The Missing Middle:Aligning Education and the Knowledge Economy

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Introduction

While no one can predict the future, today's economic and demographic realities suggest the opportunities and challenges that will face America in the years to come. The U.S. economy has already undergone dramatic changes in the latter part of the twentieth century. The extension of product and labor markets has expanded global competition, and the infusion of technology has been widespread across all sectors of the economy. Both of these forces have affected the structure of jobs and the way we work, fueling increases in educational attainment and the demand for skill.

The kind of education and skill demanded has also changed. General reasoning, problem-solving, and behavioral skills as well as a positive cognitive style are increasingly needed to supplement the narrow cognitive and occupational skills sought in a more directed work environment. Access to good jobs and earnings in the American system are driven by the complementarities between these soft skills, general education beyond high school, occupational preparation, and the resultant access to learning and technology on the job.[1]

As we begin the twenty-first century, our ability to produce and disseminate education will increasingly determine our nation's economic competitiveness as we shift from an industrial to an information economy. Education facilitates the current transition in two ways: First, the initial stock of education in individual nations determines growth potential in the new information economy. Countries whose populations have high levels of education are fertile soil for information-based technology (Romer, 1990).[2]

Second, increases in a country's overall level of educational attainment causes corresponding increases in their overall rate of economic growth (Topel, 1998; Krueger and Lindahl, 1999).[3]

But increases in the demand for skilled workers can have varying effects on individual workers. Ratcheted-up skill requirements, while beneficial for the most educated and skilled workers, are ever more problematic for the least educated and skilled.[4] The United States has increasingly turned to workers with at least some college or postsecondary training to fulfill a wide variety of labor-market slots, leaving the least educated workers with few opportunities to access good-paying jobs.[5] Currently, almost six in ten jobs are held by workers with at least some college, compared with two in ten in 1959. Even more stunning is the fact that the wage premium for college-educated workers, compared with high school educated workers, has increased by almost 70% since the early 1980s in spite of the fact that the supply of college-educated workers has increased by 60% over the same period.

The increasing divide between those with skills at the "some college" level and those with skills typical of people with high school or less has increased income dispersion in the United States to the point where we have surpassed Great Britain as the nation with the widest income differences among the world's advanced economies. Currently, about 40% of American adults do not have skills typical of those with some college, but the fastest job growth will occur in those jobs in which incumbent workers currently have skill levels that reflect at least some postsecondary education or training. Looking into the future, there is every reason to believe that the demand for college-educated workers will continue to grow along with the income divide between those who have some postsecondary education and those who do not.

The growing importance of education in overall economic growth and individual opportunity creates two primary economic challenges for education reformers. The first is to meet the need for a greater quantity and quality of human capital necessary to foster overall growth in the new knowledge-based economy. The second is to reduce the growing differences in family incomes by closing the gap between the nation's education-haves and education-have-nots.

Absent of reforms allowing us to produce and distribute education cheaper, faster, and better, we may not be able to afford all the education we need to maintain our competitive position or to reduce the gap in earnings between the most and least educated. At a minimum, greater efficiency will require a stronger alignment between curriculum and work requirements as well as stronger relationships between educational institutions and employers.

Strengthening the relationship between education and work

requirements begins with a stronger focus on the "missing middle" in education policy: the years when academic and applied learning overlap between the completion of basic academic preparation and the completion of occupational or professional training.[6] These are the critical years when young adults begin to mix educational experiences with their growing independence in families and communities, and with their early attachment to the world of work and careers. The missing elements at the critical juncture between education and careers are curricula that effectively mix academics and applied learning as well as institutional relationships that create venues for applied learning and successful transitions from school to school and school to work.

For most, the missing middle begins early in high school. At this juncture in the education pipeline, more applied curricula become an effective complement to abstract academic pedagogy in deepening knowledge even among college-bound students. Yet, most college-bound students continue their studies by moving up in the hierarchy of academic disciplines taught in isolated silos via abstract methods. At the same time, general academic content is missing from many high school vocational and general education curricula, creating barriers to the achievement of academic standards as well as barriers to access and success in postsecondary education and training programs.

Relationships also are missing in the years between the completion of basic academic competencies and the final establishment of occupational or professional credentials. At each grade level, applied contexts for learning at work and in the community are rare. Institutional relationships that encourage successful transitions from high school to postsecondary education and training and from school to work are haphazard.

Economic and demographic changes already underway will increase the need to align curricula with work requirements and to create stronger relationships between high schools and colleges, communities, and employers. The economic and technological forces that fuel the demands for access to postsecondary education and training will only accelerate in the future. Demographic trends will bring added pressures. As the baby boomers with postsecondary education retire over the next twenty years, we will be hard pressed to produce a sufficient number of Americans with postsecondary education or training to meet our needs. Shortages of workers with some college-level skills could increase to more than 12 million by 2020.

In addition, we actually may experience a bottleneck in the transition from secondary to postsecondary education as the smaller "Generation X" gives way to a much larger "Generation Y." The added costs of providing postsecondary education for "Generation Y" could reach $19 billion by 2015 (Carnevale and Fry, 2001a). Between now and 2015, we will face a surge in the number of 18- to 24-year-olds that will force hard fiscal choices among the diverse missions in postsecondary institutions. In addition, there will be competition for resources throughout the education pipeline. Preparation for college begins in preschool, and increasing access to postsecondary education requires increases in investment in the quantity and quality of education throughout the entire Pre-K-16 system.

The costs of delivering the education we need will be high, even with successful reforms. But the costs of failure will be even higher. Failure will jeopardize our future competitiveness in the global economy. We are currently number one in the global economic race but our mediocre performance on international assessments of educational quality suggests that our preeminent status is living on borrowed time. Our current edge in global competition is based more on our size and market-based flexibility and less on the quality of our workforce. In the future as the European Union and other global trading coalitions achieve scale and learn flexibility and as financial capital and technology become even more footloose, the quality of human capital will become the decisive competitive edge in global competition. Finally, as retirements and economic change increase the demand for workers with at least some college, income differentials between the most and least skilled will continue to grow, threatening the egalitarian base at the core of our culture.

Where the Jobs Are

Early in this country's history and, in fact, pretty much through our first 200 years, a job was easy to find—especially an entry-level low-skilled job. Throughout our history, the American dream and the American reality have been that people could start at the bottom and, without much formal education, work their way to the top. Even in the modern industrial era beginning in the early twentieth century when college became a requirement for the growing numbers of professionals, getting through high school and then working hard and playing by the rules were enough to secure good jobs for most of the rest of us. But in the past 40 years, the rules have

changed because the global economy has changed.

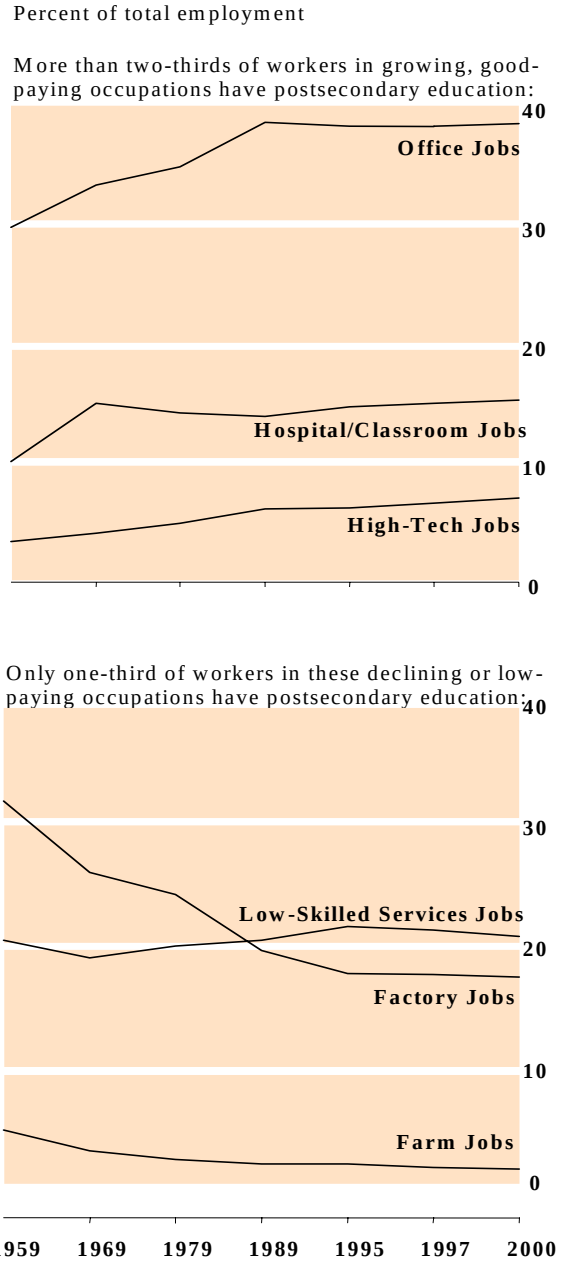
The concentration of jobs in the United States today is radically different than it was in 1959 (Carnevale and Rose, 1998; Carnevale, 1999). In the new economy, the number of high-paying blue-collar jobs available to workers with high school diplomas is shrinking, largely as a result of productivity improvements.[7] The shares of farm and factory jobs have each declined by at least one-half, while the share of jobs in low-skilled services has remained relatively stable (see Figure 1). And farm and factory jobs have not only lost employment shares, but have suffered actual job losses.

New job creation has been concentrated in "knowledge jobs" rather than production jobs or extraction jobs like farming and mining. Tracking the share of total employment shows that jobs in hospitals and classrooms have grown substantially, but white-collar office employment has grown the most—accounting for almost 40% of all jobs in 2000. The overall number and share of technology jobs also has grown, but they still do not represent a large share of all jobs.

The changes in the kinds of jobs available and the skills required to get them have been dramatic. These days, if the competition for jobs were a track meet, one might think of entering the job market as competing in the pole vault: The bar is very low for entry-level jobs with low pay; all a person needs is a high school diploma, at most. The bar is set quite a bit higher for jobs in the middle tier of the economy that require at least some college and preferably an associate degree. And for the really good jobs, the bar is far above one's head—and the only way to vault it is with at least an associate degree and preferably a bachelor's degree.

Figure 1

Employment and Education, 1959-2000



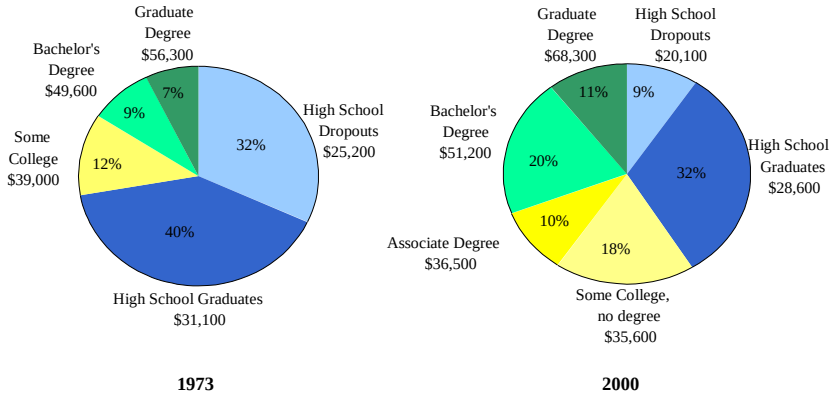
Source: Authors' Analysis of 1960 Census, and Current Population (March 1970-2001).

In 1973, only 28% of prime-age workers[8] had any postsecondary education (see Figure 2). Today, 59% of prime-age workers have attended some type of postsecondary institution. In fact, the proportion of workers with an associate degree, certificate, or some college has more than doubled from 12 to 28% of the workforce—10% hold an associate degree, while 18% have a certificate or some college coursework but not a degree. The proportion of workers with bachelor's degrees also has

Figure 2

Distribution of Education in Jobs, 1973 and 2000

Percent of prime-age (30-59) employment. Earnings in 2000 dollars.

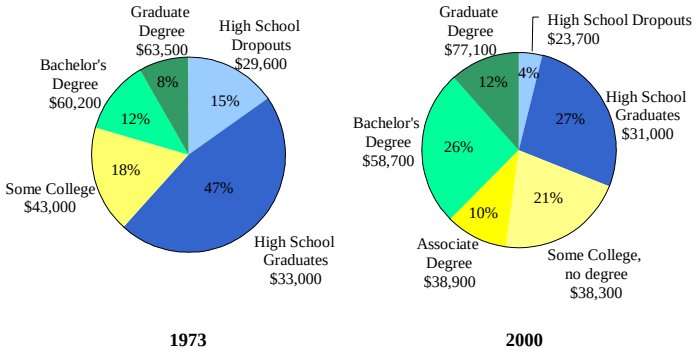


Source: Authors' Analysis of Current Population Survey (March, 1974 & 2001).

Figure 3

Distribution of Education in Office Jobs, 1973 and 2000

Percent of prime-age (30-59) employment. Earnings in 2000 dollars.

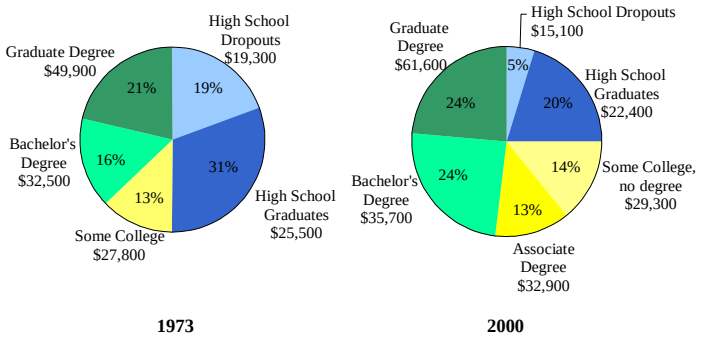


Source: Authors' Analysis of Current Population Survey (March, 1974 & 2001).

Figure 4

Distribution of Education in Education and Health Care Jobs, 1973 and 2000

Percent of prime-age (30-59) employment. Earnings in 2000 dollars.



Source: Authors' Analysis of Current Population Survey (March, 1974 & 2001).

more than doubled, from 9% in 1973 to 20% in 2000, while graduate degree holders have increased at a slightly slower pace, increasing from 7 to 11% over the same period.

These educational changes result from two kinds of labor market shifts: 1) a shift in job creation toward occupations tending to require at least some college; and 2) increasing postsecondary skill requirements in all jobs, which used to require high school or less. The largest share (about 72%) of the increase in postsecondary education requirements comes from "upskilling"—higher demands by employers for jobs that previously did not require any college. A significant but smaller share (about 28%) comes from occupational shifts toward jobs that always required postsecondary education.[9]

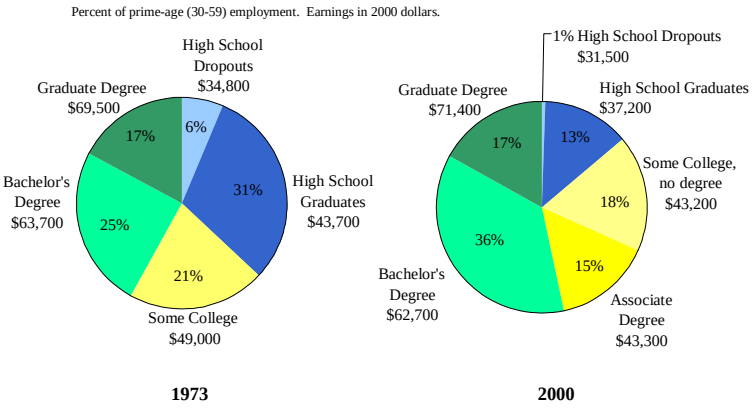
White-Collar Office Jobs

The greatest increase in jobs has occurred in the nation's offices, whether situated on downtown street corners or suburban office complexes. Office workers—managers, accountants, editors, and marketers among other office jobs— are the largest, fastest-growing, and generally best-paid group of employees. In 2000, there were 53 million white-collar office jobs in the economy, or 39% of all jobs, up from just 30% in 1959. These office jobs tend to pay more than jobs in other economic sectors, $44,800, on average, per annum.

Office workers are on the front lines of the knowledge economy. They don't create productivity-enhancing technology and do not have specific technical skills, but they are more productive because they are empowered by the information technology that has spread throughout the workplace. In 1973, only 38% of office workers had some kind of postsecondary education. Today, 69%

Figure 5

Distribution of Education in Technology Jobs, 1973 and 2000



Source: Authors' Analysis of Current Population Survey (March, 1974 & 2001).

of office workers have some kind of postsecondary education, while 37% have at least a bachelor's degree—making office work one of the most highly educated job sectors (see Figure 3).

Education and Health-Care Jobs

More of us are working in education and health care—jobs associated with the development and maintenance of human capital—because the new economy requires more education, the demand for health care continues to rise, especially as the population ages, and productivity is not rising as fast in these education and health-care jobs as it is in manufacturing. Because of the increased demand and slow productivity growth, since 1959 health care has grown from 4 to 8% of all jobs. Over the same period and for similar reasons, education jobs have grown from 6 to 9% of all jobs.

The health-care and education sectors have always been one of the most postsecondary education intensive in the economy. Even in 1973, one-half of workers in schools and health-care institutions had at least some higher education. In 2000, 75% of education and health-care workers had at least some college—second only to technology jobs (see Figure 4).

Technology Jobs

Since the late 1970s, the share of technology jobs has doubled, but they still only account for about 7% of all jobs in the economy.[10] More and more of us are using technology on the job, but it takes fewer of us to make, maintain, or repair our information technology. Growing productivity has held the overall number of jobs that require technical education to around 10 million, out of the total 138 million jobs in the U.S. economy. However, changing demands within the technical workforce—for instance, the shift from high-tech crafts workers to computer technicians—do create openings and worker shortages in growing occupations. While technology jobs have always required highly educated and skilled employees, the demand for these workers has increased. In 1973, 63% of technology workers had at least some college and by 2000, 86% had postsecondary education—more than one-half had at least bachelor's degrees (see Figure 5).

The powerful impact of the new information technology comes from its pervasive use by nontechnical workers and consumers not from employment areas in the production and maintenance of the technology (Carnevale, 1999; Lerman, 1998; Freeman and Aspray, 1999). The effects of the information technology at the core of the new information economy are consistent with past trends in economic development. For instance, electricity was the core technology in building the urban industrial economy that began in the early twentieth century, but very few of us needed to become electricians.

Low-Wage Services Jobs

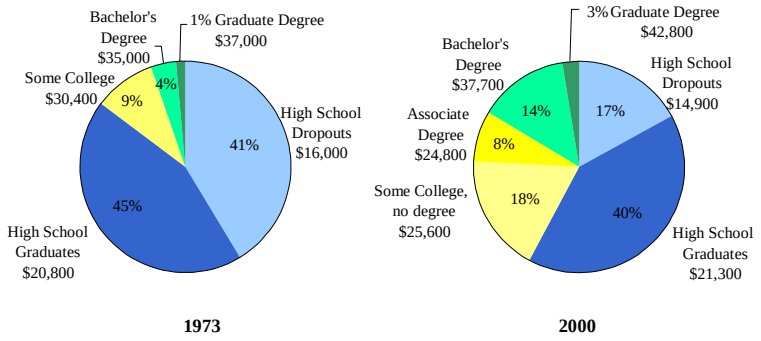
Low-wage services jobs are a mixed bag. For some they are dead-end jobs, but for many they are transitional jobs that provide entry-level work that leads to further education or career mobility. Most of these jobs are at the bottom of the new earnings and skill hierarchy. They include jobs for cashiers, retail clerks, stockers, cab drivers, cleaners, and other occupations that typically pay low wages and require low skills.

The share of low-wage services jobs has not grown since Eisenhower was president in the 1950s, remaining at about one-fifth or about 28 million of the available work opportunities. These jobs are not growing as a share of all jobs due to low minimum wages and no benefit guarantees, we have a lot of these low-wage services jobs in the United States, compared to other nations that guarantee high minimum wages and benefit guarantees for all workers. The majority of these jobs require high school or less. In 1972, 86% of workers in low-wage services jobs had only a

Figure 6

Distribution of Education in Low-Wage Service Jobs, 1973 and 2002

Percent of prime-age (30-59) employment. Earnings in 2000 dollars.

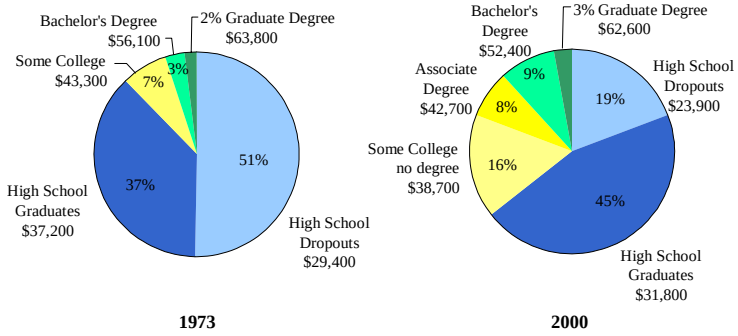


Source: Authors' Analysis of Current Population Survey (March, 1974 & 2001).

Figure 7

Distribution of Education in Factory Jobs, 1973 and 2000

Percent of prime-age (30-59) employment. Earnings in 2000 dollars.



Source: Authors' Analysis of Current Population Survey (March, 1974 & 2001).

high school education or less. Today, still nearly 60% of workers in these jobs do not have any postsecondary education (see Figure 6).

These jobs are easy to get but they don't pay well and carry few or no benefits. Among those workers with postsecondary education who are employed in these types of jobs, many are students who are working temporarily until they complete their education. This is especially true for workers below the age of 25 who comprise about 30% of employment in this sector and will likely move on to better jobs when they complete their education. Low wages and no benefits are not a long-term concern for people such as students, immigrants, part-time workers, retirees, and others who do not want or are not ready for better jobs. At the same time, those stuck in these jobs for the long-term struggle to meet basic living standards.

Factory Jobs

While low-wage services jobs are not growing as a proportion of all jobs, frontline factory jobs are shrinking both proportionally and in absolute numbers. Between 1959 and 2000, the share of factory jobs fell from 32 to 17% of all jobs. That translates to 20 million fewer factory jobs in 2000 than would have existed had the 1959 share of employment continued.

Workers who have skills beyond high school are filling the declining number of factory jobs that remain. New technology and high-performance work processes enable manufacturers to produce more while using fewer, but more highly skilled, workers. For instance, since 1960 the United States has increased real manufacturing output by more than $2 billion annually, while cutting by nearly one-half the number of production workers. In addition, because of the changing technology and the introduction of flexible high-performance work processes, the factory workers who remained needed more skill.

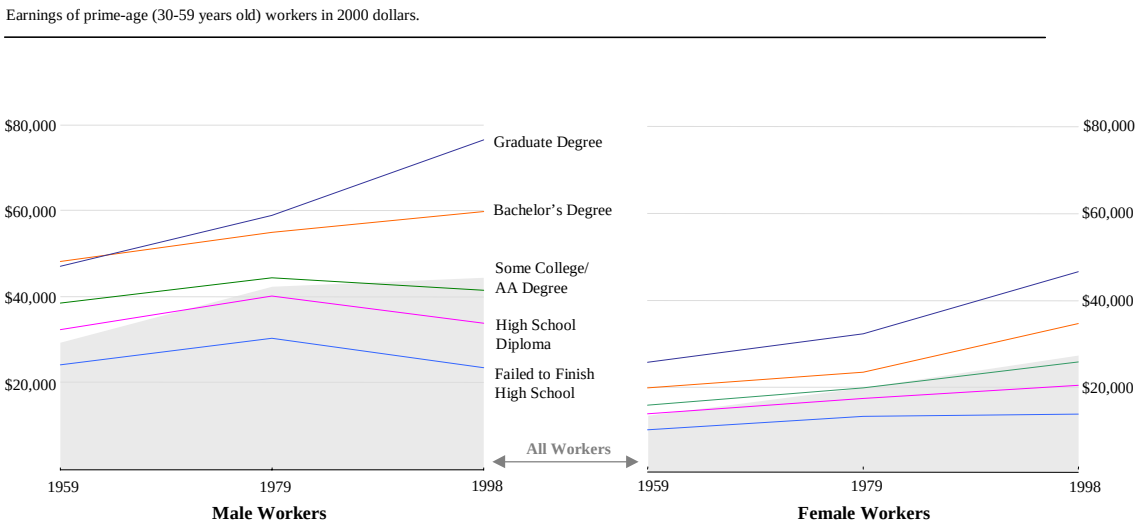
In 1973, one-half of factory workers were high school dropouts and, by 2000, only about one in five had not completed high school (see Figure 7). In spite of the increase in college-educated workers in factory jobs, they are still a minority. In 1973, only 12% of workers on the factory floor had any college and, by 2000, that proportion had increased to more than 36 percent.

Education and Wages

Wage trends also suggest an increase in demand for skilled labor. Among prime-age women, earnings at all levels of education have risen, but the earnings of those at the top of the education ladder have risen the most (see Figure 8). The earnings of prime-age men with at least a bachelor's degree also have increased, but at a slightly slower rate. In contrast, the earnings of men with some college or less have seen declines in their inflation-adjusted earnings.

Figure 8

Earnings Depend Increasingly on Educational Attainment



Source: Authors' Analysis of Current Population Survey (March 1980 &1999) and Public Use Microdata Sample, 1960 Census.

The increase in the wages of college graduates relative to high school graduates is the most telling sign that the economy demands highly skilled workers. As the share of workers with postsecondary education has increased, the wage advantages of college-educated workers have also continued to increase. For an increase to occur simultaneously in both the supply and the wages of more-skilled workers, the demand for skilled workers must be rising faster than the supply. Furthermore, among workers with the same credentials, the highest earnings go to those with the highest assessed skills, suggesting that employers are buying skills, not degrees (Levy and Murnane, 1992; Levy, 1998).

Where Job Growth Will Occur

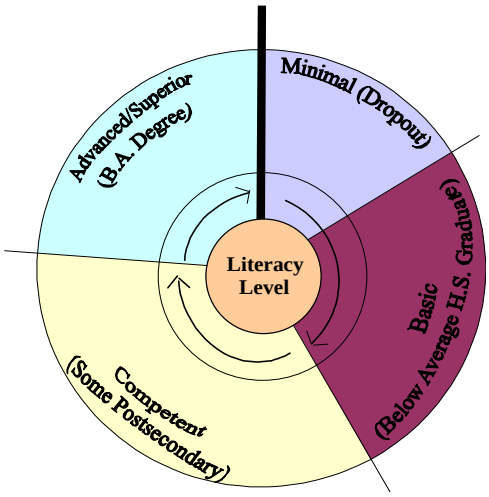
Employment shifts experienced during the latter half of the twentieth century are expected to continue to increase throughout the decade. Jobs that require an associate degree are expected to grow the fastest, increasing by 32% through 2010, followed by jobs that require a bachelor's degree, growing by 24 percent (Hecker, 2001). Apart from education requirements, jobs that require the highest levels of assessed cognitive skills also are expected to grow the fastest. About six in ten workers already have skills similar to those demonstrated by people with at least some postsecondary education and access to jobs that pay at least $33,400, on average, per year. Jobs that require skills typically demonstrated by four-year degree holders will likely grow by nearly 20 percent, while those requiring skills similar to those with a sub-baccalaureate education will likely grow by 15 percent (see Figure 9).

Although the most robust job growth will occur within skilled jobs, more moderate job growth and creation will occur at the lower end of the education and skill continuum. Less skilled jobs, those employing workers whose skills are similar to below-average high school graduates or high school dropouts, are expected to grow slower than average, by 13 percent. Similarly, employment projections by education level correspond to those by skill level, showing that jobs requiring apprenticeship or other work-based training greater than a year's duration are only expected to grow 8% by 2010. Jobs that require less than a year of customized training beyond high school also are expected to grow slower than average at 13 percent.

While not growing as fast as high-skilled jobs, there will still be a sizable number of job openings for less skilled workers. But because workers in these jobs change jobs more often, these jobs are more likely to create openings through greater job turnover rather than by new job creation. Only one-third of total job openings in less skilled jobs are a result of new job creation,

Figure 9

The Labor Force Spans All Skill Levels, But Projected Job Growth Favors High Skill Levels



Skill Level	*Shares of the Labor Force (16-64) by Literacy Level, Percent Growth, Distribution of Jobs, and Average Annual Earnings of Year-round Workers (16-64)*
Minimal (Dropout)	15% of the Labor Force 13% Job Growth, 2000-2010 10% Share of New Jobs, 2000-2010 12% share of All Jobs in 2010 2000 Earnings: $21,500
Basic (Below Average H.S. Graduate)	24% of the Labor Force 13% Job Growth, 2000-2010 22% Share of New Jobs, 2000-2010 25% Share of All Jobs in 2010 2000 Earnings: $26,900
Competent (Some Post-secondary)	35% of the Labor Force 15% Job Growth, 2000-2010 36% Share of New Jobs, 2000-2010 37% share of All Jobs in 2010 2000 Earnings: $33,400
Advanced/Superior (Bachelor's Degree)	26% of the Labor Force 19% Job Growth, 2000-2010 31% Share of New Jobs, 2000-2010 26% share of All Jobs in 2010 2000 Earnings: $48,000

Source: Authors' Analysis of National Adult Literacy Survey, 1992; Current Population Survey, 2001; BLS Employment Projections, 2000-2010.

compared to 47% in the highest-skilled jobs.

While more and more workers need skill on the job, not all workers need to go to college to prepare for work. About one-half of those who terminate their education with a high school diploma get training from various sources, but principally from their employers (see Figure 10). Three-quarters of high school dropouts have jobs for which do not require training. Overall, roughly 20% of all workers are in jobs that do not require training but a substantial number of those jobs are transitional. Although these less skilled workers may be able to find jobs, the almost 40% of the current workforce whose skills are similar to workers in low-paying jobs typically earned no more than an average of $26,900 per annum.

The Skills Employers Want

As the structure of the U.S. economy has shifted, so have the kinds of skills required. While we can easily quantify changes in the economy using information on education and cognitive skill levels, the skill requirements in modern workplaces encompass broader, and often less measurable, general skills (Lynch and Nickell, 2001). The demand for specific vocational skills has been augmented with a growing need for general skills, including reasoning abilities, general problem-solving skills, and behavioral skills. Cognitive styles, such as how workers handle success and failure on the job, also are important in determining success on the job. And while general skills are becoming increasingly important, occupational and professional competencies are still needed to complement these more general skills.

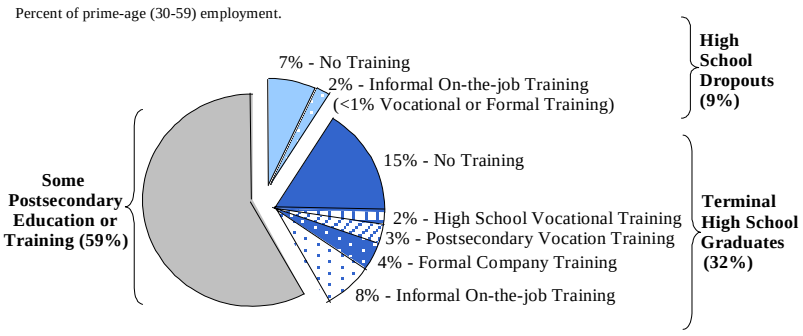
General Skills: Reasoning, Problem-Solving, and Behavioral Skills

Little is known about how to develop and assess general problem solving and behavioral skills in students and workers, whic most employers associate with educational attainment, especially college-level attainment. Educational attainment also is used as a proxy for reasoning ability. As a result, employers use education and training as the standard by which to screen job applicants.

The new applied skill requirements have emerged, in part, as a result of the changing

Figure 10

Training AmongHigh School Dropouts and High School Graduates, 2000



Source: Author's Analysis of Current Population Survey, 2000, and adaptations from Eck, 1993.

occupational structure of the economy. Increasing productivity in manufacturing and other technology intensive industries means fewer workers with specific technical skills are needed to do the same amount of work. Since most of the new positions are being created in business services, education, health care, and office jobs, fewer technical skills and more general skills typical of these jobs are required. Broader and more general skills also are required because of the spread of "high-performance work systems" that locate broader responsibilities to work teams at the point of production and service delivery (Office of Technology Assessment, 1990; Dertouzos, Lester, and Solow, 1989; Cyert and Mowery, 1987; Hirschorn 1988; Zuboff, 1988; Cohen, Dickens, and Posen, 2001).

The new business, education, health care, and office service jobs require higher levels of interpersonal and problem-solving skills because the work entails higher levels of human interaction and personalized responses to people's wants and needs. These same behavioral skills are required in high-technology and manufacturing jobs as well. The technology itself takes on more of the rote, manual processing tasks, allowing employees to spend time interacting with each other to exploit the new technologies capable of providing higher quality, variety, and speed of operation (Ichniowski, Shaw, and Prennushi, 1997; Autor, Levy, and Murnane, 2001).

These new problem-solving and behavioral skills are required to create new kinds of value added in both manufacturing and service areas. Unlike the old manufacturing-based economy where productivity—high volume at low cost—was paramount, the new economy demands new kinds of value, measured by a complex set of performance standards and workers with broad skills to meet these standards. These kinds of value include quality, variety, customization, customer focus, speed of innovation, and the ability to add novelty and entertainment to products and services.

For instance, companies that make or sell quality products or deliver quality service need workers with solid academic and occupational preparation. But good academic basics do not guarantee quality. Companies that meet quality standards require conscientious employees who are able to take responsibility for the final product or service—regardless of their position in the company. Variety and customization require workers who are creative and good at problem solving.

Continuous innovation requires a general ability to learn and work in groups. Adding novelty and entertainment value requires creativity. The consumer demand for customization and variety requires workers with problem-solving skills that emphasize the flexible application of reasoning abilities in multifaceted work contexts. To continuously improve products and services, institutions require employees up and down the line to have leadership and learning skills. Successful teamwork and good customer service require interpersonal and communication skills.

Positive Cognitive Style

The new, fast-paced, and unforgiving global economy results in constant change in skills required for specific jobs. Constant economic and technological change also discourages growth in job tenure and increases the overall rate of job creation and job destruction. The subtlest behavioral asset in managing school, work, and life in the constant flux of modern times is a positive cognitive style (Seligman, 1998).

The notion of "positive cognitive style" is more than "self-esteem" or "the power of positive thinking." "Self-esteem" and "positive thinking" are internal attitudes that persist irrespective of external experiences of success or failure. Cognitive styles are the various ways people process information gained from experience—positive cognitive styles encourage

success and negative styles encourage failure. The notion of "positive cognitive style" argues that the way in which people understand and engage reality can encourage successes and discourage failures. From this perspective, individual choices are the key to explain otherwise differences in human behavior that cannot be explained by environmental or biological factors.[11] Cognitive style helps explain why some succeed against the odds and others fail in spite of their advantages.

Cognitive psychologists tend to agree that the way people explain events to themselves, or their cognitive style, is a key determinant of success and failure.[12] Those with a negative cognitive style tend to see failure as a result of causes that are "permanent, pervasive, and personal." They tend to discount successes as temporary, limited in scope, and unrelated to personal merit (Seligman, 1998). People with a negative cognitive style tend to be less successful because they cede control over the choices in their lives to their circumstances, reducing their ability to act and persevere.[13]

Occupational and Professional Competencies

The general reasoning, problem-solving, and behavioral skills, as well as a positive cognitive style, are critical for lifelong learning and success in modern labor markets. However, everyone has to put an occupational point on his educational pencil. There is a general consensus that occupational preparation—or college-level coursework leading toward occupational or professional preparation—should begin sometime in high school. A small share of students begin to receive occupational preparation in high school through vocational programs, career academies, and other applied curricula. For the most part, these programs survive as an alternative applied pedagogy to meet statewide academic performance standards and as preparation for further postsecondary education. Among those who terminate their education with high school, the half that need training get it primarily from their employers.

For most high school students, occupational preparation continues or begins after high school with enrollment in occupationally oriented programs in degree and non-degree granting postsecondary programs. A much smaller share continues their education past the first four years of college and gets their occupational or professional credentials in graduate or professional schools.

Increases in general education requirements on the job is the driving force that results in complementary increases in job-specific certificates, certifications, and customized job training. The most highly educated get the most initial job training and retraining. In addition, there is an increasing share of occupations in fields such as information technology, public safety, and health care that supports or requires regulated proficiency standards (Carnevale and Desrochers, 2001).

To some extent the increase in the demand for occupational credentialing derives from the changing relationships between employers and employees. These days a career is no longer defined by working for one company, but by moving among employers within an industry or occupation (Neumark, 2000). Workers change jobs more often, and employers, constantly changing form in response to economic and technological change, are always looking for new talent.

As change accelerates on the job, employers can no longer take the time to develop talent from the ground up (Cappelli et al., 1997). As relationships between employers and employees become less stable and as the pace of change accelerates, reliable occupational credentials become more important in matching individual job skills to new job requirements. Employers want the most training-ready employees, those with educational and occupational credentials, and then add company-specific training or training prompted by changes in work processes or technology (Bishop, 1996).

Workers who also have a solid base of general knowledge and current occupational know-how become more portable, since their value is internalized in their individual experience and credentials and not tied to a particular company. An associate or bachelor's degree with a particular occupational emphasis is more likely than a high school diploma to ensure these basic transferable skills.

The need for certified occupational skills also is driven by the geographic extension of labor and product markets. Product markets, and to a more limited extent service markets, have extended their boundaries from local to regional, from regional to national and, in some cases, from national to global markets. The principal effect of the expanding geography of markets on workers is not to increase geographic mobility but to raise skill requirements from local to national and, ultimately, world-class standards (Porter, 1998; Kanter, 1997).

The Demographic Twist

Although future economic realities favor higher levels of education and a broader array of skills, a reversal in two

longstanding demographic trends may make it difficult to fulfill these needs. The most powerful of these trends is the retirement of the baby boom. The U.S. workforce, whose size has increased by almost 40% over the past 20 years, will slow its growth by one-half over the next several decades, creating a growing need for youth with postsecondary education or training to replace college-educated retirees (Ellwood, 2001).

For instance, we know that retirements begin aggressively after age 55, especially for men, and retirement ages have been declining steadily. The only debate among labor economists is whether they will continue to decline or stabilize. We also know that by 2020 there will be about 46 million baby boomers with at least some college who will be over 55 years of age (Carnevale and Fry, 2001b). These boomers are working today, but they will age beyond 55 years from here on out. Over the same period, if we maintain current attainment rates in postsecondary education, there will likely be about 49 million new adults with at least some college—a net gain of about 3 million (Carnevale and Fry, 2001b). If the Bureau of Labor Statistics projections of a 22% increase in jobs that will require at least some college by 2010 continue through 2020, roughly 15 million new jobs that require college-educated workers will be created. This far exceeds the small net increase expected in the college-educated population, resulting in a net deficit in workers with at least some college of about 12 million workers by 2020.

We also will experience a second demographic reversal as "Generation X" gives way to "Generation Y." As the baby boom leaves the labor force taking their experience, education, and training with them, there will be a surge in the number of 18- to 24-year-olds. But on balance, the increase in the number of 18- to 24-year-olds will be far short of the number of youth necessary to replace the education and experience of the retiring baby boomers. Moreover, the increasing costs of providing postsecondary education and training for the surging Generation Y may limit access to skills. The result will be an even more substantial shortage in skilled workers with at least some postsecondary education and training.

In addition, the present economic slowdown may actually accelerate these longer-term trends toward shortages of educated and skilled labor. During the 1990-91 recession, companies aggressively used the pause to restructure production processes and to shift toward fewer workers using more sophisticated technology. These productivity-enhancing retrenchments require higher skill levels in the remaining job slots. It is conceivable that the present economic pause will encourage a further reorganization of production and service delivery processes, accelerating the increase in demand for skilled labor.

In the face of sharply reduced labor force growth rates and possible skill shortages, education and training policies will have to play the lead role. We know that a plethora of policies underlying the social safety net has effects on individuals' decisions to work. While changes in social policies might increase the size of the labor force, only expensive and politically difficult policy changes are likely to increase the available numbers of highly skilled workers (Ellwood, 2001).

Increasing retirement ages, for instance, will sustain labor force participation among those most dependent on social security payments for retirement. These tend to be the lowest paid and least skilled workers. Further increases in the labor force participation of married women by expanding child care assistance to the middle class may be the best bet for bringing more skilled workers, but would be extremely expensive (Ellwood, 2001). Large-scale skill-based immigration policies would be effective but politically sensitive.

Meeting Skill Needs: The Missing Middle in Education Policy

Policy goals are well defined in elementary and higher education, but the middle sections in the K-16 education pipeline have become the "missing middle" in the education policy dialogue. It is widely agreed that the road to meeting work-based skill needs starts by ensuring that all students in elementary education master the basics upon which more advanced education and training are based. In the United States, there are standards and goals for elementary education and broad agreement that all students should meet common standards sometime between the 8th and the 12th year of public schooling. It is also widely agreed that the K-12 system should prepare all students for some kind of postsecondary education, training, or good jobs. But while there is a policy consensus on the need to meet high standards sometime prior to high school graduation and the value of postsecondary education and training, there is much less agreement on curriculum appropriate to achieve these goals in the middle years that begin in high school and end with the transition from postsecondary education and training to work.

At issue is the mix of academic and applied curriculum appropriate in the transition of years from high school to college or high school to training and work. This is the nexus, beginning in the middle years of the K-16 pipeline, where general education, occupational education, and work begin to overlap—the terrain covered by the more highly regulated European "dual systems."

The missing piece in American education and training policy has gradually come to light in response to the diverse needs among adolescents and young adults over the last twenty years. In general, these needs tend to arise in different ways among the most and least educationally advantaged and among the majority of students caught in the middle of their high school class.

The "comprehensive" high school that provided something for everybody now focuses on a single set of standards for all students but fewer educational paths to meet those standards. The general consensus on performance standards has yet to produce alternative pedagogies that meet the diverse needs of the student population in their young adult years.

There are still three educational pathways to meet standards: the high road, the low road, and the middle path. The most advantaged and able students are on the high road to college and graduate education.

Few would disagree with the basic democratic premises that are implicit in standards-based school reform. But what do we do with students on the high road who master standards long before high school graduation? They are too young to go off to college. Instead, we bring the college curriculum to them in the form of dual enrollments, academically enriched summer school, and an elite "Advanced Placement" curriculum that currently exists in 13,680 high schools. In 2001, 845,000 students took 1.4 million AP exams, an increase of 10% over the previous year (College Board, 2001).

The educationally disadvantaged are on the low road with the steepest uphill climb to meet standards. The egalitarian instincts in the standards-based education reform movement demand that educationally disadvantaged students be held to the same standards as other students. These are the 11% of young adults who have no high school diploma, and the 37% of students who do not get any kind of postsecondary education or training directly after high school (NCES, 2001). Policymakers reason correctly that meeting standards will give these students the threshold skill required for better chances at postsecondary education, training, or job opportunities after high school. What's missing are the compensatory resources and customized curricula and pedagogy that help these students learn and enable them to meet the high standards that provide access to postsecondary education, training, and good jobs.

Further evidence of the missing middle in K-16 policy comes from students who are themselves caught in the middle between the educationally advantaged and the educationally disadvantaged in American high schools. These students are on the muddy middle path to college. They complete high school successfully and go on to college but do not finish. For instance, more than 45% of high school students go on to four-year schools but just less than three in five graduate within five years (Horn, 1998; Berkner, Cuccaro-Alamin, and McCormick, 1996).

The Curriculum Mismatch

The current core secondary curriculum is organized around discrete disciplines including math, science, English, and languages. Moreover, the "back-to-basics" spirit of the education reform movement tends to strengthen the hold of the traditional academic silos on secondary education. Currently, transcript studies show that in 1998, 56% of students met the "new basics"[14] requirements (excluding the half year of computer science) recommended in *A Nation At-Risk*, compared with only 14% in 1982 (Roey et al., 2001).

Our ability to move the majority of high school students into the most rigorous curriculum is a remarkable achievement. Furthermore, the current academic curriculum produces the math and verbal reasoning skills that correlate with success in college and in subsequent careers (Adelman, 1999). In fact, success in the traditional academic curriculum, especially the math curriculum, is the most powerful predictor of wage advantages from increased postsecondary attainment, and improvements in mathematics skills account for most of the growth in wage premium from increased postsecondary educational attainment since the early 1980s (Murnane et al., 1995; Grogger and Eide, 1995).

Starting in the middle years of the K-16 pipeline, part of what is missing is a curriculum that matches up with the diverse educational and career needs of young adults. In particular, we are still hard at work trying to develop curricula that (1) integrate academic competencies into applied and vocational pedagogies, especially in high schools; (2) align the content of the core academic curriculum that now dominates in second-

ary schools with the more applied curricula that now dominate postsecondary education and training; (3) align academic curricula more closely to the competencies people actually use on the job once they finish their initial education, including cognitive reasoning abilities and "soft skills" such as problem solving, interpersonal skills, and positive cognitive styles that are important in career success.

First, there is a need to integrate academic and applied curricula. The current math, science, and humanities curriculums are organized as discrete hierarchies focused almost exclusively on preparing students for the next rung up in the disciplinary sequence. Because they are taught as specialties, they are less accessible to generalists at each successive level of specialization. And because they are taught abstractly, they do not take advantage of applied pedagogy and are less accessible to students with an applied orientation and learning style.

Second, the focus on an academic core curriculum in high school does not provide a transition to the more applied focus of postsecondary education and training. The majority of students step off the disciplinary hierarchy in math, the sciences, English, and the humanities after high school. In postsecondary education, the vast majority of students avoid math, science, and the humanities for a vocational curricula with a focus such as business, engineering, and K-12 teaching.[15]

Third, it appears that there is a mismatch between the content and pedagogy associated with both academic and applied courses and skill requirements on the job. The current curriculum is best at producing general reasoning abilities, but the content of academic curriculum does not match up well with job requirements in particular. For instance, the current math curriculum that emphasizes arithmetic through calculus does provide high levels of mathematical reasoning ability, but does not match up with the math requirements of the vast majority of jobs. Even a casual analysis of the distribution of occupations demonstrates that relatively few of us, less than 5%, use geometry, algebra, or calculus on the job. In spite of these realities, in 1998, 75% of high school students took geometry, 63% took algebra I, 62% took algebra II, and 18 percent of high school students took calculus (NCES, 2000). However, mathematical literacy in labor markets is an ability to use arithmetic operations with increasing independence and in situations of increasing complexity.

Does the fact that only 5% of us use mathematics beyond arithmetic on the job mean that we should stop teaching algebra, geometry, trigonometry, and calculus in high schools? Does the fact that even fewer of us use Shakespeare, world history, or French at work mean these studies are a waste of time? Not necessarily, and certainly not until we can do better. In the current education curriculum, these higher-level courses are the means by which people learn higher level reasoning skills. Throwing out the current curriculum without a superior alternative in place would be like throwing out the baby with the bath water.

While we are striving to meet common academic standards, educators should continue to explore alternative pedagogies that mix academic and applied learning to provide students with the same higher level reasoning abilities conveyed by the current curriculum. The support for applied curricula is that they are superior to more abstract academic pedagogies and provide practical learning that keeps young people interested and in school. While these pedagogies are still controversial and still under construction, the emerging consensus view is that they should be focused on occupational and industry-based content that ties into the traditional academic disciplines.

What's At Stake?

If we are unable rise to the challenge of meeting increasing skill demands, there will be broad and diverse impacts on the U.S. economy that will be both economically and socially costly. A stabilization or decline in the productivity gains that we have only recently reaped, or a slowdown in growth, may be the primary negative economic impacts. The financial benefits of a robust economy may also be dampened if companies are forced to move to off-shore production to find skilled workers—American workers will lose out on job opportunities, foreign workers will spend their dollars overseas, and U.S. state, local, and federal governments will lose corporate and personal tax dollars. But if we are able to increase the skills of American workers, we also could increase the tax dollars that flow into our financial coffers.

Neglecting to raise the achievement of youth will also put these new workers at a disadvantage in the labor market. High school graduates without a solid set of skills are less likely to have access to technology and on-the-job training, both which increase earnings. They also are more likely to remain in low-wage, low-opportunity jobs that provide few career path options. In addition, those high school students who do not graduate with a solid base of skill will have curtailed their options for obtaining additional postsec-

ondary education and training and the wage increases that accompany them. They may also stimulate broader social problems; particularly continued increases in wage inequality as employers pay increasingly high wage premiums to skilled workers who are in short supply.

Education and Economic Growth

The ultimate determinates of economic growth are labor supply, usually measured by hours worked, labor productivity, which depends on the amounts of human and physical capital, and changes in technology and the organization of work (Bluestone and Harrison, 2000). Education has historically played a strong role in growth, by improving human capital. During the postwar years from 1948 to 1973, education accounted for 29% of the increase in gross domestic product (GDP), and economic innovation accounted for 37 percent (Shapiro, 1998; Denison, 1984).[16] So all totaled, the direct and indirect benefits of increases in education accounted for more than two-thirds of the increase in U.S. economic growth.

Targeted studies tend to confirm the macro data on the importance of education and training in improving productivity growth. Increasing the education level of workers by one year has been shown to increase productivity by 8.5% in manufacturing and 12.7% in non-manufacturing industries (Black and Lynch, 1996). Training affects productivity as well: one hour of training can increase productivity five times as much as it impacts wages. Formal employer-provided training has been shown to increase productivity by 10 to 19 percent (Bartel, 1989 and 1994; Bishop, 1994).

A better-educated workforce can also have real fiscal impact. Sweden is one of the most literate countries in the world. If the distribution of skill in the United States mirrored that of Sweden, a back-of-the-envelope calculation suggests that we could increase GDP by $463 billion and reap as much as $162 billion in additional federal, state, and local tax dollars.[17]

Skill and U.S. International Economic Competitiveness

Our ability to produce high levels of skill is critical to the overall performance of the American economy in global competition. Although American educational performance is improving at home, our scores on international tests are consistently subpar. And among youth aged 25 to 34, we have quietly dropped to sixth in the world in high school graduation rates behind Norway, Japan, Korea, Czech Republic, and Switzerland (OECD, 2001).[18] How can we reconcile our mediocre educational standing in the world and our economic success in the high-tech global economy?[19] The answer is that we may not have, on average, the world's *best* stock of skills, but we are pretty good and because of our size we have *more top students*.

On average, we may be in the middle of the pack on international tests but, because of our size, we tend to have more high performers than the nations that do better than the United States. For instance, our population is roughly four times the size of that of France, Italy, and the United Kingdom, and three times the size of Germany.

Our student population is only twice as large as the Japanese school-age population but our size advantage still prevails. For instance, in the TIMSS data on eighth-grade students, the Japanese rank 5th in math and we rank 18th. Sixty-four percent of Japanese eighth-graders scored in the top quartile of international benchmarks in math, compared with 28% of American students. Due to our eighth-grade population being twice as large as Japanese the eighth-grade population, there are 970,000 U.S. students in the top international quartile, compared with 928,000 Japanese eighth-graders.

More is not always better. But oftentimes, four pretty good engineers tackling a business problem is better than one very good engineer working alone addressing the same issue. Similarly, four companies in the software business competing directly against each other are likely to produce better software than a single company.

A second advantage that allows us to be the number one economy with a mediocre educational performance is our flexibility (Bertola, Blau, and Kahn, 2001). In the United States, labor markets are flexible, allowing employers enormous agility in hiring, paying, and allocating workers. America's agility gives us an edge in the global race because it allows us to make better use of our talent.

In Europe and Japan, by comparison, access to jobs and pay is highly regulated by skill certification and seniority. And jobs are protected shelters from economic and technological change. Unemployed or underemployed workers are eligible for high levels of income assistance, pensions, and benefits. The result is job security, income security, and structural rigidity. But European and Japanese education and labor market systems have a tough time redesigning jobs or shifting human and machine capital investments in response to economic and technological change. In recent years, the equitable but inflexible European and Japanese models have

driven up costs, suppressing job creation, and driving up unemployment. In contrast, the agile American model has boosted job creation *and* income inequality.

America's flexibility also means employers do not need to rely on the nation's homegrown talent. Immigration is a major source of talent among math and science professionals. For instance, a majority of America's civil engineers are foreign born and more than a third of all engineers are foreign born. In addition, American companies are free to produce offshore if they cannot find the talent at home at the right prices.

The problem is that our advantages won't last. We cannot remain a first-rate economic power with mediocre human capital. All forms of advantages are temporary in global economies. The European and Japanese versions of highly planned economies surged in the 1970s but lost out to American flexibility in the 1980s. Eventually, our competitors will narrow our economic lead as they learn how to create their own versions of agility and scale. At that point, the competition will really come down to who has the best human capital; especially in a world where people are no longer nation bound and technology and financial capital ignore national boundaries as they hop across borders from one entrepreneurial opportunity to the next.

At some point soon, if we are to retain the lead in the global economic race, we will have to rely on our homegrown human capital for our competitive edge. Eventually, we will have to close the education gap between our competition and ourselves.

The Individual Cost of Skill Deficits

The growing importance of skills, especially at the college level, in allocating economic opportunity is significant in the United States. Our growing reliance on postsecondary education and training as the threshold for allocating opportunity means that poorly educated individuals, rather than employers or governments, pay the price of educational inequality.

Individuals who do not acquire college-level skills are more likely to be forced into low-wage and low-benefit jobs, and the earnings disadvantage associated with those jobs has been rising since the 1970s. The college-wage premium—the earnings advantage of college-educated workers over high school graduates—in 1979 was 36% for men and 34% for women. By 1997 however, the premium rose to 67 and 72% for men and women, respectively (Mishel, Bernstein, and Schmitt, 1999). The wage premiums for those with "some college" have also doubled, although they remain far below the premiums for four-year college graduates. In addition to the increasing wage premium over the past 20 years, real inflation-adjusted earnings of less educated men have actually declined over the period. But those with at least some education beyond high school—a year's worth of courses—can earn from 5 to 11% more than high school graduates.

Workers with the least education are less likely to receive training and access to technology on the job, which leads to earnings advantages. Training can increase employee wages by 3 to 11%, with formal training providing higher returns than informal training (Bishop, 1996; Mincer, 1988; Altonji and Spletzer, 1991; Loewenstein and Spletzer, 1998). Those who receive training earn more, on average, than more-educated workers who do not (Eck, 1993). High school dropouts who use technology on the job earn about 15% more than high school dropouts who do not, but the earnings premium for college graduates who use technology is nearly twice as high (Krueger, 1993; Mishel and Bernstein, 1995). Good pay and benefits are linked to postsecondary educational attainment, achievement, training, and technology.

As access to college becomes more important in allocating economic opportunity, the large gaps between youth from high- and low-socioeconomic status families become a greater threat to upward mobility. Families with the highest incomes are likely to be parents with the highest level of educational attainment. Parental education and income are strong threads in the complex weave of social and economic forces that influence academic readiness for college and college enrollments. As a result, many are concerned that access to college, especially highly selective ones, and career opportunity are becoming more concentrated among families with high incomes and high levels of parental education. There is a further concern that advantages are passed on from one generation to the next, frustrating the American promise of intergenerational mobility.

Thus far, the available evidence on opportunity is mixed. First the good news: educational performance and college going has improved among all income classes and racial and ethnic groups since the early 1970s, when policy, especially federal policy, began funding targeted assistance for disadvantaged students throughout the education pipeline. This has continued in spite of the widening income distribution. But there is also bad news: the gap in educational performance and access to college has not narrowed

in spite of those same policies.

In our work-based society, failure to give people the knowledge and the skills they need to get and keep good jobs can have disastrous personal consequences. Those with the least education are much more likely to experience violence, addiction, poverty, illness, incarceration, and other forms of abuse. And those who can't get and keep jobs often drop out of the political system, withdraw from community life, and in some cases, create alternative economies, cultures, or political structures that are even more damaging to the mainstream.

Conclusion

Providing all youth with sufficient skill necessary to access good jobs that tend to require at least some education or training after high school presents fiscal, curriculum, and institutional challenges. Simply adding years of schooling at both ends of the education pipeline in order to meet expanding skill requirements on the job will be prohibitively expensive. In order to afford the human capital we need in the new economy, we will have to produce Pre-K-16 education cheaper, faster, and better. This will require a more effective alignment of the Pre-K-16 education curriculum to meet rising labor market requirements for (1) cognitive reasoning skills, (2) problem-solving skills, (3) "soft" behavioral skills, (4) positive cognitive styles, and (5) specific occupational preparation.

Aligning education curricula to labor market requirements is no small feat. The alignment challenge has both horizontal and vertical dimensions. The horizontal dimension focuses on the integration of academic and applied curricula at each grade level, especially in high school and beyond. The vertical dimension is the alignment of the education pipeline and labor market institutions.

The curriculum challenge lies in the alignment of academic and applied curricula in the middle years of the education pipeline where basic academic development of cognitive skill begins to overlap with the need for more applied forms of learning and career choices. The traditional vocational curricula have not been successful in teaching the core cognitive math and verbal competencies, especially in high schools. The current academic curriculum, "the new basics," in secondary schools represents the state of the educational art in producing cognitive reasoning ability, but it is organized as a set of discrete disciplinary hierarchies and is taught in an abstract manner that discourages interdisciplinary and applied learning. In addition, the current academic curriculum in both secondary and postsecondary institutions does not lend itself easily to teaching problem solving, behavioral skills, positive cognitive styles, or occupational competencies—other than the content knowledge necessary for a career in teaching one of the core academic subjects.

Making better sense of the missing middle in education policy also requires better alignment among secondary, postsecondary, and employer institutions. In the American system, the alignment between general education and occupational education and training and jobs is market driven. Relationships between employers and educational institutions are informal. Secondary and postsecondary institutions are only loosely aligned. Secondary schools are locally controlled and the postsecondary education and training system is market driven and increasingly diverse in its offerings of degreed programs, certificates, certifications, and customized training.

The vision of a system that can fill the missing middle in education policy should be judged by standards that measure its ability to increase choices and opportunity for both work and learning for students, as well as its ability to satisfy requirements in school and on the job. The diversity among American students, workplaces, and communities requires a variety of alternative paths that mix work and learning integrated by an incremental and sequential system of competency-based standards (Carnevale and Porro, 1994).

The challenge is to build an integrated system of pathways with different points of access and exits controlled by posteducation standards. Individuals should not be allowed to enter or exit a particular path without certification of qualifying skills and applied competencies. Every exit from a learning path should be validated by accredited learning and lead to either work or continued progress along another learning path that ultimately makes a four-year college degree accessible (Carnevale and Porro, 1994).

While reforming and aligning education is costly, not implementing these changes is perhaps even more expensive. At stake are our economic competitiveness and our ability to sustain high levels of growth and the productivity gains we have recently recaptured. The number of youth coming through the education pipeline will not offset impending demographic changes as the baby boom retires, and social policies show little promise of alleviating skill needs. Education is the best bet to help us maintain out competitive edge. At the same time, failure to serve the educa-

tionally disadvantaged is a lost opportunity in a time when more and more skilled workers are needed. Failure to take advantage of the unmet demand for skilled labor will move us further away from our egalitarian goals as low-skilled workers are blocked off from access to good paying jobs, further increasing earnings inequality between the most and least educated.

The inescapable reality is that our society is largely based on work *and* knowledge. If educators cannot fulfill their *economic* mission to help our youth and adults become successful workers, they also will fail in their *cultural* and *political* missions to create good neighbors and good citizens.

References

Adelman, C. (1999) *Answers in the Tool Box: Academic Intensity, Attendance Patterns, and Bachelor's Degree Attainment.* U.S. Department of Education, Office of Education Research and Improvement. Washington, D.C.: U.S. Government Printing Office.

Altonji, J.G., & Speltzer, J.R. (1991, October). Worker Characteristics, Job Characteristics, and the Receipt of On-The-Job Training. *Industrial and Labor Relations Review, 45* (1).

Autor, D.H., Katz, L.F., & Krueger, A. (1997). Computing Inequality: Have Computers Changed the Labor Market? *NBER Working Paper 5956.* Cambridge, MA: National Bureau of Economic Research.

Autor, D.H., Levy, F., & Murnane, R.J. (2001). The Skill Content of Recent Technological Change: An Empirical Exploration. *NBER Working Paper 8337.* Cambridge, MA: National Bureau of Economic Research.

Barrick, M.R., & Mount, M.K. (1991, Spring). The Big Five Personality Dimensions and Job Performance: A Meta-Analysis. *Personnel Psychology, 44* (1).

Bartel, A.P. (1989). Formal Employee Training Programs and Their Impact on Labor Productivity: Evidence from a Human Resource Survey. *NBER Working Paper 3026.* Cambridge, MA: National Bureau of Economic Research.

Bartel, A.P. (1994, October). Productivity Gains Form the Implementation of Employee Training Programs. *Industrial Relations.*

Barton, P.(2000). *What Jobs Require: Literacy, Education, and Training, 1940-2006.* Princeton, NJ: Educational Testing Service, Policy Information Center.

Berkner, L.K., Cuccaro-Alamin, S., & McCormick, A.C. (1996). *Descriptive Summary of 1989-90 Beginning Postsecondary Students: Five Years Later.* NCES 1996-155. U.S. Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office.

Bertola, G., Blau, F.D, & Kahn, L.M. (2001). Comparative Analysis of Labor Market Outcomes: Lessons for the United States From International Long-run Evidence. In Alan B. Krueger and Robert Solow (Eds), *The Roaring Nineties: Can Full Employment Be Sustained*? New York: The Russell Sage Foundation and The Century Foundation.

Bishop, J.H. (1994). T*he Impact of Previous Training on Productivity and Wages.* ILR Reprints No. 696. Ithaca, NY: School of Industrial and Labor Relations, Cornell University.

Bishop, J.H. (1996, May/June). Is the Market for College Graduates Headed for a Bust? Demand and Supply Responses to Rising College Wage Premiums. *New England Economic Review.*

Black, S.E. & Lynch, L.M. (1996, May). Human Capital Investments and Productivity. *AEA Papers and Proceedings, 86* (2).

Bluestone, B., & Harrison, B. (2000). *Growing Prosperity: The Battle for Growth with Equity in the 21st Century.* New York: Houghton Mifflin Company and The Century Fund.

Cappelli, P. (1993, April). Are Skill Requirements Rising? Evidence From Production and Clerical Jobs. *Industrial and Labor Relations Review, 46* (3).

Cappelli, P. (1996, May/June). Technology and Skill Requirements: Implications for Establishment Wage Structures. *New England Economic Review.*

Cappelli, P., Bassi, L., Katz, H., Knoke, D., Osterman, P., & Useem, M. (1997). *Change at Work.* New York: Oxford University Press.

Carnevale, A.P. (1999). *Education=Success: Empowering Hispanic Youth and Adults.* Princeton, NJ: Educational Testing Service.

Carnevale, A.P., & Porro, J.D. (1994). Quality Education: School Reform for the New American Economy. U.S. Department of Education, Office of Educational Research and Improvement. Washington, D.C.: Government Printing Office.

Carnevale, A.P., & Rose, S.J. (1998). *Education for What? The New Office Economy.* Princeton, NJ: Educational Testing Service.

Carnevale, A.P., & Desrochers, D.M. (2001). *Help Wanted . . . Credentials Required: Community Colleges in the Knowledge Economy.* Princeton, NJ: Educational Testing Service.

Carnevale, A.P., & Fry, R.A. (2001a). The Demographic Window of Opportunity: Launching College Access and Diversity in the New Century. In *Condition of Access report to the U.S. Congress and the Secretary of Education* presented by the Advisory Committee on Student Financial Assistance. Washington, DC.

Carnevale, A.P., & Fry, R.A.(2001b, november/December). The Economic and Demographic Roots of Education and Training. In *Center for Workforce Success What's Working Newsletter, 11.*

Cohen, J., Dickens, W.T., &Posen, A.(2001). Have the New Human-Resource Management Practices Lowered the Sustainable Unemployment Rate? In Alan B. Krueger and Robert Solow (Eds), *The Roaring Nineties: Can Full Employment Be Sustained*? New York: The Russell Sage Foundation and The Century Foundation.

College Board. (2001). *AP National Summary Report 2001.* Retrieved February 28, 2002 from www.apcentral.collegeboard.com

Cyert, R. M., & Mowery, D.C. (Eds). (1987). *Technology and Employment: Innovation and Growth in the U.S. Economy.* Washington, D.C.: National Academy Press.

Dertouzos, M., Lester, R., & Solow, R. (1989). *Made in America*. Cambridge, MA: MIT Press.

Denison, E.F. (1984). *Trends in American Economic Growth, 1929-1982*. Washington, DC: Brookings Institution.

Eck, A. (1993, October). Job-Related Education and Training: Their Impact on Earnings. *Monthly Labor Review, 16* (10).

Ellwood, D.T. (2001). The Sputtering Labor Force of the 21st Century: Can Social Policy Help? In Alan B. Krueger and Robert Solow (Eds), *The Roaring Nineties: Can Full Employment Be Sustained*? New York: The Russell Sage Foundation and The Century Foundation.

Flynn, J.R. (1998). IQ Gains Over Time: Toward Finding the Causes. In Ulric Neisser (Ed), *The Rising Curve: Long-Term Gains in IQ and Related Measures*. Washington, D.C.: American Psychological Association.

Freeman, P., & Aspray, W. (1999). *The Supply of Information Technology Workers in the United States*. Washington, D.C.: Computing Research Association.

Goldin, C., & Margo. R.A. (1992, February). The Great Compression: The Wage Structure in the United States at Mid-Century. *Quarterly Journal of Economics*.

Gottschalk, P. (1997, Spring). Inequality, Income Growth, and Mobility: The Basic Facts. *The Journal of Economic Perspectives, 11* (2).

Greenfield, P.M. (1998). The Cultural Evolution of IQ. In Ulric Neisser (Ed), *The Rising Curve*: *Long-Term Gains in IQ and Related Measures*. Washington D.C.: American Psychological Association.

Grogger, J., & Eide, E. (1995, Spring). Changes in College Skills and the Rise in the College Wage Premium. *The Journal of Human Resources* XXX, *2*.

Hecker, D.E. (2001, November). Occupational Employment Projections to 2010. *Monthly Labor Review, 124* (11).

Horn, L.J. (1998). Confronting the Odds: Students at Risk and the Pipeline to Higher Education. *NCES 1998-094*. U.S. Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office.

Hirschhorn, L. (1988). The Post-Industrial Economy: Labor, Skills, and the New Mode of Production. *Service Industries Journal, 8* (1), 19-38.

Ichniowski, C., Shaw, K., & Prennushi, G. (1997, June). The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines. *American Economic Review, 87* (3), 291-313.

Johnson, G.E. (1997, Spring). Changes in Earnings Inequality: The Role of Demand Shifts. *The Journal of Economic Perspectives, 11* (2).

Juhn, C. (1999, April). Wage Inequality and Demand for Skill: Evidence From Five Decades. *Industrial and Labor Relations Review, 52* (3).

Judy, R.W., & D'Amico, C. (Eds). (1997). *Workforce 2020: Work and Workers in the 21st Century*. Indianapolis, IN: Hudson Institute.

Kanter, R.M. (1997). *World Class: Thriving Locally in the Global Economy*. New York: Touchstone Books.

Katz, L.F., & Autor, D.H. (1999). Changes in the Wage Structure and Earnings Inequality. In Orley Ashefelter and David Card (Eds), *Handbook of Labor Economics* 3A. Amsterdam, The Netherlands: Elsevier Science B.V.

Katz, L.F., & Murphy, K.M. (1992, February). Changes in Relative Wages, 1963-1987: Supply and Demand Factors. *Quarterly Journal of Economics*.

Krueger, A. (1993). How Computers Have Changed the Wage Structure: Evidence from Microdata, 1984-89. *Quarterly Journal of Economics*.

Krueger, A.B., & Lindahl, M. (1999). Education for Growth in Sweden and the World. *NBER Working Paper 7190*. Cambridge, MA: National Bureau of Economic Research.

Lerman, R.I. (1998). *The Labor Market for Information Technology Workers*. Testimony before the Subcommittee on Immigration, Committee on the Judiciary, United States Senate.

Levy, F. (1998). *The New Dollars and Dreams: American Incomes and Economic Change*. New York: The Russell Sage Foundation.

Levy, F., & Murnane, R.J. (1992, September). U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations. *Journal of Economic Literature, 30*.

Loewenstein, M.A., & Spletzer, J.R. (1998, January). Dividing the Costs and Returns to General Training. *Journal of Labor Economics, 16* (1).

Lynch, L.M., & Nickell, S.J. (2001). Rising Productivity and Falling Unemployment: Can the U. S. Experience be Sustained and Replicated? In Alan B. Krueger and Robert Solow (Eds), *The Roaring Nineties: Can Full Employment Be Sustained*? New York: The Russell Sage Foundation and The Century Foundation.

Mangum, Stephen L. 1990. "Impending Skill Shortages: Where is the Crisis?" *Challenge* (September/October).

McNeil, W.H. (1999). *A World History* (4th Edition). New York: Oxford University Press.

Mincer, J. (1988). Job Training, Wage Growth, and Labor Turnover. *NBER Working Paper 2690*. Cambridge, MA: National Bureau of Economic Research.

Mishel, L., & Teixeira, R.A. (1991). *The Myth of the Coming Labor Shortage: Jobs, Skills, and Incomes of America's Workforce 2000*. Washington, D.C.: Economic Policy Institute.

Mishel, L., & Teixeira, R.A. (1993, Summer). Whose Skills Shortage: Workers or Management? *Issues in Science and Technology*.

Mishel, L., & Bernstein, J. (1995). *The State of Working America, 1994-95*. Armonk, NY: M. E. Sharpe.

Mishel, L., Bernstein, J., & Schmitt, J. (1999). *The State of Working America, 1998-99*. Ithaca, NY: Cornell University Press.

Mount, M.K., & Barrick, M.R. (1998, Winter). Five Reasons Why the 'Big Five' Article Has Been Frequently Cited. *Personnel Psychology, 51* (4).

Murnane, R., Willet, J., & Levy, F. (1995, May). The Growing Importance of Cognitive Skills in Wage Determination. *Review of Economics and Statistics*.

Murphy, K.M., & Welch, F. (1993, May). Occupation Change and the Demand for Skill, 1940-1990. *AEA Papers and Proceedings, 83* (2).

National Center for Education Statistics, U.S. Department of Education. (2001). *The Condition of Education.* Washington, DC: U.S. Government Printing Office.

National Center for Education Statistics, U.S. Department of Education. (2000). *Digest of Education Statistics*. Washington, D.C.: U.S. Government Printing Office.

Neisser, U. (Ed). (1998). *The Rising Curve: Long-Term Gains in IQ and Related Measures*. Washington, D.C.: American Psychological Association.

Neumark, D. (2000). Changes in Job Stability and Job Security: A Collective Effort to Untangle, Reconcile, and Interpret the Evidence. In David Neumark (Ed), *On the Job: Is Long-Term Employment a Thing of the Past*. New York: The Russell Sage Foundation.

Office of Technology Assessment. U.S. Congress. (1990). *Making Things Better: Competing in Manufacturing*. OTA-ITE-443. Washington, D.C.: U.S. Government Printing Office.

Organization for Economic Co-operation and Development, Centre for Educational Research and Innovation. (2001). *Education at a Glance: OECD Indicators 2001*. www.oecd.org.

Organization for Economic Co-operation and Development, Centre for Educational Research and Innovation. (1995). *Literacy, Economy, and Society: Results of the first International Adult Literacy Survey.* Ottawa, Canada: Statistics Canada.

Porter, M.E. (1998). Clusters and Competition: New Agendas for Companies, Governments, and Institutions. In *On Competition.* Boston: Harvard Business School Press.

Roey, S., Caldwell, N., Rust, K., Blumstein, E., Krenzke, T., Legum, S., Kuhn, J., & Waksberg, M. (2001). *The High School Transcript Study Tabulations: Comparative Data on Credits Earned and Demographics for 1998, 1994, 1990, 1987, and 1982 High School Graduates*. NCES 2001-498. U.S. Department of Education, National Center for Education Statistics. Washington, D.C.: U.S. Government Printing Office.

Romer, P.M. (1990, October). Endogenous Technological Change, Part 2: The Problem of Development: A Conference of the Institute for the Study of Free Enterprise Systems. *Journal of Political Economy, 98* (5).

Rosenzweig, M.R.(2000). Schooling, Learning, and Economic Growth. In Ray Marshall (Ed), *Back to Shared Prosperity: The Growing Inequality of Wealth and Income in America*. Armonk, NY: M. E. Sharpe.

Seligman, M.E.P. (1998). *Learned Optimism: How to Change Your Mind and Your Life*. New York: Pocket Books.

Schooler, C. (1998). Environmental Complexity and the Flynn Effect. In Ulric Neisser (Ed), *The Rising Curve: Long-Term Gains in IQ and Related Measures.* Washington, D.C.: American Psychological Association.

Shapiro, R.J. (1998). The Economic Power of Ideas. In Jerry J. Jasinowski (Ed.), *The Rising Tide: The Leading Minds of Business and Economics Chart a Course Toward Higher Growth and Prosperity.* New York: John Wiley & Sons, Inc.

Tett, R.P., Jackson, D.N., & Rothstein, M. (1991, Winter). Personality Measures as Predictors of Job Performance: A Meta-Analytic Review. *Personnel Psychology, 44* (4).

Tett, R.P., Jackson, D.N., Rothstein, M., & Reddon, J.R. (1994, Spring). Meta-Analysis of Personality-Job Performance Relations: A Reply to Ones, Mount, Barrick, and Hunter. *Personnel Psychology, 47* (1).

Topel, R.H. (1997, Spring). Factor Proportions and Relative Wages: The Supply-Side Determinants of Wage Inequality. *The Journal of Economic Perspectives, 11* (2).

Topel, R.H. (1998). Labor Markets and Economic Growth. Forthcoming in Orley Ashefelter and David Card (Eds), *Handbook of Labor Economics*. Amsterdam, The Netherlands: Elsevier Science B.V.

Zuboff, S. (1988). *In the Age of the Smart Machine: The Future of Work and Power*. New York: BasicBooks.

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Endnotes

1 Education, training, and technology tend to be sequential and complementary in producing productivity and earnings. The career and earnings advantages of the sequence of academic, occupational, and work-based learning accumulate rapidly. Higher levels of formal education not only increase access to jobs with training, they also increase access to technology that complements rather than replaces skills. More highly educated workers use technologies that increase worker autonomy and complement skill—for instance, desktop computers and flexible machine tools. To some extent, education, training, and technology can be substitutes as well as complements for one another. Technology can substitute for both education and training by deskilling jobs. Less educated workers tend o use technology that reduces the level of skill required—for instance, cash registers with pictures of foods on keyboards rather than numbers. Narrow training can substitute for broader educational deficiencies, although it does not provide longer-term adaptability, especially if narrow tasks are automated or shifted offshore.

2 Comparisons among OECD countries show that the level of education does not have a significant effect on growth (Krueger and Lindahl, 1999). However, in less developed countries that are "in transition," levels of education may be a more important determinant because very low levels of education stocks make it difficult to implement complex growth-inducing technologies and productivity-enhancing

practices (Rosenzweig, 2000).

3 Krueger and Lindhal (1999) find that these returns are "at least as much as" the increase in the individual returns to schooling, which are about 5 to 15% for each additional year of schooling.

4 The notion that skill requirements are growing and that people are becoming more skilled is a safe bet. The value of knowledge has increased inexorably for roughly 3,000 years since early efficiencies in agriculture provided food surpluses that freed up human labor for more complex tasks (McNeil, 1999). Increasing complexity requires more formal teaching and learning. At the same time, daily life and work in environments of growing complexity also enhance knowledge and reasoning ability as we learn by doing (Schooler, 1998; Greenfield, 1998; Neisser, 1998). The empirical evidence of the synergy between social complexity and new learning ability is that the performance on standardized tests of human reasoning power has been rising about three points every decade ever since testing began early in the 1900s. For instance, the average scores for Americans taking the Wechsler-Binet or the Stanford reasoning test has increased by 15 to 25 points since 1918 (Neisser, 1998). In Great Britain, scores on the Raven Progressive Matrices test of abstract reasoning show that score levels that included the bottom 90 percent of the population born in 1877, include only the bottom 5% of the population born in 1967 (Flynn, 1998). These increases in basic reasoning ability have occurred in spite of the fact that the highest fertility rates persist among the lowest scorers. Although the dispersion in the scores is not changing, scores are rising at similar rates across the board.

5 The phrase "at least some college" as well as the term "college-educated" includes all those who have had coursework that leads to two-year or four-year degrees, including both those who attain a degree as well as those who pursue college coursework but do not attain a degree.6 We first heard this phrase in conversation with Hans Meeder, Deputy Assistant Secretary, Policy and Planning, Office of Vocational and Adult Education, the U.S. Department of Education.

6 Trade is another factor that both eliminates and creates jobs both on the production line and managerial and professional jobs in manufacturing. Of the 20 million jobs lost to trade, about 3 million were probably lost to trade and the other 17 million were lost to productivity improvements. Jobs lost to trade tend to be low-skilled low-wage jobs. Jobs gained from trade tend to be more highly skilled and highly paid, both in manufacturing and in the economy on the whole. The globalization of competition for low-skilled jobs, especially in manufacturing, holds down wages of low-skilled workers. Some estimates suggest that trade accounts for as much as 30% of the increase in wage disparities since the 1970s. Ultimately, however, trade affects wages more than the number of jobs. Trade tends to drive down the earnings of low-skilled labor and increase the relative earnings of skilled workers in manufacturing and in the economy on the whole.

7 We first heard this phrase in conversation with Hans Meeder, Deputy Assistant Secretary, Policy and Planning, Office of Vocational and Adult Education, the U.S. Department of Education.

8 Prime-age workers include those aged 30 to 59.

9 A debate exists over the extent to which skills and skill requirements have increased in the economy. Different measures of skills—direct measurement, wage inequality, and skills gaps—often result in different outcomes (see Cappelli, 1993 and 1996 for a review of this literature). However, the balance of the literature that examines wage inequality and supply and demand shifts concludes there has been an increase in skill requirements in the economy (Autor, Katz, and Krueger, 1997; Katz and Autor, 1999; Katz and Murphy, 1992; Murphy and Welch, 1993; Goldin and Margo, 1992; Juhn 1999; Levy and Murnane, 1992; Johnson, 1997; Topel, 1997; Gottschalk, 1997). The literature that emphasizes skill measurement concedes that there has been an increase in skill requirements, although some argue the changes are not exceedingly large and have slowed dramatically since 1960 (Judy and D'Amico, 1997; Mishel and Teixeira, 1991; Mangum, 1990; Barton, 2000). The evidence on upskilling within specific occupations is mixed with some evidence to support the thesis and additional evidence that upskilling in some occupations is offset by deskilling in others (Cappelli, 1993; Mishel and Teixeira, 1993).

10 Although there is much discussion about the importance of technology employment, it is rarely carefully defined. This document defines technology jobs to include only those jobs that are heavily science-based and/or utilize specialized machinery and equipment. These jobs either require at least a bachelor's degree (e.g., engineers, chemists, architects, computer system analysts, etc.) or some specialized postsecondary education or training (e.g., computer programmers, medical and other technicians, cad-cam operators, etc.). Virtually, all workers today have some contact with technology, especially information technology, but the definition of high-technology workers used in this paper limits their number to those with some special expertise, education, and training.

11 This derives from new thinking in cognitive psychology in response to the failure of behaviorism—the notion that people were purely products of their environments—and the Freudian emphasis on deep-seated sexual drives to explain behavior. After 1967, with the publication of Ulric Neisser's *Cognitive Psychology,* psychologists began to argue that human actions could be better understood by examining

the way people processed information, using advances in computer information processing as a relevant model.

12 Studies on personality also show that some personality traits correlate with success on the job. For example, "conscientiousness" correlates positively with job performance, the ability to learn on the job, and positive personnel data such as low absentee rates. While the relationship between "positive cognitive style" and "conscientiousness" is not well established, it seems logical that cognitive styles are among the mediating forces that determine successful traits like "conscientiousness." (For a meta-analysis of the effects of "personality dimensions" on job performance and learning see Barrick and Mount, 1991; Mount and Barrick, 1998; Tett, Jackson, and Rothstein, 1991; Tett et al., 1994.)

13 The available evidence and old-fashioned common sense suggests that the feelings of helplessness that underlie a negative cognitive style are a learned behavior subject to environmental influences (Seligman, 1998). If those subjected to persistent negative feedback in their interactions with the world learn to perceive failures as "persistent, pervasive, and personal," this can lead to "learned helplessness" unless extraordinary compensatory support is provided.

14 The New Basics recommended by the National Commission on Excellence in Education (1983) include four years of English, three years each of mathematics, science, and social studies, and one-half year of computer studies.

15 Of the 1,184,000 bachelor's degrees conferred in 1998, 33,000 were conferred in the liberal arts and sciences, general studies, and humanities. In 1998, there were 12,000 bachelor's degrees awarded in math but, in the same year, there were 233,000 bachelor's degrees awarded in business; 17,000 bachelor's degrees awarded in parks, recreation, leisure, and fitness studies; 50,000 in communications; 52,000 in the visual and performing arts; 17,000 in home economics; and 25,000 in protective services (NCES, 2000). The same pattern is reinforced in the expansion in applied subbaccalaureate associate degrees, certificates, certifications, and customized training (Carnevale and Desrochers, 2001). Of the 555,000 associate degrees conferred in 1996, 115,000 were conferred in the liberal arts and sciences, general studies, and humanities, and only 758 were conferred in mathematics (NCES, 2000).

16 Of the remainder, 15% was attributed to increases in plant and equipment, 10% was attributed to greater economies of scale, and the final 10 percent was attributed to shifts and more efficient use of labor and capital (Shapiro, 1998; Denison, 1984).

17 Using data from the International Study of Adult Literacy shows that workers in Sweden have the following distribution of skills: Level 1 (lowest): 5%; Level 2: 17%; Level 3: 40%; and Level 4/5 (highest): 38 percent. In contrast, the distribution of workers' skill in the United States is much lower: Level 1 (lowest): 16%; Level 2: 24%; Level 3: 33%; and Level 4/5 (highest): 27 percent (OECD, 1995). To estimate the increases in GDP and taxes that would occur if we had a skill distribution similar to Sweden, we first calculated the number of workers in the United States in each skill level, and second, applied the distribution of skill in Sweden to the total number of workers in the U.S. to estimate how many workers would fall in each skill level if the United States' skill levels resembled Sweden. Taking both of the distributions, we multiplied the average earnings of U.S. workers in each skill level by the number of workers in each level, and summed to get aggregate earnings. The difference in aggregate earnings using the U.S. and Sweden distributions provides an estimate of the potential increase in GDP. We then multiplied the estimated increase by 35% to capture the additional federal, state, and local taxes that would be paid by these more skilled workers.

18 Among the 25- to 64-year-old population, the United States still has the largest secondary education completion rate.

19 Japanese students are among the front-runners in international tests. But the average purchasing power of American families is 40% greater than the average purchasing power of Japanese families. In general, members of the European Union outperform us on international tests. But in 1996, the U.S. gross domestic product per capita towered over that of the European Union nations¾$27,800 versus $19,300. During the same period, U.S. unemployment has been consistently less than half the European level.