ABSTRACT

TARANT, STEPHANIE ANN. Predicting Retention of Recent College Graduates In Science and Engineering: Implications For States and Organizational Recruiting Practices. (Under the direction of Denis O. Gray.)

Today's labor force is more mobile than any cohort in recent history. Labor force mobility and state level retention can have profound effects on the economy of a state. It is necessary for organizations to both effectively retain their own talent as well as to attract top talent from other states. Understanding the individual level factors that predict who will move and who will stay in-state after graduating from college is important for policy makers and organizations looking to tailor their recruiting efforts in order to maximize their efforts to attract and retain top talent in science and engineering fields. The present study examined data collected by the National Science Foundation in their *National Survey of Recent College Graduates (NSRCG:1997)* to determine factors that predict state retention of high school and most recent college degree recipients in science and engineering fields. Logistic regression was used to analyze two dichotomous dependent measures of retention, high school degree and most recent college degree. Results found support for a core set of predictors common to both measures; they include race, college major, annual salary, and stayers (those who stayed in-state to attend college). In addition, undergraduate GPA predicted retention at the high school level while respondent age and citizenship predicted retention/ most recent degree. By far, stayers had the largest effect on retention for both dependent measures.

PREDICTING RETENTION OF RECENT COLLEGE GRADUATES IN SCIENCE AND ENGINEERING: IMPLICATIONS FOR STATES AND ORGANIZATIONAL RECRUITING PRACTICES

by

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This work is dedicated to

My mother,

Christina Butler, and to

The memory of my stepfather,

Harold Butler.

Their unconditional love, support, and ceaseless encouragement

enabled me to pursue my goals and realize my own strength and potential (Proverbs 22:6).

AUTHOR BIOGRAPHY

I was born on October 29, 1971 in Silver Spring, Maryland to Christina and Paul Tarant. I lived in Silver Spring, Maryland with my mother and stepfather where I graduated from Albert Einstein High School in 1989. I did my undergraduate work at the University of North Carolina at Wilmington. While attending UNC-Wilmington, I was initiated into the Nu Lambda Chapter of the Chi Omega Fraternity. I learned many interpersonal, organizational and leadership skills as a result of my fraternal involvement.

My interest in the field of Industrial/ Organizational (I/O) Psychology began with a dual interest in both psychology and business. I quickly realized that my difficulty in deciding between a major in psychology and business was really an opportunity for me to combine them and pursue an advanced degree in I/O Psychology. I therefore decided a degree in psychology would be most beneficial with a minor in business. Since such a program was not offered at the time, I ventured out and created my own. I received special permission from the Cameron School of Business to develop a minor curriculum in business that would accommodate my academic goals. I graduated in 1994 from UNC-Wilmington with a Bachelor's degree in Psychology and a minor in Business Management. Although there was not a formal curriculum in I/O, the instruction in research methods and personal attention that I received at UNC-Wilmington was invaluable. I owe special thanks to Dr. Kate Bruce and Dr. Dale Cohen for their guidance and encouragement. My research with them examined attitudes about AIDS and people with HIV and culminated in my first journal publication. As a result of that research, I was chosen to assist the Southeastern North Carolina HIV Prevention Community Planning Group as a research and grant writing assistant. These experiences gave me exposure to the multiplicity of this world and served to bolster my compassion towards others. I was accepted the following year to the graduate program in Industrial/ Organizational and Vocational Psychology at North Carolina State University where I have had the opportunity to work with Dr. Denis Gray on cutting edge projects that have resulted in several published works.

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TECHNOLOGY AND THE NEW ECONOMY

The onslaught of technological innovation in this country is forcing a rapid change in the nature of the American economy. Until recently, this country operated under an economy that was dominated primarily by manufacturing. Today, the U.S. economy is steadily moving away from manufacturing and moving towards an economy dominated by information and service. The state of the *'new economy'* is being built around talented people with special knowledge and skill, much more so than historical economic plans, and the shift from goods-producing jobs to jobs in the service sector is projected to continue into the next millennium. The Bureau of Labor Statistics projects the growth rate for jobs requiring a college degree to proliferate at a rapid rate (Fullerton, 1995). As a result, higher numbers of jobs are being created that require greater academic preparation (Plane & Rogerson, 1994). Even vocational or traditionally blue-collar jobs are beginning to require more advanced knowledge and higher skill levels than ever before. As this shift continues, organizations are becoming increasingly reliant on people with scientific and technical expertise and it has become apparent that work-force needs of the future are radically different than those of even the recent past.

Although there are dramatic differences in regional and interstate participation in the new economy there are general factors that help clarify and define the nature of the changing economy. In a recent study Tornatzky, Gray, Tarant, and Howe (1998) described several key characteristics of the new economy. The first of these characteristics relates to the fact that economic growth in this country is becoming increasingly tied to technology. In terms of percentage of sales, U.S. firms have doubled their R&D intensity over the last 15 years and technology-based companies and industries are gaining international market share at a much

faster rate than other industries. Second, advances in transportation and communications technologies have enabled U.S. industries to spread across national boarders and create a global economy that thrives on international competition. Third, small entrepreneurial companies are becoming increasingly important in the state of the new economy, as they have begun to account for a disproportionate share of job creation, new product innovations, and aggressive positioning in international markets. The fourth and perhaps most important characteristic of the new economy is the high premium that is now placed on highly trained and skilled workers that have backgrounds in scientific and technical disciplines (Tornatzky, Gray, Tarant, Howe, 1998). There are a variety of issues that are specifically related to the supply and demand of manpower in the new economy. These issues include education, human resources, and the decision matrix involved in the science and engineering pipeline. The following is a brief discussion of these issues.

ISSUES RELATED TO MANPOWER AND THE NEW ECONOMY

Education

Education rates directly affect the supply of manpower trained in highly technical fields. As the basis of the economy continues to shift toward information and services, all levels of education are undergoing revolutionary changes. Information technologies are changing the ways in which instruction is delivered in the classroom. Students are now required to have a certain level of computer mastery before they are permitted to matriculate. Education systems across the country are increasing the number of computers in individual elementary and secondary classrooms, and many colleges and universities now require their freshmen to posses their own personal computers. Similarly, instruction is no longer restricted to the confines of the classroom. Advances in communications and information

technologies have made education accessible to individuals in remote areas, at flexible times, and to a much broader audience than traditional instruction. The economic shift towards information and services requires more cognitive ability than was once required by a manufacturing focus. As a result of these higher cognitive requirements, scientists and engineers of the future should be trained not just to think, but to be versatile problem solvers' in a multitude of situations (Brennan, 1997). Education, particularly in the science and engineering fields should foster creativity, flexibility, problem-solving abilities, and communication skills that will prepare students for employment prospects in a variety of settings (Wilkinson, 1998; Regets, 1997; Brennan, 1997).

The number of students educated in a given field has a direct effect on the subsequent labor supply in that field. There has been a great deal of controversy surrounding the size of the future labor pool in scientific and technical fields, and the issue of whether enough PhDs are being produced for the number of slots that is likely to be available to them has been widely debated. In the 1970's, the number of international students pursuing physical science PhDs at U.S. Universities increased. Later, employment opportunities from foreign countries for students with baccalaureate and master's degrees began having a competitive impact on the growth of doctoral engineering programs in the United States, and the demand for these professionals in both academic and industrial settings continues to grow. This high international demand for science and engineering PhDs led the National Science Foundation to "trigger alarms" about a PhD shortfall predicted for the early twenty-first century. Although PhD production was growing from about 19,000 a year between 1976 and 1986 to 26,000 in 1995, great concern was noted for the decreased rate of growth rather than for the actual number of degrees produced (National Science Board, 1998; Salters, 1997).

The 'philosophical' answer regarding the number of PhDs being produced is that there can never be too many well-educated people in a technological society. As eluded to earlier, the number of people educated in a given field affects the size of the human resource pool from which organizations have to select their employees. The following discussion describes the impact that the supply of human resources has on the state of the new economy.

Human Resources

Our nation's economic performance and security depend on several key factors, including the ability to make better use of our human resources in science and engineering. A strong partnership between science, technology and the federal government could accelerate the movement of ideas from the laboratory and facilitate the use of new technologies throughout the economy (Committee on Science, Engineering & Public Policy, 1993). At the present time, the government is responsible for planning, budgeting, and reviewing the nations' policies to promote science and engineering research and development, but is ill equipped to mange the process of personnel development and placement. The benefits of efficiently utilizing our human resources (i.e. science and engineering personnel) would contribute to our national objectives for a competitive knowledge based economy.

Human resource issues related to manpower are typically at the top of most companies list of pressing business issues, particularly if they are in the position to hire scientists and engineers during this would be "shortage". The number of recruiting sources available to organizations is limited. Successful recruiting strategies are of immense importance for staffing organizations with top quality employees. In an ideal situation, there should be enough applicants that recruiters have the freedom to choose among a qualified pool, and

applicants that are selected should be an exact match for the position to be filled. To do this, companies use a variety of screening techniques including, interviews, aptitude and ability tests, personality measures, work sample tests, application blanks, reference and academic record checks (Jewell & Siegall, 1990). The number of potential employees that are obtained by the recruiting process directly affects the stringency of the requirements established for the job and the caliber of those who are finally hired. It is no longer sufficient to look in your own back yard so-to-speak for a supply of quality applicants. Companies must now conduct national searches for even basic level jobs. If there is a shortage of applicants and the job must be filled in a few weeks, some standards will have to be lowered. It is necessary to monitor the labor supply because jobs change and the characteristics of job applicants also change.

Companies expect that new entries have all the academic skills needed to promote the company's success. Organizations typically look for applicants that have been trained in an academic area relevant to the job. The number of individuals entering an educational program, completing it to degree, and entering the workforce is called the *pipeline*. The following discussion describes the impact of the science and engineering pipeline on the state of the new economy.

Science and Engineering Pipeline

The condition of the U.S. science and engineering infrastructure is critical to the health of the new U.S. economy. Scientists and engineers contribute to the development of new products, offer improvements in productivity, enhance defense capabilities, provide environmental protection, and drive advances in communications and health care (Braddock, 1992). Time and time again, industry leaders note that the biggest problem firms face today

is the inadequate supply of high-skilled labor. Employers find it difficult to fill technical jobs requiring complicated training and technical skills (American Electronics Association, 1997). A shortage of highly skilled quality workers does not contribute to our national objectives for a competitive knowledge based economy. Dolittle (1996) described the science and engineering pipeline as a long-term dynamic and complex process that involves a series of decisions about one's education and career path. This complex decision matrix defines the process by which individuals enter, go through, and leave the science and engineering educational system and workforce.

The number of entrants into the college and university system and the enrollment rate for students in science and engineering fields in the U.S. education system has been declining since the mid 1980's (National Science Board, 1998). This trend is expected to reverse and college enrollment is expected to increase in the year 2000 when the children born to baby-boomers reach college age (Dolittle, 1996). However, this projection should be conveyed with caution. An increase in the general college population does not necessarily indicate an increase in the enrollment rates of individuals in science and engineering professions.

There are several reasons that enrollment in science and engineering fields may be declining. First, economic and demographic factors affect choices of college major and the types and numbers of degrees that are ultimately awarded. Finn & Baker (1993) found that there is a lagged-relationship of approximately five years between students' choice of college major and market salary data. This lag is a result of the fact that students do not have information about future job opportunities and salaries therefore; their choice of college major is influenced by wages and job openings available at the time they declare a major. For example, if engineers are in high demand and being paid well in the field, students will

be attracted to those fields of study. However, if a given field is saturated and lacks competitive starting salaries, students will tend to avoid choosing to major in that field (Finn & Baker, 1993; Braddock, 1992). Another reason for declining enrollment in specifically science and engineering fields is the increased participation of women and minorities in the college and work force populations. Although these workers are increasing in the general workforce, they are still under-represented in science and engineering fields of study and in the employment sector (more will be said on this subject in later sections).

Although the information presented so far has described a deficit in the number of scientists and engineers projected for the early twenty-first century, there are others who argue that this is not the case (Braddock, 1992; Finn & Baker, 1993). Studies predicting a science and engineering shortfall can be criticized for several reasons. First, studies declaring widespread shortfalls base their generalizations solely in terms of a declining supply in a particular field of science and / or technology. When we look at all scientists and engineers, the picture may be quite different. Studies have also been criticized for assuming that future demand will mirror present day demand, and as we have already seen things change, jobs change and characteristics of workers change. Studies have been further criticized for using simple comparisons between projected degrees with past performance of degree awards. Simple comparisons seriously distort future projections. Projections of future supply and demand ratios should account for all factors in the economic and industrial environment that may predict future needs more accurately than simple head counts.

Projections of future supply and demand vary greatly. To date, there is no way to predict future shortages or surpluses of scientists and engineers with a high degree of accuracy. Tobias, et. al. (1995) asserts that “given the time lag in producing scientists…it is

particularly hard to predict, no less adjust, supply and demand." There are many ways in which information regarding labor market trends and population movement can be obtained. The following sections describe the key aspects of demographic studies and provide a brief description of general workforce trends in recent years.

DEMOGRAPHIC & POPULATION STUDIES

Demographic and population studies provide us with some useful insight into characteristics of the labor force. Demographers study population and are able to provide us with general information regarding the mobility or migration patterns of college graduates. Population research is highly interdisciplinary. *Demography* is the statistical study of population, whereas *Population Studies* is a broader term that incorporates many approaches other than the purely statistical. Within the academic discipline of geography, population studies assume an important role. For the geographer, the locational dimension assumes principal importance. Although spatial studies of fertility and mortality patterns can be found in the geographic literature, the largest body of population research by geographers by far focuses on the migration component of population change. The geographical analysis of population entails two important related concepts: population distribution (geographic pattern of the location of people or people within a specific area) and population composition (characteristics of people within a specific area) (Long, 1988; Plane & Rogerson, 1994). Because of its complexity, migration is often the most difficult component of population change to accurately model and forecast (Long, 1988; Plane & Rogerson, 1994). While demographic literature has the possibility of providing us with useful information about the general workforce, there has been very little empirical study focusing specifically on scientists and engineering graduates in the workforce.

Since the science and technology work force is greatly affected by the total labor population, it is helpful to first understand general labor force dynamics. The following section provides a brief description of trends in the general labor force.

CHARACTERISTICS OF THE AGGREGATE LABOR FORCE

Typically, changes in the composition of the labor force result from persons entering, leaving, or staying in the labor force (Fullerton, 1995). Changes in the general labor force may be better understood if they are decomposed into two components: changes in the labor force *population* and rates of *participation (*Long, 1988; Plane & Rogerson, 1994; Fullerton, 1995).

Population changes. The population is an important component of labor force change. During the last 2 decades, there were about the same changes for men and women of the same age (Fullerton, 1995). In general, the population of younger workers (aged 16-24) is declining while the population of older workers (aged 25-54) is increasing (Fullerton, 1995). These changes reflect the aging "baby-boom" generation and the subsequent smaller cohort entering the labor force after them. Similarly, population projections indicate a decline in the size of the college population until the year 2000, when children of the baby-boom generation finish college and will begin to enter the workforce (Dolittle, 1996; Braddock, 1992).

Participation rate changes. As expected, changes in the population directly effect the rate of growth for labor force participation. The growth of labor force participation witnessed in the early 1980s reflected increased involvement of women, and the effect of aging baby boomers graduating to age groups typically characterized by higher participation rates (Schlottmann & Herzog, 1984; Fullerton, 1995; Plane & Rogerson, 1994).

In the last two decades, the labor participation rate of men has continued to decline, while that of women has steadily increased. By 2005, the rate of growth in the women's labor force is expected to slow down, but still increase at a faster rate than that of men (Fullerton, 1995). Because there are fewer men entering the workforce and fewer women leaving the workforce, women are expected to comprise almost half (47.8 %) of the entire workforce population by 2005 (Fullerton, 1995). Similarly, the labor force participation rates of minorities including African Americans, Hispanics, and Asian/ others are also projected to increase in the 2005 workforce (Fullerton, 1995).

In general, annual participation rates projected for the 2005 work force are expected to decline from 1.5% to 1.3% (Horton & Anderson, 1994; Fullerton, 1995). Now that we have a general sense of the dynamics of the general workforce population, we can examine specifics in the science and engineering fields. The following sections will examine specific characteristics of the science and engineering workforce by subgroups.

CHARACTERISTICS OF THE SCIENCE AND ENGINEERING LABOR FORCE

This review of data on the size, composition, and growth rates of the science and technology labor force is not intended to be comprehensive. The primary purpose of this review is to set in context, the characteristics of the supply and demand of scientists and engineers in the state of the new economy.

Understanding characteristics of the science and engineering segment of the workforce will paint a clearer picture of future economic success. Specifically, understanding these characteristics within subgroups will allow us to more accurately determine where there are acute shortages in this segment of the workforce. Merely stating that there is a shortage or surplus is not in-and-of itself informative. For example, although

the total number of scientists may be high, you cannot have any scientist working as a nuclear scientist. They must be trained in a specific area of content. To better understand the issues surrounding supply and demand of this specialized population, the following section will discuss the disparity between the number of science and engineering degree recipients who are working in related and unrelated jobs. Subsequent sections will examine segments of the science and engineering workforce by gender, level of degree, field of major, and foreign nationals, describing relevant characteristics for each.

Job Related to Field of Degree?

Not all students granted degrees in science and engineering actually enter the field (Braddock, 1992; Regrets, 1995; Blumenthal & Wilkinson, 1998). For example, large portions of those receiving bachelor's degrees in natural science become teachers or enter medical or dental school. There are almost twice as many people with degrees in science and engineering that are actually employed in non-science and engineering occupations (Blumenthal, & Wilkinson, 1998). Compared to the 2.6 million science and engineering degree holders working in the field in 1995, approximately 4.7 million people whose highest degrees were in science and engineering fields were working in non-science and engineering occupations (Blumenthal, & Wilkinson, 1998). It seems odd that although the high-technology industry, generates well-paying, productive, and internationally competitive jobs across the country, a large percentage of individuals with science or technical degrees chose to work in non-degree related occupations. These individuals are typically employed in fields such as management/ administration, sales and marketing, and other non- science and engineering related teaching fields (Regets, 1997; NSF 1996; American Electronics Association, 1997; Blumenthal & Wilkinson, 1998).

To further our understanding of the supply and demand issues that affect the mobility of this special population, the following sections will examine the size, composition and growth of the science and engineering workforce by gender, level of degree, field of major, and percentage of foreign nationals earning U.S. degrees.

Gender Issues

The demographic make-up of scientists and engineers has undergone dramatic changes in the last thirty years. Increased participation of women and minorities in the workforce necessitates that positions in these fields no longer be reserved exclusively for white middle class men. Still, while women and minorities are rapidly becoming key players in the technical arena they continue to be under-employed and under-represented in scientific and technical occupations when compared to overall employment trends. Women constitute 51% of the U.S. population and 46% of the U.S. labor force, but only 22% of the scientists and engineers in the labor force (National Science Foundation, 1996). Within science and engineering, women are more highly represented in some fields than in others: 50% Sociology or Psychology; 9% Physicists; 8% Engineers (National Science Foundation, 1996). Women scientists are more likely than men to be employed in academia. However, within academia, those in specifically science and engineering fields are still predominantly male (National Science Foundation, 1996). The National Science Foundation reports that women are less likely to be engaged in funded research, be a principal investigator, or to have published books or articles. Women in science and engineering also tend to be more highly represented in fields with lower average salaries, such as social sciences (National Science Foundation, 1996).

In terms of gender differences related to degree awards, women that graduate with a baccalaureate degree in science or engineering are less likely to be in the labor force, be employed full time, or to be employed in their major-field than are men (National Science Foundation, 1996). Differences by gender begin to diminish when we compare men and women with advanced degrees. Women and men PhDs working in industry and having similar number of years of professional experience are equally likely to be in management positions (National Science Foundation, 1996).

Interestingly, recent studies have found that the qualifications of men and women doctoral recipients beginning careers in science are now similar in three important respects (Zuckerman, et. al., 1991). First, the intellectual caliber of men and women, measured by standardized tests and academic performance, is remarkably similar. Women do as well, or better, on such tests as men. However, measured ability seems unrelated to research performance in science (Zuckerman, et. al., 1991). Second, overall, the proportions of men and women getting degrees from top ranking research university departments do not differ. These similarities are seen when departmental rankings are measured by receipt of research funds or by ratings of the quality of doctoral programs.

The third similarity of recent doctoral recipients is that men and women are now much the same age when they receive their doctoral degrees. In 1981, the median ages of men and women receiving doctoral degrees were 30.3 years and 31 years respectively, with variation among fields. In the mid 1960s, new women PhDs were markedly older, 30.9 years of age for men and 32.5 for women. Historically, it has taken women longer to get their degrees, and more women than men were forty or more by the time they received their doctoral degree. By 1981, women were beginning to catch up, and only in the medical

sciences did we see women beginning careers substantially later than men. In all other fields, their ages were approximately the same- that is, within a year of one another (National Science Foundation, 1996). Differences tend to appear within certain fields. For example, significantly fewer women than men get degrees from top ranked departments in mathematics and physics but significantly fewer men than women get degrees from top departments in microbiology and psychology (National Science Foundation, 1996). The economic importance of retaining and using women as human capital is becoming more widely recognized (Green, 1997).

Degree Level (BS/MS/PhD)

Another way to look at supply and demand for this segment of the workforce is by level of degree. Of the 3.2 million individuals in the science and engineering workforce of 1995, 83% (2.6 million) received their highest degree in a science or engineering field (Wilkinson, 1998). Of those working in science or engineering jobs, 58% were held by individuals with a bachelors degree, 28% held a masters degree, and only 13% held doctoral level degrees (Blumenthal, & Wilkinson, 1998).

By far, the private sector is the largest employer of science and engineering workers at the baccalaureate and masters levels while the academic sector is the largest employer of PhD recipients (Wilkinson, 1998). Median annual salaries for those employed full-time in science and engineering occupations is $48,000 for individuals with a baccalaureate degree, $53,000 for those with a master's degree, and $58,000 for those with a PhD (Wilkinson, 1998; Blumenthal, & Wilkinson, 1998; National Science Board, 1998). The American Chemistry Society annual survey of starting salaries suggests that new PhDs with previous work experience have an advantage in finding permanent employment (Brennan, 1997). For

PhDs in general, salaries are higher in engineering and math/ computer science fields (~$70,000) and lower in the social sciences (~$53,000) (Regets, 1997; National Science Board, 1998; Blumenthal & Wilkinson, 1998). There is also a substantial salary gap between men and women with science and engineering PhDs. A majority of this gap (90% or~$13,000) can be explained by individual differences including: years from doctorate, degree field, individual background, work-related employee characteristics, employer characteristics, and type of work performed (National Science Board, 1998; National Science Foundation, 1996).

A study by Ellis (1990) indicates that rankings of the states and universities that produce the most engineers do not change much from one year to the next. California and New York remain the largest producers of engineering degrees at every level (B.S., M.S., PhD). At the institution level, for three years in a row, the University of Illinois- Urbana was the largest generator of bachelor's degrees. Stanford and Johns Hopkins remain in the first and second positions as the top producers of master's degrees, and MIT continues to be the leading producer of engineering PhDs. At the graduate level, the number of master's and doctoral degrees increased, but at a notably slower rate (Ellis, 1990).

In the last thirty years, the percentage of women earning science and engineering degrees has seen a steady increase at all levels (B.S.= 20%, M.S.= 23%, PhD= 22%) (National Science Foundation, 1996). Minorities are also earning more degrees in these traditionally white male occupations than ever before. The number of Asians earning science and engineering degrees at every level has actually doubled since 1985, making them the fastest growing segment of the science and engineering population (National Science Foundation, 1996). Hispanics and African Americans are the second largest minority groups earning degrees in

science and technology fields at all levels. Similar trends have been witnessed in the number of foreign citizens earning U.S. degrees in science and technology. While the number of foreign citizens earning a bachelors degree jumped from ~8,000 in 1977 to almost 15,000 in 1995, the number of masters degrees skyrocketed from ~8,000 to a little over 21,000 in the same time period (National Science Board, 1998).

The effects of supply and demand on scientists and engineers at differential degree levels could have a significant impact on the migration or mobility of this strategic population. Knowledge of these differences could have implications for organizations looking to staff their firms with individuals at a certain degree level.

Field of Major

Like most occupations, scientific and technical occupations are disproportionately distributed across industries. There are more scientific occupations than engineering occupations and within each, the number and type of jobs vary widely. As a result, the growth of certain industries has a significant impact on the employment growth for workers in these fields. For scientist, engineers and technicians as a group, growth over the 1990-2005 period is projected to range from 9 to 59 percent (Braddock, 1992). Among individual occupations, the groups of scientific and technical occupations that are projected to have the fastest rates of growth include computer, mathematical and operations research analysts, and computer systems scientists and engineers (National Science Board, 1998; Braddock, 1992). The following sections describe individual fields of study within the science and engineering workforce.

Computer and Mathematical Scientists. By 2006, computer and mathematical related occupations are projected to grow faster than all other occupations in the science and

technology fields combined (National Science Board, 1998; Braddock, 1992). Growth in this area is expected for computer systems analysts, computer scientists and engineers, and for operations research analysts. Whirlwind advancements in technology has led economists to project computer and mathematical occupations to be among the ten fastest growing occupations in the economy of the early twenty first century (National Science Board, 1998; Braddock, 1992). Following engineers, computer and mathematical scientists represented the second largest group (30%) employed in science and engineering of the total science and engineering workforce (3.2 million) employed in 1995 (National Science Board, 1998; Wilkinson, 1998). The majorities (72%) of computer and math scientists were employed in private sector organizations in 1995 (National Science Board, 1998).

Engineers. Engineers represented 42% (1.34 million) of the almost 3.2 million people employed in science and engineering occupations in 1995 (National Science Board, 1998; Wilkinson, 1998). Although lower defense spending has had a significant impact on the expected employment growth of engineers, projections indicate that this segment of the workforce will have substantial growth in the 2006 market (Braddock, 1992; National Science Board, 1998). Within the field of engineering, the number of jobs for electrical engineers was projected to have the highest growth rate (National Science Board, 1998). The majorities (76%) of general engineers were employed in private sector organizations in 1995 (National Science Board, 1998).

Life Scientists. Life scientists accounted for 9.5% of the total science and engineering workforce (3.2 million) employed in science and engineering occupations in 1995 (National Science Board, 1998; Wilkinson, 1998). Moderate growth has been projected for this domain. Growth in this area is attributable to the expansion in medical and biotechnological

research, and to employment related to environmental protection. Although the domain of life scientists is expected to grow at a moderate rate in the 2006 market, employment growth in this area is in areas that do not have a high concentration of scientists and engineers (e.g., medical instruments, supplies, and drug manufacturing industries) (Braddock, 1992). Although jobs within the life science domain have not been projected to witness substantial growth, biological life science jobs are projected to have the most growth within that domain (National Science Board, 1998). The majority of individuals employed in life science were employed in academic institutions or by private sector companies in 1995 (National Science Board, 1998).

Physical Scientists. Physical scientists accounted for 9% of the total science and engineering workforce (3.2 million) employed in science and engineering in 1995 (National Science Board, 1998; Wilkinson, 1998). Although the Bureau of Labor Statistics predicts a wide range of growth between 1990 and 2005 for physical scientists (Braddock, 1992) the National Science Board does not project such significant growth rates (National Science Board, 1998). Physical Scientists in 1995 were typically employed in the private sector and comprised the smallest segment of scientists or engineers working for the state and local governments (National Science Board, 1998).

Social Scientists. Social scientists accounted for 10% (317,500) of the total science and engineering workforce (3.2 million) employed in science and engineering occupations in 1995 (National Science Board, 1998; Wilkinson, 1998). Employment in this field is less affected by broad economic conditions than are many other occupations (Braddock, 1992). Due to the expected employment growth of psychologists the growth for social scientists in general is above average for the economy (Braddock, 1992). Academic institutions

employed the largest proportion of social scientists in 1995 (National Science Board, 1998; Wilkinson, 1998).

Foreign Nationals

It is interesting to note the geographic origins of those earning science and engineering doctoral degrees in this country. Universities in the U.S. draw students from all over the world to study for a research doctorate and most of these students come to earn a degree specifically in science and engineering fields (Hill, 1996). Forty percent (N=10,493) of all doctoral degrees in science and engineering (N=26,515) awarded in 1995 and 1996 were received by persons who were citizens of non-U.S. countries (Hill, 1996). This figure was actually 13% higher than in the previous decade. Specifically, 33% of doctoral degrees awarded to foreign nationals were granted in engineering, 51% in natural sciences, and 16% in social sciences (Hill, 1996). Of those non-U.S. citizens, two thirds held visas granting temporary residency in this country, and of those on temporary visas, over half (57%) planned to remain in the U.S., and almost all (92%) holding permanent visas planned to remain in the U.S. (Hill, 1996). Over half of non-U.S. citizens with definite plans to remain in the U.S. were continuing their studies with postdoctoral appointments. One fourth were employed in industry and only 13% were employed in academia (Hill, 1996).

The number of foreign nationals earning U.S. degrees has increased since the late 1970s. In general, the number of bachelors degrees awarded in all science and engineering fields doubled from 1977 (~8,000) to 1995 (~15,000) (National Science Board, 1998). Fields with the highest growth at the bachelor's level included math and computer science and the social sciences. The number of master's degrees awarded in science and engineering fields to foreign nationals between 1977 and 1995 almost tripled, 8,000 to 21,000 respectively

(National Science Board, 1998). Fields with the highest growth for advanced degrees included math and computer science, social science and overall engineering (National Science Board, 1998).

SUMMARY OF SCIENCE AND ENGINEERING CHARACTERISTICS

There are many issues that can affect manpower in this country and manpower has a direct relationship with the state of the new economy, if demand for these critical resources increases disproportionately with supply, it could have detrimental effects on our national and state economies. Therefore, it is imperative to understand the factors that affect the supply and demand of this population. Any stress or imbalance in the supply and demand relationship creates concern at a number of levels. At the organizational level, companies invest large dollars into their recruiting, selection and retention practices. Shortages of qualified workers can cost an organization in productivity, hiring and recruiting costs, and may also hinder organizational growth. These costs have been estimated at approximately six to eight thousand dollars per employee (Business Wire, May 1999).

The focus of the current research centers on more global geographic mobility of manpower. The relation between science /engineering and economic development has become a major concern in recent times. At the state or region level, employees contribute to the revenue and financial strength of the state. Highly skilled science and technology workers also contribute to the competitive advantage of that state. The phenomenon of differential supply and demand of highly skilled workers has been called the *brain drain* phenomenon. The following section provides a more in-depth look at the brain drain phenomenon.

BRAIN DRAIN PHENOMENON

It is difficult to pick up a journal, professional magazine or newspaper that does not contain an article on the growing shortage of employees to fill high skill jobs in a certain field or geographic area (Bresnick, 1998). The migration phenomenon of skilled and professional workers, commonly known as the *brain drain*, has been an important topic for economists and government planners for quite some time (Wong & Yip, 1998). Specifically, brain drain is the outflow of skilled workers from one area (regional, state, or national) to another (Wong & Yip, 1998). On a national level, human capital is one of our most valuable resources, and there has been great concern regarding the scarcity of this commodity in specific geographic areas. We know that while some areas act as magnets for science and engineering professionals, others act as net exporters creating a deficit for that area (Tornatzky, et. all, 1998).

Advancements in technology continue to change the ways in which we work, learn and interact with others. In addition to the increased specialization of particular jobs, some geographical areas are more or less productive in science and technology than are others. For example, some areas that are better known for their productivity in technology include Massachusetts' Route 128, Silicon Valley, and North Carolina's Research Triangle Park. Lack of opportunities in a given area forces people with specialized knowledge and skills to either migrate to areas where technical and professional opportunities are more affluent, or enter into jobs that are unrelated to their degree and hence detrimental to the state of the new economy. Accordingly, migration patterns of science and technology graduates are of particular concern for organizations looking to staff their facilities with highly skilled, quality professionals.

It's not only a challenge to find people with the right knowledge and skills, but it is also a challenge to attract and keep them. Losing these workers creates great concerns about the possible adverse effects this phenomenon may have on the economic growth, education, income distribution, and welfare of a particular area (Blom, 1998; Chandrasekaran, 1998). Surprisingly, there has been very little work in the literature that examines the linkage between brain drain and economic growth. Research needs to be done to discover the factors that impact this phenomenon. Blom (1998) found that in general, the culture, climate, attitudes, morale, market, and level of opportunity influence the decision of candidates in the labor market to migrate from one area to another.

It is a known fact that some individuals who go to colleges outside their original state end up leaving for good. In recent years many states and local areas of the U.S. have developed programs to attract students, graduates, and jobs to their areas. State legislatures' in 1998 have produced an array of new laws and programs that make it easier for people to attend and pay for college. According to the state legislatures conference, state budgets for fiscal 1999 call for total state general funding on college operations to grow by more than 7 percent (Schmidt, 1998). Elementary and secondary spending were the only other category of state general fund expenditures slated to grow as fast (6%) (Schmidt, 1998).

Programs have been specifically designed to help states keep their own best and brightest students home for college and in the states labor market following graduation. Georgia's highly publicized HOPE Scholarship program that was established in 1993, received a great deal of interest at the 1998 legislative summit. This program uses state lottery revenues to finance the education of students who maintain at least a 'B' average in college. As a result of the HOPE scholarships program, Georgia has seen a rise in SAT

scores, a decrease in high school drop outs, a rise in college enrollment and a decrease in the numbers of students needing to take college remedial course work (Wicker, 1999).

At least a dozen states adopted some sort of merit-based scholarship program during the 1998 sessions. For example, Nebraska launched a merit scholarship program in an attempt to "stanch the brain drain" (Schmidt, 1998). Merit based scholarship programs pay as much as half of tuition and fees, and can be used at any state accredited public or private college. Scholarship recipients are typically required to earn degrees in any of 12 high-demand fields identified by state higher education officials and must promise to work in the state for at least three years after graduating. Florida's Bright Futures Scholarship is another example of a state funded merit based program aimed at keeping its students in the state (McKinnon, 1999).

Some states have modified the requirements and conditions of the merit awards they will offer. For example, Kentucky structured its lottery-financed fund so that those students who maintain good grades from the ninth grade on are eligible to receive financial incentives (Schmidt, 1998). Maryland, established a scholarship program that benefits good students who enter computer science or engineering fields. Upon completion of their degree, recipients are required to work in the state one year for each year they received funding. Some states including, Massachusetts, Connecticut, Maine, and Idaho are focusing on trying to decrease tuition costs for state schools. Other states are looking towards providing more money for professors (Schmidt, 1998).

Little is known about the causes and effects of state brain drains, much less how to stop them. Critics say that lawmakers are risking millions of dollars on programs that may be ineffective or that offer few real economic and educational benefits in the long run

(Schmidt, 1998). In order to understand this phenomenon, it is essential to examine the factors involved in the decision to relocate. It is obvious that a greater understanding of patterns of migration is central to understanding issues surrounding brain drain.

MIGRATION

The complexity and multidisciplinary nature of the subject of migration in conjunction with the proliferation of articles on specialized topics have made the study of this phenomenon extremely difficult (Greenwood, 1993). It is reasonable to assume states prefer to retain graduates from their own institutions for employment within the state. Land-grant Universities, for example, receive large sums of money from taxes. Therefore, when students move to another state and are not replaced by someone moving to the state, the tax revenue raised from that employee does not benefit the cost of education incurred by the degree granting state (Ballweg & Li, 1992). It is interesting to note the extent to which states deviate in the numbers of individuals who cross state lines either to enter or to leave. (Tornatzky, et. Al., 1998). Understanding general population migration will help us understand who is likely to leave among science and technology professionals and what those patterns look like.

Fulton, Fuguitt, and Gibson (1997) examined the demographic and socioeconomic characteristics of migration streams between metropolitan and non-metropolitan areas between 1975 and 1993. This study utilized data obtained by the U.S. Census *Current Population Surveys* (CPS). The CPS contains a one-year migration question which along with information regarding respondents current residence allows respondents to be classified into four migration groups: metro-to-non-metro movers, non-metro-to-metro movers, metro stayers and non-metro stayers. Demographic variables examined in this study included sex,

race, age, education, poverty status (poor, near poor, not poor) and occupation (lower blue collar, upper blue, lower white collar, and upper white).

In terms of specific demographic characteristics, Fulton, et al. (1997) found age to be inversely related to migration such that younger individuals tend to move more. The general relationship between age and propensity to migrate has been known for some time (Greenwood, 1993). The authors assert that increased movement among younger individuals may have been necessitated by a search for a particular educational program, employment or a better job. Similarly, the authors note higher levels of migration among males, respondents with 4 or more years of college, those above the poverty level and those whose occupational status was classified as white collar.

In terms of general migration patterns between rural and urban areas, they found three major (and unanticipated) shifts. Until the 1970s, non-metropolitan areas typically observed net population losses. However, the first observed shift occurred during the 1970s when non-metropolitan areas witnessed an increase in net in-migration and retention particularly of young and better-educated residents. The second trend occurred in the 1980s where the trends of the 1970s were reversed and non-metropolitan areas witnessed net migration losses particularly of young, better-educated residents and those working in white-collar occupations. In the 1990s, migration patterns have been similar to those in the 1970s such that non-metropolitan areas again showed net gains among higher status groups.

Shelley and Koven (1993) examined state level factors thought to impact interstate migration in the United States during the 1970s. They argue that migration has political, economic as well as social relevance. Politically speaking, migration affects the electoral power of states and the size of a states' delegation to congress. Since economic

environments are said to influence ones decision to move, migration is also related to the economic health of a given area. Similarly, migration is obviously related to the amenities present in a given area or the "quality of life" that is available to area residents. This study examined the relationship between net migration and a wide array of variables that are subsumed under five composite dimensions; fiscal policies (taxes and spending), social hostility (crime and wealth), labor relations (right to work laws, unemployment, union membership, wages, and work stoppages), ecological context (size of state population, population density, temperature, school enrollments, public assistance, and maturity of interest group structures), and infant mortality.

The study used data obtained in the *Statistical Abstract of the United States*, *State Government Finances, Handbook of Labor Statistics, State and Metropolitan Area Data Book, Vital Statistics of the United States,* and *Uniform Crime Reports for the United States*. Multiple regression was used to estimate how well the independent variables predicted state migration patterns. Results based on the full model were ambiguous due to problems with multi-colinearity, and an exploratory factor analysis was conducted. As described above, four dominant factors and one minor factor consisting of only a single factor (infant mortality) emerged. Principle components multiple regression was then performed ($F=18.44$, $p< .0001$, $R^2=.68$). The hypothesized model proved to be highly salient in predicting rates of net state migration in the 1970s. Specifically, results of this study indicate that ecological context (quality-of-life) variables exert the greatest predictive power, and that composites of fiscal policy and labor relations (e.g., factors that are more controllable by public decision-makers) were also significant. Infant mortality was significant and Social Hostility did not

prove to be statistically significant. It is my opinion that while these patterns were true of the 1970s they may be different today.

Our nations population movement patterns have become much more complex than they were in the past. The study of migration and retention may provide answers to some basic questions that are frequently cited in the literature. "Why do some areas grow while others decline? Why do people move? Do different types of people move for different reasons? And, are we in danger of a population explosion that test the capacity of our resources?" Research by Long (1988) shows that more than one half of households in the U.S. moved for job-related reasons in the late 1980s.

Understanding population composition, distribution, and change is essential for making decisions in both the public and private sectors (Plane & Rogerson, 1994). In the private sector, the success of an organization is often directly linked with the ability to identify and target specific demographic groups or segments of the local population down to the smallest geographic units for both market and employment selection purposes. In the public sector, for example, school enrollment levels depend critically upon the size and age composition of the population at the neighborhood or community level.

Until recently, a thorough knowledge of how local populations are likely to change would have dramatically affected an organizations planning process for personnel recruiting and selection. However, today, demographic knowledge of the local population is not enough to sustain quality work-force needs. Organizations, both public and private, now need a more comprehensive understanding of how to attract quality personnel from widely disbursed geographic locations. Therefore, an understanding of demographic trends that are associated with the composition, distribution, and change of a particular population (i.e.

recent science and engineering graduates) is of more immediate concern to many decision-makers, practicing planners, and business people.

THEORIES OF MIGRATION

General Theories of Migration:

There are several prominent theories of migration. Literature on migration stems from a number of different disciplines that are rarely integrated. As a result, reliance on a single approach is likely to lead to a highly specific and incomplete view of the complex processes affecting an individual's decision to migrate. Before we begin to examine specific theories of migration, we should understand the important issues surrounding it. Themes underlying theories of migration include: the optimality of one's choices, availability of alternatives, geographic space, supply and demand, motivation, temporal factors, and the level of analysis (Molho, 1986). Before introducing specific theories of migration, I will briefly review these issues.

First, is the notion of *optimality* in one's decision making. When a less than optimal choice is made, the issue becomes the extent to which the lesser choice is due to a lack of information. A lack of complete and accurate information could prevent an individual from selecting the most optimal choice. A second issue involves the availability of alternatives or the distinction between *speculative migration*, (the decision to move with merely the hope of finding a suitable opportunity), and *contracted migration* (in which an opportunity has already been secured before the move is undertaken. Another issue involves the consideration of *space* in terms of the geographical distribution of opportunities such as costs involved in commuting or transportation. There are also issues surrounding the *supply* and *demand* of opportunities associated with a given location that ultimately affect the options

from which one chooses. Issues surrounding supply and demand include the type of opportunities available, whether those opportunities are related to their field of degree, and individual preferences. *Motivation* for moving and the interaction between workplace and residential decisions is another. Finally, the question arises as to whether we should focus on the individual's behavior or on aggregate patterns of movement. The different approaches to migration that will be discussed next vary in terms of the degree to which they emphasize or neglect one or more of these issues (Molho, 1986).

There are six prominent theories of migration including the economic perspective, human capital approach, rationality and stress, random utility, information and search, and gravity models. The *Economic Competition Model* is the dominant approach for studies of employment migration, and asserts that people migrate in order to improve their economic well-being by selling their services in the market that offers them the highest return (Bartel, 1979; Molho, 1986). This could have major policy implications for organizations looking to recruit the "best and brightest". The ability to manipulate key variables that would attract quality personnel could guarantee a state of competitive advantage.

The *Human Capital* approach suggests that migration is a process that is modeled as an investment in human capital. The basic model asserts that individuals determine their decisions to migrate on the basis of their perception of expected utility (EU) from residence in any one area (Molho, 1986). Expected utility within this framework is essentially the anticipated benefits and costs that would result from migrating to a given geographic area. This theory suggests that the individual evaluates the expected utility minus the cost of moving for each option and selects to live in the area with the highest net outcome. This model further asserts that ultimately one considers all factors (social, economic, and

environmental) that affect the possible alternatives. This theory is criticized for its assumption regarding the treatment of information, as it unrealistically assumes that individuals have complete and accurate information on all available opportunities and does not account for the decision making process when individuals do not have this information.

Psychologists argue that with complex sets of alternatives, people cannot efficiently maximize over all possible alternatives. The *Rationality, Stress, and the Treatment of Information* approach asserts that individuals construct simplified models of reality in which only a subset of alternatives are considered, and they evaluate the costs and benefits of only a few select alternatives (Molho, 1986). This theory describes the human migration decision as "satisficing" rather than "maximizing". In contrast to the Economic Perspective, this theory asserts that individuals make decisions solely on the basis of the information in which they have acquired rather than all possible information. Therefore, it is assumed that one's decision to migrate is based on partial information that is easily available rather than on a comprehensive set of information.

The premise underlying the *Random Utility* theory assumes that individuals maximize utility functions, and that those functions are partitioned into two separate components. These components reflect to the behavior of a *representative group of individual* s and a *random variable* that reflects the individuals unobserved idiosyncrasies such as situational factors which cause them to alter their behavior (Molho, 1986). Specifically, the utility function incorporates individual characteristics that systematically influence one's decision to migrate. The fact that not all migrants move in quite the same direction even within broadly homogeneous sections of the population is captured in the random utility framework

through a stochastic component in each individual's utility function, and this component reflects the unobserved factors that are specific to each individual.

In order to understand the decision-making process, focus must be directed toward understanding the underlying search strategy an individual embraces. A decision making framework that involves an initial decision to undertake the search, followed by the ultimate decision as to the optimal location in which the individual is likely to receive the best rewards (Molho, 1986). According to the *Information and Search Theory*, once the base search method has been identified, the likelihood that one will actually move is dependent upon whether an opportunity exists in that geographical area, and whether one chooses to accept or reject that given opportunity.

Until now, the models we have reviewed relate to individual behavior. However, there are substantial theoretical and analytical problems involved in empirical modeling at this level. Historically, *Gravity Models* originated in the study of human geography, and typically analyze aggregate data. Just as economists emphasize monetary influences and psychologists have emphasized rationality, human geographers emphasized *space* as a key determinant of migration or non-migration (i.e.. retention).

The gravity model in its most general form, "posits gross migration flows within a regional network to be a function of origin and destination specific push and pull factors" (such as size of the regional population, relative housing, and/ or labor market conditions) that are combined multiplicatively with some form of distance deterrence function reflecting the degree of spatial separation between origin and destination" (Molho, 1986).

Research suggests that heterogeneity of the migrant population that one is trying to predict is a major problem for the above models. Researchers have suggested that the

primary source of such unpredictable behavior stems from the existence of different levels or fields of an individuals search and the differences related to ones underlying motives for moving. Differences in the fields of search that individuals operate within stem from the hierarchical nature of information networks those individuals have access to. There are three key *Temporal Aspects* involved in theories of migration. First, there are likely to be delays in the diffusion of information about employment opportunities. Second, individual's expectations of future benefit streams involved in the decision to accept or reject an opportunity are likely to depend on some weighted average of past trends. Finally, significant adjustment lags are likely to arise between the decision to migrate and the final move (Molho, 1986).

As we look at the literature in this area, we don't see any references to employment migration of scientists and engineers related to the themes mentioned in beginning of this section. An adequate theory of migration among college graduates requires incorporation of both availability of job opportunities and individual characteristics. Typically research in this area is conducted under the premise of one theory to the exclusion of the others and neglects factors that occur beyond the scope of that particular theory. Although these theories provide some insight for a comprehensive theory of migration, each of these models is somewhat fragmented, and reliance on a single model will likely lead to misleading results. In addition to the theories that have already been mentioned, there are other theories that have the potential to provide insight into individual's decisions to migration.

Vocational Theories

Vocational psychology examines some related issues and is another field that has the potential to provide relevant information. In terms of a conceptual framework, Vocational

Psychology has the potential to add something to our understanding of the migration process as it looks at the congruence between individuals' alternatives and their actual choices.

Many theories in Vocational or Counseling Psychology speak to the issue of career planning, choice, and development, which in turn affect their ultimate patterns of migration. Before going into the specific theories, it is best to review some basic concepts as defined by the National Career Development Association (www.ncda.org). *Career development* refers to the total constellation of psychological, sociological, educational, physical, economic, and chance factors that combine to influence the nature and significance of work in the total lifespan of any given individual. *Career*, is the totality of work, both paid and unpaid, that one does in their lifetime. *Vocation* is one's primary work task at any given period of life. *Occupation* is one's primary work task in the world of paid employment. *Job*, is an identified set of duties and responsibilities, paid or unpaid, assigned to be performed usually on a sustaining, ongoing basis by one person. *Position*, is a set of competencies (skills and knowledge) required as a component of the overall mission of the agency, organization, or setting in which the position exists. With these definitions in mind, let us turn our attention to prominent theories and the history of Vocational Psychology.

The view of career posited in contemporary career theories reflects modern day philosophy. Because motivation and meaning are thought to reside in the person, the path to success and personal fulfillment follow a course shaped by both self-expression and individual effort. Historically, the choice of a particular occupation typically followed family traditions such as staying on the farm or joining the family business. As modern organizations developed the notion of a "career" emerged. People who had worked for themselves on farms and in towns then moved to cities to "climb the organizational ladder".

Vocational psychology was designed, and still functions today, to help people choose and adjust to the specialized work that defines their identity, their social status, and determines their wages (Walsh & Osipow, 1995). As industries downsize, the cities that they supported struggle to survive. Now, the large bureaucratic organizations that supported careers are disappearing. People can no longer expect to spend 40 years at IBM or General Motors, establishing and maintaining their careers through the predictable stages articulated by Super (Walsh & Osipow, 1995). In fact, the average number of times an individual changes careers in a lifetime is around 10. As the nature of work shifts towards information and technology, it is no longer acceptable to be limited by geographical location. More often than not, workers are being forced to go where the jobs are.

There are several theories in vocational psychology that deal with individuals and the choices they make regarding careers and career development. The following section will discuss John Holland's theory of Personality and Vocational Choice, Vroom's Expectancy Theory, and Super's segmental theory of Work Values.

At its most basic level, John Holland's theory of Personality and Vocational Choices asserts that an individual's career choice is a projection or extension of oneself. In this sense, occupational choice is seen as an expressive act of individual factors, including motivation, knowledge, ability, and personality. According to Holland, both personality and work environments can be defined by a three-letter combination of six core dimensions (e.g., Realistic, Investigative, Artistic, Social, Enterprising, and Conventional). Holland further asserts that satisfaction with one's job is directly related to the degree of congruence or fit between one's personality type and one's job environment fit (often termed "P-E fit"). This theory operates under two basic assumptions: 1) that there is homogeneity within and

heterogeneity between occupational categories; and 2) increased similarities between an individuals interests and interests of individuals working in that occupation will lead to better "fit" (Brown, & Brooks, 1990). This theory was developed to help people explore their interests and make career decisions that are representative of those interests.

In terms of application, Holland's theory provides explanations for three common and fundamental questions: 1) What personal and environmental characteristics lead to satisfying career decisions, involvement, and achievement, and what characteristics lead to indecision, dissatisfying decisions, or lack of accomplishment?; 2) What personal and environmental characteristics lead to stability or change in the kind of level and work a person performs over a lifetime?; and 3) What are the most effective methods for providing assistance to people with career problems (Holland, 1992). Holland's theory predicts that one will choose an occupation consistent with one's personal orientation. The *Vocational Preference Inventory* is a measure that is based on normed data and designed to assess one's preferences for different jobs and match them to an appropriate occupation. One's personality type is then said to drive one's direction or vocational choice (Holland, 1985; Holland, 1992; Brown & Brooks, 1990).

One's vocational choice may have relevant influences on migration. If one chooses to enter into a non-science or technical field, they may not be faced with the problem of relocating to find relevant work. As we have seen earlier, it is possible to predict students major on the basis of their values. If there are individual differences between individuals that choose to enter into a given field, we may be able to predict those that are willing to migrate and those who will be reluctant.

Rather than interests, Vroom's Expectancy Theory asserts that human needs are the basis for motivation and are more relevant to career preferences and occupational choices. Occupational preference and career choice are determined by one's motivation, perceptions, expectations, and values. The Expectancy model is comprised of three primary components, valence, instrumentality, and expectancy. Valence is defined as the attractiveness or desirability of outcomes. Instrumentality is defined as the expectations regarding the availability or the likelihood of outcomes, and the relation between Valence and Instrumentality results in Expectancy (Brown & Brooks, 1990). Therefore, one's occupational choice is based on results of the ratio between valences and instrumentality. Similar to the economic theory of migration discussed earlier, this theory hypothesizes that an individual will choose the occupation that yields the highest returns.

While Super has not contributed an integrated, comprehensive, and testable theory, he has posited a "segmental theory" that is a loosely defined set of assumptions. These assumptions deal with specific aspects of career development, taken from developmental, differential, social, personality, and phenomenological psychology and are held together by his notion of self-concept and learning theory (Super, 1990- Career Decisions).

Donald Super's efforts in the area of *work values* may lead to some insight regarding individual's patterns of migration. Super views work values as particular values affecting the motivation to work, and defines values as "the qualities people desire and seek in the activities in which they engage and in the situations where they live" (Neumann & Neumann, 1983). Super defined 15 work values that predict a wide range of attitudes and behaviors that affect motivation to work (Creativity, Management, Achievement, Surroundings, Supervisory Relations, Way of Life, Security, Associates, Aesthetics, Prestige,

Independence, Variety, Economic Return, Altruism, and Intellectual Stimulation). Levels of importance to components of the work allow an individual to determine the range of jobs that they will perform effectively or ineffectively. Values also serve as a screening mechanism for organizations and educational systems attempting to match individuals in an applicant pool to their organizations. On the basis of Super's theory of work values, one experimenter was able to accurately discriminate between individuals with engineering and liberal arts majors (Neumann & Neumann, 1983).

As we have seen, vocational psychology offers a broad literature that examines individuals and the decision making process. However, to date this field has not addressed individual's decision-making process beyond career choice. Although this literature provides a conceptual framework for understanding the phenomenon of migration, there has been no research regarding these factors in this area. As we will see shortly, in spite of the theoretical basis that these theories provide, there is very little empirical information directly related to the migration of science and engineering graduates.

LITERATURE SEARCH

An extensive search of the psychology, sociology, regional studies, geography, and economics literature was done. The search was intended to locate literature regarding migration of recent college graduates in science and engineering fields. The goal of this search was to examine relevant literature in order to understand factors used in previous research to explain the phenomenon of migration and the brain drain. Search engines utilized for the purposes of the present review included Psych Info, Social Science Citation Index, Expanded Academic Index, and ABI Inform. Key words used in the search were *migration, brain drain, college, graduates, labor, movement, policy, jobs, employment, characteristics,*

and *study*. Attempts were made to find the most current articles published in this area. Search results revealed that although there has been a great deal of literature regarding general population migration, there has been little research examining retention and movement patterns of specifically science and engineering college graduates. Several journals including *Regional Studies, Monthly Labor Review,* and *Economic Geography* were specifically examined.

One of the major contributors to the field, Michael Greenwood (1993), stated, "When I completed my first survey [of the migration literature] twenty years ago, I thought it was the most difficult academic assignment I had undertaken to date .... [However,] I [now] feel that my latest effort was far more difficult than any prior effort. The literature has become so massive.... and the nature of the research so specialized [that it has] made such surveys extremely difficult and .... even the most diligent researcher finds difficulty in [pulling it all together]." The narrow body of existing empirical literature necessitated the need for a much broader topical review than was initially intended.

Types of available data

Most research in the empirical literature defines migration as a dichotomous, onetime event (i.e., moves or not moves). Contrary to existing research, DaVanzo (1983) asserts that most moves are not isolated occurrences and are in fact what he terms 'repeat moves'. Migration research regarding college graduates in science and engineering fields is limited. Not only have there been very few studies of migration that focus specifically on scientists and engineers, but also studies of migration typically focus on a particular segment of the population and tend to reflect researchers' distinctive disciplinary interests, styles, and methods of research (Zuckerman, Cole, & Bruer, 1991). For example, many studies are

sharply focused on scientists rather than engineers. This is a significant limitation in the existing literature because engineers actually outnumber scientists and comprise 56% of those working in science and engineering jobs. Many studies also limit themselves to research on academics rather than industrial or government workers when only about 12% of all scientists and engineers work in academic institutions. Similarly, other research studies focus on individuals possessing a doctorate rather than those with lower level degrees when doctoral recipients represent only 11% of all scientists and engineers. Similarly, most studies of scientists and engineers tend to focus exclusively on the two most recent decades rather than looking at trends through time (Zuckerman, et. al., 1991).

Although college graduates are an appropriate sample for many reasons, they are difficult to track. Migration studies of college graduates based on individual characteristics have been few because of the difficulty associated with tracking those graduates after graduation (Ballweg, & Li, 1992). Although some schools require their graduates to provide an exit interview, most do not.

The following sections describe empirical research related to the factors that influence individuals' decision to move (see Table 1for summary of empirical literature and results). Ideally, studies would have been included if they dealt specifically with the migration and / or movement patterns of science or engineer degree holders. However, upon examination of the published literature, it was clear that the present review would have to be much broader to fully understand the factors that influence an individuals' decision to move. The following section is organized into three distinct sections, studies of general population movement, college aged population movement, and the movement of science and engineering graduates. The goal of the following sections is to review previous research in

order to understand what is known and not known about factors that influence an individual's decision to migrate and apply that information to the current research with regard to recent graduates in science and engineering. While reviewing the research presented in the next sections it is important to remember the limitations mentioned above. Conclusions based on specific segments of the population may not be relevant for all segments of the population.

EMPIRICAL LITERATURE REVIEW

General Population Studies

In order to understand the movement patterns of science and engineering graduates, it is helpful to consider movement patterns of the general population. Understanding the factors that influence the mobility of the general population may provide valuable insight into the factors that influence the mobility of scientists and engineers. This section reviews several studies that examine general population movement. First, movement trends of the general population at the aggregate state level are presented, followed by general movement trends at the individual level. The focus of the subsequent studies in this section turns away from analysis of the total population to factors that affect the mobility of the general labor force. Qualitative analyses of the factors that influence the migration of dual career households are reviewed. Finally, the migration patterns of general labor force participants across the life span are reviewed.

One of the early studies of general labor migration was done in the late 1960s. Greenwood (1969) studied the degree in which state level factors influenced interstate migration of the general population between the years of 1955 and 1960. Greenwood used 1960 *Population Census data*. State level factors that Greenwood examined included: *distance* (mileage between states), *income* (state median income), *median education* (original

and destination state), *unemployment* (original and destination state), *mean temperature* (yearly ratio of destination to original state), and *migrant stock* (the ratio of individuals born in the original state and living in the destination state). The dependent variable was measured as the number of individuals five years of age and older living in the destination state in 1960 who resided in the original state in 1955. Stepwise multiple regression analysis was used to determine gross migration for each of the 48 continuous states. The data obtained in the 1960 census was used to estimate two relationships, one including *migrant stock* and one excluding migrant stock as a predictor of gross state migration.

Results of Greenwood's study found migrant stock (defined earlier) to be the single most important predictor of state migration. Migrant stock had a strong positive relationship with interstate migration ($t=42.06$, $p<.001$) indicating that individuals have a strong tendency to migrate to states that other natives of their original state have previously migrated. First considering the equation with migrant stock included, distance ($t= -11.21$, $p<.001$) and median education of destination state ($t=-2.95$, $p<.01$) had negative relationships with migration indicating that the greater the distance or the higher the education level of the destination state, the less likely one would be to move to that state. Median educational attainment for individuals in the origin state ($t= 16.6$, $p<.001$) and rates of unemployment in the state of origin ($t= 8.44$, $p<.001$) had positive relationships with migration indicating that that lower levels of educational attainment and unemployment in the origin state contribute to an individuals decision to stay in that state. Mean yearly temperature ($t= 6.49$,$p<.001$) also had a positive relationship with gross migration such that the more temperate the temperature of the destination state the greater the likelihood of migration to that state. Median income

and unemployment rate of the destination state had a non-significant relationship with migration.

Upon examination of the second equation excluding migrant stock, distance was found to be the most important predictor and had a negative relationship with gross migration (t= -27.55). Median income had a positive relationship but explained the least amount of variance (t=2.99,p<.001). Education (origin, t=8.72; destination, t=5.06, p<.001), unemployment (origin, t=5.09; destination, t=5.15, p<.001) and mean yearly temperature (t=9.49, p<.001) all had significant positive relationships with gross migration. The results of this study clearly show that migrant stock is the single most important predictor of gross interstate migration (Greenwood, 1969).

Opposed to other studies that measure migration as a one-time event, DaVanzo (1983) examined repeat migration patterns in the U.S. DaVanzo asserts that most moves in this country are repeat moves, either to a new location or back to places where migrants lived prior to the move. The study used individual survey data obtained from the 1968-1975 waves of the *University of Michigan's Panel Study of Income Dynamics*, which provide information about 5,000 US families over an eight-year period. The data were restructured so that each observation represented an individual's residence for each year in the study, called "person-year observations" and aggregated up to standard metropolitan statistical areas (SMSA).

This study expands the *human capital* model of migration to incorporate the concepts of *location specific capital* and information costs. Specifically, migration is an investment in human capital such that an individual chooses to migrate because they expect that the benefits of moving outweigh the costs incurred by the move. However, only when an

individual has perfect information regarding all possible options would the individual be able to perfectly weigh the advantages and disadvantages associated with the potential decision. DaVanzo further asserts that an individual searches for information only as long as they perceive that there are benefits of having more information. Then, only individuals who perceive positive net benefits of migrating will move.

In general, results of this study support the proposition that the less reliable the information on which the initial move is based, the more likely a subsequent 'corrective' move (either to a new location or back to the place they lived before the move) will be. Less educated individuals base their initial moves on limited information, lowering their success rate of their moves and increasing the likelihood of a corrective move back to where they came from. More highly educated individuals are more likely to move in general and are also more likely to make subsequent moves to a new location that is different from both where they came from and where they have already been. DaVanzo found that the farther the initial move, the likelihood that they will move again increases. Initial moves pressured by unemployment tend to be followed by repeat moves. Individuals who are more embedded in their community (i.e., own a home) are less likely to make an initial move. Similarly, the longer the person lived at the pre-initial move dwelling the more likely they are to return to that area. DaVanzo found that very young household heads were particularly prone to return to where they had lived before within a year or so of leaving. Finally, DaVanzo looked at aggregate information regarding general job market conditions that may affect an individual's decision to move. He found that the less promising the job market conditions in the area of potential return the less likely a person is to choose that area over some other destination if he moves again (DaVanzo, 1983).

Green (1997) did a qualitative analysis of individual level factors that influenced the location and mobility strategies of dual career households. In this study, dual career households were defined as the subset of dual earner households' with two (or more) earners working in managerial, professional or associate professional occupations. This group was chosen because professional occupations typically place higher demands on individuals and require a certain degree of commitment. This study used a biographical case study approach to study this phenomenon. The author selected a particular location in Great Britain that closely approximated the national proportion of dual career households. From this area, five companies including an institution of higher education, a large health services establishment, a major bank, and two large manufactures were selected to participate. A structured questionnaire was sent out to the employees of each of these companies requesting background information on age, household structure, occupation, qualifications, employer name and address, journey-to- work information, mode of transportation, distance to work, and time to work. Of the 160 respondents that reported a dual career household, 30 were randomly selected to participate in a qualitative in-depth interview session.

There are a variety of dual career household types. For example, in traditional households with a conventional division of labor, the man's job takes precedence over the woman's job, therefore he leads and she follows. Historically, women have engaged in more flexible careers such as secretarial work, nursing, or teaching. However, in a dual career household today it is not always the case that the mans career takes precedence over the woman's career. In Green's study, out of the 30 couples interviewed, the man's career took priority in 19 cases, the woman's career took priority in 5 cases and there were 6 cases where propriety was shared and no leader could be determined. Through qualitative analysis, Green

identified three key factors that determined which of the two careers were to be considered the 'lead' career. In many cases, the person who is paid the highest leads. The second key factor in determining the lead career is whether or not one career is constrained by location. If it is more difficult for one to find a job, then it is usually the case that the more locationally constrained earner leads. A third factor to consider when deciding who leads is whether one career offers more security than the other. Typically, the more secure career leads. Green also found that lead roles are not permanent. In some of the households studied, one career led at one time and in turn followed at a later time.

Results of this study indicate that accessible semi-rural areas emerge as the most preferred residential environments for dual career households. In fact, many couples indicated that they were prepared to commute (typically by car) long distances to work in order to live in such areas. Qualitative evidence from this study also indicated that couples were unwilling to consider migrating for non-permanent employment contracts (Green, 1997).

It is interesting to note the effect that a spouse's employment status plays in the decision to migrate. Historically, the husband's career took precedence and women were expected to follow their husbands. On the basis of Greens results, it appears that the division of labor is much more equitable in today's workforce. These results are particularly valuable for organizations developing strategic recruiting programs. Organizations can develop incentive programs such as job placement assistance for spouses in order to lure the best and brightest employees to their company.

In general, some occupations or careers are more mobile than others and can be performed in a number of locations. Just as Green talked of locational constraints, Bartel

(1979) examined the role of job mobility in the decision to migrate. Although Bartel does not examine factors that affect the specific labor mobility of occupations in science and engineering fields, it is helpful to understand factors that influence general labor migration. Bartel used individual level data obtained in three data sets that encompass different age groups across the life span including the *National Longitudinal Surveys (NLS) of Young (men aged 19-29) and Mature (men aged 45-59)* and the *Coleman Rossi Retrospective Life History Study (men aged 26-35)*. Logit regression was used to test the independent effects of wage, education, family status, job tenure and length of residence on the individuals' decision to migrate.

This study is grounded in the Economic Theory of migration that predicts an individual will attempt to sell their services in the market that offers them the highest return. In general for all three samples studied by Bartel, approximately two-thirds of all moves involved a job separation (i.e., when a person voluntarily chooses or is involuntarily asked to leave their job). Voluntary moves that involved job separations that were made for economic reasons are caused by organizational or market pull factors that affect an individuals' decision to change jobs.

Bartel (1979) found that the measured effects of the independent variables on migration depended heavily on the associated job separation (i.e., voluntarily quit or involuntarily terminated). In all three samples studied, individuals who voluntarily initiated a separation and migrated had higher wage gains than those migrants who suffered organizationally initiated separations. In general, results indicate that one-half (52%) of all interstate moves are associated with organizational or market factors that lead to a voluntary decision to change jobs. For example, if an individual lives in a location that does not

provide degree related job opportunities they must decide to either remain in that area and take a job that is unrelated to their degree or move to an area that does offer degree related opportunities.

Bartel found that education has a positive and significant effect on migration at all ages, such that it appears that more educated individual's have a greater ability to adapt to new locations and to search for jobs in other locations. Costs of migration that are associated with marital status were measured in terms of the wife's labor participation, the wife's hourly wage and annual income and whether the respondent had school aged children. In terms of family status, for men in their 30s - 50s the affect of wives labor force participation has a negative but non-significant effect on migration in all age groups. Where as the presence of school aged children had a negative but significant relationship with the decision to migrate for voluntary separations of older men. Job tenure was found to reduce the probability of a job separation for all ages because of the positive correlation between tenure and job-specific training. In other words, as job tenure increases so does training and familiarity with that job and as a result, the likelihood of migration decreases. Length of residence in the current location is an important determinant on the decision to migrate. Individuals who have lived in one place for a long time are said to have built up strong community ties and are less likely to move (Bartel, 1979).

College Aged Population Studies

In order to understand the migration patterns of college graduates, it is helpful to consider movement patterns of college students. The study of student movement across state lines is important for several reasons. The number of graduates within a state in a given field has a direct affect on the state labor market in that field. If a state wishes to have an ample

supply of highly skilled technology workers, then it must actively contribute to the development of these workers. Similarly, lower numbers of highly skilled workers creates a deficit for that state and requires aggressive recruiting efforts at both academic and organization levels if the state wishes to fill jobs and or attract new firms. It has also been proven that one who migrates once is more likely to migrate again (Plane & Rogerson, 1994; Long, 1988). Therefore, if an individual leaves their state of origin to pursue an education, then it can be said that they may be predisposed to the option of moving in the future. In this section, articles related to college student migration will be reviewed. First, an empirical study that examines institutional level influences will be presented. Then, regional and individual level factors will be examined.

Fryman (1988) examined institution level factors thought to predict first-time freshmen student migration of Iowa state residents to four-year public institutions outside the state. The U.S. Department of Education reports that in 1984 approximately 14% of the total college student population in the U.S. crossed state boundaries to attend school. In general, freshmen attending private institutions were more likely to migrate across state boundaries (45%) than those attending public institutions (14%). Approximately 10% of Iowa's college freshman chose to cross the states' borders to attend a public four-year institution during the 1984 fall semester. Of those, 79% enrolled at one of the 67 public universities located in the seven adjacent states. Fryman's study utilized institution level data obtained from the *Educational Directory, Barronns' Guide to U.S. Colleges, Peterson's Four Year Colleges, College Costs, the Office of Education Resource and Information division* and *the National Center for Educational Statistics*.

Using bivariate correlation and stepwise multiple regression, Fryman examined the relationship between the following factors and first-time freshman migration: *distance* between the closest Iowa state boarder and the destination school, educational *costs* (out-of-state tuition rates), institutional *size* (total institution enrollment), perceived *quality* of the institution (index), the *non-resident percentage* at each institution (percent of out-of-state enrollment excluding Iowans) and state *admissions policies* regarding non-resident students (higher admission standards, quota restrictions, higher out-of-state tuition). Detailed statistical data allowed the author to match the twelve hundred students that migrated across Iowa state lines with information regarding the specific destination institution.

Results of Frymans' study indicate that approximately three-fourths of migrating students made relatively short moves and traveled no further than fifty miles from the Iowa border. A negative bivariate relation between distance and the number of Iowa students in other states was observed (r= -.37) indicating that the greater the distance the less likely one would find Iowa students enrolled. A negative bivariate relation (r= -.32) was observed between the numbers of Iowans enrolled out-of-state and tuition indicating that higher out-of-state tuition hindered the enrollment of Iowa students or that low out-of-state tuition lured them. A positive correlation (r= .42) was obtained between the percentage of non-residents and the number of Iowans enrolled out-of-state. There was a negative but non-significant correlation between enrollment and number of Iowa students. Similarly, a non-significant negative correlation was observed between institutional quality and the number of students attending out-of-state institutions. Stepwise regression was performed to determine which variables best predicted student migration behavior. Results of this analysis revealed that the percentage of out-of-state students was the overall best predictor, distance was second, and

tuition was third. Enrollment and quality did not appear to have a significant association with frequency of Iowans in the seven surrounding states. The author notes that policy issues intuitively have a significant effect on student migration, but acknowledges that this variable could not be examined at the time of study.

We should be careful not to generalize findings of this study. Iowa only has three four-year public institutions in the entire state, all located in the eastern part of the state. In many cases, it is closer for Iowa students to attend neighboring state universities than one of the three Iowa institutions (Fryman, 1988).

Greenwood (1973) examined the regional mobility of college graduates based on standardized metropolitan statistical areas (SMSA). Greenwood asserts that income and education are interdependent and that education is likely to play a crucial role in the quality and quantity of information an individual acquires regarding a potential move. Specifically, this study examines the differences that region level factors have on the migration patterns of white and non-white college graduates. Previous research conducted by Greenwood indicates that nonwhite gross-migration rates are lower than white gross-migration. Data related to education and color by SMSAs was obtained from *Regional Census* data. Multiple regression analysis was used to examine the following factors: median *family income*, *employment* (white/ non-white), *percent change in employment*, *rate of unemployment,* and *regional area* (dummy variables for south vs. non-south, west vs. non-west).

Results indicate that non-white college graduates are attracted to locations with high levels of nonwhite income, but no similar trends where found for white graduates. As one would expect, areas with higher income levels were found to have lower out-migration rates for both white and non-white individuals. The size of the labor market exerts an important

influence on migration. Areas with larger labor markets were associated with larger rates of in-migration. Greater increases in employment were associated with higher in-migration and lower out-migration. The greater the rate of white employment growth, the lower the rate of out-migration of whites, but no similar trends were found for non-whites. Higher rates of white unemployment in a given area were associated with lower rates of white in-migration.

Contrary to their hypothesis, out-migration of non-white graduates was lower in areas with higher unemployment rates. The author suggests that this may be due to the fact that unemployment rates used in this study were based on white or nonwhite labor force participation as a whole and not on the unemployment rates of white and non-white college graduates. Different results may have been observed if unemployment rates of college graduates rather than total unemployment rates were examined. Finally, neither regional dummy variable was significant in the in-migration equation for non-whites, but both where negative and significant for whites. This suggests that in-migration rates of white college graduates tend to be higher for SMSAs in the South and West than for those in the rest of the country. Not surprisingly, net in-migration rates of non-white college graduates tend to be lower for Southern SMSAs than other areas in the country (Greenwood, 1973). These results may be due to the racial animosity historically observed in the south.

Ballweg & Li (1992) examine the effects of employment on migration of graduates from land-grant universities in the south. The authors contend that studies of migration of college graduates based on individual differences are few and far between. The study provides insights into individual level factors that predict the probability of college graduates migration across state lines. Their basic hypothesis is that graduates move out of state in response to economic incentives.

The dataset used for the study was the *Occupational Career of Former Students Survey of Southern Land-Grant Universities* conducted in 1986-87. A survey of agricultural students enrolled in universities across eleven southern states was conducted in 1976. In 1986 almost a decade after their projected graduation date, the original survey was sent to the same individuals who participated in the 1976 study. Approximately 73% of the original sample was located and of those, 92% completed the follow-up survey (N=1858). Respondents from the follow-up survey were divided into four distinct groups; those whose (1) first and present job were in the state where their degree was received (32.6%); (2) both first and current jobs were outside the state their degree was received (27.6%); (3) first jobs were in the state, but current job was outside the degree granting state (32.2%); and (4) first job was outside the state but current job was within the state where their degree was received (7.6%).

In order to determine what factors were most influential in decisions to accept a job either in or out of the state, graduates were asked to describe the relative importance of sixteen factors associated with employment. The sixteen factors were classified into four categories including: *Economic Factors* (Pay, Fringe benefits, and Security of job), *Work Characteristics* (Challenges of work, Importance of work, Change for advancement, Opportunity to use my education, Opportunity to develop new skills, Respect people have for this kind of work, and Opportunity to travel), *Environmental Situation* (Working conditions, Good work associates, Job as a whole, and Location of job), and *Worker Independence* (Chance to be boss, and Amounts of supervision). Respondents were asked to rate each factor on a likert type scale that ranged from 1 (not important) to 5 (very important). Analysis of variance was used to compare the mean score of each reason between migrant

graduates and non-migrants. Migration was measured as a dichotomous dependent variable (i.e., whether respondents took their first job inside or outside the degree granting state). Logistic regression models were used to estimate the effects of independent factors on the dichotomous migration variable.

Results revealed that in accordance with previous studies, economic earnings were found to be the most important factor for predicting employment migration of graduates. Work characteristics were 'claimed' to be an important reason for accepting the first job by male graduates who moved out of the degree granting state, while those who stayed within state borders considered environmental conditions, such as location of job, more important. The study found that these factors did not significantly influence female graduates. Not surprisingly, this study also revealed gender differences such that male graduates received higher salaries and benefits than did female graduates on their first job. On the basis of these results, it would appear that in order for a state to retain its graduates, it must have employment opportunities that appear more attractive in terms of economic characteristics, work characteristics, environmental and worker characteristics to graduates than other jobs outside the state. Since we know that salaries are of primary importance for recent graduates, it would behoove industries to offer salaries that are nationally competitive (Ballweg & Li, 1992).

Science & Engineering Graduates

Ideally, studies would have been included in this section if they dealt specifically with the individual level factors that influence the migration patterns of recent college graduates in science and engineering fields. However, as noted in the previous sections this topic has received minimal attention in the empirical literature. Although no article in this section

identically matches the criteria, this section reviews articles that relate to the movement of science and engineering graduates. The first study presented in this section examines the migration patterns of foreign nationals earning a science or engineering Ph.D. in the United States. The second article reviewed examines the factors that influence the mobility of military scientists and engineers. Finally, factors that influence the aggregate migration patterns of recent college graduates in science and engineering at the state level are examined.

Finn, Pennington, & Anderson (1995) examined the behavior of foreign nationals who received PhD degrees in science or engineering from U.S. universities during the 1984-1990 period. Specifically, this study addressed two questions; "What proportion of foreign students stay to work in the U.S. after graduation?" and "Do foreign students who leave the U.S. differ from those who stay?" This study utilized individual level data obtained from the National Science Foundations *Survey of Earned Doctorates, the National Research Council's Survey of Doctorate Recipients Longitudinal File,* and the *Social Security Administration*. Social security numbers were requested from all respondents on the survey. Stay rates were determined by identifying individuals that reported earnings in the U.S. In order to assure that each respondent's earnings could be traced, the Office of Social Security verified social security numbers. Any respondent that did not enter a valid social security number, and could therefore not be traced, was removed from the analyses (~7%).

Specifically, the proportion of students who stay in the U.S. after graduation (i.e., stay rates) were determined by calculating the proportion of foreign nationals who earned a degree in science or engineering in 1984 and who reported at least $5,000 in earnings in social security covered employment in any year from 1986 to 1992. Surprisingly, the

proportion of all foreign nationals (temporary residents) earning a degree in any science or engineering field that remained in the U.S. after graduation proved to be quite stable across time (40% 1986; 42% 1987; 43% 1988; 43% 1989; 43% 1990; 44% 1991; 42% 1992). Stay rates reported by sub-field reveal similar results for those earning an engineering degree, but substantially lower rates for those earning degrees in either life science (range 24%-34%) or social science (range 25%-28%) were reported. While results for stay rates by degree appear to be relatively stable, results indicate considerable variation in stay rates by country of citizenship for those foreign nationals that received their degree 1987-1988. Countries that had above average stay rates were India (77%), Iran (72%), and the Peoples Republic of China (66%). Countries with stay rates below average include Japan (12%), Brazil (15%), and Korea (20%). These results were consistent across degree fields. It is interesting to note that foreign nationals from Taiwan, India, Iran, and Asia Pacific earning engineering or physical science degrees were most likely to stay in the U.S. after graduation, and engineering students from Japan and Korea were more likely than all engineering students to leave the U.S. after graduation. These differences may be a result of differential job opportunities available to graduates in their country of origin compared to the opportunities in the U.S. at the time of graduation.

Finn, et al. (1995) used descriptive information provided in the Survey of Doctorate Recipients (SDR) Longitudinal File to compare individual characteristics of stayers' and leavers'. The SDR is not a sample survey. It is a complete census of new doctorate recipients in the U.S that is administered close to the time of degree completion. Collected by the National Research Council, this file is an on-going census of all research doctorates earned in the U.S. that is collected from individuals every two years. The SDR is conducted

by the National Research Council and is funded by several federal agencies. The survey changes every two years as the oldest cohort is dropped and a new cohort of graduates is included. Until 1989, the survey included Ph.D recipients who earned their degree during the previous 42-year period. The SDR contains data that allowed the authors to examine the characteristics of a person most likely to stay in (or leave) the U.S. after they completed their degree. The 1991 survey revealed substantial differences in average salary between stayers ($55,590) and leavers ($42,800). Higher salary market conditions may prove to be an incentive strong enough to influence one's decision to stay in the U.S. rather than migrate back to their country of origin. Similarly, this study seemed to support the notion that the more embedded in the community or geographic area one is, the less likely they are to move away from that area. Marital status and the presence of school age children served as measures of embeddedness.

Results indicated that in general, higher percentages of stayers were married (1991: 79% vs. 43%; 1987: 64% vs. 57%), and had children (1991: 77% vs. 39%; 1987: 43% vs. 30%). Similarly, higher percentages of stayers in 1991 were employed in industry (32% vs. 22%) or an academic tenure or tenure-track position (39% vs. 17%). While higher percentages of leavers in 1991 were employed in academic non-tenure track (22% vs. 16%) or government / non-profit positions (39% vs. 13%). Information based on these results suggest that individuals with a degree in engineering, who earn higher salaries, are married, have children, are employed in either industry or an academic tenure-track position, and who are natives of India, Iran, or China are likely to stay in the U.S. after completing their degree (Finn, et al, 1995). Therefore, it appears that stayers tend to be embedded in the community

in terms of marital / family status and who came from countries with lower market value for their degrees.

Ellis, Barff, and Markusen (1993) examine state level factors that influence the location and movement of defense related industrial workers in the U.S. space program. They examine the hypotheses that the geographic location and general activity level of military industrial firms and the government's willingness to subsidize labor relocation significantly affect interregional migration patterns of highly skilled scientists and engineers. This study uses data obtained by the *U.S. Department of the Census (1975-1980)*. The authors argue that because other locational factors dominate in the defense business and because the government frequently pays for recruitment, workers in white-collar defense related industries tend to follow jobs over time rather than vice versa. Because blue-collar workers are more likely to bear the cost of migrating than are professionals, they are less likely to migrate. The authors assert that state policy has with few exceptions been ignored in either descriptive or analytical migration research concerned with trends in interregional population movements.

Results of the study indicate several interesting findings. First, defense related workers were not more likely to migrate than non-defense workers. In fact, the opposite was true, privately employed workers least dependent on the military had the highest mobility rates. Second, the geographic destination of defense related workers was closely related to areas with increased military spending. Third, although scientists and engineers least dependent on military funding have the highest mobility rates, those who are most closely tied to defense spending tend to move farther. Similar results were found in terms of blue-collar workers, results indicate that those most dependent on military funds tend to move less

often but farther than workers that are less dependent on military spending. Together, these results suggest that defense related workers follow jobs rather than vice versa.

Occupational categories of scientists and engineers with few ties to the military are disproportionately concentrated in Delaware, New Jersey, West Virginia, and Louisiana. Occupational categories include aeronautical engineers, oceanographer, physical scientist, industrial engineer, agricultural scientist, nuclear engineer, and electrical engineer to name a few. Interestingly, states with a relatively large concentration in one of the categories of defense dependency usually do not possess heavy concentrations of scientists and engineers in other categories, which suggest a well-defined regional division of labor. States with the lowest concentration of defense scientists and engineers are Florida and Minnesota. Migration patterns of defense related scientists and engineers tend to form new geographic labor patterns such that as the proportion of workers in scientific and engineering occupations that are dependent on defense dollars increases; there is a general tendency for employment to gravitate toward Washington, California, Arizona, Florida, Texas, and New England (Ellis, et. al., 1993). Implications of this study suggest that defense related workers are more mobile than non-defense related workers, and that white-collar workers in this area are particularly more mobile. In general, this study provides support for the theory that highly skilled professionals in science and engineering are mobile. This study has shown that defense related personnel tend to go where the jobs are rather than waiting for the jobs to come to them.

Tornatzky, Gray, Tarant, & Howe (1998) looked at the interstate migration and retention of high school and college students. This study is extremely relevant to the present research in that it specifically examined state level factors that influenced post graduation

employment of graduates in science and engineering fields. The study utilized data obtained from the National Science Foundations *National Survey of Recent College Graduates, 1993.* From this database, the researchers developed state level indices of *migration and retention*. This study was one of the first of its kind to measure and explain the "brain drain" that threatens the economy of many states in this nation.

Outcome benchmarks of migration and retention were constructed from the database on the basis of which state individuals received their degree and the state in which they were employed following graduation. Individual data were then aggregated to form state level indices. Using bivariate correlation and multiple regression analysis, Tornatzky, et., al. looked at the relationship between the following sets of factors and the dependent measures 1) Geographic characteristics, 2) Industrial structure, 3) State economic performance, 4) Federal spending, and 5) R&D technology intensity.

Results of this study indicate that the factors that predict state retention of its graduates are different than the factors that predict net migration. Geographic factors including population and border permeability are significant predictors of both retention and migration. The percentage of a state's high school graduates who stay in the state to attend college also predicts both retention and migration. State economic indicators including, higher wages in the technology industry predict net migration, and lower in-and out-of-state tuition at public universities serves to increase a states ability to attract students from other states.

Specifically, state retention of individuals earning their most recent degree was influenced by geographic factors including state population, and absence of geographic patterns that permit border permeability, the states percent of students that stay at home to

attend college, and the state's income per capita. Similarly, state retention of high school graduates was influenced by the same factors that predicted retention of recent degrees plus the percentage of a state's workforce employed in the wholesale sector. Results indicate that geographic factors that states have little control over appear to be the strongest predictors of retention at both levels.

Net migration of individuals earning their most recent degree was influenced by the percentage of students that stay at home to attend college, the percentage of the states gross state product, and the average cost of out-of-state tuition at public post-secondary institutions. The percentage of students that stay in the state to attend college was the most powerful predictor. Net migration of high school students was influenced by the average cost of in-state tuition for public institutions, total state employment, the absence of geographic factors that permit border permeability, average wage in the technology industry, and federal defense funding per capita.

The results of this study lead to the current proposed research project. Although Tornatzky, et., al. took a relatively pioneering stab at explaining state level migration and retention patterns, it is obvious that more research needs to be done to understand these patterns at an individual level. Understanding these patterns will allow academic institutions and organizations in both the public and private sector to tailor their recruiting tactics and enhance their competitiveness in the state of the new economy.

Table 1. Summary of Empirical Literature Review

GENERAL POPULATION STUDIES						
Author (Year)	**Level of Analysis**	**Sample**	**Methodology**	**Independent Variables**	**Dependent Variables**	**Results**
Greenwood (1969)	State	General Pop: Census data (N=48)	Multiple Reg.	-Distance (Hwy mileage b/t states) -Median male income (state) -Median education (origin state) -Median education (destination state) -Unemployment (origin state) -Unemployment (destination state) -Mean yearly temperature ratio (destination / origin) -Migrant stock (#born origin / # living in destination)	Migration Ratio: (Origin - Destination) / Total Pop of Origin	Migrant stock (MS) had a positive relationship and was the single most important predictor of state migration. Distance had a negative relationship with Migration and was the most important predictor when MS was left out of the equation. Income was not significant when MS was included in the equation but had a significant positive relationship with migration when MS was left out (Income contributed least to the variance explained). Education (Origin) had a positive relation in both equations. Education (Destination) had a positive relation without MS but a negative relation when MS was included. Unemployed (Origin & Destination) both had a positive relationship with Migration. Temperature had a positive relation with migration such that the better the temperature in the destination state the greater the likelihood of migration.
DaVanzo (1983)	Individual	General Pop: (N=5,000)	Polytomous Logit Reg.	Location Specific Capital: -Home Ownership -Years in dwelling -Education (# years) -Age (dummy <20yrs) -Move Distance -Employment Status:	Migration as Polytomous Variable (Stay, return, or move on)	Less reliable information for initial move increases the likelihood that one will move again as a corrective measure. Less educated individuals base their initial moves on limited information, lowering their success rate of their moves and increasing the likelihood of corrective return moves. More highly educated individuals are more likely to undertake an initial move and are more likely to make subsequent onward moves. Individuals who are more embedded in their community (i.e., own a home) are less likely to move. The longer the person lived at the pre-initial move dwelling the more likely they were to return to that area. The farther the initial moves, the increased likelihood for a repeat onward or return move. Initial moves pressured by unemployment tend to be followed by repeat moves. Very young household heads are prone for return moves within a year of their initial move. The less promising the job market conditions in the area of potential return the less likely a person is to choose that area over some other destination if they move again.
Green (1997)	Individual	General Pop: Dual Career Couples (N=30)	Qualitative Analysis: Biographical case study with structured interviews	-Age -Number of children -Household structure -Occupation -Qualifications -Employer Name / Address -Mode of Transportation -Distance to work -Time to work -Recent work history -Recent migration history	N/A	Quality of life factors play a big role in the decision to move for dual career couples. Accessible semi-rural areas were the most preferred residential environments for dual career households. Many couples indicated a willingness to commute (by car) long distances to work in order to live in semi-rural areas. Couples also indicated a willingness to migrate for non-permanent employment opportunities.
Bartel (1979)	Individual	General Pop: -Young men (N=1608) -Mature men (N=1790) -Middle aged (N=579)	Logit Reg.	-Wages -Education -Family status -Job tenure -Length of residence	Migration as a Dichotomous variable	Voluntary migrants had higher wage gains than involuntary migrants. Individuals with more education were more likely to move than those with less education. Family status had a negative relationship with migration. Community ties tended to decrease the likelihood that one would migrate (e.g., having a working wife and the presence of school aged children). Increased job tenure and length of time in residence decreased the likelihood of migration.

Table 1. Continued

COLLEGE POPULATION STUDIES						
Author (Year)	**Level of Analysis**	**Sample**	**Methodology**	**Independent Variables**	**Dependent Variables**	**Results**
Fryman (1988)	Institution	College freshmen (N=67)	Correlation Stepwise Reg.	-Distance -Tuition -Enrollment size -Quality of institution -Non-resident percent	First time Freshman Migration	Percent of non-residents (out-of-state student enrollment) was the best predictor of freshman migration. Distance was the second best and Tuition was the third best predictor of student migration. Enrollment and Quality had no effect.
Greenwood (1973)	Regional / SMSA	White and non-white college graduates (N= 66)	Multiple Regression	-Median family income -Employment (white / nonwhite) -Percent change in employment -Unemployment rates (white/ nonwhite) -Southern region dummy (SMSA) -Western region dummy (SMSA)	In-Migration Out-Migration Net Migration Migration Efficiency	***-White In-Migration:*** Employment negatively related. Percent change in employment, positively related. Southern & Western region, negatively related. ***-White Out-Migration****:* Median yearly income, negatively related. Employment, negatively related. Percent change in employment, negatively related. ***-White Net Migration****:* Median yearly income, positively related. Percent change in employment, positively related. ***-Non-white In-Migration:*** Median yearly income, positively related. Employment, negatively related. Percent change in employment, positively related. ***-Non-white Out-Migration:*** Median yearly income, negatively related. Employment, negatively related. Unemployment rates, negatively related. Southern region, positively related. ***-Non-white Net Migration:*** Median yearly income positively related. Percent change in employment, positively related.
Ballweg & Li (1992)	Individual	College graduates from land-grant univ. (N=1858)	ANOVA Logistic Reg.	**-Economic Characteristics** (Pay, Benefits, Job Security) **-Work Characteristics** (Challenge, Importance, Advancement, Use of Education, Develop skills, Respect, Travel) **-Environmental Situation** (Working conditions, Associates, Job, Location) **-Worker Independence** (Boss, Supervision)	Migration as a Dichotomous variable	When asked the most important reason to migrate, respondents indicated characteristics of the work as most important. However, when rating items individually, economic factors proved to be the most important variables involved in the decision to migrate.

Table 1. Continued

SCIENCE & ENGINEERING GRADUATES						
Author (Year)	**Level of Analysis**	**Sample**	**Methodology**	**Independent Variables**	**Dependent Variables**	**Results**
Finn, Pennington & Anderson (1995)	Individual	Foreign nationals earning U.S PhDs (N= 11,219)	Multiple Reg.	-Year of degree award -Degree field or major -Type of employer (industry or Gov) -Marital status -Number of Children	Migration as a Dichotomous variable	This study found that foreign nationals who tend to remain in the us after completion of their degree have the following characteristics: degree in engineering, originated in India, Iran, or the Peoples Republic Of China; earn higher salaries; are married with children; and are employed in industry or a tenured academic track position.
Ellis, Barff, & Markusen (1993)	State	Military S&E (N=48)	Census Comparison	-Military affiliation -Tie to military spending -Geographic destination -White collar vs. Blue collar workers	Migration as a Dichotomous variable	Defense related scientists and engineers are more mobile than non-defense related workers with the same degree. White-collar workers were particularly more mobile than their blue-collar counterparts. Defense related workers typically migrate to areas where there are degree related job opportunities.
Tornatzky, Gray, Tarant, & Howe (1998)	State	Recent College Graduates (N=49)	Correlation, Benchmarking Multiple Reg.	-Geographic -Industrial Structure -State Economic Performance -Federal Funding -R&D Intensity -Policy Variables	High School Grad: Migration Retention Recent Degree Grad: Migration Retention	-The most important predictor of state Net H.S. Migration was the average cost of in-state public institution tuition. Other variables found to predict H.S. migration were total state employment, the absence of geographic factors that permit migration, and average technology wages. -Retention of H.S. graduates was predicted by the size of the state's workforce, absence of geographic factors permitting migration, percentage of in-state students, state income per-capita, and the percentage of the states workforce in the wholesale sector. -Migration of Recent degree holders was predicted best by the percentage of students staying in-state, gross state product, and the average cost of out-of-state public tuition. -Retention of most recent degrees were predicted by the size of the state workforce, and the absence of geographic factors that permit migration, the ratio of individuals that opt to stay at home to attend college, and state income per capita.

EMPIRICAL LITERATURE SUMMARY

The decision to migrate after graduation is complicated by a number of influential factors. After graduation from college, individuals who live in areas that do not provide job opportunities related to their degree must decide to either stay in that area and take a job that is unrelated to their degree, or move to an area that will provide relevant degree related opportunities. As we have seen, the decision to move can have profound effects on the economy of a given area. Understanding the individual level factors that influence this decision is very important to policy makers and many businesses looking to recruit key talent. In combination, the results of the articles reviewed in the previous sections shape the current research questions regarding individual level predictors of migration and retention for science and technology workers. In general, there were several variables that appeared to have a significant impact on the decision to migrate. The variables studied in the previous sections can be classified into *regional, organizational, and individual level* variable domains. The following section summarizes what is known and what is not known about migration and employment within these variable domains.

Regional Variables

There were several regional level variables examined in the previous sections that may impact the migration patterns of science and technology workers. Region level variables can be decomposed into three specific variable domains*, job market conditions, economic performance*, and *geographic characteristics.* Job market conditions at the regional level include employment and unemployment rates, average wages for technology workers and aggregate educational attainment. Economic performance variables include

gross state product, and state income per capita. Geographic characteristics include total population, climate, and distance between origin and destination locations. This section summarizes what is known and unknown about the specific domains of region level predictor variables.

Job market conditions are driven by supply and demand circumstances in the region. Tornatzky, et. al. (1998) found that total state employment was a significant predictor of net high school migration. Similarly, Greenwood (1973) found that regions with larger labor markets tended to have more people moving into those regions. Contradictory results were reported for the effects of unemployment such that regions with higher unemployment rates were found to have fewer people entering or leaving the region (Greenwood, 1969; 1973). The contradictory nature of these results may be due to the method in which unemployment was measured in the two studies. In the 1973 study, unemployment was measured as total unemployment for the region rather than as the specific rate of unemployment for college graduates. Intuitively, we would expect that higher rates of unemployment would create a surplus and decrease the demand for these workers. Future research should examine how the unemployment of college graduates in science and technology affects the mobility of the labor force in that region.

Supply and demand conditions are also realized in the average market value of a particular area. In accordance with the *economic theory of migration*, average wages for technology workers were found to be a significant predictor of the net migration of high school graduates such that the higher the average wage in a given region, the higher the average net gain would be in that area (Tornatzky, et., al, 1998). In general, Bartel (1979)

found that individuals who moved for a new job earned higher wages than did those who did not move.

Median educational attainment was found to influence the perception of supply and demand and ultimately influence one's decision to move. Greenwood (1969) found that the higher the median educational attainment in a given region, the less likely one would be to move there. On the basis of these findings, one could speculate that areas with higher levels of educational attainment appear as if they have a surplus of key talent and would therefore serve as a deterrent to people choosing to move there.

Economic performance variables serve as a measure of economic stability. Tornatzky, et., al, (1998) found that gross state product significantly predicted net migration gains of individuals earning their most recent degrees. Similarly, states with higher income per capita were found to retain more of their own graduates earning their most recent degree (Tornatzky, et. al., 1998). On the basis of these results, it appears that states with higher economic stability tend to attract and retain more individuals than states that have less economic stability. What is unclear is the magnitude with which individuals consider these variables in the decision making process when deciding to move to or stay in a given region or state.

Geographic characteristics at the region level were also found to affect mobility. In general, geographic variables cannot be affected by programmatic change, but can provide policy makers and organizations alike with valuable information. For example, if a region does not have geographic characteristics that are considered desirable (climate, resources, location, etc.), then state leader's and/ or organizations can offer other incentives that will attract people to their areas (e.g., tax breaks, higher wages, etc.). Total population of a given

region or state serves as a proxy variable for size. Total population was found to influence state retention of individuals earning their most recent degree (Tornatzky, et. al., 1998). Greenwood (1969) found that regions with better or more temperate climates had higher rates of people choosing to live there. Areas with more temperate climates are typically characterized by lower costs of living, and are therefore more appealing as a place to live. It is unclear what affects climate has on the migration decisions of graduates in today's warmer climates.

Many studies examined in the previous sections looked at the distance between the origin and destination locations. Distance appears to have a negative relation with one's decision to move such that the farther the destination, the less likely one is to move there (Greenwood,1969; DaVanzo, 1983; Fryman, 1988; Ellis, 1993). Regions with permeable borders (e.g., New Jersey, Maryland, DC, Virginia, etc.) tend to have higher rates of out migration than do states that have barriers to boarder penetration (Tornatzky, et. al., 1998). It is still unclear how distance affects an individual's decision to move. How far are people willing to go today? How is migration affected by the advancements in the telecommunication industry? Does the distance people are willing to travel differ by state?

Organization Level Variables

There were several organization level variables examined in the previous sections that may impact the migration patterns of science and technology workers. Organization level variables can be decomposed into two specific variable domains *work characteristics* and *institution level characteristics*. Work characteristics include job relatedness, importance of work, income, and field of degree. Institution characteristics include tuition, institution size,

commute distance, and out-of-state enrollment. The following section summarizes what is known and unknown about the specific domains of organization level predictor variables.

Work characteristics include factors that measure the type of work one does. Although graduates reported job characteristics (e.g., challenging work, relatedness to degree, prestige) as the number one reason for taking a job outside the state, they tended to value financial rewards more than job characteristics (Ballweg & Li, 1992). One explanation for this result would be that 'job characteristics' is a more socially desirable response than 'financial rewards'. Therefore, in accordance with the economic theory of migration, when asked what was most important to them, graduates tend to indicate financial rewards, but when asked specifically why they moved they indicated in the socially desirable direction (e.g., that job characteristics were their primary reason for moving). What is not known (and may never be known) is whether recent graduates genuinely believe that they are moving for job characteristics, but quickly learn that financial rewards are more salient. What is also not known is how individuals most efficiently obtain information about the job or the geographic region.

Studies show that defense related scientists and engineers were more likely to go where the jobs were rather than the other way around. Now that there is a de-emphasis on a defense related economy, it is unclear if this trend will appear among other fields of scientists and engineers (e.g., non-defense related life scientists, social scientists, chemical engineers etc.) in the state of the new economy. It is unclear whether individuals in certain degree fields are more or less mobile than are individuals in other degree fields. Further research should examine the role of mobility among fields of study.

In terms of *institution factors*, studies in the previous sections indicate that low academic tuition (Fryman, 1988; & Tornatzky, 1998), and high educational capacity (or large departments) (Finn, et. al., 1995) tends to attract individuals to them. This is important because policy makers can affect tuition and capacity levels in order to attract the type of quality talent that is desired. Further research will provide a better understanding of other variables that impact one's decision to move. Fryman (1988) found that students typically traveled less than 50 miles from the state border to attend college, even if that institution was located across the states' border. Fryman (1988) also found that individuals gravitated towards academic institutions outside the state that had high numbers of out of state students in attendance.

Individual Level Variables

There were several individual level variables examined in the previous sections that may impact the migration patterns of science and technology workers. Individual level variables can be decomposed into two specific variable domains, individual *characteristics and community embeddedness*. Individual characteristics include age, race, gender, and education level. Factors of embeddedness include the number of years in the home residence, marital status, number of school age children, job tenure, dual career status, and foreign national status.

Individual characteristics include factors that identify an individual. In general, younger individuals were found to be more mobile than their older counter parts (Bartel 1979; DaVanzo, 1983). Although younger individuals have been more mobile in the past, it is unclear what affect age will have on the mobility of the current workforce. Baby boomers have represented a large portion of the workforce for the last several decades, and as they

age, will they keep pace with the mobile job market standards that they help put in place? Similarly, an individual who moves once is more likely to move again at some point in the future (DaVanzo, 1983). Most studies focus on migration as a onetime event. However, the magnitude of this relationship is still unclear. Does migration for educational purposes predispose one to future moves? What effects do age and time between moves have on the likelihood of future movement?

Greenwood (1973) found that white individuals were more mobile than their black counter parts. It would be interesting to note the mobility differences between races in today's labor force. Greenwood's study was done in the late 1960s during the civil rights movement, and only examined the differences in black and white individuals. The current workforce is much more diverse and yet little is known about the mobility of different races. More research needs to be done in order to understand factors that predict mobility of individuals within the various racial groups.

Gender is another individual characteristic that should be examined. Historically, men have been the 'bread winners' of the family and women where consistently expected to follow their husbands careers. While Green (1997) examined the mobility of dual career households, he did not examine the specific affects that gender had on mobility. Bartel (1979) examined the mobility of men across the life span, but did not examine these effects for women. This is a serious deficit in the empirical literature. It is unclear if there are differences in individual mobility patterns among men and women. One could speculate that women have traditionally taken fewer risks, and have therefore been less willing to move, but to date, there is no empirical evidence supporting this claim. As the nature of the workforce is changing and women, older workers, minorities, and foreign nationals are becoming more

prominent stakeholders it is increasingly important to understand the affects that these individual level characteristics have on the mobility of the ensuing workforce.

The notion of *embeddedness* also emerged as an important factor in the migration decision. Age, marital status, dual career status, the number of school age children, home ownership, length of time at the current residence and job tenure have been used as measures of embeddedness. On the basis of the literature presented in the previous sections, it appears the more ties one has to a particular area, the less likely they will be to leave that area. Davanzo (1993) examined these affects and concluded that individuals who were more embedded in their community (e.g., own a home, etc.) were less likely to move. Similarly, Bartel (1979) found that men who where head of household, with longer job tenure, and who had lived in the same place of residence for longer periods of time were less likely to move. Finn, et. al., (1995) found that foreign nationals who were married, and had school aged children were also less likely to move. Understanding the factors that influence ones' decision to move can have significant impacts on the competitive advantage of the new economy in this country. It is still unclear how measures of embeddedness would fare in today's workforce. What is the magnitude of the negative relationship between community ties and mobility? Do people have as many ties to their community today as they have in the past? What other ties (if any) affect the factor of community embeddedness?

As we have seen, there are many variables that affect the potential workforce. The decision to move can have profound effects on the economy of a given area, and understanding the individual level factors that influence this decision is very important to many policy makers and businesses looking to recruit key talent from across the country. In combination, the results of the articles reviewed in the previous sections have shaped the

followed research questions regarding individual level predictors of migration for science and technology workers. The next section details the methodology of the present study.

METHODOLOGY

Research Purpose

The preceding review indicates a clear deficit in the empirical literature with regard to individual level factors that predict state level retention of recent college graduates in science and technology fields. The current research serves as a natural extension of the recent research conducted by Tornatzky, Gray, Tarant, and Howe (1998). Tornatzky, et. al., utilized survey data collected by the National Science Foundation in 1993 to examine migration and retention rates for U.S. states. From the obtained database, the authors developed state-level estimates of retention and migration for science and engineering trained personnel. The results of that study provide important insight into the recent policy debate regarding the current brain drain phenomenon. While that report provided valuable insight into the ability of states to attract and keep their high school and college graduates, it is clear that further investigation of individual level factors is needed. Examination of individual level predictors will be useful in our quest to understand the specific circumstances that predict the movement and retention of key science and technology graduates in the new knowledge-based economy. This information will also benefit organizations in the private sector by allowing them to utilize this information to develop competitive recruiting and retention strategies. The purpose of the current research study was to examine the following research questions:

Research Question 1a: Do the following demographic characteristics predict retention/ high school and most recent degree at the bivariate level; age, race, gender, and stayers? 1b: Does citizenship predict retention/ most recent degree?

Research Question 2: In combination, do the following demographic characteristics predict retention/ high school and most recent degree at the domain level; age, race, gender, stayers, and citizenship?

Research Question 3: Do the following educational characteristics predict retention/ high school and most recent degree at the bivariate level; undergraduate GPA, number of degrees earned, level of degree earned, or college major?

Research Question 4: In combination, do the following educational characteristics predict retention/ high school and most recent degree at the domain level; undergraduate GPA, number of degrees earned,. Level of degree earned, and college major?

Research Question 5: Do the following social and financial characteristics predict retention/ high school and most recent degree at the bivariate level; annual salary, community embeddedness; professional sophistication; source of financial assistance?

Research Question 6: In combination do the following social and financial characteristics predict retention/ high school and most recent degree at the domain level; annual salary, community embeddedness; professional sophistication; source of financial assistance?

Research Question 7: In combination do the domain level variables predict high school retention at the multivariate level; age, race, gender, stayers, undergraduate GPA, number of degrees earned, level of degree earned, college major, annual salary, community embeddedness; professional sophistication; and source of financial assistance?

Research Question 8: In combination do the domain level variables predict most recent degree retention at the multivariate level; age, race, gender, stayers, citizenship, undergraduate GPA, number of degrees earned, level of degree earned, college major, annual salary, community embeddedness; professional sophistication; and source of financial assistance?

National Survey of Recent College Graduates

The National Survey of Recent College Graduates (NSRCG) is an on-going project that has been sponsored and maintained by the National Science Foundation since 1993. The NSRCG is a survey of science and engineering degree recipients who received bachelors or master's degrees from U.S. institutions of higher education. The survey was designed to provide data on four fundamental aspects of recent degree recipients entering the science and engineering labor market including educational characteristics, employment characteristics, various work-related information, and individual demographic information. The primary goal of the NSRCG was to create a comprehensive database regarding the future generation of scientists and engineers. The 1997 version of the NSRCG was used in this study.

Survey Sampling

Extensive sampling procedures produced an initial sample of 275 colleges and universities and 14,057 recent graduates across the United States and its surrounding territories. Of these, 1,032 respondents were ineligible. The final sample of eligible respondents that completed the survey consisted of 274 institutions and was made up of 10,452 recent graduates (response rate 82%). The survey sampled respondents with degrees in computer and math sciences, life sciences, physical sciences, social sciences, and engineering. Data weighting procedures accounted for unequal selection probabilities and non-response rates at both the individual and institutional level. These procedures produced a representative sample from which conclusions about the general population of recent graduates in science and engineering can be inferred.

Probability Sampling Procedures

The NSRCG design was based on a two-stage sample. Westat, Inc., was the outside vendor that NSF contracted to conduct the survey. The first stage involved the selection of institutions and the second stage involved the selection of individual's within institutions. First, colleges and universities offering bachelors and master's degrees in science and engineering were stratified and subsequently sampled proportional to size. The second stage was a little more complex. Individuals within each institution were selected proportional to institutional size based on the type of degree they received, the year they received it, and their specific field of study.

Stage 1. Educational institutions were sampled with a probability-proportional-to-size. Specifically**,** 102 large institutions offering bachelors and master's degrees in science and engineering from across the nation were sampled with a probability of one, and 173

smaller institutions offering relatively rare major specialties were sampled with a probability-proportional-to-size. In addition, universities with a higher proportion of Hispanics, African Americans and foreign students were over-sampled. Thus, consistent with the survey's goals, large and small institutions for all major fields of interest within the science and engineering domain were sampled. Sampled institutions were asked to provide a roster of graduates who received S&E bachelors or master's degrees from their institutions between July 1994 and June 1996.

Stage 2. Recent graduates were then sampled within the representative sample of institutions. Graduates were classified according to their major field of study and their type of degree. Westat, Inc., took precautions to ensure that all recent graduates included in the survey received a bachelor's or master's degree from the institution from which they were sampled, that the received degree was awarded within the time period (year) from which they were sampled, that they were under the age of 76, and were living in the United States during the survey target week (April 15th, 1997). Graduates were then assigned a respondent sampling rate. Respondent sampling rates were determined by dividing the overall sampling rate for the major fields by the institution's probability of selection. This selection process ensured that the final sample would contain respondents from all institutions sampled, in all major fields of interest, for both bachelors and master's degree recipients during the survey timeframe.

Data Collection

After obtaining the list of graduates to be surveyed, Westat went through lengthy procedures to find these graduates. Graduates were located using information provided by school registrars, change of address services, and U.S. postal service change of address

services, post office verification, referrals, and alumni office information. A computer telephone-number look-up service that provides phone numbers based on name and address information was used to obtain respondent phone numbers. Graduates were primarily surveyed using computer aided telephone interviews (CATI). The overall response rate was 82% (n=10,452). Of the 10,452 total respondents, 97% responded by CATI, and 3% responded by mail.

Data collection was conducted from may through November 1997. The CATI system was very time efficient as it automatically guided interviewers through many complex "skip patterns" reducing the potential for interviewer error. Interviewers underwent a total of 16 hours of training. To obtain maximum response rates, no limit was imposed on the number of contact attempts interviewers could make. Messages were left on answering machines for difficult to reach respondents, asking them to call a toll free number. Hard copies were also mailed to hard to reach respondents.

Data Weighting Procedures

In addition to the careful sampling of institutions and individuals within institutions that was conducted prior to data collection, individual weights were developed to accommodate unequal selection probabilities, non-response rates and the possibility of being sampled twice if respondents received both bachelors and master's degrees. In other words, in some instances an individual's responses were "counted" only once while in other instances (in more rare major fields) were "counted" more than once. So for example, if a respondent had a particularly rare degree, or if there was something else special about that type of respondent then that respondent's responses would be given more weight in the data

than a respondent who received a more common degree from a larger institution. Weighting adjustments were also made to account for non-response.

Study Population

The current research utilized data collected in the 1997 NSRCG Survey. Variables relevant to the movement and retention of recent graduates were extracted from the larger NSRCG database to create a smaller data set. The national NSRCG sample was refined to include only the 7,910 respondents that were employed for profit full or part time during the reference week (April 15th, 1997). Although the NSRCG:97 sampling frame was intended for recent graduates who received either a bachelor's or master's degree during the target period, the two-year time frame actually allowed a small number of respondents to complete an advanced degree (doctoral or other professional). To maintain homogeneity of the analysis population, respondents who indicated receiving a doctoral or other professional degree as their most recent degree were eliminated from the sample. Respondents who reported receiving their most recent degree from an institution or country outside the U.S., those who received a non-science or engineering degree, or were missing grade-point-average data were also removed from the analysis. The final sample for the current analysis included 7,741 employed NSRCG:97 respondents. Further examination of the database revealed that of the 7,741 respondents, only 6,963 attended a high school located in one of the 50 U.S. states Washington D.C., or Puerto Rico and were therefore appropriate for a measure of high school state retention. Therefore, dependent measures of retention at the high school level include only the 6,963 respondents who completed a high school degree in the U.S. while retention measures at the university level will include the total sample (n=7,741).

Table 2. Summary of Analysis Variables

VARIABLES CATEGORIZED BY VARIABLE DOMAIN	VARIABLE DESCRIPTIONS
Retention	
High School Degree	Derived dichotomous variable (working or not working in the state where the respondent received their high school degree). Respondents working in the same state in which they received their high school degree will be considered "retained".
Most Recent Degree	Derived dichotomous variable (working or not working in the state where the respondent received their most recent degree). Respondents working in the same state in which they received their most recent degree will be considered "retained".
Individual Characteristics	
Age	Respondents age at time of survey (5 yr increments)
Race	Self reported race (Hispanic, White, Black, Asian, Native American)
Gender	Self reported gender (Male or Female)
Stayer	Dichotomous variable (whether or not the respondent went to college in the same state in which they received their high school degree). Those who attended college in same state they attended high school will be considered "stayer" all others labeled "leaver"
Citizenship	U.S. citizen, U.S. permanent resident, U.S. temporary resident
Social & Financial Influences	
Salary	Self reported annual salary in 10k increments
Community Embeddedness	Embeddedness measured as a composite index. Respondents receive one point for each of the following indicators: being married, dual earning household, and if they have a school age child living in their household
Professional Sophistication	
Professional Meetings	The number of professional national or international society meetings respondents reported attending in the last year
Professional Memberships	The number of national or international professional society memberships respondents reported current membership in the last year.
Financial Support	
Assistantships / Work Study	Self-report dichotomous item. 'Yes' received or 'No' not received
Employer Assistance	Self-report dichotomous item. 'Yes' received or 'No' not received
Earnings from Employment	Self-report dichotomous item. 'Yes' received or 'No' not received
Gifts Parents/ Relatives	Self-report dichotomous item. 'Yes' received or 'No' not received
Tuition Waiver/ Grants/ Scholarships	Self-report dichotomous item. 'Yes' received or 'No' not received
Interest bearing loans School/ Bank/ Government	Self-report dichotomous item. 'Yes' received or 'No' not received
Education	
Overall GPA	Self report overall grade point average on a 4- point scale.
Number of degrees at Bachelor's and higher	Self reported total number of academic degrees attained at the bachelor's level and above
Highest degree attained	Self reported highest degree attained (Bachelor's or Master's)
College Major	Engineering, Computer/ Math Science, Life Science; Physical Science; Social Science

Dependent Variables:

Retention The NSRCG database affords the ability to look at two different measures of retention. Retention can be evaluated both at the high school level and the college/university level by comparing the state in which an individual lived while completing an academic degree (either high school or most recent college degree) and the state in which they were employed during the target week of the NSRCG:97 survey. Retention was measured based on responses to "In what state or foreign country did you last attend high school", "From which college/ university did you receive your most recent degree (list state/ foreign country)", and "Who was your principle employer during the week of April 15th, 1997 (list state/ foreign country)".

Responses to survey items regarding state of high school and state of employment were compared and high school retention was measured as a dichotomous variable (working or not working during the target week in the state where the respondent received their high school degree). Respondents who reported working in the same state in which they received their high school degree were considered "retained". High School Retention was coded "1" for retained and "0" for not retained.

Similarly, responses to survey items regarding state of college and state of employment were compared and retention of respondents earning their most recent college degree was measured as a dichotomous variable (working or not working in the state where the respondent received their most recent degree). Respondents who reported working in the same state in which they received their most recent college degree were considered "retained". Retention for Most Recent Degree was coded "1" for retained and "0" for not retained.

Independent Variables

Demographic Characteristics. : Demographic characteristics included in the present study include respondent age, gender, race (Caucasian, African American, Hispanic, Asian, Native American), citizenship (U.S. citizen, permanent resident, temporary resident), and whether or not they crossed state lines for college (stayer, leaver). All variables except whether they crossed state lines for college were self-report (see appendix a for individual items).

The variable "stayers" represents related but distinct variables for each outcome measure. For retention of high school graduates, stayers was defined as individuals who attended college in the same state they attended high school, and leavers were those who left the state and attended college in a different state than they attended high school. Stayers at the most recent degree level were also defined by individuals who attended college in the same state they attended high school, and arrivers were defined as individuals who attended high school in another state but attended college in the focal state. The stayers variable was a dichotomous variable based on responses to *"in what state or foreign country did you last attend high school", and "from which college/ university did you receive your most recent degree (list state/ foreign country)"*. The stayers variable was coded as "1" for stayers and "0" for leavers/ arrivers.

Social and Financial Influences. Social and Financial characteristics examined in the present study include degree of community embeddedness (range 0-3), level of professional sophistication (range 0-2), annual salary ($10,000 increments), and type of financial assistance received (Employer, Repayable Loans, Non-repayable Grants/ Scholarships, Monies Earned from work, Other).

The concept of *Community Embeddedness* reflects variables that indicate the number of ties one has to the community. Research has shown that in general the more ties one has to the area in which they live, the more difficult and hence, less likely it would be for them to pick up and relocate (see Davanzo, 1993). For the purposes of the present study, ties to the community include being married, having a spouse working for pay, and having school aged children in the home. Embeddedness was measured as a rationally derived composite index based on responses to *"As of the week of April 15th, 1997 were you (1=Married, 0=Widowed,0=Separated, 0=Divorced, 0=Never Married)", "During the week of April 15th, 1997 was your spouse working for pay (or profit) at a full-time or part-time job (1=Yes, 0=No)", and "During the week of April 15th, 1997 did you have any school aged children(0-18 years old) living with you as part of your family (1=Yes, 0=No)".* Each of the three survey items were converted to a dichotomous variable where "1" represented the presence of the tie and "0" represented the absence of the tie. The ties were added together to derive an index of community embeddedness. Responses could range from "0" (indicating the absence of any ties) to "3" (indicating the presence of all three ties).

Research has also shown that individuals who have more access to better and greater amounts of information about opportunities and locations outside of their current location are more likely to actually move (Greenwood, 1969; Bartel, 1979). Professional Sophistication was measured as a rationally derived composite index based on responses to *"During the past year, did you attend any professional society or association meetings or conferences? Please include regional, national, or international. (1=Yes, 0=No)", and "To how many national or international professional societies do you currently belong? (List number)".* The number of memberships item was converted to a dichotomous variable where "1"

represented membership in at least one professional society and "0" represented having no professional memberships. The items were added together to derive an index of Professional Sophistication. Responses could range from "0" (indicating the absence of any professional ties) to "2" (indicating the presence of both professional ties).

As we have seen, research suggests that individuals who move for employment related reasons have greater financial gains (i.e., make more money) than do those who do not (see Bartel, 1979). Respondents were asked *"Before deductions, what was your basic annual salary on your primary job as of the week of April 15th, 1997? Do not include bonuses, overtime, or additional compensation for summertime teaching or research"*. Annual salary was coded in increments of $10,000.

Related to annual income is level of financial need. While the NSRCG did not include an objective measure of financial need, it did include data on sources of financial aid. Variables that refer to the specific sources of financial support are based on responses to the survey item that asks *"From which of the following sources, if any, did you receive financial support for your most recent degree- mark all that apply? (Support from relatives not to be repaid; Repayable loans from school, bank, government; Employer; Tuition waivers or grants; Assistantships/work study; Earnings from employment; Other)"*. Respondents were asked to indicate any source of assistance received. Categories were not mutually exclusive therefore, respondents could select as many as applied. Reponses to this item were collapsed and recoded to create separate dummy variables for each type of financial assistance. Collapsed categories include assistance from Employer, Repayable loans, Non-repayable loans/grants, Earned from work, and Other. Dummy variables were coded "1" if the respondent received that type of assistance and "0" did not receive that type of assistance.

To date, research has not examined the impacts that type of financial support has on the mobility of college graduates in S&E.

Education. Research has shown that in general, individuals with higher levels of education have greater access to more sources and more accurate information, are in higher demand, and are more mobile than their less educated counterparts (Bartel, 1979). Educational characteristics examined in this study include self-reported *overall undergraduate grade-point-average (on a four point scale), self-reported number of degrees achieved (bachelors and above), the level of degree attained (bachelor's, master's); and college major.*

Overall undergraduate grade point average was self-reported using a 4-point scale in half point increments. *"Using a 4-point scale, what was your overall undergraduate grade point average?"* (Mostly A's (range 3.75-4.0); About half A-half B (range 3.25-3.74); Mostly B's (range 2.75-3.24); About half B- half C (range 2.25-2.74); and Mostly C's (range less than 2.0).

Respondents were asked to report the number of college degrees they had earned. The variable used to measure number of degrees was based on responses to the survey item that asks, *"How many college or university degrees do you have at the bachelor's level or higher?"*. Level of degree was based on the survey item, *"What type of degree did you receive (as your most recent degree)? (Bachelor's; Master's; Doctorate; Other Professional; Other)"*. To maintain consistency in the target population, only respondents indicating a bachelors or masters as their most recent degree were examined. Respondents who indicated receiving a doctoral, other professional, or other degree as their most recent degree were not included in the analysis.

Variables assessing college major were based on responses to, *"Using the education codes listed on survey page 18-19, select the relevant degree field codes(s) and titles(s)" (see appendix A).* Respondents indicated their specific major and all fields reported were later collapsed and classified into one of five broad categories (Computer and Math Sciences; Life and Related Sciences; Physical Sciences; Social Sciences; Engineering).

Analysis Methods

In order to test the relationship between individual characteristics and state retention, a multivariate analysis model using logistic regression was employed. Logistic regression is a form of multivariate analysis that was specifically designed for use with discrete dependent measures. Logistic regression provides more flexibility and is more appropriate to use with nominal dependent variables than other multivariate techniques. Logistic procedures allow us to predict the log-odds of falling into one rather than the other category, and logistic procedures make no assumptions about the distribution of the independent variables included in the model. Unlike other types of multiple regression, the logistic method uses chi square statistics to evaluate model fit (Tabachnick & Fidell, 1996).

Selecting one level of the variable to be the baseline and comparing the other levels to it using logistic regression tested Polytomous variables. Multiple comparisons across levels were hand calculated and tested for significance with the t-statistic. Effect size was determined by calculating the odds ratio for each comparison across levels of a polytomous variable.

There are two primary indices used to interpret logistic models, the odds ratio and the analog R^2. An odds ratio is a statistic that indicates the size and direction of the effect of an individual predictor on the dependent measure. Odds ratios are interpreted relative to 1.0.

An odds ratio of 1.0 would indicate the predictor has no effect on the outcome variable. An odds ratio above one indicates that every unit change in the predictor increases the odds of retention by that amount. For example, an odds ratio of 2.0 indicates that for every unit change in the predictor, the odds of being retained increases two times. An odds ratio below one indicates that every unit change in the predictor decreases the odds of retention. Therefore, an odds ratio of .50 indicates that every unit change in the predictor decreases the odds of being retained by half. The other statistic that is helpful to interpret logistic models is the analog R^2. Analog R^2 is a proportional measure of error reduction and can range from zero to one. An analog R^2 of .25 indicates that in combination, the predictor variables entered into the model proportionally reduce the error in predicting the log odds by approximately 25 percent.

RESULTS

This section provides an overview of the descriptive statistics, and the results of the predictive bivariate, domain, and multivariate logistic regression analyses. As previously stated, the focus of the present study was to identify individual characteristics that influence state level retention of recent college graduates in science and engineering. The following variables were examined in the current analysis: *age, gender, race, citizenship, stayers, type of financial assistance received, annual salary, degree of community embeddedness, level of professional sophistication, undergraduate GPA, number of post-secondary degrees, level of post-secondary degree, and field of college major.* See Table 2 for a Summary of Analysis Variables.

DESCRIPTIVE STATISTICS BY VARIABLE DOMAIN

Since the high school sample is only a slightly smaller subset of the total study population, all descriptive statistics will refer to the total college sample (n=7,741) *see table 3*. Information regarding high school versus total sample populations is included in the Methods section on Study Population. There were no statistical differences between the two samples.

Table 3.
Summary of Descriptive Statistics

	High School (n=6,963)				**Most Recent Degree (7,741)**			
	N	%	Mean	SD	N	%	Mean	SD
Individual Characteristics								
Age	**6,963**	100%	27.91	5.981	**7,741**	100%	28.21	6.03
Stayer	4,443	64%	-	-	4,443	57%	-	-
Leavers	2,520	36%	-	-	3,298	43%	-	-
Gender	**6,963**	100%	-	-	**7,741**	100%	-	-
Male	4,206	60%	-	-	4,754	61%	-	-
Female	2,520	36%	-	-	2,987	39%	-	-
Race	**6,963**	100%	-	-	**7,741**	100%	-	-
Caucasian	4,958	71%	-	-	5,131	66%	-	-
Hispanic	721	10%	-	-	805	10%	-	-
African American	806	12%	-	-	899	12%	-	-
Asian	390	6%	-	-	816	11%	-	-
Native American	88	1%	-	-	90	1%	-	-
Citizenship	**6,963**	100%	-	-	**7,741**	100%	-	-
US Citizen	6,842	98%	-	-	7,065	91%	-	-
Permanent Resident	110	2%	-	-	313	4%	-	-
Temporary Resident	11	0%	-	-	363	5%	-	-
Educational Characteristics								
Undergraduate GPA	**6,963**	100%	3.17	0.41	**7,741**	100%	3.20	0.41
Number of Degree's	**6,963**	100%	1.29	0.51	**7,741**	100%	1.35	0.55
Major	**6,963**	100%	-	-	**7,741**	100%	-	-
Engineering Major	2,312	33%	-	-	2,679	35%	-	-
Computer & Math Major	744	11%	-	-	957	12%	-	-
Life Science Major	919	13%	-	-	956	12%	-	-
Physical Science Major	754	11%	-	-	818	11%	-	-
Social Science Major	2,234	32%	-	-	2,331	30%	-	-
Level of Degree	**6,963**	100%	-	-	**7,741**	100%	-	-
Bachelors	5,227	75%	-	-	5,487	71%	-	-
Masters	1,736	25%	-	-	2,254	29%	-	-
Social & Financial Characteristics								
Salary (10k)	**6,963**	100%	32,295	15,915	**7,741**	100%	33,144	16,184
Embedded	**6,963**	100%	0.67	1.01	**7,741**	100%	0.71	1.02
Professional Sophistication	**6,963**	100%	0.85	0.82	**7,741**	100%	0.85	0.83
Financial Assistance	**6,963**	100%	-	-	**7,741**	100%	-	-
Employer Assistance	1,065	15%	-	-	1,207	16%	-	-
Repayable Loans	3,664	53%	-	-	3,935	51%	-	-
Non-repayable Grants	5,741	82%	-	-	6,344	82%	-	-
Money Earned Working	5,268	76%	-	-	5,881	76%	-	-
Other Sources	115	2%	-	-	133	2%	-	-

Retention

Respondents who reported working in the same state in which they received their degree, either high school or college, were considered retained by the state. Of the eligible high school population, 57% (n=3,957) reported working in the same state in which they received their high school degree and were considered retained, while 43% (n=3,006) were not retained. Of the most recent degree population, 62% (n=4,801) reported working in the state in which they received their most recent degree and were considered retained, while only 38% (n=2,940) were not retained.

Demographic Characteristics

Demographic characteristics included in the analyses were *respondent age, gender, race, citizenship, and stayers.* Of the 7,741 respondents, the average age of respondents included in the study was 28. The majority were male 61% (n=4,754). Not surprisingly, 91% were U.S. citizens (n=7,065)(either native born or naturalized), while only 4% were Non-U.S. citizens-Permanent resident (n=313) and 5% were Non-U.S. citizens-Temporary residents (n=363). When asked about racial background, 66% self-identified themselves as Caucasian (n=5,1331), 12% African American (n=899), 11% Asian (n=816), 10% Hispanic (n=805), and 1% Native American (n=90). The majority of respondents 57% (4,443) were considered Stayers by staying in-state for college, while leavers/ arrivers who crossed state lines for college made up 43% (n=3,298) of the total study population.

Social and Financial Influences

Social and Financial characteristics included in the analyses were degree of community embeddedness, level of professional sophistication, annual salary, and type of financial assistance received. Embeddedness was measured by the number of ties one had to

their community. Of the 7,741 survey respondents, the majority 63% (n=4,910) had no ties to the community (not married, no spouse working for pay, and no children in the home); 9% (n=695) reported having one tie, 20% (n=1,559) reported having at least 2 ties, and only 7% (n=577) reported having all three ties.

Professional Sophistication was measured as a composite index of professional society memberships and meeting attendance within the last year. Professional sophistication could range from zero to two. Of the total study population, the majority 42% (n=3,290) reported having no professional ties (did not attended professional meeting and did not claim membership in any professional organization), 30% (n=2,307) reported at least one professional tie, and 28% (n=2,144) reported both attending a professional meeting and membership in at least one professional society or organization.

Annual salary was measured in increments of $10,000. Annual salary ranged from less than $10,000 to $298,000 with an average annual salary of $33,144. Multiple response variables that indicate sources of financial assistance included, Employer Assistance 16% (n=1,207), Non-Repayable monies such as parent/ family support, scholarships and grants 82% (n=6,344), or Interest Bearing Loans such as those from a bank, parent, or relative 51% (n=3,935), or money earned from Work 76% (n=5,881). To date, research has not examined the impacts of financial support on the mobility of college graduates in S&E.

Education

Educational characteristics included in the analyses were self-reported *overall undergraduate grade-point-average (on a four point scale), self-reported number of degrees achieved (bachelors and above), the level of degree attained (bachelor's, master's); and*

college major (Computer and Math Sciences; Life and Related Sciences; Physical Sciences; Social Sciences; and Engineering).

Overall undergraduate grade point average was measured on a 4-point scale in increments of a half point. Of the total study population, 12% (n=907) reported mostly A's (GPA range 3.75-4.0); 33% (n=2,589) about half A-half B (GPA range 3.25-3.74); 42% (n=3,234) mostly B's (GPA range 2.75-3.24); 12% (n=895) about half B- half C (GPA range 2.25-2.74); and 1% (n=116) Mostly C's (GPA range less than 2.0).

Respondents were asked to report the number of college or university degrees they earned at the bachelor's level or higher. Sixty-eight percent (n=5,302) earned one degree; 28% (n=2,171) earned 2 degrees, 3% (n=248) earned 3 degrees; and less than 1% (n=20) earned 4 degrees.

Of the total study population, 71% (n=5,487) of respondents reported their highest degree to be a Bachelor's and 29% (n=2,254) reported their highest degree was a Master's. Respondents indicated their specific major and all fields reported were collapsed and classified into one of five overall major fields: Engineering 35% (n=2,679), Social Sciences 30% (n=2,331), Computer and Math Sciences 12% (n=957), Life and Related Sciences 12% (n=956), and Physical Sciences 11% (n=818).

Analysis Strategy

The statistical analysis followed a three-stage approach using logistic regression. In the first stage, all predictor variables were subjected to individual bivariate analysis with each of the dependent measures. All significant predictors were then grouped by variable domain and these predictions were tested. Finally, in the third stage, all variables significant at the domain level were combined and included in the full model for multivariate analysis.

Because the ultimate goal of the present study was to produce a multivariate model of retention the results will highlight significant variables and the direction of the effect at the bivariate and domain level, and a more detailed interpretation of the odds ratios will be held for the final multivariate analysis. As large samples can influence tests of statistical significance a conservative 'p' level of $p < .001$ was utilized.

BIVARIATE ANALYSIS

Retention of High School Graduates

Bivariate relationships between twelve individual predictor variables and retention/ high school were examined (see Table 4). Results of this analysis found ten of the twelve variables to be significant predictors of retention at the high school level while only two variables failed to predict. Age and community embeddedness failed to predict retention at the high school level and they were dropped from subsequent analyses. Of the ten significant predictors, only stayers/ leavers was hypothesized to have a positive relationship with retention/ high school and this relationship was supported at the bivariate level. Support was found for six variables hypothesized to have a negative relationship with retention; gender, GPA, number of degrees, level of degree, annual salary, and professional sophistication. Support was also found for three polytomous variables hypothesized to have a significant relationship with retention; race, major, and financial assistance. All significant relationships supported the hypothesized direction.

Table 4.
Summary of Bivariate Logistic Relationships with State Retention

High School (n=6,963)

	Coefficient	Odds ratio	X^2	df
Individual Characteristics				
Age	-0.00606	0.994	2.25	1
Stayer	2.3605	10.596**	1907.39	1
Gender (Males vs Females)	-0.2169	0.805**	19.1	1
Race (Caucasian Reference)	-	**	101.69	4
Hispanic vs Caucasian	-	2.282**	-	-
Black vs Caucasian	-	1.11	-	-
Asian vs Caucasian	-	1.440**	-	-
Native American vs Caucasian	-	1.353	-	-
Educational Characteristics				
GPA	-0.2117	0.809**	58.9	1
Number of Degree's	-0.4928	0.611**	109.08	1
Major (Engineering Reference)	-	**	123.74	4
Computer & Math vs Engineering	-	1.574**	-	-
Life Sciences vs Engineering	-	1.842**	-	-
Physical Sciences vs Engineering	-	1.139	-	-
Social Science vs Engineering	-	1.789**	-	-
Level of Degree (Masters vs Bachelors)	-0.6384	0.528**	-	-
Social & Financial Characteristics				
Salary (10k)	-0.1555	0.856**	96.72	1
Embedded	-0.00243	0.998	0.0102	1
Professional Sophistication	-0.1044	0.901**	12.64	1
Financial Assistance (Employer Assistance)	-	**	22.13	4
Repayable Loans vs Employer Asst.	-	1.183**	-	-
Non-repayable Grants vs Employer Asst.	-	1.128*	-	-
Money Earned Working vs Employer Asst.	-	1.086	-	-
Other Source vs Employer Asst.	-	1.064	-	-

*** p<.01 **p<.001**

Retention of Most Recent Degree

Bivariate relationships between thirteen individual predictor variables and retention/ most recent degree were examined (see Table 5). Results indicate that twelve of the thirteen variables were significant predictors of retention of most recent degree recipients, while only one failed to predict at the bivariate level. Professional sophistication failed to predict retention and was dropped from subsequent analyses. Of the twelve significant predictors, three were found to have a positive relationship with retention/ most recent degree; age, stayers/ arrivers, and embeddedness. Support was found for five variables hypothesized to

have a negative relationship with retention/ most recent degree; gender, GPA, number of degrees, level of degree, and annual salary. Support was also found for four polytomous variables hypothesized to have a significant relationship with retention/ most recent degree; race, citizenship, major, and financial assistance. All significant relationships supported the hypothesized direction.

Table 5.
Summary of Bivariate Logistic Relationships with State Retention

Most Recent Degree (7,741)

	Coefficie	Odds ratio	X^2	df
Individual Characteristics				
Age	0.055	1.057**	165.6	1
Stayer	1.4277	4.169**	872.92	1
Gender (Males vs Females)	-0.2131	0.808**	19.44	1
Race (Caucasian Reference)	-	**	77.36	4
Hispanic vs Caucasian	-	1.937**	-	-
Black vs Caucasian	-	0.965	-	-
Asian vs Caucasian	-	0.884	-	-
Native American vs Caucasian	-	1.773*	-	-
Citizen (US Citizen Reference)	-	**	24.64	2
Permanent Resident vs US Citizen	-	1.393**	-	-
Temporary Resident vs US Citizen	-	0.645**	-	-
Educational Characteristics				
GPA	-0.0989	0.906**	14.2	1
Number of Degree's	-0.096	0.908**	5.22	1
Major (Engineering Reference)	-	**	101.82	4
Computer & Math vs Engineering	-	1.490**	-	-
Life Sciences vs Engineering	-	1.551**	-	-
Physical Sciences vs Engineering	-	1.203	-	-
Social Science vs Engineering	-	1.746**	-	-
Level of Degree (Masters vs Bachelors)	-0.145	.865**	7.98	1
Social & Financial Characteristics				
Salary (10k)	-0.118	0.889**	65.27	1
Embedded	0.1655	1.180**	50.73	1
Professional Sophistication	0.0183	1.019	0.41	1
Financial Assistance (Employer Assistance)	-	**	35.43	4
Repayable Loans vs Employer Asst.	-	0.993	-	-
Non-repayable Grants vs Employer Asst.	-	0.717**	-	-
Money Earned Working vs Employer Asst.	-	1.153**	-	-
Other Source vs Employer Asst.	-	1.122	-	-

***p<.01 ** p<.001**

DOMAIN LEVEL ANALYSIS

In the second stage of analysis, significant variables at the bivariate level were grouped by domain and multivariate relationships were examined for each domain (see Tables 6 and 7). All non-significant predictors at the bivariate level were dropped from domain level analyses.

Retention of High School Graduates

Demographic Characteristics: Of the three demographic variables tested for retention/ high school, all three remained significant at the domain level (see Table 6). The variables examined in this analysis included stayers/ leavers, gender, and race. The direction of the effects was consistent with bivariate effects. The overall model for the domain of demographic characteristics at the high school level was significant (X^2 =1969.71, df= 6, p< .0001). In combination, demographic characteristics were subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 26.08. Therefore, knowing respondents demographic information reduces the error in predicting retention/ high school level by 26%.

Educational Characteristics: Of the four educational variables tested, three were found to be significant and only one failed to predict retention/ high school (see Table 6). Number of degrees failed to predict and was therefore dropped from further high school analyses. Significant predictors included undergraduate GPA, level of degree, and college major. The direction of the effects was consistent with bivariate effects. The overall model for the domain of educational characteristics at the high school level was significant (X^2 =282.15, df= 7, p< .0001). In combination, educational characteristics were subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model

was 3.05. Therefore, the model is said to reduce the error in predicting state retention at the high school level by 3% from knowing information about the respondent's educational history.

Table 6.
Summary of Domain Logistic Relationships with State Retention

High School (n=6,963)		Coefficient	Domain Odds ratio	X^2	df
Individual Characteristics	***(Domain R^2= 26.08%)***			**1969.71**	**6**
Stayer		2.346	10.440**	-	-
Gender (Males vs Females)		-0.262	0.770**	-	-
Race (Caucasian Reference)			**	-	-
Hispanic vs Caucasian		0.582	1.791**	-	-
Black vs Caucasian		0.103	1.109	-	-
Asian vs Caucasian		0.312	1.367**	-	-
Native American vs Caucasian		0.200	1.221	-	-
Educational Characteristics	***(Domain R^2= 3.05%)***			**282.1575**	**7**
GPA		-0.178	.836**	-	-
Number of Degree's		0.031	1.032	-	-
Level of Degree (Masters vs Bachelors)		-0.597	.550**	-	-
Major (Engineering Reference)			**	-	-
Computer & Math vs Engineering		0.522	1.686**	-	-
Life Sciences vs Engineering		0.560	1.752**	-	-
Physical Sciences vs Engineering		0.114	1.122	-	-
Social Science vs Engineering		0.561	1.753**	-	-
Social & Financial Characteristics	***(Domain R^2= 1.22%)***			**114.83**	**6**
Salary (10k)		-0.073	0.929**	-	-
Professional Sophistication		-0.082	0.921**	-	-
Financial Assistance (Employer Assistance)				-	-
Repayable Loans vs Employer Asst.		0.114	1.121	-	-
Non-repayable Grants vs Employer Asst.		-0.024	0.976	-	-
Money Earned Working vs Employer Asst.		0.106	1.112	-	-
Other Source vs Employer Asst.		0.065	1.068	-	-

***p<.01 ** p<.001**

Social and Financial Characteristics: Of the three social and financial variables that were tested for retention/ high school, two were found to be significant and one failed to predict (see Table 6). Financial assistance failed to predict retention and was excluded from further high school analyses. Significant predictors included annual salary, and professional sophistication. The direction of the effects was consistent with bivariate effects. The overall model for the domain of social and financial characteristics at the high school level was

significant (X^2 =114.83, df= 6, p< .0001). Social and financial characteristics were subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 1.22. Therefore, the model is said to reduce the error in predicting state retention at the high school level by about 1% from knowing information about the respondent's social and financial history.

Most Recent Degree Retention

Demographic Characteristics: Of the five demographic variables tested for retention/ most recent degree, all five remained significant at the domain level (see Table 7). The direction of the effects was consistent with bivariate effects. The variables included in this analysis included stayers/ arrivers, age, gender, race, and citizenship. The overall model for the domain of demographic characteristics at the most recent degree level was significant (X^2 =1253.59, df= 9, p< .0001). In combination, demographic characteristics were subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 13.89. Therefore, the model is said to reduce the error in predicting state retention at the most recent degree level by 14% from knowing the respondents demographic information.

Educational Characteristics: Of the four variables tested in the educational domain for retention/ most recent degree, two remained significant and two failed to predict (see Table 7). Number of degrees and level of degree failed to predict and will not be included in the final multivariate model. Significant educational characteristics included undergraduate GPA and college major. The direction of the effects was consistent with bivariate effects. The overall model for the domain of educational characteristics at the most recent degree level was significant (X^2 =118.29, df= 7, p< .0001). In combination, educational

characteristics were subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 1.16. Therefore, the model is said to reduce the error in predicting state retention at the most recent degree level by 1% from knowing information about the respondent's educational history.

Social and Financial Characteristics: Of the three variables tested in the social and financial domain for retention/ most recent degree all three remained significant. Significant variables included annual salary, community embeddedness, and financial assistance. The direction of the effects was consistent with bivariate effects. The overall model for the domain of social and financial characteristics at the most recent degree level was significant (X^2 =189.78, df= 6, p< .0001). In combination, social and financial characteristics were subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 1.88. Therefore, the model is said to reduce the error in predicting state retention at the most recent degree level by about 2% from knowing information about the respondents social and financial history.

The overall multivariate model for retention at the high school level was significant (X^2=2118.25, df= 14, p< .0001). In combination, the high school multivariate model was subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 28.61. Therefore, the combined effects of all domain level variables reduce the error in predicting state retention at the high school level by about 29%. The combined effects of these variables represent an incremental reduction in error when predicting retention/ high school of approximately 3% from the individual domain level analysis of only 26%.

Table 7.
Summary of Domain Logistic Relationships with State Retention

Most Recent Degree (7,741)		*Domain*		
	Coefficient	Odds ratio	X^2	df
Individual Characteristics	***(Domain R^2= 13.89%)***		**1253.59**	**9**
Age	0.0749	1.078**	-	-
Stayer	1.6271	5.089**	-	-
Gender (Males vs Females)	-0.2344	0.791**	-	-
Race (Caucasian Reference)				
Hispanic vs Caucasian	-	1.633**	-	-
Black vs Caucasian	-	0.943	-	-
Asian vs Caucasian	-	1.039	-	-
Native American vs Caucasian	-	1.474	-	-
Citizen (US Citizen Reference)				
Permanent Resident vs US Citizen	-	2.209**	-	-
Temporary Resident vs US Citizen	-	1.502**	-	-
Educational Characteristics	***(Domain R^2= 1.16%)***		**118.29**	**7**
GPA	-0.0934	0.911**	-	-
Number of Degree's	0.1066	1.112	-	-
Level of Degree (Masters vs Bachelors)	-0.1772	0.838	-	-
Major (Engineering Reference)				
Computer & Math vs Engineering	-	1.519**	-	-
Life Sciences vs Engineering	-	1.530**	-	-
Physical Sciences vs Engineering	-	1.200	-	-
Social Science vs Engineering	-	1.737**	-	-
Social & Financial Characteristics	***(Domain R^2= 1.88%)***		**189.78**	**6**
Salary (10k)	-0.1698	0.844**	-	-
Embedded	0.1895	1.209**	-	-
Financial Assistance (Employer Assistance)				
Repayable Loans vs Employer Asst.	-	0.949	-	-
Non-repayable Grants vs Employer Asst.	-	0.676**	-	-
Money Earned Working vs Employer Asst.	-	1.165**	-	-
Other Source vs Employer Asst.	-	1.101	-	-

***p<.10 **p<.01 *** p<.001**

MULTIVARIATE ANALYSIS

Finally, all variables significant at both the bivariate and domain level were combined and subjected to overall multivariate analysis for each of the dependent variables. Results of the overall final model are presented in Tables 8 and 9.

High School Degree Multivariate Analysis: Of the eight variables tested for retention/ high school, three variables failed to predict. The variables that fell out of the model include gender, level of degree, and professional sophistication. Significant predictors

at the bivariate and domain levels that remained significant in the full multivariate model at the high school level included stayers/ leavers, race, undergraduate GPA, college major, and annual salary. It was hypothesized that in combination, the variables entered into the final multivariate model would produce a significant model that would decrease the error in predicting retention/ high school degree compared to the domain level analysis. Results of this analysis are presented in Table 8.

By far, the predictor with the largest effect size was Stayers/ leavers. The odds of being retained in the state in which one went to high school was over 10 times greater (odds= 10.343) for those individuals who stayed in-state for college. Race was a significant predictor. Hispanics and Asians were consistently more likely to be retained by the state in which they received their high school degree than either Caucasians (odds= 1.707) (odds= 1.444) or African Americans (odds= 1.740) (odds=1.470). There were no other significant differences between the races.

Undergraduate GPA was found to have a significant negative relationship with retention/ high school in the final multivariate model such that for every half point increase in undergraduate GPA, the odds of being retained rather than not by the high school state decreases .877 times. Major proved to have a significant relationship such that engineering majors were consistently the most mobile and least likely to be retained by the state in which they went to high school than were individuals who chose other majors. The odds of being retained by the state were consistently higher for Computer/ Math majors (odds= 1.651), Life Science majors (odds= 1.712), and Social Science majors (odds= 1.874) than for Engineers. There were no other significant comparisons among majors at the high school level.

Salary had a significant negative relationship with retention/ high school such that for every $10,000 increase in salary, the odds of being retained by the state in which the individual went to high school decreased by .926 times.

Table 8.
Summary of Multivariate Logistic Relationships with State Retention

High School (n=6,963)	*Multivariate*			
	Coefficient	Odds ratio	X^2	df
Individual Characteristics				
Stayer	2.336	10.343**	-	-
Gender (Males vs Females)	-0.060	0.941	-	-
Race (Caucasian Reference)			-	-
Hispanic vs Caucasian	-	1.707**	-	-
Black vs Caucasian	-	0.984	-	-
Asian vs Caucasian	-	1.444		-
Native American vs Caucasian	-	1.117	-	-
Educational Characteristics				
GPA	-0.131	0.877**	-	-
Level of Degree (Masters vs Bachelors)	-0.108	0.897	-	-
Major (Engineering Reference)			-	-
Computer & Math vs Engineering	-	1.651**	-	-
Life Sciences vs Engineering	-	1.712**	-	-
Physical Sciences vs Engineering	-	1.221	-	-
Social Science vs Engineering	-	1.874**	-	-
Social & Financial Characteristics				
Salary (10k)	-0.077	0.926**	-	-
Professional Sophistication	-0.024	0.976	-	-

***p<.01 ** p<.001 *** p<.001** **Overall Model Analog R^2 =28.61%**

Most Recent Degree Multivariate Analysis: Of the ten variables tested for retention/ most recent degree, four variables failed to predict. The variables that fell out of the model include gender, undergraduate GPA, community embeddedness, and sources of financial assistance. Significant predictors at the bivariate and domain level that remained significant in the full multivariate model for the most recent degree included stayers/ arrivers, age, citizenship, race, college major, and annual salary. It was hypothesized that in combination, the variables entered into the final multivariate model would produce a

significant model that would decrease the error in predicting retention/ most recent degree. Results of this analysis are presented in Table 9.

By far, the predictor with the largest effect size was stayers/ arrivers. The odds of being retained in the state in which one received their most recent degree was over 5 times greater (odds= 5.049) for those individuals who stayed in-state for college. Age proved to have a significant positive relationship with retention/ most recent degree such that for every five-year increase in age, the likelihood of being retained by the state in which one received their most recent degree increased 1.081 times. Citizenship was found to have a significant relationship with retention/ most recent degree such that U.S. citizens are less likely to be retained than are either permanent or temporary residents. Permanent residents have odds of being retained that are 2.269 times greater than U.S. citizens and temporary residents have odds of being retained 1.601 times greater than U.S. citizens. Race had a significant relationship with retention/ most recent degree. Hispanics were the most likely to be retained and least likely to move. Hispanics had odds of being retained 1.608 times greater than Caucasians, 1.76 times greater than African Americans, and 1.38 times greater than Asians. While not as mobile as Caucasians, African Americans are more mobile than Hispanics, Asians, and Native Americans. African Americans had odds of being retained .78 times lower than Asians and .66 times lower than Native Americans. There were no other significant differences between the races.

College major was found to have a significant relationship with retention/ most recent degree such that engineers were more mobile and less likely to be retained than individuals who choose other science or engineering majors. The odds of being retained by the state were consistently higher for computer/ math majors (odds= 1.317), and social science majors

(odds= 1.450) than for engineers. There were no significant differences between engineers and physical science majors, but similar to engineers, physical science majors were also less likely to be retained than either computer/ math (odds= 1.21) or social science (odds= 1.333) majors. In addition to being more likely to be retained than engineers, and physical science majors, social science majors had odds of being retained that were 1.25 times higher than life science majors. There were no other significant comparisons among majors at the most recent degree level.

Salary was found to have a significant negative relationship with retention/ most recent degree such that for every $10,000 increase in salary, the odds of being retained decreases by .851 times.

The overall multivariate model for the most recent degree was significant (X^2=1395.18, df= 20, p< .0001). In combination, the most recent degree multivariate model was subjected to goodness of fit analysis. Results of this analysis indicate that the analogue R^2 for the model was 15.70. Therefore, the combined effects of all domain level variables reduce the error in predicting state retention at the most recent degree by about 16%. The combined effects of these variables represents an incremental reduction in error when predicting retention/ most recent degree of approximately 2% from the individual domain level analysis of only 14%.

Table 9.
Summary of Multivariate Logistic Relationships with State Retention

Most Recent Degree (7,741)	Coefficient	Multivariate Odds ratio	X^2	df
Individual Characteristics				
Age	0.077	1.081**	-	-
Stayer	1.619	5.049**	-	-
Gender (Males vs Females)	-0.056	0.945	-	-
Race (Caucasian Reference)				
Hispanic vs Caucasian	-	1.608**	-	-
Black vs Caucasian	-	0.911	-	-
Asian vs Caucasian	-	1.167	-	-
Native American vs Caucasian	-	1.383	-	-
Citizen (US Citizen Reference)				
Permanent Resident vs US Citizen	-	2.269**	-	-
Temporary Resident vs US Citizen	-	1.601**	-	-
Educational Characteristics				
GPA	-0.025	0.975	-	-
Major (Engineering Reference)				
Computer & Math vs Engineering	-	1.317**	-	-
Life Sciences vs Engineering	-	1.157	-	-
Physical Sciences vs Engineering	-	1.091	-	-
Social Science vs Engineering	-	1.450**	-	-
Social & Financial Characteristics				
Salary (10k)	-0.161	0.851**	-	-
Embedded	0.051	1.053	-	-
Financial Assistance (Employer Assistance)				
Repayable Loans vs Employer Asst.	-	0.893	-	-
Non-repayable Grants vs Employer Asst.	-	0.819	-	-
Money Earned Working vs Employer Asst.	-	1.052	-	-
Other Source vs Employer Asst.	-	1.007	-	-

***p<.10 **p<.01 *** p<.001** **Overall Model Analog R^2 = 15.70%**

Multivariate Summary: Of the variables tested in the present study, there appears to be a core set of predictors common to both retention of high school graduates and most recent degree recipients. The predictive models varied slightly depending on the dependent measure that is examined. There were four significant variables common to both high school and most recent degree recipients and they include stayers/ leavers- arrivers, race, college major, and annual salary.

In addition to the core predictors common to both dependent measures, the retention model for high school graduates also includes undergraduate GPA. It appears that

individuals who do better academically in high school will be more likely to move outside of the state for employment opportunities later. While GPA did not prove to be a significant predictor in the model for most recent degree, two additional variables, age and citizenship, were found to predict over and above the core predictors for recent degree. By pure definition of the high school population, citizenship was not testable at the high school level, and therefore could not have been part of the high school retention model.

There are substantial differences in the analog summary statistic accounting for the aggregate effect of all predictors introduced into each model. The combination of predictors in the high school model serve to reduce the error of prediction by producing an analog R^2 of 29% while the combination of predictors in the most recent degree model only reduce the error by 16%. The difference in these results can likely be accounted for by differences in the effect size of the stayer/ leaver- arriver variable. Due to the sheer magnitude of these effects, it appears necessary to conduct an exploratory analysis of the stayer variable.

Exploratory Analysis

Whether or not a student graduating from high school goes on to college in the same state was by far the most important predictor of where they worked after college graduation. A similar multistage approach was followed for the exploration of the stayers variable as was followed for the primary analyses. All predictor variables were examined at the bivariate, domain, and multivariate level using stayers as the dependent measure. See Table 10 for a detailed summary of bivariate, domain, and multivariate results.

Of the nine variables that remained significant at the bivariate and domain level, six failed to predict stayers when tested at the multivariate level. The variables that dropped were; age, race, number of degrees, college major, salary, and professional sophistication.

The three variables that proved to have a significant relationship with stayers included undergraduate GPA, financial assistance, and level of degree.

Undergraduate GPA was found to have a significant negative relationship with stayers such that for every half point increase in GPA the individual is .803 times less likely to stay in-state for college (odds= .803).

Financial assistance was found to have a significant relationship with stayers. In general, individuals who receive financial assistance from their employer or from working are more likely to stay in-state for college than individuals who receive non-repayable monies for college in the form of grants, scholarships, and parental assistance. Results prove that individuals who receive non-repayable grants, scholarships, or assistance from parents are less likely to stay in-state for college than either individuals who receive financial assistance from their employer or from work. Individuals who receive non-repayable funding have odds of staying in-state for college that are .872 times less likely to stay in-state for college than individuals who receive assistance from their employer, and are .590 times less likely to stay in-state for college than individuals who earn money from work. Individuals who receive financial assistance that must be repaid in interest bearing loans, etc. have odds that are .650 times less likely to stay in-state for college than are individuals who earn money from work.

Level of degree was found to have a significant negative relationship with stayers such that an individual earning a master's degree was .464 times less likely to stay in-state for college.

Table 10.
Summary of Bivariate, Domain, and Multivariate Logistic Relationships with Stayers

	Bivariate odds ratio	Domain odds ratio	Multivariate odds ratio
Individual Characteristics			
Age	1.031**	0.970**	1.000
Gender (Males vs Females)	1.130*	0.911	-
Race (Caucasian Reference)			
Hispanic vs Caucasian	0.636**	1.564**	1.447**
Black vs Caucasian	1.213*	0.816	0.681**
Asian vs Caucasian	3.094**	.323**	0.420**
Native American vs Caucasian	0.740	1.413	1.191
Educational Characteristics			
GPA	1.383**	0.806**	0.803**
Number of Degree's	2.589**	0.738**	0.769
Major (Engineering Reference)			
Computer & Math vs Engineering	1.072	1.059	1.126
Life Sciences vs Engineering	0.613**	1.388**	1.277
Physical Sciences vs Engineering	0.974	0.938	0.872
Social Science vs Engineering	0.738**	1.188*	1.124
Level of Degree (Masters vs Bachelors)	3.210**	0.478	0.464**
Social & Financial Characteristics			
Salary (10k)	1.163**	0.875**	0.979
Embedded	1.063*	0.998	-
Professional Sophistication	1.076*	0.945*	1.020
Financial Assistance (Employer Assistance)			**
Repayable Loans vs Employer Asst.	0.761**	1.243**	0.953
Non-repayable Grants vs Employer Asst.	0.818**	1.083*	0.872*
Money Earned Working vs Employer Asst.	0.807**	1.272**	1.472**
Other Source vs Employer Asst.	1.216	0.825	0.863

*** p<.01 **p<.001** **Overall Model Analog R^2 = 8.66%**

DISCUSSION

State retention of college graduates in technical fields is a growing concern in the state of the *new economy*. As industry moves away from manufacturing, knowledge becomes a very important factor in the success or failure of the new economy. In this environment, a states' economy is able to thrive to the extent that they are able to attract, employ, and retain highly skilled people. Retaining this talent becomes a challenge as knowledge workers are in high demand throughout the country and as a result are highly mobile. Forty-three percent of high school graduates in this study found work in a state

different from the one in which they received their high school diploma. In most arenas, a return on investment of a little over 50% would not be enough to sustain business.

Retention is a bigger issue for some states than others. In a previous study, it was noted that states like California, Georgia, Texas, Michigan, and Massachusetts were in the top quartile for their ability to retain both high school and most recent degree graduates. While Maine, New Hampshire, North Dakota, Vermont, West Virginia, and Wyoming were in the bottom quartile for retaining high school and recent degree graduates (Tornatzky, et. al., 1998). Within the top quartile of the previous study, are several "nation states", either large in area and population (California, Texas) or high wage states (Massachusetts, Michigan). While states in the bottom quartile tend to be smaller with lower average wages.

The relevant literature in this area was limited. Many of the studies reviewed pre-dated the current technology-driven economic boom. More recent studies focused on specific subpopulations such as chemical engineers or foreign students or doctoral recipients, or examined a small number of individual demographic variables. Most of the studies were based on small non-probability samples that seriously undermined the confidence one could place in generalizing the results of their findings to a broader audience.

This research was the first of it's kind to examine these issues on a national level and come to some firm conclusions regarding the factors that predict and fail to predict state level retention of college graduates in science and engineering fields. This study took advantage of a large national probability sample with a high response rate that was representative of multiple disciplines, and cut across many demographic segments. Many questions addressed in this study have never been addressed in previous studies.

Although an excellent source of data, the NSRCG was not comprehensive. There were few psychological variables captured, and it was necessary to use crude proxy's to measure some constructs such as community embeddedness and professional sophistication. There were some interesting variables that were not captured by the NSF survey. The survey did not capture student's access and utilization of internship or co-op opportunities. Information on the student's exposure to potential employers in their local area would have been ideal. However, the NSRCG did not afford that capability. The survey did not provide temporal items that referenced specifically how long it had been since the respondent graduated. We can hypothesize that there could only be a two year window between college graduation and the survey. The longer one is out of school, the more opportunities there are to move for work. Therefore, there may be differences among the groups depending on the length of time after graduation before the survey was administered. It is unclear whether these results will generalize beyond this short two-year period immediately after graduation. What happens to these graduates in five years or ten years after graduation?

The sampling strategy used to collect data was an appropriate method for examining overall national level effects. However, in order to test the relationship between retention and state, it became necessary to pair down the larger dataset and exclude some respondents. Excluding respondents changed the stratification of the sample and may have effects on these results. The sampling procedures were not designed for probability samples within states therefore, breaking out state level differences became difficult because sample sizes were small and were not probability samples.

The current analysis of graduate retention began with a large number of potential predictors, but ended with only a few proven to be statistically significant. It is interesting to

note the indicators that did not predict retention. Many seemingly promising variables did not lend support to our understanding of the phenomenon of retention in the multivariate model. These variables include: gender, community embeddedness, professional sophistication, level of degree, number of degrees, and sources of financial assistance. Many, if not all, of these variables seemed to be related when examining one-to-one relationships with each of the measures of retention, but the significance of these effects proved to be redundant with other variables included in the multivariate model. For example, gender had a significant relationship with retention at the bivariate level, such that females were more likely to be retained, but when combined with other variables in the multivariate model it did not remain statistically relevant. Therefore, contrary to the traditional stereotype, gender does not offer a unique contribution to the retention model.

Race was an important statistical predictor, but it was a crude proxy for other variables that were not captured by the NSRCG instrument (e.g., socioeconomic status, cultural differences, immigrant status, etc.). One possible explanation that Asian's and Hispanic's were shown to be retained may be that they represent relatively new generations of American's and are striving to embed themselves in the community and put down roots. This finding is confounded by region. In a larger study publication that examined state level and regional characteristics along with individual characteristics, race did not prove to be a significant factor in predicting retention. Due to multi-dimensional nature of race, the variance explained by the race variable overlapped with other variables in the analysis and failed to produce a significant statistical effect.

There were only four statistically significant variables common across both dependent measures of retention. By definition, citizenship could only be tested in relation to retention/

most recent degree and for those individuals who graduated from a U.S. institution and were working within the states. Permanent residents had greater odds of being retained than temporary residents but results indicated that in general, non-U.S. nationals were more likely than U.S. citizens to stay and work in the state where they received their most recent degree. Foreign students may play a critical role in the U.S. science and engineering workforce. Viewing the world market as the best possible talent pool suggests that U.S. economic development will benefit if universities attract the smartest people from around the world. If foreign students who are permanent residents are more likely to stay where they received their most recent degree than U.S. citizens then it would be beneficial to integrate these students into local business and industry early on in their academic careers.

Of the core variables common across both dependent measures, stayers were by far the largest predictor of where an individual would work after college graduation. At the high school level, the odds of retaining an individual who went to high school and college in the same state is 10 times greater than the odds of retaining someone who did not stay in-state for college. At the most recent degree level, the odds of retaining 'stayers' are 5 times greater than for arrivers. Admittedly, some students will decide to leave home to attend college in another state and there is nothing that can be done about it. However, states should monitor the number of leavers they have relative to the number of out-of-state arrivers that they gain. To some degree, arrivers counter balance the effects of the leavers. State's that are able to attract at least as many students as they lose will have an advantage in the new economy. In an attempt to retain the best and brightest, some states have implemented tuition scholarship programs that reward top students for staying in-state for college. Georgia's Hope Scholarship and Florida's Bright Future's are examples of these initiatives.

Some states, Maryland for instance, target specific majors and disciplines, while some states require that students work in state after graduation or the scholarship becomes a loan. In theory, these programs should serve to combat the brain drain problem, but they are either too new or have not been subject to rigorous quantitative evaluation to fully understand their effectiveness at retaining top talent.

Race was a common predictor for both retention measures. The base-line category in this polytomous analysis was Caucasian. In general, it appears that Caucasians are the most mobile, and African American's second. Multiple comparisons between races revealed that by and large, Hispanics and Asians tend to have the highest retention rates. While race is obviously not a characteristic that one can change, policy makers would be wise to target the traditional stayers in order to keep them in-state or attract more mobile races from other states. States should encourage and assist Hispanic students to attend college in their state because they are more likely to be retained after graduation.

College major was a common predictor for both measures of retention. Engineers were the base-line category in this polytomous analysis. Results clearly indicated that Engineers appeared to be more mobile and therefore less likely to be retained than were any of the other majors examined. Social science majors were consistently the most likely to be retained of any of the majors examined. Multiple comparisons between majors revealed that physical science majors were also less likely to be retained by the state than were computer/ math, life, or social science majors. It is possible that the nature of engineering and physical science career patterns are increasingly important in the new economy there are options that may decrease the rate at which these skill sets are depleted from a given state. For example, Arkansas and Pennsylvania have targeted financial assistance programs for individuals with

specific skill sets. Students who are engaged in local industry early during their educational experience are less likely to leave. Increased opportunities for internship or co-op positions would also support this cause.

Annual salary was a common predictor for both measures of retention. As salary increases the likelihood of being retained by the state from which you graduated decreases. The demand for skilled knowledge workers in these types of jobs creates a new marketability that was not the case in the manufacturing days. Today's graduates have very specific skills sets that make them marketable and in order to remain competitive in the new economy industry is willing to pay for it. As a result, skilled labor, if they are willing to move, can demand higher wages. States need to insure that conditions are in place that supports higher wages for both individuals and jobs within their state.

Retention of high school graduates was negatively related to GPA, but GPA was not related to retention of most recent degree recipients. Results indicate that many high school graduates leave the state for college and are not likely to return for work after graduation. Results of the exploratory analysis indicate that as GPA increases, the odds of stayers (e.g., staying in-state for college) also decrease. Many states have developed programs that were specifically designed to keep their best and brightest home for college. The Georgia Hope Scholarship, or Florida Bright Futures Scholarship was designed with this in mind. States that target their own top talent high school graduates will have an advantage in the new economy.

Although age had a significant relationship with retention/ most recent degree it did not have a relationship with retention/ high school. Perhaps age does not affect the decisions of young high school graduates when the possibilities of life choices may seem endless, but it

does appear to have an anchoring affect later in the life planning process when moving may be perceived as an inconvenience or incompatible with other life choices as one gets older.

Results of this study indicate that by far, stayers had the largest impact on state level retention of both high school and recent degree recipients. Future research should consider examining variables that help understand the decision making process that students go through when deciding where to live and work after graduation. Efforts should be made to examine variables that were not currently available including information on access to and utilization of internships or co-op's, length of time between graduation and time surveyed, number of moves prior to time of survey, when and where they lived previously, and where they received information about jobs or other states. Attempts should also be made to insure that differences between states can confidently be determined based on appropriate sampling procedures at the state level.

Understanding the cognitive processes behind the decision to move or stay will enable industry leaders and public policy makers alike to specifically target recruiting initiatives. Establishing a working knowledge of this type of information should be an on-going process. As the economy changes over time there will be caveats and mutations of the key drivers of retention. The ability to have a finger on the pulse of the top talent pool will afford industry and states a competitive advantage that is good for this country on a global level. Regardless of the current recession, future projections indicate that there will be a shortage of highly qualified labor in the science and engineering fields in the coming years. It would be interesting to see how the state of the current economy will effect the demand, market, and mobility of these workers in the future.

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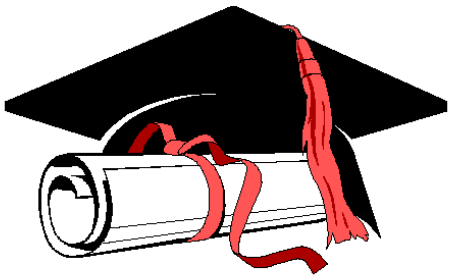

1997 National Survey of Recent College Graduates

This information is solicited under the authority of the National Science Foundation Act of 1950, as amended. All information you provide will be treated as confidential and used only for research or statistical purposes by the survey sponsors, their contractors, and collaborating researchers for the purpose of analyzing data and preparing scientific reports and articles. Any information publicly released (such as statistical summaries) will be in a form that does not personally identify you. Your response is voluntary and failure to provide some or all of the requested information will not in any way adversely affect you. Actual time to complete the questionnaire may vary depending on your circumstances. On the average, it will take about 25 minutes to complete the questionnaire. If you have any comments on the time required for this survey, please send them to Gail McHenry, Division of Administrative Services, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB number for this project is 3145-0077.

Conducted by:

Westat
Rockville, MD

for the
National Science Foundation
Arlington, VA

INSTRUCTIONS

Thank you for taking the time to complete this important questionnaire. Directions for filling it out are provided with each question. Because not all questions will apply to everyone, you may be asked to skip certain questions.

- In order to get comparable data, we will be asking you to refer to the week of April 15, 1997 (i.e., April 13-April 19, 1997) when answering most questions.
- Follow all "SKIP" instructions after marking a box. If no "SKIP" instruction is provided, you should continue to the next question.
- Either a pen or pencil may be used.
- When answering questions that require marking a box, please use an [X].
- If you need to change an answer, please make sure that your old answer is either completely erased or clearly crossed out.
- You may notice that some question numbers are not consecutive. This was done to maintain consistency with previous survey cycles. Please answer questions in the order they are printed except when following a "SKIP" instruction.

Thanks again for your help. We really appreciate it.

PART A - Education

A1. In what year did you receive your high school diploma or high school equivalency certificate?

YEAR

19 [ ][ ] **OR** ☐ Did not finish high school

A2. In what state or foreign country did you last attend high school?

State: _____ **OR**

Foreign Country: _____

A3. Have you ever taken courses at a community college?

1 ☐ Yes
2 ☐ No ☐ ***SKIP to A4X***

A4. *(IF YES)* **For which of the following reasons have you taken courses at a community college?**

Mark (X) Yes or No for each	YES	NO
b. As part of a high school advanced placement (AP) program	1 ☐	2 ☐
c. To prepare for college/increase chances of being accepted into college	1 ☐	2 ☐
d. To complete an associate's degree	1 ☐	2 ☐
e. To complete credits toward a bachelor's degree	1 ☐	2 ☐
f. To gain further skills or knowledge in your academic or occupational field	1 ☐	2 ☐
g. To change your academic or occupational field	1 ☐	2 ☐
h. To increase opportunities for promotion, advancement, or higher salary	1 ☐	2 ☐
i. For leisure or personal interest	1 ☐	2 ☐
j. For financial reasons (e.g., 4-year college too expensive, needed the money for other priorities)	1 ☐	2 ☐
k. Other - *Specify* [ ]	1 ☐	2 ☐

A4X. Do you have a 2-year associate's degree?

1 ☐ Yes
2 ☐ No

A5. When you first entered college to begin working on a bachelor's degree, in what field of study did you want to major?

☐ ☐ **MARK (X) THIS BOX IF YOU WERE UNDECIDED AND THEN SKIP TO A7**

MAJOR FIELD OF STUDY [ ]

A6. Using the EDUCATION CODES (LIST A: pp. 18-19) choose the code that best describes your first intended major.

CODE [ ][ ][ ] NOTE: Education codes range from 601 to 995

A7. Using a 4-point scale, what was your overall undergraduate grade point average (GPA)?

IF YOU HAVE MORE THAN ONE BACHELOR'S DEGREE: *Give your overall grade point average for your first bachelor's degree.*

Mark (X) ONLY one

1 ☐ 3.75 - 4.00 GPA (Mostly A's)
2 ☐ 3.25 - 3.74 GPA (About half A's/half B's)
3 ☐ 2.75 - 3.24 GPA (Mostly B's)
4 ☐ 2.25 - 2.74 GPA (About half B's/half C's)
5 ☐ 1.75 - 2.24 GPA (Mostly C's)
6 ☐ 1.25 - 1.74 GPA (About half C's/half D's)
7 ☐ Less than 1.25 (Mostly D's or below)
8 ☐ Have not taken courses for which grades were given

A10. How many college or university degrees do you have at the bachelor's level or higher?

NUMBER [ ]

A10a. In what month and year did you first enroll in a course offered by a college or other postsecondary institution for which you received credit towards your first bachelor's degree? This may be at the institution that granted your degree, or at another institution.

Month [ ][ ] Year 19 [ ][ ]

A11. Starting with your most recent college or university degree, please provide the following information for each degree you have at the bachelor's level or higher.

If more than 3 relevant degrees, complete the grid for your two most recent degrees and your first bachelor's degree.

MOST RECENT DEGREE	2ND MOST RECENT DEGREE	1ST BACHELOR'S DEGREE (If not previously reported)
a. From which college/university and department did you receive this degree? (College/University Name) (Department) (City/Town) (State/Foreign Country)	**a. From which college/university and department did you receive this degree?** (College/University Name) (Department) (City/Town) (State/Foreign Country)	**a. From which college/university and department did you receive this degree?** (College/University Name) (Department) (City/Town) (State/Foreign Country)
b. In what month and year was this degree awarded? Month Year 19	**b. In what month and year was this degree awarded?** Month Year 19	**b. In what month and year was this degree awarded?** Month Year 19
c. What type of degree did you receive? *Mark (X) ONLY one* 1 ☐ Bachelor's 2 ☐ Master's (includes MBA) 3 ☐ Doctorate (e.g., Ph.D., D.S.C, D.Sc., Ed.D.) 4 ☐ Other professional degree (e.g., JD, LLB, ThD, MD, DDS, etc.) - *Specify* 91 ☐ Other - *Specify*	**c. What type of degree did you receive?** *Mark (X) ONLY one* 1 ☐ Bachelor's 2 ☐ Master's (includes MBA) 3 ☐ Doctorate (e.g., Ph.D., D.S.C, D.Sc., Ed.D.) 4 ☐ Other professional degree (e.g., JD, LLB, ThD, MD, DDS, etc.) - *Specify* 91 ☐ Other - *Specify*	**c. What type of degree did you receive?** *Mark (X) ONLY one* 1 ☐ Bachelor's 2 ☐ Master's (includes MBA) 3 ☐ Doctorate (e.g., Ph.D., D.S.C, D.Sc., Ed.D.) 4 ☐ Other professional degree (e.g., JD, LLB, ThD, MD, DDS, etc.) - *Specify* 91 ☐ Other - *Specify*
d. Using the EDUCATION CODES (LIST A: pp. 18-19), select the relevant degree field code(s) and title(s). MAJOR FIELD CODE SECOND MAJOR OR MINOR CODE	**d. Using the EDUCATION CODES (LIST A: pp. 18-19), select the relevant degree field code(s) and title(s).** MAJOR FIELD CODE SECOND MAJOR OR MINOR CODE	**d. Using the EDUCATION CODES (LIST A: pp. 18-19), select the relevant degree field code(s) and title(s).** MAJOR FIELD CODE SECOND MAJOR OR MINOR CODE
e. From which of the following sources, if any, did you receive financial support for this degree? *Mark (X) all that apply* g ☐ Financial support from parents/spouse/ other relatives, not to be repaid a ☐ Loans from the school you attended, banks, federal or state government b ☐ Loans from parents or other relatives c ☐ Financial assistance from your employer d ☐ Tuition waivers, fellowships, grants, scholarships e ☐ Assistantships/Work Study f ☐ Earnings from employment h ☐ Other - *Specify*	**e. From which of the following sources, if any, did you receive financial support for this degree?** *Mark (X) all that apply* g ☐ Financial support from parents/spouse/ other relatives, not to be repaid a ☐ Loans from the school you attended, banks, federal or state government b ☐ Loans from parents or other relatives c ☐ Financial assistance from your employer d ☐ Tuition waivers, fellowships, grants, scholarships e ☐ Assistantships/Work Study f ☐ Earnings from employment h ☐ Other - *Specify*	**e. From which of the following sources, if any, did you receive financial support for this degree?** *Mark (X) all that apply* g ☐ Financial support from parents/spouse/ other relatives, not to be repaid a ☐ Loans from the school you attended, banks, federal or state government b ☐ Loans from parents or other relatives c ☐ Financial assistance from your employer d ☐ Tuition waivers, fellowships, grants, scholarships e ☐ Assistantships/Work Study f ☐ Earnings from employment h ☐ Other - *Specify*

For questions A12a and A12c, include the total amount borrowed from ALL sources, (e.g., government, private lenders, parents, relatives, friends). Include loans that have been repaid or forgiven. If your loans were consolidated, please estimate how much was borrowed for your undergraduate degrees and how much was borrowed for your graduate degrees.

A12a. Thinking about only the undergraduate degrees you completed before May 1997, what is the total amount you have borrowed from any source to finance your undergraduate degree(s)?

$ _____ .00 **OR**

☐ NONE ☐ ***SKIP to A12c***

A12b. *(IF ANY)* **As of the week of April 15, 1997 how much of this undergraduate amount did you still owe?**

$ _____ .00 **OR**

☐ NONE

A12c. Thinking about only the graduate degrees you completed before May 1997, what is the total amount you have borrowed from any source to finance your graduate degree(s)?

0 ☐ ☐ MARK (X) THIS BOX IF NO GRADUATE DEGREES, AND THEN SKIP TO A13_1

$ _____ .00 **OR**

☐ NONE ☐ ***SKIP to A13_1***

A12d. *(IF ANY)* **As of the week of April 15, 1997 how much of this graduate amount did you still owe?**

$ _____ .00 **OR**

☐ NONE

Questions A13_1 through A21a ask about college or university courses you may have taken since completing your most recent degree.

A13_1. Have you completed a degree since the week of April 15, 1997?

1 ☐ Yes ☐ ***SKIP to A21a, page 4***

2 ☐ No

A13. Between completing your most recent degree and the week of April 15, 1997, did you take any college or university courses or enroll in a college or university for any other reason, such as completing a master's, PhD, medical, or law degree?

1 ☐ Yes ☐ ***SKIP to A18, page 4***

2 ☐ No

A14. Which of the following were reasons why you were not enrolled or taking college courses during that time period?

Mark (X) Yes or No for each

	YES	NO
1. You had achieved your educational goals (at least temporarily)	1 ☐	2 ☐
2. You were waiting for the next school term to start	1 ☐	2 ☐
3. Financial reasons (e.g., too expensive, needed the money for other priorities)	1 ☐	2 ☐
4. Had a job, needed to work	1 ☐	2 ☐
5. Had to stop due to family responsibilities (e.g., caring for children or other family members, had a baby)	1 ☐	2 ☐
6. Moved, could no longer take courses at the school you were attending	1 ☐	2 ☐
7. No longer certain of which field of study you wanted to pursue	1 ☐	2 ☐
8. Needed a break, tired of going to school	1 ☐	2 ☐
9. Other - *Specify* _____	1 ☐	2 ☐

A14a. Which two reasons marked in A14 represent your most important reasons for not taking college courses during that time period? *Enter number of appropriate reason from A14 above.*

1. ☐ MOST important reason

2. ☐ SECOND MOST important reason *(Enter "0" if only one reason selected in A14.)*

A15. Have you taken any college or university courses since the week of April 15, 1997?

1 ☐ Yes ☐ ***SKIP to A25, page 5***

2 ☐ No

A16. *(IF NO)* **How likely is it that you will one day take additional college or university courses?**

Mark (X) ONLY one

1 ☐ Very likely

2 ☐ Somewhat likely → ***SKIP to A25, page 5***

3 ☐ Very unlikely

A18. What was your primary field of study between completing your most recent degree and the week of April 15, 1997?

☐ MARK (X) THIS BOX IF NO PRIMARY FIELD OF STUDY AND THEN SKIP TO A20

PRIMARY FIELD OF STUDY

A19. Using the EDUCATION CODES (LIST A: pp. 18-19) choose the code that best describes your primary field of study during that time.

CODE ☐☐☐ NOTE: Education codes range from 601 to 995

A18a. In which college or university department were you primarily taking classes or doing research (for example, English, chemistry)?

DEPARTMENT

A20. During that time, toward what degree or certificate, if any, were you (or are you) working?

IF WORKING ON MORE THAN ONE DEGREE: *Mark the highest level.*

Mark (X) ONLY one

- 0 ☐ No specific degree or certificate
- 1 ☐ Bachelor's degree
- 2 ☐ Post-baccalaureate certificate
- 3 ☐ Master's degree (including MBA)
- 4 ☐ Post master's certificate
- 5 ☐ Doctorate (Ph.D., D.S.C, D.Sc., Ed.D.)
- 6 ☐ Other professional degree (JD, LLB, ThD, MD, DDS, etc.) - *Specify*
- 91 ☐ Other - *Specify*

A21. From which of these sources did you receive financial support for coursework or enrollment between completing your most recent degree and April 15, 1997?

Mark (X) Yes or No for each	YES	NO
g. Financial support from parents/spouse/ other relatives, not to be repaid	1 ☐	2 ☐
a. Loans from the school you attended, banks, federal or state government	1 ☐	2 ☐
b. Loans from parents or other relatives	1 ☐	2 ☐
c. Financial assistance from your employer	1 ☐	2 ☐
d. Tuition waivers, fellowships, grants, or scholarships	1 ☐	2 ☐
e. Assistantships/Work Study	1 ☐	2 ☐
f. Earnings from employment	1 ☐	2 ☐
h. Other - *Specify*	1 ☐	2 ☐

A21a. For which of the following reasons were you taking classes or enrolled during that time?

Mark (X) Yes or No for each	YES	NO
a. To gain further education before beginning a career	1 ☐	2 ☐
b. To prepare for graduate school	1 ☐	2 ☐
c. To change your academic or occupational field	1 ☐	2 ☐
d. To gain further skills or knowledge in your academic or occupational field	1 ☐	2 ☐
e. For licensure or certification	1 ☐	2 ☐
f. To increase opportunities for promotion, advancement, or higher salary	1 ☐	2 ☐
g. Required or expected by employer	1 ☐	2 ☐
h. For leisure or personal interest	1 ☐	2 ☐
i. Other - *Specify*	1 ☐	2 ☐

A22. More specifically, during the week of April 15, 1997, were you either taking college or university courses or enrolled for other reasons such as completing a master's, PhD, medical, or law degree?

MARK "YES": *If you were enrolled in school but on vacation that week.*

1 ☐ Yes
2 ☐ No ☐ ***SKIP to A25***

A23. *(IF YES)* **What college or university were you attending during the week of April 15, 1997?** *Please do not abbreviate the school name.*

School Name:_____

City/Town:_____

State/Foreign Country:_____

A24. Were you taking courses as . . .

Mark (X) ONLY one

1 ☐ A part-time student

2 ☐ A full-time student

A25. Thinking ahead to the future, what is the highest degree you ever expect to complete? *If your current highest degree is the highest degree you expect to complete, please answer for that degree.*

Mark (X) ONLY one

1 ☐ Bachelor's
2 ☐ Master's (includes MBA)
3 ☐ Doctorate (e.g., Ph.D., D.S.C., D.Sc., Ed.D.)
4 ☐ Other professional degree (e.g., JD, LLB, ThD, MD, DDS, etc.) - *Specify*

91 ☐ Other- *Specify*

PART B - Employment Status

B1. At any time during the three months following the completion of your most recent degree, did you have what you considered to be a "career-path" job? *For "most recent degree," please do not include any degrees awarded after April 1997.*

A "career-path" job is a job that will help you in your future career plans or a job in the field in which you want to make your career.

1 ☐ Yes ☐ ***SKIP to B2***
2 ☐ No

B1a. At any time during that same three-month period, did you accept what you considered to be a "career-path" job?

1 ☐ Yes
2 ☐ No ☐ ***SKIP to B3***

B2. *(IF YES)* **When did you first start working for that employer?**

IN THE ANSWER CATEGORIES BELOW: *For "most recent degree," please do not include any degrees awarded after April 1997.*

Mark (X) ONLY one

1 ☐ Before working on your most recent degree
2 ☐ While working on your most recent degree

SKIP TO B4, page 6

3 ☐ After completing your most recent degree

B3. *(IF NO)* **At any time during that same three-month period were you seeking a "career-path" job?**

1 ☐ Yes
2 ☐ No

The next several questions are about your employment status during the reference week of April 13-19, 1997.

B4. Were you working for pay (or profit) during the week of April 15, 1997? Please include self-employment and any jobs from which you were temporarily absent, for example, for illness, vacation, or parental leave (even if leave was unpaid).

STUDENTS: *Count jobs required as part of a financial aid award, such as work study or assistantships. Do not count financial aid awards with no work requirement.*

1 ☐ Yes ☐ ***SKIP to B10***
2 ☐ No

B5. *(IF NO)* **Did you look for work during the four weeks preceding April 15, 1997 (that is, anytime between March 19 and April 15, 1997)?**

1 ☐ Yes
2 ☐ No

B6. What were your reasons for not working during the week of April 15, 1997?

Mark (X) Yes or No for each

		Year Retired	YES	NO
a.	Retired → 19	☐☐	1 ☐	2 ☐
b.	On layoff from a job		1 ☐	2 ☐
c.	Student		1 ☐	2 ☐
d.	Family responsibilities		1 ☐	2 ☐
e.	Chronic illness or permanent disability		1 ☐	2 ☐
f.	Suitable job not available		1 ☐	2 ☐
g.	Did not need or want to work		1 ☐	2 ☐
h.	Other - *Specify* ☐		1 ☐	2 ☐

B7. Prior to the week of April 15, 1997, in what month and year did you last work for pay (or profit)?

☐ ☐ MARK (X) THIS BOX IF NEVER WORKED FOR PAY (OR PROFIT) AND THEN SKIP TO PART D, PAGE 13

	Month	Year
LAST WORKED	☐☐	19 ☐☐

B8. What kind of work were you doing on this last job--that is, what was your occupation? *Please be as specific as possible, including any area of specialization.*

EXAMPLE: *High school teacher - Math*

_____
_____
_____
_____

B9. Using the JOB CODES (LIST B: pp. 20-21), choose the code that best describes the work you were doing on this last job.

CODE ☐☐☐ ☐ ***SKIP to Part C, page 12***

NOTE: Job codes range from 010 to 500

B10. *(IF WORKING DURING WEEK OF APRIL 15)* **Counting all jobs you held during the week of April 15, 1997, was your typical work week 35 hours or more per week?**

1 ☐ Yes, worked 35 or more hours ☐ ***SKIP to shaded box, page 7***
2 ☐ No, worked less than 35 hours per week

B10a. *(IF LESS THAN 35 HOURS)* **During the week of April 15, 1997, did you want to work a full-time work week of 35 or more hours?**

1 ☐ Yes
2 ☐ No

B11. *(IF LESS THAN 35 HOURS)* **What were your reasons for working a part-time work week of less than 35 hours during the week of April 15, 1997?**

Mark (X) Yes or No for each

		Year Retired	YES	NO
a.	Retired or semi-retired → 19	☐☐	1 ☐	2 ☐
b.	Student		1 ☐	2 ☐
c.	Family responsibilities		1 ☐	2 ☐
d.	Chronic illness or permanent disability		1 ☐	2 ☐
e.	Suitable full-time work week job not available		1 ☐	2 ☐
f.	Did not need or want to work full time		1 ☐	2 ☐
g.	Other - *Specify* ☐		1 ☐	2 ☐

Please answer the next series of questions for your principal job held during the week of April 15, 1997, that is, the job in which you worked the most hours during the week of April 15, 1997. A second job, if held, will be covered later.

B12. Which of the following categories best describes your employer during the week of April 15, 1997?
IF EMPLOYER WAS A SCHOOL: *Mark (X) the type of organizational charter (e.g., mark "state government" for state schools or "local government" for schools run by the local school district. Most private schools are "private not-for-profit".).*

Mark (X) ONLY one

1 ☐ A PRIVATE FOR-PROFIT company, business or individual, paying you wages, salary or commissions
2 ☐ A PRIVATE NOT-FOR-PROFIT, tax-exempt, or charitable organization
3 ☐ SELF-EMPLOYMENT in own NOT INCORPORATED business, professional practice, or farm
4 ☐ SELF-EMPLOYMENT in own INCORPORATED business, professional practice, or farm
5 ☐ Local GOVERNMENT (e.g., city, county)
6 ☐ State GOVERNMENT
7 ☐ U.S. military service, active duty, or Commissioned Corps (e.g., USPHS, NOAA)
8 ☐ U.S. GOVERNMENT as a civilian employee
91 ☐ Other - *Specify*

B13. Was your principal employer an educational institution?

1 ☐ Yes
2 ☐ No ☐ ***SKIP to B15a***

B13a. *(IF EDUCATIONAL INSTITUTION)* **Was this educational institution . . .**

Mark (X) ONLY one

1 ☐ A preschool, elementary, or middle school or system
2 ☐ A secondary school or system
3 ☐ A 2-year college, junior college, or technical institute
4 ☐ A 4-year college or university, other than a medical school
5 ☐ A medical school (including university-affiliated hospital or medical center)
6 ☐ A university-affiliated research institute
91 ☐ Something else - *Specify*

SKIP to B15b

B15a. Thinking about your April 1997 employer's main business, (that is, what that employer makes or does), under which of the following categories does that employer's *main business* best fit?

IF PRINCIPAL EMPLOYER HAD MORE THAN ONE TYPE OF BUSINESS: *Please answer for the type of business primarily performed at the location where you worked.*

Mark (X) ONLY one

1 ☐ Agriculture, forestry, or fishing
2 ☐ Biotechnology
3 ☐ Construction or mining
4 ☐ Education
5 ☐ Finance, insurance or real estate services
6 ☐ Health services
7 ☐ Information technology or computer services
8 ☐ All other services (e.g., social, legal, business)
9 ☐ Manufacturing
10 ☐ Public administration/government
11 ☐ Research - *Specify*
12 ☐ Transportation services, utilities or communications
13 ☐ Wholesale or retail trade
91 ☐ Other - *Specify*

B15b. Counting all locations where this employer operated, how many people worked for your April 1997 employer? Your best estimate is fine.

Mark (X) ONLY one

1 ☐ Under 10 employees
2 ☐ 10-24 employees
3 ☐ 25-99 employees
4 ☐ 100-499 employees
5 ☐ 500-999 employees
6 ☐ 1,000-4,999 employees
7 ☐ 5,000+ employees

B15c. Did your April 1997 employer come into being as a new business within the past 5 years?

1 ☐ Yes
2 ☐ No

B15d. Who was your principal employer during the week of April 15, 1997?

IF MORE THAN ONE JOB: *Record employer for whom you worked the most hours that week.*

IF EMPLOYER HAD MORE THAN ONE LOCATION: *Record location where you usually worked.*

Employer Name: _____

City or Town: _____

State/Foreign Country: _____

ZIP Code: _____

The next several questions ask about some alternative or temporary working relationships that people may have with their employers.

B15e. Did any of the following apply to your relationship with your principal employer during the week of April 15, 1997?

Mark (X) Yes or No for each	YES	NO
a. Self-employed working as an independent contractor, independent consultant, free lance worker or otherwise self-employed	1 ☐	2 ☐
b. Your principal employer contracted out your services to other organizations (not including temporary help or employment agencies)	1 ☐	2 ☐
c. Working through a temporary help or employment agency	1 ☐	2 ☐
d. Working on an "as needed", "seasonal" or short term basis	1 ☐	2 ☐
e. Job sharing	1 ☐	2 ☐
f. Working from home for 50 percent or more of your work time	1 ☐	2 ☐
g. Some other alternative or temporary working arrangement - *Specify* ☐	1 ☐	2 ☐

B15e_1. Did you answer "yes" to any of the categories in B15e?

1 ☐ Yes
2 ☐ No ☐ ***SKIP to B15h*, page 9**

B15f. *(IF YES)* **What were your reasons for having an alternative or temporary work arrangement during the week of April 15, 1997?**

For this study, being self-employed is considered an alternative working relationship.

Mark (X) Yes or No for each	YES	NO
1. Schedule flexibility	1 ☐	2 ☐
2. Only type of work you could find	1 ☐	2 ☐
3. To gain experience that may lead to a permanent job	1 ☐	2 ☐
4. Better pay	1 ☐	2 ☐
5. Family-related reasons (e.g., children, spouse's job moved)	1 ☐	2 ☐
6. In school or some type of training program	1 ☐	2 ☐
7. Enjoy being your own boss	1 ☐	2 ☐
8. Employer changed your status to temporary	1 ☐	2 ☐
9. Other - *Specify* ☐	1 ☐	2 ☐

B15g. Which two factors in B15f represent your most important reasons for having an alternative or temporary working arrangement or being self-employed? *Enter the number of the appropriate reason from B15f above.*

1. ☐ MOST important reason

2. ☐ SECOND MOST important reason (Enter "0" if only one reason selected in B15f.)

B15h. If you could have any type of working arrangement you wanted, would your first choice be . . .

Mark (X) ONLY one

1 ☐ A permanent job (either full time or part time), that is a job with no set end date

2 ☐ Being self-employed

3 ☐ Some other type of working arrangement - *Specify*

B15i. Concerning your principal job during the week of April 15, 1997, were any of the following benefits available to you, even if you chose not to take them?

Mark (X) Yes or No for each	YES	NO
a. Health insurance that was at least partially paid by your employer	1 ☐	2 ☐
b. A pension plan or a retirement plan to which your employer contributed	1 ☐	2 ☐
c. A profit-sharing plan	1 ☐	2 ☐
d. Paid vacation, sick or personal days	1 ☐	2 ☐

B16. What kind of work were you doing on your principal job held during the week of April 15, 1997--that is, what was your occupation? *Please be as specific as possible, including any area of specialization.*

EXAMPLE: *High school teacher - Math*

B17. Using the JOB CODES (LIST B: pp. 20-21), choose the code that best describes the work you were doing on your principal job during the week of April 15, 1997.

CODE ☐☐☐ NOTE: Job codes range from 010 to 500

B17_1. Did you record job code "141" (executive, manager, or administrator) in B17?

1 ☐ Yes

2 ☐ No ☐ ***SKIP to B19***

B18a. *(IF YES)* **Did your duties on this job require the technical expertise of a bachelor's degree or higher in . . .**

Mark (X) Yes or No for each	YES	NO
a. Engineering, computer science, math, or the natural sciences	1 ☐	2 ☐
b. The social sciences	1 ☐	2 ☐
c. Some other field (e.g., health or business) - *Specify*	1 ☐	2 ☐

B19. During what month and year did you start this job, (that is, your principal job held during the week of April 15, 1997)?

JOB STARTED Month ☐☐ **19** Year ☐☐

B20. As of the week of April 15, 1997, were you licensed or certified in your occupation? *Do not include academic degrees (e.g., BA, MA, PhD).*

1 ☐ Yes

2 ☐ No

B21. Thinking about the relationship between your work and your education, to what extent was your work on your principal job held during the week of April 15, 1997, related to your highest degree field? *For "highest degree," please do not include any degrees awarded after April 1997.*

Mark (X) ONLY one

1 ☐ Closely related
2 ☐ Somewhat related → ***SKIP to B24***
3 ☐ Not related

B22. *(IF NOT RELATED)* **Did any of these factors influence your decision to work in an area OUTSIDE THAT DEGREE FIELD?**

Mark (X) Yes or No for each	YES	NO
1. Pay or promotion opportunities	1 ☐	2 ☐
2. Working conditions (e.g., hours, equipment, working environment)	1 ☐	2 ☐
3. Job location	1 ☐	2 ☐
4. Change in career or professional interests	1 ☐	2 ☐
5. Family-related reasons (e.g., children, spouse's job moved)	1 ☐	2 ☐
6. Job in field not available	1 ☐	2 ☐
7. Other reason - *Specify* ☐	1 ☐	2 ☐

B23. Which two factors in B22 represent your most important reasons for working in an area outside that degree field? *Enter number of appropriate factor from B22 above.*

1. ☐ MOST important reason

2. ☐ SECOND MOST important reason *(Enter "0" if only one factor selected in B22.)*

B24. The next question is about your work activities on the principal job you held during the week of April 15, 1997. Which of the following work activities occupied 10 percent or more of your time during a typical work week on this job?

Mark (X) Yes or No for each	YES	NO
1. Accounting, finance, contracts	1 ☐	2 ☐
2. Applied research - study directed toward gaining scientific knowledge to meet a recognized need	1 ☐	2 ☐
3. Basic research - study directed toward gaining scientific knowledge primarily for its own sake	1 ☐	2 ☐
4. Computer applications, programming, systems development	1 ☐	2 ☐
5. Development - using knowledge gained from research for the production of materials, devices	1 ☐	2 ☐
6. Design of equipment, processes, structures, models	1 ☐	2 ☐
7. Employee relations - including recruiting, personnel development, training	1 ☐	2 ☐
8. Managing and supervising	1 ☐	2 ☐
9. Production, operations, maintenance (e.g., truck driving, machine tooling, auto/machine repairing)	1 ☐	2 ☐
10. Professional services (e.g., health care, counseling, financial services, legal services)	1 ☐	2 ☐
11. Sales, purchasing, marketing, customer service, public relations	1 ☐	2 ☐
12. Quality or productivity management	1 ☐	2 ☐
13. Teaching	1 ☐	2 ☐
14. Other - *Specify* ☐	1 ☐	2 ☐

B25. On which two activities in B24 did you work the most hours during a typical week on this job? *Enter number of appropriate activity from B24 above.*

1. ☐☐ Activity MOST hours

2. ☐☐ Activity SECOND MOST hours *(Enter "0" if only one activity selected in B24.)*

B26. Did you supervise the work of others as part of your principal job held during the week of April 15, 1997?

MARK "YES": *If you assigned duties to workers and recommended or initiated personnel actions such as hiring, firing, or promoting.*

TEACHERS: *Do not count students.*

1 ☐ Yes
2 ☐ No ☐ ***SKIP to B28***

B27. *(IF YES)* **How many people did you typically . . .**

IF NONE: *Enter "0."*

	Number Supervised
a. Supervise directly?	
b. Supervise through subordinate supervisors?. .	

B28. Before deductions, what was your basic annual salary on this job as of the week of April 15, 1997? (Do not include bonuses, overtime, or additional compensation for summertime teaching or research.)

IF NOT SALARIED: *Please estimate your earned income, excluding business expenses.*

Include tips as part of salary.

$ _____ .00
Basic Annual Salary/Earned Income

B29. During a typical week on this job, how many hours did you usually work?

NUMBER OF HOURS PER WEEK

B29PAID. And, for how many hours during a typical week were you paid?

NUMBER OF HOURS PER WEEK

B29WEEKS. Was your salary based on a full year, that is, 52 weeks, or something less than 52 weeks?

1 ☐ 52 weeks ☐ ***SKIP to B30***
2 ☐ Something else

B29a. Including paid vacation and paid sick leave, on how many weeks per year was your salary based?

NUMBER OF WEEKS PER YEAR

B30. During the week of April 15, 1997, was any of your work on this job supported by contracts or grants from the U.S. government?

FEDERAL EMPLOYEES: *Please answer "No."*

Mark (X) ONLY one

1 ☐ Yes
2 ☐ No ☐ ***SKIP to B32a, page 12***

B31. *(IF YES)* **Which Federal agencies or departments were supporting your work during the week of April 15, 1997?**

Mark (X) all that apply

1 ☐ Agency for International Development (AID)
2 ☐ Agriculture Department
3 ☐ Commerce Department
4 ☐ Defense Department (DOD)
5 ☐ Department of Education (include NCES, OERI, FIPSE, FIRST)
6 ☐ Energy Department (DOE)
7 ☐ Environmental Protection Agency (EPA)
8 ☐ Health and Human Services Department (EXCLUDING NIH)
9 ☐ Interior Department
10 ☐ National Aeronautics and Space Administration (NASA)
11 ☐ National Institutes of Health (NIH)
12 ☐ National Science Foundation (NSF)
13 ☐ Transportation Department (DOT)
91 ☐ Other - *Specify*

B32a. How would you rate your overall satisfaction with the job you held during the week of April 15, 1997?

Mark (X) ONLY one

1 ☐ Very satisfied
2 ☐ Somewhat satisfied
3 ☐ Somewhat dissatisfied
4 ☐ Very dissatisfied

B35. During the week of April 15, 1997, were you working for pay (or profit) at a second job (or business), including part-time, evening, or weekend work?

1 ☐ Yes
2 ☐ No ☐ ***SKIP to Part C***

B36. *(IF YES)* **What kind of work were you doing on your second job during the week of April 15, 1997--that is, what was your occupation?** *Please be as specific as possible, including any area of specialization.*

IF MORE THAN TWO JOBS THAT WEEK: *Answer for the job at which you worked the second most hours.*

EXAMPLE: *High school teacher - Math*

_____
_____
_____
_____

B37. Using the JOB CODES (LIST B: pp. 20-21), choose the code that best describes the work you were doing on your second job during the week of April 15, 1997.

CODE ☐☐☐ NOTE: Job codes range from 010 to 500

B39. To what extent was your work on this second job related to your highest degree field? *For "highest degree," please do not include any degrees awarded after April 1997.*

Mark (X) ONLY one

1 ☐ Closely related
2 ☐ Somewhat related
3 ☐ Not related

PART C - Other Work-Related Information

C2. During the past year, did you attend any professional society or association meetings or conferences? *Please include regional, national, or international meetings.*

1 ☐ Yes
2 ☐ No

C3. To how many national or international professional societies or associations do you currently belong?

Number ☐☐ **OR** ☐ NONE

C4. During the past year, did you attend any work-related workshops, seminars, or other work-related training activities? *Do not include college courses.*

Do not include professional meetings unless you attended a special training session conducted at a meeting or conference.

1 ☐ Yes
2 ☐ No ☐ ***SKIP to Part D, page 13***

C5. *(IF YES)* **During the past year, in which of the following areas did you attend work-related workshops, seminars, or other work-related training activities?**

Mark (X) Yes or No for each	YES	NO
a. Management or supervisor training	1 ☐	2 ☐
b. Training in your occupational field	1 ☐	2 ☐
c. General professional training (e.g., public speaking, business writing)	1 ☐	2 ☐
d. Other work-related training - *Specify* ☐	1 ☐	2 ☐

C6. For which of the following reasons did you attend training activities during the past year?

Mark (X) Yes or No for each

	YES	NO
1. To facilitate a change in your occupational field	1 ☐	2 ☐
2. To gain further skills or knowledge in your occupational field	1 ☐	2 ☐
3. For licensure or certification	1 ☐	2 ☐
4. To increase opportunities for promotion, advancement or higher salary	1 ☐	2 ☐
5. To learn skills or knowledge needed for a recently acquired position	1 ☐	2 ☐
6. Required or expected by employer	1 ☐	2 ☐
7. Other - *Specify* ☐	1 ☐	2 ☐

C7. Which of the reasons marked in C6 represents your most important reason for attending training activities? *Enter number of appropriate reason from C6 above.*

☐ MOST important reason

PART D - Background Information

D1. What is your birthdate?

Month ☐☐ Day ☐☐ 19 ☐☐

D2. In what U.S. state, U.S. territory, or foreign country were you born?

State/Territory: _____ **OR**

Foreign Country: _____

D4DAD. What is the highest level of education completed by your father or male guardian?

Mark (X) ONLY one

1 ☐ Less than high school diploma
2 ☐ High school diploma or equivalent
3 ☐ Some college, vocational, or trade school (including 2-year degrees)
4 ☐ Graduated from a 4-year college (Bachelor's degree)
5 ☐ At least some graduate or professional school

D4MOM. What is the highest level of education completed by your mother or female guardian?

Mark (X) ONLY one

1 ☐ Less than high school diploma
2 ☐ High school diploma or equivalent
3 ☐ Some college, vocational, or trade school (including 2-year degrees)
4 ☐ Graduated from a 4-year college (Bachelor's degree)
5 ☐ At least some graduate or professional school

D5. Are you of Hispanic origin or descent?

1 ☐ Yes
2 ☐ No ☐ ***SKIP to D7***

D6. Which of the following categories best describes your Hispanic descent?

IF MORE THAN ONE CATEGORY APPLIES: *Please select the one you consider the most important part of your background.*

Mark (X) ONLY one

1 ☐ Mexican, Mexican-American, Chicano
2 ☐ Puerto Rican
3 ☐ Cuban
91 ☐ Some other Hispanic descent - *Specify*

D7. Are you . . .

Mark (X) ONLY one

1 ☐ White
2 ☐ Black or African American
3 ☐ Asian or Pacific Islander
4 ☐ American Indian or Alaskan Native (e.g., Eskimo, Aleut)
91 ☐ Other - *Specify*

D8. Are you . . .

1 ☐ Male
2 ☐ Female

D9. During the week of April 15, 1997, were you . . .

Mark (X) ONLY one

1 ☐ A U.S. citizen
2 ☐ Not a U.S. citizen ☐ ***SKIP to D9_2***

D9_1. *(IF U.S. CITIZEN)* **Were you . . .**

Mark (X) ONLY one

1 ☐ A native-born citizen
2 ☐ A naturalized citizen
→ ***SKIP to D12***

D9_2. *(IF NON-U.S. CITIZEN)* **During the week of April 15, 1997, did you have . . .**

Mark (X) ONLY one

3 ☐ A Permanent U.S. Resident Visa
4 ☐ A Temporary U.S. Resident Visa
5 ☐ No U.S. Visa - You were living outside the United States

D10. *(IF NON-U.S. CITIZEN)* **Of which country were you a citizen during the week of April 15, 1997?**

COUNTRY

D12. During the week of April 15, 1997, were you living in the United States or one of its territories, or were you living in another country?

1 ☐ United States or one of its territories
2 ☐ Another country

D13. As of the week of April 15, 1997, were you . . .

Mark (X) ONLY one

1 ☐ Married ☐ ***GO to D14, page 15***
2 ☐ Widowed
3 ☐ Separated
4 ☐ Divorced
5 ☐ Never Married
→ ***SKIP to D16, page 15***

D14. *(IF MARRIED)* **During the week of April 15, 1997, was your spouse working for pay (or profit) at a full-time or part-time job?**

1 ☐ Yes, full-time
2 ☐ Yes, part-time
3 ☐ No ☐ ***SKIP to D16***

D15. *(IF YES)* **Did your spouse's duties on this job require the technical expertise of a bachelor's degree or higher in . . .**

Mark (X) Yes or No for each	YES	NO
a. Engineering, computer science, math or the natural sciences	1 ☐	2 ☐
b. The social sciences	1 ☐	2 ☐
c. Some other field (e.g., health or business) - *Specify* ☐	1 ☐	2 ☐

D16. **During the week of April 15, 1997, did you have any children <u>living with you</u> as part of your family?**
Only count children who lived with you at least 50 percent of the time.

1 ☐ Yes
2 ☐ No ☐ ***SKIP to D18, page 16***

D17. *(IF YES)* **How many of these children living with you as part of your family were . . .**

IF NO CHILDREN IN A CATEGORY: *Enter "0."*

	Number of Children
e. Under age 2	☐
f. Aged 2-5	☐
b. Aged 6-11	☐
c. Aged 12-17	☐
d. Aged 18 or older	☐

PLEASE go to D18, page 16

The next question is designed to help us better understand the career paths of individuals with different physical abilities.

D18. What is the usual degree of difficulty you have with . . .

	MARK (X) ONE FOR EACH LINE				
	None	Slight	Moderate	Severe	Unable to Do
a. SEEING words or letters in ordinary newsprint (with glasses/contact lenses if you usually wear them)	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐
b. HEARING what is normally said in conversation with another person (with hearing aid, if you usually wear one)	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐
c. WALKING without human or mechanical assistance or using stairs	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐
d. LIFTING or carrying something as heavy as 10 pounds, such as a bag of groceries	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐

D18_1. ☐ ☐MARK (X) THIS BOX IF YOU ANSWERED "NONE" TO ALL ACTIVITIES IN D18 AND SKIP TO D22

D19. What is the earliest age at which you first began experiencing any difficulties in any of these areas?

AGE ☐☐ **OR** ☐ SINCE BIRTH

D22. In case we need to clarify some of the information you have provided, please provide an address, telephone number(s), and any e-mail address (if applicable) where you can be reached.

Number and Street/Apt. No.

City/Town | State | Zip Code - Plus 4

Country (If outside U.S.)

Telephone Numbers:

Daytime Area Code ☐☐☐ - Number ☐☐☐ - ☐☐☐☐

Evening Area Code ☐☐☐ - Number ☐☐☐ - ☐☐☐☐

E-mail Address(es):

D22a. Does the name appearing on the back cover of this questionnaire match your current name?

☐ Yes ☐ ***SKIP to D21 below***
☐ No

D22b. Please provide your current name.

First Name	Middle Name	Last Name

D21. Since we are interested in how education and employment change over time, we may be recontacting you in the future. To help us contact you, please provide the name, address, and telephone number of someone who is likely to know where you can be reached. Do not include someone who lives in your household.
As with all the information provided in this questionnaire, complete confidentiality will be provided. This person will only be contacted if we have trouble contacting you in the future.

First Name	Middle Name	Last Name

Number and Street/Apt. No.

City/Town	State	Zip Code - Plus 4

Country (If outside U.S.)

Area Code ☐☐☐ - Number ☐☐☐ - ☐☐☐☐

THANK YOU FOR COMPLETING THE QUESTIONNAIRE

LIST A: EDUCATION CODES

This list is ordered alphabetically. The titles in bold type are broad fields of study. To make sure you have found the BEST code, please review ALL broad categories before making your choice. If you cannot find the code that BEST describes your field of study, use the "OTHER" code under the most appropriate broad field in bold print. If none of the codes fit your field of study, use Code 995.

Agriculture Business and Production
601 Agriculture, economics (also see 655 and 923)
602 OTHER agricultural business and production

Agricultural Sciences
605 Animal sciences
606 Food sciences and technology (also see 638)
607 Plant sciences (also see 633)
608 OTHER agricultural sciences

610 **Architecture/Environmental Design**
(for architectural engineering, see 723)

620 **Area/Ethnic Studies**

Biological/Life Sciences
631 Biochemistry and biophysics
632 Biology, general
633 Botany (also see 607)
634 Cell and molecular biology
635 Ecology
636 Genetics, animal and plant
637 Microbiology
638 Nutritional sciences (also see 606)
639 Pharmacology, human and animal (also see 788)
640 Physiology, human and animal
641 Zoology, general
642 OTHER biological sciences

Business Management/Administrative Services
651 Accounting
652 Actuarial science
653 Business administration and management
654 Business, general
655 Business/managerial economics (also see 601 and 923)
656 Business marketing/marketing mgmt.
657 Financial management
658 Marketing research
843 Operations research
659 OTHER business management/admin. services

Communications
661 Communications, general
662 Journalism
663 OTHER communications

Computer and Information Sciences
671 Computer/information sciences, general
672 Computer programming
673 Computer science (also see 727)
674 Computer systems analysis
675 Data processing technology
676 Information services and systems
677 OTHER computer and information sciences

Conservation/Renewable Natural Resources
680 Environmental science studies
681 Forestry sciences
682 OTHER conservation/renewable natural resources

690 **Criminal Justice/Protective Services**
(also see 922)

Education
701 Administration
702 Computer teacher education
703 Counselor education/guidance services
704 Educational psychology
705 Elementary teacher education
706 Mathematics teacher education
707 Physical education/coaching
708 Pre-elementary teacher education
709 Science teacher education
710 Secondary teacher education
711 Special education
712 Social science teacher education
713 OTHER education

Engineering
721 Aerospace, aeronautical, astronautical engineering
722 Agricultural engineering
723 Architectural engineering
724 Bioengineering and biomedical engineering
725 Chemical engineering
726 Civil engineering
727 Computer/systems engineering (also see 673)
728 Electrical, electronics, communications engineering (also see 751)
729 Engineering sciences, mechanics, physics
730 Environmental engineering
731 General engineering
732 Geophysical engineering
733 Industrial engineering (also see 752)
734 Materials engineering, including ceramics and textiles
735 Mechanical engineering (also see 753)
736 Metallurgical engineering
737 Mining and minerals engineering
738 Naval architecture and marine engineering
739 Nuclear engineering
740 Petroleum engineering
741 OTHER engineering

LIST A: EDUCATION CODES - Continued

Engineering-Related Technologies
751 Electrical and electronic technologies
752 Industrial production technologies
753 Mechanical engineering-related technologies
754 OTHER engineering-related technologies

Languages, Linguistics, Literature/Letters
760 English Language and Literature/Letters
771 Linguistics
772 OTHER foreign languages and literature

Health Professions and Related Sciences
781 Audiology and speech pathology
782 Health services administration
783 Health/medical assistants
784 Health/medical technologies
785 Medical preparatory programs (e.g., pre-dentistry, pre-medical, pre-veterinary)
786 Medicine (e.g., dentistry, optometry, osteopathic, podiatry, veterinary)
787 Nursing (4 years or longer program)
788 Pharmacy (also see 639)
789 Physical therapy and other rehabilitation/ therapeutic services
790 Public health (including environmental health and epidemiology)
791 OTHER health/medical sciences

800 **Home Economics**

810 **Law/Prelaw/Legal Studies**

820 **Liberal Arts/General Studies**

830 **Library Science**

Mathematics
841 Applied (also see 843, 652)
842 Mathematics, general
843 Operations research
844 Statistics
845 OTHER mathematics

850 **Parks, Recreation, Leisure, and Fitness Studies**

Philosophy, Religion, and Theology
861 Philosophy of science
862 OTHER philosophy, religion, theology

Physical Sciences
871 Astronomy and astrophysics
872 Atmospheric sciences and meteorology
631 Biochemistry
873 Chemistry
874 Earth sciences
680 Environmental science studies
875 Geology
876 Geological sciences, other
877 Oceanography
878 Physics
879 OTHER physical sciences

Psychology
891 Clinical
892 Counseling
704 Educational
893 Experimental
894 General
895 Industrial/Organizational
896 Social
897 OTHER psychology

Public Affairs
901 Public administration
902 Public policy studies
903 OTHER public affairs

910 **Social Work**

Social Sciences and History
921 Anthropology and archeology
922 Criminology (also see 690)
923 Economics (also see 601 and 655)
924 Geography
925 History of science
926 History, other
927 International relations
928 Political science and government
929 Sociology
910 Social work
930 OTHER social sciences

Visual and Performing Arts
941 Dramatic arts
942 Fine arts, all fields
943 Music, all fields
944 OTHER visual and performing arts

995 OTHER FIELDS (Not Listed)

LIST B: JOB CODES LIST

This list is ordered ALPHABETICALLY. The titles in bold type are broad job categories. To make sure you have found the BEST code, please review ALL broad categories before making your choice. If you cannot find the code that BEST describes your job, use the "OTHER" code under the most appropriate broad category in bold print. If none of the codes fit your job, use Code 500.

010 **Artists, Broadcasters, Editors, Entertainers, Public Relations Specialists, Writers**

Biological/Life Scientists
021 Agricultural and food scientists
022 Biochemists and biophysicists
023 Biological scientists (e.g., botanists, ecologists, zoologists)
024 Forestry and conservation scientists
025 Medical scientists (excluding practitioners)
026 Technologists & technicians in the biological/life sciences
027 OTHER biological/life scientists

Clerical/Administrative Support
031 Accounting clerks, bookkeepers
032 Secretaries, receptionists, typists
033 OTHER administrative (e.g., record clerks, telephone operators)

040 **Clergy & Other Religious Workers**

Computer Occupations (Also see 173)
*** Computer engineers (See 087, 088 under Engineering)
051 Computer programmers (business, scientific, process control)
052 Computer system analysts
053 Computer scientists, except system analysts
054 Information systems scientists or analysts
055 OTHER computer, information science occupations

*** **Consultants** *(Select the code that comes closest to your usual area of consulting)*

070 **Counselors, Educational & Vocational** (Also see 236)

Engineers, Architects, Surveyors
081 Architects
*** Engineers (Also see 100-103)
082 Aeronautical, aerospace, astronautical engineer
083 Agricultural engineer
084 Bioengineering & biomedical engineer
085 Chemical engineer
086 Civil, including architectural & sanitary engineer

*** Engineers (continued)
087 Computer engineer - hardware
088 Computer engineer - software
089 Electrical, electronic engineer
090 Environmental engineer
091 Industrial engineer
092 Marine engineer or naval architect engineer
093 Materials or metallurgical engineer
094 Mechanical engineer
095 Mining or geological engineer
096 Nuclear engineer
097 Petroleum engineer
098 Sales engineer
099 Other engineer
*** Engineering Technologists and Technicians
100 Electrical, electronic, industrial, mechanical
101 Drafting occupations, including computer drafting
102 Surveying and mapping
103 OTHER engineering technologists and technicians
104 Surveyors

110 **Farmers, Foresters & Fishermen**

Health Occupations
111 Diagnosing/Treating Practitioners (e.g., dentists, optometrists, physicians, psychiatrists, podiatrists, surgeons, veterinarians)
112 Registered nurses, pharmacists, dieticians, therapists, physician assistants
236 Psychologists, including clinical
113 Health Technologists & Technicians (e.g., dental hygienists, health record technologist/technicians, licensed practical nurses, medical or laboratory technicians, radiologic technologists/technicians)
114 OTHER health occupations

120 **Lawyers, Judges**

130 **Librarians, Archivists, Curators**

Managers, Executives, Administrators
(Also see 151-153)
141 Top and mid-level managers, executives, administrators (people who manage other managers)
*** All other managers, including the self-employed - *Select the code that comes closest to the field you manage*

LIST B: JOB CODES LIST - Continued

Management-Related Occupations (Also see 141)
151 Accountants, auditors, and other financial specialists
152 Personnel, training, and labor relations specialists
153 OTHER management related occupations

Mathematical Scientists
171 Actuaries
172 Mathematicians
173 Operations research analysts, modelling
174 Statisticians
175 Technologists and technicians in the mathematical sciences
176 OTHER mathematical scientists

Physical Scientists
191 Astronomers
192 Atmospheric and space scientists
193 Chemists, except biochemists
194 Geologists, including earth scientists
195 Oceanographers
196 Physicists
197 Technologists and technicians in the physical sciences
198 OTHER physical scientists

*** **Research Associates/Assistants**
(Select the code that comes closest to your field)

Sales and Marketing
200 Insurance, securities, real estate, & business services
201 Sales Occupations - Commodities Except Retail (e.g., industrial machinery/equipment/supplies, medical and dental equip/supplies)
202 Sales Occupations - Retail (e.g., furnishings, clothing, motor vehicles, cosmetics)
203 OTHER marketing and sales occupations

Service Occupations, Except Health (Also see 111-114)
221 Food Preparation and Service (e.g., cooks, waitresses, bartenders)
222 Protective services (e.g., fire fighters, police, guards)
223 OTHER service occupations, except health

Social Scientists
231 Anthropologists
232 Economists
233 Historians, science and technology
234 Historians, except science and technology
235 Political scientists
236 Psychologists, including clinical (Also see 070)
237 Sociologists
238 OTHER social scientist

240 **Social Workers**

Teachers/Professors
251 Pre-Kindergarten and kindergarten
252 Elementary
253 Secondary - computer, math, or sciences
254 Secondary - social sciences
255 Secondary - other subjects
256 Special education - primary and secondary
257 OTHER precollegiate area
*** Postsecondary
271 Agriculture
272 Art, Drama, and Music
273 Biological Sciences
274 Business Commerce and Marketing
275 Chemistry
276 Computer Science
277 Earth, Environmental, and Marine Science
278 Economics
279 Education
280 Engineering
281 English
282 Foreign Language
283 History
284 Home Economics
285 Law
286 Mathematical Sciences
287 Medical Science
288 Physical Education
289 Physics
290 Political Science
291 Psychology
292 Social Work
293 Sociology
294 Theology
295 Trade and Industrial
296 OTHER health specialties
297 OTHER natural sciences
298 OTHER social sciences
299 OTHER Postsecondary

Other Professions
401 Construction trades, miners & well drillers
402 Mechanics and repairers
403 Precision/production occupations (e.g., metal workers, woodworkers, butchers, bakers, printing occupations, tailors, shoemakers, photographic process)
404 Operators and related occupations (e.g., machine set-up, machine operators and tenders, fabricators, assemblers)
405 Transportation/material moving occupations

500 OTHER OCCUPATIONS (Not Listed)

THANK YOU FOR COMPLETING THE QUESTIONNAIRE

Please return the completed form in the postage-paid envelope provided. If you lose the envelope and want another, or if you have any questions, please call Ronnie Goodman at 1-800-937-8283. Our address is:

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Rockville, MD 20850
Attn: Cindy Gray, TA 2140F