. They are connected to each other in the sense of shared organizational membership, but each is relatively autonomous, their relations being circumscribed and having limited mutual effects. Since subunits are fairly autonomous, this organizational form can retain more mutations and novel solutions than a tightly coupled system--a characteristic that

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[4]Cooperative Institutional Research Program, *The American Freshman: National Norms for Fall 1983*, Graduate School of Education, University of California at Los Angeles, 1983.

[5]Table 73, p. 90, U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics 1983-84*, U.S. Government Printing Office, Washington, D.C., 1983.

[6]They have also been called "organized anarchies" (e.g., Cohen, March, and Olsen, 1972).

clearly has disadvantages as well as advantages. For example, the form is not selective about what persists; it perpetuates both archaic traditions and innovations. It also reduces the chances of system-wide adjustments. At the same time it lets subunits, such as a chemistry department, respond to change without requiring the active support of the whole system. If one part of the system deteriorates or misfires, the damage is also more limited in organizations of this type.

Evidence of Response

Since we cannot measure demand for educational services independent of their supply, we cannot assess how well or how rapidly the educational system adjusts to demand changes. However, we can document the kind and magnitude of recent changes that the system has accommodated. Some of the data introduced in Chapter III to assess youth's educational flexibility are re-examined here to assess the flexibility of educational institutions.

The data show that in the last 20 years the educational system has absorbed major changes. These include changes in total demand for educational services, changes in the demand for different fields, changes in demand for different levels of education, and changes in the demographic composition of student bodies.

Total demand. The system handled enormous increases in total demand for post-secondary education. Between 1966 and 1981, enrollments in institutions of higher education increased from 6.4 million to 12.4 million.[7] Part of this increase was attributable to faster growth in parttime than in fulltime students. However, even when we convert these numbers to fulltime equivalents, enrollments still doubled from about 4.5 million to 9.0 million.[8]

Between 1961-62 and 1980-81 the total number of B.A., M.A., Ph.D., and professional degrees awarded increased from 514 thousand to 1.3 million. The number of B.A. and professional degrees doubled, and the number of M.A. and Ph.D. degrees more than tripled.[9] The number of awards for post-secondary vocational programs of at least one year and less than four years in duration tripled in about a decade (1969-70 to 1980-81) from 124 thousand to 375 thousand.[10]

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[7]Table 77, p. 93, U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics, 1983-84*, U.S. Government Printing Office, Washington, D.C.

[8]Tables 77 and 79, pp. 93-94, *Digest of Education Statistics, 1983-84*.

[9]Table 114, p.132, *Digest of Education Statistics, 1983-84*.

[10]Table 124, p. 96, *Digest of Education Statistics, 1971;* and Table 117, p. 135, *Digest of Education Statistics, 1983-84*.

Demand by field. The system also handled changes in demand by field that differed markedly from the overall pattern of change. For example, in the 1960's mathematics B.A. degrees increased from 11 thousand to 27 thousand. However, in the 1970's they declined back to 11 thousand. Although the total number of B.A. degrees increased by 61 percent in the 1960's, the number of engineering B.A. degrees did not change. However, while the total number of B.A. degrees awarded stabilized in the last half of the 1970's, the number of engineering B.A. degrees increased from 47 thousand to 75 thousand.

Although the total number of B.A. degrees awarded increased by 13.5 percent in the 1970's, the number awarded in education declined by 42.7 percent from 177 thousand to 101 thousand. The number awarded in business increased by 87 percent from 114 thousand to 213 thousand. The number awarded in computer science increased by 749 percent from two thousand to 20 thousand.

Although the number of associate degrees awarded in all the major curricula increased between 1966 and 1982, there were large changes in the "market shares" of the different curricula. The proportion of associate degrees awarded in the arts declined from two-thirds to a third. The proportion awarded in the science and engineering technologies increased from less than a fifth to more than a third.[11]

Demand by level. The system has accommodated significant changes in demand by level of the degree awarded. As Table 22 shows, in the 1970's pre-baccalaureate awards and professional degrees increased their shares of total awards and degrees; the shares of B.A. and Ph.D. degrees both declined.

Demographic changes. The system accommodated changes in the age, in the mode of participation (fulltime versus parttime), and in the racial, ethnic, and gender composition of student bodies. Between 1970 and 1982 the percent of those enrolled who were 25 years and older increased from 27.8 to 39.1. Those enrolled fulltime declined from 67.8 percent in 1970 to 58.1 percent in 1982.

Although the racial and ethnic composition of graduate and professional degree enrollments was fairly stable from fall 1968 to fall 1979, the non-Hispanic white share of total undergraduate enrollments declined from 9 out of every 10 students to 8 out of every 10 students. We do not have enrollment figures for the associate level, and the time series on the racial and ethnic composition of associate degrees granted is very short. However, in just three years (1975-76 to 1978-79) the non-Hispanic white share of associate degrees declined from 85.2 percent to 82.3 percent.

[11]Table 125, p. 97, *Digest of Education Statistics, 1971;* and Table 118, p. 137, *Digest of Education Statistics, 1983-84.*

Table 22

DISTRIBUTION OF POST-SECONDARY AWARDS AND DEGREES BY LEVEL: 1969-70 AND 1980-81

	1969-70 Awards/Degrees		1980-81 Awards/Degrees	
Level	Number	Percent	Number	Percent
Total	1,317,621	100.0	1,866,344	100.0
Pre-B.A. Awards(a)	252,230	19.1	530,551	28.4
B.A. Degrees	792,316	60.1	935,140	50.1
M.A. Degrees	208,291	15.8	295,739	15.8
Ph.D. Degrees	29,866	2.3	32,958	1.8
Professional Degrees	34,918	2.7	71,956	3.9

SOURCE: Tables 117, 121, 124, and 125, National Center for Education Statistics, *Digest of Education Statistics, 1971 Edition;* and Tables 100, 105, 117, and 118, National Center for Education Statistics, *Digest of Education Statistics, 1983-84 Edition.*

(a)This category includes all associate degrees and all non-associate post-secondary awards from curricula of at least one and less than four years.

The gender composition of post-secondary enrollments has changed dramatically in the last two decades. In 1963 women constituted 38 percent of these total enrollments; in 1982, 52 percent.

PAST AND FUTURE ADJUSTMENT PROBLEMS

In sum, in the last 20 years the post-secondary educational system has accommodated quite profound changes in the demand for its services--changes in the total numbers of students, among fields, between levels, and in the social composition of student bodies. In general, the behavior of these institutions seems consistent with March's (1981) observations about organizational change:

> A common theme in recent literature, particularly in studies of the implementation of public policy, is that of attempts at change frustrated by organizational resistance. . . . The ability to frustrate arbitrary intention, however, should not be confused with rigidity; nor should flexibility be confused with organizational effectiveness. Most organizational failures occur early in life when organizations are small and flexible, not later. There is considerable stability in

> organizations, but the changes we observe are substantial enough to suggest that organizations are remarkably adaptive, enduring institutions, responding to volatile environments routinely and easily, though not always optimally. . . .
>
> Most change in organizations results neither from extraordinary organizational processes or forces, nor from uncommon imagination, persistence or skill, but from relatively stable, routine processes that relate organizations to their environments. Changes takes place because most of the time most people in an organization do about what they are supposed to do; that is, they are intelligently attentive to their environments and their jobs. Bureaucratic organizations can be exceptionally ineffective, but most of the organizations we study are characterized by ordinary competence and minor initiative. . . . If the environment changes rapidly, so will the responses of stable organizations; change driven by such shifts will be dramatic if shifts in the environment are large (pp. 563-564).

However, the educational system has both chronic and emerging problems that promise to affect the speed and quality of its adjustments to changes in the demand for educational services. These include persistent difficulties with secondary vocational education in the comprehensive high schools, the implications of unprecedented enrollment declines at the post-secondary level for the speed and quality of these institutions' responses to changes in training requirements, and the implications of the compensation practices of post-secondary schools for staffing the courses required to train students in computer-related fields. We discuss each of these issues in the next chapters.

Secondary Vocational Education

For secondary students who concentrate in the vocational curriculum, the central purpose of their training is preparation for the labor market. At least since the 1950's, the educational policy community has raised questions about the benefits of secondary vocational education, and the empirical literature on the employment and wage effects of this curriculum increasingly validate its concerns. Vocational educators typically respond defensively to critics, partly, we suggest, because most secondary vocational education is embedded in institutional structures that make it difficult for them to respond constructively.

Even when non-curricular variations that affect wages and employment are eliminated, most studies show null or negative wage and employment returns to secondary vocational training *except for skills easily acquired in limited formal classroom training,* such as typing. An analysis of commercial coursework yielded a statistically significant wage benefit in the seven years after high school graduation for women. However, coursework in home economics had negative wage effects in every year; coursework in technical subjects, a positive effect in the first two years and negative effects for the subsequent six. For men commercial courses yielded no wage benefit; trade and industrial arts courses, an initially positive wage benefit that ultimately became negative; and other technical subjects, no clear wage pattern (Meyer, 1981).[12]

Studies of employer wage practices seem consistent with these findings. For example, a study of a representative sample of Los Angeles employers showed that when vocational training earned a wage premium, it tended to be for professional-technical jobs that required a *post*-secondary, not secondary, vocational degree (Wilms, 1983).

Analyses of the employment effects of secondary vocational education yield results similar to those for wages (Meyer, 1981),[13] and again results of studies of employers' hiring practices support these findings. Twice as many Los Angeles employers preferred applicants from an academic to those from a vocational curriculum. When they preferred vocational over academic graduates, again the jobs were higher level and required vocational preparation more intense than the usual secondary vocational preparation (Wilms, 1983).

Studies also suggest that the secondary vocational curriculum may impede the acquisition of the verbal and quantitative skills that increase trainability and therefore employability. A major study shows that the high school curricula affect students' verbal and mathematical abilities independently of variations in these abilities at high school entry. The academic track enhances these abilities at grades 11 and 12, relative to the vocational track (Alexander, Cook, and McDill, 1978).

In sum, except for commercial training for women, even high levels of occupationally specific secondary vocational education do not give graduates an employment or wage edge over counterparts with little occupational training. This lack of effect for secondary vocational training has been explained as indicating that the job market for youth is essentially a market for training opportunities, not fully developed skills (Thurow, 1979). In other words, it has been argued that employers tend to hire the ability to acquire job skills, not the skills themselves. This perspective leads inevitably to the argument that academic courses, especially ones that enhance verbal and quantitative skills, should replace vocational courses.

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[12]Using data from the *National Longitudinal Study of the High School Class of 1972,* Meyer (1982) analyzed the longitudinal wage and employment effects by vocational field, gender, and race and ethnicity for low, medium, and high numbers of hours of secondary vocational education.

[13]These results are consistent with those of an earlier study (Creech et al., 1977) that used the same data base. This study found that verbal and quantitative, but not vocational, skills increased employment.

Certainly the data suggest that secondary vocational curricula do not adequately integrate academic and vocational training. However, it is not clear that academic coursework should entirely replace vocational courses. Even if employers' hiring and wage behaviors indicate that they prefer trainability over training, we can as easily argue that these behaviors simply reflect employers' *adaptations* to secondary vocational programs that do not give students the kind of training that employers want. In other words, employers may have no option but to hire the most trainable, as opposed to the most trained, high school graduates because "trained" graduates are in fact not well trained. The positive effects of vocational training in some European countries and of programs in certain American vocational high schools suggest that it is the kind of vocational education usually delivered in secondary schools, not the concept of vocational education itself, that is the problem.

Occupationally-specific vocational programs vary wildly in quality, as measured by graduation requirements, grading standards, curriculum, equipment, and faculty. They range from good programs, such as those offered in Aviation High School in New York, to automotive programs that only teach students how to wash and wax cars. The quality of a vocational education program seems to depend importantly on the type of institution in which it is offered. Although the quality of the vocational education offered in comprehensive high schools varies, generally vocational high schools and area vocational schools offer training of much greater rigor and relevance than the comprehensive high schools (Sewell, 1983; Hoachlander, 1984).

There seem to be several reasons for the problems with vocational education, as delivered in comprehensive high schools. First, in contrast to the European system of separate vocational and academic schools, the comprehensive high school was supposed to give all students access to vocational and academic opportunities without prejudice. In fact, the comprehensive high school remains normatively middle class, its most valued mission being to prepare its students for college. In this environment vocational education became the residual category. Its mission tends to be, not aggressively vocational, but simply non-academic. The mission of a specialized vocational high school, on the other hand, is unambiguously vocational.

Second, quality vocational education requires much more expensive technical equipment than academic education. In the comprehensive high school system vocational students are dispersed across several schools, precluding the economies of scale that can be achieved by concentrating vocational students in one school. Few comprehensive high school budgets can afford up-to-date industrial and clerical equipment.

Third, vocational high schools and area vocational centers are less tied to student residential areas than comprehensive high schools. They are thus freer to locate closer to major employers, increasing the possibility of strong relationships with markets for their graduates.

Response to Decline

Although the post-secondary system absorbed major changes in the past, *these accommodations occurred in a context of enrollment growth.* Fall enrollment in grades 9-12 began to decline in 1977,[14] but post-secondary enrollments--both total and fulltime equivalents--continued to increase through 1982.[15] In fact, *the history of the post-secondary system for the past three centuries has been one of enrollment growth,* with accelerated increases after the Civil War, World War II, and as the baby boom entered the system in the 1960's.

The enrollment decline began in 1983 and is projected to continue until 1997. Although the size of the projected decline is unclear, the Carnegie Council on Policy Studies in Higher Education concludes that it will probably range between 5 and 15 percent, not between the 40 and 50 percent projected by some studies. The Council also notes that institutions vary in their probable vulnerability to enrollment decline. They anticipate that research universities, selective liberal arts colleges, and public two-year colleges will be least vulnerable; doctorate-granting universities and comprehensive colleges and universities, moderately vulnerable; and less selective liberal arts colleges and private two-year colleges, most vulnerable (Carnegie Council, 1980).

Responding to demand changes in a context of decline is obviously not the same as responding in a context of growth. Thus, we may not be able to generalize the post-secondary system's recent history of successful adaptation to change to the rest of this century. A major difference between periods of growth and decline is in the amount of "organizational slack," defined as the difference between the organization's total resources and the total payments required to maintain the organization (Cyert and March, 1963). The concept of slack is similar to that of discretionary income. Boom periods tend to create organizational slack; extended periods of decline, to deplete it. Organizational slack facilitates change. If demand for a field is declining, organizations can use slack to reduce faculty size by offering incentives for early retirement or to "carry" excess faculty. If demand for a field is increasing, they can use it to increase capacity in that field without having to cut resources going to other units in the institution.

Although post-secondary enrollments continued to increase during the 1970's, these were not boom times for post-secondary schools. The rate of enrollment increase slowed, the system to be maintained had expanded enormously, and other factors that affected slack were less positive--e.g., government funding of research, the stock market, inflation rates, and energy prices.

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[14]Table 6, p. 34, U.S. Department of Education, National Center for Education Statistics, *Projections of Education Statistics to 1990-91,* Vol. I, U.S. Government Printing Office, Washington, D.C., 1982.

[15]Table 77, p. 93, *Digest of Education Statistics, 1983-84.*

Declining enrollments will further reduce slack. Student-generated income is an important component of post-secondary financing for public and private institutions. In 1981-82 revenues from students (fees, tuition, residence halls, food services) accounted for 80 percent of private two-year college revenues and for almost 50 percent of private four-year college and university revenues. Although student-generated revenues accounted *directly* for only about a quarter of the revenues of public institutions, government funds are tied to enrollments. In 1981-82 government funds accounted for 58 percent of the resources of public four-year colleges and universities and 73 percent of the resources of public two-year colleges.[16]

In this environment of increasing resource scarcity, we can expect resource allocation decisions to shift from a contest over who should get how much of the expanding pie to who should absorb the cuts. Conflicts between equity and entitlement considerations complicate the redistribution. Since individuals weigh losses more heavily than gains (Tversky and Kanneman, 1974), affected parties tend to participate more actively in reallocation processes than in allocation decisions.

In the next decade post-secondary institutions are likely to respond more slowly to increases in demand for particular fields of training. Since schools will generally have less, if any, organizational slack, they are more likely to have to re-allocate resources from other parts of the institution to respond to increasing demand in particular fields. Departments experiencing substantial enrollment declines are an obvious source of funds for those with enrollment increases. Thus, responding to increased demand becomes much more contingent on dealing with decreased demand, i.e., on reallocating resources among departments.

As suggested, resource reallocations are difficult for several reasons. First, members of all departments are more threatened, not just those of departments targeted for cuts. Defensive coalitions are therefore more apt to form to ward off cuts. Second, because resources are scarce, it is less easy, if not impossible, to buy off losers. Third, in the 1970's the percent of tenured faculty members in four year institutions increased from 50 to 75 percent. In this same period the percent of unionized institutions increased from 7 to 22 percent (Carnegie Council, 1980). These changes increase institutional rigidity. And finally, reallocation requires planning and a centralized authority that can make and enforce targeted cuts (Levine et al., 1982). However, power-sharing, not centralized authority, is the typical decision structure in post-secondary institutions.

At the same time, the economics of post-secondary education are increasingly governed by what the Carnegie Council calls "consumer sovereignty," i.e., student demand. As the Council observes:

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[16]Table 2.7, p. 80, U.S. Department of Education, National Center for Education Statistics, *The Condition of Education,* 1984 Edition, U.S. Government Printing Office, Washington, D.C.

> The orientation of higher education has changed substantially over the past nearly three and one-half centuries. At first it was toward preparation for the ministry, for teaching, and for community leadership . . . with curricular emphasis on the Bible and the classics. Later it added preparation for the other ancient professions, specifically law and medicine. After the American Civil War, attention was turned toward agricultural and industrial production, toward science, engineering, and later business administration. Increasingly in the past two decades training has been added for policemen, firemen, nurses, and several of the skilled manual trades. . . . More recently the mass student market has become more important, particularly for the community colleges, but most colleges have placed additional emphasis upon it. . . .
>
> Consumer sovereignty is not the only way to set the agenda for higher education, and consumer sovereignty itself will express quite different tastes in an elite as compared with a mass system of higher education. In addition to consumer sovereignty, there are two other major ways of setting the agenda. One is by the academic guild of the professors, as historically has been the situation in England and in the United States--particularly in the Ivy League and the most selective of the liberal arts colleges. The other is by external authority. . . . It may be the state . . . as in France with emphasis upon the civil service and French culture, or as to some extent in the United States with the emphasis of the federal government on encouraging science. It may be the church, as in many early American institutions. . . . It may be a class, in a class-dominated society, as in England in centuries past and in much of Latin America in more recent times. It may be industry, [as in] schools of technology and business administration. . . .
>
> The clear trend . . . has been toward the student market. . . . Academic guild interests have been best protected by private endowments, alumni support, and federal research funds; and public interests by earmarked funds such as those for agriculture or health care or mineral technology. But most public funds follow the student market through formulas based on enrollment and through direct aid to students, and so do most private funds in the form of tuition (pp. 29-30).

This link between the economic health, if not survival, of post-secondary institutions and responding to changes in student demand encourages post-secondary institutions to resolve the reallocation problem. In sum, we can predict that post-secondary institutions will have to cope with powerful countervailing pressures in the next 15 years--the pressures to resist change that arise out of resource scarcity and pressures to change in order to survive economically.

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Implications of Decline for Educational Quality

The post-secondary system may adjust to a reduced need for faculty and declining enrollments in ways that erode the quality of the faculty, courses, enrollees, and ultimately of post-secondary degrees. Growth in the post-secondary faculty has stopped except for a few fields,[17] and between 1982 and 1995 total post-secondary faculty employment is projected to *decline* by at least 13 percent (Silvestri et al., 1983).

Not only is the post-secondary faculty projected to decline in total size, but separation rates will also be low. Members of the professions change occupations at low rates, the large faculty cohorts hired in the 1960's will not start to retire until the end of this and beginning of the next century, and tenure rules and unions protect tenured faculty against being fired. These factors will combine to produce a dramatically aging faculty. In 1980 43.6 percent of the tenured faculty in colleges and universities were between the ages of 26 and 45. The Carnegie Council (1980) projects that the percent in this age group will drop to 17.8 by 1990 and increase slightly to 21.3 percent by the year 2000. For this same time period the Council projects that the 56-65 year old tenured faculty will increase from *a fifth to almost a half of the nation's total tenured faculty*.

This change in age structure will raise the average cost of faculty salaries and make it difficult to introduce the new fields and courses that may be needed to meet technologically-generated changes in training requirements. At the same time, the quality of the future non-tenured faculty that traditionally staffs the newest fields may be lower than in previous decades. The best students are the most able to choose fields with good employment and salary opportunities, and the bleak job market and low salaries for college teachers are not apt to attract the most able individuals.

How institutions adjust to enrollment declines may also endanger the quality of post-secondary entrants, their degrees, and institutional leadership. The Carnegie Council (1980) notes that institutions already show signs of trying to limit enrollment declines in ways that affect quality:

- lowering admission requirements;
- seeking nontraditional students, who have previously been less preferred academically;
- increasing efforts to retain students in part by grade inflation and in spite of poor performance;

[17] In the 1960's the *fulltime* faculty grew at an average rate of 19,600 per year. The yearly average growth declined to 8,200 for 1970-79 and to 3,000 for 1980-82.

- responding rapidly to changes in student, field-specific demand, whatever its merit; and
- recruiting top leadership clever at economic survival, but not educationally visionary.

The Council summarizes this response pattern in the following way:

> The road to survival now leads through the market place. In the 1960's the revolution consisted of many institutions trying to become research universities and failing. In the 1980's and 1990's it will take more the form of . . . [emulating] the community colleges in adjusting to the market and often succeeding. Excellence was the theme. Now it is survival. Institutions were trading up; now they are trading down (p. 30).

Response to Field-Specific Faculty Shortages

In this discussion the term "shortage" means a shortage of workers relative to the wages offered. It also means a shortage of *appropriately* trained and experienced individuals. This last point is important because organizations work hard to keep the "production line" moving. If they can't find good candidates to fill important vacancies, they will find someone.[18]

Post-secondary schools have military-like compensation arrangements, i.e., approximately the same compensation for the same rank, regardless of occupation or field (Freeman, 1976). If faculty shortages emerge in particular fields, schools are less able to increase compensation--or unable to increase it enough--to attract individuals away from competitors, such as the private sector. In an era of resource scarcity it is politically even more difficult for institutions to offer variable compensation. Since technologically-generated changes in skill requirements are apt to create high demand among all kinds of employers for individuals who possess the new skills, the educational system's limited ability to adjust rewards might produce faculty shortages and therefore a training bottleneck.

Individuals have believed or speculated that there are faculty shortages in fields related to computer-based equipment, such as computer science and electrical engineering. To assess these speculations, we used National Science Foundation (NSF) data on young and senior science and engineering faculty in 1980. We assumed that

[18]For example, it is generally believed that high schools have shortages of mathematics and science teachers. However, 1983-84 data on these fields from the National Center for Education Statistics show very low vacancy rates and low rates of uncertified teachers. It is suspected that the shortage is a quality shortage--the use of temporarily certified teachers and teachers minimally qualified to teach these fields.

certain outcomes should indicate a faculty shortage in a field: higher wages than for other faculty with the same years of experience; greater reliance on part-time faculty; greater reliance on non-doctorate faculty; higher percent of non-tenured faculty in the tenure track; faster promotion rates; higher rates of tenured recent doctorates; lower course loads (and thus, more time for outside consulting or research); higher rates of voluntary turnover; and lower rates of involuntary termination. The NSF data included information on all of these variables except wages and course loads, and these data are displayed in Table 23.

The data indicated a possible shortage of--and at least a brisk market for--computer science faculty, but not of electrical engineering faculty. Relative to the total science and engineering faculty, computer science faculty are much more apt to be part-time and less apt to have doctorates; their non-tenured members are more apt to be on a tenure track; both tenured and non-tenured members have higher voluntary turnover and their non-tenured members lower involuntary turnover. Recent doctorates are not particularly likely to have higher ranks and do not have higher rates of achieving tenure.

Electrical engineering faculty do not differ particularly on these dimensions from the total science and engineering faculty. In fact, there is less evidence of a shortage in electrical engineering than in engineering as a whole, although adequate supplies in aggregate do not preclude spot shortages, either in specific courses or geographically. Like the computer science faculty, electrical engineers are less apt to have doctorates. However, the higher percent of non-doctorates in both of these fields may say less about shortages than about field variations in the amount of training required for employment. We noted earlier that employed computer scientists and engineers are much less apt to have doctorates than, for example, employed physical scientists.

Even if there is a shortage of computer science faculty, we do not know how this shortage affects student training. We do not know how much of what kind of instruction about computer-based equipment is uniquely available in which departments or courses or how damaging the absence of uniquely available instruction might be. For example, some of the knowledge required to perform the tasks associated with computer-based equipment--design, manufacture, marketing, maintenance, and use--can be learned in courses other than computer science courses. Certainly students in all of the highly quantitative fields gain experience with computer-based equipment and software germane to these fields.[13] In other words, to some extent sources of knowledge can substitute for each other.

[13]In fact, one of the explanations of the heterogeneous backgrounds of science and engineering graduates who work in computer science jobs is that opportunities to learn the necessary computer skills are widely diffused among the science and engineering fields.

Table 23

INDICATORS OF SHORTAGES OF COMPUTER SCIENCE AND ELECTRICAL ENGINEERING FACULTIES

Indicator	All S/E(a)	Computer Science	All Engineering	Electrical Engineering
	Type of Faculty			
	(Percent)			
Part-time faculty(b)	23.9	38.2	23.6	25.3
Non-doctorate fulltime faculty	4.6	8.2	10.8	7.7
Non-tenured faculty on tenure track	84.0	91.0	89.0	85.0
Faculty rank of recent doctorates(c)				
Full professor	2.0	1.0	2.9	1.0
Associate professor	15.0	19.0	19.0	17.0
Assistant professor	78.0	78.0	76.3	79.0
Instructor	3.0	2.0	1.1	2.0
Other	2.0	0.0	0.6	1.0
Tenured recent doctorates	14.0	15.0	14.0	11.0
Voluntary turnover (1978-79)				
Tenured faculty	3.5	6.1	4.8	4.8
Non-tenured faculty	7.5	9.3	9.2	7.5
Involuntary turnover (1978-79) (non-tenured faculty only)	3.5	1.5	1.6	1.5

SOURCE: Table B-6, p. 8, National Science Foundation, *Academic Science/Engineering: Scientists and Engineers, January 1983,* Report No. NSF 84-309, Washington, D.C.: U.S. Government Printing Office, 1984. Tables B-7, B-9, B-10, and B-37, pp. 23-24, 26-29, 30-31, and 85-86, National Science Foundation, *Young and Senior Science and Engineering Faculty, 1980,* Report No. NSF 81-319, Washington, D.C.: U.S. Government Printing Office, 1981.

(a)"All S/E" means all science and engineering faculty, defined to include the faculties in engineering, the physical sciences, the biological sciences, mathematics, the computer sciences, the social sciences, and psychology.

(b)Data on part-time faculty are for January, 1983; for all other indicators, for the spring, 1980.

(c)Recent doctorates refers to doctorates who have had their Ph.D. degrees for seven or fewer years.

SUMMARY

The data showed that in the last 20 years the post-secondary educational system accommodated profound changes in the demand for its services--changes in the total number of students, among fields, between levels, and in the social composition of student bodies. We discussed five characteristics of the post-secondary system that seemed to facilitate its adaptiveness: the number of different institutions and sectors, substitution between them, heterogeneity among them, student geographic mobility, and the internal organization of the institutions in major sectors of the system.

However, the educational system has three important problems and a potential fourth problem that affects its ability to respond to changes in training requirements. First, secondary vocational education in comprehensive high schools is relatively unresponsive to changes in skill requirements. It has been argued that the job market for high school graduates is essentially a market for training opportunities, not fully developed skills. Although employers act as though this is the case, we can as easily argue that employers have no option but to hire the most trainable, as opposed to the most trained, high school graduates. It appears that the institutional context for most vocational education in this country--the comprehensive high school, as opposed to the vocational high school--is the problem, not the concept of vocational education itself. For example, in the comprehensive system vocational students are dispersed across high schools, precluding the economies of scale required to justify the costs of sophisticated, modern equipment that the vocational high schools can realize.

Second, the post-secondary system is facing a period of unprecedented enrollment decline that promises to slow its response to change. Since student-generated revenues constitute a significant part of the total revenues of both public and private institutions, institutions increasingly have to cut the resources going to some units in order to free money to respond to fields with enrollment growth. This process usually generates considerable resistance, particularly in institutions organized in the way that most post-secondary institutions are organized--with dispersed, rather than centralized, authority. The percent of schools that have unionized and the proportions of faculties that are tenured have also increased over the last decade, making institutions more rigid.

Third, we identified quality as a potential problem in the educational system. Institutions face a dramatically older post-secondary faculty by the year 2000, a development that will raise the average cost of faculty salaries and make it difficult to introduce the new fields and courses that may be needed to meet technologically-generated changes in skill requirements. At the same time, the quality of the future non-tenured faculty that traditionally staffs the newest fields may be lower than in previous decades. The best students are the most able to choose fields with good employment and salary opportunities, and the bleak job market and low salaries for college teachers are not apt to attract the most able individuals.

How institutions adjust to enrollment declines may also endanger the quality of post-secondary entrants, their degrees, and institutional leadership. Institutions already show signs of trying to limit enrollment declines in ways that affect quality, such as lowering admission requirements, seeking nontraditional and academically less preferred students, and responding rapidly to changes in student, field-specific demand, whatever its merit.

Fourth, technologically-generated changes in skill requirements are apt to increase demand among all kinds of employers for individuals who possess the new skills. Since the military-like compensation structures of post-secondary schools limit their ability to compete for the scarce labor required to teach these new skills, there has been concern that the post-secondary schools will become training bottlenecks for the skills most needed to integrate technological advances into the economy.

Our analyses indicate that there is at least a brisk market for, if not shortages of, computer science faculty. We did not see evidence of electrical engineering faculty shortages, although there may be spot shortages in narrow specialties or in particular types of institutions. Perhaps more important, we do not know what effect a faculty shortage has on student training. Substitution can operate as much in the world of learning opportunities as it does in the employment world.

V. POLICY CONCLUSIONS

SUBSTITUTION POSSIBILITIES

This project dramatizes our need to know--and our lack of knowledge--about what can substitute for what among learning opportunities, formal training, or work experience. Being able to answer this question is key to understanding how rapidly management and labor can accommodate technologically-generated skill changes.

All of the recent reports on public high schools have sounded alarms about students' verbal, mathematical, and scientific skills. These concerns have been predicated partly on the assumption that a solid skill base equips individuals to adjust to job and occupational changes by giving them the basis to learn new skills. This view seems consistent with private sector training behaviors. Employers conduct training that is critical for helping labor adjust to technological change, but they typically train "at the margin," i.e., build on a base.

This concept of flexibility does not seem to carry over into how we usually think about skill shortages or over-supplies, especially for somewhat higher skill occupations. We implicitly assume that these occupations require occupationally-specific education. As we noted earlier, if occupations require distinct bundles of skills, they operate like countries with immigration barriers. Workers cannot move freely among these countries. However, data presented in this report indicate that this is a mechanistic and fundamentally inaccurate theory of human cognitive capacities, the educational system, the effects of schooling, and the nature of jobs. We see that students and even highly skilled workers move between post-secondary fields and between high skill occupations. The movement is not unconstrained, but there is movement. We also see evidence that learning opportunities--for example, about computer-based equipment--seem more widely dispersed among post-secondary courses and departments than might be thought. This raises questions about the meaning of field-specific faculty shortages.

The problem for public and private sector policy is that we do not have good knowledge about what substitutes for what and under what conditions. Answers to this fundamental question could drastically alter private and public sector training policies. Certainly they would position employers and policymakers to anticipate better when technologically-generated changes in skill requirements will and will not cause adjustment problems.

YOUTH AND SCHOOLS: ADJUSTMENTS TO TECHNOLOGICALLY-DRIVEN SKILL REQUIREMENTS

Computer-based equipment promises to ultimately transform the American economy. However, 16-24 year olds evidence a range of behaviors that promise that they will adequately adjust to

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technologically-generated changes in skill requirements. In their educational process, they change their fields of concentration--from mathematics to computers or from physics to engineering, thus reducing the time that is required to graduate specialists. They change jobs readily, a behavior that particularly helps meet technologically-generated changes in the demand for lower skill jobs. They change geographic residence quite easily, behaviors that can alleviate geographically-specific supply/demand imbalances. Successive groups of youth change the amounts and fields of education in ways that are consistent with changes in occupational opportunities. Finally, the sheer numbers that complete educational programs each year represent a remarkable opportunity to rapidly re-configure the skill profile of the American labor force, given that graduates tend to choose fields of study in response to labor market opportunities.

We see more problems with the secondary and post-secondary educational system than with youth, most being problems of quality. The academic performance of high school seniors has deteriorated relative to 1972 high school seniors, and the question for the next decade is whether this performance decline will be arrested and reversed. Probably the quality of secondary education will improve, at least in the sense that students will take more of what *A Nation at Risk* called the five basics (English, mathematics, science, social studies, and computer science). However, although state after state has legislated or is contemplating legislation to improve elementary and secondary education, these reforms may ultimately affect quality only marginally. The structural problems that produced the decline in educational quality are profound, and their amelioration requires fairly major reform. Public education is still locally controlled, and state governments have limited power to reform public education in the state. And although the states *together* have taken a number of actions, the relevant question is the adequacy of the package of reforms passed by any one state.

In contrast to area vocational schools and special vocational high schools, secondary vocational education in comprehensive high schools has not proved responsive to demands for vocational training of higher quality and greater relevance. In fairness, we think that the institutional context for most vocational education in this country, the comprehensive high school, limits the ability of vocational educators to respond to these demands. At the same time, the costs of lost opportunities continue.

The post-secondary system has shown a remarkable ability to accommodate major changes in the numbers, fields, levels, and the social composition of enrollments. We suspect that it will continue to be responsive, although declining enrollments will probably slow the rates at which they respond. The serious question about this system is about the quality of the education delivered, not about responsiveness.

Post-secondary institutions will have a much older faculty by the year 2000, a fact that will raise payroll costs and make it difficult to introduce new fields and courses. The quality of new faculty that traditionally staffs the newest fields may also decline: the bleak job market and low salaries for college teachers should make it difficult to attract the best people into teaching. How institutions adjust to enrollment declines may endanger the quality of post-secondary entrants, their degrees, and institutional leadership. Post-secondary schools already show signs of trying to limit enrollment declines by lowering admission requirements and responding rapidly to changes in student, field-specific demand, whatever its merit.

In sum, creating, producing, and integrating computer-based equipment into the economy are facilitated if youth leave the school system with the type, level, and quality of skills required by this technological revolution. In this context, the public policy problems seem to be the tough ones of the *quality* of skills, not their type or level. The quality issue pervades secondary education, not just vocational education in the comprehensive high schools. It promises increasingly to affect the post-secondary system.

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APPENDIX A

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Table A.1

TOTAL NUMBER AND PERCENT OF 1980 HIGH SCHOOL SENIORS BY CURRICULUM, GENDER, RACE, AND ETHNICITY

Curriculum	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American
Total	3,041,000	1,465,762	1,575,238	2,429,759	352,756	197,665	21,287	39,533
Percent	100.0	48.20	51.80	79.90	11.60	6.50	.70	1.30
Academic								
Total	1,178,768	571,647	604,891	981,623	120,995	50,602	5,386	20,162
Percent	100.0	48.50	51.32	83.28	10.26	4.92	.46	1.71
General								
Total	1,106,887	556,990	565,510	879,573	122,406	82,031	10,345	12,532
Percent	100.0	50.32	51.09	79.46	11.06	7.41	.93	1.13
Vocational								
Total	753,268	337,125	404,836	566,134	109,707	65,032	5,556	6,839
Percent	100.0	44.75	53.74	75.16	14.56	8.63	.74	.91

SOURCE: pp. 11, 49, National Center for Education Statistic, High School and Beyond: A National Longitudinal Study for the 1980's, High School Seniors: A Comparative Study of the Classes of 1972 and 1980, U.S. Government Printing Office, Washington, D.C., 1984.

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Table A.2

NUMBER AND SHARES OF 1980-81 COMPLETIONS OF NON-COLLEGIATE POSTSECONDARY OCCUPATIONAL PROGRAMS (MAJOR FIELDS)

Field	Total	Share
Total	889,969	100.0
Agribusiness	3,516	.40
Marketing and Distribution	191,778	21.55
Health Occupations	91,603	10.29
Home Economics	4,702	.53
Business and Office	180,455	20.28
Technical Occupations	65,534	7.36
Trade and Industry	352,389	39.60

SOURCE: Table C-2, pp. 99-100, U.S. Department of Labor, Bureau of Labor Statistics, Occupational Projections and Training Data, 1984 Edition, U.S. Government Printing Office, Washington, D.C., 1984.

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Table A.3

NUMBER OF 1979 APPRENTICESHIP COMPLETIONS BY TRADE, RACE, ETHNICITY, AND GENDER

Trade	Total	White	Black	Hispanic	American Indian	Asian American	NEC*	Percent Minority	Percent Female
Air Cond & Refrigeration Mech	2,167	1,754	152	91	14	53	103	19.1	1.3
Aircraft Mechanics	418	345	34	33	3	2	1	17.5	5.6
Auto & Related Mechanics	10,531	8,265	656	620	109	207	674	21.5	1.1
Auto and Related Body Repairers	3,225	2,573	262	135	98	81	76	20.2	2.3
Barbers & Beauticians	1,373	1,109	180	38	9	11	26	19.2	63.1
Boilermakers	4,046	3,506	271	142	63	64	0	13.3	2.0
Bookbinders & Bindery Workers	705	618	45	32	2	2	6	12.3	14.4
Bricklayers Stone & Tile Sets	9,274	7,329	1,085	558	189	110	3	21.0	2.0
Butchers & Meat Cutters	2,056	1,551	145	258	28	67	7	24.6	7.6
Cabinetmakers, Wood Machinists	2,107	1,620	153	194	19	43	78	23.1	5.1
Car Repairers	3,019	2,540	282	121	51	25	0	15.9	4.0
Carpenters	48,505	40,072	3,861	2,834	843	885	10	17.4	4.0
Cement Masons	3,574	1,941	837	642	76	77	1	45.7	5.9
Compositers	318	282	24	8	1	2	1	11.3	20.2
Construction Workers, NEC	1,228	900	173	120	28	7	0	26.7	3.3
Cooks & Bakers	2,697	1,995	448	148	19	51	36	26.0	16.1
Drafters	803	711	45	18	1	9	19	11.5	11.2
Electrical Workers, NEC	944	788	90	39	4	12	11	16.5	5.2
Electricians	38,685	33,301	2,902	1,591	544	327	20	13.9	3.2
Electronic Technicians	1,440	1,144	84	94	5	91	22	20.6	10.9
Floor Coverers	1,897	1,499	126	202	31	39	0	21.0	.9
Glaziers	1,317	1,075	92	81	23	46	0	18.4	1.0
Industrial Technicians	1,393	1,040	123	175	24	31	0	25.3	11.5
Insulation Workers	1,689	1,352	160	81	49	47	0	20.0	3.9
Lathers	1,594	1,197	151	177	50	19	0	24.9	1.1
Line Erectors Light & Power	5,232	4,635	167	241	111	66	12	11.4	2.4
Lithographers Photoengravers	1,872	1,641	148	54	11	12	6	12.3	3.5
Machine Set-up & Operators	1,554	1,223	180	63	28	52	8	21.3	3.2
Machinists	15,586	13,562	948	571	87	402	16	13.0	3.3
Maintenance Mechanics	5,069	4,445	403	139	22	54	6	12.3	5.5
Mechanics & Repairers, NEC	4,781	4,137	315	145	40	113	31	13.5	2.3
Medical & Dental Technicians	5,573	4,935	289	194	58	20	77	11.4	5.8
Millwrights	6,140	5,276	552	215	78	18	1	14.1	2.5
Molders & Coremakers	629	507	55	59	2	6	0	19.4	1.6
Office Machine Servicers	916	776	87	36	8	6	3	15.3	1.8
Operating Engineers	6,517	4,590	1,047	552	228	99	1	29.6	8.5
Optical Workers	328	299	16	7	1	4	1	8.8	15.8
Ornamental Ironworkers	185	147	13	6	2	0	17	20.5	1.1
Painters	7,634	5,674	988	641	155	171	5	25.7	7.8
Patternmakers	1,016	957	31	19	8	1	0	5.8	2.6

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Table A.3 (continued)

Trade	Total	White	Black	Hispanic	American Indian	Asian American	NEC*	Percent Minority	Percent Female
Pipeftr, Sprinklerftr, Steamftr	15,737	13,167	1,397	594	310	258	11	16.3	3.2
Plasterers	1,580	935	307	263	26	48	1	40.8	3.7
Plumbers	18,704	15,081	1,431	749	245	194	4	14.0	1.6
Press Operators	1,009	814	132	50	1	12	0	19.3	2.9
Printing & Publishing Workers	1,077	939	71	44	2	9	12	12.8	10.2
Radio & TV Repairers	572	492	44	19	2	4	11	14.0	2.1
Roofers	7,023	4,699	1,281	801	160	81	1	33.1	1.3
Sheet Metal Workers	12,395	10,122	1,292	574	199	193	15	18.3	2.3
Stationary Engineers	1,928	1,538	210	116	30	32	2	20.2	3.2
Structural Steel Workers	10,246	8,353	1,052	407	336	96	2	18.5	1.7
Tapers & Dry-Wall Installers	1,816	1,404	145	205	47	15	0	22.7	5.1
Toolmakers & Diemakers	14,231	13,245	599	255	41	58	33	6.9	3.3
Miscellaneous Trades, NEC	23,133	19,065	2,361	947	203	376	181	17.6	7.0
U.S. Total	317,488	262,165	27,942	16,398	4,724	4,708	1,551	17.4	4.1

Occupation	Total	White	Black	Hispanic	American Indian	Asian American	NEC*	Male	Female
Those registered who completed programs									
Total	43,347	35,918	3,190	2,258	704	765		2,211	1,243
Share of Completions, %	100.0	82.86	7.36	5.21	1.62	1.76	1.18	97.38	2.87
Completion Rate, %	15.34	15.48	12.49	15.56	15.69	16.79	34.43	15.06	14.12

SOURCE: Reports No. 3, 4, and 9, U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, Bulletin No. 81-22, U.S. Government Printing Office, Washington, D.C., 1981.

*NEC = Not Elsewhere Classified.

NOTE: Excludes those with no racial/ethnic identification.

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Table A.4

OCCUPATIONS IN WHICH FY82 ENLISTEES WITH 13+ MONTHS OF SERVICE RECEIVED TRAINING BY RACE, ETHNICITY, AND GENDER

Occupation	White	Black	Hispanic	American Indian	Asian American	Other	Total	Male	Female
Unknown	961	149	47	5	9	21	1,192	1,119	73
Infantry, General	15,226	4,130	937	192	245	335	21,065	21,061	4
Special Forces	175	2	1	0	2	0	180	180	---
Military Training Instructor	111	7	3	0	1	1	123	109	14
Armor & Amphibious, General	3,048	802	156	27	45	45	4,123	4,121	2
Combat Engineering, General	3,097	568	144	35	48	51	3,943	3,937	5
Artillery & Gunnery	4,216	2,454	393	49	119	145	7,376	7,359	17
No Name (42)	461	90	13	1	0	5	570	543	27
Missile Artillery, Operating Crew	1,233	536	60	17	8	20	1,874	1,814	60
Air Crew, General	154	4	2	0	1	1	162	146	16
Pilots & Navigators	4	0	0	0	0	0	4	4	---
Boatswains	698	120	32	4	7	8	869	825	44
Navigators	566	106	22	4	3	2	703	669	34
Small Boat Operators	161	23	4	0	2	3	193	164	29
Security Guards	4,092	890	110	14	28	51	5,185	5,183	2
Radio/Radar, General	1,731	100	44	8	17	12	1,912	1,818	94
Communications Radio	3,738	524	109	15	32	41	4,459	4,102	357
Navigation, Communication & Countermeasure, NEC	3,839	249	88	8	29	25	4,238	4,028	210
Air Traffic Control Radar	222	10	5	1	2	3	243	221	22
Surveillance/Target Acquisition & Tracking Radar	1,208	107	49	4	8	9	1,385	1,332	53
Bomb-Navigation	148	10	3	0	2	1	164	161	3
Airborne Fire Control	481	46	12	2	3	3	547	515	32
Shipboard & Other Fire Control	554	37	10	2	4	2	609	596	13
Missile Guidance & Control	2,014	246	85	11	20	17	2,393	2,308	85
Missile Checkout Equipment, Test Equipment, & Calibration	445	42	4	1	2	3	497	469	28
Torpedo	438	89	27	5	3	3	565	485	80
Sonar, General	900	76	16	2	9	2	1,005	996	10
Nuclear Weapons Equipment Repair, General	220	24	6	0	1	5	256	232	24
ADP Computers, General	1,112	99	24	1	14	6	1,256	1,188	68
Teletype & Cryptographic Equipment, General	1,720	167	43	7	9	14	1,960	1,724	236
Training Devices	652	66	26	1	22	18	785	727	58
Shipboard Inertial Navigation Systems	117	8	5	0	1	0	131	131	---
Electronic Instruments, NEC	2,889	253	63	6	31	37	3,279	3,003	276
Radio Code	3,733	1,926	275	24	47	61	6,066	5,184	882

Table A.4 (continued)

Occupation	White	Black	Hispanic	American Indian	Asian American	Other	Total	Male	Female
Non-Code Radio	2,285	867	115	25	20	44	3,356	3,048	308
Non-Radio Communications (Visual)	303	44	8	0	2	1	358	349	9
Sonar Operator, General	613	32	15	4	3	4	671	535	136
Radar	2,309	364	89	14	12	27	2,815	2,726	88
Air Traffic Control	1,073	133	37	3	9	9	1,264	1,002	261
Signal Intelligence/Electronic Warfare, General	96	16	3	1	1	2	119	117	2
Intercept (Code & Non-Code)	1,910	336	68	2	6	12	2.334	1,662	672
Analysis	1,065	33	12	2	6	6	1,124	852	272
Electronic Countermeasures	719	54	16	2	6	5	802	691	111
Language Interrogation/ Interpretation	83	5	3	0	2	1	94	58	36
Image Interpretation	398	31	10	2	1	4	446	319	127
Operational Intelligence	362	58	6	2	2	5	435	361	74
Counterintelligence	74	4	1	0	1	0	80	62	18
Combat Operations Control, General	2,591	579	128	10	33	29	3,370	3,301	69
Communications Center Operations, General	2,090	1,023	126	18	20	47	3,324	2,250	1,074
Medical Care & Treatment, General	4,791	1,589	332	28	134	101	6,975	5,057	1,918
Operating Room	317	83	23	2	14	8	447	295	152
Mental Care	245	53	3	1	4	6	312	215	97
Therapy	78	18	7	0	4	0	107	72	35
Orthopedic	49	19	2	0	4	0	74	62	12
Laboratory	631	199	47	2	30	21	930	629	301
Pharmacy	210	69	16	2	15	4	316	242	74
Radiology	393	98	17	2	14	7	531	405	126
Food Inspection & Vet. Services	287	66	13	1	0	2	369	254	115
Preventive Medical Services	182	62	9	2	2	2	259	184	75
Dental Care, General	680	254	47	7	16	13	1,017	588	429
Dental Laboratory	86	12	7	1	5	1	112	71	41
Photography, General	475	90	8	4	4	11	592	434	158
Mapping	55	29	3	0	1	1	89	76	13
Surveying	569	88	21	5	11	8	702	646	56
Drafting	42	13	1	0	0	0	56	53	3
Illustrating	132	29	3	0	1	2	167	121	46
Weather, General	437	46	9	1	3	4	500	353	147
EOD/UDT	178	8	0	0	1	1	188	179	9
Diver	2	0	0	0	0	0	2	2	---
Musicians, General	501	79	12	3	1	1	597	499	98
Physical Science Laboratory	52	9	5	0	1	1	68	53	15
Memorial Activities & Embalming	18	8	0	0	0	0	26	23	3
Nuclear, Biological, and Chemical Warfare Specialists	450	293	47	2	10	11	813	757	56
Firefighting & Damage Control	949	178	34	3	9	17	1,190	1,177	13
Other Tech. Specialists & Assistants	37	7	10	0	4	0	58	41	17
Personnel, General	1,880	1,388	256	15	70	56	3,665	2,520	1,145
Administration, General	4,976	3,163	374	45	178	144	8,880	5,766	3,114

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Table A.4 (continued)

Occupation	White	Black	Hispanic	American Indian	Asian American	Other	Total	Male	Female
Stenography	32	24	1	0	0	0	57	5	52
Legal	174	79	11	2	3	4	273	199	74
Medical	360	202	30	2	5	8	607	396	211
Combined Personnel & Admin., General	362	101	15	4	1	17	500	418	82
Operators/Analysts	1,077	121	32	4	9	9	1,252	818	434
Programmers	303	28	8	0	7	6	352	284	68
Auditing & Accounting	266	65	9	1	7	6	354	227	127
Disbursing	557	292	32	5	34	19	939	633	306
Supply Administration	4,060	2,684	426	32	190	121	7,513	5,922	1,591
Unit Supply	1,103	1,231	226	19	71	46	2,696	2,124	572
Transportation	972	386	82	7	28	15	1,490	1,189	301
Postal	199	76	10	1	1	6	293	224	69
Aviation Maint. Records & Reports	370	89	20	3	3	5	490	316	174
Flight Operations	321	119	16	1	4	5	466	349	117
Functional Analysis	106	25	1	0	2	4	138	101	37
Chaplain's Assistants	284	82	11	0	5	5	387	236	151
Recreation & Welfare	136	61	7	0	2	2	208	149	59
Information & Education, General	258	30	7	1	2	0	298	183	115
Aircraft, General	7,525	712	259	24	98	74	8,692	8,429	263
Aircraft Engines	1,786	237	65	12	24	32	2,156	1,975	180
Aircraft Accessories	4,290	739	163	15	59	64	5,330	4,840	490
Aircraft Structures	1,264	142	50	4	16	18	1,494	1,410	84
Aircraft Launch Equipment	511	129	35	1	14	7	697	681	16
Automotive, General	2,889	727	149	28	53	60	3,906	3,694	212
Track Vehicle	3,196	496	104	29	37	34	3,896	3,875	21
Construction Equipment	921	154	37	11	15	19	1,157	1,123	34
Linemen	1,576	923	116	26	28	62	2,731	2,534	197
Central Office	278	67	22	1	22	16	406	359	47
Interior Communications	715	120	21	7	14	7	884	811	73
Missile Engine	19	5	2	0	0	0	26	24	2
Missile Mechanic	298	34	10	3	5	1	351	344	7
Missile Launch & Support Facilities	392	48	12	1	2	2	457	447	10
Small Arms Repair	169	40	15	2	1	1	228	208	20
Artillery Repair	82	13	2	1	2	2	102	101	1
Turret Repair	487	90	22	7	14	9	629	622	7
Nuclear Weapons Main. & Assembly	200	42	7	2	1	1	253	219	34
Ammunition Repair	1,132	365	51	3	3	13	1,567	1,474	93
Aviation Ordnance	2,911	546	108	16	31	39	3,651	3,477	174
Mines & Degaussing	61	7	4	0	2	0	74	59	15
Main Propulsion	3,563	382	135	13	93	24	4,210	4,205	5
Auxiliaries	1,581	144	54	9	25	13	1,826	1,716	110
Nuclear Power	2,063	52	41	7	15	9	2,187	2,186	1
Electric Power	1,884	347	71	13	68	35	2,418	2,258	160
Precision Equipment, General	309	62	11	4	2	5	393	337	56
Other Mechanical & Electrical Equipment, General	76	55	11	2	6	2	152	149	3
Metalworking, General	28	7	3	0	1	1	40	39	1

Table A.4 (continued)

Occupation	White	Black	Hispanic	American Indian	Asian American	Other	Total	Male	Female
Welding	478	49	16	3	5	3	554	509	45
Machinist	629	29	17	2	9	3	689	656	33
Sheetmetal	82	13	6	1	2	4	108	94	14
Metal Body Repair	207	55	7	3	1	2	275	246	29
Construction, General	670	60	13	1	4	8	756	733	23
Steelworking	133	7	0	1	0	0	141	135	6
Woodworking	406	95	14	1	8	7	531	513	18
Construction Equipment Operation	1,308	179	28	5	6	14	1,540	1,508	32
Utilities, General	1,027	219	41	11	14	25	1,337	1,273	64
Electrician	605	104	40	6	24	25	804	773	31
Lithography, General	111	56	7	0	3	3	180	134	46
Indus. Gas & Fuel Prod., General	24	3	0	0	1	1	29	29	---
Fabric, Leather, & Rubber, General	281	141	11	1	4	7	445	386	59
Other Craftsmen, NEC, General	1,298	88	29	4	10	5	1,434	1,327	107
Food Service, General	4,162	2,233	199	28	135	103	6,860	5,682	1,178
Stewards & Enlisted Aides	3	0	0	0	1	0	4	1	3
Motor Vehicle Operators	3,722	1,096	146	32	25	52	5,073	4,606	467
Missile Fuel & Petroleum	1,116	638	133	10	31	18	1,946	1,805	141
Warehousing & Equipment Handling	1,247	626	90	4	28	44	2,039	1,756	283
Sales Store	385	189	31	1	14	8	628	552	76
Law Enforcement, General	5,425	649	112	26	23	37	6,272	5,543	729
Corrections	265	93	15	2	2	4	381	367	14
Investigations	2	0	0	0	0	0	2	1	1
Laundry & Personal Service, General	205	147	17	4	5	6	384	360	24
Forward Area Equip. Support, General	544	76	25	3	12	7	667	594	73
Cadets & Other Officer Candidates	230	4	2	0	1	0	237	228	9
Students	24	2	0	2	0	0	28	21	7
Undesignated Occupations, General	696	210	22	3	3	4	938	896	42
Not Occup. Qualified, General	12,381	3,392	764	75	241	149	17,002	15,506	1,495
Total	183,849	43,322	9,070	1,209	3,071	2,935	248,456	222,163	26,288

SOURCE: Defense Manpower Data Center, Office of the Secretary of Defense, Department of Defense, Occupational Conversion Manual, Enlisted/Officer/Civilian, 1980.

Table A.5

NUMBER AND SHARES OF 1980-81 ASSOCIATE DEGREES AND OTHER AWARDS IN OCCUPATIONAL CURRICULA BY PROGRAM LEVEL AND GENDER

		2-4 Year Curriculum		1-2 Year Curriculum	
Curriculum	Total	Male	Female	Male	Female
Total	374,820	133,141	154,275	38,030	49,374
Percent	100.0	35.52	41.16	10.15	13.17
Data Processing Technologies					
Total	19,003	7,781	7,753	1,184	2,285
Percent	100.0	40.95	40.80	6.23	12.02
Health Services and Paramedical Technologies					
Total	86,815	7,774	56,705	1,754	20,582
Percent	100.0	8.95	65.53	2.02	23.71
Natural Sciences Technologies					
Total	19,643	8,823	5,731	2,970	2,119
Percent	100.0	44.92	29.18	15.12	10.79
Mechanical and Engineering Technologies					
Total	89,315	56,232	5,045	25,752	2,286
Percent	100.0	62.96	5.65	28.83	2.56
Business and Commerce Technologies					
Total	127,057	38,816	63,788	4,548	19,905
Percent	100.0	30.55	50.20	3.58	15.67
Public Service Related Technologies					
Total	32,987	13,715	15,253	1,822	2,197
Percent	100.0	41.58	46.24	5.52	6.66

SOURCE: pp. 135-136, National Center for Education Statistics, Digest of Education Statistics 1983-84, pp. 135-136, U.S. Government Printing Office, Washington, D.C., 1983.

Table A.6

NUMBER AND SHARE OF B.A. DEGREES AWARDED IN 1980-81, BY FIELD, GENDER, RACE, AND ETHNICITY

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Total	934,800	469,625	465,175	807,319	60,673	21,832	3,593	18,794	22,589
Percent	100.0	50.24	49.46	86.36	6.49	2.34	.38	2.01	2.42
Agriculture and Natural Resources									
Total	21,886	15,154	6,732	20,234	380	248	96	312	616
Percent	100.0	69.24	30.76	92.45	1.74	1.13	.44	1.43	2.81
Architecture and Environment Design									
Total	9,455	6,800	2,655	8,069	300	270	24	296	496
Percent	100.0	71.92	28.08	85.34	3.17	2.86	.25	3.13	5.25
Area Studies									
Total	2,585	1,031	1,554	2,242	67	104	4	118	50
Percent	100.0	39.88	60.12	86.73	2.59	4.02	.15	4.56	1.93
Biological Sciences									
Total	43,216	24,149	19,067	37,276	2,269	1,144	137	1,489	901
Percent	100.0	55.88	44.12	86.26	5.25	2.65	.32	3.45	2.08
Business and Management									
Total	200,857	127,058	73,799	174,198	13,400	4,114	636	3,943	4,566
Percent	100.0	63.26	36.74	86.73	6.67	2.05	.32	1.96	2.27
Communications									
Total	31,282	14,179	17,103	27,473	2,405	557	110	368	369
Percent	100.0	45.33	54.67	87.82	7.69	1.78	.35	1.18	1.18
Computer and Information Sciences									
Total	15,120	10,202	4,918	12,565	786	302	21	669	777
Percent	100.0	67.47	32.53	83.10	5.20	2.0	.14	4.42	5.14
Education									
Total	108,265	27,069	81,196	93,724	9,494	2,847	569	723	908
Percent	100.0	25.0	75.0	86.57	8.77	2.63	.53	.67	.84
Engineering									
Total	74,954	67,255	7,699	60,848	2,449	1,433	195	3,066	6,963
Percent	100.0	89.73	10.27	81.18	3.27	1.91	.26	4.09	9.29

Table A.6 (continued)

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Fine and Applied Arts									
Total	40,241	14,624	25,617	35,933	1,835	779	187	788	719
Percent	100.0	36.34	63.66	89.29	4.56	1.94	.46	1.96	1.79
Foreign Languages									
Total	10,319	2,520	7,799	8,614	293	909	25	210	268
Percent	100.0	24.42	75.58	83.48	2.84	8.81	.24	2.04	2.60
Health Professions									
Total	63,649	10,519	53,130	56,790	3,603	1,153	209	1,312	582
Percent	100.0	16.53	83.47	89.22	5.66	1.81	.33	2.06	.91
Home Economics									
Total	18,370	916	17,454	16,260	1,125	230	73	395	287
Percent	100.0	4.99	95.01	88.51	6.12	1.25	.40	2.15	1.56
Law									
Total	776	388	388	731	22	10	2	5	6
Percent	100.0	50.0	50.0	94.20	2.84	1.29	.26	.64	.77
Letters									
Total	40,028	16,107	23,921	36,315	1,980	694	103	460	476
Percent	100.0	40.23	59.76	90.72	4.90	1.73	.26	1.15	1.19
Library Science									
Total	375	22	353	339	30	1	2	2	1
Percent	100.0	5.87	94.13	90.40	8.0	.27	.53	.53	.27
Mathematics									
Total	11,078	6,342	4,736	9,445	584	185	18	391	455
Percent	100.0	57.25	42.75	85.26	5.27	1.67	.16	3.53	4.11
Military Science									
Total	305	293	12	289	6	3	1	4	2
Percent	100.0	96.07	3.93	94.75	1.97	.98	.33	1.31	.66
Physical Science									
Total	23,950	18,062	5,888	21,246	906	405	65	596	732
Percent	100.0	75.42	24.58	88.71	3.78	1.69	.27	2.49	3.06

Table A.6 (continued)

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Psychology									
Total	40,833	14,295	26,538	34,701	3,308	1,305	196	839	484
Percent	100.0	35.01	64.99	84.98	8.10	3.20	.48	2.05	1.19
Public Affairs and Services									
Total	36,311	15,266	21,045	29,310	4,869	1,176	224	416	316
Percent	100.0	42.04	57.96	80.72	13.41	3.24	.62	1.15	.87
Social Services									
Total	100,647	56,156	44,491	85,535	8,129	2,888	474	1,645	1,976
Percent	100.0	55.80	44.20	84.99	8.08	2.87	.47	1.63	1.96
Theology									
Total	5,807	4,334	1,473	5,352	166	88	5	58	138
Percent	100.0	74.63	25.37	92.16	2.86	1.52	.09	1.0	2.38
Interdisciplinary Studies									
Total	34,491	16,884	17,607	29,830	2,267	987	217	689	501
Percent	100.0	48.95	51.05	86.49	6.57	2.86	.63	2.0	1.45

SOURCE: Table 101, pp. 120-121, National Center for Education Statistics, Digest of Education Statistics 1983-84, U.S. Government Printing Office, Washington, D.C., 1983.

Table A.7

NUMBER AND SHARE OF M.A. DEGREES AWARDED IN 1980-81, BY FIELD, GENDER, RACE, AND ETHNICITY

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Total	294,183	145,666	148,517	241,216	17,133	6,461	1,034	6,282	22,057
Percent	100.0	49.52	50.48	82.0	5.82	2.20	.35	2.14	7.50
Agriculture and Natural Resources									
Total	4,003	3,061	942	3,083	73	63	7	67	710
Percent	100.0	76.47	23.53	77.02	1.82	1.57	.17	1.67	17.74
Architecture and Environment Design									
Total	3,153	2,234	919	2,391	122	65	5	112	458
Percent	100.0	70.85	29.15	75.83	3.87	2.06	.16	3.55	14.53
Area Studies									
Total	718	335	383	532	14	39	6	38	89
Percent	100.0	46.66	53.34	74.09	1.95	5.43	.84	5.29	12.40
Biological Sciences									
Total	5,978	3,654	2,324	5,210	171	69	15	145	368
Percent	100.0	61.12	38.88	87.15	2.86	1.15	.25	2.43	6.16
Business and Management									
Total	57,541	43,045	14,496	47,474	2,359	869	155	1,633	5,051
Percent	100.0	74.81	25.19	82.5	4.10	1.51	.27	2.84	8.78
Communications									
Total	3,105	1,448	1,657	2,556	187	43	9	66	244
Percent	100.0	46.63	53.36	82.32	6.02	1.38	.29	2.13	7.86
Computer and Information Sciences									
Total	4,143	3,176	967	2,818	70	60	12	279	904
Percent	100.0	76.66	23.34	68.02	1.69	1.45	.29	6.73	21.82
Education									
Total	98,380	28,079	70,301	82,779	8,645	2,831	453	973	2,699
Percent	100.0	28.54	71.46	84.14	8.79	2.88	.46	.99	2.74
Engineering									
Total	16,358	14,998	1,360	10,147	260	278	31	1,079	4,563
Percent	100.0	91.69	8.31	62.03	1.59	1.70	.19	6.60	27.89

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Table A.7 (continued)

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Fine and Applied Arts									
Total	8,629	4,056	4,573	7,624	267	132	22	160	424
Percent	100.0	47.0	53.0	88.35	3.09	1.53	.25	1.85	4.91
Foreign Languages									
Total	2,104	694	1,410	1,636	33	174	8	26	227
Percent	100.0	32.98	67.02	77.76	1.57	8.27	.38	1.24	10.79
Health Professions									
Total	16,515	4,316	12,199	14,175	889	251	54	448	698
Percent	100.0	26.13	73.87	85.83	5.38	1.52	.33	2.71	4.23
Home Economics									
Total	2,570	252	2,318	2,191	132	31	10	63	143
Percent	100.0	9.81	90.19	85.25	5.14	1.21	.39	2.45	5.56
Law									
Total	1,832	1,506	326	1,366	38	52	1	37	338
Percent	100.0	82.21	17.79	74.56	2.07	2.84	.05	2.02	18.45
Letters									
Total	8,301	3,229	5,072	7,208	250	131	18	114	580
Percent	100.0	38.90	61.10	86.83	3.01	1.58	.22	1.37	7.00
Library Science									
Total	4,859	841	4,018	4,324	216	58	17	69	175
Percent	100.0	17.31	82.69	88.99	4.45	1.19	.35	1.42	3.60
Mathematics									
Total	2,565	1,690	875	1,890	67	40	7	97	464
Percent	100.0	65.89	34.11	73.68	2.61	1.56	.27	3.78	18.09
Physical Science									
Total	5,227	4,144	1,083	4,115	107	55	11	153	786
Percent	100.0	79.28	20.72	78.73	2.05	1.05	.21	2.93	15.04
Psychology									
Total	7,998	3,358	4,640	7,016	424	179	32	77	270
Percent	100.0	41.99	58.01	87.72	5.30	2.24	.40	.96	3.38

Table A.7 (continued)

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Public Affairs and Services									
Total	20,074	8,957	11,117	16,435	1,893	629	92	306	719
Percent	100.0	44.62	55.38	81.87	9.43	3.13	.46	1.52	3.58
Social Services									
Total	11,917	7,442	4,475	9,150	615	280	44	233	1,595
Percent	100.0	62.45	37.55	76.78	5.16	2.35	.37	1.96	13.38
Theology									
Total	3,728	2,461	1,267	3,282	71	50	1	55	269
Percent	100.0	66.01	33.99	88.04	1.90	1.34	.03	1.48	7.22
Interdisciplinary Studies									
Total	4,485	2,690	1,795	3,814	230	82	24	52	283
Percent	100.0	59.98	40.02	85.04	5.13	1.83	.54	1.16	6.31

SOURCE: Table 102, pp. 122-123, National Center for Education Statistics, Digest of Education Statistics 1983-84, U.S. Government Printing Office, Washington, D.C., 1983.

Table A.8

NUMBER AND SHARE OF PH.D DEGREES AWARDED IN 1980-81, BY FIELD, GENDER, RACE, AND ETHNICITY

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Total	32,839	22,595	10,244	25,908	1,265	456	130	877	4,203
Percent	100.0	68.81	31.19	78.89	3.85	1.39	.40	2.67	12.8
Agriculture and Natural Resources									
Total	1,067	940	127	664	15	14	2	29	343
Percent	100.0	88.10	11.90	62.23	1.41	1.31	.19	2.72	32.15
Architecture and Environment Design									
Total	93	73	20	56	6	2	---	5	24
Percent	100.0	78.49	21.51	60.22	6.45	2.15	---	5.38	25.81
Area Studies									
Total	157	100	57	124	6	1	1	6	19
Percent	100.0	63.69	36.31	78.98	3.82	.64	.64	3.82	12.10
Biological Sciences									
Total	3,718	2,666	1,052	3,177	64	40	8	140	289
Percent	100.0	71.71	28.29	85.45	1.72	1.08	.22	3.77	7.77
Business and Management									
Total	844	719	125	619	32	2	5	25	161
Percent	100.0	85.19	14.81	73.34	3.79	.24	.59	2.96	19.08
Communications									
Total	182	107	75	147	10	---	1	2	22
Percent	100.0	58.79	41.21	80.77	5.49	---	.55	1.10	12.09
Computer and Information Sciences									
Total	252	227	25	184	1	---	1	14	52
Percent	100.0	90.08	9.92	73.02	.40	---	.40	5.56	20.63
Education									
Total	7,900	4,164	3,736	6,391	614	140	57	105	593
Percent	100.0	52.71	47.29	80.90	7.77	1.77	.72	1.33	7.51
Engineering									
Total	2,551	2,447	104	1,352	24	23	5	191	956
Percent	100.0	95.92	4.08	53.0	.94	.90	.20	7.49	37.48

Table A.8 (continued)

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Fine and Applied Arts									
Total	654	396	258	587	17	4	2	7	37
Percent	100.0	60.55	39.45	89.76	2.60	.61	.31	1.07	5.66
Foreign Languages									
Total	588	274	314	470	9	37	1	5	66
Percent	100.0	46.60	53.40	79.93	1.53	6.29	.17	.85	11.22
Health Professions									
Total	842	475	367	689	26	8	6	25	88
Percent	100.0	56.41	43.59	81.83	3.09	.95	.71	2.97	10.45
Home Economics									
Total	247	78	169	206	9	1	1	6	24
Percent	100.0	31.58	68.42	83.40	3.64	.40	.40	2.43	9.72
Law									
Total	60	56	4	40	1	1	---	---	18
Percent	100.0	93.33	6.67	66.67	1.67	1.67	---	---	30.0
Letters									
Total	1,790	1,010	780	1,549	56	14	7	22	142
Percent	100.0	56.42	43.58	86.54	3.13	.78	.39	1.23	7.93
Library Science									
Total	71	31	40	51	9	1	---	3	7
Percent	100.0	43.66	56.34	71.83	12.68	1.41	---	4.23	9.86
Mathematics									
Total	728	614	114	507	9	6	2	31	173
Percent	100.0	84.34	15.66	69.64	1.24	.82	.27	4.26	23.76
Physical Science									
Total	3,140	2,764	376	2,445	32	23	4	106	530
Percent	100.0	88.03	11.97	77.87	1.02	.73	.13	3.38	16.88
Psychology									
Total	2,955	1,681	1,274	2,637	116	65	10	33	94
Percent	100.0	56.89	43.11	89.24	3.93	2.20	.34	1.12	3.18

Table A.8 (continued)

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Public Affairs and Services									
Total	433	260	173	330	52	10	2	11	28
Percent	100.0	60.05	39.95	76.21	12.01	2.31	.46	2.54	6.47
Social Services									
Total	3,119	2,272	847	2,465	100	52	12	72	418
Percent	100.0	72.84	27.16	79.03	3.21	1.67	.38	2.31	13.40
Theology									
Total	1,169	1,071	98	993	45	7	1	33	90
Percent	100.0	91.62	8.38	84.94	3.85	.60	.09	2.82	7.70
Interdisciplinary Studies									
Total	279	170	109	225	12	5	2	6	29
Percent	100.0	60.93	39.07	80.65	4.30	1.79	.72	2.15	10.39

SOURCE: Table 103, pp. 124-125, National Center for Education Statistics, Digest of Education Statistics 1983-84, U.S. Government Printing Office, Washington, D.C., 1983

Table A.9

NUMBER AND SHARE OF FIRST-PROFESSIONAL DEGREES AWARDED IN 1980-81, BY FIELD, GENDER, RACE, AND ETHNICITY

Field	Total	Male	Female	White	Black	Hispanic	American Indian	Asian American	Nonresident Alien
Total	71,340	52,194	19,146	64,551	2,931	1,541	192	1,456	669
Percent	100.0	73.16	26.84	90.48	4.11	2.16	.27	2.04	.94
Dentistry									
Total	5,460	4,672	788	4,896	195	86	10	204	69
Percent	100.0	85.57	14.43	89.67	3.57	1.58	.18	3.74	1.26
Medicine									
Total	15,505	11,672	3,833	13,723	769	395	51	446	121
Percent	100.0	75.28	24.72	88.51	4.96	2.55	.33	2.88	.78
Optometry									
Total	1,097	890	207	1,017	9	16	2	40	13
Percent	100.0	81.13	18.87	92.71	.82	1.46	.18	3.65	1.19
Osteopathic Medicine									
Total	1,145	957	188	1,091	16	13	8	14	3
Percent	100.0	83.58	16.42	95.28	1.40	1.14	.70	1.22	.26
Pharmacy									
Total	664	381	283	471	20	19	3	115	36
Percent	100.0	57.38	42.62	70.93	3.01	2.86	.45	17.32	5.42
Podiatry									
Total	597	528	69	552	20	12	1	8	4
Percent	100.0	88.44	11.56	92.46	3.35	2.01	.17	1.34	.67
Veterinary Medicine									
Total	1,922	1,245	677	1,846	37	11	4	17	7
Percent	100.0	64.78	35.22	96.05	1.93	.57	.21	.88	.36
Chiropractic									
Total	2,337	1,948	389	2,144	13	24	3	22	131
Percent	100.0	83.35	16.65	91.74	.56	1.03	.13	.94	5.61
Law, general									
Total	36,331	24,563	11,768	33,109	1,576	899	101	530	116
Percent	100.0	67.61	32.39	91.13	4.34	2.47	.28	1.46	.32
Theological Professions, general									
Total	6,282	5,338	944	5,702	276	66	9	60	169
Percent	100.0	84.97	15.03	90.77	4.39	1.05	.14	1.0	2.69

SOURCE: Table 104, pp. 126, National Center for Education Statistics, Digest of Education Statistics 1983-84, U.S. Government Printing Office, Washington, D.C., 1983

NOTE: Excludes degree recipients whose racial/ethnic group was not reported.

Table A.10a

1980 SHARES OF WORK EXPERIENCE IN HIGH TECHNOLOGY OCCUPATIONS
FOR THE TOTAL LABOR FORCE AND FOR 16-24 YEAR OLDS
BY RACE, ETHNICITY, AND GENDER

	Total			White			Black		
Occupation	Total	Male	Female	Total	Male	Female	Total	Male	Female
All Occupations									
Total	100.0	57.36	42.64	86.06	50.02	36.03	9.56	4.79	4.77
16-24 year olds	100.0	52.73	47.27	85.95	45.40	40.55	9.16	4.56	4.59
Architects									
Total	100.0	91.80	8.20	92.13	84.65	7.48	2.75	2.48	.27
16-24 year olds	100.0	83.56	16.44	90.38	75.63	14.74	5.63	5.10	.53
Engineers									
Total	100.0	95.43	4.57	92.08	88.08	4.00	2.53	2.22	.31
16-24 year olds	100.0	86.78	13.22	91.72	80.04	11.67	3.95	2.99	.96
Surveyors and Mapping Specialists									
Total	100.0	96.35	3.65	95.03	91.64	3.40	2.26	2.11	.15
16-24 year olds	100.0	93.68	6.32	93.49	87.51	5.98	3.53	3.42	.10
Mathematical and Computer Scientists									
Total	100.0	74.05	25.95	90.48	68.04	22.44	5.22	2.89	2.32
16-24 year olds	100.0	59.45	40.55	90.44	54.17	36.27	5.17	2.75	2.42
Natural Scientists									
Total	100.0	80.36	19.64	90.47	73.73	16.74	3.74	2.52	1.22
16-24 year olds	100.0	62.02	37.98	91.35	57.08	34.28	4.95	2.90	2.05
Technicians and Related Support Occupations									
Total	100.0	56.31	43.69	86.88	50.35	36.53	8.31	3.10	5.21
16-24 year olds	100.0	51.94	48.06	89.64	46.65	42.98	6.21	2.86	3.35
Computer Equipment Operators									
Total	100.0	40.96	59.04	83.49	33.94	49.55	11.62	4.68	6.95
16-24 year olds	100.0	38.50	61.50	85.19	31.98	53.21	10.14	4.42	5.73
Mechanics and Repairers									
Total	100.0	96.69	33.17	89.94	87.20	2.75	6.37	5.94	.43
16-24 year olds	100.0	96.33	3.67	91.27	88.16	3.11	4.87	4.47	.40

Table A.10a

	Total			White			Black		
Occupation	Total	Male	Female	Total	Male	Female	Total	Male	Female
Precision Production Occupations									
Total	100.0	82.19	17.81	88.08	73.53	14.55	7.27	5.35	1.92
16-24 year olds	100.0	78.78	21.22	87.16	69.70	17.46	6.98	4.81	2.17
Health Diagnosing Occupations									
Total	100.0	88.33	11.67	88.93	79.96	8.97	2.78	2.16	.62
16-24 year olds	100.0	40.05	59.95	90.41	35.76	54.65	5.36	2.23	3.13
Health Assessment and Treating Occupations									
Total	100.0	13.97	86.03	87.78	12.30	75.48	7.77	1.00	6.77
16-24 year olds	100.0	11.42	88.58	91.40	9.91	81.49	5.88	1.03	4.85

SOURCE: Table 280, pp. 232-267, U.S. Department of Commerce, Bureau of Census, 1980 Census of Population, U.S. Summary, U.S. Government Printing Office, Washington, D.C., 1984.

Table A.10b

1980 SHARES OF WORK EXPERIENCE IN HIGH TECHNOLOGY OCCUPATIONS
FOR THE TOTAL LABOR FORCE AND FOR 16-24 YEAR OLDS
BY RACE, ETHNICITY, AND GENDER

	Hispanic			American Indian			Asian American		
Occupation	Total	Male	Female	Total	Male	Female	Total	Male	Female
All Occupations									
Total	5.59	3.37	2.22	.52	.30	.23	1.73	.93	.80
16-24 year olds	6.90	4.00	2.90	.60	.33	.27	1.36	.68	.68
Architects									
Total	3.97	3.65	.32	.20	.20	.02	3.97	3.63	.35
16-24 year olds	5.20	4.08	1.13	.26	.26	.00	1.63	1.09	.53
Engineers									
Total	2.27	2.13	.15	.24	.22	.02	4.54	4.35	.19
16-24 year olds	2.96	2.54	.42	.24	.20	.05	2.88	2.51	.37
Surveyors and Mapping Specialists									
Total	3.36	3.20	.16	.90	.84	.03	.82	.80	.02
16-24 year olds	5.42	5.14	.27	.85	.68	.17	.14	.14	.00
Mathematical and Computer Scientists									
Total	2.32	1.67	.65	.29	.19	.09	3.41	2.50	.92
16-24 year olds	2.84	1.72	1.11	.24	.16	.07	3.16	1.82	1.34
Natural Scientists									
Total	2.25	1.65	.60	.37	.28	.09	1.74	.33	1.41
16-24 year olds	3.09	1.94	1.15	.76	.46	.30	1.77	.82	.95
Technicians and Related Support Occupations									
Total	3.75	2.23	1.53	.47	.25	.22	3.13	1.89	1.24
16-24 year olds	4.37	2.62	1.75	.43	.25	.19	2.11	1.24	.88
Computer Equipment Operators									
Total	5.14	2.35	2.79	.46	.18	.27	2.63	1.34	1.29
16-24 year olds	5.84	2.47	3.37	.43	.14	.29	1.88	1.00	.89
Mechanics and Repairers									
Total	5.44	5.24	.20	.53	.51	.02	1.12	1.07	.05
16-24 year olds	5.86	5.58	.28	.57	.54	.03	.87	.83	.04

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Table A.10b

Occupation	Hispanic			American Indian			Asian American		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Precision Production Occupations									
Total	9.14	7.44	1.69	.50	.37	.12	1.58	.99	.58
16-24 year olds	8.59	6.40	2.19	.62	.47	.14	1.37	.93	.44
Health Diagnosing Occupations									
Total	3.43	2.93	.50	.13	.11	.02	7.57	5.62	1.94
16-24 year olds	5.22	2.36	2.86	.47	.24	.22	1.99	.95	1.05
Health Assessment and Treating Occupations									
Total	2.41	.51	1.90	.32	.04	.27	3.45	.46	2.99
16-24 year olds	2.52	.50	2.03	.23	.03	.20	1.67	.25	1.42

SOURCE: Table 280, pp. 232-267, U.S. Department of Commerce, Bureau of Census, 1980 Census of Population, U.S. Summary, U.S. Government Printing Office, Washington, D.C., 1984.

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Table A.11

PROJECTED NUMBER OF PRE-BACCALAUREATE DEGREES(a) FOR 1984-1985
BY LEVEL AND ALTERNATIVE FIELD SHARE ASSUMPTIONS(b)

Field	Field Shares 1970-71	Field Shares 1981-82
Curricula of At Least 2 and Less Than 4 Years		
Business & Commerce Technologies	1,174,339	1,150,919
Data Processing Technologies	204,087	244,236
Health Services & Paramedics	655,756	722,670
Mechanical, Engineering & Electronic	813,004	754,789
Natural Sciences	163,939	160,593
Public Services	331,224	311,150
Total(c)	3,342,349	3,344,357
Curricula of At Least 1 and Less Than 2 Years		
Business & Commerce Technologies	265,952	277,515
Data Processing Technologies	42,048	54,662
Health Services & Paramedics	362,662	272,259
Mechanical, Engineering & Electronic	259,645	331,126
Natural Sciences	32,587	58,867
Public Services	88,300	57,713
Total(c)	1,051,194	1,050,142

(a)SOURCE: Table A.5 displays the number of degrees by program level used for these projections.

(b)SOURCE: Text Table 11 displays the field shares for 1970-71 and 1981-82 used in these projections.

(c)The total degrees by program level should be the same for the two different share assumptions, but vary slightly because of rounding error in the field shares.

Table A.12

PROJECTED NUMBER OF POST-SECONDARY DEGREES(a) FOR 1984-1995
BY LEVEL AND ALTERNATIVE FIELD SHARE ASSUMPTIONS(b)

Field	B.A.		M.A.		Ph.D	
	1970-71	1981-82	1970-71	1981-82	1970-71	1981-82
Agribusiness & Agricultural Production	38,464	53,647	7,943	10,166	2,887	2,668
Agricultural Science	85,025	131,586	20,651	27,005	8,151	7,968
Renewable Natural Resources	29,354	38,464	5,401	7,625	1,316	1,425
Architecture & Environmental Design	66,805	103,244	23,510	35,900	402	914
Area & Ethnic Studies	31,378	30,366	14,297	8,578	1,645	1,133
Business & Management	1,368,494	2,257,206	365,037	658,910	9,174	9,540
Business & Office	16,195	16,195	0	32	0	0
Communications	124,501	344,148	24,463	33,359	1,645	2,047
Communications Technologies	6,073	19,232	1,271	2,542	0	219
Computer & Information Sciences	28,342	215,599	21,921	53,056	1,462	2,814
Education	2,128,657	1,073,944	1,226,004	1,007,744	72,881	85,819
Engineering	541,527	711,577	224,932	188,396	41,411	29,277
Engineering & Engineering-Related Technologies	61,744	137,659	1,906	4,448	11	183
Foreign Languages	240,904	104,257	65,446	21,604	8,882	5,994
Allied Health	30,366	64,781	2,542	6,989	110	37
Health Sciences	273,294	609,344	72,436	164,251	5,117	10,124
Home Economics	130,574	183,208	19,697	25,098	1,389	2,778
Vocational Home Economics	4,049	6,073	318	318	22	0
Law	6,073	9,110	13,026	20,333	219	256
Letters	782,431	364,392	153,767	68,941	21,126	14,653
Liberal/General Studies	65,793	192,318	7,625	11,755	110	402
Library & Archival Sciences	12,146	3,037	96,581	48,608	439	950
Life Sciences	431,197	442,331	79,107	63,222	41,484	41,813
Mathematics	298,599	123,488	71,483	29,228	13,633	7,602
Military Sciences	4,049	3,037	29	635	0	0
Multi/Interdisciplinary Studies	100,208	187,257	15,885	41,619	914	4,021
Parks & Recreation	19,232	56,683	3,177	5,719	22	366
Philosophy & Religion	98,183	66,805	18,427	12,390	6,323	4,057
Theology	45,549	63,769	37,489	43,843	3,545	14,401
Physical Sciences	258,111	255,074	87,685	59,410	49,964	36,733
Psychology	456,502	436,258	60,998	83,873	20,285	31,068
Protective Services	24,293	132,598	2,542	14,297	11	256
Public Affairs	75,915	199,403	113,101	195,703	2,120	4,349
Social Sciences	1,871,558	1,057,749	227,156	127,715	41,667	34,211
Visual & Performing Arts	366,416	429,173	92,133	94,039	7,054	7,494
Total(c)	10,122,001	10,123,012	3,177,986	3,177,351	365,421	365,572

(a)SOURCE: U.S. Department of Education, National Center for Education Statistics, Projections of Education Statistics to 1992-93, forthcoming, and unpublished projections of number of degrees by level for 1993-1995.

(b)SOURCE: Text Table 12.

(c)The total degrees by level under the two field share assumptions should be the same, but vary slightly be[illegible] of rounding error in the field shares.

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Table A.13

PROJECTED NUMBER OF PROFESSIONAL DEGREES(a)
FOR 1984-1995 BY LEVEL AND ALTERNATIVE
FIELD SHARE ASSUMPTIONS(b)

Field	1970-71	1981-82
Dentistry	76,690	59,051
Medicine	181,755	176,387
Optometry	10,737	12,270
Osteopathic Medicine	9,970	11,504
Podiatry	4,601	6,902
Veterinary Medicine	25,308	23,007
Law	355,075	401,089
Theology	102,765	76,690
Total(c)	766,901	766,900

(a)SOURCE: U.S. Department of Education, National Center for Education Statistics, Projections of Education Statistics to 1992-93, forthcoming, and unpublished projections for 1993-1995.

(b)SOURCE: Text Table 13.

(c)The total degrees by level under the two field share assumptions should be the same, but vary slightly because of rounding error in the field shares.

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Table A.14

FIELD SHARES OF TOTAL M.A. DEGREES: RATIOS OF 1976-77 SHARES TO 1980-81 SHARES BY RACE AND ETHNICITY

Field	Total	White	Black	Hispanic	American Indian	American Asian
Agriculture and natural resources	.85	.84	.56	.94	1.82	1.48
Architecture and environmental	.99	.99	.11	1.53	1.94	1.03
Area studies	1.30	1.27	3.25	1.32	0	1.82
Biological sciences	1.08	1.08	.98	1.14	1.07	1.36
Business and management	.74	.75	.56	.70	.73	.70
Communications	.92	.94	.72	.73	.47	.82
Computer and information sciences	.66	.69	.76	.82	.27	.47
Education	1.18	1.18	1.20	1.00	1.14	1.25
Engineering	.95	.99	.74	.94	.79	.84
Fine and applied arts	.92	.92	.79	.92	1.31	1.07
Foreign languages	1.43	1.43	2.47	1.36	.40	2.95
Health professions	.72	.72	.60	.74	.75	.96
Home economics	.83	.85	.68	.54	.10	1.00
Law	.78	.61	.55	.51	1.00	.66
Letters	1.18	1.17	1.27	1.45	1.43	1.62
Library science	1.45	1.42	1.47	1.67	1.39	2.90
Mathematics	1.44	1.47	1.62	1.11	1.82	1.14
Military sciences	--	--	--	--	--	--
Physical sciences	.95	.95	.71	.93	2.05	1.14
Psychology	.96	.93	.98	1.84	.87	1.48
Public affairs and services	.89	.90	.81	.87	.89	.99
Social sciences	1.24	1.23	1.28	1.29	.87	1.45
Theology	.76	.76	.73	1.26	2.10	.74
Interdisciplinary studies	.94	.95	.69	1.22	.63	1.67

SOURCE: Table 111, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1980, U.S. Government Printing Office, Washington, D.C.; and Table 102, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1983-84, U.S. Government Printing Office, Washington, D.C.

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Table A.15

FIELD SHARES OF TOTAL PH.D DEGREES: RATIOS OF 1976-77 SHARES TO 1980-81 SHARES BY RACE AND ETHNICITY

Field	Total	White	Black	Hispanic	American Indian	American Asian
Agriculture and natural resources	.87	.86	.74	.63	2.05	1.56
Architecture and environmental	.75	.73	1.36	.86	0	0
Area studies	1.02	1.02	1.02	1.73	0	1.34
Biological sciences	.87	.87	.82	.63	2.57	.99
Business and management	1.01	1.04	.41	3.05	.82	.85
Communications	.93	.96	.10	--	--	1.30
Computer and information sciences	.83	.85	1.00	--	1.36	.86
Education	1.01	1.00	1.13	1.02	.77	.98
Engineering	1.06	1.11	.97	.95	.55	.87
Fine and applied arts	.99	.96	1.25	1.09	2.05	1.14
Foreign languages	1.28	1.28	1.58	1.02	4.10	.81
Health professions	.61	.61	.54	.77	1.60	1.12
Home economics	.64	.64	.68	--	--	.68
Law	.73	.73	2.00	--	--	--
Letters	1.22	1.21	1.08	1.93	.78	1.63
Library science	1.00	1.05	.34	2.59	--	1.79
Mathematics	1.16	1.16	1.13	2.61	2.05	.99
Military sciences	--	--	--	--	--	--
Physical sciences	1.05	1.03	1.42	1.47	2.05	1.18
Psychology	.91	.91	.91	.75	1.51	1.01
Public affairs and services	.75	.81	.43	.79	1.37	.12
Social sciences	1.21	1.21	1.18	1.03	.57	1.35
Theology	.88	.92	.47	.37	--	.08
Interdisciplinary studies	1.07	1.08	1.09	.70	.68	.90

SOURCE: Table 111, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1980, U.S. Government Printing Office, Washington, D.C.; and Table 103, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1983-84, U.S. Government Printing Office, Washington, D.C.

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Table A.16

FIELD SHARES OF TOTAL PROFESSIONAL DEGREES: RATIOS OF 1976-77 SHARES TO 1980-81 SHARES BY RACE AND ETHNICITY

Field	Total	White	Black	Hispanic	American Indian	American Asian
Dentistry	1.05	1.05	1.21	1.17	1.57	.83
Medicine	.97	.97	1.07	.84	.58	.85
Law	1.05	1.05	.99	1.07	1.18	1.05
Theology	.97	.96	.84	1.32	.54	1.14
Other	.83	.82	.74	.63	1.07	1.31

SOURCE: Table 111, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1980, U.S. Government Printing Office, Washington, D.C.; and Table 103, U.S. Department of Education, National Center for Education Statistics, Digest of Educational Statistics, 1983-84, U.S. Government Printing Office, Washington, D.C.

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